# Promoting Green Power in Canada

## Green Power Policies: A Look Across Borders


Prepared by:
Martin Tampier

for:
Pollution Probe


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It is with great pleasure that Pollution Probe brings you this report on Promoting Green Power in Canada. At this critical point in the debate about ratifying the Kyoto Protocol, it is essential that the public understand the solutions that can be implemented to reduce our emissions of greenhouse gases and to lessen the impact that electricity generation has on environmental quality in general.

This report contains an in-depth review of green power policies in jurisdictions outside Canada. It documents the successes and failures of green power marketing and incentives, and explores the implications for Canada of undertaking similar initiatives here. A number of valuable lessons have been learned elsewhere in the world, and Canada should take advantage of the knowledge and experience gained by others as we embark on our own green power pathways.

Pollution Probe is dedicated to making positive, tangible progress on reducing greenhouse gas emissions and improving the quality of the environment for ourselves and for future generations. We are grateful to Martin Tampier, the principal researcher and writer of this report, for the tremendous effort he put into making this a major contribution to the Green Power debate in Canada.

Ken Ogilvie
Executive Director

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# List of Acronyms

| | |
|---|---|
| CHP | Combined Heat and Power |
| CRCE | Canadian Renewable Conservation Expense |
| DER | Discrete Emission Reduction |
| EPA | Environmental Protection Agency (US) |
| EPS | Emission Performance Standard |
| EPT | Energy Payback Time |
| EU | European Union |
| GP | Green Power |
| GPS | Generation Performance Standard |
| IPP | Independent Power Producer |
| IRR | Internal Rate of Return |
| NFFO | Non-Fossil Fuels Obligation |
| NFPA | Non Fossil Purchasing Agency |
| NRCan | Natural Resources Canada |
| PV | Photovoltaic |
| REC | Renewable Energy Certificate |
| RFP | Request For Proposal |
| ROC | Renewables Obligation Certificate (UK) |
| ROO | Renewables Obligation Order |
| RPS | Renewable Portfolio Standard |
| R&D | Research and Development |
| SBC | System Benefits Charge |
| WPPI | Wind Power Production Incentive |

# Executive Summary


This report examines and assesses policy initiatives in countries that have implemented strategies to promote the development of green power markets and renewable electricity generation capacity. The report contains a large amount of information on policies and incentives that may be effective and appropriate for implementation in Canada.

The research included documenting and analyzing literature on the subject, exchanging information via targeted e-mails, and making phone calls to a number of experts in the field. In addition, in-house research was carried out by Pollution Probe in order to apply the study findings to the Canadian renewable energy situation.

The key findings of the report are:

- Canada has a large resource base upon which to produce renewable power. Many renewable power projects would be feasible at 2 cents per kilowatt hour above the price of electricity from combined cycle natural gas plants.
- Many options to bridge this financial gap could be implemented by Canadian governments. For example, providing tax incentives or increasing and broadening the Wind Power Production Incentive could reduce the price of renewable electricity enough to make it competitive with conventional energy sources.
- Voluntary initiatives, such as green power marketing or green pricing, have important roles to play, but have limited effects on the deployment of new renewable energy generation capacity.
- Meaningful and stable policies, such as a Renewable Portfolio Standard, are necessary to create long-term markets for renewable power. These policies need to be accompanied by other measures or incentives to be successful — no single policy can overcome all of the barriers to causing a shift in Canada's energy planning.

The main recommendations are:

- The federal government should set a national renewable energy portfolio target, which can be achieved through cooperation with provincial policies, such as provincial renewable portfolio standards and renewable energy certificate trading.
- The federal government should increase the Wind Power Production Incentive and broaden it to include all non-large hydro renewable power technologies, so as to match or surpass the support that such projects enjoy in the United States.
- Additional financial measures, such as broadening the Canadian Renewable Conservation Expense to include capital investment cost, are highly recommended in order to make the renewable power sector financially more viable.
- To facilitate the development of renewable energy sources, a national effort is needed to identify Canada's potential renewable energy sources.

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**Appendices**

# 1. Background and Purpose

Canada has traditionally had a relatively low-carbon electricity generation portfolio, with more than 60% of its electricity supply provided by large hydro facilities. Over the past two decades, many industrialized countries have started to shift towards new renewable power sources, with wind power taking the most eminent position. With provincial power market openings in Alberta and Ontario, customer choice and green power has also entered the Canadian arena. However, Canada is lagging behind international developments concerning green power and only produces about 2.8% of its electricity from renewable sources other than large hydro, with currently few incentives provided to change this situation.

This study looks at policies that are being used in the United States, Australia, the UK, and Europe in order to promote renewable electricity production. Important lessons can be learned from these countries, and the implementation of progressive policies in Canada can help put this country among the top players in this new economic field.

A large number of research and guidance documents from the US EPA and other sources have been reviewed and evaluated in this study. Special attention was given to emissions trading and renewable power set-asides, feed-in tariffs as they are used in European countries, and tendering schemes, such as the former UK Non-Fossil Fuel Obligation. In addition, existing Renewable Power Portfolio Standard (RPS) Policies, including the UK's New Renewables Obligation and the Texas and Australian policies, are examined in this study.

New approaches, such as green tags, which represent the environmental and social benefits of green power-generated electricity detached of the basic "null electricity" service, are beginning to shape markets in the US, with VisionQuest, Inc. (Alberta) being the first company to offer them in Canada. Green tags may play an important role in fostering the construction of new renewable power plants in Canada. An early evaluation of opportunities and problems with green tags is provided in this report.

It is important to reach agreement within Canada on Green Power (GP) definitions and certification requirements, and to understand consumer expectations, in order to avoid mistakes made in other jurisdictions when introducing GP products. Comments on Environment Canada's *Guideline on Renewable Low-Impact Electricity* have been collected, feeding into the Canadian *Environmental Choice* certification process. These comments indicate that the definition of "green" power is not yet a decided issue. Work is still needed on developing a Canadian definition, which could also contribute to achieving international consensus over the coming years.

This study complements a 2002 study commissioned by Environment Canada and carried out by the Pembina Institute, which focused on existing GP initiatives in Canada.

Exchange rates for the Canadian dollar versus the currencies examined in this report have varied substantially even while it was written. The following rates have been used for convenience and represent trends observed during recent years:

| | |
|---|---|
| 1 (US) $ | C$1.60 |
| 1 € | C$1.40 |
| 1 £ | C$2.25 |
| 1 (AUS) $ | C$0.85 |

# 2. What Really is a "Green" Power Source?

## 2.1 Terms and Acronyms

Three main terms are used to describe power sources different from conventional energy sources that have sustained modern industrial economies: alternative power, renewable power, and green (or clean) power. These terms are not equivalent. For example, although large hydro is a renewable power source, it is often excluded from renewable sources in a green power marketing context because it is seen as a mature technology that does not need to be supported by green premiums. Renewable power sources may not be the same as "green" power sources since they can have important negative environmental impacts that would disqualify them from being considered green.

A variety of products are currently sold under the "green power" label. The energy sources mentioned in the list of terms below represent today's commercially available and proven technologies, as well as emerging technologies, such as ocean energy.

**Conventional power sources —** nuclear, coal, oil and gas-fired power stations, large hydro.

**Alternative power sources —** other sources than conventional energy sources.

**Renewable power sources —** wind, solar, hydro, geothermal, ocean energy, biomass.

**Ocean energy —** tidal energy (water stored from high tide and flowing through a turbine at low tide) and wave energy (energy generated from the movement of waves).

**Biomass —** a wide variety of fuels have been included under this heading: fuels extracted from specially grown oil seeds (energy crops); agricultural waste; biogas from controlled fermentation processes; landfill gas; waste-to-energy; wood waste; sewage sludge incineration; etc.

**Solar power —** photovoltaic energy (direct conversion of sunlight into electricity) and thermal solar (electricity generated from heat created by sunlight).

**Hydro power —** large hydro (larger than 30 MW), small hydro (1 MW to 30 MW), mini hydro (<1 MW), and micro hydro (<10kW); the threshold from small to large hydropower is generally defined as somewhere between 20 and 30 MW.

**Existing power sources —** power stations in operation before a given base year.

**New power sources** — power stations in operation since, or after, a given base year.

**Negawatts/energy savings —** a concept developed by the Rocky Mountain Institute, representing energy consumption avoided through energy efficiency or energy saving measures; negawatts can be viewed as an energy source as the unconsumed energy is free for use in other applications.

**CHP —** combined heat and power, also called cogeneration.

**Trigeneration —** CHP in the cold season plus cooling/air conditioning in the hot season.

As of today, there is no official definition of terms such as "renewable" or "green." It will be crucial for Canada and other countries to develop clear definitions of these terms, both in energy and health policy contexts and with respect to power marketing and labelling. These definitions will become especially important at the international level if green power certificates are traded among countries.

## 2.2 An LCA-Based Comparison of Power Sources

Whereas conventional energy sources are known for their polluting emissions (e.g., coal, oil, gas) or their safety and waste problems (nuclear), alternative energy sources can also have negative environmental impacts. One method used to compare the relative impacts is life-cycle analysis (LCA), which looks at impacts from the manufacture, construction, use and decommissioning of energy production plants. Some environmental impacts can be quantified and compared, others can only be evaluated on a qualitative basis. The information contained in this chapter will help the reader understand the "greenness" of alternative energy sources.

**Box 2.1 — Literature on Connected Issues**

For a description of the harmful effects of smog-causing pollutants, see The Smog Primer at **www.pollutionprobe.org/ Publications/ Air.htm**.
For a description of the harmful effects of mercury, see The Mercury Primer at **www.pollutionprobe.org/ Publications/Mercury.htm**.
For a description of some renewable energy sources and technologies, see UNEP's technology fact sheets at **www.uneptie.org/energy/act/re/fs/**, and see The Renewable Energy Technologies Primer at **www.pollutionprobe.org/ Publications/Energy.htm**.

### *2.2.1 Emissions of $CO_2$, $SO_2$ and $NO_x$*

Energy-related emissions include carbon dioxide ($CO_2$), nitrogen oxides ($NO_x$), sulphur dioxide ($SO_2$), particulates, volatile organic compounds (VOCs), and mercury. Comparative data were only available for the first three types. Emissions are compounded over the whole life cycle of a plant, including construction and decommissioning.

As renewable power sources are added to the grid, they influence power generation from existing, often fossil fuel-based, sources. The changes in operation due to the addition of sources with variable outputs, such as wind or solar, lead to additional emissions that may not otherwise occur. These are called back-up emissions. The inclusion of back-up emissions increases the emissions ascribed to the renewable sources. If the use of renewable power leads to the replacement of fossil fuel-based energy generation. the back-up emissions will eventually be reduced as more low-emission sources get on the grid. Back-up emissions have been left out of the following discussion of the environmental impacts of power sources.

Figure 2.1 compares life-cycle air emissions from different energy sources. Air emissions from alternative energy sources are generally lower than those from conventional sources. Only nuclear technology has air emissions as low as renewable power sources. Natural gas contains little or no sulphur and therefore causes essentially no $SO_2$ emissions. So-called "clean coal" technology is now being proposed and can reduce emissions to levels closer to, but still higher than, those of natural gas and renewable power sources through technologies such as fuel cleaning and gasification (clean coal technologies include, for example, Fluidized Bed, Integrated Gasification Combined Cycle Technology and Low-Emission Boiler Systems).

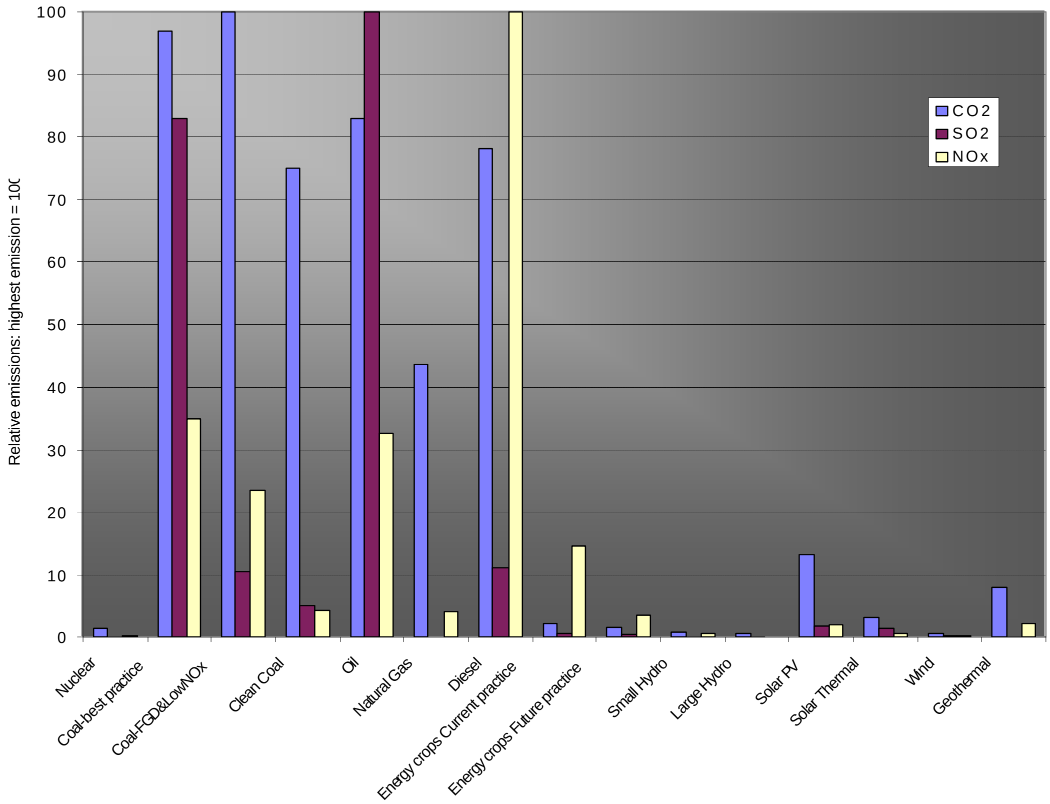



**Figure 2.1 — A Comparison of Air Emissions from Different Electricity Generating Sources**
(N.B.: emissions of different pollutants have different orders of magnitude; see Appendix A for exact values)

$CO_2$ emissions from photovoltaic energy production are currently of the same order of magnitude as those from gas-fired power plants. This will change in the future, as the current technology is based on printed circuit board technology, which entails high greenhouse gas emissions, and will be replaced by a less greenhouse gas intensive process [HQ 2002c] (see “current” and “future” in Figure 2.2). Also, gas produces no or very little $SO_2$ emissions and has life-time NOx emissions close to those of photovoltaics and other renewable sources. The emissions from photovoltaic energy generation are mainly due to the energy-intensive production of photovoltaic panels, currently still manufactured using mainly fossil fuel-based power generation (mostly coal). There are also some problems with geothermal energy. Geothermal plants emit important amounts of non-condensable gases, among which $CO_2$ is a major concern. $CO_2$ is set free from the deep rocks when water or brine is pumped through wells to be heated up, and then returns with the water through a second well. $CO_2$ emissions can be reduced by more than 90%, however, through reinjection of the heated fluid in a circuit. Finally, NOx emissions from energy crops are elevated in comparison to other alternative energy sources, since the energy is produced through combustion. Again, these emissions can be considerably reduced through the use of gasification technologies, in which biomass is partially burned to produce a combustible gas composed of carbon monoxide, hydrogen, methane and carbon dioxide. This low calorific value gas is then burned in either gas engines or gas turbines. Gasification plants based on gas engines have been demonstrated and are now becoming available commercially. For better comparability, Figure 2.2 leaves out conventional energy sources.

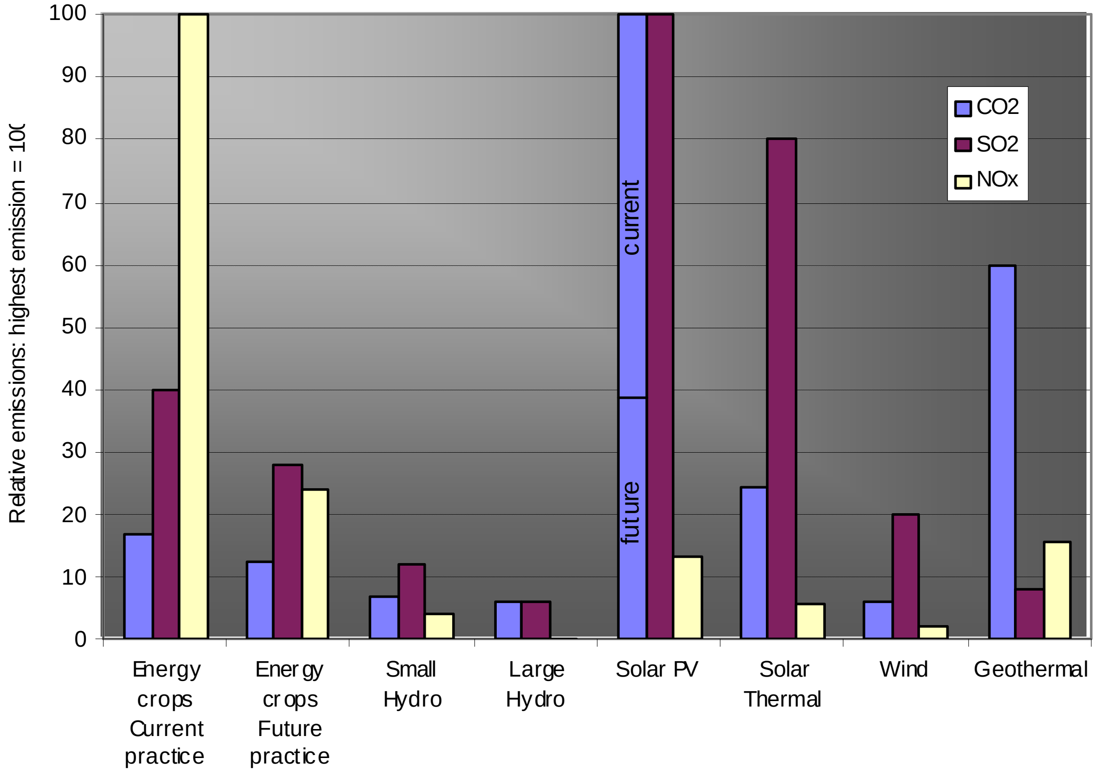



**Figure 2.2 — A Comparison of Air Emissions from Alternative Electricity Generating Sources** (close-up of a section of Figure 2.1)

Figures 2.1 and 2.2 show that large hydro plants outperform all other energy sources with respect to life cycle air emissions, closely followed by small hydro, nuclear and wind. This means that total emissions might increase in some provinces if such plants were to be replaced by other alternatives. However, the possibility of displaced carbon sequestration in forests or plants by flooding caused by dams has not been included in these figures and can alter the picture, especially if large areas are affected by dams.[1] The carbon emissions of certain wave energy plants have been estimated to be 25g/kWh, thus equal to those of energy crops, but higher than, for example, hydropower or wind [PT 2001, p. 10].

Although all renewable power sources perform better than fossil fuels from a $CO_2$ perspective, other emissions can be important and, in some cases, are higher than those of conventional sources. This is especially true for biomass energy.

Concerning mercury emissions, very little information is available on alternative energy sources. It can be safely assumed, however, that mercury emissions from most renewable power sources are several orders of magnitude lower than those of coal-fired plants or municipal waste incineration. However, biomass-based generation emits similar levels of mercury as coal-fired plants (with carbon filters), oil and gas-fired plants [IEA 2000, p. 77].

As renewable power sources gain a larger market share, life-cycle emissions from the construction of energy plants will be reduced, which is especially important for photovoltaic energy, which creates most of its emissions during the production phase. This aspect of attributing emissions based on the current energy mix can be overcome by another evaluation parameter, the Energy Payback Time.

### *2.2.2 Energy Payback Time (EPT) and Energy Payback Ratio (EPR)*

The EPT is based on the number of years needed for a given plant to make up for the energy consumed during its manufacture and construction, as well as during its own use. The EPT is the amount of time it takes for the plant to produce a positive net energy output beyond the amount needed for its construction and operation.

A similar ratio to the EPT, called the EPR, can be calculated as a $CO_2$ breakeven point, instead of one related to energy production and consumption. EPT is generally used to avoid the controversy arising from trying to determine the quantity of $CO_2$ emissions an alternative energy source can displace — as such displacements are calculated based on the existing energy mix, which can be shifted towards less greenhouse gas intensive sources through green power promotion policies. The energy breakeven point does not depend on the composition of the background mix and therefore helps determine the most energy-efficient technology for a long-term energy strategy.

Figure 2.3, with values calculated for North America, shows that the energy payback ratios for hydro-based energy sources are far superior to those of all other options. The other conventional and renewable power sources have similar ratios, with wind and forestry residues having a slight advantage. Intermittent sources are singled out as needing back-up power for power management purposes. Other sources, such as large hydro or natural gas, need to be used to fill in for these sources when they do not produce enough electricity (e.g., due to lack of wind), so during those periods the EPRs of the back-up technology used would apply.

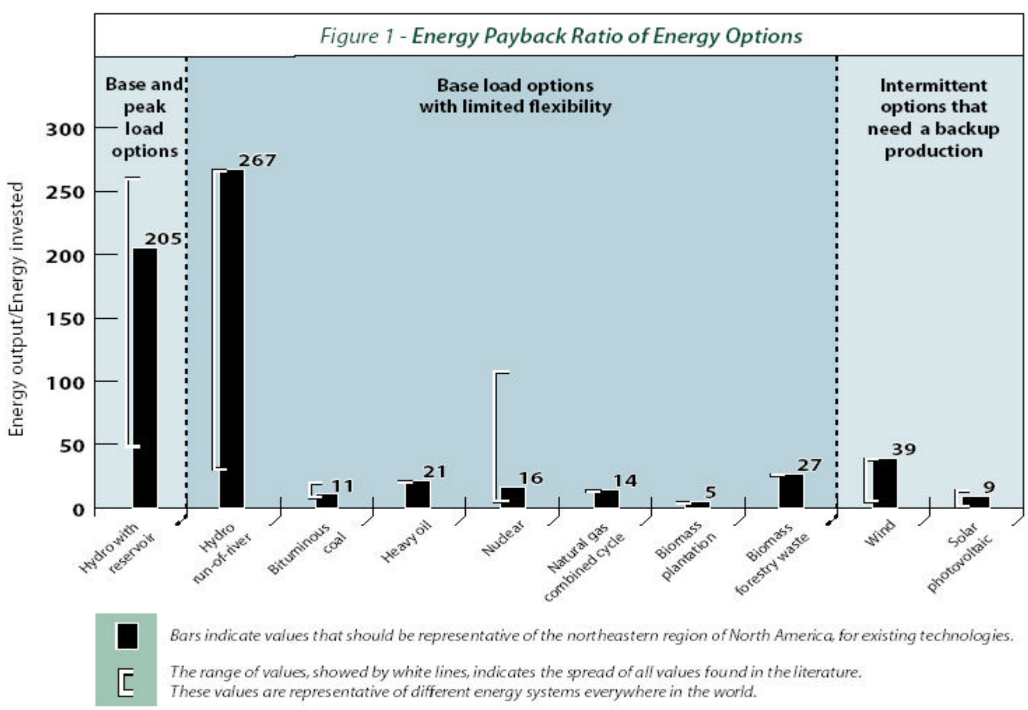



**Figure 2.3 — Comparison of Energy Payback Times of Different Technologies** [HQ 2000]

Solar PV is found to be one of the least performing options. The EPT for solar PV depends on the technology used and where it is used (i.e., local solar radiation intensity and duration). The EPT has been estimated by one source at 10 years for monocrystalline, 3–5 years for polycrystalline, and 0.5–2 years for a-Si solar PV modules [GEF 1996, p. 37]. A more recent study found EPTs of 4.1 years for monocrystalline and 2.2 years for thin film modules, at an energy output of 1.7 MWh per $m^2$ per year, and the authors estimate that a further 30% reduction is possible through improved production techniques [KNAPP 2000]. As energy needed for the manufacture of transmission lines is not included in these calculations, grid-integrated solar panels may enjoy a further EPT reduction in comparison to technologies that require new transmission lines to be built to deliver their electricity to the power grid.

### *2.2.3 Water and Land Use*

Hydro power uses water to store energy, influencing the natural course of waterways and biological processes or ecosystems (e.g., salmon runs, wetlands). Other energy sources need water for cooling purposes, again influencing conditions in waterways or lakes.

Land use varies depending on how diffuse a form of energy is. Solar energy, for example, requires a much larger surface than a gas power plant in order to produce a given amount of energy. Giving the typical surface used by a power generating plant in $m^2$ per kWh does not, however, reflect the kind of use. For example, a gas power plant does not leave any space for biodiversity on its premises; a wind power plant may use a lot more space per kWh, but will allow for secondary uses of the area around the wind turbines, such as

**Table 2.1 — Water and Land Use for Different Energy Generating Sources**

| Power Source | Land Use [ha/1000 GWh annual] | Water Use [$m^3$/GWh] |
|---|---|---|
| Nuclear | 48 | 3.6–5.7 (consumptive)<br>995,000 (non-consumptive) |
| Coal | 363 | 2.8–4.3 (cons.)<br>730,000 (non-cons.) |
| Natural Gas | 25–200 | 1.1 (cons.)<br>730,000 (non-cons.) |
| Oil | 25–200 | 1.3 (cons.)[1] |
| Waste-to-Energy | 445 | No data available[1] |
| Forest surface set aside for sustainable forestry | 132,000–220,000 | 11.8 |
| Energy crops | 60,000 | >11.8 |
| Large Hydro | 75,000 | 2,700,000–33,600,000;<br>average: 16,100,000 |
| Small Hydro | Run-of-river: 28 | 81,500,000 |
| Solar PV | 2,000 | 0.14 |
| Solar Thermal | 250 | ~4.2 |
| Wind | 11,666 total<br>233 actual | 0 |
| Geothermal | 3,750 | 0 |

[1] *Cooling water consumption for oil and waste-to-energy combustion are assumed to be in the same range as that of coal and natural gas.*

cattle grazing (see actual/total in the table below). Table 2.1 compares water and land uses for different energy options. The sources for this table are disclosed in Appendix A.

Concerning land use, energy crops are by far the most land consuming. Large hydro, and by the same measure also small hydro if it is not run-of-river, comes second, followed — with a large gap — by wind energy. Wind turbines require a large surface area, but actually only occupy a small percentage of it, leaving opportunities for other uses. Geothermal and solar PV still need large surfaces in comparison to fossil fuel-based sources, which require less surface area than any other source except solar thermal or run-of-river hydro facilities.

In terms of water use, fossil fuel-based installations are on the higher end due to cooling water consumption. A hydro plant uses up to a hundred times more water than a fossil plant, but it does not affect the temperature of the water. On the other hand it can be argued that large hydro plants provide beneficial water uses due to recreational value for boating and fishing, and they can serve as drinking water reservoirs and help with flood control management.

It is difficult to compare the environmental effects of changes in river flow patterns and fish migration caused by the water use of hydro plants with the temperature increase in rivers due to warmer cooling water discharges from fossil fuel-based plants (or diminished flows in case cooling towers are used). It should also be noted that the consumptive use of water by fossil fuel-based sources is several magnitudes lower than the non-consumptive use by hydro plants. Water consumption for wood-fired steam electric plants is low, but biomass energy can require larger water inputs if the irrigation of energy crops is involved. Solar energy requires minimal water inputs (solar PV for production only) and wind and geothermal plants hardly require any extra water to function.

However, groundwater can be depleted under certain circumstances in high temperature geothermal fields. A cold groundwater zone usually overlays most such systems and, in certain cases, cold water may flow downwards into the field, leading to a drop in the groundwater level. This effect can be avoided by maintaining the reservoir pressure. The groundwater level may also fall as a result of breaks in the casing of unused wells, but the effect of this can be minimized by monitoring the condition of the wells and repairing them promptly [IEA 1998a].

### *2.2.4 Other Factors*

Some aspects of energy sources, such as availability, public acceptance and certain ecological impacts, cannot be quantified, but will often play a role in national and regional renewable power policies and local permitting practices. For example, bird kills and noise are often linked to wind power. However, there is a general trend in the wind energy industry to replace small turbines by larger, slower-turning (less noisy) turbines, which reduce bird kills. Recent studies performed by the California Energy Commission demonstrate that bird kills in the Altamont Pass — where the state agency estimated an average of 40 golden eagle deaths occur annually — is an anomaly. At both the Tehachapi and San Gorgonio wind farm sites, bird kills of any sort are few and far between [CEERT 2002]. The visual impact of wind parks is large, but local acceptance will be influenced by ecological thinking and identification of local people with green power projects (e.g., Denmark encourages financial participation of local people in such projects). Ocean energy is still at the pilot stage, and whether or not it has ecological drawbacks is not fully known, but there are concerns about fish mortality and changed flow patterns at tidal barrage power plants. The problems linked to hydropower, such as its impact on fish migration and flooding patterns, are well known, but are much reduced with smaller operations currently discussed as being "green." All types of biomass combustion lead to air emissions, but the ecological impacts of biomass use for energy production, compared to composting and other such uses, has not been exhaustively analysed.

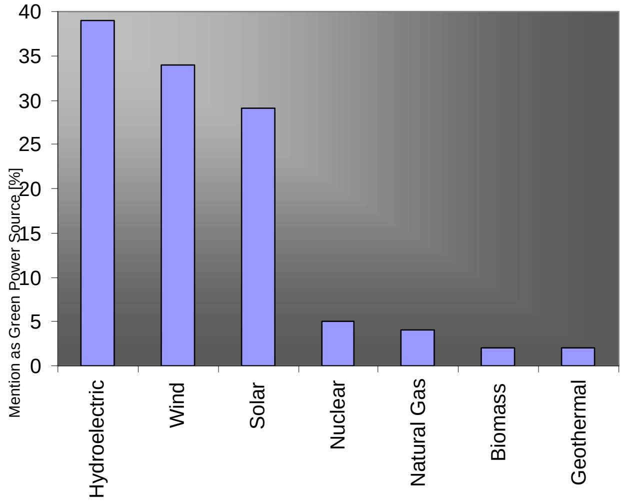



**Figure 2.4 – Total Mentions in Percent of Technologies thought of as Green Power Sources** [ENV 1999]

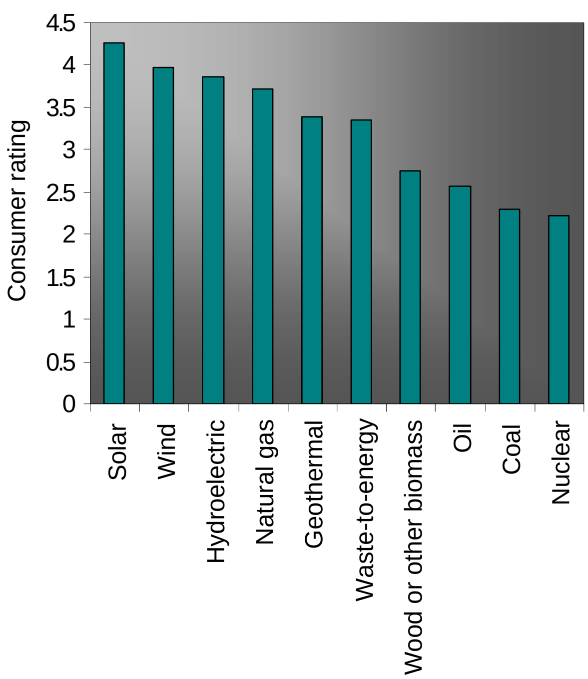



**Figure 2.5 — US Consumer Survey Results on Consumer Rating of Energy Sources** [NCCEI 1998]

### *2.2.5 How Consumers Rank Energy Sources*

A 1999 Environics survey showed that many Canadians name hydropower among green power sources, followed by wind and solar. Fewer people name biomass or geothermal energy, and some include nuclear power and natural gas among green power sources (see Figure 2.4). Many of those interviewed (40%) could not identify any green power sources by themselves. A BC government survey of public opinion published in September 1998 resulted in the following ranking of alternative energy sources: solar energy – wind power – tidal energy – small hydro – large hydro – biomass [BC 1998]. For another survey carried out among consumers across the United States in 1997, consumers were asked to rank energy sources according to environmental performance on a scale from 1 to 5. While solar and wind again scored best, hydro came directly afterwards (small and large hydro were not distinguished), followed by natural gas. Geothermal was less popular than natural gas, and waste-to-energy was ranked nearly equally with geothermal. Biomass energy was only slightly preferred over oil. Coal and nuclear were clear losers (see Figure 2.5).

### *2.2.6 Prices of Energy from Different Sources*

The price of energy will clearly be a key factor determining Canada's energy future. Figure 2.6 compares electricity prices from different sources. The sources of information for this figure are disclosed in Appendix B-1. As the comparison shows, while conventional energy sources are still the cheapest, the price difference is shrinking and many renewable power sources can produce electricity at close to five or six cents per kWh — only one or two cents more than currently paid for coal and natural gas-based electricity generation.

Solar PV is still the most expensive energy source, although the cost has come down considerably over the past decades, and is still falling.[2] Price projections assume that utility-scale PV electricity prices may fall below 10 Canadian cents per kWh by 2020 [EPRI 1997, p. 7–3]. With net metering provisions and peak time billing, solar PV could help buffer the summer peaks of electricity demand in many Canadian cities. Nuclear energy is shown as being one of the cheapest energy sources — however, this price reflects current wholesale prices, which do not include the full cost of nuclear waste disposal and decommissioning. Including these costs, prices of more than 20¢/kWh have been suggested [GREENS 1996]. Hydro generation cost is mainly influenced by the scale of the plant; small hydro plants can generally produce electricity at 5–6¢/kWh, whereas micro-hydro can cost 12¢/kWh. Large hydro is the cheapest energy option in Canada and prices can be as low as 3¢/kWh [HQ 2002a]. Wind and tidal energy costs depend on the velocity of (wind or water) currents. Tidal stream energy is supposedly cheaper than tidal barrage as no dams need to be constructed and turbines can often be integrated with existing structures, such as bridges. Tidal technologies are a little behind the development of wave-based electricity generation, for which the first few commercial plants have already been deployed (although all under 1 MW capacity). Wave energy can be very cheap and prices were quoted at as little as 4.5¢/kWh for a utility-scale power plant. Energy from biomass is expensive when produced in power plants solely based on biomass because these plants have higher capital costs and operating and maintenance costs than fossil fuel plants. Biomass plant power output efficiencies are poor (in the US, an average of 20% nationwide), so fuel costs are higher than those for more efficient fossil fuel plants. A Canadian agricultural research centre estimated the cost to be 5.5–8.6¢/kWh for sawmill and forestry residues, 8.7–9.8¢/kWh for straw, and between 10 and 11¢/kWh for dedicated energy crops (see Appendix B-2). Observers expect more efficient technologies, such as gasifiers, to have electrical output efficiencies of 25% to 35% [CREST 2002] and even 40% to 50% as the technology develops over the coming ten years [WWS 1999, p. 164]. The cost of using biomass is much lower when co-fired with coal.

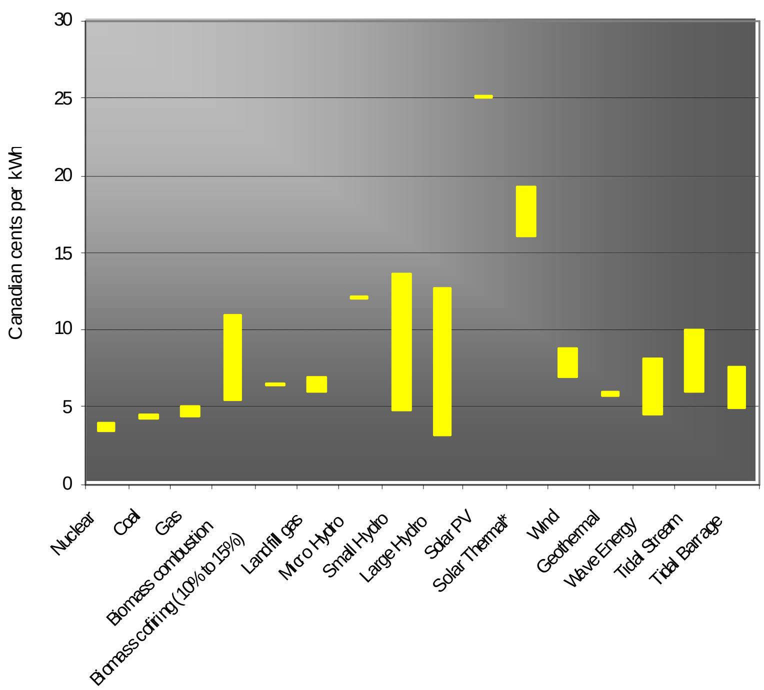



**Figure 2.6 — Comparison of Generation Prices of Different Energy Sources**

With natural gas prices going up and alternative energy prices going down, the overall price structure may begin to favour alternative energy sources in the near future. As wind energy is already very well developed and commercially viable, it is currently leading the field in alternative energy developments internationally. This has allowed countries like Denmark to phase out subsidies for wind energy [GP 2002a]. However, increased use of renewable power can also reduce or stabilize the demand for fossil fuels and so contribute to a slower price increase for those energy sources. In the US, a 10% share of renewable power combined with enhanced energy efficiency has been projected to result in 27% lower natural gas prices due to reduced demand. A share of only 2.4% has been projected based on current trends [UCS 2001a, p. 19]. The US Energy Information Agency projects this impact to be smaller, with only 1% lower natural gas prices for the residential sector, 2% lower for the commercial sector, and 4% for the industry sector. However, this effect is expected to undo the extra cost incurred by increasing the share of non-large hydro renewable power on the whole, making a 10% Renewable Portfolio Standard proposed for 2020 in the US energy cost-neutral [EIA 2002, p. 21].

*Electricity generation from renewable energy sources has become cheaper, to the extent that it is often only 1 or 2¢/kWh more expensive than conventional electricity.*

On the whole, the cost of several renewable power sources has fallen considerably over the past years. For instance, the cost of wind energy systems decreased by more than a factor of three in the 1980s, while the cost of PV modules (per unit of capacity) fell by a factor of 15 between 1980 and 1995, and there is still significant potential for further cost reductions [IEA 1997]. Figure 2.7 illustrates renewable power price evolution using the example of wind power, in cents US. The importance of these developments should not be underestimated. As electricity from renewable power sources becomes priced in the same range as electricity from conventional sources, renewables will play an important role as an effective price hedge against price hikes in fossil fuel markets.

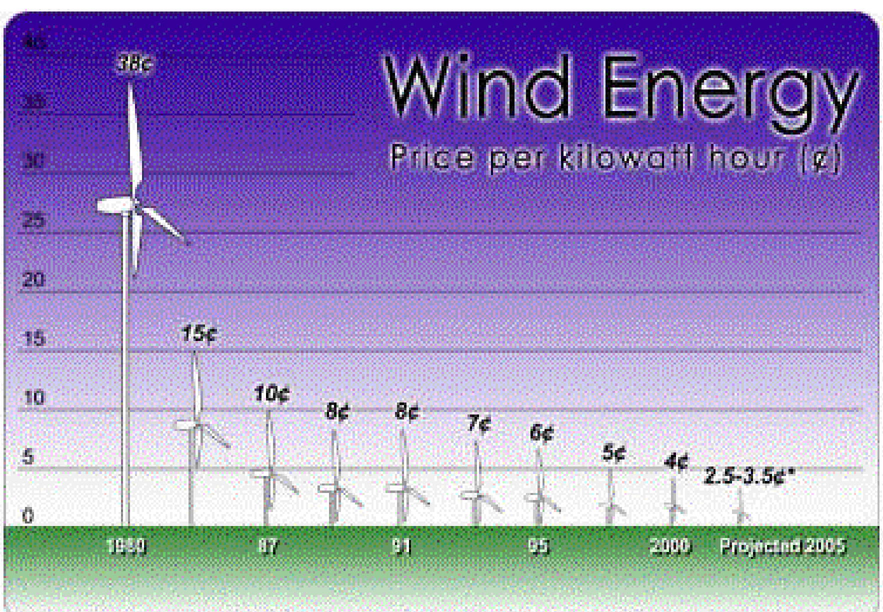



**Figure 2.7 — Price Evolution of Wind Power** [RC 2002]
** Assumptions: Levelised costs at excellent wind sites: large project areas, not including the production tax credit (post 1994); in US cents*

*A 10% increase of non-large hydro renewables has been projected to virtually offset its extra cost through a reduction in natural gas prices caused by reduced demand.*

## 2.3 A Comparison of Definitions of Green Energy Sources

### *2.3.1 An Overview of Current Practices from Around the World*

Table 2.2 provides an overview of green power definitions used throughout the world (see Appendix D for more detail on the US). There is a lot of agreement concerning solar, wind and geothermal. Large hydro is sometimes included, sometimes not. There is no agreement as to where the border between small and large hydro should be. Most controversy, however, exists with respect to waste-related sources: waste-to-energy is sometimes included, landfill gas is often included as well, and there are different definitions of biomass energy. For example, the Canadian draft guidelines for renewable low-impact electricity require that certain management and social and environmental pre-assessment rules be followed. Ocean energy is only rarely mentioned, less because it is not eligible, but rather because the technology is not very prevalent.[3] In some cases, CHP is admitted as "green" energy. Texas regulations, for example, define natural gas as a green energy source. Biomass energy is generally admitted as renewable. As biomass is defined as a fuel derived from living matter, the Netherlands admit both landfill gas, which is formed through biological decomposition of waste in landfills, and the organic fraction of municipal waste (about 50%) as renewable power sources. This idea has also found its way into the European Renewable Energy Directive, passed in October 2001. The private US Green-e program also certifies waste-to-energy as "renewable" in states where this is permitted, but waste-to-energy has been banned for Green-e sales in the Mid-Atlantic states (PA, NJ, DE, MD).[4] Energy savings (negawatts) are sometimes also admitted as "green energy," for example in Australia. The fact that thermal solar is often not mentioned in the documents that were evaluated for this comparison should not be seen as excluding it, but rather it is ignored as a little used resource.

### *2.3.2 Definitions from Legislation and Other Pertinent Documents*

*Canadian Definitions*

The following definitions for 'alternative use electricity' and 'renewable' are quotes from the draft Canadian Guideline on Renewable Low-Impact Electricity [ECP-79], which is currently being discussed in the context of the Environmental Choice logo:

**Alternative-use electricity:** electricity generated from the installation of a supplemental process and/or equipment to alter and/or add to the processes of an existing operation in order to generate electricity from a renewable energy source. The existing operation must not have been originally designed or intended for electricity generation, nor have had any processes in place at the time of commissioning that would have facilitated electricity generation. Although biogas-fuelled electricity is a form of alternative-use electricity, it is defined as a separate category by this guideline.

**Renewable:** replenished through natural processes or through sustainable management practices so that a resource is not depleted at current levels of consumption.

**Table 2.2 — Energy Sources Included in Selected Green Energy Definitions**

| Source | NG | CHP | WtE | LG | BM | WD | PV | ST | LH | SH | GT | WE | TE | ES | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Canadian Low Impact Electricity Guideline (draft) | | | | x | x | x | x | | x | x | x | x | x | | Hydro: has to comply with performance criteria (48-hour shaping). Requires additional measures in planning stage and during operation, such as prior stakeholder consultation, environmental management. Biomass: wood wastes, agricultural wastes and/or dedicated energy crops, biofuels. |
| Pembina Green Power Guidelines | | | | x | x | x | x | x | | x | x | x | x | | Biomass: wood waste; feedlot waste, energy crops. Small hydro: run-of-river only. Also includes fuel cells if hydrogen is not derived from fossil fuels. |
| Ceert.org | | | | x | x | x | x | x | | | x | x | x | | |
| US Green-e logo | | | | x | x | x | x | | | x | x | x | x | | Biomass:co-fired fuels (mainly landfill gas). |
| California Energy | | | x | | x | x | x | x | | x | x | | | | Biomass: residues produced from logging, mill operations and the manufacture of wood, pulp, paper, and fiberboard, agricultural field and orchard crops, livestock and poultry growing operations, food processing, and demolition (urban wood waste). Waste-to-energy: combustible residues from industrial processes, municipal solid waste ("garbage," including tires but not garden trimmings because these are considered "biomass" fuels), and municipal liquid wastes. Small hydro: up to 30 MW. |
| Texas PURA §39.9044 | x | | | x | x | x | x | x | | | x | x | x | | Waste-based biomass also eligible; solar hot water and heat pumps are also eligible under the RPS obligation. |
| Maine RPS | | x | x | | x | x | x | | | x | x | x | x | | Small hydro: <100 MW — this size restriction is valid for ALL alternative energy sources. |

***Table 2.2 continued ...***

| Source | NG | CHP | WtE | LG | BM | WD | PV | ST | LH | SH | GT | WE | TE | ES | Comments |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Australian Renewable Energy Act | | | x | x | x | x | x | x | x | x | x | x | x | x | Biomass: bagasse co-generation, black liquor, wood waste, energy corps, crop waste, food and agricultural wet waste, landfill gas, municipal solid waste combustion, sewage gas. Energy savings: electricity savings from solar water heaters; includes fuel cells as renewable energy source. Large hydro: existing dams only. |
| EU Renewable Energy Directive (10/2001) | | | x | x | x | x | x | | x | x | x | x | x | | Biomass: biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste. Also acknowledges solar hot water heaters. |
| The Netherlands (groencerti-ficaten) | | | x | | x | x | x | | | x | | | | | Small hydro: under 15 MW. Biomass: generation of electricity through biomass without co firing or mixing with synthetic materials, biomass waste. Waste-to-energy: 50% of waste-to-energy sources. |
| German OK Power certification [OK 2002] | | | | | x | x | x | | x | x | x | | | | Biomass: untreated wood; organic energy crops, wood from certified forestry, co-firing. Hydro: only reactivated or refurbished dams, newly built only as run-of-river technology. Up to 50% from fossil cogeneration allowed; at least one-third from new plants (after 1997). |

*NG: Natural Gas; RPS: Renewable Portfolio Standard; CHP: Combined Heat and Power; LG: Landfill Gas; WtE: Waste-to-Energy; BM: Biomass; WD: Wind; PV: Photovoltaic; ST: Solar Thermal; LH: Large Hydro; SH: Small Hydro; GT: Geothermal; WE: Wave Energy; TE: Tidal Energy; ES: Energy Savings (negawatts)*

Currently, the Canadian Environmental Choice Program uses a combination of listing green energy sources and additional performance criteria, some of which are included below:

- During project planning and development, appropriate consultation with communities and stakeholders must have occurred, and prior or conflicting land use, biodiversity losses and scenic, recreational and cultural values must have been addressed.
- No adverse impacts can be created for any species recognized as endangered or threatened.
- Supplementary non-renewable fuels must not be used in more than 2.00% of the fuel heat input required for generation.
- Solar (cadmium containing wastes must be properly disposed of or recycled).
- Wind (protection of concentrations of birds, including endangered bird species).
- Water (compliance with regulatory licenses; protection of indigenous species and habitat; requirements for head pond water levels, water flows, water quality and water temperature; and measures to minimize fish mortality and to ensure fish migration patterns).
- Biomass (use only wood wastes, agricultural wastes and/or dedicated energy crops; requirements for rates of harvest and environmental management systems/ practices; and, maximum levels for emissions of air pollutants).
- Biogas (maximum levels for emissions of air pollutants; and leachate management).
- Other technologies that use media, such as hydrogen or compressed air, to control, store and/or convert renewable energy.
- Geothermal technologies.

The Pembina Institute for Appropriate Development has developed **green power** criteria, based on quantitative emissions limits and on some qualitative requirements relating to water use, waste production and other environmental impacts [Pembina 2000]. The requirements include both primary criteria applicable to all power sources and additional criteria relating to the use of biomass for electricity production.

In a flyer on renewable energy [BCH 2002a], BC Hydro gives the following criteria for **green electricity** projects:

**Renewable** — the resources can be replenished within, at most, one human life span.

**Environmentally responsible** — the project has minimal impact on the environment.

**Socially responsible** — the project does not generate electricity in a way that conflicts with key social values.

**Licensable** — the project meets all relevant regulations and standards.

*United States Definitions*

The following definitions for 'clean' and 'renewable,' including the comments, are quotes taken from the US National Association of Attorneys General document, Environmental Marketing Guidelines for Electricity [NAAG, pp. 14–15]:

**Renewable:** A "renewable" energy source is defined as any energy source that is replenishable and replenished on some reasonable time scale. Renewable energy sources include, but are not limited to, wind, sun, heat from the earth's interior, oceans and rivers, and eligible biomass. It is deceptive to represent, directly or by implication, that electricity is derived from renewable sources when it is not. It is also deceptive to claim, directly or by implication, that a renewable energy source has no significant negative environmental impacts by sole virtue of the fact that it is renewable. Notwithstanding the above, if a particular state's law provides for a different definition of "renewable," that definition would prevail in that state.

*Comment: In defining "renewable" for the purpose of these Guidelines, the Attorneys General have opted for the common meaning of the word, focusing on replenishability on a reasonably short time scale, and applying it to energy sources, rather than technologies. Under this definition, there is no basis for distinguishing between large-scale and small-scale hydro. However, renewable resources can still have a significant environmental impact, so "renewable" is not equatable with "green," "clean" or similar terms, and care must be taken to avoid overstating the environmental import of renewability. The term "eligible biomass," as used in this Guideline, refers to plant matter and animal waste which are replenishable and replenished on some reasonable time scale. Municipal solid waste does not satisfy the definition of "eligible biomass" because it has a significant component of non-renewable organic and inorganic material. Nonetheless, municipal solid waste may be marketed as "renewable" in a particular state if it is so considered under the law of that state.*

**Clean:** A "clean" energy source is defined as any energy source that does not cause significant emissions. It is deceptive to misrepresent, directly or by implication, that any product or company is "clean." Claims using the term "cleaner" should be presented in conformity with this subsection and with the Guideline on comparative claims.

*Comment: The term "clean" has a common vernacular meaning of "not dirty." As an environmental marketing claim, it can be expected to connote to most consumers an absence of significant emissions. It is deceptive to represent, directly or by implication, that electricity is derived from clean sources when it is not.*

In its publication, Renewable Energy Credits Trading: The Potential and the Pitfalls [CRS 2001a], the Center for Resource Solutions, which issues the Green-e logo, uses the following definition for renewable energy:

**Renewable Energy:** energy from solar, wind, geothermal, hydro, biomass and other diverse sources whose common characteristic is that they are non-depletable or naturally-replenishable, but flow-limited. Excluded are all fossil and nuclear fuels and electrical energy derived from these sources.

The US Federal Government grants a federal tax credit of 1.5¢/kWh to renewable energy sources [CFR 2002], including some kinds of biomass. Only closed loop biomass is eligible for the credit and the definition originally excluded waste-related sources, apart from poultry litter. The SAFE Act 2001 has amended this by including landfill gas and other biomass-related sources [UCS 2001a, p. 5].

**Closed loop biomass:** any organic material from a plant which is planted exclusively for purposes of being used at a qualified renewable energy facility to generate electricity, or from a second harvesting of such a plant if planted before October 1, 1993.

**Renewable energy source:** solar heat, solar light, wind, geothermal energy and biomass, except for (1) Heat from the burning of municipal solid waste; or (2) Heat from a dry steam geothermal reservoir which (i) Has no mobile liquid in its natural state; (ii) Is a fluid composed of at least 95 percent water vapor; and (iii) Has an enthalpy for the total produced fluid greater than or equal to 2.791 megajoules per kilogram (1200 British thermal units per pound).

The June 2002 New York State Energy Plan [NY 2002, p. 3-40] defines **renewable energy** as: energy from resources that are not depletable or are naturally replenished when used at sustainable levels. Renewable energy resources include hydropower, solar, wind, biomass, ocean and landfill gas. In addition, fuel cell technology is included because fuel cells provide potentially significant, long-run environmental and economic benefits, can be powered with renewable energy, need support for commercialization, and have market barriers similar to barriers for renewable energy development.

The US Department of Energy definition of **biomass** is: Any plant derived organic matter available on a renewable basis, including dedicated energy crops and trees, agricultural food and feed crops, agricultural crop wastes and residues, wood wastes and residues, aquatic plants, animal wastes, municipal wastes and other waste materials.[5]

The US Low Impact Hydro Institute (LIHI) has defined guidelines for the certification of green hydro projects. Coming from a more capacity-based approach, the LIHI is now moving towards evaluation criteria based on environmental impacts.

*European Definitions*

The new EU Renewable Energy Directive [EU 2001] defines renewable energy by identifying the sources:

**Renewable energy sources:** renewable non-fossil energy sources (wind, solar, geothermal, wave, tidal, hydropower, biomass, landfill gas, sewage treatment plant gas and biogases). "Biomass" shall mean the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste.

*New Zealand Definitions*

A New Zealand governmental strategy document on renewable energy [NZ 2001] defines renewable energy as follows:

**Renewable energy source:** Energy that occurs naturally, the use of which will not deplete energy sources of that kind. This includes water, wind, solar, geothermal (with certain controls) and biomass. Biomass, in the energy context, is any recent organic matter, originally derived from plants as a result of the photosynthetic conversion process, which is destined to be used as a store of chemical energy. Woody biomass is an energy source derived from conventional forest operations, wood process residues and purpose-grown fuel wood plantations.

*Australian Definitions*

The Australian Renewable Energy Act [AUS 2000] defines **renewable energy sources** eligible in the context of the Act by listing them: hydro, wind, solar, bagasse co-generation, black liquor, wood waste, energy corps, crop waste, food and agricultural wet waste, landfill gas, municipal solid waste combustion, sewage gas, geothermal-aquifer, tidal, photovoltaic and photovoltaic

Renewable Stand Alone Power Supply systems, wind and wind hybrid Renewable Stand Alone Power Supply systems, micro-hydro Renewable Stand Alone Power Supply systems, solar hot water, biomass co-firing, wave, ocean, fuel cells and hot dry rocks. Not eligible are: fossil fuels or waste products derived from fossil fuels.

Australia's Sustainable Energy Development Authority (SEDA) defines **renewable energy** as the production of electricity, transport fuel or process heat from sources that don't run out — sunshine, wind, flowing water and organic material (biomass energy). Renewable energy technologies include photovoltaics (solar-panelled power systems), solar thermal, wind turbines, hydro power, wave and tidal power, biomass-derived liquid fuels and biomass-fired generation.

The SEDA Green Power Program[6] defines **renewable energy** as energy derived from sources that cannot be depleted or can be replaced, such as solar, wind, biomass, wave or hydro. Renewable sources will always be available and are essentially non-polluting. In addition, biomass electricity is defined as energy from organic sources, including landfill gas, sewage gas and bagasse. Each generation project is assessed on a case-by-case basis, depending on its impact on the environment and its acceptance by the community. For example, only sustainable plantation forestry sources are acceptable under the Green Power program — Green Power is not sourced from old growth forests or regrowth native forests.

*British New Renewable Energy Policy*

In the document, New & Renewable Energy — Prospects for the 21st Century [GB 1999], the terms "renewable energy" and "renewable energy source" are defined as follows:

**Renewable energy** is the term used to cover those continuous energy flows that occur naturally and repeatedly in the environment.

**Renewable sources of energy** are those that are continuously and sustainably available in our environment, such as wind and solar energy. These sources produce significantly lower levels of environmental pollutants than conventional sources of energy; in particular, they generally emit no greenhouse gases or are neutral over their life-cycle in greenhouse gas terms (for instance, energy crops produce carbon dioxide when they are burnt, but the new crop growth absorbs an equivalent amount of carbon dioxide from the atmosphere, making the process as a whole neutral in carbon terms). Waste for which there is no more economic use, such as recycling, can also often be used as a fuel and achieve savings in fossil fuel use and reductions in $CO_2$ emissions. New energy sources include technologies, such as fuel cells, which convert the energy of a chemical reaction, typically between hydrogen and oxygen (generally from air) directly into low voltage direct current electricity and heat. The sustainability of renewables means that they will continue to be available even in the longer-term future, when fossil fuel sources may be getting scarcer.

### *2.3.3 A Discussion of the Word "Renewable"*

Energy sources that are considered renewable in the original sense of the word are hydro and ocean energy, wind and solar energy. They are continually renewed through abiotic processes. As Box 2.2 (see Figure 4.14) shows, geothermal energy is not as renewable as the other forms of energy and can be depleted locally, although not globally. It should be noted, though, that some geothermal fields, like those in Italy, have been delivering electricity for more than 90 years.

Fossil fuels are derived from plant and animal matter and are therefore also biomass — but as opposed to newly grown biomass, which can be regrown in a relatively short time, fossil fuel stocks cannot be replaced.

Biomass regrowth can occur naturally (e.g., forests) or artificially, through the planting of trees or energy crops. Organic waste from processing plants or animals, as well as from household activities, is also a form of biomass. The differences here are whether or not growth-enhancing activities take place (extensive vs. intensive agriculture), or whether biomass is purposely grown for use as an energy fuel or whether it is a waste derived from other economic activities. The main difference between fossil and non-fossil energy sources is that the non-fossil ones require additional input, apart from sunlight, in the form of nutrients that need to be replenished over time, either through natural processes or through the addition of fertilizers. The use of biomass for energy production is also linked to air emissions, although the carbon cycle may be more or less closed, depending on the case.

**Box 2.2 — Is Geothermal Energy Renewable?**

Available data from the California Department of Conservation's Division of Oil, Gas and Geothermal Resources and industry sources show that operating capacity at The Geysers has declined by about 30–40% (about 700 MW) since 1988, representing some 5 billion kWh of lost generation from peak production levels. It is physically impossible to reverse this decline, which, in colloquial terms, resulted from developers putting "too many straws in the soda," depleting the naturally generated geothermal steam at a much faster rate than the earth is able to renew it. The economic practice of curtailing production during the winter and spring has the side benefit of slowing the rate of decline of the resource [RADER 1998, p. 17].

## 2.4 Conclusions About Existing Definitions

### *2.4.1 "Conventional" vs. "Alternative"*

There is little disagreement that "conventional" power sources include energy production from fossil fuels and nuclear energy. Some controversy has developed as improved technologies come into play. For example, co- or trigeneration, fluidized bed, very high efficiency gas, and co-firing of biomass improve the environmental performance of conventional sources, but do not necessarily turn them into alternative sources. Clarification is also needed concerning large and small hydropower generation. Large hydropower, although clearly renewable, is often seen as unsustainable due to its damaging effects on ecosystems. Small hydro plants are generally seen as "green" power sources, although their life-cycle impacts can be higher, especially if they have a reservoir, as opposed to run-of-river hydro. However, the delimitation of small and large hydro is unclear. It has often been based solely on the generation capacity of power plants, but the threshold has varied from one country to another (generally, it lies between 10 and 30 MW). Recently, the tendency has been to assess the effects of a plant according to environmental and social criteria, replacing the former evaluation scheme based on capacity. Whereas non-emitting power sources, such as large hydro and nuclear, are sometimes called "clean," they have environmental and societal problems attached to them that disqualify them from being considered "green." Also, they do not need the financial support mechanisms currently discussed to promote green power sources.

### 2.4.2 Is "Renewable" the Same as "Green"?

*Solar, Hydro, Wind, Geothermal, Ocean Energy*

These sources are least controversial concerning the definition of "renewable". They are fuelled through natural processes and do not deplete any resource over their useful lives, and are generally defined as being "green." Caution about these sources is nevertheless warranted due to the possible negative effects discussed above. As many of these technologies are just now emerging and becoming more widely used, their environmental effects should be monitored to determine whether any mitigating action will become necessary as their market share grows.

*Biomass*

Biomass is only partly renewable. For example, energy crop production depletes soils of minerals and, especially in an intensive farming scenario, will require replenishment of essential minerals. There is no consistent approach to this issue, and much resistance exists to its inclusion in the green energy definition (see Box 2.3). Whereas the United States has, in the past, only supported selected types of biomass (i.e., biomass crops/closed-loop biomass and poultry waste) with a production tax credit, there has been resistance from at least one political sector in Denmark to include biomass in its renewables definition (see chapter 3.3.3). It is clear that electricity production from biomass causes air pollution and that the only emission that is clearly reduced by regrowing the feedstock is carbon dioxide. Other issues related to biomass are that it can indirectly support and perpetuate the use of coal if it is co-fired with this fossil fuel, and that it emits more particulate matter than coal [PEM 2002, p. 31]. It should also be noted that grave concerns remain about the use of wood residue for electricity generation. As harvesting techniques improve and more and more residues are commercialized instead of being left on-site to replenish the soil, the need for an overall assessment of these techniques is necessary to determine whether or not the use of residues for electricity production is sustainable. Also, energy crops, such as switchgrass, may be better used for space heating than for electricity generation [REAP 2002a]. Whether all or certain kinds of biomass are unsustainable for electricity production, and how sustainability is influenced by scenarios, such as biomass co-firing, transport and cogeneration, remains a large issue and needs to be investigated further in the context of a Canadian renewables strategy.

*Waste-Related Energy Sources*

The waste-to-energy concept refers to the combustion of "biofuels" contained in waste (i.e., materials derived from plant material and animal waste). Landfill gas is based on the same concept and represents the combustion of gas from the microbial decomposition of organic waste materials. Can these sources be seen as renewable energy sources, as they require constant replenishment through human activities? They are based on an unwanted effect of economic activity, as opposed to purposely producing fuels for energy production. Environmentalists generally agree on a priority ranking of waste avoidance over reuse over material recycling over energy recycling. While the incineration of waste may be environmentally preferable to landfilling, waste incineration is primarily aimed at the inertization of waste, whereas energy production is merely a side effect. This becomes even more evident in the case of many kinds of industrial or hazardous waste, for which supplementary fuels have to be added to inertize toxic materials. Whether these energy sources can be called "renewable" or "green" is therefore not obvious, and in

Germany, for example, they are not included in the definition of renewable energy [FIRE 1998, p. 30]. Their environmental benefit lies mainly in the net reduction of greenhouse gas emissions and the reduction of toxic effluents from landfills. Some of these benefits may be turned into monetary value through the trading of carbon credits.

**Box 2.3 — Biomass: To Burn or Not to Burn?**

In the past few years entrepreneurs have learned to make a commercial product out of what was previously a waste. In Minnesota, poultry manure was considered a waste ten years ago. Turkey growers had to pay to have it hauled away. But farmers have learned that this dry manure is easy to store and transport (unlike liquid hog manure) and that it can not only provide nutrients to the soil, but also can provide organic matter that retains moisture and increases microbial activity. Today, selling and applying manure has developed into a healthy local industry. Applicators pay turkey growers for their manure and sell it to conventional and organic farmers alike.

When Minnesota legislators recently decided to expand the state's definition of biomass to include poultry manure, qualifying it for electricity subsidies, they chose to favor incineration over other uses. Manure applicators argued, to no avail, against the legislation, which would give subsidies of 3–4 cents per kilowatt-hour to electricity generated from poultry manure.

The manure applicators argued that if the state wanted to subsidize manure disposal, it should do so on a per ton basis, not a per kilowatt-hour basis, as the legislature proposed. That way, if there is an area that has excess manure, the subsidy can be used to cover the costs of transporting the manure to areas that can use it. By anointing only a single end product, the state was skewing the market away from recycling the manure for its nutrient value and favoring the incineration of the manure for its energy value.

The manure applicators lost their battle in Minnesota this spring, and in Congress last fall. Today if you recycle poultry manure you receive no federal benefits. If you burn it to generate electricity you receive $10–20 per ton.

This is true for other products as well. A rapidly expanding industry is converting increasing amounts of agricultural residues (mainly wheat straw) into construction products. More than half a million tons are used in this fashion today and this could triple in the next two years. This is being done with no subsidies. If the straw were pelletised and burned in a residential fireplace it also would receive no incentives. But if it is burned to generate electricity, it would receive a subsidy equal to more than $10 per ton.

Wood waste is another example of a raw material which has multiple end uses, but which in the past has been offered subsidies for only one. In the early 1980s, California required its electric utilities to offer a long-term contract to purchase biomass-generated electricity at a very high price (about 10 cents per kWh). From 1980 to 1990, 44 bioelectricity plants came on line in California, increasing 13-fold the amount of wood burned for electric generation, from 374,000 tons to 4.8 million tons.

***Box 2.3 continued ...***

At the peak of California's high-priced standard contract offer for biomass-generated electricity, one company, California Biomass, Inc., supplied 25,000 tons of waste wood per year to incineration plants. Because of the high price of electricity, incinerators could pay suppliers $36–38 per dry ton of wood waste. With the end of those contracts in the early and mid-1990s, incineration plants have had to get their fuel free to be able to compete.

California Biomass identified a more profitable market: compost. Business is booming. Dave Hardy, owner of California Biomass, says the company now produces over 100,000 tons of compost per year from green waste. Four years ago, 80 percent of the company's revenue came from incineration plants. Now, 70 percent of its production is compost; only 7 percent is fuel for incineration plants.

Another supplier operating in California, Apollo Wood Recovery, faced a similar crisis with the downturn in waste wood prices from electricity producers. Apollo now sells urban wood waste to a different market: medium density fiberboard (MDF). Apollo currently handles 6,000 tons of urban waste wood per month; in 1995, it handled only 500 tons (Morris 2000).

# 3. Green Power Initiatives Abroad

## 3.1 An International Overview

Several jurisdictions serve as examples of the market penetration of green power, and of measures that have been used to accelerate the growth of the green power sector. Although large-scale green power deployment with meaningful government support is a fairly new phenomenon, clear trends can be observed among the forerunners of green power promotion: the US, Europe in general, and especially the Netherlands, Denmark, Great Britain and Australia, all of which use slightly different approaches.

The basic distinction between the approaches taken is whether they are voluntary/ market-based or due to government regulation of electricity markets. Blends of these approaches can be found, and a closer look at the failures and successes of the above-mentioned examples yields some important lessons for Canada.

Figure 3.1 shows the annual increase of installed wind power capacities in countries throughout the world. Spain's green power sector has grown the most over the past few years. Japan's and several European countries have also seen a steady growth of their wind power capacities. Growth in the United States stagnated, and was even slightly negative in 1996, but took off again in 2001. Figure 3.2 illustrates these developments in absolute figures: Germany has now taken the lead with nearly 7 GW of wind capacity installed. The United States, a leader in alternative energies in earlier years, has now taken third place after Spain concerning wind energy. Japan only recently started this development and has small capacities so far, although wind power capacity is growing rapidly. In terms of capacity per capita, a measure of how much wind energy contributes to a country's energy portfolio, Denmark takes first place (in 2001, 15% of Denmark's electricity was generated from wind), followed, with a large gap, by Germany and Spain.

Europe contributed two-thirds of the total addition to wind power-generating capacity in 2001 (some 4,500 MW), with Germany alone installing 2,600 MW. Several German

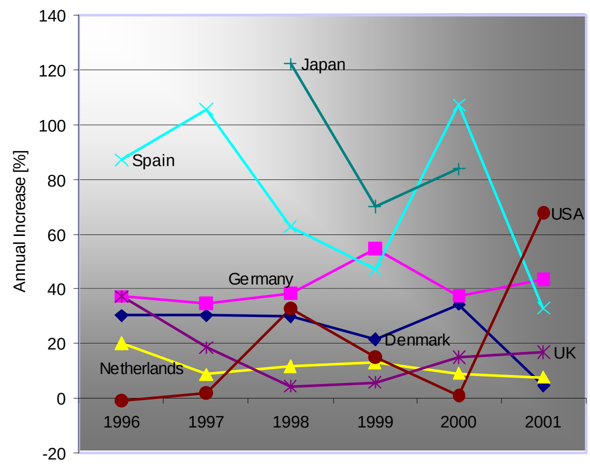



**Figure 3.1 — Annual Increase of Installed Wind Energy Capacity** [BWE 2002]

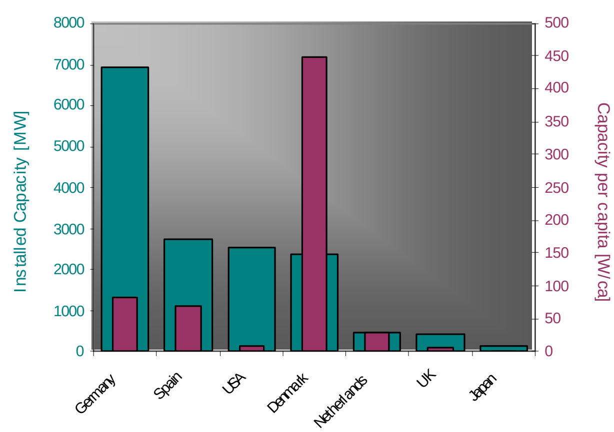



**Figure 3.2 — Comparison of Installed Wind Generating Capacities, as of June 2001 (Absolute and per Capita)** [BWE 2002]

states now obtain more than 10% of their electricity from wind [AWEA 2002]. By contrast, in Canada, total wind generating capacity in 2001 was 198 MW: the bulk of that generating capacity, roughly 100 MW, comes from one generating station in Gaspé (QC), while the remainder comes mainly from Alberta [CEC 2001, p. 40].

Currently, wind and solar power are by far the fastest-growing renewables worldwide. Installed wind capacities quadrupled during the five year period from 1996-2001, and wind is currently experiencing sustained annual growth rates of 30% [AWEA 2002]. Photovoltaic energy capacity is growing at similar rates, although installed capacities are much smaller than wind. Figures based on actual and foreseen investments in renewable capacity coming from system benefits charges in the United States confirm these worldwide trends: in terms of planned projects, wind energy is by far the most-favoured technology with nearly 880 MW of planned installation, followed by geothermal in California with 157 MW, and landfill gas with 101 MW. Biomass and hydropower have smaller shares [BOLIN 2001, p. 17]. Lately, progress has been made in the field of wave energy: a commercial facility went on-line in Scotland in the year 2001, and several pilot projects focusing on wave energy are planned along the Pacific coast of America (e.g., BC Hydro).

The following sections look at the leading countries in the renewable power field, analyze their policies and discuss the factors that drive renewable power markets.

## 3.2 US Markets — Limited Success

### *3.2.1 Overview and Federal Initiatives*

In 2000, 2% of the electricity consumed in the United States was generated from renewable non-hydro resources [NEPDG 2001, p. viii]. The US installed a total of 1,695 MW of new wind capacity in 2001, with some of the world's largest projects going into operation in the western US: a 278-MW wind farm was completed in West Texas, at King Mountain; and new wind turbines totalling 261 MW are now operating at the Stateline project along the Washington-Oregon border [AWEA 2002]. The most successful renewables efforts have been made in the two states that aggressively implemented

**Box 3.1 — The US Public Utility Regulatory Policy Act**

The Public Utility Regulatory Policy Act (PURPA) was passed in 1978, between the world-wide energy crises, to reduce US dependence on foreign oil, to promote alternative energy sources and energy efficiency, and to diversify the electric power industry. PURPA created a market for power from non-utility power producers, which now provide 7 percent of the country's power. Before PURPA, only utilities could own and operate electric generating plants. PURPA required utilities to buy power from independent companies that could produce power for less than what it would have cost for the utility to generate the power, called the "avoided cost." PURPA has been the most effective single measure in promoting renewable energy. Some credit the law with bringing on line over 12,000 megawatts of non-hydro renewable generation capacity. The biggest beneficiary of PURPA, though, has been natural gas-fired "cogeneration" plants, steam is produced along with electricity.

Source: Union of Concerned Scientists, http://www.ucsusa.org/energy/brief.purpa.html

**Table 3.1 — Top Ten Utility Green Pricing Programs — Most Participants Are Customers (as of February 2002)[7]**

| Rank | Utility | Program | Number of Participants |
|---|---|---|---|
| 1 | Los Angeles Department of Water and Power | Green Power for a Green L.A. | 87,000* |
| 2 | Xcel Energy (Colorado) | WindSource | 18,600 |
| 3 | Sacramento Municipal Utility District | Greenergy — All Renewables | 14,200 |
| 4 | Xcel Energy (Colorado) | Renewable Energy Trust | 10,900 |
| 5 | Wisconsin Electric Power Company | Energy for Tomorrow | 10,700 |
| 6 | PacifiCorp | Blue Sky | 7,300 |
| 7 | Austin Energy | GreenChoice | 6,600 |
| 8 | Portland General Electric Company | Salmon Friendly and Clean Wind Power | 5,700 |
| 9 | Wisconsin Public Service | SolarWise for Schools | 5,200 |
| 10 | Tennessee Valley Authority | Green Power Switch | 4,900 |

** About half of the total are low-income customers that receive existing renewables at no extra cost due to the California customer credit.*

PURPA (see Box 3.1): California and Maine. In the 1980s and early 1990s, California developed almost 6,092 MW of renewable capacity — about 14 percent of the state's generation capacity. Maine developed 855 MW, providing over 35 percent of the state's power plant capacity [UCS 1999, p. 23].

A 2001 National Renewable Energy Laboratory report, "Forecasting Growth of Green Power Markets in the US," projects the growth of US non-hydro green power capacity, currently 9,100 MW (capacity factors included), to be between 7 and 43% over the next 10 years [NREL 2001, p. vi]. NREL holds that regulated markets will have a much higher impact on the creation of new renewable capacity, based on the assumption that regulated green pricing programs will only support new renewable generation, whereas free retail competition will heavily rely on existing renewable power sources.

Much of the growth in the renewable power sector, and especially in the wind power industry, has been fostered by the inflation-adjusted Federal Production Tax Credit of 1.5 (US)¢/kWh. In April 2002, the US Senate passed the new Federal Energy bill, expanding the tax credit for another five years. Under the new provisions, the Credit, which was limited to mainly wind and some narrowly defined biomass projects, also includes geothermal, biomass and landfill gas [DSIRE 2002]. The credit has been extended for five years for geothermal, solar, and animal waste, and three years for biomass. The bill also proposes a federal Renewables Portfolio Standard of 10% by 2020, which would be implemented through a national credit trading system [ENS APR25].

Developments in the States have been influenced by green pricing initiatives (i.e., regulated utilities offering green power to their customers, and market opening paving the way for green power marketing). Table 3.1 shows the green pricing programs that have been the most successful so far. There was small growth in comparison to June 2001 ratings, with Austin Energy losing more than 2,000 customers, moving from 6th to 7th place in the table. Wisconsin Public Service has also lost 200 customers since 2001.

By the end of the year 2001, more than 85 utilities had either created green pricing programs or had announced intentions of developing a program. The result of these initiatives was the installation of more than 110 MW of new renewable resources, with firm development plans for another 172 MW [ERI 2002, p. 8]. Considering that there are more than 3,000 utilities in the United States, 85 utilities is not a large number. In addition, although some utilities have attained customer participation of up to 7.3% with their green pricing programs, the median penetration is only 0.8%, based on a comparison of 39 US utilities [WISER 2001, p. 7].

In deregulated states, early activity demonstrates market demand for clean power in the residential market running between one percent and three percent of households [ERT 2002]. Figure 3.3 shows that overall switching activity has been highest in Pennsylvania, followed by California. However, the number of customers switching to green power products has been modest, with less than 300,000 by the year 2000. These findings are confirmed by data given in Table 3.2, which compare market penetration in residential and non-residential markets for regulated and deregulated markets in the US.

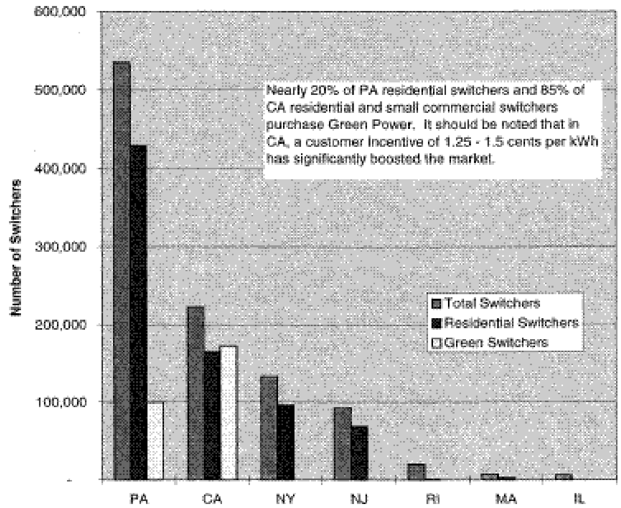



**Figure 3.3 — Numbers of Customers Switching to Alternative and Green Providers after Market Opening**
[XEN, p. 285]

### *3.2.2 California*

California had a strong renewable power base for the longest time, consisting largely of geothermal resources, biomass and waste, and wind energy. Together with solar energy, these sources covered 7.7% of California's electricity demand in 1998. With the

**Table 3.2 — Comparison of Market Penetration in Regulated and Deregulated Markets in the US** [NREL 2001, p. 27]

| Market Type | Consumer Type | Market Penetration |
|---|---|---|
| Regulated Markets | Residential | <1% to 7.3% (0.8% median) of load with access to green power |
| | Non-residential | 20% of residential demand in many, but not all, markets |
| Restructured Markets | Residential | 1.6% (PA) to 1.9% (CA at height of market — is at ~1% now) |
| | Non-residential | 20% (PA) to 100% (CA at height of market) of residential market |

PA: Pennsylvania; CA: California

introduction of retail competition in March 1998, falling electricity prices led to a decline of the shares of geothermal and biomass energy, but capacities rose again when the California customer credit created demand for green electricity (see Figure 3.4). From 1998 to 2000, electricity production from these four sources rose by 12%, to a market share of 8.6%. Together with hydroelectric power, 23.6% of California's electricity came from non-fossil energy sources in 2000 [CEC 2000b].

At the peak subscription rate to direct retail programs, on May 15, 2000, 222,548 (2.2%) of the total 10.1 million customer accounts in California had switched suppliers. Of the total switching population, the majority were residential (164,636) and small commercial (38,195) customers. The residential switchers represent 1.9% of total residential customers and 2.3% of the direct access load; small commercial (<20kW) switchers represent 3.9% of total small commercial customers and 5.3% of the direct access load. About 85% of these customers switched to a green power product. In comparison, the 1,009 large industrial users (>500kW) that switched represented 19.3% of the industrial customers and 34.6% of the industrial direct access load. Local governments have also begun to play a major role in the green power market, with more than 100 municipal entities in California purchasing approximately half of the green power in the state [XEN, p. 279–280].

*Only 85 out of 3,000 US utilities had adopted green pricing programs by 2001. Most North American customers have no direct access to green power.*

This "green" success of California's market opening is mainly due to the Renewable Customer Credit, funded through the state's System Benefits Charge (SBC). In fact, with default service rates historically pegged to the wholesale price of power in California, the customer credit has been the *only* mechanism by which competitive electricity suppliers have been able to compete for smaller customers, allowing some of them to retail green electricity at a lower rate than conventional power [XEN, p. 280, WISER 2000, p. 7, BOLIN 2001, p. 24].

As a result of the program, nearly all of the residential and small commercial customers that have switched to competitive retail electricity providers in the state have been served by eligible renewable power sources. Because the customer credit (originally set at 1.5¢/kWh) exceeded the wholesale premium for renewable power by as much as one cent per kWh, most California energy retailers serving small customers have supplied their customers with eligible renewable power —

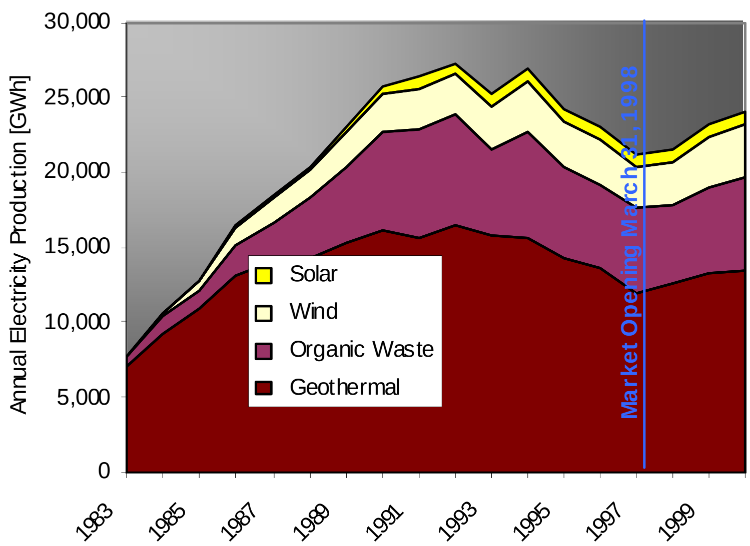



**Figure 3.4 — Electricity Production from Renewable Energy Sources in California** [CEC 2002b]

*The high switch rate to green power in California was largely due to the fact that green power could be offered at lower prices than other electricity products. Many customers were not aware they had switched to a green product.*

whether or not their customers have requested it — in order to profit from the extra margin coming from the customer credit, and some others won over customers to renewable power products by offering them at a discount to conventional rates. This tactic was first widely employed in January 1999, when Commonwealth Energy, the only major supplier offering price discounts to residential customers, switched all of its 38,000 residential and small commercial customers to a 100% renewable power product [NREL 1999a, p. 5]. The ensuing wave of renewable power sales chasing a fixed amount of funds necessitated the lowering of the customer credit to 1.25¢/kWh in December of 1999, and then again to 1.00¢/kWh in July 2000, where it remains today [BOLIN 2001, p. 55].

Interviews with retailers offering renewable power products reveal that the credit has strongly influenced product pricing, and that marketers have come to rely heavily upon the credit in a market that is largely hostile to retail choice. Three marketers indicated that they would most likely exit the market if the incentive were reduced, while others would raise prices and wait to see how their customers react, and still others would reduce the amount of renewable power in their product mix. Perhaps even more telling are the responses to a survey of customers purchasing products containing renewable power: 40% of residential and 72% of non-residential customers that are purchasing products containing renewable power are unaware that they are doing so. These customers were probably attracted to the product by its low price, and it remains to be seen how many of these customers would continue to purchase the product if the level of the customer credit declined and prices rose accordingly. It is therefore possible that the market for renewable power will collapse once incentives end [BOLIN 2001, p. 56].

As the peak, subscription rates to green power (about 2% in 2000) only amounted to some 25% of existing green power generation capacity in California. The customer credit had little effect on installed capacities in California. However, renewable generation capacities went up just after market opening in 1998 (see Figure 3.4). The reason for this increase can be found in other ways that California's system benefits charge supports renewable power. As of 1998, part of the money went towards existing facilities, newly built facilities (through per-kWh production incentives),

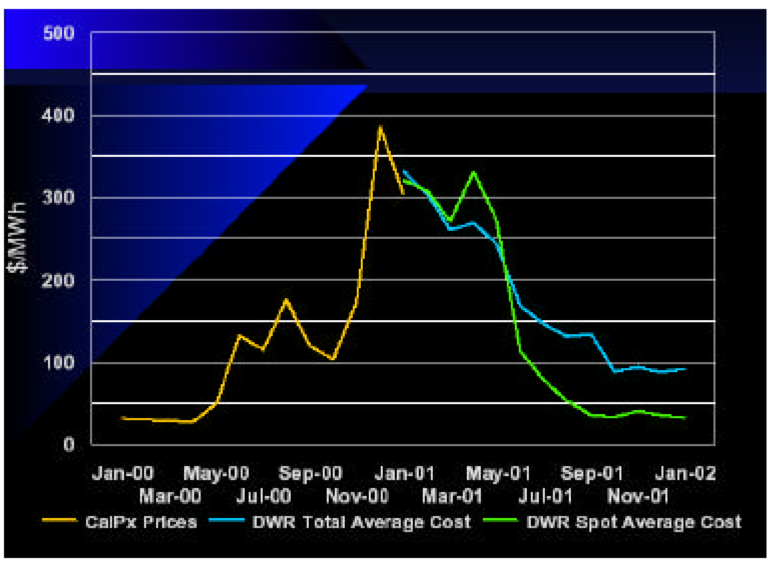



**Figure 3.5 — California Wholesale Power Prices**
[NRRI 2002]

and a distributed generation buy-down program (see chapter 4.3 for more details). These incentives, together with the Federal Production Tax Credit of 1.5¢/kWh, led to the reactivation of some mothballed biomass facilities, increased output from already active facilities, and triggered the deployment of some new generation due to the California production incentive from the New Renewables Account [CEC 2002]. California is currently discussing the introduction of a renewable portfolio standard, with a target that 17 percent of California's electricity consumption be renewable by 2006 [CEC 2002a, p. III-4-6].

Due to the California energy crisis, California suspended customer choice in September 2001. Figure 3.5 shows how wholesale energy prices developed in California. From an average of (US)$26 per MWh in 1998 and $31 in 1999, prices rose to more than $150 in August 2000 and came close to $400 in December 2000. These developments were due to an unfortunate coincidence of a 12% peak demand increase from 1996 to 1999, a 5% overall demand increase in the first eight months of 2000, high summer temperatures, unit outages, decreased hydroelectric production, a steep rise of the price of $NO_x$ emission credits in the South Coast Air Quality District, and increasing natural gas prices, in a setting in which a small number of suppliers control significant portions of generating capacity [NRRI 2000a]. At these rates, many renewable electricity retailers were no longer able to offer their products at the rates that their customers had subscribed to and therefore had to turn them back to their default service providers [CEC 2002c]. The number of green power subscribers was reduced to less than half of what it had been in mid-2000 (see Figure 3.6).

A recent report describing the situation in California attributes the low increase in new renewable power generation to an instability in policies supporting green energy sources. Whereas 1,300 MW of new renewable power supply has been authorized over the past two years, only 201 MW of this amount is currently in operation, most of which is upgrades or repowers to existing wind farms [ASMUS 2002, p. 5]. This situation is attributed to long permitting procedures (up to eight years), failing power markets and a lack of political leadership [ibid.]. Stable policies, standard power purchasing contracts, government guidance on power purchases and long-term contracts were

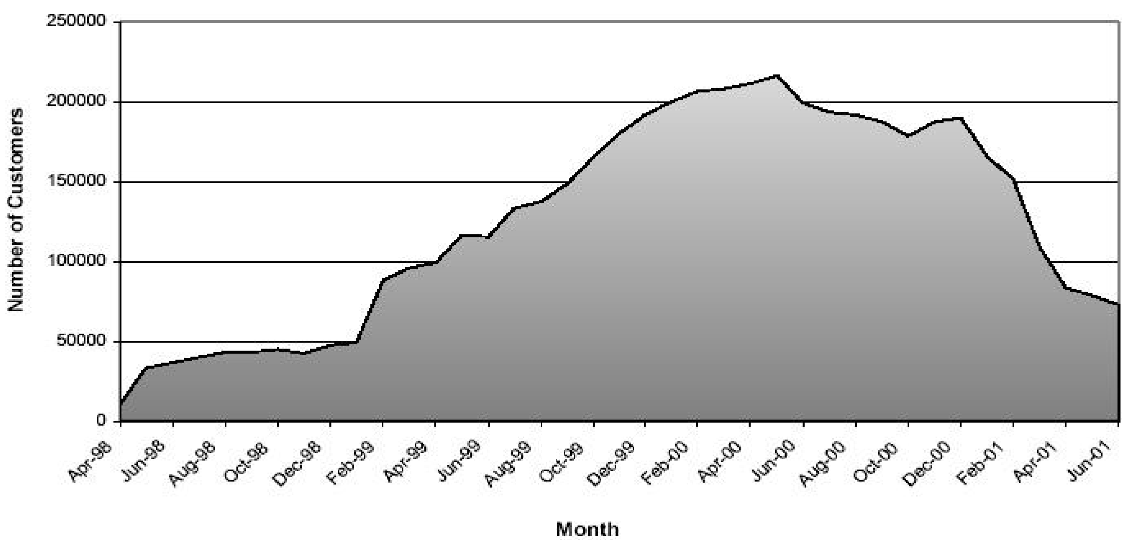



**Figure 3.6 — Number of Californian Customers Purchasing Renewables from a Direct Access Provider** [CEC 2002a, p. III-4-5]

named as the elements necessary to drive green power deployment. California's biomass plants, for example, work under short-term or 5-year contracts providing between 5 and 6 ¢/kWh — too little for the sector to function profitably. It was feared that many of the plants would shut down over the coming years, leading to a deterioration of air quality through increased open-field burning of agricultural wastes [p. 16]. This may now have been averted through the introduction of Senate Bill 1078, defining a renewable portfolio standard that requires utilities to increase their eligible green power portfolio from 12 to 20% by 2017 [KRT 2002].

### 3.2.3 Pennsylvania

Pennsylvania opened its markets to retail competition on January 1, 1999. By April 2000, just over 10% of the total 5.2 million customer accounts in Pennsylvania, or 535,445, had selected an alternative supplier, including almost 430,000 residential customers. Equivalent to about 10% of the residents in the state, and this right at the start of market opening, this is substantially more than the 0.9% switchers California saw 9 months after consumer choice became available there [NREL 1999a, p. 9]. One in five of the total switchers, and nearly one in four of residential switchers (about 80,000 or 1.6% of eligible customers), had selected a green power supplier by 2000 [XEN, p. 281]; this number rose to 119,000 in 2001 — the largest participation throughout the United States [PA 2002c].

Pennsylvania has set the default generation price (also called shopping or generation credit) at the highest level of all states, amounting to a maximum of 5.65 cents/kWh for 1999 in PECO's service territory. Contrary to California, where default generation prices were close to wholesale electricity prices, Pennsylvania's default prices were defined close to retail prices, allowing a larger savings margin for switching customers: several (though not all) of the utilities offer default generation service at a price that exceeds that available on the open market. Consequently, consumers that switch suppliers are given a realistic opportunity for significant cost savings — up to 15% — and green power could be offered at a lower overall cost relative to utility rates [NREL 1999a, p.8].

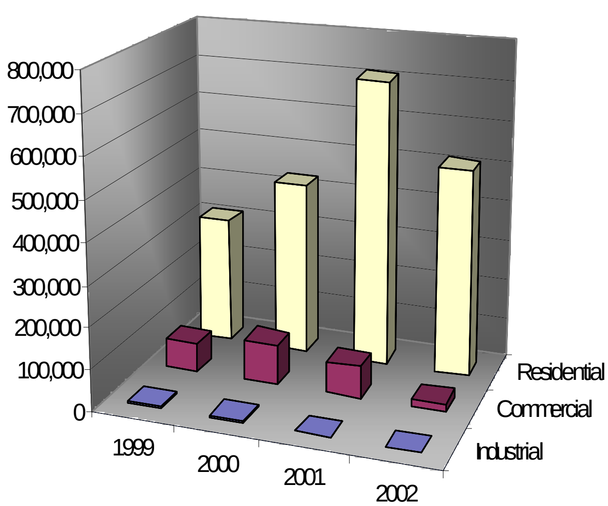



**Figure 3.7 — Number of Customers Served by an Alternative Supplier**
(numbers for April of each year) [PA 2002a]

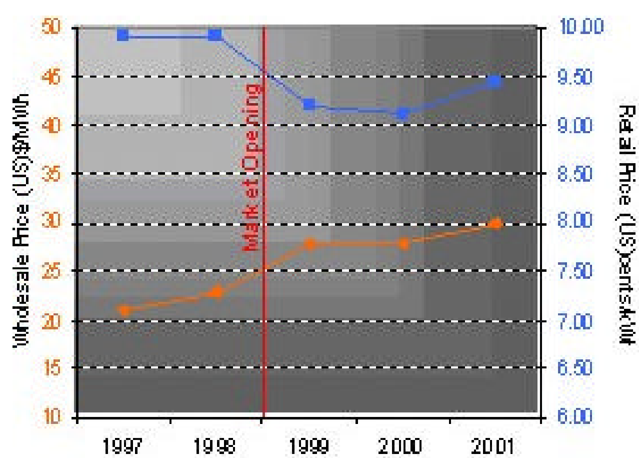



**Figure 3.8 — Average Residential Retail and Wholesale Electricity Prices**
[PA 2002a]

However, as wholesale electricity prices rose this margin disappeared quickly, and so did customer switching activity. Pennsylvania shopping statistics show the addition of residential customers who were switching dropped from 10,000 a month in 1999 to 5,000 in 2000, to a dramatic decline in 2001. This is why the initial switching numbers have not changed much over the past few years (see Figure 3.7), and even decreased slightly from 2001 to 2002. Figure 3.8 shows how retail prices were reduced due to state legislation, while wholesale prices continued to rise, narrowing or eliminating the shopping credit customers enjoyed at the start of market opening. Due to these developments, approximately three-quarters of the firms offering alternative service, who were serving almost ten percent of the customers who had switched to another electricity supplier, exited the market in the first half of 2001 [CFA 2001, p. 2]. Already by the year 2000, most electricity products containing a percentage of renewable power were priced above the default electricity price, and customers now pay a premium price of about 1.6¢/kWh for these products — still less than the three or four (US) cents per kilowatt-hour customers have to pay in many other states [BARK 2002]. However, local prices may differ widely: a May 2002 comparison between Allegheny Power (generic electricity) and Green Mountain (renewables-based electricity) shows a mark-up of up to 100% for green power, depending on the region [OCA 2002].

As in California, the influence of this switching activity on the green power generation market is limited because most switchers have selected a "light" green product consisting of 1% landfill gas and 99% natural gas. Approximately 20,000 customers have selected a product with more than 50% renewable power content [WISER 2000, p. 10]. However, 34 megawatts of utility-scale wind power capacity has been created since 1999, with an additional 120 MW planned [AWEA 2001]. These developments are due, among others, to Pennsylvania's system benefits charges, which are collected in two funds that support new renewables development: the Sustainable Energy Fund of Central Eastern Pennsylvania and the Sustainable Development Fund. These funds promote, research and invest in clean and renewable power technologies, energy conservation, energy efficiency and sustainable energy enterprises. Both funds provided funding and other support for two new wind farms, which began operation in October 2001, and are heavily involved in supporting additional wind energy development in Pennsylvania [PA 2002b].

On the other hand, market demand can be essential in creating additional demand. A wind power product offered by Community Energy, which is a green tag electricity product that does not require switching suppliers to purchase green energy, has been very successful, and most of the newly created (October 2001) capacities of 24 MW were quickly bought up through industrial, government and institutional purchases requiring "new" wind power. The Pennsylvania government is purchasing 5% of its electricity from renewable sources, 20% of which has to come from newly created facilities [PA 2002d]. Community Energy is currently not targeting residential markets, but the government is working with groups, such as Citizens for Pennsylvania's Future, to promote renewable power though television and radio ads and a website (www.cleanyourair.org) to educate the public about renewable energy issues.

The Pennsylvania government established individual settlements with each utility, requiring them to provide 2% of their electricity from renewable sources, increasing half a percent per year. Although this arrangement is not officially called a Renewable Portfolio Standard, its effect is exactly the same. The start dates for this requirement are: 6/1/00 for General Public

Utilities (GPU), 6/1/01 for PECO and West Penn Power, and 6/1/02 for Pennsylvania Power & Light (PP&L). Eligible renewables include photovoltaic, solar thermal, wind, low head hydro, geothermal, landfill and mine-based methane gas, and energy from waste and sustainable biomass.

### *3.2.4 Texas — The Midwest Wind Rush*

*The Texas RPS Success*

Texas was the sixth state in the US to adopt RPS rules and is the only one so far to implement a certificate trading system for compliance. The RPS obliges all Texas retailers in competitive markets (80%) to share the obligation to put new renewable capacity on the market, and expires in 2019. Eligible resources are those commissioned after September 1, 1999. This is also the baseline for the RPS — nearly 901 MW[8] of electricity was produced from renewable energy, most of it large hydro [PUCT 2002b]. The first binding goal for the addition of new renewables is 400 MW by the year 2003, resulting in a total of 1,301 MW. Due to a sudden wind energy installation boom, Texas is now well ahead of this target (see Figure 3.9): nearly 1,700 MW of new wind turbines were installed in the US in 2001, and more than half of this amount (915 MW) was in Texas — more than had ever been installed before in the entire country in a single year.

The wind boom was due to the US wind production tax credit expiring in 2003 (now extended until 2007). Projects completed before this deadline are eligible for a 1.7¢/kWh subsidy over ten years. However, Texas managed to attract the bulk of new wind power investments in the US. This is due to a combination of reasons: first, the RPS creates a market demand and caused many utilities to contract wind energy in anticipation of future RPS obligation levels. Second, surging natural gas prices created a climate in which wind was becoming competitive with other fossil fuels, with many long-term wind contracts (10–25 years) being locked in at fairly high prices. Third, Texas has extraordinary wind resources: most of the planned wind power plants are located in West Texas, where average annual wind speeds of 8 m/s are common and capacity factors can exceed 40% [WISER 2001, p. 11]. Finally, grid expansion costs, crucial for many wind projects that may be located far away from existing electricity infrastructure, are paid for by Texas electricity customers rather than by the power plant operator. Fees to recover the embedded costs of existing and new transmission infrastructure are placed on electricity consumers based on a flat fee, or postage stamp approach, independent of the location of production or consumption (congestion costs will also be charged). Scheduling rules and requirements for intermittent generation are also relatively favourable [ibid., p. 15]. The climate in Texas is reflected in the following

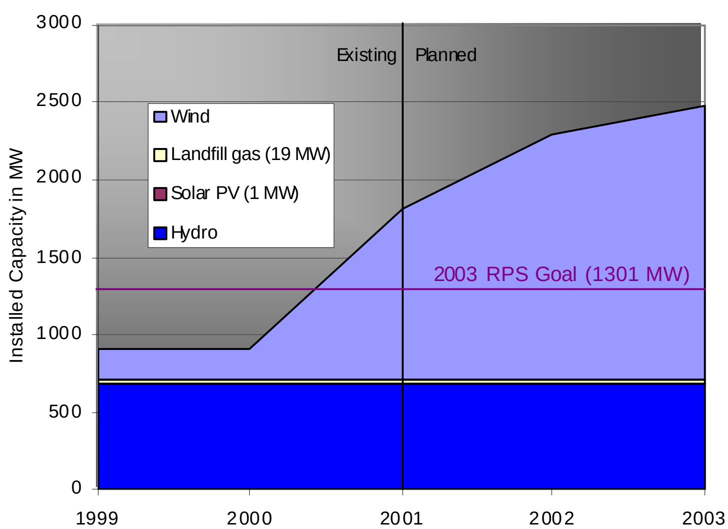



**Figure 3.9 — Renewables Deployment in Texas**
[ERCOT 2002, PUCT 2002a]

quote: “There are all kinds of transmission constraints in West Texas. Hell, the utilities never had to worry much about building transmission capacity out there because nobody wants to live out there because of the damn wind! But when we sit down with the utilities, they have a can do attitude. They want to help out and help build new transmission capacity that will help build the market for wind. In California, the utilities can get away with doing nothing. In the current political and regulatory environment, they have no incentive to be accommodating to wind or other renewable energy technologies.” [ASMUS 2002, p. 10]

The RPS allows wind projects to gain the economies of scale necessary for deep cost reductions, and in combination with cheap land prices, this results in wind power projects being able to sell wholesale power at the busbar profitably at (US) 3.0 to 4.0¢/kWh — competitive with conventional power [SLOAN 2000].

Apart from wind, only landfill gas production is increasing in Texas due to the fact that no other renewable resources exist (landfill gas and small hydro electricity generation capacity together was 100 MW in 1999 [SLOAN 2001]). With the “wind rush,” certain transmission lines are now overcharged at peak wind production as the infrastructure could not keep pace with the vast increases of wind-based generating capacity over such a short period of time. Many wind facilities need to reduce their output at peak times because of thermal constraints with transmission lines, resulting in wind farm operators asking for compensation for renewable energy certificates lost due to reduced production [PUCT 2002b].

Texas’ rules are widely praised for being flexible, but they are designed in a way that effectively retains the environmental benefits of renewable power production within the state. While Texas allows out-of-state resources, the requirement that a project be physically metered and verified in Texas generally means it must have a dedicated transmission line into the state. There may well be occasions in which that may work technically and economically, but it most likely restricts projects to within state lines [NWCC 2001a, p. 50].

*Texas will meet its RPS obligations with ease and could surpass the new capacity renewable energy objectives by 100%, given recent trends.*

*Renewable Energy Certificates*

The Texas RPS is administered through a certificate trading system — so far the only one implemented in the United States: one MW of renewable power creates one Renewable Energy Certificate (REC), which can be used to fulfill the RPS obligation towards the regulatory authority on an annual basis. The Texas Public Utilities Commission enforces compliance; the Independent System Operator (ERCOT) serves as the REC trading administrator. If not enough certificates can be obtained, the penalty applied will be the lesser of 5 (US)¢ or 200% of the mean REC trade value in the compliance period for each missing kWh, providing a (high) cost cap for the price of certificates [WISER 2001]. Certificates were trading for prices of around $4–5 per MWh in 2002 (or a dollar less for 2001 certificates), which at a wind power production cost of (US)$40–50 per MWh in Texas [RE 2002] amounts to about 10% of this cost.

The innovation of tradable RECs allows electricity retailers from any area of the state to seek out the lowest cost renewable resources without having to take physical delivery of the electricity. This has resulted in larger projects and further cost reductions.

Other key factors that make the Texas system functional are a long-term commitment continuing 10 years beyond the legislated target (through 2019), a meaningful penalty for non-compliance and modest provisions for banking credits (banking is allowed for three years) [SLOAN 2000].

### 3.2.5 Massachusetts

Massachusetts was the first state in the nation to fully open its electricity markets to retail competition on March 1, 1998. In comparison to California and Pennsylvania, switching activity in Massachusetts has been very low: through the end of January 2000, only 1,831 residential customers had switched — 0.1% of both customer accounts and customer sales (kWh). In contrast, 11.4% of large commercial and industrial customers had switched, representing 18.2% of sales in this sector. This is due to the small savings margins, resulting from low default service charges, which can be multiplied by large purchasing volumes of industrial consumers — for small customers, the current wholesale price structure in Massachusetts is only now becoming favourable due to rising default prices [XEN, p. 283]. Because the cost of electricity in Massachusetts' wholesale market runs from 3.5–4¢/kWh, it has been practically impossible for a competitive supplier to undercut the utility price. Residential consumers would likely have to pay a 1¢/kWh premium just to have the privilege of choosing a competitive supplier [NREL 1999a, p. 7]. Consequently, the only green electricity product customers are offered in Massachusetts is a "green tag" product, where customers pay (US)$8 for 2,000 MW of "ReGen," the green attributes of electricity production from landfill gas, in addition to their usual electricity bill [XEN, p. 283].

The Massachusetts green power market has also been impeded by a lack of ratepayer funding to support renewable power development. The Massachusetts restructuring legislation earmarked a system benefits charge dedicated to renewable power development. However, a lawsuit had challenged the constitutionality of the mechanism to collect the funds. Approximately $100 million had been collected and remained largely unspent due to the pending lawsuit [XEN, p. 283].

In Massachusetts, new regulations are in place for a state-wide standard for production of electricity from renewable power sources. The Massachusetts Renewable Portfolio Standard (RPS) of April 26, 2002, specifies that retail suppliers of electricity must draw on new renewable power projects to provide one percent of their power in 2003, increasing to four percent by 2009. However, electricity suppliers can avoid the requirement by purchasing credits from the Massachusetts Technology Park Corporation, which administers the state's Renewable Energy Trust. For 2003, the credits will cost $50/MWh (5¢/kWh), which is likely to be higher than the incremental cost of new renewable power sources.

### 3.2.6 New Hampshire

Whereas the planned US Four-Pollutant Bill has been given up by the Bush administration and is now being discussed as a three-pollutant bill without $CO_2$, New Hampshire has pressed ahead with its own emission cap legislation, culminating in House Bill 284, which was passed and signed by the governor in May 2002. Table 3.3 shows the emission limits imposed on fossil fuel-based power production. The Public Services Company of New Hampshire (PSCNH) can use the system benefits charge of (US)$0.0018 per kWh to invest in energy efficiency and emissions reductions projects. Although no emissions allowances are granted to renewable power projects, the PSCNH will get as many allowances for its investments in renewable power projects as the expenses made correspond to, at the allowances' market value. A trading and

**Table 3.3 — New Hampshire Four-Pollutant Emission Caps** [NH 2002]

| Emission | Emission Cap [t/a] |
|---|---|
| $CO_2$ | 5,425,866 until Dec.31, 2010 — Lower cap for period after 2010 to be recommended by March 31, 2004 |
| $NO_x$ | 3,644 |
| $SO_2$ | 7,289 |
| Mercury | Tbd by March 31, 2004, based on EPA best technology definition |

banking program will be developed for emissions allowances.

Similar to the country-wide $SO_2$ trading program (see Box 4.2), the provision contained in Bill 284 may not lead to increased investment in renewables in New Hampshire as power companies may find it cheaper to invest in reduction technologies than starting up new renewable power facilities in order to comply with the Bill's provisions [NHDES 2002]. New Hampshire also takes part in seasonal NOx allowances trading, and has a set-aside for renewable power. Bill 284 extends NOx trading over the whole year, but even so, the extra allowances gained by electricity companies from investing in projects would only cover part of the renewable power generation price and could not justify such investments.

## 3.3 Europe — Taking the Lead in Renewable Power

### *3.3.1 Initiatives at the European Union Level*

In November 1997, the European Commission (EU) adopted a White Paper which, for the first time, set out a comprehensive Strategy and Action Plan to achieve an ambitious goal — doubling the renewables share of the EU's total energy supply, from 6% to 12%, by 2010 [DTI-EU]. The Strategy's main features are the reinforcement of policies, such as agricultural and rural policy, regional policy, and internal market measures in the regulatory and fiscal areas, affecting market penetration by renewables. The strengthening of cooperation among EU Member States is also proposed, along with measures to facilitate investment and information dissemination.

The *Renewable Energy for Europe Campaign for Take-Off*, targeting the key renewable power sectors, represents a key element of the

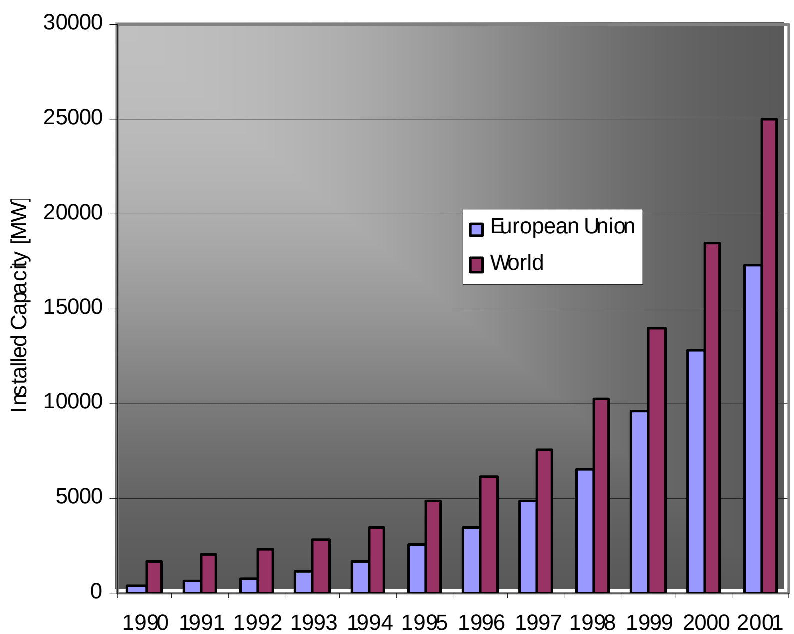



**Figure 3.10 — EU Share of World Wind Generation Capacity** [EWEA 2002]

**Table 3.4 — Estimated Contributions to EU Energy Supply, by Sector, in 2010** [DTI-EU]

| Energy Source | Contribution in 1995 | Contribution in 2010 |
|---|---|---|
| Wind | 2.5 GW | 40 GW |
| Hydro | 92 GW | 105 GW |
| - large | (82.5 GW) | (91 GW) |
| - small | (9.5 GW) | (14 GW) |
| PV | 0.03 $GW_p$ | 3 $GW_p$ |
| Biomass | 44.8 Mtoe | 135 Mtoe |
| Geothermal | | |
| - electricity | 0.5 GW | 1 GW |
| - heat (incl. heat pumps) | 1.3 GW | 5 GW |
| Solar thermal collectors | 6.5 million $m^2$ | 100 million $m^2$ |
| Passive solar | | 35 Mtoe |
| Others | | 1 GW |

$GW_p$: Gigawatts peak (capacity at peak radiation)

Strategy and Action Plan. Concentrating on the PV, wind and biomass sectors, the Campaign aims to accelerate the development of the Strategy in its early stages (to the year 2003) by stimulating increased private investment in renewables, with an emphasis on near-market technologies. The following deployment objectives will be pursued during the Campaign: 1,000,000 PV systems; 15 million $m^2$ of solar collectors; 10,000 MW of wind turbines; 10,000 $MW_{th}$ of combined heat and power biomass installations; 1,000,000 dwellings heated by biomass; 1,000 MW of biogas installations; 5 million tonnes of liquid biofuels. Investment opportunities will be highlighted by promotional activities focusing on the key sectors, and national and EU programmes and schemes will trigger and complement private capital. It is estimated that the Campaign will require

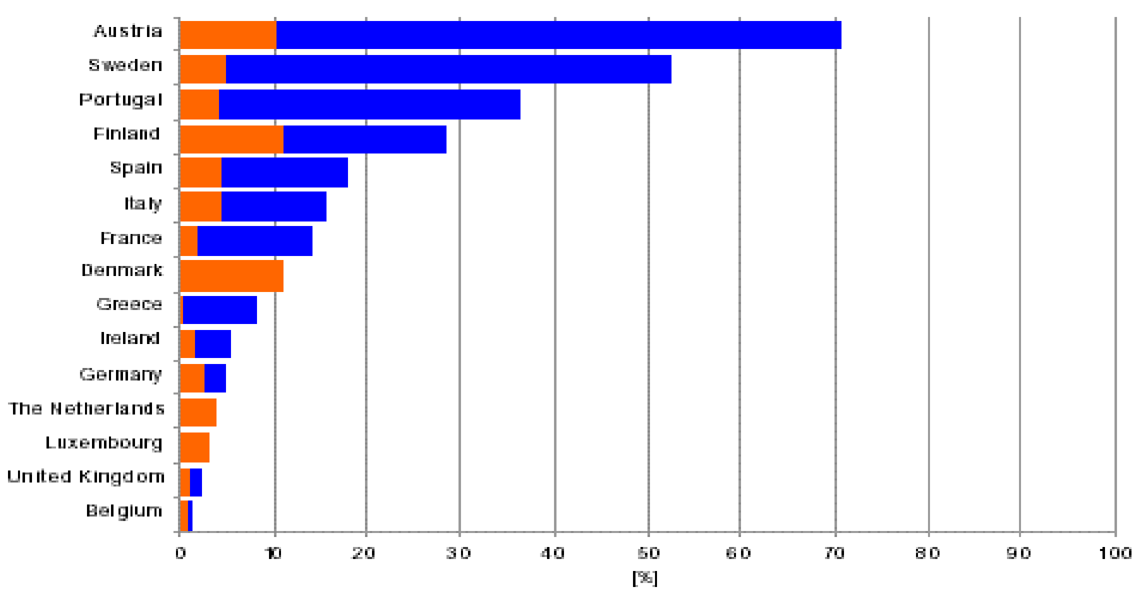



**Figure 3.11 — Share of Renewable Energy in European Electricity Production**
(blue: large hydro >10 MW; orange: all other sources) [Haas 2001, p. 7]

investment funding of around €30 billion in total, with 75–80% coming from private sources. Much of the necessary public funding is already in hand, mainly at the national level, but also from EU programs. The EU ALTENER program (a funding program for alternative energy) will be the main promotional tool for the Campaign. Indeed, ALTENER forms the basic instrument for implementing the Action Plan. As a whole, ALTENER will continue to support: the development of sectoral market strategies, at national, regional and local levels; the establishment of information and education infrastructures; the development of new market and financial instruments; and information dissemination activities.

In October 2001, the EU Directive on the promotion of electricity from renewables in the internal electricity market was passed [EU 2001]. The key features of the Directive are the following:

- Member States are required to adopt national targets for renewables that are consistent with reaching the Commission's overall target of 12% of energy (and 22.1% of electricity) from renewables by 2010; for example, the indicative target that the proposal sets for the UK is 10% of electricity (see Figures 3.12 and 3.13).
- The Commission will monitor progress and propose "individual and mandatory national targets," if needed.
- Introduction of a European system of "certification of origin" for renewables.
- Support schemes for renewables are left to Member States, but the Commission may propose harmonization at a later date, in case the set targets are not met.
- Member States have to ensure transmission and distribution from renewable electricity sources, and should give these sources priority access to the electricity grid.

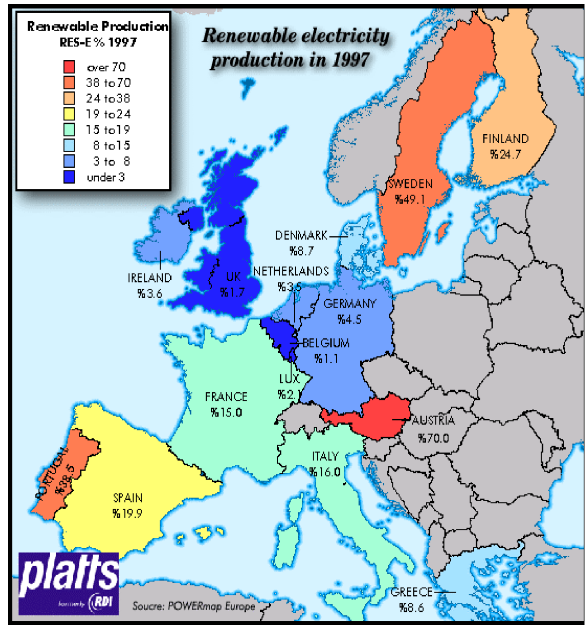



**Figure 3.12 — Actual Electricity Production from Renewables in EU Countries in 1997**

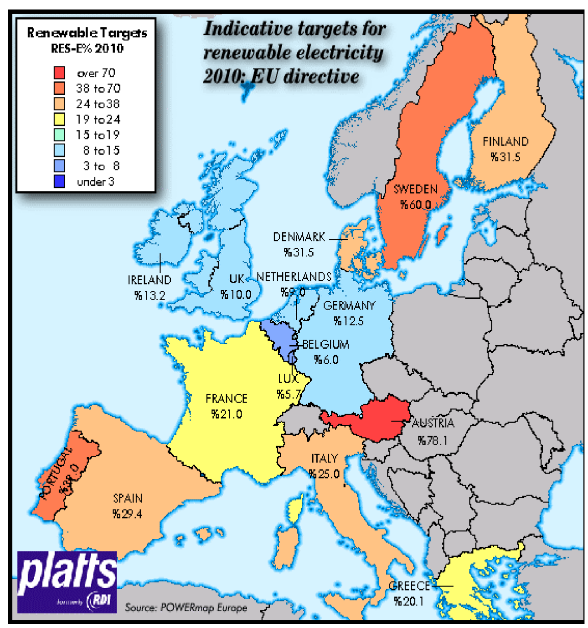



**Figure 3.13 — Indicative Renewable Electricity Production Targets for EU Countries for 2010 (including existing large hydro resources)**

Table 3.5 lists a few strategies applied so far by European governments to promote renewable power sources, whereas Figure 3.11 above gives an overview of the share of renewable power in current European electricity generation. Most prominent in Europe are Denmark and Germany for wind power, and Italy for the use of geothermal energy. The use of biomass (mainly waste-to-energy, landfill gas and sewage gas) is present in most countries, most prominently in Finland and Germany [Haas 2001, p. 10].

**Table 3.5 — Strategies to Promote Green Power in Europe** [Haas 2001]

| Year | Country | Type of Strategy | Program Name | Technologies Addressed |
|---|---|---|---|---|
| 1978–1985 | DK | Rebate | | Wind |
| 1989–1993 | DE | Rebate | "1000-Dächer-Programm" | PV |
| 1990–1999 | UK | Bidding | NFFO/SRO/ NI-NFFO | Selected technologies |
| 1990–present | DE | Regulated Rates | "Einspeisetarif" | PV, Wind, Biomass, Small hydro |
| 1991–present | SE | Electricity Rebate | "Bra Miljöval" | PV, Wind, Biomass |
| 1992–1994 | AT | Regulated Rates | 200 kW PV-Program | PV |
| 1992–2000 | IT | Rebate/Tax relief | "CIP 6/92" | All technologies |
| 1991–1996 | SE | Rebate/Tax relief | | Wind, Solar, Biomass |
| 1992–1997 | DK | Rebate/Tax relief | | Wind, Biomass |
| 1992–1999 | DE/CH/ AT | Regulated Rates | "Kostendeckende Vergütung" | PV |
| 1994–1999 | GR | Rebates | "Operational Programme for Energy" | PV, Wind, Biomass, Small hydro |
| 1994–present | ES | Regulated Rates | "Royal Decree 2366/ 1994" resp."R.D. 2818/1998" | All technologies (except large hydro) |
| 1996–present | DE/CH/ NL/AT/UK | Green tariffs | "Solarstrombörse" | Selected technologies |
| 1996–present | CH | Trading | Various brands | PV |
| 1998–present | DE | Labelled "Green Electricity" | TÜV, Grüner Stromlabel e.V., Öko-Institut | PV, Wind, Biomass, Small hydro |
| 1999–present | DE | Soft loans | "100,000 Dächer-Programm" | PV |
| 1999–2000 | NL | Green certificates | | All technologies (exempt municipal waste incineration) |
| 2000–present | DE | Regulated Rates | "Renewable energies law“ | Selected technologies |

### 3.3.2 Germany — A Wind and Solar Leader

*Government support for renewables in Germany was driven by awareness of export markets and inward investment.*

Germany restructured its electricity markets in 1998, with retail competition, including residential green power offerings, starting in August 1999. Green power sales had limited influence on new renewables creation: there are currently (2002) 325,000 German green power customers (about 0.75 % of all electricity customers), 75% of whom have selected products that are offered as green and based on 100% existing large hydropower. This can be explained by the fact that, initially, marketers priced these products below generic electricity, although more recently they have been offered at a 5-10% price premium [NREL 2002, p. 25]. Retailer NaturEnergy, which offers a large hydro product, was the first company offering a green power product on the German market and gained most of its large market share when its sister company, Energie Dienst GmbH, switched all of its 150,000 customers to the cheaper green product in 1999 (priced 10% below previous rates), similar to what happened in California. A second German retailer, Aquapower, has gained another 84,000 customers with its large hydropower product being priced below standard rates. Since it tries to market its green product at a premium, consumer interest has slowed down considerably [NREL 2002, p. 28]. Given that wind power now represents 3.3% of Germany's energy portfolio, it is clear that green power marketing has not created a significant pull for new renewables development. The reasons for Germany's wind boom (see Figure 3.14) must be found elsewhere.

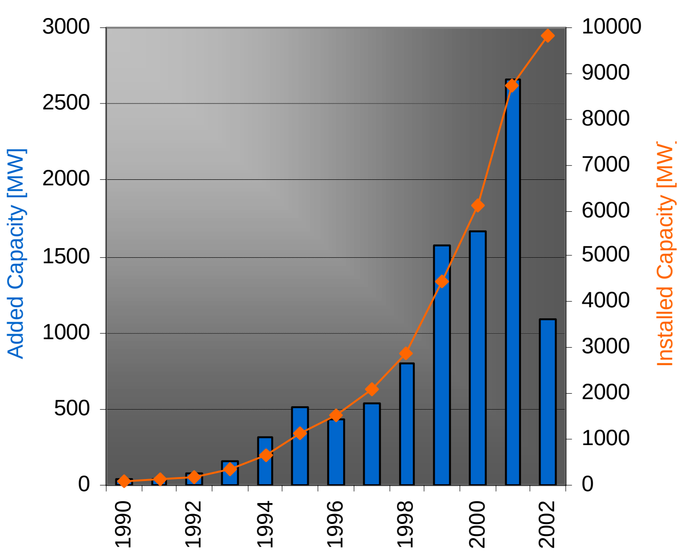



**Figure 3.14 — Added and Total Wind Power Capacities in Germany (as of June 2002)** [BWE 2002]

The country continues to lead the world in wind energy, with 12,250 wind turbines totalling 9,840 MW in generating capacity. The industry employs 35,000 people. The northern region of Lower Saxony harbours the largest amount of wind generating capacity, with 2,426 MW in operation. Schleswig-Holstein (1,555 MW) remains the leading region in terms of the proportion of wind electricity generation (28%), followed by Mecklenburg-Western Pomerania (21%), Saxony-Anhalt (11%), Lower Saxony (10%), and Brandenburg (9%) [AWEA 2002]. Germany also leads the way with photovoltaic purchases by building and homeowners with a 100,000-solar roof program, similar to the one in Japan (see Box 3.2). The government provides 10-year interest-free loans, with repayments

**Box 3.2 — Japan: A New Player in Photovoltaics**

Japan's Photovoltaics program strategy is principally focused on lowering the manufacturing costs for mass production of PV modules and developing the associated technologies needed to deploy such systems. A key element of the Japanese photovoltaic deployment strategy is their rooftop program. The program is a promotional instrument with the goal of removing the cost barriers by stimulating the demand for photovoltaics, promoting the popularization of residential PV systems and developing better manufacturing and system technologies and infrastructure. To-date, some 17,500 households have installed 65 MW of grid-connected photovoltaic rooftop systems. Japan set an ambitious target of 5,000 MW of installed modules as part of its plans to achieve compliance with the Kyoto protocol by supplying 3.1% of the primary energy demand based on non-carbon fuels by the year 2010 [CETC 2001].

Japan's renewable energy efforts are focused most specifically on solar photovoltaics for one obvious reason: on Japan's densely populated Island, there is room for PVs on rooftops, but little or only very costly room on the ground for wind turbines, biomass facilities and most other forms of renewable energy. The Japanese government's budget for renewables was 87.5 billion yen (C$1.2 billion) in 1999 [REPP 1999, pp. 18,22] — Canada's budget for renewables was $20 million that year (see chapter 4.7.1).

only starting after three years, and a guaranteed price of 50 cents per kWh of electricity sold back to the grid over a ten-year period. The program, begun in 1998, proved so popular, adding 45 MW in 2000, that the government had to place limits on funding for budgetary reasons [Moomaw 2002, p. 9]. The German government expects to see 500 MW of new PV capacity installed under this program between 1999 and 2005 (see Figure 3.15) [JLS 2002, p.17]. Awareness of potential world markets and export opportunities was a significant driver for government support for renewable technologies, both at federal and regional levels. The extent of support also creates a positive environment for inward investment, and Germany has become the country of choice for renewable power companies, such as Shell Solar [HCEAC 2002, p. 16].

The main reason for Germany's success lies in its feed-in tariffs for renewable power. Renewable power generators can sell their electricity to utilities at a guaranteed price far above wholesale prices (a percentage of the pre-tax retail price). The cost above the wholesale price is then evenly shared among all electricity consumers, similar to system benefits charges in the United States. In 2000, the German government significantly increased the feed-in tariffs, particularly for PV, which now receives about 51 €cents/kWh (CDN¢71/kWh), while wind generators get about 9 €cents/kWh (CDN¢12.6/kWh) [NREL 2002, p. 60]. Large hydro had originally been supported by the scheme, but is no longer included under the new 2002 feed-in tariffs. Table 3.6 provides an overview of German feed-in tariffs and other support mechanisms for renewable power.

In 1997, the Feed-in Law of 1991 was amended to include a clause that up to 5% of renewable power would have to be accommodated by all utilities. Due to rapid growth of wind power generation capacities in Germany this threshold was soon going to be reached for some utilities, placing an

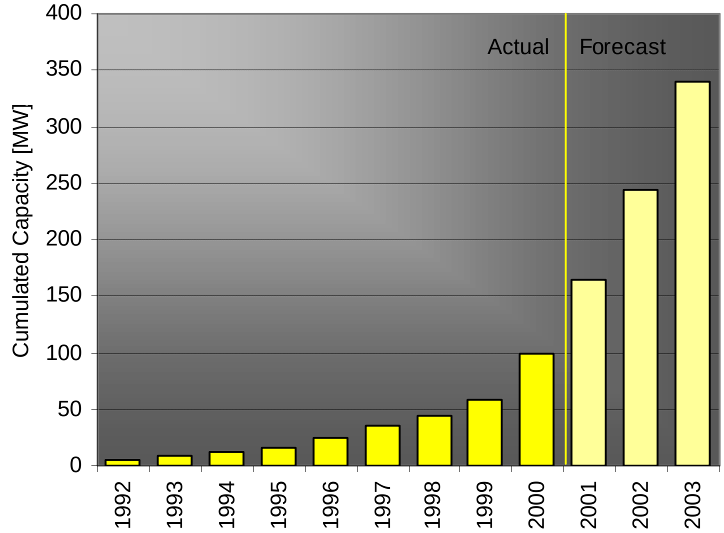



**Figure 3.15 — Installed Grid-Connected PV Capacity in Germany** [FJ 2002]

Before introducing the feed-in tariffs, Germany's renewable power support started out with the "100 MW Wind Program" in June 1989. As the program was very successful, it was extended to the "250 MW Wind Program" in February 1991. The program, which ran out in 1996, provided grants for the installation and operation of wind turbines at suitable sites. From the beginning, a "Scientific Measurement and Evaluation Program" was part of the support scheme. All turbines installed under the program are scientifically examined for ten years. The wind farms received both subsidies — up to 25% of the total investment, to a maximum of 150,000 DM [REPP 1999] (about $110,000 CDN) — and a production incentive of up to 6 Pfennig (4.4¢ CDN) per kWh in addition to the guaranteed feed-in prices [ENER 2001a, p. 15]. By the end of 1996, more than 1,500 MW of wind capacity had been installed in Germany.

unequal burden on Northern utilities, where wind deployment was highest. German utilities tried to crush the Law in the courts, claiming it was unconstitutional, a subsidy to renewable power producers, and that it treated utilities unfairly by putting the burden to pay for the extra cost of renewable power generation on them. However, all court cases brought forth against it were defeated, even up to the European Court of Justice [ENER 2001a, p. 14]. Due to the uncertainty of the incentive when legal action was first brought forth against it, the rapid growth of wind energy deployment was halted in 1996 (see Figure 3.14). It rebounded quickly over the following years, as the constitutionality of the legislation was confirmed [REPP 1999]. In 2000, the new Renewable Energy Sources Act removed the cap and distributed the burden among all German transmission network operators, thereby creating an equal share of renewables for all distributors and suppliers [EEA 2001, p. 41]. This development is of importance for Canada as our coastal areas have the best renewable resource potential (see chapter 4.8.3.2) and could be subjected to similar burdens if a comparable system is introduced here.

Apart from the feed-in tariffs, which assure investors of long-term secure returns of wind power projects, Germany's Deutsche Ausgleichsbank (DtA) played an important role in wind power deployment: nearly all wind power plants were financed to up to 30% with cheap loans provided through the DtA, which are 2–3% below the usual interest rates [FIRE 1998, pp. 54,22]. For wind, as for most renewable power projects with high capital and small operating costs,

*The Electricity Feed-in Law has been very unpopular with German utilities, to the extent that some refused to pay the feed-in tariff and went to court, trying to crush the Law.*
FIRE 1998, p. 23

**Table 3.6 — Incentives for Renewable Power in Germany** [EEA 2001, p. 37ff.; ENER 2001b]

| Technology | Incentives (1990s) | New 2002 Feed-in Tariffs |
|---|---|---|
| Solar PV | Feed-in tariff: raised from € 0.08/kWh to € 0.51/kWh (71¢ CDN/kWh) in April 2000 — this led to oversubscription of the program.<br>1000 Roofs Program: since 1991, subsidized 50–60% of investment cost for distributed solar panels; extended to the 100,000 Roofs Program in 1999 (€650 million). The target is expected to be achieved in 2003 — one year earlier than planned. | 48.1 €cent/kWh (67.3¢ CDN), reduced by 5% per year |
| Wind | Feed-in tariff: DM 0.1715/kWh (12.6¢ CDN/kWh).<br>Tax-deductible investments in wind energy projects to encourage citizens to provide funds to wind park development.<br>Regional Government subsidies (e.g. Northrhine Westfalia).<br>Cheap loans (1.91% interest rate in 2001) for up to 50% of investment cost through the Deutsche Ausgleichsbank (€1.78 billion/$2.5 billion CDN have been given to wind projects between 1990 and 1997).<br>Planning guidance to determine areas open and closed to wind development, as well as national land use directives indicating how much renewable power should be developed in each region, are being developed. | **Onshore:**<br>first five years:<br>9.00 €cent/kWh (12.60¢ CDN),<br>afterwards:<br>6.17 €cent/kWh (8.64¢ CDN), reduced by 1.5% per year<br><br>**Offshore:**<br>first nine years:<br>9.00 €cent/kWh (12.60¢ CDN),<br>afterwards:<br>6.17 €cent/kWh (8.64¢ CDN), reduced by 1.5% per year |
| Small Hydro/ Biomass/Waste | Feed-in tariff: DM 0.1492/kWh (11.0¢ CDN/kWh) | Small Hydro/Landfill gas:<br>7.67 €cent/kWh (10.74¢ CDN)<br>Biomass (> 5MW):<br>8.60 €cent/kWh (12.04¢ CDN), reduced by 1% per year |
| Large Hydro | Feed-in tariff: DM 0.1212/kWh (8.9¢ CDN/kWh) | Geothermal[1] (> 20MW):<br>7.16 €cent/kWh (10.02¢ CDN) |

[1] Large hydro does not benefit from feed-in tariffs under the new Act.

**Table 3.7 — Evolution of the German Electricity Tax, in €cent per kWh** [SSDE 2002]

| 4/1999 | 2000 | 2001 | 2002 | 2003 and later |
|---|---|---|---|---|
| 1.02 | 1.28 | 1.53 | 1.79 | 2.05 (2.9¢ CDN) |

a decrease in investment cost translates nearly proportionately into a decrease of production cost [ibid., p. 93]. Government support is sometimes seen as conflicting with green power marketing, as customers do not want to pay premiums for products that are already sufficiently supported by these programs. Certification organizations, in particular OK-Power, have tried to address this issue by setting standards for the inclusion of government-subsidized capacity in green power products [NREL 2002, p. 29].

In 1999, Germany introduced an energy tax, in the framework of its ecological tax reform. This tax increases over time (see Table 3.7) and renewable power is exempt from the tax. Tax reductions are available for energy use during off-peak times or for certain sectors, such as agriculture [SSDE 2002]. Most of the funds raised through the electricity tax are returned to the citizen through a reduction in pension insurance contributions. €200 million per year, or €250 million (C$350 million) in 2003, will be used to support renewable power deployment [BMU 2002].

### *3.3.3 Denmark — People Power*

Denmark has been very successful in increasing its renewable power portfolio (see Figure 3.16). Denmark is now the nation with the highest proportion of electricity generated from wind (18%), and generates about 6% of its electricity from biomass. With 27% of its electricity expected to come from renewables in 2002, Denmark is well ahead of its national goal of 20% by 2003 [AWEA 2002]. This has been accomplished in the absence of any green pricing or marketing schemes, in which consumers opt for green electricity products [DWIA 2001].

The secret of Danish success has been, like in Germany, the use of feed-in tariffs, in combination with other incentives: a 4.4 €cent/kWh feed-in tariff is paid for wind over a ten-year period. In addition, a renewable power production incentive of 2.3 €cent/kWh is paid to all renewable power projects; finally, all renewable power is exempt from the 1.3 €cent/kWh $CO_2$ tax. The funds for the production tax credit are covered by the $CO_2$ tax revenues [IEA 1998b]. Like in Texas,

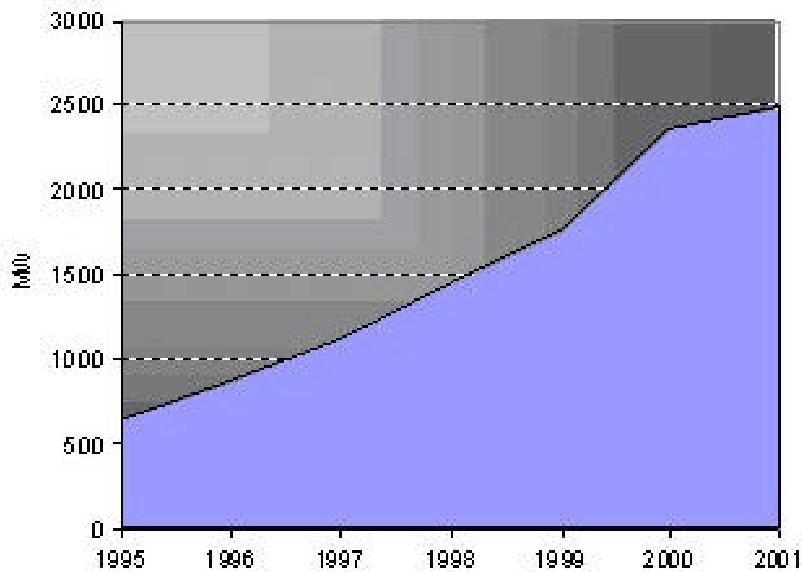



**Figure 3.16 — Installed Wind Generating Capacity in Denmark** [BWE 2002]

the infrastructure to integrate wind farms into the electricity grid is paid for by all consumers [HAAS 2001, p. 22f.]. The feed-in tariff, together with the production tax credit, represents a per-kWh support equivalent to 9.4¢ CDN/kWh.

In addition, Denmark has implemented a set of measures, including ensuring that the energy supply to small communities is met by biomass-based district heating of CHP (rather than natural gas); increasing the flexibility of regulations governing the quantities of wood chips and straw to be used in electricity generation; making wind turbine planning a regular feature of regional and municipal planning; promoting solar heating through collaboration with energy distribution companies; and setting up a demonstration geothermal plant. The 1997 Biomass Agreement requires energy companies to use at least 1 million tons of straw, 0.2 mt of wood chips and 0.2 mt of either straw, wood chips or willow per year, in order to minimize the need for expensive imports of straw from neighbouring countries. Total biomass incineration should be 19.5 PJ/year (0.46 Mtoe) from 2000 onwards. Another part of the plan allows individual towns and communities to adopt, if they wish, biomass technologies on their own initiative [IEA 1998]. Switching fuels from coal to biomass is supported with an investment subsidy of nearly 50% [FIRE 1998, p. 22]. Denmark is also on its way to becoming a world leader in wave energy. The Danish Wave Energy Program was initiated in 1998 and is funded with €5.3 million (about $7.4 million CDN) over a period of 4 years. The Program is designed to involve the general public and has allowed for over 40 different concepts to be evaluated, nine of

**Box 3.3 — The Danish Wave Power Initiative**

In Denmark, wave energy has an appeal to what one could call the “popular engineering spirit.” Many people have ideas for wave-energy machines and started testing them in their backyards. Many of these people and inventors, firms and institutions are organized as the “Association for the Promotion of Wave Energy,” which was established in 1997. Important government funding was obtained as the left-wing party, the Unity List, which favours wave energy over biofuels for ecological reasons, joined the ruling party to support wave energy in 1997.

Denmark’s new initiative is building on its success with the development of wind turbines, which in contrast to other countries was truly built on broad popular interest and initiative — a “bottom-up” development. Instead of its old wave-energy program, which focused on the development of one single technical concept, the new program has its popular and political base in the “Folk Center for Renewable Energy,” an independent institution under the Danish Energy Agency, which develops sustainable energy technologies for Danish firms with state funding. A network of about 300 individuals, private companies and institutions interested in wave energy has been developed since 1993 by writing articles, holding conventions at regular intervals and issuing letters and information.

An important factor is the openness of the entire process, to allow all those involved to participate in a process of development and learning, so that one concept can fertilise another and design components be transferred from one concept to another, to concentrate on a handful of machines that will pave the way for the final breakthrough of wave energy [WEDK 1998].

which are now further supported. Denmark hopes to repeat its success with wind power deployment, which made it the leading technology exporter of wind turbines, with wave energy (see Box 3.3) [TUD 2000].

An important feature of Denmark's renewable power structure is the fact that many citizens own shares of wind power plants. In a 1999 report, a number of 100,000 families were quoted as participating in such schemes [REPP 1999], and this has certainly contributed to local acceptance and the overall success of wind power in Denmark, combining the "top-down" approach of mandatory feed-in tariffs with the "bottom-up" involvement of the locals.

The Danish wind power policy changed after a centre-right government took office in 2001. Guaranteed minimum prices for wind energy, significantly above market prices, will be abolished in 2004 and three out of five planned offshore wind parks have been scrapped. Denmark still plans to build two offshore wind farms in 2002 and 2003 with a total capacity of 300 MW, but three additional projects of 150 MW each have been cancelled [REU 2002]. Denmark was planning to replace the feed-in tariffs by an RPS with certificate trading in 2003 [DWIA 2001], but the proposal was shelved due to massive concerns expressed during a public hearing about the new system. An RPS is considered to be necessary by EU member states as there is a continuous effort to harmonize subsidies and support systems, and the tariff-based support for renewable power may not survive such harmonization [ibid.]. It is therefore possible that Europe will move away from feed-in tariffs and towards the RPS over the coming years, as the Renewable Energy Directive creates the infrastructure of Europe-wide certificate trading.

### *3.3.4 The Netherlands — Demand Exceeds Supply*

In the Netherlands, green electricity was first introduced in 1995, and all 12 electricity distribution companies have offered green power since 1999. Through the last two years, the number of residential green power customers has exploded from 140,000 in the year 2000 to 1,000,000 households (July 2002); the one million household mark will probably be reached in the summer of 2002. With 13% of residential customers, this is the highest subscription rate in the world. Reasons for this impressive increase are the liberalization of the Dutch market for green energy as of July 1, 2001, in concert with several regional and nation-wide marketing campaigns organized by the Dutch energy companies, but the main reason is the energy tax exemption for green electricity, which reduced the premium to be paid for renewable electricity products.

Market opening has been gradual and proceeded over several years in the Netherlands: until 2004, green electricity will

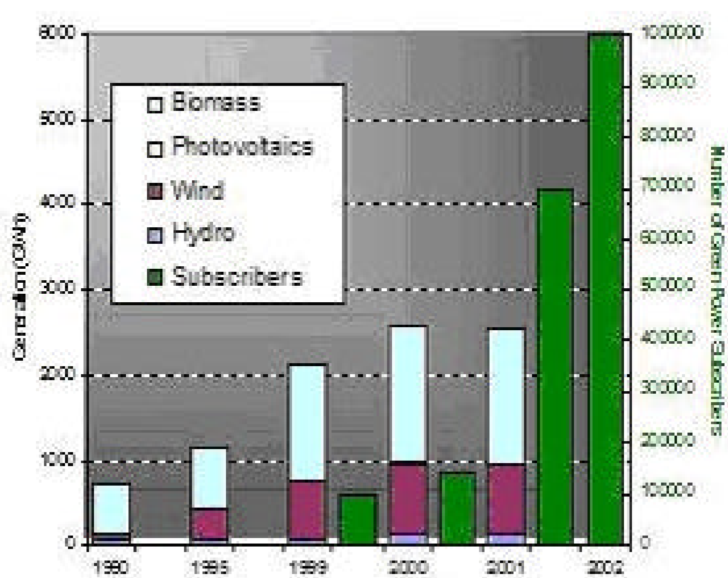



**Figure 3.17 — Growth of Green Power Demand and Supply in the Netherlands** [NOVEM 2001, NREL 2002, p. 33] Note: All hydropower in the Nether lands (38 MW total) is small or micro-hydro

be the only electricity product that residential customers can switch to (industrial consumers can choose other products as well). This has opened new markets for retailers that could only serve customers in their own service area, and led to the above-mentioned intensive marketing activities, with power retailers trying to attract as big a share of this new market as possible [MEZ 2001b]. A gradual increase of the energy tax has only helped these developments (see Table 3.8), bringing green electricity prices close to those of conventional products, with some retailers even undercutting current rates since early 2002. In addition, green power products are offered by established energy companies so that most customers do not have to switch providers in order to buy a green energy product. Finally, the market is supported by a media campaign launched by the World Wildlife Fund, a well-known global environmental organization. This was very important at the beginning, when no other mechanisms to support green power credibility were available, and continues to be so as products complying with WWF's criteria are allowed to carry the popular WWF logo [NOVEM 2002].

**Table 3.8 — Evolution of the Dutch Energy Tax** [MEZ 2002b]

| Year | Tax paid by small consumers (up to 10,000 MWh per year) in €cent/kWh |
|---|---|
| 1998 | 1.35 |
| 1999 | 2.25 |
| 2000 | 3.72 |
| 2001 | 5.84 |
| 2002 | 6.01 |

Demand has also been driven by government procurement. Four ministries cover their entire energy consumption with green energy. As part of a national strategy to achieve carbon neutrality, the Dutch government plans to purchase green power to meet 50% of the public sector's electricity needs during 2002–2004. However, as mentioned before, the most important market driver is the tax exemption for green power purchases — green power customers are exempt from this levy. Exemptions from the Regulating Energy Levy (REB) are granted through an electronic certificate trading system. Each green power producer is eligible for green certificates (available for 1, 10, 100 or 1,000 MWh of electricity produced), which are further discussed in the section on green tags (see chapter 5). Introduced in 1997, the levy has increased substantially each year since then, particularly for small consumers using less than 10,000 kWh/year. Figure 3.18 shows the price evolution of electricity as a function of REB increases. Together with the production credit, the levy has made

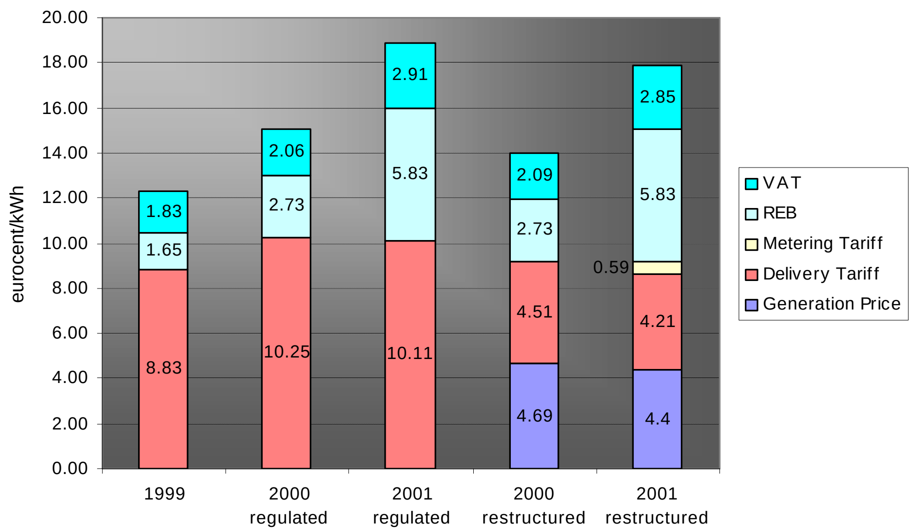



**Figure 3.18 — Evolution of the Dutch Electricity Price Due to Rising Ecotax (REB) Rates** [MEZ 2002a, p. 46] ***Note: So far, only 63% of the market has been restructured. The remainder will follow by January 2004. Tax rates are averaged between small and large consumers.***

green power more cost-competitive with conventional power: currently the major green power marketers charge either no premium or a small premium of 1.5–9.5%. Figure 3.19 illustrates the income per kWh generated for a wind power producer, and the margin that electricity retailers can achieve by buying green certificates: paying the wind farm 3 €cents/kWh for the certificates and selling the electricity at the same price as conventional electricity results in a 3 €cent gain (4.2¢ CDN) per kWh, as the REB exemption is worth 6.01 €cents. Greenchoice sells an 80% wind and 20% biomass product at a 2.6% discount [NREL 2002, p. 34]. A soccer club has teamed up with energy provider EnergyXS and offers green energy at a 5% discount to its members; the same energy company also works with the Union of Pig Farmers to offer the members green energy. As of 2002, Energiebedrijf has offered its green power product at a 25% discount [GP 2002c].

To provide extra funds for investment in green projects, the government has exempted so-called "green funds" from income tax, and they are now important investment sources for renewable power projects (see Box 3.4). However, the country's green energy resource development has not kept up with this pace of increased demand (see Figure 3.17). For wind energy, 2001 was still an average year, with the installation of 63 turbines having a total capacity of 42.25 MW. Total installed capacity now stands at 483 MW, and annual wind energy production at 988 million kWh, or 0.91% of national demand. The average yearly increase since 1994 has amounted to 44.4 MW. That is less than half the official goal of the Ministry of Economic Affairs (100 MW per year, going to 1,500 MW by 2010) [AWEA 2002]. It is expected that the rate of installation will increase in the coming years, but with a current overall Dutch capacity sufficient for only 550,000 households, much of the green electricity has to be imported [DE 2002a]. Some Dutch utilities have even stopped advertising their green power products or have begun wait-listing customers because they could not supply enough domestically generated green electricity [NREL 2002, p. 33]. With current trends continuing, the renewables share of Dutch power generation would be 3.5% by 2010, somewhat short of the Dutch goal of 5% [MEZ 2002a, p. 69], and far lower than the indicative 9% target set by the European Renewables Directive (see Figure 3.13).

*Dutch Green Power sales have increased ten times between the years 1999 and 2002.*

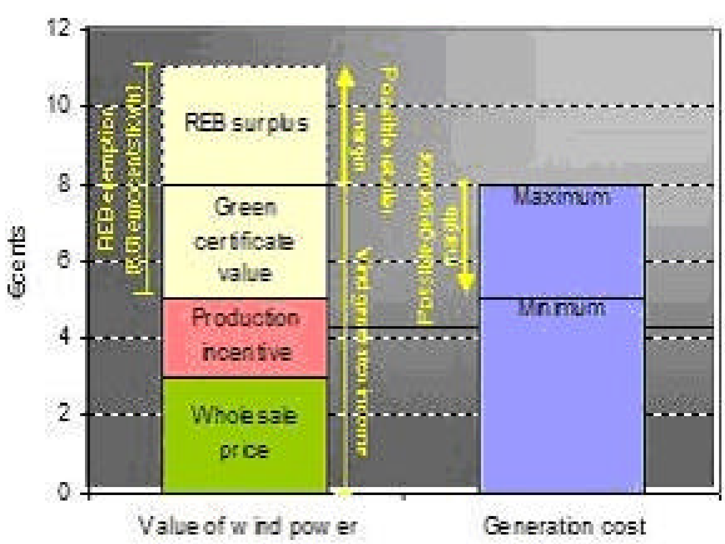



**Figure 3.19 — Effect of the REB on Wind-Generated Electricity** [MEZ 2002b] ***The REB exemption, worth 6.01 €cents per kWh, is split between the power producer, who sells the green certificate for half the amount of the REB exemption, and the retailer, who can earn a margin with the REB surplus.***

**Box 3.4 — The Dutch Green Funds**

The interest gained on investments in green funds is not subject to income tax in the Netherlands. These funds also support renewable energy projects, and had attracted €260 million in 1998 ($356 million). The funds have a return of 4% and especially helped wind projects in the Netherlands. Loans are provided for 1–2% less than current rates to green projects. Instead of projects having to look for investors, fund administrators usually actively look for projects they can invest in, further facilitating the position of project developers [FIRE 1998, p. 54].

The two main problems causing this lag have been identified as difficulties of finding suitable sites for renewable power projects, and very long permitting procedures, which can delay the realization of projects by five to ten years [MEZ 2002a, p. 71]. Nevertheless, wind resources have been estimated to be 1,500 MW on-shore by 2010 and another 6,000 MW off-shore by 2020, plus a considerable possible growth margin for biomass co-firing with coal [p. 70]. The Dutch government has created a new initiative (Bestuursovereenkomst Landelijke Ontwikkeling Windenergie, BLOW) in order to streamline efforts to foster renewable power in each Province. Talks with market players have shown that there are market uncertainties with respect to the continuity of financial incentives provided by the government, as these determine the long-term financial viability of investments in green power. The government has declared it wants to address these concerns as well [ibid., p. 74].

*High demand for green power does not necessarily lead to increased green power deployment unless planning and investment conditions are also favourable.*

The Dutch government is concerned about securing green electricity supplies, as a large percentage of green electricity is currently imported. There are fears that a change in national policies abroad could redirect these electricity products towards national consumption, resulting in shortages of green electricity supply in the Netherlands [MEZ 2002a, p. 70]. In fact, the Ministry of Finance is considering replacing the Ecotax scheme by direct subsidies to renewable power projects inside the Netherlands in order to stimulate local supply [GP 2002d]. As retail markets open up to full competition, including conventional electricity in 2004, Dutch green power customers may switch back to those energy sources if prices for green electricity rise compared to the default price, due to planned budget cuts. As of 2003, the new Dutch government will reduce the REB to 3.5 €cents/kWh, and a new mechanism, the MEP (environment-friendly energy production) levy, similar to a system benefits charge, will be used to raise €250 million in order to continue paying the 2 €cents/kWh production incentive to renewable power producers so retailers will not have to increase their prices for green energy [GP 2002e].

The Dutch example provides a very important lesson for Canada, as Canada may be affected by electricity trade with the US in two ways. If US policies increase green electricity demand across the border, many Canadian suppliers may find it more lucrative to sell their electricity to the US grid. On the other hand, if Canada chooses a policy that creates high demand for green electricity, but does not give enough support to increase domestic generation capacities, it may find itself in a similar situation as the Netherlands and will have to allow the import of green electricity in order to fulfill national portfolio targets, limiting the environmental and economic benefits to its citizens.

## 3.4 Great Britain — A System Overhaul

### *3.4.1 The Non-Fossil Fuel Obligation*

*The British NFFO has been less successful than renewable energy policies in Germany and Denmark* [CMUR 2001, p. 302].

Long before customer choice was introduced, the British government introduced the Non-Fossil Fuel Obligation (NFFO), and required the Regional Electricity Companies in England and Wales[9] to buy renewable electricity generated from facilities that were accepted through the NFFO tendering process. This process was carried out by the specially created Non-Fossil Purchasing Agency (NFPA). Renewable power providers could tender for inclusion in the NFFO by submitting an offer based on a price per kWh. NFPA then selected the companies offering the lowest prices, but also applied quotas according to different technologies, so that no single technology could completely dominate the market. In practice, the total cost of all projects tendered for each technology band was calculated based on the expected output in MWh, and a cut-off price was then determined for each band depending on the overall budget [CMUR 2001, p. 288]. The budget was set to £150 million (C$338 million) a year, with an obligation to reduce the cost over time, which led the Department of Trade and Industry to declare more expensive or risky technologies, such as offshore wind and energy crops, ineligible [ibid., p. 289]. Solar PV was also not supported by the NFFO [FIRE 1998, p. 25].

Between 1990 and 1998, NFPA tendered five times for renewable power projects. The resulting Non-Fossil Fuel Orders required electricity companies to purchase all generation within their local area that was contracted through the tendering process at predetermined prices from the NFPA. Such prices were administered according to expected costs for the type of technology in question and therefore tended to be above the wholesale price. An average price of 2.71 p/kWh (6.1¢ CDN/kWh) was provided to 261 projects with a total Declared Net Capacity[10] (DNC) of 1,177 MW during the fifth and latest NFFO round in September 1998. The contracts were for a relatively long period (up to 15 years and price index-linked) to facilitate bank finance.

For those schemes contracted and operating, a surcharge per unit of output was guaranteed for the whole contract period. The Regional Electricity Companies only had to pay the current Pool Selling Price (wholesale price). The difference between the surcharge paid to NFFO generators (premium price) and the wholesale price was covered by a compensation payment to electricity companies financed through the fossil fuel levy imposed on all electricity sales of licensed electricity suppliers. The cost of this levy was passed on to consumers. The levy (about 0.3% of the retail price) remains now only to continue the previously contracted arrangements [Haas 2001, p. 19].

The five Orders (NFFO1–NFFO5) resulted in the addition of less than 1,000 MW of new renewable generation by the year 2000, and did not meet the set target of 1,500 MW. While the volume of renewable capacity has increased with each NFFO round, the volume of NFFO schemes coming to market has been disappointing, as depicted in Figure 3.20. The shortage of NFFO 4 and 5 schemes can partially be attributed to the development lag following each site being awarded with a NFFO contract (usually at least two years). However, only 37% of NFFO 2 and 41% of NFFO 3 schemes have so far successfully come to market.

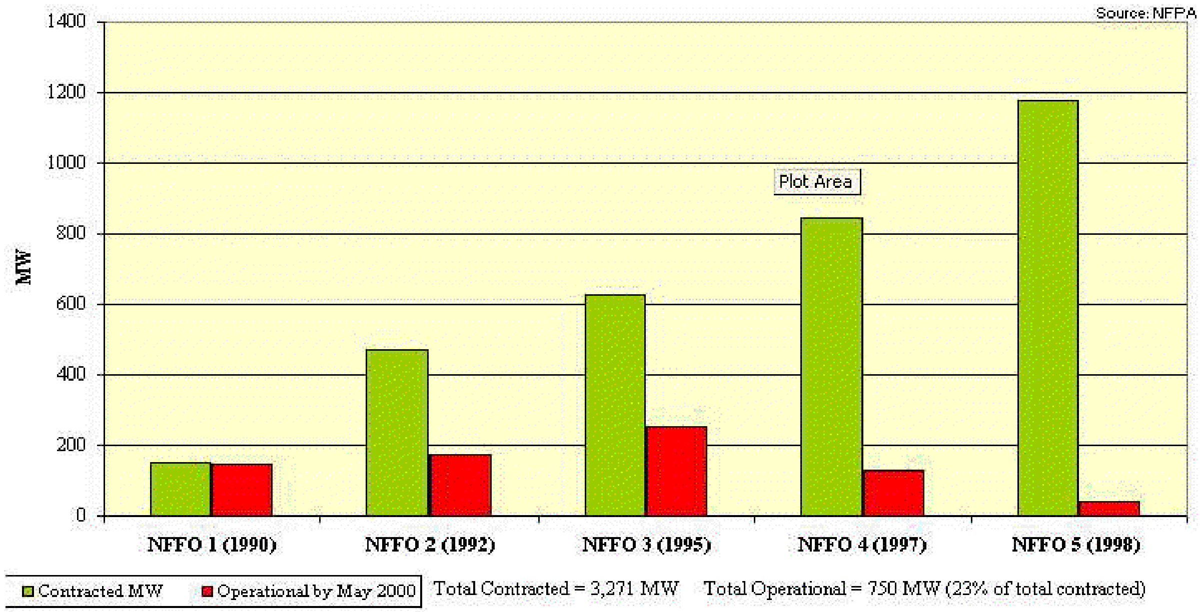



**Figure 3.20 — Contracted and Commissioned Capacities of NFFO Renewable Orders**
[RT 2002]

Three main reasons have been identified for this situation: first, the NFFO was very competitive and many bidders used best scenarios and anticipated technology cost reductions to make their bids. The program structure thus invited speculative bidding, even if the chances for realizing a project were not high. A possible remedy proposed for this flaw is to incorporate a penalty for projects that are not commissioned. Second, many projects — especially wind projects — failed to obtain planning permission, with an overall success rate of only 25% in England and Wales [HCEAC 2002, p. 27]. However, the bidding process did not emphasize the probability of obtaining planning permission, but only the price, which may have prejudiced the choice of sites for the projects. There was considerable local resistance against many NFFO projects, which has been attributed to the British government's failure to secure the support of local and regional levels of government, and to encourage initiatives at those levels as well [EEA 2001, p. 57]. Third, some eligible projects were based on new approaches, such as energy crops or forestry and agricultural waste technologies, and no demonstration projects had been realized yet. Such projects often failed to make it to commissioning as there was not enough R&D support due to government cuts in these programs and failure of the private sector to make up for the cuts. Finally, although the NFPA expected that at least one-third of the contracts would not be realized, they still were obliged by the treasury not to grant more contracts than they had funds for. This further reduced the possibility of achieving higher success rates in terms of MW commissioned [CMUR 2000, p. 297f.].

A major difference between the German/ Danish and the British system is that the support for renewables on the Continent is open-ended, with feed-in tariffs allowing as many renewable power plants to go on-line as can work under the price conditions set by the feed-in tariffs. As the NFPA had to work with a limited budget, the number of projects that could be supported was also limited. Of course, schemes developed within the Scottish Renewable Order and the Northern Irish NFFO will also contribute towards the 5% and 10% targets alluded to within the Renewable Obligation. There have been three Scottish

Renewable Orders (1994, 1997 and 1999) providing a total of 336 MW of contracted projects, from which only 28 MW of capacity has so far come to market [RT 2002].

One success of the NFFO was that it enhanced competition, and average per-kWh prices dropped from 7.0 p/kWh for NFFO1 to 2.71 p/kWh for NFFO5. For each new NFFO tender, the average price of the last tender virtually stood for the amount that had to be undercut. This was due to price reductions in virtually all technology bands — with wind being the foremost. Wind generation prices fell from 10 to 2.88 p/kWh, translating into a reduction of the subsidy per kWh from 7.2 p to 0.22 p [CMUR 2001, p. 292].

The Fossil Fuel Levy (FFL) was not only used to support renewables deployment, but (mainly and foremost) to subsidize the nuclear industry. Initially, most of the FFL funds (90–100%) went towards state nuclear power stations.[11] As these were privatized, the relation started shifting in 1996, until no more payments were made to the nuclear energy sector by 1999. At the same time, the amount to be collected through the FFL, which is redetermined each year, was reduced from over a billion pounds per year to 50 million pounds in 2000, or from 11% of the average electricity bill to 0.3%. The NFFO has been praised for being successful in reducing the cost of renewable electricity generation, and while the cost to society was cut through lower prices paid to developers (in conjunction with falling costs for renewables worldwide), it is much less clear that the NFFO has produced cost reductions from the perspective of the developer, because much of the renewable technology implemented under the NFFO was imported, frequently from Denmark and Germany. NFFO cost reductions likely came at the expense of profits to the renewable industry, and few domestic benefits were gained. This has produced low-cost renewable implementation in the UK, whereas renewables have been more expensive to implement in nations using feed-in tariffs, which are sometimes paying twice as much for implementation compared to NFFO prices. However, the renewables industries of other countries are much stronger, and their implementation rates much higher.

*While renewable projects were implemented more cheaply in the UK than in other countries, this happened at the expense of reduced benefits for renewable electricity generators and of little capacity building or job creation inside the UK.*

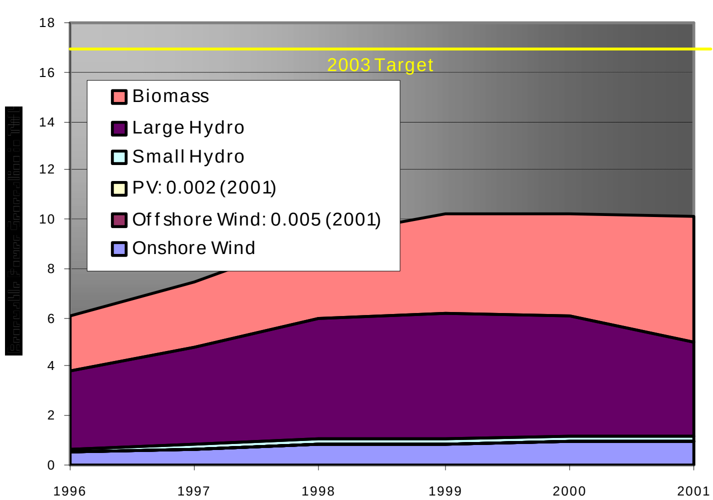



**Figure 3.21 — Renewable Energy Deployment under the NFFO** [ETSU 2002]

Non-large hydro renewable power generation has increased steadily over the past few years. However, only 2.8% of the UK's electricity was produced from renewables in the year 2000, and trends indicate that the original 2003 goal of 5%

(including large hydro resources) will not be reached (see Figure 3.21). Another criticism of the NFFO was that the tendering process favoured large companies that were able to achieve economies of scale, disallowing small investors, independent developers and the domestic renewable power manufacturing industry to benefit from the scheme [REPP 1999, p. 14] — in stark contrast to Denmark, for example, where individual inventors are encouraged to participate and where the locals are involved in many of the renewable power projects.

The replacement of the electricity wholesale market (The “Pool”) by a commodity type market under the “New Electricity Trading Arrangements” (NETA), together with the limited success of the NFFO, has led the UK government to choose a different approach to deploy renewable power. Although existing NFFO schemes will continue to receive their contract prices through the NFPA, no new renewable schemes will be subsidized under the NFFO. A new Renewables Order has been written into section 62 of the Utilities Act 2000. Scotland has a separate Renewables Obligation for power providers active in its territory [RT 2002].

### 3.4.2 The Renewables Obligation Order

The Renewables Obligation Order (ROO) replaced the NFFO, with renewable power portfolio targets applicable as of April 1, 2002. The main features distinguishing it from the NFFO are the introduction of a certificate trading system instead of the NFFO tendering process, and obligatory renewable portfolio targets applied to electricity suppliers, similar to RPS obligations in North America.

For 2002, the ROO requires 3% of electricity to be purchased from renewable sources, which would be matched by a market demand of 675,000 households [FOE 2002]. The Obligation increases in several steps to 10.4% in 2010 and stays at that level until the year 2027 [UK 2002]. These targets require a build rate of slightly less than 1,000 MW per annum over the nine-year period 2002–11. Assuming the technology mix suggested by the regional assessments under the high scenario, this number breaks down to 470 MW/yr for onshore wind and 165 MW/yr for offshore wind, shown in Figure 3.22. These wind build rates can be compared with recent rates of wind build in Continental Europe of 300–350 MW/yr in Germany and Denmark, 50 MW/yr in the Netherlands, and 400–700 MW/yr in Spain. The biomass contribution translates into an average annual build rate of 90 MW/yr. Build rates for other technologies total about 100 MW/yr.

Energy producers must prove for each fiscal year that they have created or purchased enough

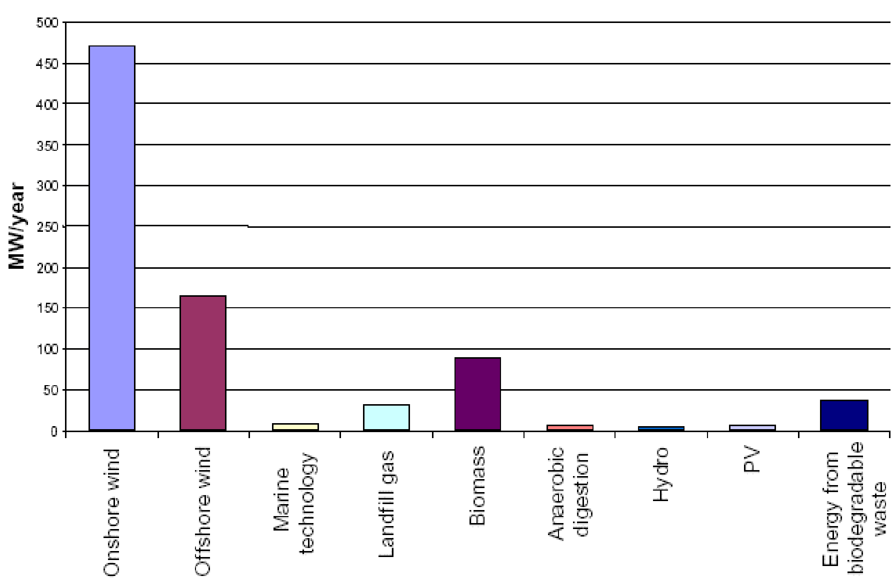



**Figure 3.22 — Expected Annual Split Between Technology Bands Under the New Renewables Obligation** [DTI 2002a, p. 13]

Renewables Obligation Certificates (ROCs, issued for each unit of eligible renewable power production), or pay a penalty of £30 per MWh (6.75¢ CDN per kWh) [UK 2002].

The NFFO Fossil Fuel Levy could no longer be raised due to electricity restructuring [CMUR 2000, p. 307]. The Finance Act 2000 introduced the Climate Change Levy (CCL), which only has to be paid by non-domestic electricity customers at a rate of 0.43p/kWh (about 1¢ CDN/kWh) since April 1, 2001. The Government is returning the revenues from the CCL to the non-residential sector, principally through a cut in the rate of employers' National Insurance Contributions of 0.3 percentage points. Businesses will also benefit from schemes aimed at promoting energy efficiency and stimulating the take-up of renewable sources of energy (e.g., solar and wind power). £50 million per annum of revenue will be allocated to these schemes — a major increase from current levels of funding.

There is also a scheme of 100% first year capital allowances for certain energy saving investments, which is expected to be worth up to £70 million in 2001/02 [DEFRA 2001].

Electricity from qualifying renewable sources is exempt from the levy [OFREG 2001], and renewable power producers can trade their Levy Exemption Certificates (LECs, see Box 3.5), together with the electricity produced, to suppliers with industrial consumers wanting to save on the CCL. This creates a second source of income on top of the ROC trading scheme. Contrary to the taxes applied to electricity in Sweden and the Netherlands, this levy has a more limited approach as it does not apply to residential customers. Moreover, its impact has been further diminished by the fact that many industry associations have already entered into voluntary agreements to reduce $CO_2$ and have negotiated tax reductions of up to 80% [NREL 2002, p. 48].

**Box 3.5 — Levy Exemption Certificates**

Levy Exemption Certificates (LECs) are evidence of CCL exempt electricity supply generated from qualifying renewable sources, including large hydro and waste incineration. Accredited generators may need to provide monthly meter information to OFGEM (possibly electronically by an outside agent). Generators will also need to provide details of the supplier(s) contracted to purchase the generator's output. Suppliers will need to provide OFGEM with a declaration that none of the qualifying renewable electricity has been exported outside the UK. OFGEM will also require confirmation of the sale from the supplier. This will enable OFGEM to be satisfied that the qualifying renewable generation has been supplied to customers in the UK. OFGEM will then electronically issue LECs to either the generating station for the corresponding amount of electricity generated or, in the case of NFFO generating stations, LECs will be issued to the supplier who bought the output through the auction held by NFPA. The LECs will be traded from the generator to the contracted supplier. LECs cannot be separated from the electricity and therefore cannot be traded separately. LECs will be redeemed by suppliers to Customs and Excise (HMCE) to demonstrate the amount of non-climate change leviable electricity that had been supplied to non-domestic customers in the given period.

OFGEM will record the trade of each certificate from the generator to the supplier who purchased the electricity. This enables OFGEM to report to HMCE the amount of levy exempt renewable electricity supplied at the end of each period. Suppliers will redeem LECs to HMCE as evidence of this supply [RT 2002].

**Table 3.9 — Government Spending on Renewable Technologies** [HCEAC 2002, p. 36]

| Technology | Foreseen Spending 2002–2005, in Million £ | |
|---|---|---|
| | DTI Press Release, March 10, 2001 | PIU Report, November 2001 |
| Offshore Wind | 10<br>39 | 25 |
| Energy Crops | 33<br>12 | 15 |
| Advanced Energy Crop Technologies | | 18 |
| Solar PV | | 10 |
| Solar, Biomass, etc. | 3 | 10 |
| Wave and Tidal | | 5 |
| Research, incl. Energy Storage | | 10 |
| Advanced Metering and Control Technologies | | 4 |
| Information and Support to Planners | | 4 |
| Non-Specific (New Opportunities Fund) | 4 | |

DTI: Department of Trade and Industry; PIU: Performance and Innovation Unit

The U.K. is backing the ROO with substantial funding (see Table 3.9). Instead of defining technology bands, the ROO requirements leave it up to market forces to determine which kind of renewable technology will be developed — currently, wind dominates the scene due to its low cost (see below). The budget is £283 million (C$638 million) over the next few years, including R&D funds [HMT 2001]. Currently, most of this money is invested in offshore wind and energy crops. Established technologies, such as onshore wind, only receive £10 million [BWEA 2002]. Subsidies for selected technologies are meant to level the playing field so they can compete in the electricity market.

The allocation of government support has been criticized for not recognizing the special need of emerging technologies, such as ocean-based technologies, which have a very large technical potential (wave energy is estimated to have a potential of 600 TWh per year), but are not supported according to this potential. Support for solar PV also does not come close to (for example) Germany's levels of support. Finally, funding decisions have been made on an ad-hoc basis and rather need to be based on a long-term commitment with programs that will survive a possible change of government in the future in order to create confidence for investors in renewable power projects [HCEAC 2002, p. 37].

The effect of the ROO can be seen from the following figures: the UK installed 64.6 MW of new wind capacity in 2001, bringing the total UK total for wind generation to 473.6 MW, enough to meet 0.37% of the country's demand. Close to 200 MW is confirmed for construction in 2002, which would make it a record year for the UK industry. Much larger proposals are lining up for the longer term.

The Crown Estate, which owns the UK's territorial seabed, granted approval for 13 offshore wind farm sites in September 2001. The combined total of all 13 offshore wind sites is expected to be between 1,000 MW and 1,500 MW. AMEC, an engineering firm, and British Energy, a nuclear power utility, subsequently unveiled in December 2001 a proposal to build what could become the world's largest wind farm, a project on the Hebridean island of Lewis. The project, if granted permission, would eventually have a generating capacity of some 2,000 MW, according to the London *Times* [AWEA 2002]. Very good wind resources and the drop in production cost achieved over the period when the NFFO was in force led many energy providers to readily invest in wind generation, as this was their cheapest option to provide for future energy needs, while allowing compliance with the Renewables Obligation (see Table 3.10). This means wind farms can often cover their full generation cost based on wholesale prices and get the full benefit of ROC trading and LECs. A dampener for wind deployment is still the need for better planning provisions. Too often, projects are denied a planning permit due to local resistance. This has much to do with (generally exaggerated) concerns about noise and bird kill and can be alleviated if the regional Planning Officer is in favour of wind energy, as is the case in Scotland [BWEA 2002]. An increasing number of projects in Scotland and Wales is being objected to by the Ministry of Defense. Wind farms are often seen as interfering with radar or impeding areas for low-level flying, and the Ministry has used its power to veto planning permission for more than 40% of planning permit applications in recent years [HCEAC 2002, p. 28].

**Table 3.10 — Electricity Wholesale Prices in the UK** [BWEA 2002]

| | |
|---|---|
| Natural Gas-based | 1.8–2.2 p/kWh |
| Coal-based | 2.6–3.25 p/kWh |
| Nuclear | 5.2–8.7 p/kWh |
| Wind-based (onshore) | 1.9–3.1 p/kWh |

The ROO is expected to cost consumers about 5% of their overall energy bill, or £780 million, by the year 2010 [GP 2002b]. Its effect on renewable power market prices is considerable. The ROCs are currently trading for 4.5p/kWh (10.13¢/kWh) in spot markets (but long-term contracts also yield prices between 4 and 5p/kWh), which represents income in addition to wholesale market prices (1.6–1.8p/kWh or 3.6–4.05¢/kWh) for renewable electricity generators. With a generation cost of renewable electricity of between 4 and 5p/kWh (9–11¢/kWh), about three to four times that of conventional electricity, this provides a good margin for the renewable product. The New Renewables Obligation was designed so there would be a shortage of ROCs during the first few years, driving up their prices in order to provide extra support for emerging renewables. Although retailers can buy out of their obligation at 3p/kWh, prices have exceeded this amount since any penalties paid to the authorities are reimbursed to retailers that fulfill their quotas, making it somewhat cheaper to comply than to pay the fine and not receive this reimbursement. ROC prices are expected to remain high even in future years and will probably not drop below 3p/kWh [DTI 2002c].

Scotland, which has the best resources to generate renewable power in Europe, plans to expand its capacities above and beyond existing targets — 30 to 40% of its own consumption by 2020 [REF 2002b]. Since the target was announced, Danish wind turbine manufacturer Vestas opened a wind turbine factory in Scotland, and the government has announced it will support research into wave and tidal technologies. Scotland's renewable power potential amounts to 75% of today's consumption in the U.K., and its total renewable power potential has been estimated to be several times as high as its current generation. For example, only from wave and tidal energy, solar PV and offshore wind, 1,000 TWh could be generated annually. Even though the current technically feasible wave energy potential is only 50 TWh, against an overall potential of 600 TWh, the U.K.'s resources are still very substantial when onshore wind and biomass are taken into account, and are said to be the best in Europe [HCEAC 2002, p. 13].

A U.K. policy aimed at reducing consumer electricity prices has recently hampered the development of renewable power sources. Under the 2001 New Electricity Trading Arrangements (NETA), intermittent resources must pay imbalance penalties, resulting in 26–27% lower prices paid to them for power delivered to the grid. A government study found that under NETA rules, a 10 MW wind farm could have so many penalties that it would have to pay 0.41p/kWh, receiving no net payment for the power delivered [EDIE 2001]. These rules are an example for problems to be avoided in Canada — measures currently being discussed to alleviate these problems are recognizing the benefits of embedded generation (as many smaller generators are feeding into local low-voltage grids instead of the national power grid), providing free administrative advice, allowing output notifications closer to real-time and making sure imbalance penalties are truly cost reflective [EDIE 2002].

### 3.4.3 Green Power Marketing

British markets fully allowed residential customer choice in 1998/99. But the experience with customer demand for green power is very similar to that of the United States; only 0.2% of households (50,000) have purchased a green electricity product [FOE 2002]. Greenpeace is very involved in the UK to promote the "Juice" green power product. Juice was launched in August 2001 and offers customers across the UK to switch at no cost (i.e., there is no premium to be paid for the green energy coming from British wind parks). Juice customers will be delivered hydropower until the planned offshore wind project is completed. The Department of Trade and Industry is skeptical about the influence of green power marketing and sees the Obligation as the primary driver for new renewables deployment. British retailers are advised by the government to incrementally raise electricity retail prices, rather than trying to recover their extra expenses for renewable power through green marketing schemes. As some green power products are sold at a premium. and given that the Obligation already puts considerable amounts of new renewable generation on the market, not many citizens are expected to opt for these products [DTI 2002c]. Many companies have actually been found to not adhere to the strict separation of ROC and voluntary green power markets. They sell green power required under the ROC system as green power, which represents a double-sale. A Platts/Friends of the Earth report recommends companies carefully choose their green power from companies creating additional green power demand with their marketing programs [PLATTS 2002].

## 3.5 Australia — Certificates for Renewable Power

The Commonwealth of Australia's *Renewable Energy (Electricity) Act 2000*, effective since April 1, 2001, encourages additional electricity generation from renewable sources to reduce greenhouse gas emissions and to ensure that renewable power sources are ecologically sustainable. The measure established a Green Tag (Renewable Energy Certificates, REC) based Renewable Portfolio Standard (RPS) (see Box 3.6). The RPS requires electricity retailers to buy increasing amounts of renewable power, in addition to existing renewable electricity generation. The

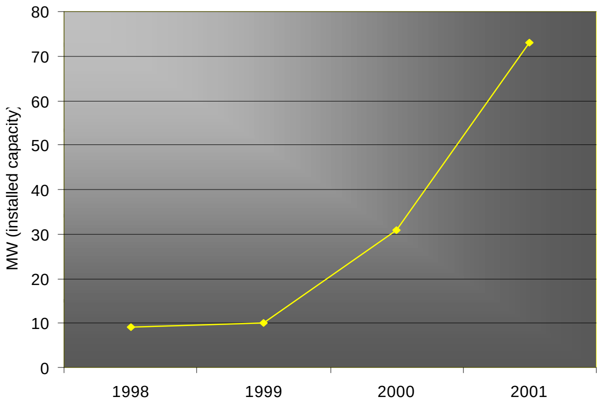



**Figure 3.23 — Installed Wind Generation Capacity in Australia** [BWE 2002, updated with AusWEA data]

set target increases from 300 GWh of newly added renewable power production in 2001 to 9,500 GWh by 2010. Due to a "safety vent" provision to pay a fine of (AUS)$40/ MWh ($34 CDN/MWh) for non-compliance instead of buying additional certificates, Australian REC prices are effectively capped.[12]

The director of Universal Carbon Exchange Managing, Mr Stuart Beil, claims the company has as much as $1 billion available from investors for the renewable power sector, thanks to the introduction of the Renewable Energy Act [AGE 2001]. "Renewable energy certificates are fundamental to this spending," Mr Beil said. "Without the legislation, there would be no approaches by institutions to do these deals." Figure 3.23 shows the impact of RPS legislation on wind energy development in Australia. Even before the Act was passed in December 2000, renewable power capacities started to increase rapidly, driven by state green power programs and the anticipated RPS legislation.

REC trading provides considerable income to Australian renewable power providers. In 2001, RECs representing 1 MWh of production were sold at prices between (AUS)$30–35 ($25–30 CDN), which is 2.5 to 3¢/kWh [PLATTS 2001]. Participation in RECs trading excludes the possibility of selling electricity as green power. State governed green power programs are completely separate from the federal certificate trading under the RPS. This separation was made in order to maximize the effect of incentives by ensuring that the same unit of production would not benefit from two different support schemes, but that green power purchases lead to the development of green power above the legal RPS requirement [AGO 2002b].

Australia has started to open its markets to retail competition, and both Victoria and New South Wales implemented customer choice as of January 2002 [NREL 2002, p. 13]. By 2001, about 1% of Australian households had subscribed to the twenty or so green power products offered on the market. Green power is offered at premiums equivalent to (CDN) 2.5–4.25¢/kWh, which represents up to 30% of generic power retail prices [ibid., p. 14]. Total retail sales of green power have grown steadily since 1996, from about 50 GWh to more than 450 GWh in 2001. In order to foster the development of new renewable power facilities, Australian state governments have obliged retailers to include at least 80%[13] of new renewable power as of 2002 — a requirement that has caused at least one green power program to stop accepting new customers since they did not have enough new energy providers to fulfil this quota [p. 15]. As of June 2001, green power marketing had led to the development of more than 100 new renewable projects with a combined capacity of nearly 200 MW, according to Australia's Sustainable Energy Development Authority. An additional 400 MW of capacity is planned for 2002 [p. 16].

Figure 3.24 shows that renewable power capacities increased by 100% between 1990 and 2002. They may grow by another 100% over the coming years if all currently planned projects are realized, putting Australia on schedule to attain its goal of 9,500 GWh of added renewable power production in 2010 (roughly equivalent to 4,000 MW if there is an important share of wind energy). Major changes since the introduction of the RPS are only seen in the wind energy sector. There is also a planned increase in energy production from wood waste, and some emerging technologies, such as a solar chimney, tidal and wave energy, are planned (wave and tidal energy are at the pilot stage only). The Australian RPS does not define different quotas for technology bands, but government incentives exist for emerging technologies that would otherwise not be able to compete for contracts under RPS legislation due to their high production cost.

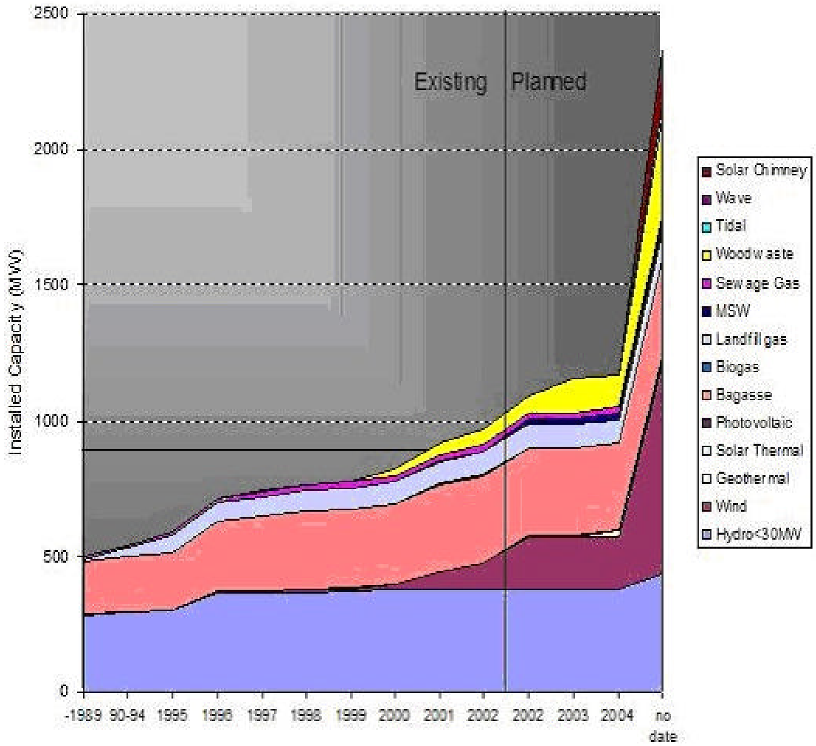



**Figure 3.24 Existing and Planned Renewables in Australia** [AGO 2002a] (data for before 1989 include "unknown" and "n/a" dates given in database)

Australia funds renewable power projects with an (AUS) $6 million Renewable Energy Industry Development Program, which is administered through a tendering process and supports the promotion of renewable power, resource assessments, consumer education and other measures, with up to 100% of project costs eligible. Grants of (AUS) $750,000 and $230,000 have been given to two wave energy companies [REID 2002], one of which is now involved in a pilot project on Vancouver Island. Australia also provides rebates of (AUS) $5/W to provide incentives for the installation of residential and commercial solar PV modules (total funding is $31 million), supports power generation from renewables in remote areas [AGO 2002c], and provides venture capital (equity, to be matched by private sector investment at a 2:1 ratio) from a fund of (AUS) $26.6 million to small companies with emerging technologies at commercialization stage [REEF 2002].

**Box 3.6 — Renewable Energy Certificates**

Renewable Energy Certificates (RECs) are often used to implement a renewable portfolio standard. They allow a power retailer to either generate its own renewable electricity, buy it (in the form of RECs representing the green benefits of green power), or pay a fine for non-compliance. Trading RECs functions very much like selling green power at a premium, as an extra price has to be paid for the certificate in addition to the wholesale power price. Through such a trading provision, governments allow power retailers to fulfill their renewable energy sales quotas the cheapest way, by buying the cheapest resources, which may not be in their own service area. A detailed description of RECs can be found in chapter 5.

# 4. A Closer Look at Regulators' Options

## 4.1 Green Pricing and Green Power Marketing — The Voluntary Approach

### *4.1.1 Key Factors for Market Success of Green Power Products*

*Customer switching was critically reduced in many US states after wholesale electricity prices rose and margins narrowed in unregulated market environments.*

The most important factor for market success is the default service price relative to wholesale market prices. The difference between the two decides whether or not green power suppliers will be able to sell their products at a large enough margin, or even to undercut current suppliers. As can be seen from the California market, the combination of very low default service prices and monetary incentives created relative success for the green power market, but in the context of an extremely stifled overall competitive marketplace. The very low levels of switching activity in New Jersey and Massachusetts also demonstrate the effects of low default service prices. Despite some strong renewables policies and programs in these states, green power markets remain stagnant. Alternatively, in Pennsylvania, the default prices were set relatively high in some service territories, and even without state-wide policies and programs (except certification) to boost the market for renewables, the green power market has been very successful at the start [XEN, p. 285]. Within Pennsylvania, the PECO and Duquesne service areas have the highest "shopping credits" (i.e., the difference between default price and cheaper alternative offers), and also the highest percentage of customers who have switched, at 13.0% and 13.8%, respectively. In contrast, Allegheny Power has the lowest shopping credit and the lowest level of switching at 1.8% [RAP 1999]. Indeed, once mandatory regulated price cuts have run out, prices have risen sharply, a problem experienced not only in California and Massachusetts, but also in Pennsylvania, New York, Montana, and the Midwest [CFA 2001, p. 4]. Critics ascribe these price hikes to the abuse of market power[14] [NRRI 2002b, CFA 2001].

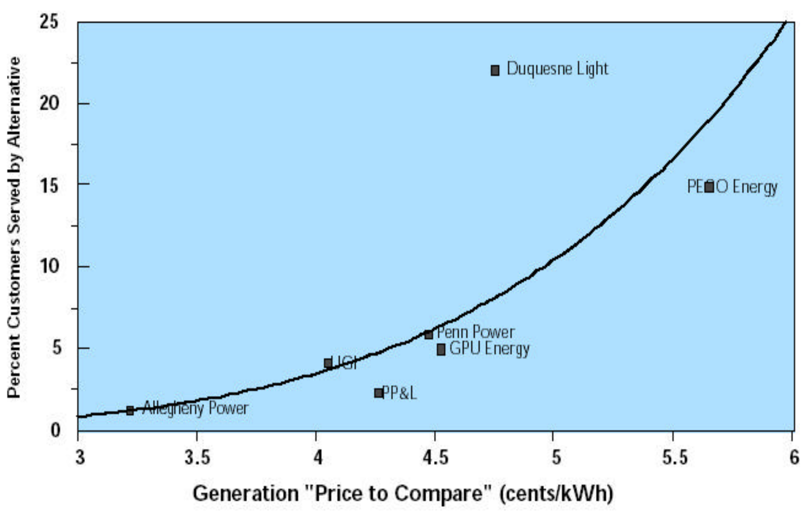



**Figure 4.1 — Correlation between the Price to Compare and Customer Switching Activity** [NRRI 2000b, p. 38]

**Table 4.1 — Customer Switching and Default Service Price** (adapted from [RAP 1999])

| State | Market opening | # switched by beginning of 1999 | Total % switched | % of switchers opting for green power | % of total "green" residential customers | Default service price ¢/kWh |
|---|---|---|---|---|---|---|
| CA | March 31, 1998 | 85,168 resid. (125,497 total) | 1.0 (1.2) | 40 (prior to price discounting) | 0.4 | 3.5 price cap (wholesale) + 1.5 customer credit |
| PA | January 1, 1999 | 316,367 resid. (395,887 total) | 6.9 (7.6) | 30 | 2.1 | 3.16–4.46 (retail) |
| MA | March 1, 1998 | 5176 | 0.2 | | | 2.8 at inception, later 3.2 (below wholesale) |

The main motivation for customers to switch providers is a lower price. California had some success in switching customers to green power due to the lower price offers made possible by the customer credit (see chapter 3.2.2). In the absence of price incentives, green switching has remained low, as few customers — contrary to the results of many pilot studies and telephone surveys suggesting a readiness to pay a premium for green energy — have switched to the generally more expensive green products. The correlation between price and customer switching can be seen from Table 4.1 and Figure 4.2.

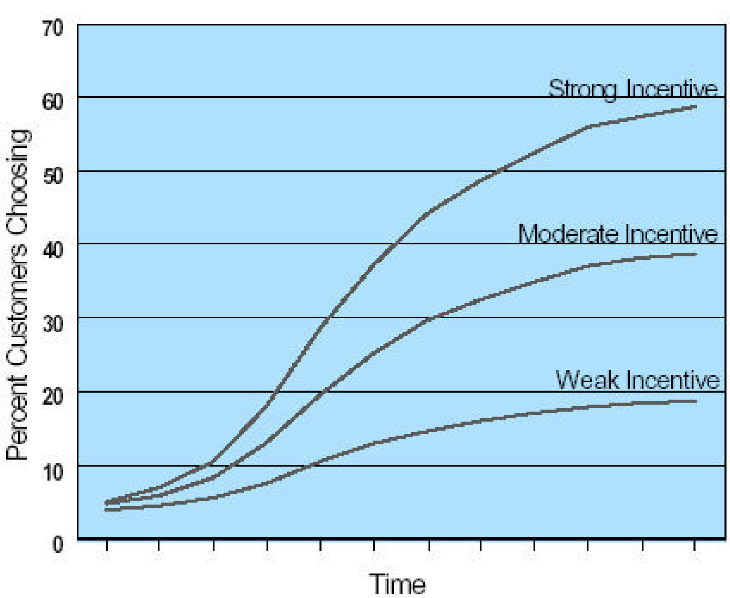



**Figure 4.2 — Influence of Incentives on Ultimate Market Penetration** [NRRI 2000b, p. 42]

Similar results have been obtained for non-residential customers. There seems to be a lack of knowledge about alternative power sources among corporate customers, and pricing is deemed very important [HOLT 2000]. Apart from some companies with a very "green" mindset, which were acting in an altruistic way without expecting much reward for their opting for green power, most of the potential green power customers that were approached in a 2000 US survey answered that they would opt for a 50% renewable power product if it was offered at a discount or at a price comparable to conventional electricity. However, a much smaller share of companies was willing to buy the same product at a 10% premium — many said they would reduce their green power purchase to cover only a small fraction of their power consumption [ibid., p. 71].

Another explanation for customer inertia is that, if customers believe that any potential savings will be exceeded by the value of their time to search for alternatives, they will stay with the standard offer or with their current supplier. A survey of Pennsylvania residential customers asked the open-ended question: "What were the biggest impediments in considering or switching to a new supplier?" The top three answers were: 52 percent said "too confusing, too difficult, too much trouble," 35 percent said "not enough savings for effort expended," and 10 percent said "no intriguing offers." So 87 percent of the survey respondents did not find it worthwhile to change their suppliers because the perceived gains did not outweigh the effort. On the positive side, these results suggest that customer education programs that provide information will help lower the transactions cost and, if opportunities for savings exist, may increase customer participation [NRRI 2000b, p. 39]. Switching becomes somewhat easier for the customer if only the product is switched, not the provider. The Netherlands has had large success with green power sales. But the vast majority of Dutch customers are buying green power from their incumbent utilities — only about 50,000 customers had switched to alternative suppliers as of the fall of 2001 [NREL 2002, p. 32].

*Default service prices will determine the margin a green power marketer can achieve and will therefore determine whether or not green power markets thrive.*

Based on past experience with market penetration, it is not likely that consumer markets will exert a strong impact on stimulating new green power production. Whereas market penetration usually follows an S-curve, meaning that switching is expected to be low at the start, later gaining momentum and eventually capturing the majority of customers after several decades, Figure 4.2 shows that this is not true in all cases. The ultimate market penetration for a given product will depend on its attractiveness to consumers. Paying a premium for green energy is likely to belong to the "small incentive" category, and it can be expected that demand will taper off before gaining a market segment substantial enough to make a difference on the supply side. Especially if customers opt for green power products that only have a 50% or less share of renewable power, the impact on energy generation will likely remain marginal.

Another important factor is the lack of public education about the importance of renewable power, which limits growth for the green power industry. Consumer response to green power marketing will remain small if consumers do not understand electricity generation and related markets and recognize that their choices can make a difference. Green power marketers will have to spend significant amounts of their marketing budgets on customer education on renewables and their environmental benefits (see Box 4.1) [XEN, p. 279]. In the early days of the California market, start-up and customer acquisition costs ran upwards of several hundred dollars or more per customer, prompting a number of marketers to abandon the residential

**Box 4.1 — The Cost of Green Power Marketing**

Green marketers have publicly testified that the advertising and marketing costs necessary to acquire one customer are approximately (US)$100. Premiums paid for renewable power, and costs for customer service, start-up, overhead and profits are in addition. The figure of $100 is a low estimate, however. Enron spent more than $300 to acquire each of the 30,000 customers it acquired before pulling out of the California residential market. Thus, a better range of estimated marketing costs is $100–$300 per customer. Green product prices of 13–15¢/kWh produce annual average residential "green consumer" bills of approximately $840. Thus, $100–$300 in per-customer marketing costs account for between 12% and 36% of a green consumer's total annual electricity bill. Assuming that a marketer has a cost recovery period of two years and that consumers remain with the marketer for two years, marketing costs would account for between 6% and 18% of a green consumer's total annual electricity bill. Thus, for example, out of average 14¢/kWh green rates, marketing costs would amount to between 0.8¢/kWh and 2.5¢/kWh.

The premiums being charged for green products with at least 50% non-large-hydro renewable energy content and that do not promise new renewables range from 0.93–3.07¢ above the cost of default utility service, as compared to the estimated 0.8¢/kWh to 2.5¢/kWh in marketing costs. Thus, it is clear that a very high percentage, perhaps 80%, of the premiums being charged for green products is accounted for by marketing costs, not by the cost of the products' renewable energy content. Viewed another way, green marketers have stated that they can acquire wholesale renewable power from utilities for a premium of less than 0.5¢/kWh, and it is widely known in the industry that the extra cost can be as low as 0.1¢ to 0.2¢/kWh. Subtracting out wholesale renewable energy costs of 0.1¢ to 0.5¢/kWh from the average 2.0¢/kWh premium charged for green products that do not promise new renewable energy content leaves 1.5¢–1.9¢/kWh for marketing and overhead costs. Thus, a reasonable estimate of the fraction of green product premiums that pay for marketing and overhead costs is 75% to 95%. Based on the average 2¢/kWh premium, therefore, consumers would pay $10 extra on their monthly bill, of which $7.50–$9.50 would go towards marketing and overhead costs. [RADER 1998, p. 35]

market, while others looked for less costly approaches to marketing their products and other ways to improve turnover [WISER 2000, p. 11]. The most successful U.S. green power program, the Los Angeles "Green Power for a Green L.A.," was audited in 2002 and found that it costs (US)$82,000 a day. Millions of dollars had been paid to a public relations firm to advertise the program, with many of the customers being subsidized [REF 2002c].

The existence of green pricing or marketing programs in a jurisdiction is clearly a basic condition for renewable electricity generators to benefit from green power premiums. In restructured markets, consumers can swap electricity providers; in regulated markets, green pricing programs can support the renewables sector. In restructured markets, regulatory conditions will influence the level of switching. Low default service prices will impede the ability to sell green power at a high enough premium to cover both marketing expenses and the higher generation cost. Other rules, such as wet signature requirements as a condition to switch energy suppliers (as opposed to enrolment over the phone or Internet), increase the administrative cost of getting customers to choose green power [NREL 2001, p. 8]. Additional factors that can have significant effects on the market for renewables include available renewable energy resources in the region, as well as state and transmission pricing and policy. Additional barriers to green power marketing were found, including [WISER 1999, p. 12]:

- **Lack of existing renewable power plants that are able to sell to marketers due to contract restrictions.**

- **Direct access processing and service fees that erect barriers for new participants:** For example, low or no customer switching fees and avoiding other administrative rules that make the position of green power marketers difficult compared to established utilities was identified as an important feature of functioning markets.

- **Protracted direct access phase-ins that favour larger customers:** The marketers surveyed preferred a rapid transition to free market access, as opposed to a slow phase-in, because they target residential consumers and their advertisement costs go up if the retail market is not open to a large consumer base.

- **Stranded cost recovery:** the recovery of debt from investments in conventional generation capacity made before market liberalisation, one of the big issues in the Ontario market opening, is seen as a market barrier. It increases the overall price of electricity (through a debt reduction charge applicable to all customers), and can mask the default service price in case its amount depends on the wholesale electricity price. Marketers therefore prefer that stranded cost is recovered in a manner minimizing the overall cost through mitigation, based on a stable per-kWh fee, and works toward a rapid cost recovery.

A challenge for green power programs that is currently emerging is the demand for ever-increasing shares of “new” renewables, as required in Australia and also under the US Green-e certification program. This criterion is meant to foster the creation of new generation capacities, but it could become a problem for certification schemes and marketing, as the renewables sector depends on long-term financial security to succeed (see chapters 4.4 and 4.6.1). So far, these schemes refer to a given year as the baseline, often the year the program was incepted. The question is, will plants built in 1999, which may well qualify as “new” at the moment, still be accepted as new generation in a few years’ time? If the base year is revised after a few years to include only recently built plants, the 1999 plant owner would have to look for another way to subsidize his/her plant beyond the new base year, creating financial insecurity, which may in turn prevent investors from financing the project in the first place. Under a renewable portfolio standard, the generation “abandoned” by green power programs would likely be purchased by retailers obliged to buy increasing percentages of green power, but where no such obligation exists, green power programs should be carefully designed and maintained to provide the needed long-term support, keeping a 10-year time frame in mind.

A valuable feature of renewable power is its independence from fossil fuel prices. Some marketers, such as Shell in the Netherlands (www.shellstroom.nl) or Green Mountain Energy (www.greenmountain.com), are exploiting this feature to win market share, promising fixed electricity rates, as opposed to fluctuating rates based on conventional generation. A similar incentive is offered by

"*The impact of green power marketing on new renewables development has been limited so far*."
NREL 2002, p. 5

Green Tags Ontario, which asserts that its members could be reimbursed if wholesale prices rise above the price of wind energy, allowing the cooperative to sell its power at a higher margin (www.greentagsontario.com).

This feature has not been widely used in green power marketing; instead, most green power products are mixed with conventional energy, or a premium has to be paid on top of current prices, so customers have no green power advantage if fossil fuel-based generation prices rise in the future. This dependence on wholesale prices has meant that many such programs could not function when prices rose, as earlier price commitments to customers could not be honoured. Thus, subscription rates faded as rising prices for wholesale power also drove up green power retail prices.

### *4.1.2 The Limits of Market-Driven Green Power Demand*

A 2001 US report concludes that among the 40 million American households with access to green power, only 350,000, or about 1%, have chosen to buy green power [NREL 2001, p. i]. A rate of between 0.1% and 1% has been found among most European green power marketing initiatives [NREL 2002, p. 56]. The first Canadian programs in Alberta have also obtained participation rates of about 1% [PEM 2002, p. 12]. Several studies in the US have identified participation rates of between 4.7% (promotion by mailing only) and 16% (with telephone surveys) among residential consumers. Overall results show that with a moderately priced green power product (corresponding to about US$10 per month) promoted through telemarketing, the maximum sign-up rate can be expected to lie at about 20%[15] [ibid., p.5]. Actual sign-up rates for utility green pricing programs in the US have been 0.8% on average, with a maximum of 7.3% in regulated markets. The penetration rate in restructured markets was slightly higher, with an average of 1.2% (figures for mid-to-late 2000). No correlation with the price premium for green power was found ($1–$10 per month) and the different penetration rates are ascribed to various factors, such as limited supply of green power, lack of awareness among customers and limited marketing efforts [p. 6]. The US report concludes that a market penetration of 5% can be achieved during the first two to three years with a focused marketing effort. Experience in Australia suggests that 15% of all customers provided with the right information about green power, for example through telemarketing, do sign up — indicating scope for future growth in customer uptake [AUS 2001].

The effect of green power demand on the deployment of new renewable power sources is modest in comparison to developable potential or to the uptake necessary to combat climate change. "Customer-driven markets for renewable energy are unlikely to adequately replace the need for more fundamental renewable energy policy measures if accelerated rates of renewable energy development are determined to be in the public interest" [NREL 2001, p. 53]. Interestingly, a Renewable Portfolio Standard (RPS) as a policy measure to foster renewable power found great support among non-residential US-customers surveyed in 2000. Companies found that measures, such as an RPS (highest support), system benefits charges, pollution taxes, and free consumer choice, were needed to help develop the renewables market [HOLT 2000, p. 36].
It is possible that consumer-driven demand may, by itself, influence the renewable power market; however, the time needed for a green product to penetrate market can be very

lengthy [WISER 2001, p. 10]. Within the first few years of program initiation, a utility can expect residential market penetration from as low as 0.1% to perhaps as high as or higher than 5% [WISER 2000, p. 5]. In the US, the renewable portion of green power products in deregulated markets is predominantly served by existing renewable power facilities, which has been a major source of criticism of the green market [WISER 2000, p. 8]. This has, for example, led Australia to demand that green power products offered to retail customers must contain 80% of electricity from new renewable power facilities [NREL 2002, p. 14].

> *"Customer-driven green power markets that are based on higher-cost renewable energy products will only thrive if a fundamental shift in the moral and ethical character of our society comes about; in its stead, collective public policy efforts will necessarily continue to be the sole or dominant method of achieving environmental improvements."*
> WISER 2001, p. 14

The number of customers switching to green power does not readily translate into substantial support for renewable power. This is particularly true in Pennsylvania, where it is estimated that perhaps 60,000 of the 80,000 customers choosing green power have selected a product whose renewable power content is 1% or less [p. 10]. The US Department of Energy estimates that, as of January 2002, 650 MW of renewable power capacity has been installed due to green pricing and green power marketing programs since their inception, with another 440 MW under construction or planned [DOE 2002]. To compare, the US installed more than 1,700 MW of wind turbines in the year 2000 alone.

Although green power marketing can potentially deliver renewable electricity more cheaply than the individual installation of distributed systems, it lacks the ability to achieve the same price reductions through economies of scale that would result from regulatory measures, such as a renewable portfolio standard, because green power marketing tends to result in relatively small amounts of new capacity deployment. Box 4.1 shows that most of the money raised through green power premiums does not benefit the producers; rather, is needed for marketing efforts. Price appears to significantly influence demand, as is evidenced by experience in the Netherlands, Germany and Sweden, but it is clearly not the only factor. In Finland, although green power has been offered at a discount, consumer response has been modest due to ineffective marketing efforts [NREL 2002, p. 23]. While the Netherlands has succeeded in creating consumer demand for green power that exceeds the currently available domestic generation capacity, this has been achieved in a highly artificial environment in which taxes have shifted the price relationship in favour of renewable electricity, and in which no products other than green power are allowed for customer choice. Unless strong measures are taken to "help" green power markets succeed in Canada, it is unlikely that consumer demand will create a market pull for renewables that will result in a major shift of power sources.

> *"Consumer demand for green power will only have a measurable impact on renewable energy supply if such demand is in addition to any supply-side obligations, such as a renewable portfolio standard."*
> NREL 2001, p. ix

**Box 4.2 — Definitions**

**Allowance:** A unit of trade created by fiat by the government as a "right" to emit a certain quantity (usually one ton) of a specific regulated pollutant.

**Set-aside**: A pool of emissions allowances that come from within a jurisdiction's emissions budget and are not distributed to emissions sources, but rather held out specifically for renewable energy and energy efficiency project developers and vendors that implement an eligible project within that state.

## 4.2 Emissions Trading

### *4.2.1 Allowance Trading*

*General*

There are several fractured emissions trading markets in the United States. Renewable power generators have not been included in these markets until the recent introduction of NOx set-asides in some US states. NOx emission credits in the north- eastern US have averaged around US $1,000 per ton, and VOC credits around US$2,500 per ton. Markets for carbon dioxide ($CO_2$) and carbon monoxide (CO) are not as well established, although there has been some experimental trading of $CO_2$ recently, usually in the $1 to $5 per ton range. In comparison, emissions trading for sulfur dioxide ($SO_2$) under the US Clean Air Act is much more advanced. Lower costs for gas scrubbing technology and an overallocation of $SO_2$ allowances have resulted in overachievement of $SO_2$ reductions goals and led to prices for $SO_2$ of less than $200 per short ton [CGP 2002]. These numbers have high potentials for creating additional income for renewable power generators and for reducing the retail price of green power.

In Canada, Ontario's former Pilot Emission Reduction Trading (PERT) Program (now Clean Air Canada Inc.) concentrated largely on the creation of credits for ground-level ozone precursors — nitrogen oxides (NOx) and volatile organic compounds (VOCs). Since January 2002, Ontario has had a mandatory trading program in place for the electricity sector, covering both NOx and $SO_2$ allowances. The Ontario trading program includes a set-aside for renewables for both NOx and $SO_2$ allowances.

*$SO_2$ Trading and NOx Set-Asides in the United States*

The US Acid Rain Program's $SO_2$ cap-and-trade provisions are the most well-known emissions trading initiative. Although the program allows for renewable power to be used to reduce emissions, this option has not stimulated the deployment of renewable power (see Box 4.3). If some of the restrictive requirements were taken away and the amount of allowances for renewable power generators was increased, this market might be a lot more successful. Instead of set-asides, allowances could be allocated to all power plants based on their output, and not just to the polluting units.

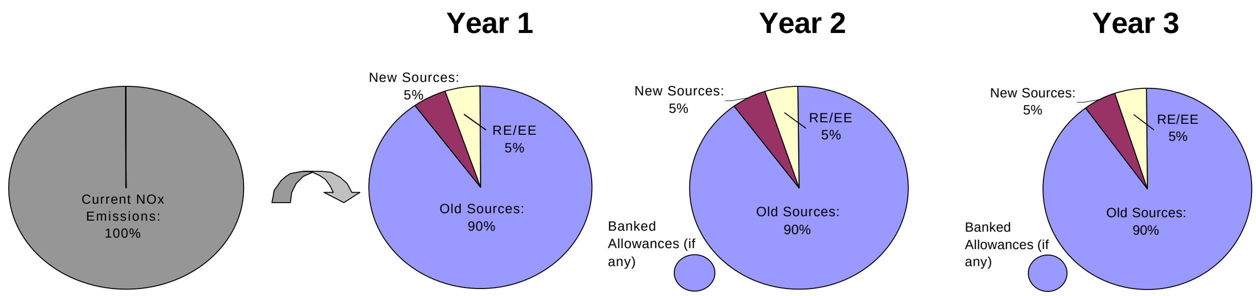
In 1998, NOx trading began in nine states[16] in the northeastern United States. Power generation units, as well as the steel, paper, chemical, refining and cement industries, are included in these state regulated cap-and-trade programs. A five-fold expansion of the programme in the US will take place during 2003/2004, when new federal regulations expand NOx allowance trading from the existing nine states to 21 states in the eastern US. These obligations are an important cost factor for power generators: NOx compliance obligations can add (US)$25/MWh to their production cost.

**Box 4.3 — $SO_2$ Emission Trading and Renewables in the United States (1992–1999)**

Under §404(f)(g), EPA established a Conservation and Renewable Energy Reserve (CRER) that contained 300,000 $SO_2$ allowances. The allowances were set aside from the emissions cap imposed on power plants. Allowances were awarded for $SO_2$ emissions avoided through energy conservation, biomass (including landfill gas), solar, geothermal, and wind energy projects implemented between 1992 and 1999. Renewable energy's minimum share of the CRER was a set-aside of 60,000 allowances. An allowance of one ton could be earned for every 500 MWh of energy produced by a qualified utility through renewable energy generation measures (to compare, at an output-based rate of about 11 lbs/MWh, a conventional coal power plant would emit 2.75 tons per 500 MWh). If fully used, over time the CRER would have displaced 885 million pounds of $SO_2$. Unhappily, this will never occur. As of June 1999, less than 12% of the 300,000 allowances had been allocated (about 36,000 allowances). Of this, only about 6,700 allowances went to renewable energy projects.

There are several reasons for the CRER's disappointing performance. The program was designed primarily to encourage early reductions (to occur before the statutory deadlines) and not as a long-term incentive for renewables. In addition, most utilities did not draw from the CRER by developing or purchasing power from renewable projects since they were easily able to meet their emissions limits with low-sulphur coal and other, more conventional, means. Since cost of compliance was low, so was the price of allowances. This was a blow to the CRER, especially in light of the unreasonably low conversion rate (i.e., one allowance per 500 MWh) by which renewables and energy efficiency could earn sulphur credits.

The CRER also contained harmful restrictions on how to earn allowances from the reserve. For example, only utilities could earn allowances. They were required to engage in least-cost planning processes in the acquisition of new generation sources and to adopt an unpopular income neutrality element in their rate structure to prevent revenue erosion from investments in energy efficiency. These concepts were cutting edge in 1990, but quickly became largely obsolete with the restructuring of the industry. Restructuring has forced divestiture of generation, loss of retail monopolies, and associated cost-cutting pressures. In short, the participants in the debate over the 1990 Amendments failed to anticipate electricity industry restructuring. As a result Congress conditioned the eligibility for CRER credits on requirements that were increasingly impossible to meet under a restructured industry [REPP 2000].




*Year 1: 90% of current NOx emissions are allocated to existing sources, 5% are set aside for new emitting plants, 5% are set aside for renewable energy/energy efficiency.*
*Year 2: The same amounts are set aside, unused allowances may be banked.*
*Year 3: Like year 2, "new" sources of year 1 have become "old" sources.*
*NOTE: The total amount of allowances can decrease if some of the allowances are retired, or if lower emission performance standards come into force. After a few years, the government may decide to reduce the overall amount of allowances granted.*

**Figure 4.3 — Allocation of NOx Allowances to Old and New Sources and Renewable Energy/Energy Efficiency Projects**

Figure 4.3 describes the allocation process for NOx emission allowances over the first three years of a generic set-aside program. First, the overall emissions are assessed (the "budget") and allowances allocated according to each power and steam generation "budget unit." Under cap-and-trade provisions, these budget units are not allowed to emit more NOx than the equivalent of the complete allowance pool. In order to enable electricity production to expand according to demand, part of the allowances pool (e.g., 5% in Massachusetts) is being set aside as a New Unit Set-Aside and is allocated to newly built power generation units. Along the same lines, the US Environmental Protection Agency (EPA) introduced a new kind of set-asides, often called public benefit set-asides, to account for the air pollution emission reductions from energy efficiency and renewable power (EE/RE) in the framework of existing NOx trading schemes. The model proposed by the EPA is to set aside another 5% of allowances in each of the first three years and 2% each year during subsequent years for the EE/RE set-aside pool. Each year, renewable power and energy efficiency projects can apply to be allocated these "set-aside" allowances [EPA 2000]. States have so far implemented smaller set-aside pools of only 3–5%, which tends to be under-subscribed according to current experience [EPA 2002a]. If either of the two set-aside allowance pools is not used up in a given year, states generally allow the shifting of surplus allowances from one pool to the other. Other options are banking them for the next year, or redistributing them to emitting units. Indefinite banking of allowances is allowed, but the value of allowances can be reduced by the program administrator if more than 10% of the overall budget is banked.

Table 4.2 provides an overview of some basic design features the EPA recommends for setting up an EE/RE set-aside. So far, five states have developed plans based on the EPA's EE/RE Set-Aside State Implementation Call, three of which have been in operation since 1999 (see Appendix F).

**Table 4.2 — EPA-Recommended Design Features of a Set-Aside Mechanism** [EPA 1999]

| | |
|---|---|
| **Who can apply for an Energy Efficiency and Renewable Energy (EE/RE) set-aside and allocation?** | Any individual or organization that uses electricity and can initiate, finance, or carry out projects that reduce or displace electricity generation other than at the core generation units: commercial and industrial building owners and operators, energy service companies, home builders and associations, home owners associations, federal, state and local government agencies, commercial businesses, manufacturers and other industrial energy users, manufacturers leasing or selling high energy efficiency equipment, as well as government agencies, retailers, and electrical generation companies providing energy efficiency services. Core units will also benefit from reduced energy consumption as it results in a reduced energy production need at the core unit, which will in turn free allowances due to reduced emissions. Eligible projects project should:<br>· reduce/displace electricity load from core source electricity generation units (EGUs) in the regulated region;<br>· not be required by Federal government regulation;<br>· not be used to generate compliance or permitting credits otherwise in the regulated region;<br>· be in operation in the year(s) for which it will receive allowances;<br>· reduce/displace energy during the summer ozone season;<br>· be measured and verified in accordance with the methods in this guidance; and,<br>· translate into not less than one (1) ton of NOx allowances, or be aggregated with other projects into one-ton increments of NOx allowances. |
| **Who cannot apply?** | As part of the determination as to which projects receive set-aside allowances, EPA generally recommends that energy efficiency or renewables projects that provide a direct benefit to entities in the form of “freed up” or “extra” allowances from an existing allocation in the NOx Budget Trading Program not be eligible to receive allowances from this set-aside. Therefore, it is recommended that projects implemented by core sources who receive an allocation of allowances in the NOx Budget Trading Program not be eligible to receive allowances from this set-aside for actions which will lower their need for and/or free up NOx allowances from their existing allocations. On-site fuel reductions at core sources are not part of the EE/RE set-aside because (1) they are the result of supply-side management actions, and (2) they are self-rewarding, as freed allowances can be used elsewhere or traded. Supply-side efficiency improvements are not attributable to end user actions in the same way that demand side management and other energy efficiency and renewable energy actions are in reducing electricity generation. |
| **Which projects should be eligible?** | *Only* reductions in or displacements of electricity use are eligible. Since the goals of the energy efficiency and renewable set-aside is to reward end user improvements, most demand-side energy efficiency and renewable energy projects are eligible. To determine whether or not a project is eligible for set-aside allowances, two tests must be met. The first consideration is whether or not the implementation of the project benefits the sponsoring entity by freeing up allowances they already have been allocated. This test generally applies to core sources, such as EGUs and non-EGUs, who may be interested in applying for set aside allowances for the projects they undertake. Second, the project must, at a minimum, meet a number of criteria that ensure the award will work within the NOx Budget Trading Program and fit within the goals of the set-aside. Whereas in general projects required by legislation should not be eligible, this should not apply to those benefiting from System Benefits Charges or those required under an RPS obligation, Model Energy Codes, or Executive Orders. |

***Table 4.2 continued ...***

| | |
|---|---|
| **Over what period should set-asides be assigned?** | At least three consecutive ozone control periods (verification of energy savings and displacements from projects receiving set-aside awards should occur annually). The length of award periods will also affect the required size of the set-aside pool. A longer stream provides more financial incentive, but limits the availability of allowances for future projects. For example, New York allows allowances to be obtained over five years. |
| **What portion of the budget should be set aside?** | 5–15%. A state can apply this percentage to the electricity generation portion of its NOx trading budget. Alternatively, a state could make an independent assessment of the number of kWh the project could be productively catalyzed through an energy efficiency and renewable energy allowance award in the state, and set the size of the pool accordingly. |
| **How to focus awards on "new" projects** | "New" projects are those which deliver additional energy efficiency and renewable energy beyond those which would occur in a "business-as-usual" scenario. Rather than making a determination of better than business-as-usual activities project by project, EPA suggests that the size of the set-aside be used as one mechanism for encouraging actions that would not otherwise occur: states can make sure that they make the allowance pool large enough so that it can accommodate both "new" and business-as-usual projects (rather 10–15% than 5%). If the scope of eligible projects has been designed or modified so that it focuses on "new" projects, then the number of allowances to be included in the set-aside may be smaller. |
| **How to award allowances for early actions** | Early actions are energy efficiency or renewable projects that are implemented prior to May 2003. Giving credit to early action prevents parties from stalling projects in the years before the set-aside is implemented, in order to benefit from the set-aside. It is possible for a state to award allowances for projects that are implemented as many as three years, or three summer ozone control periods, prior to the beginning of the NOx Budget Trading Program in 2003. Because the allowances to award early actions come from the first ozone control period (2003), a state rewarding early actions may need a larger pool of allowances to draw from as compared to a state that does not award early actions. Allowances for early action not traded during the first compliance year will be retired.[1] |
| **How to make adjustments in the size of a state's set-aside** | **Under-subscription:** States could deal with the unclaimed allowances using a variety of means such as: (1) auctioning the remaining allowances to core sources or other interested parties, (2) distributing the unclaimed allowances to core sources according to the allocation scheme in current use, (3) distributing the unclaimed allowances to existing set-aside projects on a prorated basis (in addition to the allowances they originally received); and (4) retiring the unclaimed allowances. A fifth option is to allocate the unused allowances in the next summer ozone season, rather than delaying their use until the next three-year allocation period.<br>**Over-subscription:** States could award allowances on a first come, first served basis. EPA recommends that states consider expanding the set-aside for future allocation periods. Many states allocate available allowances on a pro-rata (MWh) basis in case of over-subscription. |
| **How Are NOx Emissions Monitored?** | By a "continuous" measuring device, which transmits a measurement at least every 15 minutes. |

***Table 4.2 continued ...***

| | |
|---|---|
| **Tracking** | The EPA's NOx Allowance Tracking System (NATS) is a computer system used to track the number of allowances held and used by any account. Each allowance tracked in the NATS has a unique identification number, assigned by the NATS Administrator. The serial number of each allowance indicates the initial year the allowance may be used for compliance with the end-of-season reconciliation requirements. The EPA's NOx Emissions Tracking System (NETS) is a computer system to track the NOx emissions from budget units. |
| **What Are the Penalties for Non-Compliance?** | Massachusetts reduces next year's compliance budget by three allowances for each ton emitted in excess of those available on a party's account. |
| **Key Dates** | Compliance period: May 1–September 30 each year<br>Date by which all necessary allowance must have been purchased: November 30 |

*[1] Another option to reward early action is a trajectory. A trajectory splits the ultimate reduction goal up over all years until the final amount of emissions is reached. By holding the participants responsible for meeting the trajectory targets for each year by any combination of internal reductions or buying credits (or allowances), the early compliers have credits to sell and the late compliers become the buyer. The market gets an early start, early reductions are incented, there is not a build up of early reduction credits, and the environmental goal is achieved gradually with more assuredness [CAAC 2002, p. 100].*

### *Benefits for Renewable Power Producers from a NOx Set-Aside Program*

In the US, allowances are only required for the summer period (May through September). They are traded electronically via the EPA's NOx Allowance Tracking System (NATS), which is used to track all transactions in the states with NOx allowance provisions within the Acid Rain Program. For electric generation, NOx emissions are estimated as short tons per year, based on net electric output in MWh:

$$\frac{\text{1.5 lb NOx/MWh x net electric output in MWh/a}}{\text{2,000 tb/ton}}$$

To obtain the number of one-ton allowances to be allocated to each unit, this amount would be multiplied by the total amount of NOx allowances to be allocated that year, and then divided by the combined emissions budget of electricity and steam generation units.

The same formula is applied to renewable power producers in order to allocate set-asides. If the set-aside pool is oversubscribed, states generally opt to distribute the full set-aside pool on a pro-rata basis among all applicants, based on their annual electricity production. In order to qualify, renewable power producers must generate electricity equivalent to at least one short ton of NOx, which is a minimum of 1,333 MWh over the compliance period of five months. Table 4.3 shows the minimum generating capacities required, based on typical capacity factors linked to the different technologies.

Central electricity generation will usually have several times the required capacities installed, but distributed generation is clearly excluded from benefiting from NOx allowances. Assuming a market value of (US)$750 per NOx allowance ($1,200 CDN) and that similar prices would prevail if such a system was introduced here, an allocation of 1.5 pounds per MWh would benefit a Canadian renewable power producer with around (CDN)$0.90 per MWh during the summer months, or $0.38 per MWh if levelled over the whole year. While this is an

**Table 4.3 — Minimum Capacity Requirements to Obtain NOx Allowances**

| Technology | Capacity Factor | Minimum Plant Capacity Required to Offset 1 Short Ton of NOx Emissions (1,333 MWh) over 5 months (3,600 hours) |
|---|---|---|
| Wind | 30% | 1.22 MW |
| Solar PV | 14% | 2.61 MW |
| Geothermal | 95% | 0.38 MW |
| Wave Energy | 30% | 1.22 MW |
| Biomass Combustion | 85% | May become budget source |

important amount, it is by itself not enough to make up for the price difference between most renewable resources and fossil fuels. Due to NOx emissions arising from electricity production from biomass it is possible that this resource will not even benefit from the NOx set-aside, although it is treated the same as other renewable power sources under some US programs, such as the one in New Jersey. Although advanced biomass gasification combined-cycle systems are expected to emit relatively small amounts of NOx (0.0005 t/MWh)[17] [NREL 1997], this is still too close to the NOx allocation of 0.0007 t/MWh to generate income from NOx allowance trading.

The impacts of set-asides on renewable power development also depend on local circumstances. New Hampshire takes part in NOx trading, and has set aide 445 NOx allowances a year for energy efficiency and renewable power projects. However, very few facilities have made use of this provision so far. Only one small hydro facility and one landfill gas project[18] have benefited from the set-aside, and very little over all: the landfill gas project only qualified for two allowances per control period, and the hydro facility gained 9 allowances in 1999, 7 in 2000 and 5 in 2001 [NHDES 2002]. This is partly due to the provision that projects must have started in or after 1990 to be eligible, and partly to the fact that renewable power projects have to prove how much NOx their activities displace based on the existing background mix (with 10% discounted for uncertainty). Due to improvements in the emissions performance of the fossil fuel-based facilities over the past decade, less and less benefits can be derived from renewable power production, hence the decrease in allowances allocated to them [RYP 2002]. This procedure makes it complicated and costly to apply for allowances and, because there is high volatility and unpredictability

**Box 4.4 — Input-Based vs. Output-Based Allocation of Allowances**

Originally, the EPA's NOx trading program was based on an input-based allocation process. The NOx set-aside program is output-based. This encourages efficiency and avoids giving the wrong incentives, i.e., the most polluting units had a "free pass" to keep on working like before under the old system because an input-based approach allocates the same amount of allowances to less efficient plants as to others that may produce more electricity with the same amount of fuel. In addition, an output-based allocation process that assigns allowances based on MWh of electricity production facilitates the inclusion of renewable energy plants, some of which do not use any fuel input, but rely on natural resources, such as wind, solar energy, and water.

in NOx allowance market prices (prices varied from up to $4,000 a ton to as little as $300 a ton, when a high polluting unit was taken off-line), this seems to be a deterrent to many renewable power producers. Finally, opportunities for renewable power projects in a small state, such as New Hampshire, are scarce, and additional incentives may be needed to increase the renewables share.

In New Jersey, the conditions have been more favourable towards renewable power. Set-asides are allocated based on the 1.5 lb per MWh-rule and no measurements or calculations are therefore required to prove the exact amount of NOx displacement. Application forms are provided, and about 75 allowances annually have been claimed over the past three years by three landfill gas projects and one energy efficiency project. Officially, the New Jersey set-aside will provide 410 tons of allowances to EE/RE projects as of 2003, about 18% of which are already being claimed by the above-mentioned projects. The program administrator believes higher participation in the program is not yet taking place because many renewable power providers are not aware of the program [NJ 2002]. A New Jersey landfill gas project administrator also highlighted the fact that revenues from NOx trading are fairly small as compared to the Renewable Energy Tax Credit, which amounts to currently (US) 1.7¢/kWh (CDN 2.7¢/kWh). He indicated revenues of only (US) 0.28¢/kWh (five months' income averaged over twelve months) in 2001, which would again be reduced by US income tax rates (about 38%) [NRG 2002]. If brokering services were used to trade the allowances, a further reduction would take place due to brokerage fees. These numbers show that there may be little incentive for renewable power generators to engage in NOx trading at current rates.

New York State has had a set-aside pilot program running since 1999. It currently only provides 115 allowances for energy efficiency projects, but will include renewable power by 2003, with an increased budget (1,241 allowances). Although some 60 tons worth of allowances have been certified for energy efficiency projects, no allowances have been allocated yet as authorities have had few resources to dedicate to the administrative process creating allowances from demand reductions. However, increased activity is anticipated for 2003 as several renewable power companies (including some wind energy providers) are interested in the program, since they hear about it when their facilities are going through the permitting process. Plants will probably be eligible if they were built within the last five years, and allocations will be available for up to five years. The overall set-aside is not planned to grow and new projects can benefit from allowances as existing plants lose eligibility [NYSERDA 2002].

*NOx trading alone will not be enough to make renewable energy competitive.*

### *Generation Performance Standards*

The initial allocation process for set-asides proposed by the EPA is really a Generation Performance Standard (GPS). A GPS (sometimes referred to as an Emission Performance Standard, or EPS) regulates emissions in terms of an allowable quantity of emissions per quantity of electricity generated. This emission rate per MWh of electricity (or steam) produced is assessed based on the overall production of electricity in the previous year, or the average of several preceding years. Then the total allowable NOx budget is distributed to all sources, based on their production. This effectively creates a need for extra allowances for units that emit more than the average, which is the GPS (1.5 lb/MWh for the example of NOx allowances discussed above), and gives credits to low-emission sources. The special feature of the US NOx allowance programs is that they also have a cap-and-trade provision. Under a capless GPS regime, if more electricity is generated in a given year, overall emissions can increase. The NESCAUM Emission Performance Standard (EPS, same as GPS; see Box 4.5) was designed to apply to retailers instead of power generators to incorporate production from outside the GPS implementation area (mainly Canada, also neighbouring US states), and a cap was left out since major changes in retail markets were expected [NESCAUM 1999, p. 30]. A cap-based system may need frequent adjustments to the allowance pool, which is not the case with an EPS applied to retailers. However, under a GPS, all energy producers are normally included, such as nuclear and large hydro facilities, which heavily reduces the incentive to buy power from more expensive non-large hydro renewable power facilities. While encouraging conventional energy to become less polluting, NESCAUM's EPS still needs a renewable portfolio standard (RPS) to foster the development of renewable power.

A GPS could exclude both nuclear and large hydro, but include fossil fuel-based generation units and all non-hydro renewable power generators, instead of setting aside part of the budget for the latter. If an emission cap was applied to power

**Box 4.5 — The NESCAUM GPS Model Rule**

The Northeast States for Coordinated Air Use Management (NESCAUM), composed of the six New England states, New York and New Jersey, have developed a Model Rule based on Emission Performance Standards (EPS) for NOx, $SO_2$, and $CO_2$, with mercury and CO standards to follow later. The Model Rule provides for year-round (as opposed to seasonal obligations imposed by current NOx cap-and-trade systems in the region) NOx emissions limits and provides a mechanism for collecting data and eventually imposing a standard for mercury emissions. The EPS is applied to retail suppliers, limiting the overall environmental impacts of serving retail electricity demand in a particular state, regardless of the variety and geographic location of generation resources used to serve that demand. The proposed EPS levels are:
4 lb/MWh for $SO_2$,
1 lb/MWh for NOx, and
1,100 lb/MWh for $CO_2$.

Until more data are collected, the effective standard for mercury is defined as the actual emissions rate. A standard for carbon monoxide (CO) has been reserved for further evaluation.

The Workgroup chose to include all resources in compliance determinations, without regard to fuel type. Compliance with the standards is determined by averaging the emissions characteristics of all generating resources associated with meeting a licensed supplier's retail load obligation for each of the electricity products sold by the supplier in the EPS implementing state. Compliance is determined on an annual basis, though suppliers are required to provide information on a quarterly basis. The Model Rule assumes that authority to impose an EPS will be linked to a state's licensing authority over retail electricity suppliers; in other words, suppliers will be required to comply with the EPS as a condition of being licensed to do business within the implementing state [NESCAUM 1999].

producers, then such a system would leave fossil fuel-based generators the options of either using abatement technologies or buying electricity from renewable power providers, excluding large hydro and nuclear. At the end of each year, fines would have to be paid for excess emissions. These fines should be high enough to exceed the production cost for renewable power; that is, they should allow providers to obtain a premium. The administrator allocates allowances based on electricity production in a given year, with allocation being adjusted each year depending on actual changes in generation patterns. A GPS with cap-and-trade has virtually the same outcome as a set-aside that is under-subscribed, with unused allowances being redistributed to emitting units.

An additional benefit of the GPS with cap and trade is that, as the allocation of allowances is reassessed each year based on actual output, low-emission units are encouraged to increase their production as they then can sell off surplus allowances gained through their below-average emissions. No allowances should be allocated to large hydro and nuclear facilities as this would lead to a much higher cost for fossil fuel-based generation, which would in turn cause electricity prices to increase more than intended[19] [RFF 2002, p. 15].

### 4.2.2 Mandatory Offset Trading

The first offset trading markets came into existence in the United States under the New Source Review provisions of the 1990 Clean Air Act Amendments, in order to allow for new emission sources to come on-line in non-attainment areas (areas that do not achieve national ambient air quality standards). The market for offset credits is much less active than some of the other emissions trading programs in operation — the administrative process is cumbersome and transaction costs are generally quite high. In addition, the process of creating an offset is complex and time consuming and requires a substantial initial cash outlay to complete an emission reduction project before the credits are created. For a source that wishes to rely on offset credits as a revenue stream to fund such a project, the process can be frustratingly backwards [NWCC 2001a, p. 64]. At present, these programs do not allow renewables to participate.

*Set-asides can be seen as a special case of a GPS, equipped with a cap-and-trade feature and a slightly different mechanism to allocate allowances to renewables.*

$CO_2$ offset trading is being implemented in an increasing number of states, despite the US government's refusal to ratify the Kyoto Protocol. The Oregon Climate Trust was developed as a result of a groundbreaking law enacted by the State of Oregon in 1997. House Bill 3283 is the first state-level legislation to create a meaningful measure to control carbon dioxide emissions. The Bill requires all new energy facilities built in the state to implement measures to avoid, displace or sequester a portion of their carbon dioxide emissions in an amount equal to 17% less carbon dioxide than the least-polluting plant operating in the US (for gas-fired plants). New plant developers may choose to meet this obligation by contributing funds to a qualified nonprofit organization that, in turn, invests in carbon reduction or sequestration projects [NWCC 2001a, p. 84]. Offsets were traded at prices between (US) $1.50 and $4.50 in 2001, depending on the nature of the project [TCT 2002]. New Jersey and New Hampshire have also developed strategies to implement mandatory $CO_2$ cap and trade programs. As recently as June 2002, a report by the Commission for Environmental Cooperation recommended the introduction of a NAFTA-wide carbon trading regime [CEC 2002d, p. 32]. Ontario's Select Committee on Alternative Fuel Sources has recommended the introduction of carbon trading by July 1, 2005, in conjunction with a renewable portfolio standard [SCAFS 2002, p. 19].

### 4.2.3 Voluntary Emissions Reduction Trading

Two kinds of "credits" have so far been the focus of trading in voluntary schemes: $CO_2$ offsets and green tags. The US Department of Energy established a Climate Challenge Program in collaboration with the electric utility industry as a mechanism to implement the voluntary reporting of greenhouse gas emissions guidelines of the Energy Policy Act of 1992 for identifying and implementing activities that can reduce, avoid or sequester greenhouse gases. Canada's KEFI Exchange has been established to trade carbon dioxide emissions in anticipation of implementation of the Kyoto Protocol. Canada's Greenhouse Gas Emissions Reductions Trading pilot project (www.gert.org) is another such platform. TransAlta and other utilities, such as Ontario Power Generation and BC Hydro, have posted requests for proposals for projects yielding $CO_2$ offsets. BC Hydro's RFP specifies a standard offer of $2 per ton of $CO_2$.

Green pricing (in regulated markets) and green marketing (in deregulated markets) are means to find customers who are ready to pay a premium for renewable power. Current premiums range from (US) $1.50 to $4.00 per MWh of electricity (see Appendix E). Unless renewable power is sold through long-term bilateral contracts to utilities, it is generally sold as generic energy (null electricity) and "green tags," which represent the combined environmental benefits of renewable power production, including any emissions offsets or credits. Green tags are sold at prices equivalent to green power premiums and their value can be assessed by looking at wholesale market platforms, such as the Automated Power Exchange (APX). Green tags were offered on the APX platform for prices between (US) $1.25 and $12 per MWh in 2001.[20] In general, existing renewable power facilities obtained prices at the lower end of the scale, whereas new facilities (built within the past 2 years) sold their tags for $5 per MWh or more.

**Table 4.4 — Potential Revenues for Renewable Power Producers from Emissions Trading** (adapted from [REPP 2000])

| Emission Reduction | Credit Market Value | Emissions Avoided per MWh of Renewable [C$/short ton] | Emissions Value [C$/MWh] Energy (short tons)[1] |
|---|---|---|---|
| $CO_2$ | 2 | 0.6 | 1.20 |
| $NO_x$ | 1,200 | 0.00075 | 0.38 |
| $SO_2$ | 320 | 0.006 | 1.92 |

*[1] Estimates for $CO_2$ are based on the average $CO_2$ emissions/MWh associated with fossil fuel electricity generation in the United States, discounted by one-quarter to reflect the likely effect of a $CO_2$ cap on retirement of older coal-fired generation capacity (an allocation based on today's generation and emissions would be about 0.8lbs/MWh), with no allocation of allowances to nuclear and hydro facilities. $NO_x$ estimates are based on the proposed allocation of allowances under EPA's $NO_x$ SIP Call in the eastern US. The $SO_2$ allowance allocation rate is based on that used to assign emission allowances to fossil generation under Phase II of the Clean Air Act acid rain program. This program began in 2000, but will not be fully effective until 2010.*

#### 4.2.4 Trading as Additional Revenue for Renewable Power Producers

The total possible trading revenue shown in Table 4.4 (C$3.50/MWh) is only a small percentage of the generation cost for renewable power, which is at least $50-60 (see chapter 2.2.6). This means that trading can only reduce the generation cost by about 7%. Some caution is warranted with respect to $CO_2$ credits: while a price of $2 per ton of $CO_2$ is a conservative number, the actual revenue created depends on whether or not a buyer can be found. Since there is, as yet, no regulatory framework, $CO_2$ emission reductions may have to be established against a changing background electricity mix. On the other hand, $CO_2$ offset prices are expected to rise over the coming years and may attain values of up to (US) $15, a ton even in the absence of an obligatory international trading framework, which may make up for some of the uncertainties linked to $CO_2$ emissions.

It is also striking that the revenues from NOx allowances may well be the smallest source of income if other pollutants are regulated — mainly because of the seasonal nature of some of the NOx markets. These numbers are very similar to current market prices of the green attributes of renewable electricity, which range from (US) $1.50 to $4.00 per MWh (see chapter 5).

#### 4.2.5 Ontario's Emission Allowance Set-Asides

Ontario's emission trading system went into effect for electricity generators on December 31, 2001. Based on Regulation 397/01 and the Ontario Emission Trading Code, emission caps for both NOx and $SO_2$ have been in place since January 2002. One thousand tons (2.8% of the total) of NOx emission allowances and 4,000 tons (2.5% of the total) of $SO_2$ allowances are set aside to support renewable power generation and energy conservation measures. The Regulation allows for a maximum of 33% (NOx) or 10% ($SO_2$) of emissions to be covered by extra allowances from emission reduction credits (including on-site measures, such as fuel switching or upgraded burners). The allowance system is managed through the Ontario Emission Trading Registry [APCC 2002].

The Emission Trading Code specifies that allowances from renewable power generators will be treated in the same way as emission reductions. Applicants have to submit three documents before they can be allocated allowances: a Protocol, an Emission Reduction Report, and a Verification Report. Emitting technologies, such as electricity generation from biomass and landfill gas, are excluded from the scheme [OETC 2001, pp. 13f.]. The construction of eligible renewable power projects must have started after January 24, 2000, be located in Ontario, and be based on wind, solar PV, run-of-river hydro, or hydro generation from existing dams. A project is eligible for allowances until seven years after commissioning and allowances can only be claimed after one full year of operation [ibid., p. 27]. Allowance allocations are calculated based on seasonal emission intensities, which are different for day and night, and are related to a MWh of electricity generation. Both NOx and $SO_2$ allowances are traded throughout the year. Annual average emission factors are: NOx: 1.17 kg/MWh and $SO_2$: 3.79 kg/MWh.

As the Ontario trading regime contains a clause admitting the introduction of U.S. allowances into Canada, US prices could have a strong influence on allowance prices in Ontario, and similar values as in the US can be assumed for Canadian allowances [OPG 2002b]. While it may not be necessary even for smaller renewable electricity generators to use brokerage services at this point in time (the only buyer of allowances is currently Ontario Power Generation), allowances are subject to income tax (40%) requirements (unless for utilities that are tax exempt Crown

**Table 4.5 — Income for Renewable Electricity Producers from Allowance Trading in Ontario**

| Emission | Value per ton | Gross Value per kWh | Value after Tax |
|---|---|---|---|
| NOx | C$1,200 | 0.14¢ | 0.084¢/kWh |
| $SO_2$ | C$300 | 0.11¢ | 0.066¢/kWh |
| Total | C$1,500 | 0.25¢ | 0.150¢/kWh |

*Note: US prices for short tons are applied to metric tons as US prices are likely to be the upper price cap for Canadian allowances.*

Corporations). This reduces the potential revenue from trading to a great degree (see Table 4.5).

Since the after-tax benefits from emissions trading for renewable electricity producers are small, producers will likely opt to sell their renewable energy in green power marketing schemes, assuming a higher green premium.

### 4.3 System Benefits Charges

A system benefits charge (SBC) is an added fee on electricity use and can be used to support renewable power. In the US, SBCs raise between 0.05 and 0.3 (US) ¢/kWh, resulting in funds of between (US) $15 million (Rhode Island) and $540 million (California). From 1998 to 2012, roughly $3.5 billion will have been collected by the 15 states that have implemented system benefits charges.[21] The benefits flowing towards renewable power projects out of these funds has amounted to between 0.11 and 6.75¢/kWh [BOLIN 2001, p. 18]. An SBC to finance investment in renewable power sources has been proposed for Ontario by the Select Committee on Alternative Fuel Sources. This charge would amount to 0.1¢/kWh and would be used to subsidize equipment manufacturers, utilities and energy users [SCAFS 2002, p. 16].

The money raised through SBCs can be directed towards green energy generators through: investments (cheap loans, grants or equity investments, which may allow for the fund to become self-sustaining over time); production incentives, such as the 1.2¢/kWh[22] Wind Power Production Incentive in Canada [FINCan 2001]; or renewable power projects through support programs for marketing, R&D, education and demonstration projects (see Table 4.6 for their current use in California). The funds are administered by different bodies, including state energy, commerce or environmental agencies, quasi-public business development organizations, or independent third party organizations.

While distributed generation policies are popular among states, programs established to date have often experienced a more modest degree of success than programs targeting

**Table 4.6 — Proposed Spread of SBC Funds in California (2002–2006)** [CEC 2002e]

| Account | Million U.S.$ | % of total budget ($675 million) |
|---|---|---|
| Existing Renewable Resources | 135 | 20 |
| New Renewable Resources | 337.5 | 50 |
| Emerging Renewable Resources | 101.25 | 15 |
| Customer Credit | 67.5 | 10 |
| Consumer Education | 33.75 | 5 |

utility-scale projects. Buy-down programs allow for those acquiring distributed generation equipment to recover a large percentage (often 30–50%) of their investment through the program "buying down" part of their initial investment. But California, for example, has not been able to attract enough interest in its emerging renewables buy-down program after three years to exhaust the funds in the first and most lucrative of five funding blocks for smaller project sizes (< 10 kW). Rhode Island and New York have also met with disappointing results [BOLIN 2001, p. 20], and the picture does not change for New Jersey and Illinois, which are states offering some of the highest buy-down incentives of up to (US)$6 per watt [ibid., p. 37]. The limited success of customer-sited systems is attributed to the high installation price of the (mainly PV) systems, and to limited awareness among private and small business customers (14% and 9%, respectively, were aware of the program in California, two years after its inception). To overcome the investment barrier, Pennsylvania has started developing a leasing program for PV systems, and other alternatives, such as supporting the PV manufacturers with marketing or through equity investments, bulk purchases and working with green building initiatives [BOLIN 2001, p. 39]. The lack of awareness concerning renewable power systems and the possible savings from installing them was confirmed in the evaluation of Wisconsin's DSARE pilot program, which highlighted the need for consumer information, workshops and training programs [DSARE 2002]. The second phase of the program was re-designed to include low-interest loans (4% interest rate) for home installations and was deemed successful during the first evaluation period [DSAREII 2002].

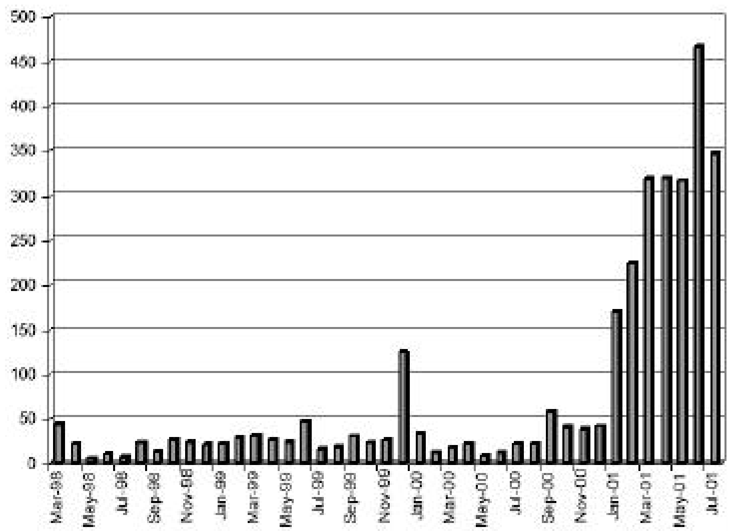



**Figure 4.4 — Requests for Funds from the Emerging Renewables Buydown Program** [CEC 2002a, p. III-4-7]

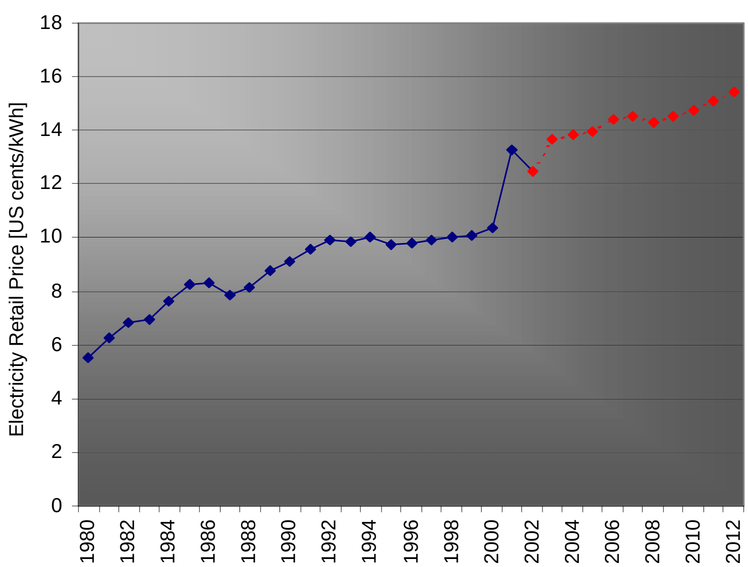



**Figure 4.5 — California Electricity Retail Prices** [CEC 2002b]

Demand for funding from the California Energy Commission's Emerging Renewables Buydown Program increased more than 1,000 percent from the third quarter of 2000 to the third quarter of 2001 (see Figure 4.4), which coincided with a steep increase in electricity cost in the same year (see Figure 4.5).

*Consumer response to buy-down programs in order to increase consumer-sited distributed generation has been disappointing throughout the United States.*

This development was enhanced through bill AB 970, passed in August 2000, which required the California Public Utilities Commission to develop and administer a program to encourage distributed generation. The program provides rebates of (US) $4.50 per watt for renewable distributed generation systems. However, distributed generation still makes up for less than one percent of the electricity generated in California [CEC 2002a, p. III-4-6].

Another important use of the SBC in California is the Customer Credit, which reduces the price of green power purchases by 1¢/kWh. Two other states (Oregon and New Jersey) have considered introducing customer credits for renewable power purchases, but so far California is the only state where this approach is used. A critique of the customer credit is that it creates an artificial market that cannot survive without the subsidy and will collapse when the subsidy is taken away. An October 2000 evaluation of this part of the program revealed that nearly half of the respondents to a survey indicated they would have reduced their output or shut down completely in the absence of the program [BOLIN 2001, p. 54]. The effectiveness of consumer credits or rebates has also been questioned as many consumers will not take the time to seek out the cheaper offers made possible by such schemes (see also last paragraph of chapter 4.5.1). SBC-funded incentives for existing plants in California helped reactivate mothballed facilities and have kept them on-line since the introduction of the SBC (see also chapter 3.2.2).

Pennsylvania adopted a slightly different way to disburse funds to renewable power projects (see Box 4.6). Connecticut uses its SBC funds to support the commercialization of technologies, very much like a venture capital fund. Private co-financing is sought with each investment, and returns from the investments are meant to make the fund self-sustaining over time [BOLIN 2001, p. 58].

**Box 4.6 — Production Credit or Lump-Sum Payment?**

One important benefit of up-front incentives is that, given the time value of money, a fixed amount of money may be able to stimulate additional renewables development if a front-loaded payment stream is used. This latter finding led the Pennsylvania Sustainable Development Fund to develop an innovative approach to distributing its production incentive. Initially planned to be a 5-year production incentive, the Sustainable Development Fund ultimately awarded a lump sum payment to winning bidders, which was available upon commercial operation of the project. Projects are assumed to “earn” this grant over time through a 1.5 cent/kWh incentive up to the aggregate grant level. Project performance is secured by a letter of credit. If projects do not “earn” their grant due to systematic under-performance, the Sustainable Development Fund has the ability — through the letter of credit — to take funds back from the project. If it is assumed that the wind developer’s cost of capital exceeds the SDF’s opportunity cost of capital by 10%, it can easily be shown that this up-front lump sum approach boosts the incentive’s leverage by 22% compared to a production incentive distributed over five years. If the cost of capital differential is 5%, an 11% leverage boost could be expected. [BOLIN 2001, p. 34]

The fund not only invests in projects leading to the installation of new generating capacity, but also in industries with export prospects.

### 4.4 Europe — Feed-In Tariffs vs. Tendering

Instead of system benefits charges paid by electricity consumers, some European countries use a system in which utilities are obliged to buy green power at set tariffs. Support for green power thus comes directly from the utilities. Over the long run, the cost is still borne by the utilities' customers since their rates have to increase slightly to finance the more expensive green power purchases, or as levies are charged in order to reimburse the utilities for their extra costs. Feed-in tariffs have attracted attention since the late 1980s, especially in Denmark, Germany, Italy and, in the 1990s, Spain. In Europe, most feed-in tariffs range from 2.5 to 5 €cents, but can reach up to 15 (small hydropower, Austria) or even 72 €cents (solar PV, Austria) [Haas 2001, p. 18].

Feed-in tariffs played a major role in the substantial growth of wind power in Denmark, Germany and Spain in the past few years. This is shown in Figure 4.6 and Table 4.7, which compare three groups of countries. First, market-based tendering programs as (formerly) implemented in France, Ireland

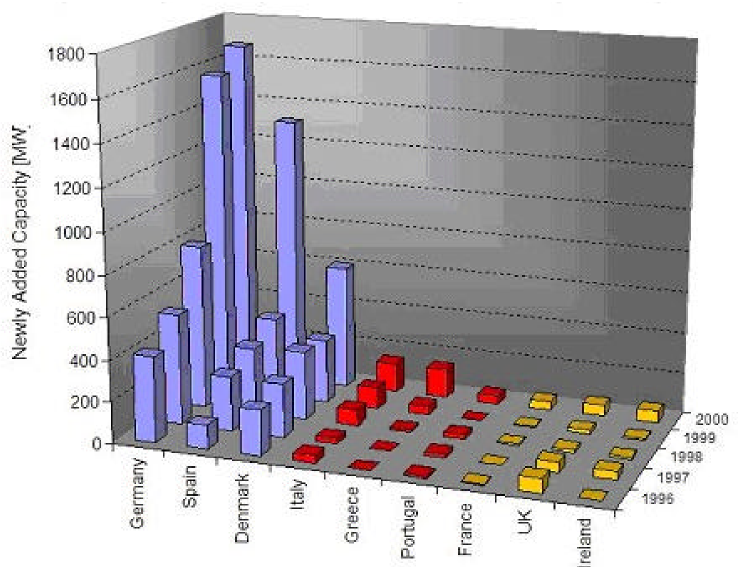



**Figure 4.6 — New Installations of Wind Energy Plants** [BWE 2002]

and the UK[23] have had modest success in fostering new wind generation (wind is taken as the example here as it leads renewable power markets throughout the world). The second group, Greece, Italy and Portugal, also implemented feed-in tariffs, but less successfully than the first group. This can be attributed to constraints, such as the uncertain political situation in Italy, that hampered renewables development since frequent changes of government created insecurity about support for renewable power [BTM 2001, p. 24], or to the fact that wind plants have to pay for access to the grid in Greece. Italy's tariffs also create some

**Table 4.7 — Wind Feed-in Tariffs in Europe (2000)** [BTM 2001, p. 38]

| Country | Tariff (¢CDN/kWh) | Comments |
|---|---|---|
| Germany | 12.60 | Stable support policies; cheap loans/grants, tax-deductible investments |
| Denmark | 8.06 | $CO_2$ tax and production tax credit |
| Spain | 8.40 | Capital grants (max. 30%); slow permitting, grid capacity constraints |
| Italy | 8.00 | Unstable policies; complex tariff pricing system |
| Greece | 10.25 | Grid connection to be paid by wind farm |
| Portugal | 11.20 | Lack of regulations concerning grid connection |

> *"In the United States and California, policies have driven the goals, while in Denmark and Germany the goals for wind have driven national policies."*
> JLS 2001, p. 343

uncertainty since they are based on avoided cost, which varies with fuel cost, rather than on consumer prices, as was done in Germany, which is more stable [FIRE 1998, p. 109]. Also, Italy's feed-in tariffs are re-negotiated each year, which contributes to uncertainty and usually results in marginal tariffs [REPP 1999, p. 23]. The most successful group, represented by Spain, Denmark and Germany, uses feed-in tariffs in combination with other incentives, such as cheap loans, production credits, regulated grid access, capital grants and tax relief for investors. This mix of policies has proven to be by far the most effective strategy to promote renewable power, although it is more expensive than the market-based options [CMUR 2000, p. 303f]. Denmark, Spain and Germany provided 80% of the EU's new wind generation capacity between 1993 and 1999 [EEA 2001, p. 61]. In Spain, lengthy permitting procedures at local levels have slowed development [BTM 2001, p. 24], but the overall figures are still among the highest.

Biomass has benefited less than wind from feed-in tariffs. This has been attributed to the fact that the tariffs have been less economically attractive for biomass than for wind, and countries, such as Germany, have increased the biomass tariffs as a consequence. In Sweden and Finland, where capital subsidies were provided in addition to feed-in tariffs, larger deployment rates for biomass projects were achieved. The same can be said for photovoltaic systems, which need even higher financial support [EEA 2001, p. 61]. As the internal rate of return (IRR) of renewable power projects is directly related to the tariff that a power producer gets paid for the product, the tariff will determine whether investments flow towards renewable power or to fossil fuel-based generation. In Europe, IRRs of 10% to 16% can be reached even for small projects [FIRE 1998, pp. 61, 86], which seems an attractive rate, especially if it is uncoupled from volatile electricity prices through long-term contracts or stable policies concerning feed-in tariffs.

This reveals one of the features of feed-in tariffs. They can be set at different rates for different technologies, effectively promoting all available technologies, as was done through the technology bands of the former British NFFO tendering process. The tariffs have prevailed over tendering because of their open-endedness. Any producer is guaranteed the feed-in tariff for each unit of electricity exported to the grid if the form of generation meets the stated criteria; no bidding process or tendering is involved. With tendering programs, in which increased tariffs are only available to the selected 'winners' after competitive tendering, and with limited budgets, the number of projects that can come on-line in a given year is restricted.

Fixed rates are the critical point of feed-in tariffs, as they work against competition, not giving preference to cheaper projects (see Table 4.8). Moreover, they pay the marginal

**Table 4.8 — Price Comparison of Wind Power in Germany and the UK, in 1999 €**
[IEPE 2001, p. 16]

| | 1993 | 1994 | 1995 | 1996 | 1997 | 1998 |
|---|---|---|---|---|---|---|
| Germany (Feed-in tariff) | 0.091 | 0.091 | 0.091 | 0.089 | 0.089 | 0.086 |
| UK (Tendering price) | n.d. | 0.076 | n.d. | n.d. | 0.057 | 0.045 |

rate required to get the last desired participant into the market, which makes them economically inefficient and places extra burdens on ratepayers. These aspects can be diminished by creating flexible rates that are reduced over time, as stipulated in the new German Renewable Electricity Act, and by revising the tariffs as a function of decreasing production costs of new projects. Such mechanisms should, however, maintain transparency in order to give confidence to investors about financial viabilities of projects in the long run. To correctly interpret the data in Table 4.7 it is also important to know that the wind resources in the UK are far superior to those in Germany, so that UK wind farms can produce electricity at almost half the price of Germany's.

It is important to understand that feed-in tariffs have been successful because they give investors long-term security. Some of the tariffs extend to 20 years or longer. In general, rules are clearly set in a way that allows investors to plan ahead — such as 8 years support at the same rate and then a reduction to a lower rate. In the Netherlands, high incentives are given though the tax exemption, but it is far less foreseeable how long these taxes will remain in place or which energy sources they can be applied to, as hydro has recently been taken out of the definition of eligible sources for the exemption. The Dutch system also grants the same amount of support to all sources, which effectively hampers the development of more expensive sources, such as PV.

On the other hand, the tariffs have been criticized as subsidies, and green power marketing schemes have taken this into account. Certification organizations, in particular OK-Power, have tried to address this issue by setting standards for the inclusion of government-subsidized capacity in green power products [NREL 2002, p. 29].

What the European experience has shown is that feed-in tariffs alone are not enough.

*No policy by itself is sufficient to foster renewables deployment, but needs to be implemented in concert with others. Feed-in tariffs together with planning and permitting support and cheap loans or grants have shown the best results.*

They have to be complemented by other supporting action. The most important hurdles, especially for wind development, have been identified as obtaining planning permission,[24] securing and financing grid access,[25] transmission rules, and high initial investment cost. In Germany, the most successful nation to implement wind farm deployment, regional planning agencies identify suitable wind park sites. The first step in identifying these sites is to map local wind velocities, a task that can easily cost several million dollars, requiring government or utility support in order to facilitate wind development. Clear and favourable rules about grid access are also necessary, as can be learned from the experience in France and the UK, where grid access charges are not fixed or transparent and vary greatly from one region to the other [EEA 2001, p. 52]. The need for grid expansion or strengthening has been a limiting factor to wind power deployment in Italy and Portugal [ibid.], and is now also a factor in Texas (see chapter 3.2.4). Government aid, or burden sharing among utilities for grid extensions or capacity increases, will help the deployment of renewable power generation. As the best renewable resources are often situated in remote locations, transmission costs that increase with distance can otherwise put an extra burden on new projects. In Sweden, transmission rules are very favourable even for small projects as they apply a tariff independent of distance [FIRE 1998, p. 83]. Germany also provides cheap loans to renewable power projects, which tackles the problem of high initial investment. Sweden, which provides generous subsidies to renewable power projects, but has no feed-in tariffs, has not been as successful as Germany, where both incentives are applied simultaneously [ibid.].

Stability and transparency of support models is crucial for long-term investments, as insecurity about rules governing green energy support will effectively hamper its deployment. This also relates to varying electricity prices against which renewable electricity generators have to compete [FIRE 1998, p. 41]. Stability can be achieved through both feed-in tariffs, which are supported by long-term contracts or stable legislation, and a tendering scheme resulting in long-term contracts between power generators and utilities. Another way of achieving this is a renewable portfolio standard (see Chapter 4.8), which has been shown to encourage long-term contractual agreements between parties.

**Box 4.7 — New Zealand's Proposed Carbon Tax**

The New Zealand government enacted a carbon tax in April 2002, to be levied in 2007 in case the Kyoto protocol comes into force. The tax would amount to NZ$25 (US$11.17) per ton of carbon dioxide emissions. New Zealand ratified the 1997 Kyoto accord in August 2002. Official papers show the tax would raise domestic energy prices by between 6 and 19 percent. Most of New Zealand's methane and carbon dioxide is produced by livestock, such as cattle and sheep, but the country's farmers will be exempt from the tax.

(For full text, see: http://enn.com/news/wire-stories/2002/05/05012002/reu_47072.asp )

## 4.5 Tax Reform

### *4.5.1 Overview*

Tax restructuring can help the deployment and sale of renewable power in many ways. At the retail level in some countries, energy or carbon taxes are successfully used to distinguish renewable and non-renewable sources, in some cases to such an extent that renewables become cheaper than conventional electricity products (see chapter 3.3.4). Some European countries have started going the way of ecological tax reform, lowering income tax on pension fund contributions and taxing resource consumption, such as energy use.

Market restructuring provides a good opportunity to change the way electricity is taxed. Taxes can be imposed based on fuel consumption or based on units of production. This essentially provides two ways of incorporating environmental concerns into taxation: a tax that penalizes environmentally harmful fuels, such as a carbon tax, or an energy tax applied to the electricity sector only and which provides incentives to buy renewables-based electricity through a reduced tax or a tax rebate.

Taxing fossil fuels with a carbon tax is the economically and environmentally preferable alternative,[26] as it encourages fuel efficiency and has an effect beyond the electricity sector. This has so far been its greatest handicap as well, as the taxation of fuels, especially gasoline, is an unpopular measure. It would also lead to market distortions if one country applies the tax and others don't, although this has not kept some countries from introducing or considering a carbon tax (see Box 4.7). Distortions can also be kept to a minimum by exempting foreign buyers from the tax, such as is the case with GST, in order to maintain export competitiveness.

If a carbon tax cannot be implemented, mostly for political reasons, then an electricity tax that differentiates the environmental footprint of energy sources, or a uniform tax with a rebate for environmentally preferable energy sources, would be another way of rewarding renewable power. This may be easier to achieve and would have similar results to an environmental fuel tax, although this option is restricted to the electricity sector. The downside of this approach is that it works well if renewable power production is only a fraction of the total. If renewable power grows to be a substantial percentage of overall production, there will be considerable losses in tax income from the energy sector. In the end, this is not a substantial problem because tax incentives can be phased out over the years as markets and technologies improve and renewable power competes with conventional energy without subsidies. In a Canadian context, consideration should be given to the possibility of displacing electric heating mainly based on low-carbon hydropower towards carbon intensive fossil fuel-based alternatives. Customers should have the ability to purchase renewable electricity at the price formerly paid for conventional power.

A rebate may have less effect than a differentiated tax. Experience with residential consumers in US states that have opened retail competition to the residential class shows that most small consumers do not dedicate the time needed to make informed choices. Absent the "informed consumer" pre-requisite for efficient resource allocation under competition, there is less likelihood that desired change will occur with a rebate system than if producers were taxed [RAP 2001, p. 22].

### *4.5.2 Tax Incentives for Investment*

Tax exemptions or reductions can be used to encourage private individuals and companies to invest in renewable power projects. In Germany and Sweden, investments in wind energy plants are tax deductible for private investors, while in Ireland, the Netherlands and Spain tax deductions are available for companies. Norway exempted renewable power technologies from investment taxes [NREL 2002, p. 53]. In Greece, solar thermal water-heating systems have been supported by tax exemptions. In the Netherlands, companies and firms that invest in energy

**Table 4.9 — Tax Incentives in Various EU Countries** [Haas 2001, p. 17]

| Country | Investment-based tax incentives |
|---|---|
| Austria | Private investors get tax credits for investments in using renewable energies (personal income tax) |
| Belgium | 13.5–14% of RES-investments deductible from company profits, regressive depreciation of investments |
| Greece | Up to 75% of RES-investments can be deducted |
| Ireland | Tax relief for certain RES-investments |
| Italy | Up to 50% of RES-investments can be deducted over a period of two years |
| Luxembourg | Tax deduction for RES-investments |
| The Netherlands investors | VAMIL scheme: RES-investors (specific renewable technologies) are allowed to offset their investments against taxable profits. EIA scheme: RES- (same technologies as VAMIL) are eligible for an additional tax deduction against their profits (from 52.5% to 40% depending on sum of the investment). Lower interest rates from Green Funds: RES-investors can obtain lower interest rates (up to 1.5%) for their investments. |
| United Kingdom | Reduction of VAT (5% rather than 17.5%) on domestic PV and wind generating capacity cost |

efficiency and renewable power projects can benefit from accelerated depreciation on their investment [EEA 2001, p. 53]. Some European investment-related tax provisions are listed in Table 4.9.

Due to the generally higher per-kWh investment of renewables as compared to fossil fuel-based projects, sales tax burdens are not only concentrated in the first year of operation, but also virtually tripled as compared to (for example) natural gas plants, as capacity factors of renewable power plants are generally only one-third those of natural gas plants. The State of Washington has created tax support for renewables by exempting the construction of renewable power facilities from the state's sales tax [RAP 2001, p. 21]. There are many other US states offering one or more financial incentives for investment in commercial and industrial applications of renewable power technologies. These incentives include income tax credits, property tax exemptions, state sales tax exemptions and accelerated depreciation allowances. US Federal tax incentives include a tax deduction for geothermal energy generation of up to 10% of the investment or purchase and installation amount of qualifying energy property, and include the Federal Modified Accelerated Cost Recovery System (MARCS) for solar, wind and geothermal property.[27] In this context, the Ontario Select Committee on Alternative Fuel Sources recommended giving a ten-year property tax holiday to wind farms, as their specific land requirements are far higher than those of fossil fuel-based generation [SCAFS 2002, p. 15].

Investments with higher rates of return, established markets and good track records are the ones that attract investors. In Canada, non-renewable power investments often perform this way. However, when the Commissioner of the Environment and Sustainable Development surveyed investors [OAG 2000, p. 22] it was found that many renewable power investments do not currently have these features.[28] The survey also revealed that the payback period is often too long for investments in renewable power and energy efficiency to make them the preferred choice. Finally, investors confirmed that the tax system can play a role in influencing their investment decisions. Tax incentives can improve the rate of return or reduce the payback period on an investment to make it more appealing. Certain tax incentives, such as accelerated write-offs, are useful when a company has sufficient profits to claim the write-offs immediately. In other situations, refundable tax credits and flow-through shares are more valuable.

On the other hand, in Europe, renewable power projects are seen as good investments by some banks because their returns are independent of economic cycles or, for example, the volatility of agricultural prices [FIRE 1998, p. 47]. This may indicate that investors can be ready to accept somewhat lower returns in part of their portfolio in exchange for the stability of the business they invest in. In any case, investors may be hesitant to invest in renewable power schemes simply because they lack expertise with these technologies, so that brokers with a good understanding of the financial and technical issues involved are crucial during the first years [ibid., p. 51]. Again, state grants can help reduce perceived risks with these technologies and therewith facilitate additional private investment.

Denmark has succeeded in motivating private investors to look at renewable power projects. Many Danish citizens have a desire to have a personal relationship with the projects they invest in for their private pension plans. Renewable power providers that are directly linked with the community or business of the investor have attracted many such investors as they provide a fairly regular cash flow over a long period of time. There are also a number of co-operatives financing renewable power projects in Denmark [FIRE 1998, p. 28]. Similar developments can be observed in Sweden, Austria and Germany, where several private investors have bought shares of a solar system installed on top of a soccer stadium [ibid., p. 37]. Such initiatives are often crucial for local acceptance of projects and help people identify with renewable power. They also increase local involvement in project planning and modification. This can be seen as an opportunity to maximize the local environmental and social benefits of the project, as the advantages of local involvement outweigh disadvantages with respect to the owners' autonomy [p. 114]. Co-op schemes are attracting banks' investment with ease in Denmark as they generally cover a large share of the initial expense and allow the bank to earn positive recognition with the locals [p. 53]. With many North Americans investing in shares, renewable power providers could benefit from their funds if they are educated and possibly motivated through additional tax incentives.

*Additional support of 1–2¢/kWh could be achieved by adjusting the tax system so that it treats renewable energy fairly.*

The Canadian Association for Renewable Energy asserts that the existing tax write-offs for renewable power companies are "trapped" and cannot be used to the same extent as the write-offs available to their fossil-fuel counterparts. The tax system treats capital and operating costs differently, and because renewable power companies have (in many cases) a higher proportion of capital costs than their fossil-fuel counterparts, their proportional tax write-offs are smaller than those of fossil fuel-based businesses. Existing Canadian tax incentives for renewables include the Canadian Renewable Conservation Expense (CRCE) deductions under Sections 66 and 66.1 of the Income Tax Act, as well as deductions from accelerated depreciation of the Schedule II, Class 43.1 equipment utilized in a project. The CRCE allows for the deduction of 100% of the cost incurred in the first year, but although being helpful during the exploration phase of a renewable power project, it cannot reduce the generation cost as it only covers non-tangible expenses, such as technical assessments and feasibility studies, which, for example in the case of a biomass project, only account for 1–3% of the cost of renewable power [CEA 2002, p. 6]. Changing this coverage to include capital investments would have a great impact on the Canadian renewable power business, especially since CRCE allows for flow-through share treatment[29] of the incurred cost, encouraging private investments. Accelerated depreciation of 30% per year (Class 43.1) covers the tangible capital cost, but at a lower depreciation rate. Industry experts estimate that removing federal tax barriers to renewable power would reduce costs by 1.5 to 2¢/kWh [LIREC 1999]. The Clean Air and Renewable Energy Coalition assumes that expanding the CRCE to capital cost for three years would reduce production costs for renewables by 1.9¢/kWh [CARE 2002d, p. 5]. Another option would be the inclusion of renewable power projects under the Investment Tax Credit of 20% under the Income Tax Act. Most renewable power companies would not qualify for this credit, as they are too large to be eligible. The Tax Credit provides a net benefit of 13% for each dollar invested, or a reduction of about 2¢/kWh of electricity generation cost [ibid.]. Several reasons support the use of direct subsidies, rather than tax credits (see Box 4.8), and these should be taken into account when optimizing support in Canada.

**Box 4.8 - Tax Credit or Investment Grant?**

Whereas tax credits and investment grants can have the same financial effect, they are not completely equal. The following reasons suggest that a fixed percentage subsidy is preferred over tax credits [JLS 2001, p. 340]:

1. Tax credits tend to favour the wealthy, whereas grants treat everyone alike. In Germany, many of the well-to-do started investing in wind technology simply because of the huge tax savings, rather than to support wind on its own merits. In California, wind became associated with tax loopholes, hurting the technology in the short term.
2. Grants lower the cost of the equipment in the eyes of the purchaser.
3. Grants can be obtained at any time of the year, encouraging an even distribution of investment over the months. Tax credits can only be obtained at the end of the fiscal year, which has led to an accumulation of project activity during those periods in Germany.
4. Grants can be adjusted more easily. If other benefits reduce the investment cost beyond what is intended to maintain caution on the side of the investor, and to make sure projects actually succeed and produce electricity, it is easier to downgrade or deny a grant than to change tax provisions to correct a “double-dipping” situation.
5. Some plants in California were of inferior quality or were never started up, but investors were still able to recover the tax credits. Grants will avoid this as they encourage purchase of the best technology and actual operation of the equipment more than tax exemptions do. Grants can also be split, paying out part of the sum in advance and part when the plant starts operating. This avoids giving out money for investments in machinery that is later abandoned and never gets to completion or to the operation stage.

### *4.5.3 Carbon and Energy Taxes*

In Europe, environmental tax initiatives are increasingly implemented in order to reduce greenhouse gas emissions (see Table 4.10). The taxes are used as a way of internalizing the environmental cost of fossil fuel-based energy production. Taxes are tied to actual carbon dioxide emissions or to the energy content of the fuel, but also target other emissions, such as $SO_2$ or NOx. Renewable power producers benefit through exemptions or refunds from the taxes, or by being subsidized by revenue raised from the taxes [EEA 2001, p. 62]. In Canada, a carbon tax was recommended by the Ontario Select Committee on Alternative Fuel Sources, to be introduced by 2005 [SCAFS 2002, p. 15].

$CO_2$ taxes have been implemented in Denmark, Finland and Sweden. The Netherlands, Germany and Norway have revenue-neutral taxes, offsetting income taxes or other general taxes. Norway has estimated that $CO_2$ emissions have dropped by 3–4% in response to a tax that increased the cost of heating oil by 15% and petrol by 10% [RAP 2001, p. 21]. Norway also reduced the electricity tax for renewable power to 50% of the normal tariff [NREL 2002, p. 53]. The Swedish carbon dioxide and energy taxes, exempting biomass, have helped the expansion of biomass district heating and biomass combined heat and power, making other options, in particular coal-based options, more expensive [EEA 2001, p. 62]. In Sweden, the residential sector has to pay an equivalent of 2.9¢CDN/kWh for conventional electricity, and wind energy

**Table 4.10 — Energy taxation in various EU countries** [Haas 2001, p. 24]

| | |
|---|---|
| Denmark | Carbon-based-, sulphur- and energy-taxation: Existing renewable power plants (wind, biomass, biogas) are exempt from the $CO_2$ taxation (€0,013/kWh). |
| Finland | Carbon-based environmental tax in force since 1990: The tax is refunded to energy producers using wood-based fuels, wind- and small-scale hydro power. |
| Germany | 1999 Ecological Tax Reform: Energy tax (€0,01/kWh, increasing) — revenues of taxing energy sources are being used for a renewable power support program. |
| Sweden | Carbon-based-, sulphur- and energy-taxation: Small-scale renewables based electricity production is favoured by lower or no energy taxation. Biomass (incl. waste) is not levied with $CO_2$ taxation. Biofuels are exempt from sulphur taxation. |
| The Netherlands | Users of green electricity are exempted from paying the energy tax (€0,06/kWh). Producers of green electricity receive a production incentive from the energy tax (€0,02/kWh) for electricity — similar rates for producers of biogas and for heat from biomass-CHP). |
| United Kingdom | Climate Change Levy (CCL): The new tax is to be levied on business customers, in effect from April 2001. Renewable generation is exempt. |

receives a subsidy for the same amount. As a result, green power products are offered on the market at prices equal to, or slightly higher than (max. 1¢CDN/kWh), those of conventional electricity [NREL 2002, p. 40].

The Dutch energy levy (see Box 4.9) is the most rigorous measure taken in any country. It has been increased in several increments and now amounts to 6 €cent/kWh (8.4¢ CDN/kWh) for small consumers (<10,000 kWh/year). This taxation has triggered a market for green electricity unmatched by any other country in the world (see chapter 3.3.4). On April 1, 1999 the Law Initiating the Ecological Tax Reform came into force in Germany. Similar to the Dutch approach, energy taxes are increased in small steps, while social security contributions are being reduced, making the "ecological tax reform" altogether "revenue-neutral." This law increased the price of fuels, heating oil, gas and electricity. The latter is taxed with 1.02 €cent/kWh. At the same time, contribution rates for statutory pension insurance were reduced by 0.8% points, from 20.3 to 19.5%, the reduction being split equally between employees and employers. Based on the Law on Continuing the Ecological Tax Reform, adopted by the German Parliament on 11 November 1999, energy taxes will be increased in four steps until 2003, with the electricity tax going up by 0.26 €cent/kWh at the beginning of each year from 2000 to 2003. Just as in the Netherlands, part of the tax will be used to support renewable power: increasing amounts, from €102 million to €204 million will be used for this purpose [ENER 2001a, p. 7ff.]. Britain has introduced the Climate Change Levy, which applies to

**Box 4.9 — The Dutch "Regulating Energy Levy" (REB)** [DE 2002c]

The Netherlands has subjected energy and gas to a levy, in addition to VAT, in order to provide a strong incentive to save energy. Renewable energy is exempt from this levy, which means that especially wind power can compete with conventional energy sources: most renewable energy products are offered at the same price, or a 1 €cent (1.4¢ CDN) premium (a maximum monthly cost of €2.75/$3.85 CDN to consumers). One product is even available at a discount. The funds raised by this levy are made available to renewable energy projects through a 2 €cent (2.8¢ CDN) production incentive. At an extra cost of 5–6 €cent for renewable energy in the Netherlands this would not be enough to cover the green premium by itself, but together with the tax exemption green power becomes competitive. The levy depends on the amount of energy a client consumes:

| | |
|---|---|
| 10,000 kWh | 6.01 €cent/kWh |
| 10,000-50,000 kWh | 2.00 €cent/kWh |
| 50,000–10 million kWh | 0.61 €cent/kWh |
| Above 10 million kWh | 0.00 €cent/kWh |

Large hydropower (>15MW) is considered a mature electricity product that does not need the full support of the REB. Hydro is thus not exempt from the energy levy, but still receives the production credit.

Most of the tax (about €2.8 billion/year) is re-directed to Dutch citizens and business through National Insurance (pension fund) contribution reductions. The remainder, about €200 million per year, is used to support renewable energy production through the production incentive [MEZ 2002b].

large electricity customers only and can be reduced by voluntary energy efficiency programs. Revenues from this levy also benefit renewables support programs. Table 4.11 provides an overview of some existing energy taxation schemes.

In the United States, the State of Iowa encouraged energy production from wind and methane from the electricity tax [RAP 2001, p. 21]. A somewhat particular case is Oregon's Bonneville Environmental Foundation. The Foundation offers green tags, representing the environmental and social benefits of renewable power generation, to US customers over the Internet. Expenses for these tags are tax deductible for everyone since the Foundation is a registered charity.

## 4.6 Other Policy Options

### *4.6.1 Direct Subsidies and Low-Interest Loans*

Several countries, including Canada and the United States, pay production incentives to support renewable power generation on a per-kWh basis. Such subsidies are often financed by special taxes or levies, or a system benefits charge in California, and effectively bring down the price of renewable electricity, sometimes enabling it to compete with conventional electricity. Although the California customer credit is not paid to energy generators, it has the same effect on market prices as a production incentive because it reduces the premium paid by consumers. Finland pays production

**Table 4.11 — Carbon and Energy Taxes** [CSE 2001, HAAS 2001]

| Country | Amount per kWh | Amount per kWh in ¢CDN |
|---|---|---|
| Denmark | 1.30 €cent | 1.8 |
| Finland | 0.025–0.04 FIM | 0.6–1.0 |
| Norway (coal) | 0.11 NOR[1] | 2.15 |
| Netherlands (REB) | 6.01 €cent | 8.4 |
| Germany | 1.80 €cent | 2.5 |
| Great Britain (Climate Change Levy) | 0.43 p | 0.97 |
| New Zealand (proposed) | 1.5¢[1] | 1.1 |

[1] Assuming that a formula of 0.6 tons of $CO_2$ per MWh is used

incentives to small hydro facilities, peat-fired CHP projects, and power plants fuelled by wood or waste gases from metallurgical processes. Larger production incentives (equivalent to the Finnish electricity tax) are available for wind projects [NREL 2002, p. 24].

Figure 4.7 compares several production incentives in Canadian dollars. It is important to note that the Canadian Wind Power Production Incentive of 1.2¢/kWh is not tax-exempt income and should therefore be reduced by the current tax rate of about 40% [CARE 2002a]. The Canadian Clean Air and Renewable Energy Coalition's proposal to raise this incentive to 2–3¢/kWh [CEC 2001, p. 41] would bring it into the same range as incentives elsewhere, but would virtually have to be doubled again to make up for the income tax loss. Both the US and Canadian incentives are paid over a period of ten years. However, the US incentive, originally set at (US) 1.5¢/kWh, is adjusted for inflation, that is, it grows over time and is

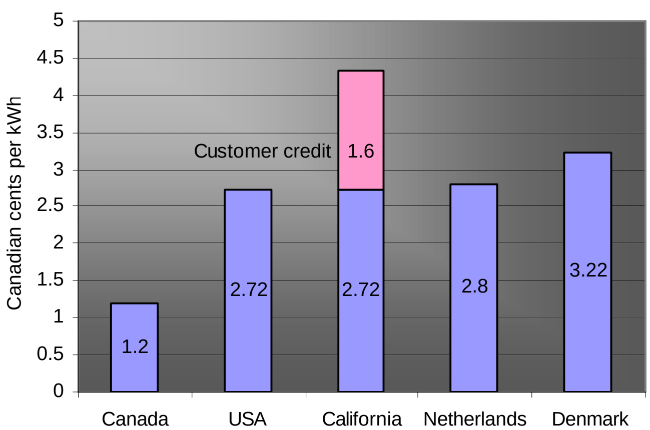



**Figure 4.7 — Comparison of Renewable Energy Production Incentives**

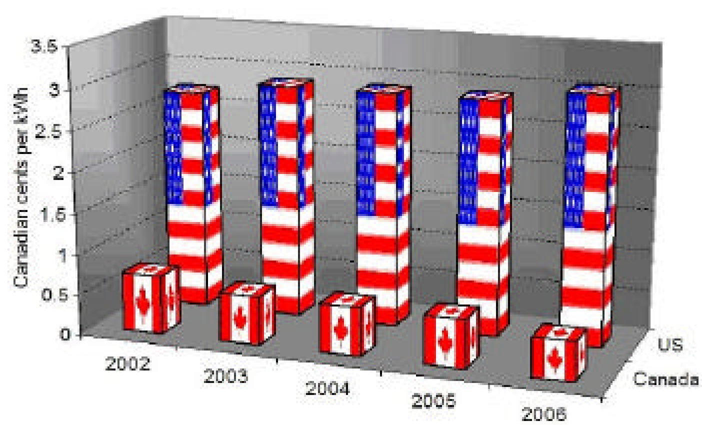
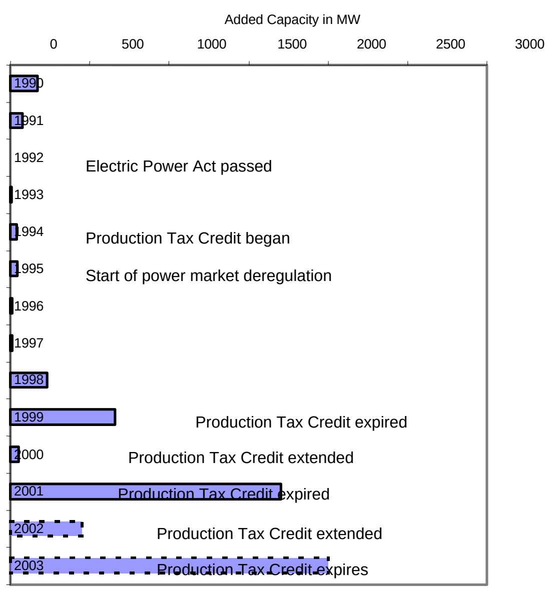



**Figure 4.8 — Comparison of US and Canadian Wind Power Incentives Over Time** (Note: US incentive increased in 2006 with an assumption of 2% annual inflation; Canadian incentive reduced by 40% tax rate.)

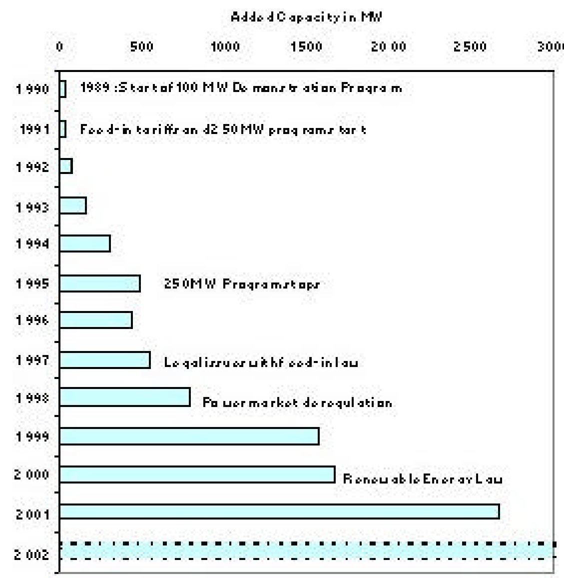
> *"The most important aspect of a subsidy may not be its specific elements or amounts, but its certainty."*
> REPP 1999

scheduled to rise from currently (US) 1.7 to 1.8¢/kWh as of 2003, whereas the Canadian incentive will be reduced to 0.8¢/kWh after five years [NRE 2002, p. 21] (see Figure 4.8).

As discussed in chapter 4.4, it is important to create long-term financial security for any given project, including renewable power projects, to attract investors. Ten years is seen as the minimum necessary duration of government support in the renewable power sector [REPP 1999, p. 23]. A comparison of California and the U.S. with Denmark and Germany shows that wind power generation rose steadily in the European countries, whereas it grew and shrunk in a boom-and-bust manner in the U.S. Figure 4.9 shows that not only was the growth in the US irregular, but also it was much smaller in total. The busts can easily be explained by insecurity created by unstable policies, such as expiration of investment tax credits, production tax credits and long-term contract provisions [JLS 2001, pp. 355f.]. This tendency can still be observed today in the US, where a boom of wind power installations took place in 2001, as many developers tried to capture the tax credit, which was going to expire that year. Although the tax credit was then extended for another two years, predictions indicate that new installations in 2002 will be much lower only to increase again for the year 2003, after which the tax credit will expire once again. Such irregular funding can lead to a sudden halt in investments and it could take a long time before activity starts again when support mechanisms are reactivated, leading to inefficiencies and losses of millions of dollars compared to stable policies that tend to be more effective even if the overall budget is lower [ibid., p. 363]. It is therefore crucial to maintain predictability and consistency in all policies supporting renewable power sources. Denmark; for example, is using a 30 year time horizon for




USA




Germany

**Figure 4.9 — Comparison of Wind Generation Capacity Growth and Related Policies in Germany and the US** (based on [JLS 2001, p. 356f.])

its renewable power policies to ensure consistency in policy and to give certainty to market participants about the scenario in which they will operate [ibid.].

Interestingly, some countries are now withdrawing their support for renewable power. Tax exemptions have been taken away from large hydro electricity in both Germany and the Netherlands, and even more notable, Denmark is no longer supporting wind energy, claiming it is now a mature technology that can compete in the market. Wind is also very competitive in the UK, which has very good wind resources and produces wind electricity at half the price it costs in continental Europe. In the US, the National Resources Defence Council now agrees with the Competitive Enterprise Institute that subsidies for wind turbines are no longer necessary as wind is a "commercially proven" technology [CEI 2002].

Apart from the price per kWh, the high investment cost of renewable power projects — as opposed to lower operating cost — is a concern when fostering its deployment. Several countries have addressed this barrier by providing cheap loans or grants to renewable power projects. In Finland, new renewable projects are eligible for grants equivalent to between 10% and 35% of investment costs [NREL 2002, p. 24]. Sweden provides grants of between 15 and 25% of investment costs to new wind power, small hydro and biomass plants [HAAS 2001, p. 23]. Germany provides cheap loans to renewable power projects up to 50% of investment costs through the Deutsche Ausgleichsbank. Spain provides grants of between 10 and 40% to renewable power projects (wind and biomass) [ENER 1998]. The UK, which did not have a grant program for renewable power under the NFFO, now provides generous capital grants for offshore wind and energy crops (see chapter 3.4.2).

Concerning distributed generation, the California buy-down program provides incentives to install wind, PV, solar thermal and fuel cell systems and offers to support up to 50% of the investment (see the California Energy Commission's website). Germany's 1,000 Rooftop Program in the 1990's subsidized an average 70% of investment costs for PV systems [HAAS 2001, p. 17]. The Canadian federal government also provides a 25% capital cost rebate for solar and biomass thermal technologies [PAPE 1999a, p. 8]. The capital cost of renewable power projects often accounts for 70% of the price of electricity [REPP 1999, p. 15], so a capital grant of 25% can reduce the price of electricity generation by 17.5% — in many cases enough to make it competitive with fossil fuel-based generation. Investment tax credits in California, for example, have contributed to the rapid increase in wind turbine efficiencies in the U.S., and are said to be more effective than the Federal wind R&D program in achieving improvement in wind power technology [ASMUS 2002, p. 7].

*A capital grant of 25% of the equipment cost will make numerous renewable energy projects price-competitive with conventional electricity production.*

Canada's Market Incentive Program is an initiative to support green power marketing and can cover up to 40% of eligible marketing (not capital) cost. The joint Natural Resources Canada/Environment Canada Program is funded with $25 million, ending in March 2006 [NRCan 2002b].

Several governments support research and development of renewable power systems (see Table 4.12 for a comparison between Canada and some other countries). It is obvious that European support for renewable electricity is far larger than in Canada concerning R&D, grants and loans, and incentives. As described in detail in Chapter 3,

**Table 4.12 — Comparison of State Programs for Renewable Power** [FIRE 1998, p. 22; NRCan 2002e, p. 30; DSIRE 2002; HMT 2001; see also previous chapters]

| Support Programs | Canada | USA | UK | Germany |
|---|---|---|---|---|
| R&D | CANMET Renewable Energies Technology Program ($5 million/year; funding received is repayable). Industrial Research Assistance Program (generic): up to $350,000 per project. Sustainable Development Technology Fund: $100 million (renewables & others). | State Programs, e.g. funding through California Energy Commission, NYSERDA, etc. Often funded through System Benefits Charges. Demonstration projects are often funded through municipal programs. 2001 Office of Energy Efficiency and Renewable Energy research budget for renewable power: US$420.3 million [CRS 2001b]. | New & Renewable Energy R&D: CDN$125 million (3 years). PV Demonstration: CDN$22.5 million (3 years). | Renewable energy research: ~CDN $70 million/year (Ministry of Industry). Ministry of the Environment: CDN$42 million (2 years) |
| Grants and Loans | None | PV and wind buy-down programs. State loans (e.g., California up to U.S.$10 million). State grants (e.g., Illinois up to U.S.$2.75 million). | Offshore wind: CDN $88 million (3 years). New Opportunities Fund (energy crops, offshore wind, small biomass): CDN$113 million (by 2005). New funding announced March 2001: $225 million (3 years). Energy crops: CDN $65 million (7 years). | Low-interest loans through Deutsche Ausgleichsbank. Former wind power deployment programs. Current 100,000 roofs program (PV): €650 million over 6 years. Grants and loans for PV, biomass, small hydro, and geothermal projects (Market Incentive Program, MAP). Budget for renewables from energy tax: CDN $350 million per year. |

***Table 4.12 continued ...***

| Support Programs | Canada | USA | UK | Germany |
|---|---|---|---|---|
| Incentives | Wind Power Production Incentive. Market Incentive Program (25% of marketing cost). | RPS. Production tax credit. | RPS. Trading of certificates. | Feed-in tariffs. |
| Tax | 30% per year depreciation. | Property tax exemptions. Sales tax exemptions. 5-year depreciation (MACRS); state schemes. 10% investment tax credit (geothermal, PV). | Climate Change Levy. | Energy tax. |
| Preferred Grid Access | No. | Sometimes introduced with RPS legislation. | Currently under consideration. | Yes. |

energy taxes in continental Europe, and the Climate Change Levy in the UK, have allowed governments to spend between CDN$300 (Netherlands) and CDN$560 (UK) million per year on renewables. The US has a very patchy support structure as each state has its own programs, but gives much better support than Canada on the whole (e.g., CDN$1 billion over five years in California from the system benefits charge). Denmark has supported wind energy for several decades and is now considered to be the international leader in this field (see Box 4.10).

Natural Resources Canada (NRCan) has given some limited support to renewable power R&D through the Energy Diversification Research Laboratory at CANMET, which develops and promotes the use of innovative technologies in renewable power and energy efficiency. The CANMET Energy Technology Centre works with private and other public sector partners to develop and use clean, energy-efficient technologies for buildings, industry, transportation and power production. It includes a program for renewable power technologies that began after the 1973 oil crisis. The program supports the Canadian industry's efforts to develop and use renewable power technologies that are cost-effective and environmentally responsible; namely, small-scale hydro-electric projects, active solar energy, wind energy and biomass, at a rate of $8 million per year [Moomaw 2002, p. 6]. NRCan also administers the interdepartmental Program on Energy Research and Development (PERD), which promotes research and

**Box 4.10 — Government Support Pays in the Long Run**

European governments have given strong supported for wind, PV and biomass over the past two decades, including funding for R&D, pilot projects, and the creation of manufacturing capacity. As a consequence:

- biomass industries in Finland and Sweden are among the most successful in the EU;
- Denmark is the world leader in wind turbine manufacturing (more than 50% of the world export market in 1999);
- Germany has a strong indigenous biomass technology industry to service the emerging domestic market; and,
- Germany and the Netherlands are leading solar photovoltaic system manufacturers.

[EEA 2001, p. 58]

development of renewable power and energy efficiency [OAG 2000, p. 29f.]. The Sustainable Development Technology Fund, with $100 million over five years, might play an important role in the emerging renewables sector, but is limited since it does not only support renewable energy technologies.

Looking at past successes, it becomes apparent that the dollar amount of support cannot explain the differences in renewable power deployment among industrialized countries. In terms of per capita spending, Denmark has favoured wind energy more than any other country. Overall, the U.S. spent more than three times the total amount of money on wind power R&D between 1973 and 2000 than was spent by the most successful countries, Germany and Denmark, and U.S. research budgets were the highest throughout the 1990's [JLS 2001, p. 334]. Still, Danish wind turbine manufacturers now hold 65% of the world market, whereas the U.S. only has one major turbine manufacturer and accounts for only 9.2% of the world market [ibid., p. 369]. The reasons for these differences lie in highly inconsistent funding in the U.S., while European funding programs have been far more stable, research results were shared, and decision-making was decentralized, as opposed to the U.S., where decisions were made centrally and inefficient designs were supported. Utilities and small manufacturing companies were closely involved in Denmark's research program, participating in funding, whereas large aerospace corporations that later abandoned the wind energy sector were supported in Germany. The focus in Denmark was on small incremental improvements and small-scale demonstration projects, rather than radical changes in the technology, as was the case in the U.S. [p. 332]. The Danish experience indicates that a bottom-up approach in research can be far more efficient than a top-down system in which research is carried out without the close participation of utilities and manufacturers.

Government purchasing may be the most neutral "subsidy" to renewable power. It has been very effective in creating demand for renewable power throughout Europe and, for example, in Pennsylvania, where newly built wind capacities have been quickly bought up by governmental and institutional buyers [PA 2002d]. The Government of Canada has committed to purchasing 20% of its electricity consumption from emerging renewable low-impact electricity by March 31, 2006, under Action Plan 2000 on Climate Change.

Whereas subsidies are often seen as unfair with respect to competition, they continue to be paid to conventional energy sources in far greater amounts than to renewable power (see e.g., [CEC 2001, p. 36]). To put things in perspective, conventional sources of energy continue to receive the vast bulk of government subsidies. In the EU, total annual subsidies for fossil fuels and nuclear energy have accounted for more than €15 billion so far, compared to €1.5 billion in support to renewable energy. From 1948 to 1998, the US provided $111.5 billion in federal subsidies to energy research and development programs. Of that $111.5 billion, $66 billion went to nuclear energy and $26 billion went to fossil fuels. Less than $5 billion has gone to non-hydro renewables, such as solar, wind and geothermal. Additionally, there has been more than $14.7 billion in federal tax credits that benefit the production of fossil fuels and nuclear fuel, while renewable credits are negligible in comparison [FOE 2001].

In Canada, federal and provincial governments have intervened in energy markets almost since their beginning. The government has influenced the energy sector through direct spending and other measures to provide Canadians with a secure supply of energy, to develop regional economies and to address environmental concerns. So far, much of this spending has been focussed on non-renewable resources, the predominant source of energy in Canada [OAG 2000, p. 10]. The Canadian nuclear energy sector receives annual subsidies, which totalled $156.5 million for the year 2000. Atomic Energy of Canada Ltd. has received $16.6 billion in subsidies since it was founded in 1952 [OC 2001]. Figure 4.10 shows that while federal government spending on fossil and nuclear energy has decreased, renewable power still gets the smallest share.

Beginning in 1998, the federal government provided $4 million annually for three years to promote investments in renewable power sources for heating and cooling purposes. Also starting in 1998, the government provided $50 million a year over three years for climate change initiatives to build momentum toward concrete action and results for investments in renewable power and energy efficiency. The February 2000 Budget extended this support for another three years at $70 million each year[30] [OAG 2000, p. 29].

**Box 4.11 — Investment or Production Subsidies?**

A subsidy linked to electricity production, such as the Canadian Wind Power Production Incentive, will provide a much better motivation to bring a renewable power project to fruition, and to focus on the reliability and performance of the technology purchased. However, emerging technologies, such as wave and tidal power, offshore wind and energy crops, will need investment subsidies to encourage deployment and to reduce the financial risk and burden for investors engaging in such projects. This can be achieved through direct subsidies, low-interest loans, tax credits on investment, and sales or property tax exemptions. Distributed power systems can be supported through buy-back schemes in a similar manner. Investment-based subsidies should be paired with performance standards (e.g., noise or other impacts in the case of wind turbines) and/or certification to warrant the quality of installed equipment [JLS 2001, p. 382]. More mature technologies, such as onshore wind, require less capital investment and could better be supported by subsidies linked to actual power production.

*"If renewables are to flourish, we must look at methods of financing the high up-front cost of green energy. Governments from Northern countries need to remove inappropriate subsidies and switch to supporting renewable energy."*

Mark Moody-Steward, former CEO of Shell [CH 2002]

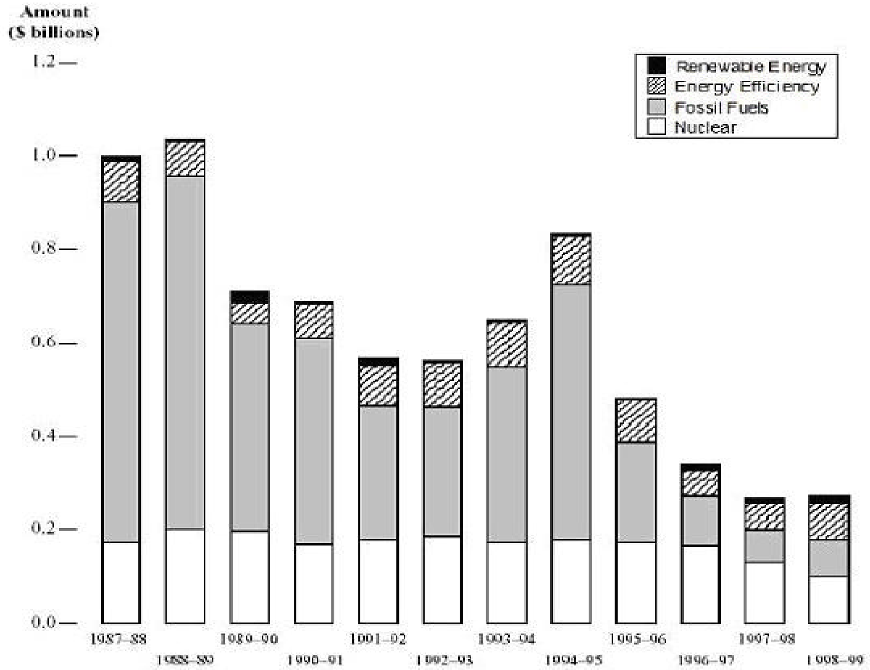



**Figure 4.10 — Direct Federal Spending on Energy in Canada [**OAG 2000, p. 12]

### *4.6.2 Net Metering and Decentralized Power Sources*

Net metering allows electricity consumers that have small energy production units, such as solar panels or wind turbines installed on-site, to obtain one bill that incorporates the energy produced on-site. This takes away hurdles to distributed electricity production, which may otherwise be subject to restrictions, such as separate metering, transmission charges, grid connection fees and low revenues for excess production.

The US Department of Energy website lists 36 states that had some type of net metering provision by December 2001[31] (see Figure 4.11). In Canada, net metering is not common and is only offered by Manitoba Hydro and Toronto Hydro, although its full introduction in Ontario has now been recommended by the Select Committee on Alternative Fuel Sources [SCAFS 2002, p. 17]. Net metering adds a significant financial incentive to customers who install renewable power systems, particularly on systems in which the timing of electricity generation does not match the household usage. Net metering participants are more aware of energy consumption, and tend not to consume all the energy being generated. Many studies, including some sponsored by utilities, have shown that direct, measurable benefits exist by having generation located close to the end user [EREN 2002]. Net metering is also being used in Germany and Japan [PAPE 1999a, p. 7], and locally in the Netherlands [NREL 2002, p. 35].

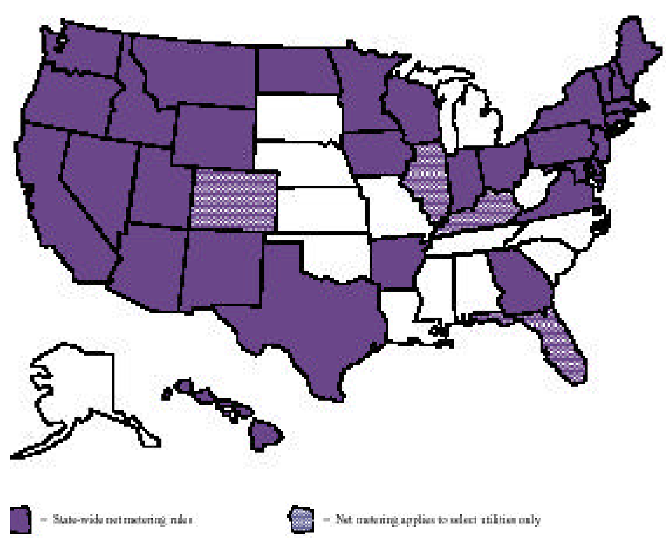



**Figure 4.11 — Net Metering Provisions in the United States**
[DSIRE 2002]

Net metering programs have, in general, attracted few participants so far, which has been ascribed to the high cost of non-standardized equipment used to connect to the grid, as well as numerous burdensome requirements imposed by utilities on consumers who engage in net metering [WWS 1999, p. 49]. The potential market for distributed generation is limited: in a 1994 study of potential early markets for solar photovoltaics, the Utility Photovoltaic Group found that the potential US market for photovoltaics at a cost of $3 per Watt is 7,630 MW for distributed power applications [UCS 1998, p. 30]. This would translate into about 800 MW for Canada, based on the population, but this is still four times the currently installed wind power capacity in Canada. For British Columbia, the potential for distributed generation under net metering has been estimated to be between 308 and 879 GWh a year [PAPE 1999b, p. IV], which is roughly 1% of annual demand.

In order to pursue air quality objectives, net metering rules should be defined to favour renewable power sources. Many existing U.S. schemes allow for fossil fuel-based power sources to be supported by net metering. This encourages carbon-intensive technologies to gain a bigger market share and should be avoided.

There is an emerging trend towards smaller fossil power stations, driven by the increasing cost of building and maintaining the power grid in relation to generation cost, and therefore better reliability and lower prices for power generated close to the point of consumption. Due to the economic benefits of decentralized power generation, many small-scale, and especially renewable resources, such as solar PV, can generate electricity at competitive prices or even more cheaply than conventional power sources [RMI 2002]. It is hoped that competitive markets will recognize these benefits and lead to increased use of these sources in the coming decades.

### *4.6.3 Fuel Source Disclosure*

Requiring power retailers to disclose the sources of their electricity helps consumers make informed choices in liberalized markets, although disclosure has also been required in non-restructured markets (e.g., Colorado) for public education and information purposes. Disclosure can support green power marketers in educating the public about the structure of electricity generation in their region and the difference they can make by choosing green energy products. Ten US states have made use of disclosure. Figure 4.12 shows the power label required by the California Energy Commission. Some states merely require the disclosure of the energy source, but some include the amount of emissions from electricity generation, or the amount of nuclear waste generated. Other details discussed for disclosure labelling include the location where the power is generated, a toll-free number from which more information can be obtained, or information about the current electricity mix where the power is marketed.

**POWER CONTENT LABEL**

| ENERGY RESOURCES | PRODUCT NAME* (projected) | 2000 CA POWER MIX** (for comparison) |
|---|---|---|
| Eligible Renewable | 56% | 12% |
| -Biomass & waste | - | 2% |
| -Geothermal | - | 5% |
| -Small hydroelectric | - | 3% |
| -Solar | - | <1% |
| -Wind | - | 2% |
| Coal | 8% | 16% |
| Large Hydroelectric | 9% | 19% |
| Natural Gas | 18% | 35% |
| Nuclear | 9% | 17% |
| Other | <1% | 1% |
| TOTAL | 100% | 100% |

* 50% of (Product Name) is specifically purchased from individual suppliers.

** Percentages are estimated annually by the California Energy Commission based on the electricity sold to California consumers during the previous year.

For specific information about this electicity product, contact (Company Name). For general information about the Power Content Label, contact the California Energy Commission at 1-800-555-7794 or www.energy.ca.gov/consumer

**Figure 4.12 — California Power Content Label**

Ontario's Select Committee on Alternative Fuel Sources recommended disclosure of the energy mix and emissions on electricity bills as of July 1, 2003 [SCAFS 2002, p. 17], and Ontario's Energy Competition Act already requires fuel source disclosure. While disclosure is helpful with green power marketing and education, it is not, by itself, a powerful tool supporting the deployment of additional green generating capacity. Other policies play a much stronger role than power labelling.

## 4.7 Synthesis of Findings Concerning Policy Options

### *4.7.1 Summarizing Barriers and Policies*

The combined effect of the many barriers to renewable power deployment is enormous. Although some technologies are becoming as cheap as conventional power sources, the lock-in of fossil fuels, vested interests, existing infrastructure, lack of confidence in new technologies, and a host of prejudices and market inertia, combine to prevent their adoption [JLS 2001, p. 388]. It will be necessary for Canada to address all of the barriers in a concerted way in order to promote the effective transition to a low-carbon power production portfolio based on domestic sources of energy.

Based on the findings of this report, Table 4.13 summarizes the main hurdles that renewable power has to overcome, as well as some of the policy measures that can be used to address them.

Before making policies or making decisions about investments in renewable power projects it is important to know where the best resources are available. Wind mapping and the assessment of other renewable power sources is crucial for both policy making and facilitating the deployment of renewable technologies. Resource mapping is expensive and can take several years to

**Table 4.13 — Barriers to Renewable Power Deployment and Corresponding Policies**

| Barrier | Possible Policy Tool |
|---|---|
| High capital cost | Low-interest loans, grants, tax incentives, buy-down of distributed generation |
| High generation price | Feed-in tariffs, energy tax exemptions, production incentives, customer credit |
| Immature technologies | Research and pilot funding |
| Permitting problems | Streamlining of permitting process, involve provinces and cities in planning |
| Grid access | Create fair and transparent rules for grid access and transmission |
| Higher land use | Reform property taxes, tax holidays |
| Low demand | Government procurement, ecological tax reform, green power pricing & marketing |
| Intermittency | Green tags, real-time balancing markets (multi-settlement systems), combination of complementary intermittent sources, back-up power provided by large hydro or storage technologies |
| Uncertainty about existing resources | Wind mapping, assessment of quantity and location of renewable resources (e.g., ocean energy, tidal stream, offshore wind) |

carry out and therefore requires government support. Once resources have been assessed, the information gained should be made public and can then be used to set targets, make informed investment decisions and help identify suitable sites for new projects, paving the way for setting aside areas where planning permits can be obtained more easily.

Probably the most important barrier to renewable power deployment is its price. Figure 4.13 shows how the end consumer price of renewable electricity can be influenced. The main idea is to make extra money available to renewable electricity generators so they can offer their products at lower prices, gaining a bigger market share. Which method to achieve this will be selected usually depends on political circumstances. Whereas all methods work towards the goal of reducing retail prices, some measures may be unpopular or limited in their impact, as discussed below. Whether, for example, an SBC is used to raise small amounts of money, which is then reinvested into renewable power, or whether a price signal is conveyed by collecting larger amounts through a carbon or energy tax in order to influence buyers and encourage switching to renewable power products, depends on the scope of measures envisaged by the government.

Again, whether support funds are collected from electricity consumers, from all energy consumers, or simply taken from the overall tax budget, depends on the amounts to be raised and on the general policy context (e.g., the National Climate Change Strategy). The government can collect funds and direct them towards renewable power generators, or power retailers can be made to buy renewable electricity and recover the extra cost for renewable electricity from their customers under an RPS or feed-in tariff scheme. In California, the SBC is used to reward green power customers with a customer credit, which reduces the price they have to pay. Other schemes simply try to

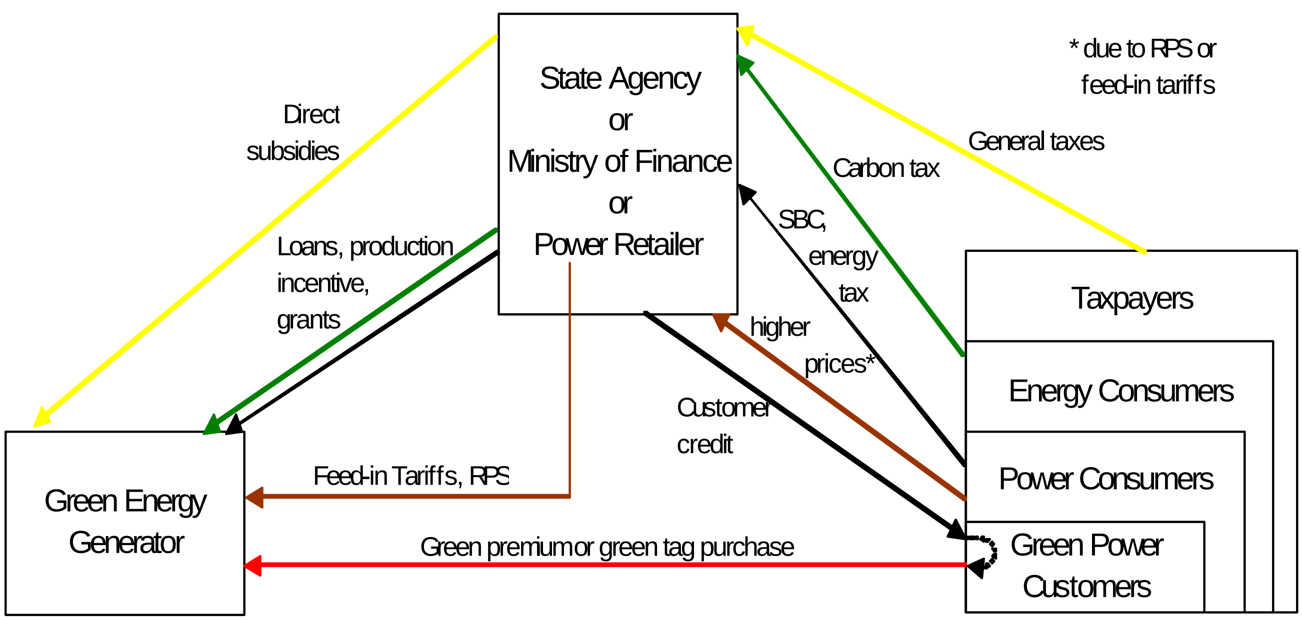



**Figure 4.13 — Ways to Influence Green Power Market Prices**

market green power to customers willing to pay an extra premium, and so cover the extra cost of green power. Finally, several ways exist to support the generators, from tax relief for loans, grants, production incentives, or through policies, such as RPS and feed-in tariffs. Often, several of these options are applied jointly to encourage renewable power deployment.

**Green power pricing and marketing** have been found to have little impact to date in the United States and Europe compared to other measures. They require a large investment in education and marketing, and generally have little “return” in terms of newly created plants, because only a small percentage of consumers is willing to pay a premium for green energy. Green energy products often only contain a small to medium percentage of renewable power (and an even smaller percentage of newly added renewables), although current trends indicate that shares of both are increasing in many products.

**Tax incentives —** both investment-related and energy tax exemptions — can reduce the cost for renewable power and can be effective policy tools. However, clear price signals are required if these incentives are to make a difference. In the Netherlands, an income-neutral energy tax led to a renewable power sales boom that quickly exceeded existing capacities. Germany has pursued similar policies, with a progressive carbon tax on fossil fuels. These taxes are high enough to bring renewable power prices close to prices for fossil fuel-based electricity, unlike the system benefits charges used in the United States, which are kept so low that they hardly affect electricity retail prices. It may be difficult to implement such taxes in a North American context unless the mindset evolves towards accepting the internalization of external costs of power production. Other incentives, such as investment tax credits or accelerated depreciation for capital cost, have tended to be used in Canada.

In similar ways, subsidies have helped renewables in many countries. With Spain providing grants of up to 40% of investment cost for wind farms, and with Germany’s low-interest loans, these two countries have created climates in which renewable power can thrive. Denmark and many other countries provide production incentives, which further reduce the retail price of renewable power. However, such incentives need to come with the assurance of long-term contracts, which are best supported by feed-in tariffs or renewable portfolio standards.

**R&D support** is necessary for some emerging technologies, such as offshore wind, tidal and wave energy, and energy crops. The absence or lack of such support is one of the reasons for the failure of the NFFO in the U.K. R&D support is needed in Canada both to reduce the cost of emerging technologies and to create domestic expertise and manufacturing capability.

**Feed-in tariffs**, if they are set at high enough levels, have proven to be the most effective tool in promoting renewable power in Europe. They create a large pull for renewable power since they result in virtually open-ended demand at set prices, which provides security for investors. The major advantages of feed-in tariffs are:

- they encourage efficient operation of the plant;
- transaction and administration costs are low;
- they provide an assured aspect of business plans for new investment;
- they allow small co-operative groups and companies to participate in the market; and,
- they have been shown to cause the highest generation and manufacturing capacities.

On the other hand, feed-in tariffs as being criticized for being a form of subsidy and for ruling out competition, and therefore increasing the macroeconomic cost of renewable power generation. Whereas tendering can deploy new capacities at lower prices, it results in higher administrative costs and is ineffective if it fails to incorporate key concerns, such as permitting and worst case planning. Furthermore, feed-in tariffs create artificial markets that could collapse once the tariffs cease to be paid. Germany is preparing for that case with its ecological tax reform, effectively making renewable power cheaper and conventional electricity more expensive. A phase-out of feed-in tariffs seems possible in a few years in Europe, as the European Union tries to harmonize support structures. Britain and some Scandinavian countries have seen that a purchase obligation (RPS) offers a better chance to become a European-wide system.

**Renewable Portfolio Standards** (RPS) are being used in Britain, Australia and the United States. Like feed-in tariffs, they can create a substantial and long-term market pull for renewable electricity. Texas utilities often opt for 10-year contracts that lock in renewable energy generation and the Renewable Energy Certificates that come with it at fixed prices. While RPS' are economically efficient, they automatically favour the cheapest form of energy which, in most cases, is wind power. But, as feed-in tariffs can be designed to pay different tariffs for different forms of electricity generation, an RPS could also contain different technology bands, such as the Arizona requirement of 50% solar power. Alternatively, subsidies can be used to assist emerging technologies to obtain market share, as is being done in the U.K. An RPS needs to be set at a challenging level to be meaningful. Examples, such as Texas, show that sometimes goals are set lower than what is feasible, which has the potential to hamper renewables deployment instead of fostering it. If tradable certificates are used to implement an RPS, financial institutions should be allowed to use the certificates as security against loans; otherwise, this additional source of income to renewable power generators may not be recognized if such institutions view the certificates with skepticism and favour larger generators that can finance projects though equity investment [HCEAC 2002, p. 35].

Providing **priority transmission access** to renewable power would ensure that these projects can be integrated into the existing electricity grid. Provisions that require grid strengthening and link-ups to be paid by all power consumers, instead of by the project owner, would greatly reduce the cost of renewable power. Other options would be to let all energy providers bid for transmission access in case capacities are restricted (open bidding), similarly to the U.S. Regional Transmission Organization approach, in which intermittent sources can bid for transmission access together with other sources in day-ahead and real-time markets [FERC 2002, p. 20]. The "pancaking" of transmission fees (for transactions crossing several service territories) can create a disadvantage for remotely located renewable power plants and should be avoided. Transmission access has been identified as a likely barrier in Ontario since energy providers with larger capacity factors will receive priority treatment in case of transmission constraint situations under current rules. Where renewable power generation is close to existing grid structures, such grid-embedded power plants can actually improve the security of the overall transmission system, as opposed to remote generation stations [WPTF 2002, p. 10]. The intermittency and unpredictability of some renewable power systems can become a major disadvantage, but innovative mechanisms, such as real-time balancing markets, allow renewable power producers to obtain the best value for power that deviates from the amounts reserved in advance [REPP 2002, p. 27].

Support with **permitting procedures** is crucial to overcome local resistance to some renewable power projects. In Britain, both England and Wales have seen only 25% of projects succeed in gaining permits, whereas Scotland has achieved a 70% rate. This was mainly due to the Scottish Executive issuing strategic and technical planning guidance for renewables in 2000 and in 2002. A 2000 survey in Scotland showed that local public opinion became far more favourable to wind farms after they were built, demonstrating that initial worries and concerns were not born out in practice [HCEAC 2002, p. 28]. In Denmark, local support has largely been gained through allowing the public to benefit financially and to influence the decision-making process for wind farm projects (see Chapter 3.3.3). Denmark and Germany have standardized national permitting procedures for wind and required municipalities to set aside areas where wind development is encouraged [JLS 2001, p. 340]. The Dutch federal government works together with the provinces to identify suitable places for wind development (see Chapter 3.3.4). In Scotland, it has now been proposed to reduce electricity prices for homes close to wind power developments in order to increase their acceptance among the population [REF 2002d].

**Emissions trading** has been described as a potentially important source of income for renewable power generators (see section 5.7.1 for a discussion of the interface between green power, certificates and emission credits). However, this can only be the case if multiple pollutant trading takes place that fully includes renewable power generators in markets for at least the three main air emissions: NOx, $SO_2$ and $CO_2$. Even if these circumstances prevail, renewable power generators may have to rely on brokers, and would have to pay tax on the revenues, which considerably reduces the potential income from trading. In addition, the price volatility of emission reduction certificates, and uncertainty about the rules governing these markets in the future, can reduce investor confidence with respect to long-term financial planning concerning renewable power plants.

### *4.7.2 Looking at Canadian Scenarios*

*Canadian Wholesale Prices and Renewables*

Table 4.14 shows that Canadian wholesale electricity prices are among the lowest of the countries examined. This poses additional problems for alternative power sources, as the market barrier for them is usually higher in Canada than elsewhere, suggesting that market incentives to support this sector must also be higher than those in other countries.

On the other hand, Figure 4.14, based on data already discussed in chapter 2.2.6, and using electricity wholesale prices as given by the Canadian Clean Air and Renewable Energy Coalition [CARE 2002b], shows that technologies, such as wind, biomass co-firing, wave energy and tidal energy, can under certain circumstances already be price-competitive with fossil fuels. The largest potential small hydro projects are closest to being financially viable throughout Canada and could thrive at a wholesale price of 5¢/

**Table 4.14 — Canadian Wholesale Prices in International Comparison**

| Country/ State | Wholesale Price* |
|---|---|
| Canada | 4.66¢/kWh |
| California | 6.4¢/kWh (~4¢/kWh US) |
| Pennsylvania | 4.8¢/kWh (~3¢/kWh US) |
| U.K. | 4.5–6.75¢/kWh (2–3 p/kWh) |
| The Netherlands | 6.16¢/kWh (4.4 €cent/kWh) |

** Based on information in chapter 3*

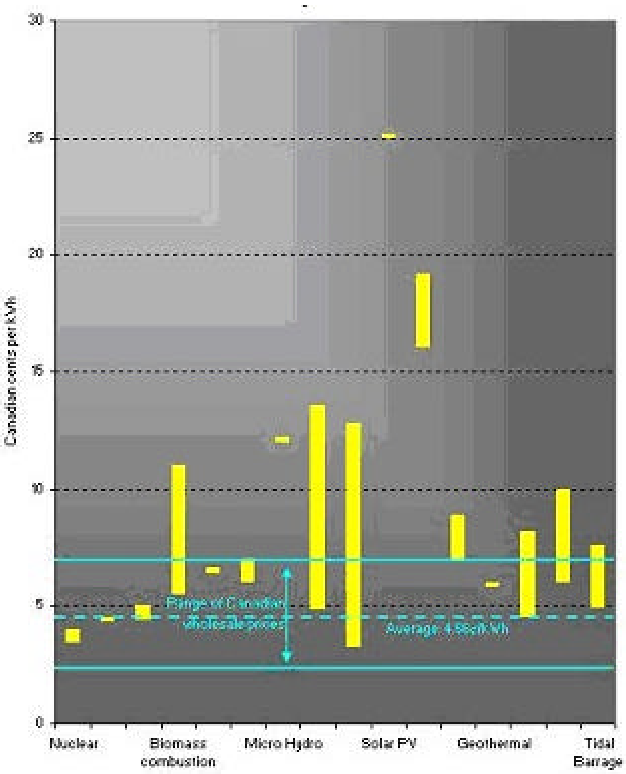



**Figure 4.14 — Comparison of Canadian Wholesale Electricity Prices and Energy Generation Cost**

kWh, which is paid to independent power producers by BC Hydro and has led a large number of small hydro projects in response to BC Hydro's RFP for green energy projects [BCH 2002b].

The federal government recently implemented wind energy production tax credits for projects commissioned between March 31, 2002 and April 1, 2007. The incentives, which are paid for 10 years, start at 1.2¢/kWh and decline to 1.0¢/kWh in the second year and to 0.8¢/kWh in the fifth year [NREL 2002, p. 21]. After tax, these incentives contribute an average of 0.6¢/kWh towards wind energy production. Figure 4.15 shows the current situation with respect to wind power in Canada. According to the Clean Air and Renewable Energy Coalition, wind energy generation costs in Canada lie between 6.91¢/kWh (40% capacity factor) and 8.91¢/kWh (30% capacity factor). Apart from Ontario, wind capacity factors are estimated to be higher than 30%, so this threshold can safely be taken as a worst case scenario for wind development. With electricity wholesale prices in Canada ranging from 2.5¢/kWh (SK) to 6.9¢/kWh (PEI), and including the production incentive, wind can be competitive at optimum sites only in Prince Edward Island, where default prices are the highest in Canada. This means the extra premium for wind power currently must be paid by green power customers, and can reach up to 5.8¢/kWh. An increased production incentive of 3.0¢/kWh, proposed by the Clean Air and Renewable Energy Coalition, which is similar to that of other countries (see Chapter 4.6.1), would yield a price reduction of about 1.5¢/kWh after tax and could make wind power competitive in three Provinces. However, no extra margin for green power marketing and customer education, back-up power

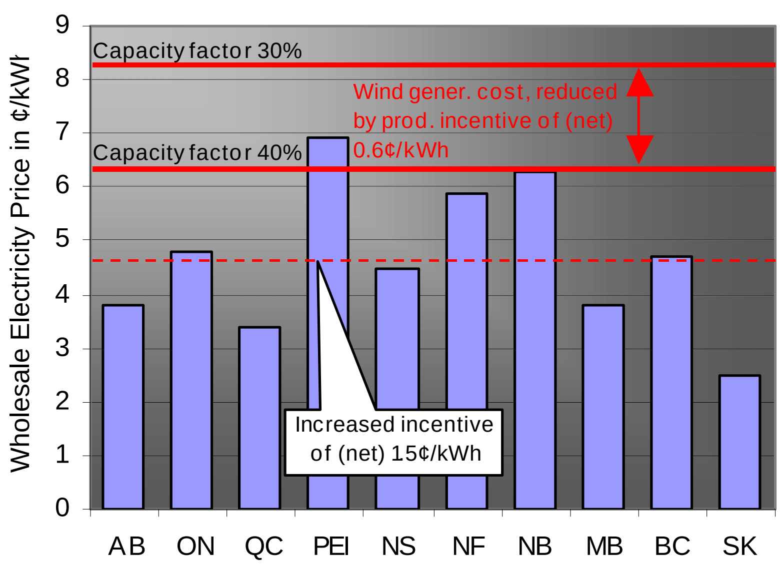



**Figure 4.15 — Influence of the Production Incentive on Price-Competitiveness of Wind Power**

surcharge, load balancing, or utility rate-of-return is taken into account here, and can be expected to require an extra 2–4¢/kWh [CARE 2002b].

### *Incentives Needed for Change*

For the following cost comparisons, it is assumed that renewable power competes with new fossil power plants. The reasoning is that renewable power would have to be made cheap enough to be more attractive for power retailers to buy electricity from these facilities than to build new fossil-fuel based plants. A safe assumption is that the default power price to be considered is the one for combined cycle gas power plants, which has been the technology of choice in Canada's political and economic environment[32] [CEA 2002].

For Ontario, this would correspond to a price of 5.0¢/kWh [CNFAQ 2002]. In order to get an idea of how natural gas prices influence the price of natural gas-based generation throughout Canada, the costs can be split into a) capital, operating and maintenance cost, and b) fuel cost. The former can be assumed to be about 18–20$/MWh for a combined cycle plant [ATCO 2002]. The fuel component for combined cycle plants can be calculated based on an assumed 7.3 GJ of natural gas per MWh generated [ibid.]. The final generation price depends on the highly volatile natural gas market: natural gas prices over the past years have fluctuated between $3 and $14/GJ, and are currently at prices given in Table 4.15.

The above example of 5¢/kWh for Ontario would assume a natural gas price of about $4.25/GJ. Based on the data in Table 4.15, recent natural gas prices moved between $3 and $5.6 on Canadian markets, with a slight price disadvantage in Ontario vs. BC and Alberta. If it is assumed that the natural gas price in Western Canada is $1 below that in Eastern Canada due to the longer transport distance to the East, this would result in an electricity price of 4.37¢/kWh there. With a price of $14/GJ, the Canadian price per kWh for electricity generated from natural gas would have been more than 12¢/kWh, far more than most renewable resources. US natural gas demand is projected to grow by 27% from 2000 to 2010 [NASEO 2002], meaning that the natural gas price may well reach 5–6¢/kWh, which would bring it into the same range as many Canadian renewable energy resources. Figure 4.16 shows in US dollars how gas power plants compare to renewable resources, depending on natural gas prices. Fossil fuel prices are expected to rise. Figure 4.17 shows that renewable power prices, on the contrary, have fallen continuously over the past few years. These figures are in US dollars, and 2002 prices have been found to be even lower in Canada than those given here (see section 4.8.3.2).

Much of Canadian potential renewable generation capacity could work economically in a range of 5–7¢/kWh. Figure 4.18 shows estimated generation prices of Canadian renewables and the return to renewable electricity generators that different incentives would generate, together with the default

**Table 4.15 — 2002 Canadian Natural Gas Prices ($Cdn/GJ)** [WM 2002]

| | 12/06 | 05/06 | 29/05 | 22/05 | 15/05 |
|---|---|---|---|---|---|
| Alberta, Empress Spot | 3.411 | 3.450 | 3.671 | 3.934 | 4.447 |
| Alberta, AECO-C Storage Facility | 3.293 | 2.215 | 3.529 | 3.789 | 4.291 |
| BC Huntingdon Spot Export | 3.236 | 3.320 | 3.286 | 3.754 | 4.483 |
| Toronto, City Gate | 3.126 | 3.226 | 5.010 | 5.319 | 5.599 |

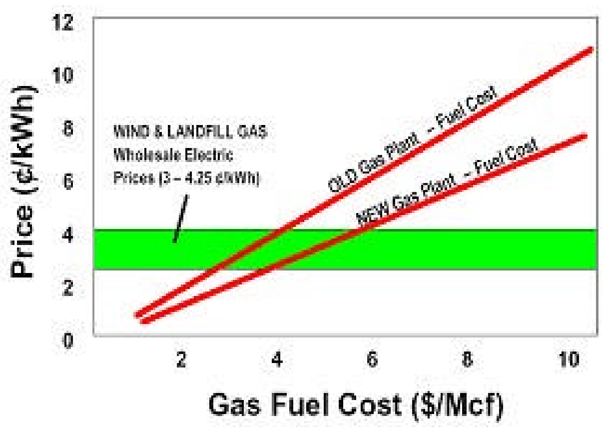



**Figure 4.16 — Relationship of Gas and Electricity Price** [SLOAN 2001]

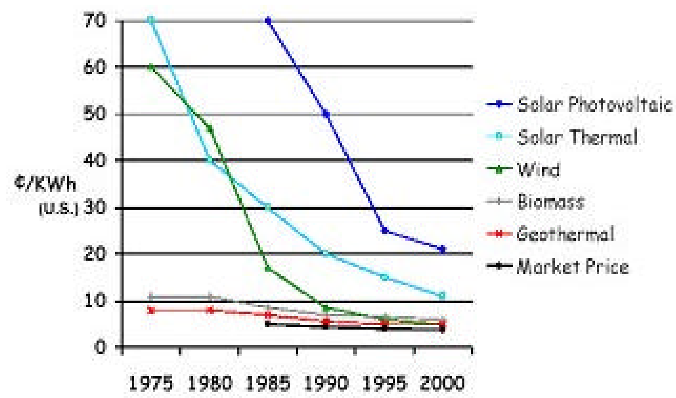



**Figure 4.17 — Evolution of Renewable Energy Prices** [NASEO 2002]

wholesale price. It should be noted that the price for wind-based generation used above (6.91–8.91¢/kWh) seems rather high compared to prices in other countries (Texas: 6.4¢/kWh; UK: 6.5¢/kWh). BC Hydro assumed a generation cost of between 5 and 7¢/kWh in its study of renewable energy resources on Vancouver Island [BCH 2001, p. 4–2], and Hydro Quebec buys wind power at 5.8¢/kWh (see section 2.2.6). To give another example, BC's Williams Lake biomass plant, with a capacity of 60 MW, fires wood waste from local sawmills and reportedly produces electricity at a capacity factor around 100% for as little as 3¢/kWh [WRBEP 1998]. The tidal barrage generation cost used was estimated in 1993 [WEC 1993] and would be between 6 and 9¢/kWh if adjusted for inflation.

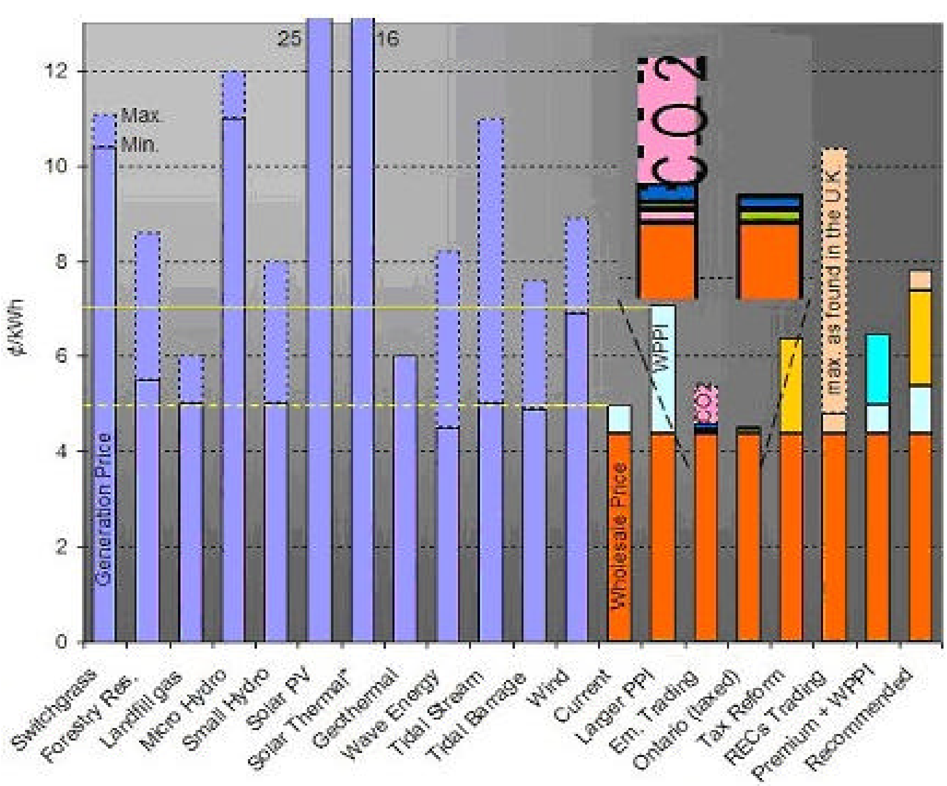



**Figure 4.18 — Generation Prices of Renewable Electricity and Revenues from Electricity Sales and Incentives**

The following discussion looks primarily at the private sector, hence an income tax rate of an estimated 40% is applied to taxable green power support options. Many Canadian utilities are crown corporations not subject to income tax, and these considerations would therefore not apply to them. Likewise, if a crown corporation invests in renewable power instead of buying it from a private company, the proposed tax reform would not benefit it either.

**WPPI:** As can be seen from Figure 4.18, the Wind Power Production Incentive was not designed to provide a large enough incentive to make wind power competitive, especially as it is subject to corporate income tax[33] (35–40%). Even if it was extended to all types of renewables, only the very cheapest landfill gas and small hydro projects would stand a chance of becoming economical. However, a tax-free incentive at the same level as the US Production Tax Credit would change this picture drastically: a universal Power Production Incentive of 2.7¢/kWh after tax would bring many biomass projects, virtually all landfill gas, small hydro, wave energy and tidal projects into profitability. Many wind power projects can also be expected to thrive, given that per-kWh prices lower than the ones used in the chart are already being quoted in Canada. The Canadian Wind Energy Association confirms that wind energy can thrive on a premium of 2.5¢/kWh [CWEA, p. 8], and a recent assessment for B.C. resulted in premiums of between 1.3 and 5.0¢/kWh, depending on wind speed [HE 2002, p. 13].

**Emissions Trading:** Very small returns (and also the highest insecurity) would come from emissions trading today, even if allowances/credits for all three main emissions ($SO_2$, NOx, $CO_2$) were traded, and if demand was high enough to require all credits from renewables (assumed values as in chapter 4.2.4, reduced by a 40% income tax rate). Under Ontario's new trading regime, NOx and $SO_2$ allowances can be traded ("Ontario" in the chart). Whereas the revenues from NOx trading are potentially higher than in the US due to year-round trading, they are still very low and subject to income tax. Whether or not an extension of such trading throughout Canada could reduce the value of the credits further due to the increased offer of renewable power projects is another issue that comes into play and would have to be assessed. If trading becomes complex and brokers are needed to help with the transactions, revenues from trading could be reduced further by brokerage fees (10–15%). The dashed pink block under Emissions Trading indicates the potential value of $CO_2$ credits after implementation of the Kyoto Protocol (estimated to be as much as $15, see section 4.2.1.4). The inclusion of other emissions, such as particulate matter or VOCs, could also enhance the effect trading has on renewables, as could the definition of more ambitious emission caps, leading to much higher values of reduction credits and allowances.

**Tax Reform:** Expanding the Canadian Renewable Conservation Expense to include all capital costs, or allowing renewable power businesses to benefit from the Investment Tax Credit, would provide about 2¢/kWh to renewable power projects with low operating costs. Biomass projects, which have high fuel costs, would not benefit from these incentives to the same extent.

**RECs Trading:** Renewable power credit trading is shown here with the premium paid in Texas (0.7¢/kWh, reduced by income tax rate), which has a similar effect as the current WPPI. In Texas, it is the retailers that buy the renewable power who are trading these certificates, as usually their contracts with wind power providers stipulate that the RECs go to the retailer together with the electricity. It is still reasonable to assume that the retailer would be ready to pay a higher price to the power generator due to the RPS obligation or the value of the REC. Depending on how an RPS is defined to create a large or small market pull, REC prices will vary and can amount to as much as 2.5¢/kWh (Australia) or even 10¢/kWh (ROCs in the UK, shown as maximum potential in the graph). Revenue from RECs sales above the production cost of renewable power would also have to be discounted with a 40% tax rate if they are treated as income under the system rules (held for resale), which has been taken into account for Figure 4.18. If they are treated as capital (held as capital), only half the corporate tax rate would apply [SUN 2002].

**Premium + WPPI:** Green power premiums in the US move between (US) 1.0 and 3.5¢/kWh, and in Canada between 3.5 and 7¢/kWh (see Appendix E). Only a percentage of this premium is actually passed on to the renewable power generator, and it is assumed here that the benefit from green premiums for the actual power plant is the vicinity of 1.5¢/kWh. This is an important amount and could help many of the cheaper renewable power projects become competitive,[34] although most projects would still depend on incentives such as the WPPI, currently only available for wind power projects, in addition to the premium. In practice, the green power producer will not get paid a separate premium on top of the wholesale price but will instead sell his product in one transaction as higher-priced renewable electricity to a retailer, who then tries to make up for the extra expense by retailing the green power at a premium. When a crown corporation buys green power from a taxable private company at a premium (the majority of cases in Canada), then the overall price it pays generally only covers a portion[35] of the supplier's green power cost premium. This means that no taxable profit is created through this sale — implying the need for extra support through the WPPI or other measures at the provincial or territorial level — and income tax is therefore not applied to the premium for Figure 4.18.

*Recent developments indicate that Europe is moving towards RPS legislation. Moreover, given the latest developments in the United States with respect to federal and state RPS provisions, the RPS seems to be the obvious tool for Canada to adopt in order to further renewable power deployment.*

**Recommended:** The last column shows a possible combination of measures that are indicated by this report: an expansion of the WPPI to all renewables and its tax exemption (with an average value of 1¢/kWh), tax reform, and RECs trading. This combination of measures could bring the income of renewable power operations to 8.04¢/kWh. Raising the WPPI to US levels (2.7¢/kWh) would increase this amount to 9.74¢/kWh. Another way of increasing the incentive would be to create analogous measures at the provincial level, possibly financed by a system benefits charge. In this context, it is important that, under current rules, the Canadian government would recover the WPPI if the operation can produce electricity profitably without it.

Figure 4.18 makes two important assumptions: that prices for electricity from combined cycle plants are as low as 4.37¢/kWh — this is a very low estimate and other sources have assumed higher prices (an estimate about half a cent higher might be closer to what can be expected[36]); and, there are no disadvantages to renewable power sources due to their intermittent supply or for grid access, as compared to conventional power plants. Whereas wholesale prices should be slightly higher on the whole, the cost of putting renewables on the grid must be paid for by the grid operator if the above scenarios are to reflect the Canadian reality. All assumptions with respect to taxability are made based on what can be reasonably expected if emissions and RECs trading are introduced. There is currently no clear guidance from Finance Canada on their treatment as either tax deductible expenses or Eligible Capital Expenses, which would be deductible at an annual rate of only 5% [SUN 2002].

What is not shown in the graph is the effect of grants or cheap loans. As all renewable power projects, apart from biomass, have low operating and high investment costs, a 25% reduction in capital cost would reduce the generation price by about 17.5% — easily equal to 1¢/kWh or more for the examples given here. A PST exemption for renewables (GST on all capital investments can already be recovered) would have a similar, but far smaller, effect in provinces charging PST.

Apart from giving financial incentives to power retailers by making renewable power cheaper through one or more of the above-mentioned measures, experience in other countries has shown that there should also be a “pull” for renewables; that is, retailers should be obliged, either by feed-in tariffs or through an RPS, to purchase renewable power. In the absence of such a pull, even renewable power that is as cheap as conventional power, or even cheaper, may not find a buyer simply because power retailers are not comfortable with these energy sources, or because existing market structures and thinking patterns create barriers that cannot easily be overcome. In addition, pure price incentives do not provide the additional help needed to deploy renewables due to the need for grid access and restructuring, and for obtaining planning permissions. Both feed-in tariffs and RPS’ create market pull and will also entice grid operators to plan for the inclusion of renewables in the generation portfolio. Feed-in tariffs are more expensive than the market-oriented RPS’ and have only been implemented in a few European countries, with recent developments showing that Europe will probably also move towards RPS generation. Moreover, given the latest developments in the United States with respect to federal and state RPS legislation, the RPS seems to be the obvious tool for Canada to adopt in order to further renewable power deployment.

## 4.8 Renewable Portfolio Standards (RPS)

### *4.8.1 The Role of RPS in Green Power Promotion*

Thirteen US states have introduced RPS requirements [DSIRE 2002]. An RPS is also being used in Australia and the UK, and is being considered in some Scandinavian countries (see sections 3.3 and 3.4). In Canada, an RPS has been proposed for Ontario, to be introduced by June 30, 2003, by the Select Committee on Alternative Fuel Sources [SCAFS 2002, p. 15], and a voluntary RPS has been defined by BC Hydro for its service area. A 10% RPS by 2020 is also being considered at the US federal level.

Under an RPS obligation, all electricity retailers must use an increasing share of renewable power in their energy mix (the RPS can also be applied to consumers or producers, but retailers seem to be the most obvious party to address with an RPS). This can be achieved either by building new facilities or by purchasing renewable power from independent providers. Such a system assures that each provider is subject to the same burden and that the cheapest renewable power options will prevail. A supplementary certificate trading system allows utilities to buy green power certificates representing units of renewable power production in order to fulfil their obligations, if that is cheaper than creating their own facilities. This decoupling of power sales and green attributes represented in the certificates (see also chapter 5) increases competition among green energy providers

**Table 4.16 — Renewable Portfolio Standards and Requirements by Year**
[UCS 2001b, expanded]

| Country/ state | Base | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2015 | 2020 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| European Union | 11% | | | | | | | | | | 22.1% | | | | | |
| Great Britain | 2.8% | | 3% | 4.3% | 4.9% | 5.5% | 6.7% | 7.9% | 9.1% | 9.7% | 10.4% | 10.4% until 2027 | | | | |
| Australia (in GWh) | 10.5% | 400 | 1100 | 1800 | 2600 | 3400 | 4500 | 5600 | 6800 | 8100 | 9500[5] | 9500 until 2020 | | | | |
| United States | 2% | | | | | +1.0% | | | | | | | | | | 10% |
| Arizona | 0.2% | | | | | 1.0% | | 1.1% | | | | | | | | |
| Connecticut | 5.5% | | | | | 6% | | | | 7% | | | | | | |
| Massachu-setts | | | | 1.0% | | | | | | 4.0% | 5.0% | | | | | 15%[1] |
| Milwaukee[7] | | | | | | | | | | | | 5.0% | | | | |
| Minnesota | | 550MW | | | | | | | | | | | 4.8% | | | |
| Nevada | | | | | | 5%[2] | | 7% | | 9% | | | | 15% | | |
| New Jersey | 2.5% | 3% | | | | | 3.5% | 4.0% | 4.5% | 5.0% | 5.5% | | 6.5% | | | |
| Pennsyl-vania | | 2% | 2.5% | 3% | 3.5% | 4% | 4.5% | 5% | 5.5% | 6% | 6.5% | | | | | |
| Texas[2] (MW) | 880 | | | 1280 | | 1730 | | 2280 | | 2880[6] | 2880 until 2020 | | | | | |
| California | 10% | At least 1% increase per year | | | | | | | | | | | | | | 20%[8] |
| Wisconsin | | 0.5% | | | | | | | | | | 2.2% | | | | |
| Hawaii[3] | | | | 7% | | 8% | | | | | 9% | | | | | |
| Illinois[3] | | | | | | | | | | | 5% | | | | | 15% |
| Minnesota[3] | | | | | | 1% | | | | | | | | | 10% | |
| BC Hydro[4] | | | | | | | | | | | 1.7% | | | | | |

*[1] +1% a year, end date of requirement to be determined by Division of Energy Resources*
*[2] capacities only; actual MWh is expected to be discounted with a 35% mean capacity factor, to be adjusted over time depending on developments*
*[3] State minimum renewable power goals*
*[4] voluntary goal: 10% of added generation/1100 GWh of 65,000 GWh total in 2010*
*[5] 12.5% of annual consumption*
*[6] about 2.3% of total annual consumption*
*[7] Wisconsin Energy Corporation's voluntary goal*
*[8] Has to be reached by 2017 already*

and avoids penalizing utilities that do not have cheap renewable energy resources in their service areas. Table 4.16 provides an overview of existing RPS' and their requirements for each year (if available), and compares them to today's share of renewable power in each country's energy mix. As the required share of renewable power increases over the years, an RPS is a continuous incentive for the creation of new renewable capacity.

Many governments have chosen very moderate RPS goals, with overall increases of the renewable power share in total generation of no more than 2% within ten years. Pennsylvania and New Jersey have been more ambitious, with an annual increase of 0.5%. Australia is in a similar range, demanding about 4,000 MW of added capacity by 2010[37] (see Chapter 3.4). California, Minnesota and Massachusetts require annual increases of 1%, and the UK works in the same range with annual increases of between 0.6 and 1.3% per year, with the EU requiring overall 1% increases as well. To compare, Germany's wind energy share was about 0.5% of total generation in

1995 and will probably exceed 4% in 2002 [BWE 2002], a 0.5% per year increase. Based on capacity data in Chapter 3.3.3, Denmark, which now produces 18% of its electricity from wind (from about 4% in 1995), has seen an increase of 1.8% per year, not taking into account energy from biomass. Both Germany and Denmark are not using an RPS, but use feed-in tariffs to increase their renewables share. In Canada, only voluntary renewable portfolio goals have so far been established. BC Hydro wants to green 10% of its new generating capacity by 2010[38] and Nova Scotia Power has committed to add 50 MW of green power to its portfolio, which is 2.5% of its current generation capacity [Moomaw 2002, p.6]. Hydro Québec has committed to bringing 1,000 MW of wind power on-line over the next ten years, plus another 200 MW of power produced using forest biomass [HQ 2002c]. This can be estimated to be about 2.6% of Hydro Québec's current electricity production for consumption inside Québec (154 TWh in 2001). These voluntary targets are very limited in their impact, and their influence on Canada's power portfolio will be small. Wisconsin Energy has committed to a voluntary share of green power sources of 5% by 2011 — in addition to generation created for its energy for tomorrow green power marketing program, which is one of the largest in the US [REF 2002a].

An RPS could also help direct renewable power development in a way that helps to secure power production in the long term. In the Netherlands, a maximum of 10–15% of intermittent power production through wind and solar can be accommodated by the grid without special compensation measures, such as storage or other ways of peak shaving.[39] Wind energy is currently taking the lead in new renewable power development as it is the cheapest of all available sources. Through an RPS, separate requirements can be defined for intermittent and less intermittent sources of energy in order to maintain the right balance among energy sources. Finally, a RPS will reduce demand for fossil fuels, especially natural gas, which in turn leads to lower prices for these fuels. A recent study found that this effect offsets the increased cost for renewables with respect to electricity price projections [EIA 2002, p. 19].

### *4.8.2 Optimizing RPS Design*

Renewable Portfolio Standards could be defined for each province, or even a national target for the whole of Canada. Due to market power considerations and Canada's low population in comparison to other countries, a system that includes all provinces may be the preferable option for Canada, as opposed to separate provincial RPS', especially if green power certificate trading is to occur. Another issue to be considered is whether only Canadian or also non-Canadian (probably US) electricity should be eligible to fulfill RPS obligations. There are three main concerns linked to this subject. First, tracking and verification can be problematic across jurisdictional lines when complementary information disclosure and tracking systems are not in place. Several tracking systems for green tags are currently being developed in the United States, but the best way to track across-the-border green energy deliveries would be through complementary certificate trading systems on both sides of the border. Secondly, allowing out-of-country resources increases supply and likely lowers the price for RPS-related electricity. This may be good for consumers and possibly bad for domestic renewable power generators unless a jurisdiction depends on resources across the border to fulfill its quota. Finally, allowing out-of-country resources makes it more difficult to capture the environmental benefits locally, although this depends heavily on the particular jurisdiction's geography and resource distribution [NWCC 2001a, p. 51f.].

Allowing out-of country resources to compete may be necessary in a NAFTA context, as it has been alleged that an RPS may otherwise constitute a trade barrier. Obligations on the choice of fuels for energy production are allowed under GATT rules, as long as the same restrictions are applied to both domestic and foreign products [UCS 2002, p. 9]. This situation has been found to exist in the United States, where an RPS restriction requiring in-state production, such as the new California RPS (Senate Bill 1078), would most likely be declared unconstitutional if challenged [RADER 2001, p. A-1]. Texas has attempted to circumvent this threat by requiring that RPS-eligible renewable electricity be physically metered inside the state (requiring a dedicated line as it must not be mixed with conventional electricity), which de facto limits the location of generation to in-state sources [ibid., p. A-2]. This provision could be challenged as discrimination without a substantial basis, and another approach has been recommended to deal with this issue [p. A-3]: eligibility could be defined as depending on whether or not the benefits of renewable power actually reach the people inside the jurisdiction. Benefits might include the displacement of more polluting energy sources, increased energy diversity, or the advancement of new technologies, including job creation.

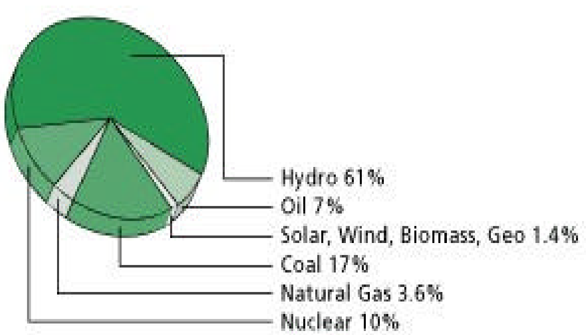



**Figure 4.19 — Electricity Production in Canada by Fuel Type** [CCPA 2000]

### *4.8.3 Canada's Current Energy Situation and Future Potential*

*Current Energy Mix and Planning*

Canada is the world's leading producer of electricity from large-scale hydropower — 61% of total Canadian electricity production is derived from this source (see Figure 4.19). In addition, there are more than 500 hydro facilities in Canada of less than 50 MW each, many of which could be defined as small hydro facilities (= 30 MW). The next major source of Canadian renewable power, after large-scale hydro, is biomass, mainly used in the pulp and paper industry. This industry meets 54 % of its energy needs for heat and electricity from forest waste. Wind energy, geothermal and solar energy provide only a small fraction of Canada's energy needs [Moomaw 2002, p. 2].

Canada's wind potential is substantial. Much of it occurs in the Prairie Provinces and along the Atlantic coast. The Québec government has recommended bringing on 1,000 MW of wind power over the next nine years. A major barrier to the development of large-scale wind electric projects in western Canada and the US is that the best wind resources of the prairies are located far from population and industrial centers. Developing long transmission lines adds to the economic and environmental costs of bringing this resource to market. However, this problem is no different than that faced by many large-scale hydroelectric projects in the past, which have overcome their location challenges. Utilizing agricultural lands to simultaneously produce electricity from wind, grain or livestock and cellulosic alcohol fuels could, for example, substantially raise living standards in rural agricultural regions [Moomaw 2002, p. 2]. Figure 4.20 shows that Canada's electricity supply has increased substantially over the past two decades, and is projected to rise by about 13% from 2000 through 2010. Natural Resources Canada estimates that energy

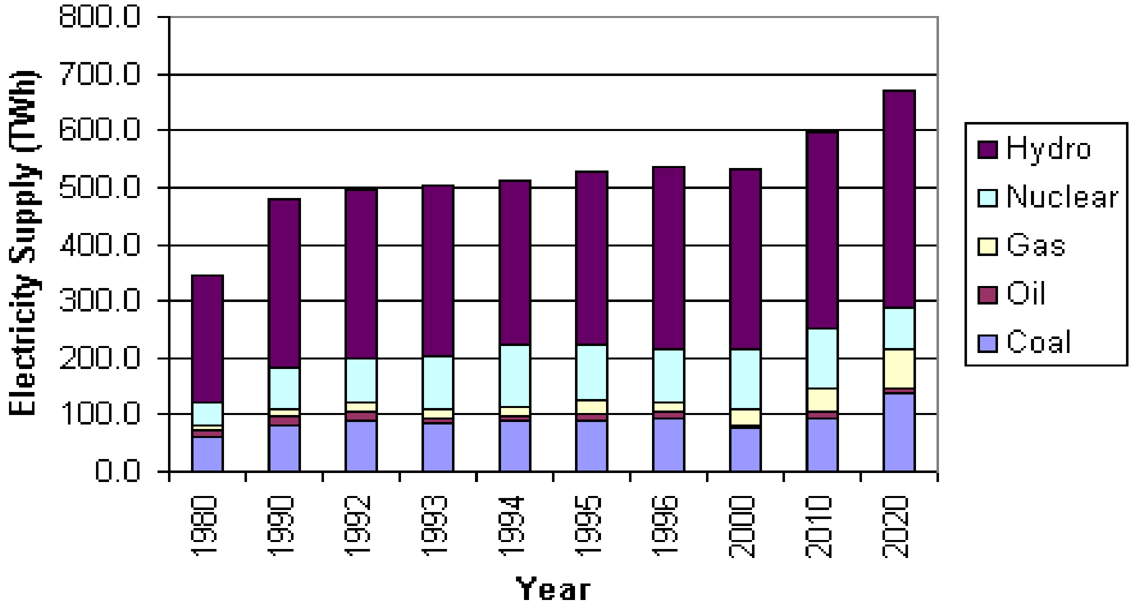



**Figure 4.20 — Electricity Supply in Canada** [ECC 1998]

demand will increase by 1.2% annually [CEM 2001]. The Canadian Electricity Association estimates that this translates into the new construction or replacement of 25–45,000 MW of power generating capacity over the coming 20 years [CEA 2001, p. 2]. As Table 4.17 shows, current planning does not encompass significant (non-large hydro) renewable power production and utilities are largely relying on natural gas, large hydro and coal to meet the expected increase in electricity demand. Although the source for this table does not specify the renewables share included under "Other," a recent CEC document asserts that planned wind energy capacities represent 2% (ON, SK), 4% (AB) and 6% (QC) of all planned projects [CEC 2002d, p. 12].

*Canada's Renewable Power Potential*

**Wind:** The Canadian Clean Air and Renewable Energy Coalition estimates that a minimum of 1,562 MW of new wind capacity can be installed within the next five years (2003–2007) [CARE 2002b]. Natural Resources Canada's (NRCan) Wind Power Production Incentive also aims at the installation of 1,000 MW of wind generation capacity over the next five years [NRCan 2002e, p. 1]. The Canadian Wind Energy Association proposes to increase Canada's wind power generating capacity to 10,000 MW (from currently about 200 MW) by the year 2010, amounting to some 5% of overall electricity generation [CWEA 2001, p. 4]. This would mean an increase of more than 1,000 MW per year. NRCan has estimated

**Table 4.17 — Planned New Electricity Generation Facilities in Canada until 2007** [CEC 2001, p. 25]

| | **Natural Gas** | **Hydro** | **Coal** | **Other** | **Totals** |
|---|---|---|---|---|---|
| Number of Units | 65 | 30 | 4 | 32 | 131 |
| Planned capacities [MW] | 8949 | 5757.35 | 1750 | 666.63 | 17122.98 |
| Percentage [%] | 52.3 | 33.6 | 10.2 | 3.9 | 100 |

**Table 4.18 Potential for Electricity Generation from Wind in Canada in MW** [NRCan 1992]

| Province/ Territory | BC | AB | SK | MB | ON | QC | PE | NB | NF | NS | NT | YT | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Utility size plants | 3,257 | 2,509 | 826 | 1,027 | 8,236 | 9,777 | 43 | 785 | 661 | 574 | - | 25 | 27,720 |
| Remote communities | 27.2 | - | 0.5 | 3.8 | 3.5 | 69 | - | - | 38.4 | - | 31.5 | - | 173.5 |

that the possible wind energy capacity will double for each 1¢/kWh increase in electricity prices, with a maximum estimate of nearly 9,000 MW by 2015 if prices were 9¢/kWh [CETC 1992]. Germany and Spain gained from past developments in Denmark and the US since they could begin their wind expansion based on better and cheaper technologies (larger turbines). Denmark, with framework conditions in place back in 1983, took 16 years to install 2,000 MW of wind capacity. The German market took off in 1990 and achieved 2,000 MW installed in only seven years. The Spanish market only started to unfold in 1994, but reached the 2,000 MW mark within five years [BTM 2001, p. 28]. North German regions achieved 5% wind-based generation in less than five years [EEA 2001, p. 51].

Table 4.18 shows Canadian wind generation potentials assessed in a 1992 NRCan study.

Local resource assessment studies carried out more recently suggest that the above early estimate may be conservative [NRCan 2002e, p. 20]. Wind power potentials were assessed based on questionable data: they depend on wind measurements at airports, the location of which is generally chosen at low wind speed spots, and they were measured at 10m, whereas wind turbines nowadays work at a height of 40–55m [CH 1998, p. 7]. Turbine capacities have also increased since the report was written, which results in more sites becoming economically attractive. Much higher potentials have been suggested by more recent assessments (e.g., 35,000 MW for Manitoba and 10,000 MW for Alberta [PEM 2001]). Ontario's wind potential (commercial only) was estimated in 2001 to be slightly less than the technical potential given above, at 7,500 MW, excluding offshore potentials (Lake Erie) [WPTF 2002, p. 38]. According to the 1992 NRCan study, wind resources in BC are too small to be exploited. However, developments or potentials discussed today include 650 MW on Vancouver Island [BCH 2001, p. 2-1] and possibly 700 MW of technical potential on mainland BC [BCH 2002b]. A recent study has estimated BC's onshore wind energy potential at 4,800 MW, with 1,200 MW close to existing grid structures [HE 2002, p. 10]. This is in line with estimates made by the California Energy Commission for California, with roughly twice BC's coastline, at 13,400 MW [JLS 2001, p. 324]. Estimates for the U.S. and Europe yield figures in the several thousand TWh range [JLS 2001, p. 324], implying MW capacities larger than Canada's by a factor of 100. Germany's Ministry of Economics estimated its onshore wind generation potential to 124 TWh [ibid., p. 325], nearly twice as much as Canada's according to the above conservative estimate.

Table 4.18 does not include offshore wind potentials, for which no comprehensive estimates were available at the time of completion of this study. These potentials can be very significant: a 2000 study by the German Wind Energy Institute found that Britain, Belgium, Holland, Germany and Denmark have an offshore wind resource in the North Sea that is three times larger than their total electricity consumption. Lake Erie offshore potentials have been estimated to be 144 TWh [WPTF 2002, p. 38], which is one-quarter of Canada's or 100% of Ontario's annual electricity demand. Offshore wind is generally seen as being more expensive, but costs can be reduced through larger turbines, smaller towers and better resources (less turbulence and more steady wind: 9 hours a day vs. a typical 6.4 hours onshore). With large installed capacities, the price of offshore wind energy may fall to about 8¢/kWh [BWEA 2001]. In British Columbia, Vancouver company Sea Breeze Energy, Inc. is exploring the installation of 200 MW of offshore wind turbines south of Vancouver Island. Another project off the Queen Charlotte Islands is looking at a 700 MW wind farm.

**Solar PV:** The installed capacity in Canada of solar PV panels amounted to 8.5 MW in 2001 (estimate), up from 1.0 MW in 1992. Most of this is installed as off-grid distributed energy generation. Some pilot on-grid systems have been installed, but totaled only 92 kW of installed capacity between 1995 and 1999. The annual growth of installed PV capacity has been about 20% [NRCan 2002e, p. 25]. A 2.5% household penetration rate (based on the theoretical share of "early adopters" and an initial 41% investment grant, gradually reduced to 4% towards the end) is deemed possible within 20 years, based on the incentive program in Maryland, USA [CETC 2001, Annex I]. Government subsidies are needed to achieve this, probably mainly from the municipal level, would amount to about $4.5 million in a city like Toronto, or $34 million for all of Canada (based on a population of 4 million in Toronto and 30 million total). Installed capacities after 20 years would be 225 MW, based on the same assumptions. The cost of solar power, starting from 30¢/kWh in 1997, is projected to halve by 2010, and to reach less than 5¢/kWh by 2030 [ibid., p. IV].

**Small Hydro:** The current capacity of all small hydroelectric facilities in Canada is about 1,800 MW, at an annual production of 9,000 GWh [NRCan 2002e, p. 9]. Natural Resources Canada has completed an inventory of Canadian small hydroelectric sites. It identified more than 3,600 sites with a technically feasible potential of about 9,000 MW. However, only about 15 per cent of that total, approximately 1,300 MW, would be economically feasible with current socioeconomic conditions and technologies. If capital costs can be reduced by 10 to 15 percent, which should be achievable with future technological improvements, an additional 1,800 MW of economically exploitable capacity would be available [NRCan 2000]. According to the International Small-Hydro Atlas, more than 10 GW of potential small hydro capacity exists in Canada for facilities larger than or equal to 1 MW (see Table 4.19), 44% of which are projects of 10 MW generating capacity or more. BC Hydro currently offers 5¢/kWh for electricity from small hydro facilities, which

**Table 4.19 — Potential Small Hydro Capacities in Canada in MW** [IEA 2002]

| Province/ Territory | BC* | AB | SK | MB | ON | QC | PE | NB | NF | NS | NT | YT | Total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Potential >1MW | 1,385 | 182 | 202 | 395.5 | 1971 | 4,293 | 0 | 426.2 | 1,168 | 150 | 91.8 | 2 | 10,265.5 |
| Potential <1MW | 51.1 | 2.7 | 0.2 | 0 | 353 | 321 | 2.5 | 8.3 | 31.3 | 8.5 | 0 | 0 | 770.4 |

* The BC potential has also been estimated at 2,400 MW [CARE 2002e]

should make many of the larger projects economically feasible [NRCan 2002d].

**Biomass energy:** Three main sources of biomass can be used for electricity production: energy crops (especially switchgrass), agricultural waste and wood residues. All of these fuels could be important for Canada's energy portfolio. In the absence of official estimates of electricity generation potentials from biomass, an estimate has been made for this study based on the assumptions outlined in Appendix C. The result of these calculations is that 1.5% of Canada's annual electricity demand could be covered by energy crops, 0.6% from currently unused wood residues (this potential may have decreased since the available wood residue potentials were assessed in 1999), and 5.3% (32 TWh, based on Appendix C) from agricultural waste.[40] These figures represent a generation capacity of more than 1,502 MW for forest residues and energy crops, and 3,672 MW for agricultural waste, in addition to existing capacities. In 1999, the Canadian pulp and paper industry, together with independent power producers, produced important amounts of electricity from wood wastes and spent pulping liquor, much of which was used internally by industry [NRCan 2002e, p. 7]. The generation capacity of the pulp and paper industry amounts to 1,500 MW, that of independent power producers to 128 MW, and the electricity production of this sector was reported as 6,393 GWh[41] for 1999 [ibid., p. 13]. There is also some potential for electricity production from municipal waste, with a potential doubling of current electricity production from municipal waste incineration (747 GWh/a) [p. 16]. Table 4.20 provides an overview of the assessment in Appendix C.

**Landfill gas:** Canadian electricity production from landfill gas (currently implemented at 8 sites) is 85.3 MW. This number could be doubled within the next five years if producers could obtain a price of 6–7¢/kWh, as most larger landfills already have gas capturing systems installed, but many still flare the gas instead of producing electricity or process heat. Smaller landfills would only become economical with higher per-kWh prices (up to 12¢/kWh) [EC 2002a]. Emissions from the 10,000 Canadian landfills have been estimated to be 25 Mt of $CO_2$ equivalent, about 25% of which is either flared or used for electricity production. The total (but not economically feasible) potential can thus be estimated to be four times current use, or eight times the electricity generating capacity, given that only about half the landfill gas currently captured is used for electricity production [EC 2002a].

**Table 4.20 — Potential Electricity Production from Biomass in Canada, in GWh**
(based on [CFS 1999] and Appendix C)

| Province | BC | AB | SK | MB | ON | QC | Atlantic Prov. | Canada |
|---|---|---|---|---|---|---|---|---|
| Forest Residues | 1,470 | 630 | 35 | 14 | 350 | 1,190 | 210 | 3,890 |
| Switchgrass* | - | 960 | 960 | 3,090 | 3,090 | 960 | 210 | 9,270 |
| Agricultural waste | 202 | 8,545 | 12,087 | 4,312 | 4,044 | 2,733 | 245 | 32,168 |
| TOTAL | 1,672 | 10,135 | 13,082 | 7,416 | 7,484 | 4,883 | 665 | 45,328 |

** Roughly one third of the total potential for ON and MB each, and another third shared between the other Provinces*

**Wave energy:** High potentials for wave energy exist along both coasts. BC Hydro is developing the first wave energy project on Vancouver Island at a pilot stage (4 MW). Two technologies (onshore and off shore) are being tested, and plans have been made to expand the plant to 100 MW over the coming years if the technology works successfully. The theoretical onshore potential on Vancouver Island, based on the length of the coastline and wave heights, has been estimated to be about 8,000 MW (25 TWh), and about the same on the Queen Charlotte Islands.[42] Currently, two suitable sites have been identified on Vancouver Island, where 400–500 MW of wave power units could be installed. Whereas the electricity generation cost for the BC pilot project will be 8¢/kWh, a larger project could achieve prices as low as 4.5¢/kWh. The potential at the East Coast is larger, mainly along the coasts of Labrador and Nova Scotia. Wave heights are about 2.2m at the West Coast, and can be as high as 2.5m on the Labrador coast and 1.7m in Nova Scotia. The overall East Coast onshore capacity can be estimated to be twice as much as the Western resources [PT 2002]. Offshore resources are even larger, but currently are also more expensive.

**Tidal barrage:** The Canadian Annapolis tidal power plant in the Bay of Fundy, between Nova Scotia and New Brunswick, was built in one of the few places in the world where tides are in the order of 10 metres, reaching up to even 16 metres. The plant, a low-head demonstration project, has a nameplate capacity of 20 MW. Additional potential for tidal power in Canada exists in several locations, including four sites at the BC coast [TRI 2002]. Three sites in the Bay of Fundy are considered to have the best economic potential, with a total capacity of 8,500 MW [NRCan 2002c, p. 111]. For two considered projects (Cumberland and Minas Basins), the electricity generation cost was estimated to be between 4.9 and 7.6¢/kWh in 1993, including transmission and re-timing (pumped storage) cost [WEC 1993, p. 10]. There are problems with fish mortality and other ecological impacts in connection with tidal barrage concepts, which can be reduced using offshore plants, but probably make this technology the least environmentally desired option among ocean energy technologies.

**Tidal current:** The world's first tidal current demonstration project was recently installed in Scotland on September 13, 2002. The 150 kW turbine, supported by the British government, will be tested for one year and is situated at Yell Sound in the North of Scotland [EREN 2002(3)]. Its ecological impacts would be smaller than those of tidal barrages, and tidal current resources are among the best in the world along the BC coast. The estimated mean annual exploitable energy for the BC coast ranges from 2.7 TWh (1,550 MW installed at 20% capacity factor) for large scale installations with existing technology to about 20 TWh (7,600 MW installed at 30% capacity factor) with realistic assumptions about near future technology.

Present tidal current energy generation costs, using demonstrated technology, appear to be competitive with other green energy sources, at 11¢/kWh for a large site (800 MW installed capacity and 1.4 TWh/year). These costs assume a conservative capacity factor of 20% and a maximum current speed of 3.5 m/s. Future energy costs are expected to decrease considerably as both existing and new technologies are developed over the next few years. Assuming that maximum currents larger than 3.5 m/s can be exploited and present design developments continue, it is estimated that future tidal current energy costs between 5¢/kWh and 7¢/kWh are achievable. No detailed assessment has been done for Canada's east coast, but a similar potential may exist there, especially along the Labrador coast, from which power lines lead south. Assuming 20 TWh for each coast at a 30% capacity factor, this would result in an overall plant capacity of about 15,000 MW. Two Canadian companies (Blue Energy and Clean Current, both in BC) promote tidal stream technologies [TRI 2002].

**Geothermal:** There are good geothermal energy resources in British Columbia. North Pacific Geopower Corporation is currently exploring a 200 MW geothermal site north of Vancouver, BC, which could be operational by 2005. The field currently being explored is estimated to have a maximum potential of 1,000–1,500 MW. There are 5–6 geothermal fields that could be exploited with today's technology, and possibly an even greater potential exists with improved technologies in the future. No drilling has so far been undertaken to assess the geothermal potential in BC, but field studies indicate that all fields together might yield as much as 5,000 MW of plant capacity. Geothermal plants would be profitable at electricity prices of as little as 6¢/kWh [NPGC 2002].

Based on the information on each technology provided above, Table 4.21 lists potentially achievable installed capacities in Canada, in the author's judgment. The potentials suggested in this scenario can be used to estimate a technically feasible national Renewable Portfolio Standard. Table 4.22 compares projected electricity consumption with the possible generation from renewables for today, 2010 and 2020, based on the capacity factors in Table 4.21. Figure 4.21 shows the renewable power potentials for electricity production in Canada by Province. This map does not show additional offshore wind or wave potentials or solar PV, nor does it take into

**Table 4.21 — Renewable Electricity Potentials in Canada (in MW)**

| Energy Source | Overall Capacity | Current Capacity | Achievable by 2010 | Achievable by 2020 | Capacity Factors |
|---|---|---|---|---|---|
| Onshore Wind | > 28,000 | 200 | 5,000 | 15,000 | 35% |
| Solar PV | > consumption | 8.5 | 100 | 225 | 14% |
| Small hydro | 11,000 | 1,800 | 6,000 | 11,000 | 60% |
| Biomass (forestry residues & energy crops) | 3,130 | 1,628[3] | 2,500 | 3,000 | 80% |
| Biomass (agricultural residues) | 3,672 | ~0 | 1,500 | 3,000 | 80% |
| Landfill gas | ~700 | 85.3 | 170 | 250 | 90% |
| Wave (onshore only) | 48,000 | 4[1] | 400 | 2,500 | 35% |
| Tidal barrage | > 8,500 | 20 | 3,000 | 8,500 | 30% |
| Tidal stream | 15,000 | 0 | 100 | 1,000 | 30% |
| Geothermal | 5,000 | 0 | 600 | 1,500 | 95% |
| **Total capacity** | **> consumption** | **3,746** | **19,370** | **45,975** | |
| **Total generation[2] in TWh** | **> consumption** | **22/17[4]** | **91** | **193** | |

*[1] Capacity still under development (BC Hydro), scheduled to be operational in 2004 only*
*[2] Total capacity x capacity factor x 8,760 hours per year*
*[3] 1,500 MW internal use of pulp and paper industry, 128 MW independent power producers*
*[4] The lower number accommodates the reported low figures for electricity output from biomass generation plants*

**Table 4.22 — Actual and Projected Share of Renewables of Canada's Electricity Generation** (based on [CEM 2001])

| Year | Projected Total Consumption | Possible Renewable Share |
|---|---|---|
| 2002 | 600 TWh | 3.7%/2.8%[1] |
| 2010 | 705 TWh | 12.9% |
| 2020 | 820 TWh | 23.5% |

*[1] Whereas the low-impact renewables share of total electricity production normally given for Canada is 1.3%, based on research for this study it should be at least 2.8%, even taking into account low outputs from biomass and tidal plants, but counting small hydro. The number could be as high as 3.7% if existing biomass generation capacity were used to the maximum.*

account that the Canadian wind resources are possibly much better than the 1992 numbers used here. The territories are left out because both estimated potentials and population density are small, suggesting distributed generation rather than centralized utility-scale power generation.

Adding up the complete technical potential for the resources shown results in 429 TWh, more than two-thirds of Canada's 2002 estimated electricity consumption. A large portion of these technical potentials will never be realized due to environmental or other concerns, but the overall potential is

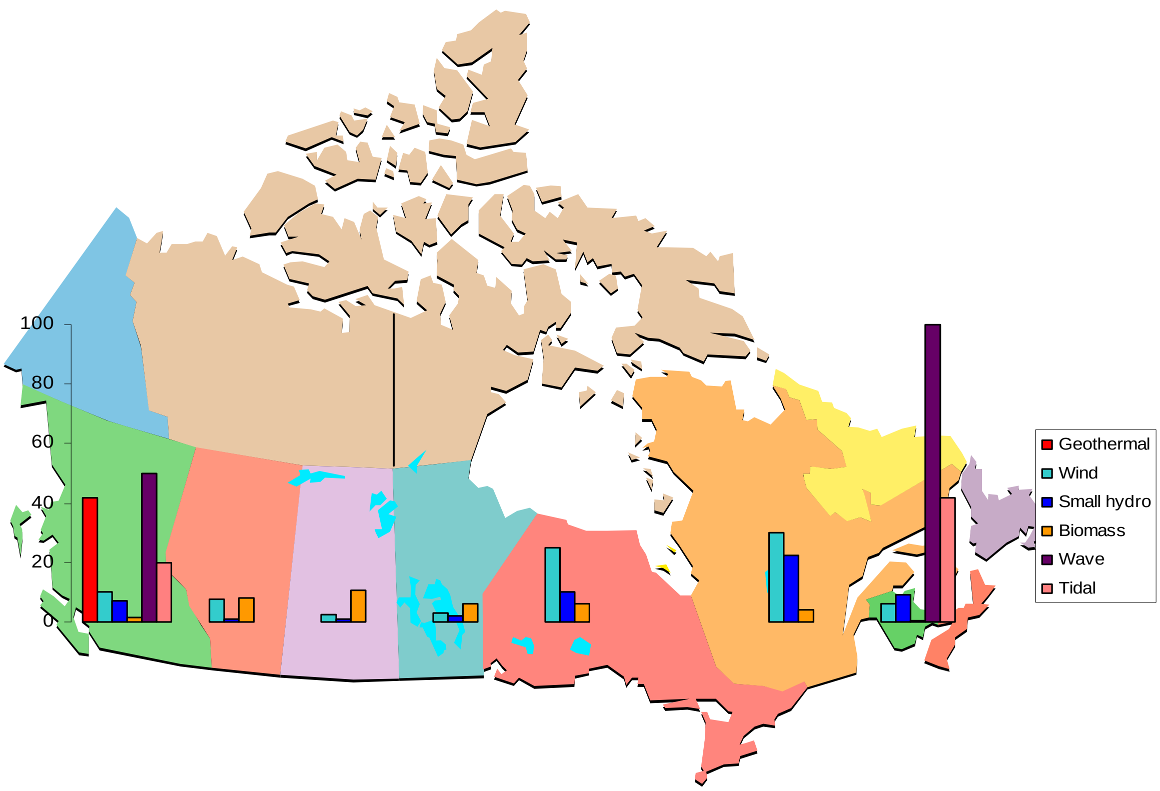



**Figure 4.21 — Technical Potentials for Electricity Production from Renewables, by Province, in TWh/a**
*Note: The potentials of all Atlantic Provinces have been aggregated*

high enough to allow for an important increase of the renewable power share in Canada's power portfolio. Table 4.22 confirms that, using a moderate estimate based on the resources and prices discussed above, a share of electricity production from low-impact renewable power of nearly 13% in 2010 and close to 24% in 2020 would be possible.

Canada's renewable power potentials are not evenly distributed. The coastal Provinces have far higher potentials than those in inland positions and would therefore be able to export green electricity, or green certificates, under an RPS regime with a trading provision. Although biomass potentials are significant, they cannot match other resources, such as wind or ocean-based generation. The Prairie Provinces have smaller potentials than the others, but will also need less energy due to smaller populations. Whether actual wind potentials are higher than those of ocean-based resources is difficult to assess and will only be known once more detailed wind resource mapping has been accomplished in Canada. Such mapping is essential to foster investment, and awareness of wind resources has led governments in the U.S., Denmark and Germany to implement policies to develop these resources [JLS 2001, p. 344]. BC Hydro has assessed wind, solar, tidal, biomass and small hydro resources in British Columbia, and will publish the results on its website.[43] Detailed assessments of wind and other renewable resources have also been carried out in the United States.[44]

### 4.8.4 Recommendations for a Nation-wide Canadian RPS

The Ontario Select Committee on Alternative Fuel Sources recommended that an aggressive RPS be introduced in Ontario that leads to the displacement of coal-fired electricity generation by 2015 [SCAFS 2002, p. 43]. Coal is currently (1999 figures) being used to generate 21% of Ontario's energy, or 31.3 TWh per year [ibid., p. 6]. To cover this amount of electricity production by wind, a capacity of 10,000 MW would have to be installed (35% capacity factor). This scenario seems unlikely to occur, and would also still require substantial amounts of fossil fuels to be used as back-up power if wind resources cannot cover the demand at peak hours. As Ontario Power Generation is planning to bring 7,000 MW of nuclear generation back on-line, it can be expected that some of the current coal-based generation capacities (7,557 MW) will be replaced. However, some of it may be replaced by gas-fired generation as nuclear plants are not flexible enough to provide short-term extra capacity to cover peak demand [OPG 2002a].

With the exception of geothermal and biomass plants, all renewable power sources are intermittent or irregular power sources. To maintain a constant supply of electricity, renewable-based generation needs to be either backed up with other energy sources or combined with energy storage (e.g., pumped water storage or production of hydrogen) to make up for low supply periods. Large hydro, gas and coal can quickly adapt to such changes and are therefore needed in combination with renewables to allow for sufficient energy management. Hydropower would be the preferred option as it reduces reliance on hot standby boilers, helping to lower emissions. There is also some potential for combining different kinds of renewable power in order to smooth out generation irregularities. For example, tidal stream peaks occur at different times at different locations, which means that several plants can be combined to obtain a more even production pattern [TRI 2002]. Similarly, but not to the same extent, this is also possible with wave and wind energy. In fact, the intermittency of wind has been found to coincide very well with afternoon winter peak demand for heating in Ontario [WPTF 2002, p. 16]. This effectively reduces the need for back-up power during peak periods, although it does not eliminate it on days with very low wind speeds. Solar PV

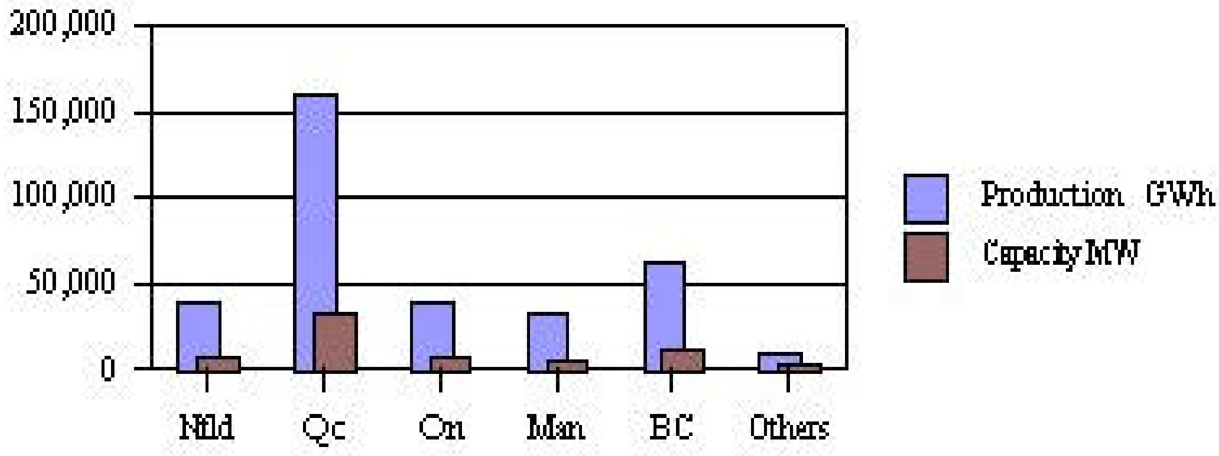



**Figure 4.22 — Canadian Hydro Resources by Province** [NRCan 2002e, p. 8]

will also deliver most electricity during peak-time daylight hours, especially during summer peak demand for air conditioning.

Provinces with a significant share of large hydro resources in their energy mix, such as Québec, BC and Manitoba, are in the best position to add intermittent sources to their grid as power generation from these sources then stretches the hydro resources, the output of which can be reduced as renewable resources produce extra power (see Figure 4.22). Other provinces, such as Alberta or Ontario, which have smaller hydro resources, may have to balance renewable power production with natural gas plants. Once renewable power obtains a larger market share and produces 10% or more of the electricity demand in a province, these issues require planning and can also limit the capacity to accommodate intermittent sources.

Whereas an annual increase of more than 1% of new generation seems technically possible based on the considerations in the previous section, and given that such speedy deployment of renewables has not been observed in other countries so far, a somewhat lower RPS goal is suggested here. It seems feasible, for example, compared to recent developments in Texas or Germany, and if the political will and support from both the Provinces and the utility sector exist, to achieve an annual growth of 1,000 MW of installed capacity,[45] which would result in an additional 3.5 TWh of electricity per year at an average capacity factor of 40% for renewables (assuming that a large share of newly added capacity will be wind power). The long-term goal should be to make up for the annual 1.2% increase in electricity demand only with renewables, which would require a doubling of the proposed annual added generation capacity. Allowing a lower capacity increase in the first year and a doubling after 2010, the resulting RPS percentages Canada could achieve under this scenario are given in Table 4.23.

Starting with a non-large hydro renewables share of 2.8% and assuming the RPS would start becoming effective in 2004, 5.8% could be achieved by 2010 and 13.5% by 2020. This assumes an annual growth of 0.5% of total generation (1% after 2010), very much in line with programs in other countries, and much more conservative than the 8% (2010) RPS proposed by the Ontario Wind Power Task Force, which is based on an annual 1% increase [WPTF 2002, p. 33]. The final RPS of 13.5% is also very much in line with the goal

**Table 4.23 — Achievable Annual Growth of Renewable Electricity Generation and Resulting RPS**

| Year | Added Generation | Cumulative Generation | Resulting RPS |
|---|---|---|---|
| 2002 | (existing) | 17.0 TWh | 2.8% |
| 2004 | 1.7 TWh | 19.7 TWh | |
| 2005 | 3.5 TWh | 23.2 TWh | |
| 2006 | 3.5 TWh | 26.7 TWh | |
| 2007 | 3.5 TWh | 30.2 TWh | |
| 2008 | 3.5 TWh | 33.7 TWh | |
| 2009 | 3.5 TWh | 37.2 TWh | |
| 2010 | 3.5 TWh | 40.7 TWh | 5.8% |
| 2011 | 7.0 TWh | 47.7 TWh | |
| 2020 | 7.0 TWh | 110.7 TWh | 13.5% |

of the United States, which is 10% in 2020, but starts with a somewhat lower initial renewables share (2% in the US vs. 2.8% in Canada). This also takes into account the expectation that prices for renewable generation will be further reduced through economies of scale and as worldwide demand and capacities incite lower prices and technology improvements over the coming years, allowing for a faster deployment in the next decade. Figure 4.23 shows how the RPS could lead to a diversification of renewable power sources over the next two decades. Currently, most of the renewable power comes from industry-owned biomass combustion plants (forestry residues only), a host of small hydro projects and some wind power, landfill gas and very little solar power. In the future, wind will have a much larger share, but other sources could also take up important amounts of generation, especially ocean energy and geothermal power.

Biomass projects would have to be “advanced biomass” projects with gasification technology, in order to increase efficiencies and reduce emissions from combustion. Whether or not more tidal barrage projects should be developed will probably depend on whether this technology is able to mitigate its large negative effects on marine ecosystems. Whereas solar power will continue to deliver a very small share of electricity — unless it is targeted by government programs including buy-downs and a massive increase in building integrated solar panels — it is noticeable that ocean-based power generation will gain a larger share after 2020, when both small hydro and biomass projects would reach their peak exploration rates. These scenarios do, of course, largely depend on both public acceptance of renewable energy projects and on government funding and policy support. The overall share of each technology will be especially sensitive to support and research programs.

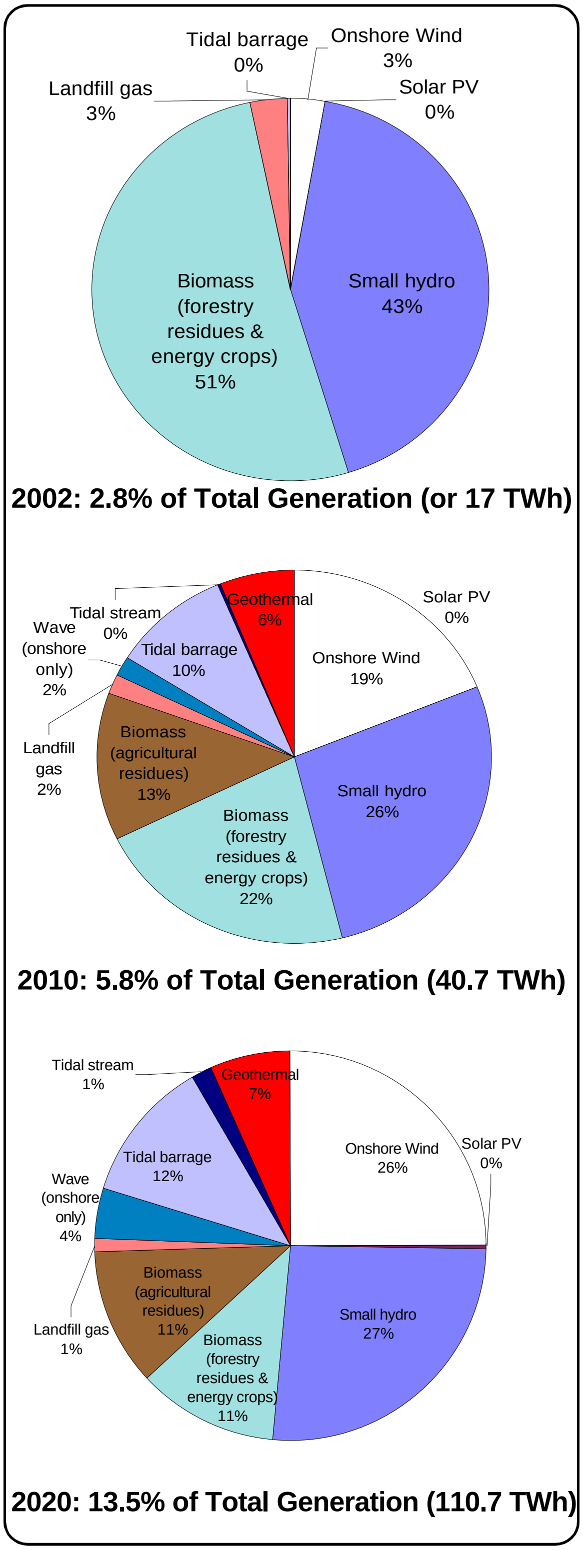



**Figure 4.23 — Shares of Non-Large Hydro Renewables in Canada's Green Power Portfolio**

A national RPS could be allocated by agreement to each Province, based on its particular resources potential and consumption patterns. However, this would put an extra financial burden on Provinces, such as British Columbia, which account for a large share of the total potential. A more equitable approach would be to apply the RPS to each Province at the same rate, but allow for the trading of renewable energy certificates throughout Canada (and possibly also with the United States) in order to fulfill the quota. This would enhance renewable power development in areas where the existing grid structures allow for easy integration and where the resources are best and cheapest. As long-term planning and grid improvements show effects, resources in remaining areas could be tapped as well.

# 5. Green Tags — Threat or Opportunity for GP Promotion?

## 5.1 What are Green Tags?

Green tags,[46] renewable energy certificates, renewable energy credits, and tradable renewable energy certificates are somewhat recent market developments. They represent environmental (and social) benefits that have been unbundled from renewable or "green energy," such as wind, solar and small hydro. This concept is demonstrated in Figure 5.1 below.

Green tags reflect the fact that it cannot be guaranteed that the green power the customer pays for is physically delivered to the customer's address. The environmental benefits are enjoyed by all in a given airshed (for reduced air emissions), or even globally, in the case of $CO_2$ emissions reductions. The green power a customer pays a premium for, on the other hand, will be delivered to those closest to the location of generation. Green tags reflect this disaggregation of electricity and environmental benefits, and allow for their geographical separation, up to a global scale. In fact, an innovative Dutch company already sells green tags from Australia and Texas to customers world-wide, including Europe and Japan.[47]

Green tags can be marketed in kWh increments, allowing consumers to match their energy consumption with the amount of green tags needed to offset perceived impacts. Compared to the bundled "green energy" product, green tags are not bound to a geographic area where green power is produced, and because they do allow a customer to not only offset electricity consumption, but also any other emission linked to heating, car or air travel, or any other fossil fuel consuming activity. Equally, one transaction can cover the activities of a company operating nationwide — for example, in February 2002, outdoor clothing manufacturer Timberland "offset" the energy consumption of its 67 retail stores across the US through the purchase of green tags.[48]

Green tags (Renewable Energy Certificates) can be important tools in the administration of renewable portfolio standards as they fit

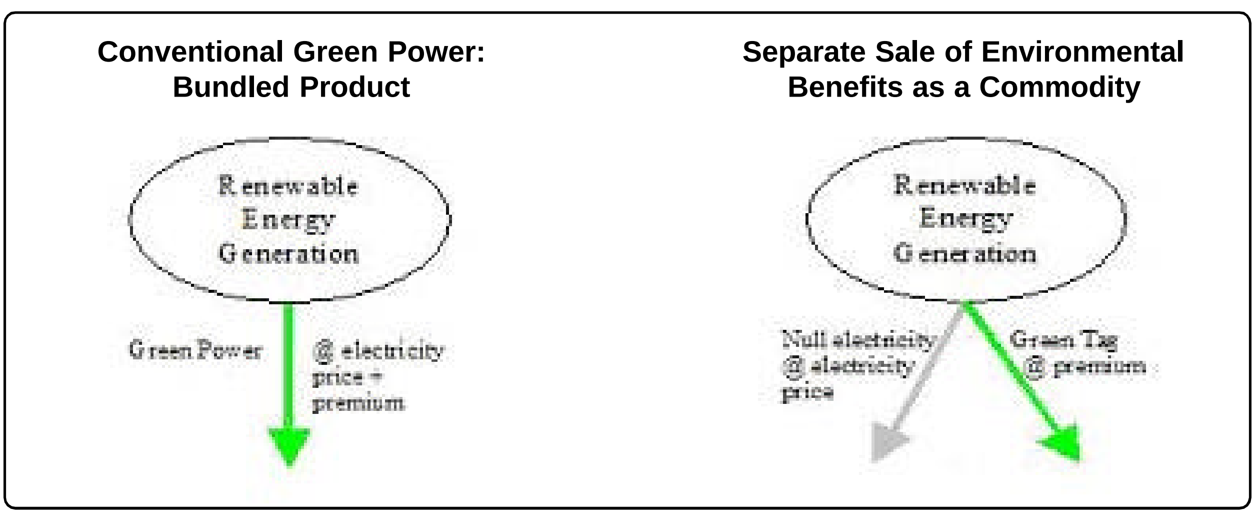



**Figure 5.1 — The Concept of Green Tags**

easily into a tracking system for green power production. They are also able to effectively shift the monetary benefits of clean power production to the sources supported by consumers, and can be worked into national and international emissions trading schemes.

## 5.2 Green Tags Linked to RPS Obligations

In the context of a renewable portfolio standard, green tags, or tradable green certificates, are used as an accounting system to verify that an obligation has been met at the end of each year. At the same time, since they are market-based instruments, they could also facilitate compliance at the lowest cost, encouraging competition among renewable power providers. They work as follows: The generators (producers), wholesalers, retailers or consumers (depending on who is targeted in the electricity supply chain) are obligated to supply/consume a certain percentage of electricity from renewable power sources. At the date of settlement, the generators have to submit the required number of Renewable Energy Certificates (RECs) to demonstrate compliance. Generators can obtain certificates in three ways:

1. they can own their own renewable power generation, and each defined amount of energy (e.g., 1 MWh) produced by these facilities would represent one certificate;

2. they can purchase electricity and associated certificates from another renewable power generator; and,

3. they can purchase certificates without purchasing the actual power from a generator or broker, (i.e., purchasing certificates that have been traded independently of the power itself).

Due to competition on the supply side, this system of tradable certificates leads, under the assumption of perfect market conditions (perfect price signal), to minimal generation costs from renewable power sources. A voluntary system of trading renewable electricity certificates has been implemented in the Netherlands. Tradable renewable certificate systems are proposed or already implemented in Austria (only small hydro), Belgium, Italy, Sweden, the UK, Australia and Texas.

## 5.3 Green Tags — Current International Developments

Green tags are being used in Australia, the Netherlands, Great Britain and Texas to monitor RPS requirements. Across the US, Green Power Sales amounted to about one million MWh in 2001. More than one-third of this amount was sold as green tags, with a strong growth tendency. In Canada, green tags are currently offered in Alberta and Ontario, and from September 2002 onwards will also be available to corporate customers in British Columbia. Table 5.1 contains an overview of Canadian and US green tag providers. Table 5.2 shows that European countries are also very active in the field. Green tags can also be traded outside of RPS requirements or national schemes, simply as green power sales through re-bundling the tags with electricity. In fact, international trade of environmental attributes has already happened and can be expected to occur more frequently in the future.[49]

**Table 5.1 — Green Tag Providers in the US and Canada (as of January 2002)**

| Organization | Type of Org. | Product |
|---|---|---|
| Bonneville Environment Foundation, Portland, OR | non-profit organization | Electricity is generated by new (since 1999) solar, wind, landfill gas and low-impact hydropower facilities. Green tag purchases through BEF are tax-deductible. |
| Sterling Planet, Roswell, GA | Private corp. | Offers a mix of geothermal and small hydro-electric Inc., power, and will soon introduce wind energy to their mix. Customers can choose packages equivalent to 50 percent, 75 percent or 100 percent of their energy use. Also works with APX wholesalers and ERT. |
| NativeEnergy North Ferrisburgh, VT | Private Company, since November 2001 | Has a membership program called WindBuilders based on their purchases of green tags that support new construction of wind farms. Initially, the membership fees will be used to support the development of the Graber Family Wind Farm in South Dakota, a three-turbine, 2.7-MW project that the company expects to be operational by late 2002. Green certificates from new wind farms will then be donated to Clean Air-Cool Planet, a non-profit environmental organization. $CO_2$ emission reductions are integrated with these green tags. |
| PacifiCorp, Portland, OR | Private utility | Offers utility green tags coming mainly from their new projects. The returns from green tag sales go back to PacifiCorp customers to lower their electricity rates. |
| PG&E National Energy Group (NEG) | Parent of Pacific Gas & Electric Company | Sells PureWind certificates representing the environmental attributes of the wind energy output from two new wind projects now operating near Palm Springs, California, and an 11-MW merchant wind facility constructed in Madison County, New York, to consumers over the Internet. The power generated from the two new projects, totaling 66.6 MW, is being sold to the California Department of Water Resources under a long-term contract. |
| Atlantic Renewable Energy Corp. (AREC) | Company | Will sell certificates created from a 12-MW wind project under development in Fenner, New York (to be starting mid-2001). AREC already has one customer lined up — the US EPA has agreed to purchase certificates representing about 2 million kWh annually for a new laboratory under construction in Chelmsford, Massachusetts. |
| Community Energy Inc., Wayne, PA | Private company | New Wind Energy is delivered into the grid by Exelon Power Team, a division of Exelon Corp., which validates the sale of New Wind Energy Certificates. |

***Table 5.1 continued ...***

| Organization | Type of Org. | Product |
|---|---|---|
| Los Angeles Department of Water & Power (LADWP) | Municipal utility | Green power certificates: feed into funds for new renewables projects. So far, most funds came from the green power sales and the tags have been very marginal and are not actively marketed. |
| Sun Power Electric Boston | Non-profit organization | Three solar facilities (about 150,000 kWh per year, supplying about 30 average-sized homes) to serve power markets in the Northeast. Sun Power is producing and marketing its “ReGen” certificates throughout the North Western US. |
| Massachusetts Energy Consumers Alliance | Non-profit consumer alliance | ReGen is a premium electricity product. Power generated from landfill gas and solar resources is delivered to the New England power grid where it displaces older, polluting sources that would otherwise need to operate. Composed of 99% landfill gas combustion, 0.1% solar energy. When members buy ReGen, they support long-term renewable power contracts held by Mass Energy‘s partner, Sun Power Electric. |
| Waverly Light and Power (WL&P), Iowa | Municipal electric utility | Iowa Energy Tags, wind power certificates representing the environmental attributes of the power output of its three wind turbines. 4,000,000 kWh or 1,600 Iowa Energy Tags™ are available each year from 01/01/01 through 12/31/06. WL&P owns and operates one 80-kW turbine located north of Waverly, Iowa and two 750-kW turbines near Alta, Iowa. Revenues from the sale of the certificates will be used to develop additional wind projects. |
| Idaho Power Company | Company | Is collecting donations from its Idaho-based customers in order to purchase green tags from the Bonneville Environmental Foundation, supporting projects in the Pacific North West. Customers can choose to contribute any amount on their monthly electricity bills to support the development of renewable resources. Customer contributions will be used exclusively to purchase green energy with program overhead and marketing expenses to be funded from other sources. |
| Environmental Resources Trust, Washington, DC | non-profit certifier and marketer | Each EcoPowerSM ticket represents the generation of a specified amount of substantiated EcoPowerSM in the electric grid of origination for the power resource. Each EcoPowerSM ticket discloses the amount and types of fuel components generated for a specified period. Upon sale to an end user of electricity, each EcoPowerSM ticket is punched to ensure credit for final use, and a copy of the punched ticket is maintained for audit purposes. A retailer may purchase tickets from generators of renewable power in other electric grids if locally generated renewable power is not available. |

***Table 5.1 continued ...***

| Organization | Type of Org. | Product |
|---|---|---|
| Renewable Energy Boulder, CO | Company | "American Wind," a 100% new wind energy option Choice supplied primarily from Texas-based wind resources, and "EcoChoice," a blend of 10% new wind resources and 90% existing renewables. |
| BC Hydro | Crown company | Pilot project with tags mainly from small hydro projects offered to business customers. Sales will start in September 2002. |
| Vision Quest Windelectric, Inc., Canada | Private company | Verified Emissions Reductions derived from new renewable energy resources: $CO_2$ emission reductions are integrated with these green tags. These are primarily windelectric sources, but also come from energy efficiency projects, by companies upgrading their plants to cause less pollution, and by clean energy sources that displace older, dirtier ones. Some customers apply the VERs against their own emissions, offsetting their automobile or household energy use. Some industrial customers purchase Green Energy® specifically to offset their emissions, thereby encouraging wind energy and reducing their impact on the atmosphere. Vision Quest has sold VERs only to industrial customers, on a confidential basis. They have offered VERs into markets in the US, Canada, and overseas. There is no set world price for VERs at this time, and there are many different types and qualities of VERs. VisionQuest's tags are also TerraChoice certified. |

The **European Renewable Energy Directive** requires member states to create national, but mutually compatible, green power certification schemes to provide a guarantee of origin, facilitating the trade of certificates. These schemes have to be established by October 2003. The guarantees of origin will disclose the power source, date and place of production, and capacity in the case of hydropower. The **Renewable Energy Certificate System** (RECS) is an extra-governmental group with its main office in the Netherlands, formed on a voluntary basis by 50 European power companies, with the goal of leading Europe towards an international trading system. The idea of RECS is to establish a National Team in each of the participating countries. The National Teams will set up green certificate systems in their own countries in which members of RECS and the local National Team can participate. Together, the National Teams will develop protocols on how to deal with the import and export of certificates. RECS started trading Europe-wide in its test phase on January 1, 2001. The test phase will be concluded in the summer of 2002, after running for 18 months.

RECS has a target of trading 100 GWh of green power during the 18 month test period, of which one third are expected to be traded internationally. One certificate is issued for every MWh produced by a renewable

**Table 5.2 — Overview of EU Initiatives Involving Tradable Certificates** [Haas 2001, p. 21]

| | **Austria** | **The Nether-lands**** | **Denmark** | **UK** | **Belgium (Flemish region)** | **Belgium (Wallon region)** | **Italy** |
|---|---|---|---|---|---|---|---|
| Period | start 2001 | 1998–2000 | start 2002 | start 2001 | start 2001 | Start 2001 | start 2002 |
| Obligation | 8% small hydro (<10 MW) | 1.7 billion kWh | 20% by end 2003 (postponed by 2 years) | 5% in 2003, 10% in 2010 | 3% in 2004 | 3% (2001), 4% (2002), 5% (2003), 6% (2004) | 2% in 2002 |
| Obligation On | end-user | supplier | end-user | supplier | supplier | supplier* | supplier |
| Technology Bands (baskets) within overall quota | two groups (new renew-ables, small hydro) | no | no | no planned | yes, | n.a. | no |
| Involved Technol-ogies | small hydro (<10 MW) | all renewables | small hydro, wind, biomass, solar, geothermal energy, no waste | small hydro, wind, biomass, solar, geothermal energy, no waste | all renewables, no solid municipal waste | all renewables, no incineration | all renewables (incl. large hydro), facilities not older than 10 years |
| International Trade allowed | no | yes, but only in exchange with physical electricity | Yes | n.a. | no | No | yes, but only in exchange with physical electricity |
| Price Restrictions (min., max. price) | Not planned max. price according to penalty | Not planned, max. price according to penalty | min.= 0.014 EURO/kWh, max.= 0.037 EURO/kWh | Not planned, max. price according to penalty | yes, planned | n.a. | n.a. |
| Penalty | yes, according worst technology | 150% of market price | fix price, 0.037 EURO/kWh | fix price, 0.048 EURO/kWh | fix price, 0.12 EURO/kWh | n.a. | n.a. |
| Trading Scheme | open | stock exchange, mostly long term contracts | stock exchange | stock exchange, develop-ment of spot, forward and derivate market planned | stock exchange | open, trading and direct support | open |

*consumers buying at least 50% from renewables are immediately eligible for the equivalent of the whole amount of green electricity consumed, producer are eligible for the purchase of peak and back-up electricity, for their self-consumption as for their clients up to the level of green electricity produced.
** The Green Label system (an initiative of the energy sector) will end by the end of 2000.

generating facility. Figure 5.2 presents a schematic of the RECS trading and certification system. Under RECS, the Issuing Body uses meter readings to issue certificates as evidence of production from renewable power sources. It also audits certificate trading, and takes certificates off the market when they have been redeemed. Certificates issued for facilities that already existed at the moment of introduction of the European Certificate system cannot be traded and are called National Certificates. Certificates issued for production units which received direct support from governments (e.g., subsidies) cannot be traded. Certificates issued for production units realized with indirect governmental support, such as demand stimulation by regulatory energy taxes, or other measures that enhance demand, can be traded with other countries.

RECS offers a high degree of freedom to participants. Within the clear and unambiguous RECS framework, each country is free to choose the regime that corresponds best to its particular situation. The RECS definition of renewable power is deliberately broad, and only excludes specific types of power (e.g., nuclear energy). Countries and individual market participants may refine this definition to exclude other types of renewables, supported renewables, or plants over a certain age. This may lead to situations in which specific types of renewable power (e.g., generated from peat) can only be traded in certain countries. To facilitate the trade between countries with different legislative frameworks, RECS Certificates have to be labelled with data on the producer, the type of renewable power, the period of production, whether it is a national certificate, the expiration date (if applicable), and the use of standard units if other than MWh are used.

## 5.4 Governments Using Green Tags Today

### *5.4.1 Texas*

In Texas, green tags are used to achieve the state renewable portfolio standard. On May 9, 2000, the Public Utility Commission of Texas (PUCT) appointed ERCOT as Program Administrator of the Renewable Energy Credits Trading Program, which is to create an additional 2,000 MW of renewable

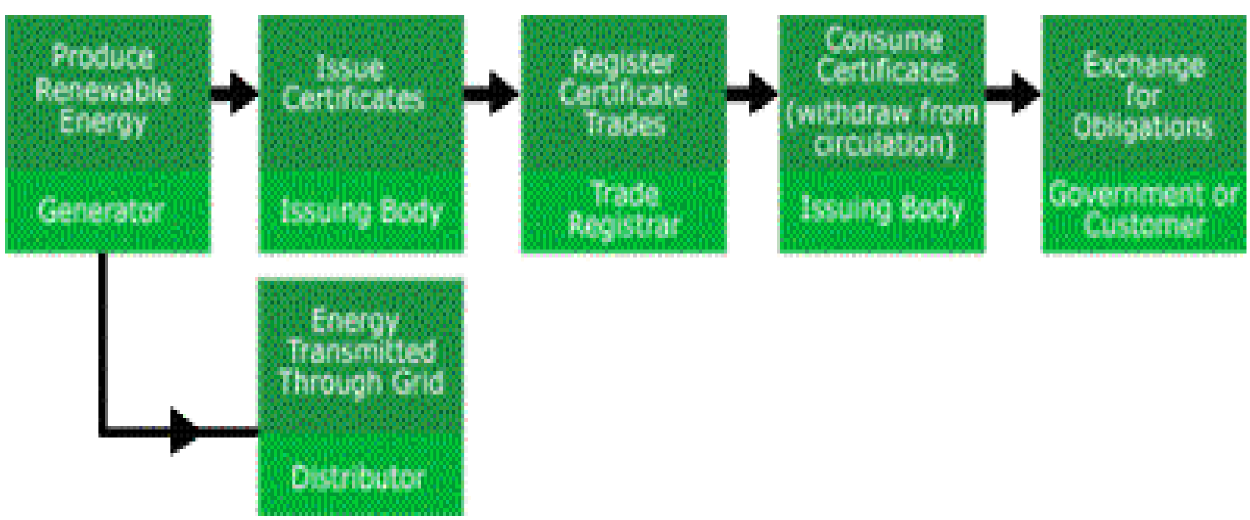



**Figure 5.2 — The RECS Renewable Certificate Trading Scheme** [RECS 2002]

**Box 5.1 — Green Tags Offered by the Bonneville Environmental Foundation (BEF) in Oregon**

BEF has teamed up with three environmental non-profit organizations to assure "certification"of green power through endorsements. The Bonneville Power Association supplies wind, low-impact hydro, landfill gas and solar energy for creating the tags. Other early supporters were the Hewlett Foundation and the Packard Foundation. These two groups provided funds to cover the administrative and start-up expenses of BEF during the first two years of operation. In addition, BEF has received contributions from New Energy Ventures, Enron Corporation, Scottish Power, Edison Enterprises and PG&E Corporation. BEF sells its green tags to residential customers over the Internet. Increasingly, the organization also sells to utilities, such as Idaho Power or cooperatives like Peninsula Light Company, who in turn retail them as green power to their customers or members.

BEF is open to inquiries from renewable power providers inside the United States for new contracts. The Foundation sells green tags to clients in up to 20 states, but its focus lies in the Northwest (Oregon, Washington, Idaho, Montana). As the Foundation is a registered charity, all green tag purchases from BEF are tax deductible although the US BEF requires that 90–95% of the revenues for green tags made available to power generators be reinvested in new renewable energy projects. BEF also retains a large portion of the revenues to cover administrative cost, finance watershed improvement projects, and to feed a fund to reinvest in new renewable power capacity.

generating capacity by 2009. The Renewable Energy Credit (REC) Program became effective July 1, 2001 and is based on an electronic trading system. Electricity retailers can either create their own RECs by generating their own renewable electricity, buy RECs from independent power producers throughout Texas, or pay a fine of a maximum of $50 per MWh (double the average market price of RECs). RECs can be banked for up to three years. In addition, deficit banking of up to 5% is allowed for the first two years. Existing plants (in operation before September 1999) are not eligible for RECs, but retailers with existing renewable capacities have an advantage because their share of the obligation is reduced, based on "offsets" created from these existing facilities [NREL 2000, p. 7] (see also chapter 3.2.4).

### *5.4.2 Australia*

The Commonwealth of Australia's *Renewable Energy (Electricity) Act 2000*, effective since April 1st, 2001, requires retailers to buy electricity from renewable sources to reduce greenhouse gas emissions and to ensure that renewable power sources are ecologically sustainable. The measure also established a Renewable Energy Certificates (RECs) scheme for Australia, including a mandated renewable power target of 300 GWh in 2001 and 9,500 GWh in 2010.

The REC system provides significant extra income for renewable power (see Chapter 3.4). One REC is created for every MWh of electricity generated from accredited renewable power generators. These Renewable Energy Certificates (RECs) are sold with the electricity they represent or can be sold separately in a market just for the RECs. The wholesale buyers of electricity who have an obligation under the Act to sell renewable power have to demonstrate compliance with their obligation by surrendering the appropriate number of RECs to the Regulator each year on February 14.

RECs are sold to utilities by renewable power generators, not to residential or industrial customers. The utilities have to comply with increasing amounts of renewable power generation specified in the *Renewable Energy (Electricity) Act*. Certification and trade is controlled by the government's Office of the Renewable Energy Regulator.

Following is a summary of the rules governing the Australian system:

**Maintenance of a registry of owners of eligible power stations:** Individuals must be registered before they can seek accreditation of power stations. Registered entities will each be allocated a unique registration number that is entered onto the Registry of Registered Persons. The registry is publicly available via the Internet.

**Accreditation of eligible power stations:** Renewable power stations must be accredited before Renewable Energy Certificates can be created for their generation. The accreditation process includes:

- verification that a power station is using eligible renewable energy sources;
- establishment of a baseline (indicating the average existing level of renewable generation prior to 1 January 1997); and,
- estimation of the amount of additional energy that will be generated and confirmation that the energy generated is being used.

**Registration of Renewable Energy Certificates:** Once a power station is accredited and has generated electricity above its baseline, it may seek to create one Renewable Energy Certificate (REC) for each MWh of eligible renewable power generated and delivered to a grid, end point user or directly to a retailer or wholesaler. Some installations of solar water heaters may also be eligible for RECs. In most cases, the number of RECs that may be created for solar water heaters will be deemed in the regulations (however, some very large industrial applications may need to provide system-specific modeling to be eligible).

Certificates are created in an electronic form via the Internet. They are not valid until they are registered by the Regulator. The Regulator may check the validity of a certificate prior to allowing it to be registered. Any transfer of ownership or retirement of certificates will also be recorded in this registry. The certificates have serial numbers identifying the person that generated the electricity, the accredited power station, the year the power was generated, and a number for each MWh registered that year, in the format 0071-WD00NS01–2001–000001. The RECs are valid indefinitely.

**Monitoring and compliance:** The Renewable Energy Regulator, appointed for five years, is responsible for ensuring compliance with the scheme. This involves overseeing the surrender of RECs from liable parties in discharging their liability. If a party cannot meet its liability, and the shortfall is greater than 10 per cent of the total liability in a given year, the Regulator must impose a penalty on the party. The role of the Office of the Renewable Energy Regulator includes:

- overseeing the creation of valid renewable energy certificates;
- assessing annual compliance statements;
- imposing any penalties for non-compliance with the provisions of the legislation;
- redeeming any renewable power shortfall charges if shortfalls are made up within three years; and,
- ensuring the integrity of the measure and undertaking audits of participants, including renewable power generators and liable parties.

### *5.4.3 The Netherlands*

The Dutch “groencertificaten” (green certificates) are used to obtain an exemption from the energy tax of 6 €cents per kWh (small consumers). This makes the Netherlands’ system unique among green tag schemes as the green certificate price is fixed by the amount of the tax instead of being determined by the market. The green certificates only exist as digital data and are not sold to residential customers. As the Netherlands could not cover its own skyrocketing residential demand for green power, green electricity from other countries has also qualified for green certificates since July 2001.

The trading system is administered by Groencertificatenbeheer (Green Certificates body/GCB), which maintains a record of the generation of and trade in green power. Subject to certain conditions, the owners of plants where electricity is generated using wind or solar energy, hydropower or biomass may register with GCB as a generator, as well as registering their plants with the regional electricity grid administrator to which the plants are (to be) connected. The grid administrator in question checks the plant and the connection and installs a measuring device for the uniform registration of the quantity of electricity fed into the electricity grid. The plant’s owner receives a Groenverklaring (Green declaration) in exchange, following which it registers with the GCB. The latter opens an account in which the deliveries of sustainably generated electricity are posted. On July 1, 2001 the grid administrators performed the reference measurement of plants that had been registered as of that date. Subsequent measurements by the same grid administrators will be used in calculating and reporting to the GCB the quantities of electricity that have been sustainably generated.

The GCB generates an “electronic certificate” for each MWh supplied, coded on the basis of the plant’s connection number, thus providing for the subsequent traceability of the electricity. There are four Green Certificates denominations (i.e., 1, 10, 100 and 1,000 MWh). The Certificate is credited to the account number of the trader having been designated by the generating company. The GCB’s system exclusively caters for certificate transfers (i.e., not for financial transactions). Generating companies and traders/suppliers of sustainable energy may register with the GCB as traders. A “current account” for the Certificates will then be opened for them. The GCB records the ownership of the Certificates and their transfer to another registered party.

The parties can access their own account using a secured login connection, so as to request information and complete transactions. Any trader that supplies green electricity to an end user instantly becomes a supplier. The trades should report the Green Certificates registered in the suppliers’ name to the Inland Revenue department. To the extent that a matching quantity of power has effectively been supplied, Inland Revenue applies the energy tax (REB) exemption (see Box 4.9 in chapter 4.5.3). When the GCB transfers a Certificate to Inland Revenue’s account, the Certificate is cancelled. All other Certificates are automatically cancelled on expiry of a one-year period from the date of issue. This ensures the reconciliation of the quantities of sustainable electricity that have been generated and used up on an annual basis [GCB 2002].

Imports of foreign green power have also been tax exempt since January 1, 2002. Certificates are only accepted from countries with competitive electricity markets (currently only Germany, Sweden, Norway, Finland and the United Kingdom) and there must be sufficient import capacity for physical delivery of the imported electricity [NREL 2002, p. 36].

### 5.4.4 Great Britain

In the UK, the Utilities Act 2000 puts an obligation on suppliers to supply increased amounts of renewable power over the coming years (i.e., 3.0% of the power supply in fiscal 2002 and 7.9% in fiscal 2007). This obligation has to be fulfilled by creating Renewable Energy Obligation Certificates (ROCs). The legislation allows for ROCs to be obtained through the purchase of green tags inside and outside the country, starting in January 2002. Large industrial energy consumers are required to obtain a certain percentage of the energy they annually consume from an authorized green energy source, and are penalized for failure to meet this requirement. As a part of this process, authorized green power generators receive ROCs from the regulatory authorities according to the amount of electricity generated. The certificates may be sold to suppliers or to the market, separately from electricity.

Britain uses yet another kind of certificates, which are similar to the Dutch groencertificaten. Since the Climate Change Levy does not apply to renewable power consumers, they are exempt from it based on Levy Exemption Certificates (LECs). These LECs do not represent the actual carbon emission offset of renewable power, which could still be traded separately from it. They can only be traded together with the electricity produced. The savings are spilt between the power generator and consumer, with the retailer getting a margin [DTI 2002c] (see also Chapter 3.4.2).

### 5.4.5 Ontario

Although Ontario has not yet legislated an RPS, the establishment of a deregulated market means that green power is mostly sold unbundled. To buy green power, an Ontario customer will generally stay with his/her current power provider and will subscribe to a different retailer offering a green tag product (see Figure 5.3). The customer will thus pay for electricity to the same default provider as before, but will pay a green premium to the other retailer, and so claim the green attributes of renewable electricity fed into the grid on his/her behalf. Green power marketers (e.g., Green Tags Ontario) have acknowledged this situation by calling their power a “tag product.” The alternative, i.e. that the power retailer sells both the power and the green attributes as a bundled green power product, is less attractive due to special licensing requirements with the Ontario Energy Board for green power retailers.

## 5.5 The Future of Green Tags

The US National Wind Coordinating Committee (NWCC) has developed principles and guidelines on green tag trading [NWCC 2001b]. The Committee heavily advocates the disaggregation of environmental attributes, and supports the creation of a trading system for $CO_2$, $SO_2$, NOx, and mercury emissions avoidance credits. Given that the Bush administration’s “Clean Skies” initiative proposes a system of tradable emissions credits that will lead to lower emissions (including mercury), similar to the system already in place for sulfur dioxide emissions, the disaggregation of green attributes is a very probable scenario. The Committee states that the disaggregation of attributes is best confined to compliance

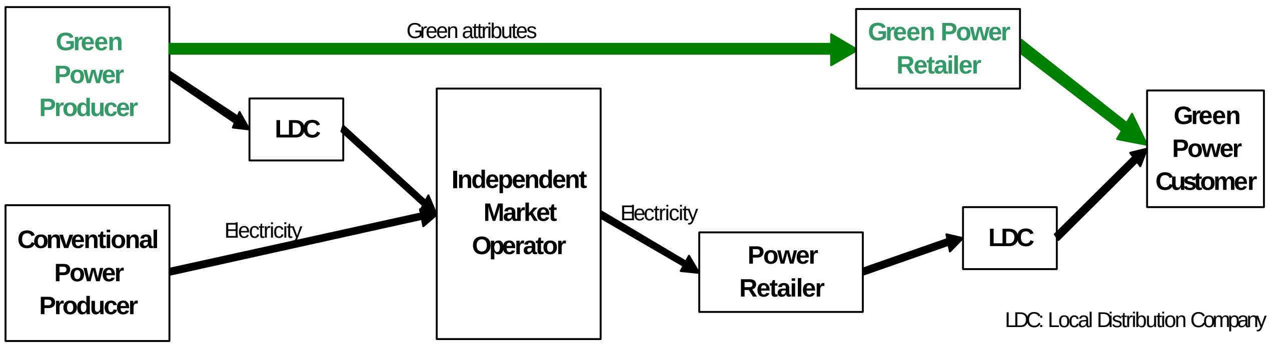



**Figure 5.3 — Green Power Sales Structure in Ontario**

(RPS) markets, and excluded from consumer markets. Disaggregation is already taking place in the US. For example, the Bonneville Environmental Foundation has bought 36,500 MWh worth of green tags, the carbon offsets part of which has been transferred to The Climate Trust (approximately 2,300 metric tons of $CO_2$) for permanent retirement [ENS 2001].

NWCC also promotes the creation of a renewable energy credit registry (one national or multiple regional registries), or another comparable mechanism, which would allow the recognition of attributes from renewable generation, help to avoid double counting, and help to cope with cross-jurisdictional “seams” issues.

According to the Center for Resource Solutions, some European countries are looking at the purchase of green tags associated with renewable power projects in developing countries not only as a means of earning credits for carbon emissions reductions, but also as a mechanism for delivering economic development aid.

International efforts to co-ordinate certificate trading have already begun. The European RECS initiative has created a networking website, www.treckin.com, dedicated to international co-operation on this issue. So far, parties from the US, Australia, Europe and Russia are involved.

## 5.6 Possible Problems and Possible Solutions

### *5.6.1 Issues with Green Tags*

A major issue of concern about non-RPS green tags is the absence of an effective tracking system. Whereas a one-time sale into RPS-based certificate markets with an electronic tracking system rules out double sales of certificates, the voluntary consumer market has no such safeguard. There is currently no system in place that would allow the auditing of such an open system. A retailer can demonstrate to an auditor that renewables were purchased from a wholesaler (or directly from the producer), but this purchase does not prove that the wholesaler has not sold those same renewable kilowatt-hours to another retailer. If multiple transactions occur between a renewable power generator and the ultimate retail sale of its power, the issue is further complicated. Unless the auditor has the authority to audit the records of each of the entities in the chain from which the retailer

> *“Laws, regulations and markets should recognize that environmental attributes can be disaggregated from each other.”*
> National Wind Energy Association

**Box 5.2 — The NEPOOL Tracking System**

New England has recently taken a big step towards the development of a "full certificates" system that would track energy and attributes through the New England ISO control area. The system will be utilized to determine compliance with RPS, GPS and disclosure requirements in the region's states. This effort, approved by NEPOOL (the New England Power Pool) on November 3, 2000, would be the culmination of years of work that started with the NECPUC (New England Coalition of Public Utility Commissioners) Disclosure Project and the NECPUC Model Disclosure Rule.

The design of the current GIS system is intended to coordinate the region's disclosure policies with RPS and GPS policies. Certificates in this case serve as a registration vehicle for all attributes associated with generation, including emissions characteristics. However, since renewable energy generators, such as wind farms, have no actual emissions to report (and then "reduce"), no emissions-related attribute will be recorded.

Certificates will be generated for each generation unit, and retail load-serving entities will have to buy certificates equal to their retail sales in the region. States that have an RPS or GPS will have to buy certificates to meet those obligations. Marketers will need to buy certificates to back up their claims. The "books" will be closed every quarter, and unclaimed certificates will revert to the ISO, and then be auctioned, so that participants can't hold back certificates and wait for better pricing at the end of a reporting system (or any other time).

This arrangement creates problems for wind because wind's production can be very uneven in the various regions. Typically, in the east, there are winter peaking periods followed by low wind summers. Underproduction during one quarter cannot be "made up" during another quarter under the NE ISO rules [NWCC 2001a, p. 25].

obtains power, it cannot be verified that the resource has not been sold twice (or more) [RADER 1998, p. 20].

In order to trace the trade of environmental attributes, "certificates of origin" that precede the creation of credits can identify and document attributes at birth (at time of generation), and then ownership of the resulting credit establishes ownership of the specific attributes contained in it. The individual attributes would have to be associated with a unique identifier, and all claims about attributes would have to be reported to a central registry or clearinghouse. Such a system, with national bodies responsible for certifying the origin of green certificates, will be established in Europe under the Renewable Energy Directive (see Chapter 3.3.1). The clearinghouse function would serve to establish that only one claim is being made about any one attribute (or group of attributes). In the case of RPS-based green tags (there called Renewable Energy Certificates, RECs), such clearinghouses track all trades of RPS-RECs by establishing accounts for each trading party and either debiting or crediting that account so that no RPS-REC is counted twice. This is happening in Texas and the Netherlands, where central authorities shift certificates from one account to the other. The same principle could work for trading of individual attributes, although it would be more complicated [NWCC 2001a, p. 20].

A tendency towards a national tracking system for TRCs can already be observed. For example, the US Center for Resource Solutions is calling for such a system, and the new Green-e certification rules already allow for green tag trade between the US, Canada and Mexico, but require a tracking system to verify green power production and sales. New England's NEPOOL started to build such a tracking scheme. Box 5.2 shows how the NEPOOL tracking system might be the prototype of a North American tracking system. It supports information disclosure, compliance with renewable portfolio standards and generation performance standards, as well as unbundled REC trading for green power products. Another tracking system organised by the US EPA tracks NOx allowances and might also be an example for, or have to interface with, a green tag tracking system (see Box 5.3). The Center for Resource Solutions has proposed the creation of an American Association of Issuing Bodies, similar to the system developing in Europe. The Association would create basic rules under which the Issuing Bodies (IBs) would function, for example labelling and information requirements needed for green certificates, which would incorporate European requirements in order to facilitate future transcontinental trade. Definitions of eligible power sources would be kept general and inclusive, and the tradability in certain areas would depend on local circumstances (e.g., RPS rules). For example, NEPOOL could become one such body, and the US Regional Transmission Organizations would be candidates, as they all have generation data available. Some IBs would be working under mandatory schemes (e.g., Texas ERCOT, which administers RECs trading under the RPS), while others could be voluntary green tag schemes. IBs would be responsible for all certificates in a given region and would communicate all trades to all other IBs so no double-sales could occur. At a stakeholder meeting in March 2002, strong support for such a system was given, and several regions currently without IBs

**Box 5.3 — The EPA NATS Database**

This database was originally created for the Acid Rain Program and was known as the Allowance Tracking System, or ATS. It has since been expanded to include nitrogen oxides (NOx) allowances issued under the Ozone Transport Commission (OTC) NOx Budget Program. For that program's use, it is called the NOx Allowance Tracking System, or NATS.

Functioning much like a bank, these systems are automated databases that track the allowances held by utilities, other affected companies, and other organizations or individuals. These allowances may be bought, sold, or transferred at any time. Specifically, they track the issuance of all allowances, holdings of allowances in accounts, holdings of allowances in various allowance reserves, such as the EPA Auction and Sale Reserve and the Conservation and Renewable Energy Reserve, the deduction of allowances for compliance purposes, and the transfer of allowances between accounts. Each allowance is a unique item identified by a serial number. The system is the official record of their creation, transfer and use for compliance purposes.

The ATS provides the allowance market with a record of who is holding allowances, the date of allowance transfers and the allowances transferred through a set of interactive reports that can be created online. The ATS does not, however, record the price or other terms associated with allowance trades. Although submitting allowance transfers to EPA is voluntary, EPA expects most transfers to be recorded in the ATS. [EPA 2002b] have indicated that they were contemplating its introduction, or had already issued RFPs for their realization [CRS 2002].

As certificates are market-based instruments, they will favour low-cost renewable power, which is currently wind, small hydro and landfill gas. Other technologies, such as energy crops or solar PV, have a disadvantage unless they are specifically supported by government aid. Price caps for certificates, as used in Australia, could intensify this effect. More expensive technologies will not easily penetrate markets through green tags unless policies require this to happen; for example, as RPS' specifying a certain percentage of solar energy, or as subsidies.

With respect to cross-border trades, national renewable portfolio standards may have differing specifications in regard to the eligibility of power sources (both source and location), limiting and complicating the trade of certificates, especially if disclosure rules do not provide enough detail to determine eligibility under different regulations. The absence of binding and uniform disclosure rules may also hamper green power sales in residential markets. The existence of several competing certification schemes, as is the case in the US and Germany, could add to this confusion.

Other problems that have been identified are that property rights about tags are unclear. Often, contracts between retailers and existing renewable power facilities have been concluded before green tags existed, and contracts therefore do not specify who owns the green assets of the electricity generated. Even when a green tag sale takes place it is not defined by law who owns the attributes. For example, a retail customer that buys green power normally never receives the actual green tag, but sometimes the attributes are retired by the retailer on the customer's behalf. As there are no national rules with respect to the life span of a green tag, a customer could re-sell certificates long after they were bought. To address this problem, many RPS regulations and also Green-e certification have set up rules that only allow for a life span of a year or less for green tags.

### *5.6.2 The Interface Between Green Tags and Emissions Credits*

As mentioned before, there are concerns about fraud or double-counting with green tags in the absence of a central tracking mechanism. As the splitting up of environmental attributes of green tags is being actively discussed, these issues are becoming more urgent. Moreover, no international rules with respect to the quantification of green tag-related $CO_2$ reductions have been defined so that their relationship with carbon trading and other emissions reduction markets is unclear. These issues require national and international cooperation. Table 5.3 identifies current green certificates, allowances and emissions reduction credits and proposes equivalencies of different schemes.

### *5.6.3 The Potential Role of Green Tags in Canada's GP Markets*

In Ontario and Alberta, green tags are already being used to sell green power. Vision Quest in Alberta, Green Tags Ontario, BC Hydro and some other market players have decoupled the environmental attributes of green power and sell them to customers that want to conveniently opt for green power without changing their current electricity providers. The remaining "null electricity" is sold as "brown power" at the current wholesale market price.

Green tags are favoured by many marketers because they reduce the administrative cost of green power sales, as opposed to the sales of both power and attributes to the same customers, and because they allow green power producers to reach areas with their green power products that could otherwise

**Table 5.3 — Assumed Equivalencies of Tradable Emission-Related Certificates**

| The following certificate | Is assumed equivalent to |
|---|---|
| **RPS-based Tradable Renewable Energy Certificates (RECs) —** Measured in MWh of electricity output. Represent all environmental benefits of renewable power production and are used for compliance with state Renewable Portfolio Standards (RPS). | **Green Tags** |
| **Green Tags —** Measured in MWh of electricity output. Represent all environmental benefits of renewable power production and are recombined with electricity to be sold as a bundled green power product. | The sum of:<br>Carbon offsets/verified emission reductions (VERs)<br>NOx emission reductions/allowances<br>$SO_2$ emission reductions<br>Mercury emission reductions<br>VOC emission reductions<br>Particulate matter emission reductions<br>CO emission reductions attributable to a given unit of renewable power production.<br>Note that energy production from nuclear fuel or natural gas can generate some of the above-mentioned emissions reductions, without being classified as a renewable power source. |
| **Emission Allowances —** So far, only $SO_2$ and NOx allowance trading exists in the US. | Emission allowances were originally designed for "closed market" trading among utilities and large industrial NOx sources. However, they can become equivalent to Green Tags if output-based and renewable power producers are allowed to participate in allowance trading through set-aside programs, which is taking place in several states already. |
| **Emission Allowances** | Can be equivalent to DERs — some State NOx Allowance Programs allow for the conversion of allowances to DERs. |
| **Discrete Emission Reduction (DER) credits —** Measured in tons; represents a project-based, one-off, retrospective, discrete emission reduction as opposed to a continuous (MWh-based) reduction. Same as SDR (Surplus Discrete Reductions) or | Elements of Green Tags can be equivalent to DERs if the emission reductions attributed to renewable power production are quantified in tons (e.g., verified $CO_2$ emissions reductions (VERs) from Canadian vendor VisionQuest). |

***Table 5.3 continued ...***

| The following certificate | Is assumed equivalent to |
|---|---|
| TER (Temporary Emission Reductions). So far, only NOx and VOC DERs have been traded. DERs can be generated by stationary, mobile, or area sources. DERs can be used to give “Reasonably Available Control Technology” sources and sources subject to New Source Review compliance flexibility and the opportunity to reduce compliance costs. Each use of DERs requires retirement of 10% of the credits. | |
| **Title 1 offsets and regulation-based Emission Reduction Credits (ERCs) —** ERCs are rate-based units (1 ERC= 1 ton/ year) representing continuous, permanent emission reductions. ERCs can be generated by stationary, mobile, or area (e.g., off-road equipment, consumer product) sources. They are “closed market” credits (i.e., restricted to certain polluters only), and are meant to allow for new sources to come on-line in non-attainment areas where national ambient air quality standards are not met. ERCs are created by changes in emission permits. A reduction of the maximum allowable amount of emissions in the permit, if lower than the legal maximum, creates ERCs — whether or not the facility emits less than before in reality. | No equivalent products. As the provisions relate to emission permits given to emitting sources only, renewable power producers are excluded from these markets. Renewable power sources that emit pollutants, such as from landfill gas or biomass combustion, may be subject to these programs and may have to purchase ERCs, rather than sell them. |

not be reached. Customers like them because they can financially express their preference for renewable power, independently of the preferences of their state government or utility. Finally, renewable power generators like green tags because they facilitate the sale of green energy from intermittent energy sources. Green tags do not require uninterrupted supply and thus allow generators to achieve higher premiums on the green value of renewable power than through bundled green power sales. In effect, green tags make renewable power more competitive and can accelerate the creation of new renewable power generation capacity. Government agencies can use green tags (RECs) in conjunction with an RPS to track green power sales and thus verify the fulfillment of RPS requirements. Also, if local renewable resource sites have been exhausted while local demand for renewable resources remains strong (either through mandated or voluntary programs, or private company efforts), certificates could satisfy the demand by supplying green power generated outside the jurisdiction. Green tags also reduce the overall compliance cost for retailers under such schemes as they can opt for the cheapest available green power sources instead of being restricted to their own service areas.

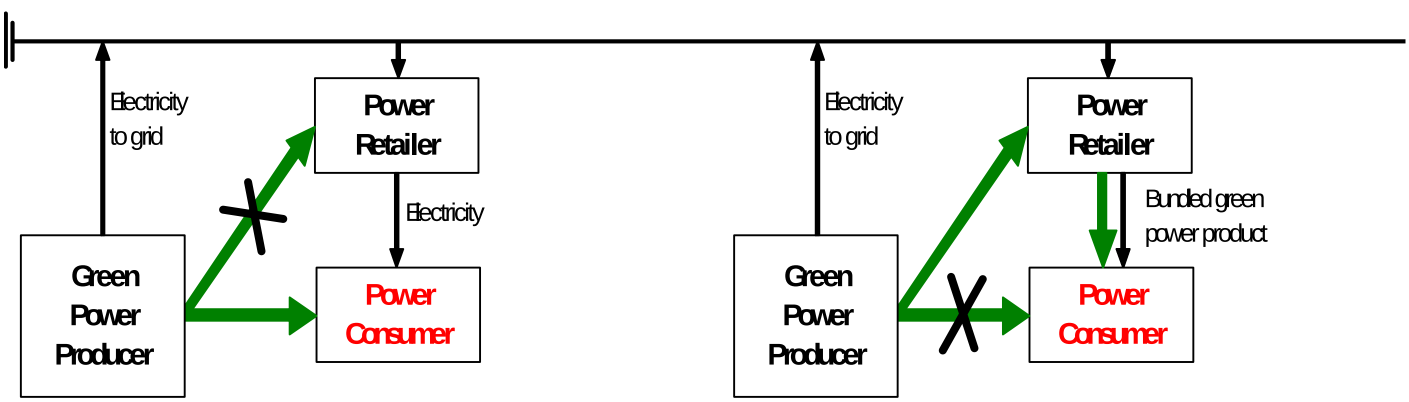
## 5.7 Double-Counting, Disaggregation of Green Attributes and Ownership

### *5.7.1 Green Tags for RPS, Green Power and Emissions Credit Trading*

Double-counting is one of the potential problems with green power products. This problem exists with all green power products, not just tags, and many of the observations and recommendations in this chapter can be applied to all such products. Figure 5.4 shows that it is not permitted to sell the same green electricity unit (a given amount of electricity produced from renewables, in MWh) to a consumer directly and once more to a retailer, who can retail it, together with electricity from the grid, as green power to another consumer. Throughout the following illustrations, the ultimate purchaser of green tags, or green power, is also considered to have acquired all of the green attributes of renewable electricity. In practice, emission reductions are often retired on behalf of the customers, rather than handed on via tradable certificates.

If more green power is produced than a retailer agreed to buy (in this case, to fulfill an RPS obligation), in the case of a wind farm, for example, because of stronger average winds in a given year, then the excess tags could be sold to other parties, as can be seen from Figure 5.5. Tags could be sold either directly to consumers or to other retailers.

Figure 5.6 shows two scenarios in which green benefits are sold as bundled green power products. Scenario C depicts the standard case, which will be encountered in regulated markets, with one monopoly power retailer per region. Scenario D shows the “California” situation, in which no premium had to be paid by green power customers. The fact that no premium was paid should not be interpreted to mean that the




***Scenario A:*** *Tags can be sold directly to a consumer, while the electricity is obtained from the default retailer (the ultimate owners of the green benefits are depicted in red)*

***Scenario B:*** *Tags can be sold as green power to a consumer via a retailer who rebundles the tags with null electricity from the grid.*

**Figure 5.4 — Green Tag Sales and Re-bundling of Attributes and Electricity**

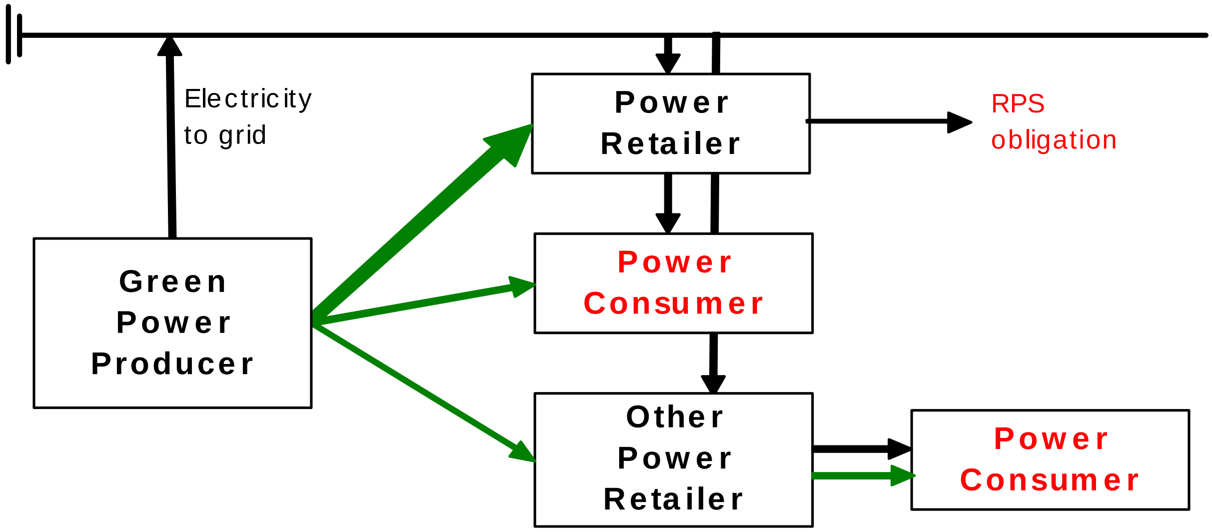
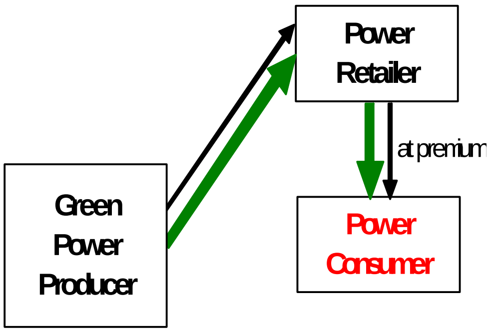



**Figure 5.5 — Sales of Excess Green Tags** (the ultimate owners of the green benefits are depicted in red

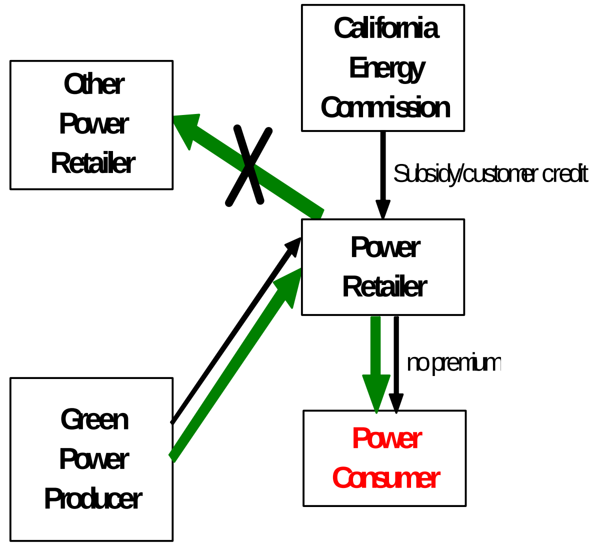
ownership of tags did not shift to the customers since the customer credit is the mechanism used to finance the premium, which would otherwise be paid by the customers opting for green power. The retailer should therefore not be allowed to sell the green benefits separately to another party.

Apart from green power and RPS certificate trading, there is another option to obtain value for the green benefits of renewable power — the sale of disaggregated environmental attributes as emissions reduction credits. The green attributes of electricity made from renewables comprise environmental (e.g., avoided emissions, reduced consumption of depletable resources) and social (e.g., employment, real estate prices, psychological benefits) benefits. As separate markets for emissions reductions are emerging in the United States, especially in the framework of the Four Pollutant Bill, renewable power producers are lobbying to be allocated allowances, or reduction credits, for emissions avoided through their activities [NWCC 2001b]. These developments could trigger the separate sale of environmental attributes, as opposed to the current practice of selling all attributes together in a green tag or as green power. Figure 5.7 shows how the green benefits may be disaggregated into different categories, such as nitrogen oxide emission reductions and avoided carbon dioxide emissions.

The separate marketing of green benefits has already begun. For example, when Timberland purchased green tags through Native Energy for its US retail stores, its main interest was to become a $CO_2$ neutral business [NE 2002]. Native Energy offers the tags based on avoided $CO_2$ emissions, based on the regional power mix. The company has recently teamed up with Green Mountain Power to offer $CO_2$ emission reductions to homes and businesses in Green Mountain's service area [SA 2002]. A case of disaggregation of green tags also took place in 2001 when the Bonneville Environmental Foundation (BEF) bought green tags, the carbon offset element of which was transferred to The Climate Trust for permanent retirement, as mentioned in Chapter 5.5. In this case, BEF also retired the other environmental




***Scenario C:*** *In the case of bundled green power sales, both electricity and green attributes are sold to a retailer, who can sell these at a premium to power consumers. This case will also apply in regulated markets, in which independent power producers can only sell to one electricity retailer. (the ultimate owners of the green benefits are depicted in red)*




***Scenario D:*** *In California, the customer credit has made it possible to sell green power at a discount compared to generic power products. However, the fact that no premium was charged does not mean that the green attributes were not sold to the consumers, since the credit is only paid to consumers opting for green power; in essence, financing the premium otherwise to be paid.*

**Figure 5.6 — Bundled Green Power Sales and Change of Ownership of Environmental Attributes**

benefits, but a separate sale of each benefit would be possible if markets for different pollutants existed. Alberta-based Vision Quest offers green tags and certified $CO_2$ emission reductions, with both based on its wind power generation activities. All of its tags are certified for the $CO_2$ emission reductions benefits that are included in the aggregated environmental benefits.
The question is, what “green benefits” would a green tag or green power customer be purchasing if several reduction credits have already been sold off? Many residential customers would have problems grasping the concept of disaggregated green benefits, which may hamper the sales of green attributes if environmental organizations and others criticize such a practice when the information provided to consumers is insufficient or misleading. In addition, if renewable power producers are fully included in emissions reduction markets, double sales of some of the green benefits might occur if emissions reduction trades are added to the current sales structures, which pre-suppose aggregated benefits.

Figure 5.8 suggests that a clear line must be drawn between consumer markets and industrial emissions credit markets. In order to avoid the confusion of residential consumers by complicated concepts linked to the disaggregation of green benefits, green power producers should be obliged to decide

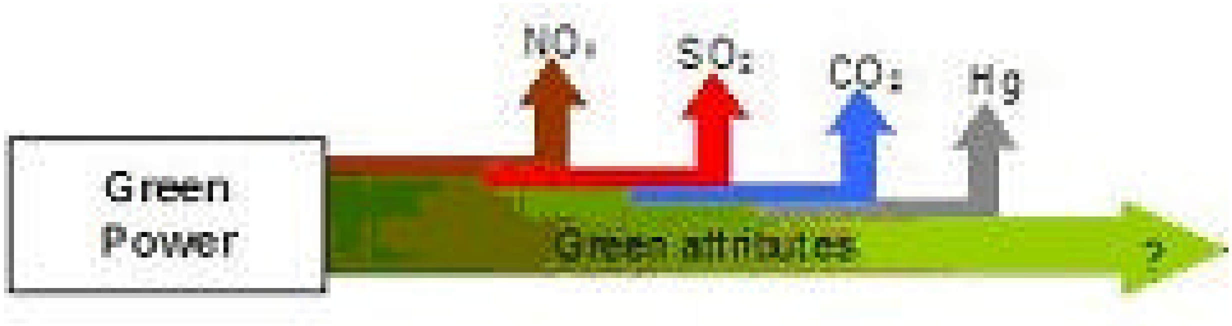



**Figure 5.7 — Disaggregation of Environmental Attributes of Green Power**

to sell the benefits linked to a given MWh amount of electricity produced either fully aggregated to consumer markets or disaggregated into industrial emissions credit markets. This means that if even one emissions credit is taken from the green benefits, then the green tags cannot be sold as green power into retail markets. Depending on whether or not markets exist for other emissions credits, the remaining tradable green benefits can also be sold into industrial markets.

As green tags cannot be used for both credit trading and green power sales at the same time, they cannot be used for either of these purposes and, at the same time, for RPS compliance. In theory, an RPS could allow the sale of either green power or emissions credits on all obligatory units of generation, leaving each retailer three options to recover the extra cost for buying the (usually more expensive) renewable electricity: the retailer could (a) average this extra cost over the customer base and charge all customers a

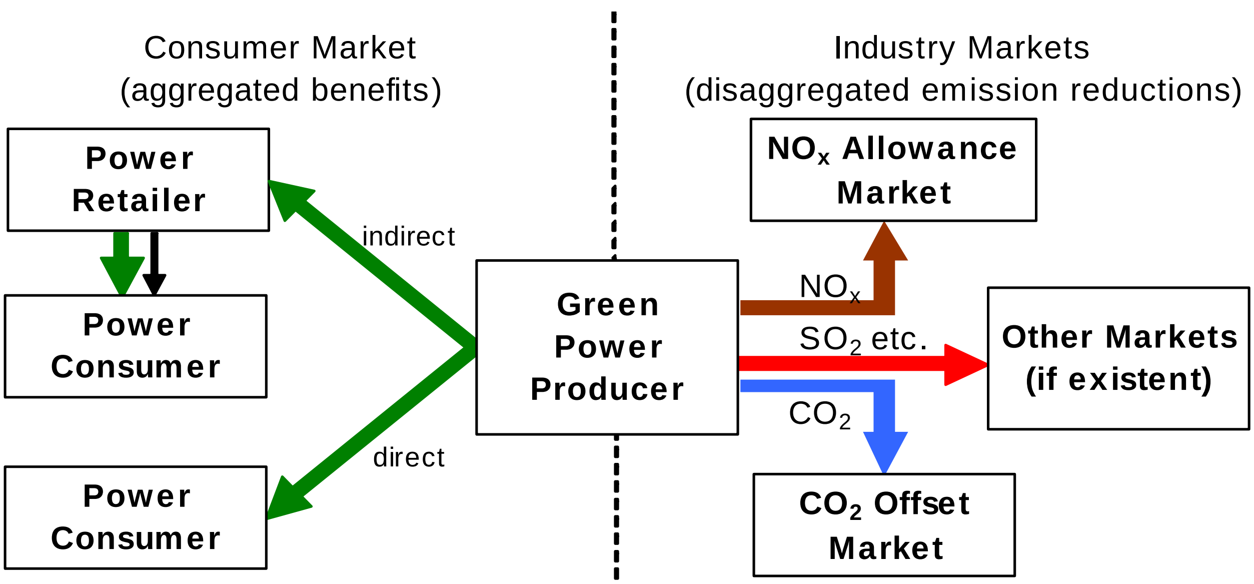
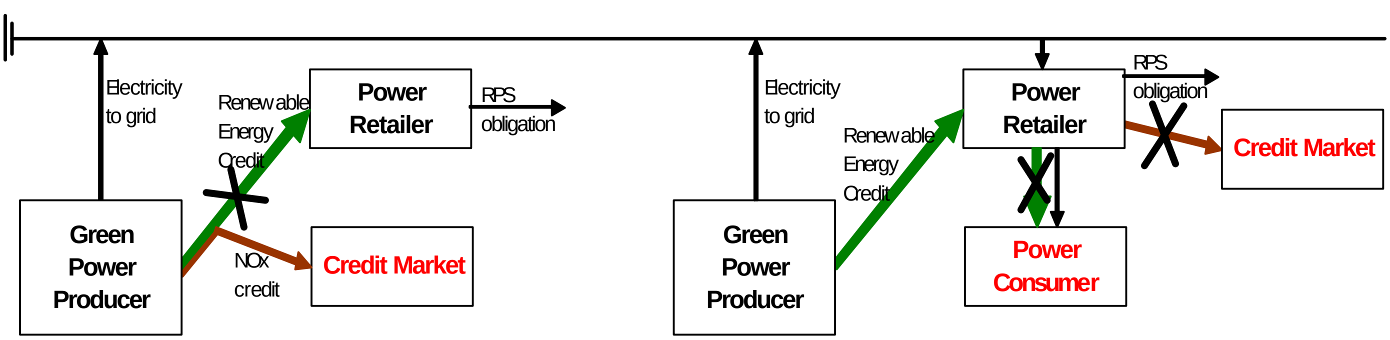



**Figure 5.8 — Aggregated and Disaggregated Sales of Green Benefits**

marginal extra amount, (b) sell the amount of green power purchased or self-generated to selected customers at a premium as "green power," or (c) sell the emissions reduction credits linked to renewable power production into emissions credit markets. RPS design ultimately decides this question: it could simply impose a renewable electricity quota on the retailers' overall portfolios, leaving it up to them which option they use to recover their extra expense to fulfill this requirement, but generally governments link the green benefits to RPS compliance, excluding their use for other purposes.

Governments that have so far introduced an RPS found that because an RPS already obliges retailers to buy a certain amount of green power, customers should not be offered this same generation as green power, suggesting that they would want to buy green power in addition to the legally required amount. This leaves retailers only option (a) to recover their cost, and green power marketing is seen as completely separate from the RPS system, and indeed intended to be additional to it. The institution most advanced in developing such concepts is the Center for Resource Solutions, which issues the American Green-e logo. The Center recommends the separation of green power sales from RPS certificates, but concedes that the issue "warrants further study by stakeholders" [CRS 2001, p. 18]. The Texas Utility Commission, which created the REC-based Texas RPS, only accepts the full set of environmental benefits for RPS defining RECs as a "tradable instrument that represents all of the renewable attributes associated with one MWh of production from a certified renewable generator" [NWCC 2001a, p. 50]. As these certificates are retired together with all their environmental benefits at the time compliance is assured, none of the benefits can be sold into other markets (see Figure 5.9). Only surplus RECs that are not needed to fulfill the quota could be sold as green power or disaggregated and sold into credit markets.

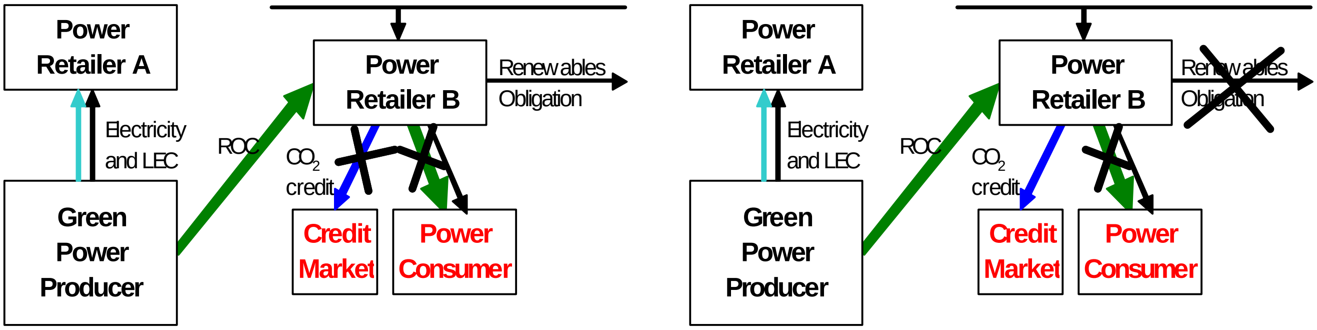
The same principle is applied in the British New Renewables Obligation. Renewable Obligation Certificates (ROCs) can be converted into carbon credits, but then cannot be used to fulfill the Renewables Obligation (see Figure 5.10). Once ROCs are retired as they are used to fulfill the Obligation, they can no longer be used for trading of environmental attributes. ROCs




***Scenario E:*** *A green power producer may not sell off single benefits of a green tag and still sell it as a renewable energy certificate to be used by a retailer to fulfill an RPS obligation.*

***Scenario F:*** *Renewable energy certificates need to be retired in quantities required under the RPS each year. This means they cannot be traded in credit markets or sold as re-bundled green power.*

**Figure 5.9 — Exclusion of Disaggregation of Green Attributes under the Texas RPS**




***UK:** A retailer that buys ROCs to fulfill the Renewables Obligation cannot sell green power into residential markets or sell green attributes separately.*

***UK:** ROC owners can turn ROCs into carbon credits, voiding their value for the Obligation. LECs and ROCs can be obtained through green power sales to industrial customers. LECs are not seen as representing actual carbon credits.*

**Figure 5.10 — Renewables Obligations and Certificate Trading in Texas and the UK**

are not seen as what the European Renewables Directive calls "Certificates of Origin," which would be equivalent to a green tag. So ROC purchasers are not entitled to sell green power into residential markets based on ROCs, but are supposed to

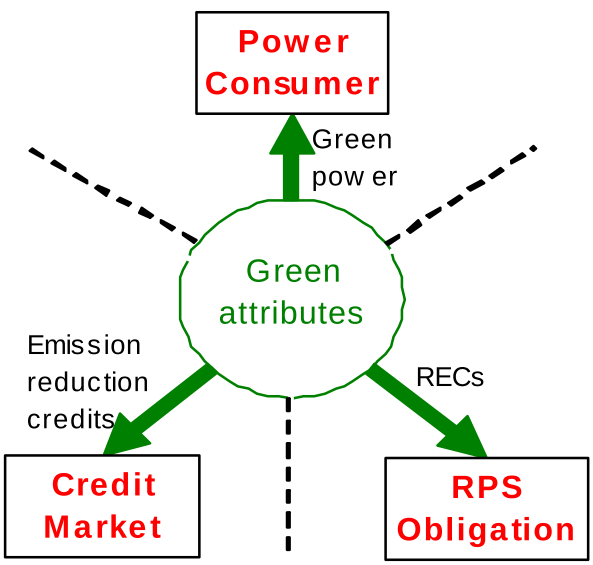



**Figure 5.11 — Alternative Options for Selling the Attributes of Renewable Power Production under an RPS Obligation**

recover their cost by adding an average charge to all their customers arising from the Obligation. Britain grants climate change levy exemptions to industrial renewable power users, based on Levy Exemption Certificates (LECs), but issues carbon credits based on ROCs, not LECs. Residential green power sales have to be bundled sales independent of, and in addition to, the ROC scheme — whereas green power sales to industrial customers allow for both ROCs and LECs creation [DTI 2002c]. In Australia, green power sales are also not allowed under the federal RPS. Similar to the UK's ROCs, Australian RECs have to be used either to fulfill the RPS obligation or to sell green power. No policy has yet been established in Australia on the splitting off of $CO_2$ and other emissions credits.

Figure 5.11 shows that under an RPS obligation as currently enacted in Australia, the UK and Texas, all three options to sell environmental attributes are mutually exclusive. In North America, a sale as green power provides the highest income for renewable power producers, followed by RECs trading (about 0.7¢ CDN/kWh in Texas), and then emissions trading.

Experience throughout the United States and Europe shows it can be difficult to find enough retail customers ready to pay a premium for green power. If a renewable power facility is only be able to sell part of its production under a green pricing or green marketing program, then the separate sale of green attributes into credit markets would provide an alternative source of income covering the share of production for which no green premium can be obtained in retail markets. If renewable power needs to rely on this income to compete with conventional electricity, then credit trading programs should cover as many types of emissions as possible, and each should allocate the an adequate amount of allowances to renewable power facilities in order to maximize this income. However, the separate trading of multiple environmental benefits may also put a new burden on the shoulders of renewable power generators and/or retailers — the administrative cost of trading. The more types of credits traded, the more transactions that need to be made as compared to the sale of all green attributes together. As the know-how about credit markets may be limited with many smaller renewable power providers, they may have to rely on brokers or associations for their credit trading. Brokering cost can reduce the income from credit trading by up to 15% [IOU 2002]. Thus, Canadian credit markets should be as stable as possible in order to increase investor confidence.

### *5.7.2 Ownership of Environmental Attributes and Certificate Tracking*

As the ownership of environmental attributes is passed on to customers, the customers could, in turn, offer them back to emissions trading markets. However, once this happens, the customers also lose all claims to have received renewable power. For example, a retail chain buying green tags and telling customers that they conduct all of their business using renewable power would make a false claim if the customers did not retain and retire the tags they bought. This situation is generally avoided by not passing on the actual emissions reduction benefits to the customer, but instead retiring them on the customer's behalf. The above-mentioned renewable power retailer, Native Energy, works according to this scheme, and all green benefits are donated to an environmental organization, Clean Air — Cool Planet, that retires all certificates purchased by Native Energy customers.

In the US, issues concerning ownership of attributes are still being debated. The California-based Center for Resource Solutions (Green-e) has carried out a significant amount of consultation and analysis on the issue of ownership in the context of its certification of green tags (called TRCs, Tradable Renewable Certificates). In its Final Recommendations, it takes the position that "the purchase of TRCs assumes the transfer to the final consumer of the renewable power including all of its attributes unless otherwise noted by contract." It also recommends that attributes remain bundled for all sales of green energy products to the consumer market [CRS 2001, p. 25f.]. In Canada, the Discussion Draft ECP-79 of a new Guideline on Renewable Low-Impact Electricity omits a clause contained in a previous version, which required ownership of environmental attributes to pass to the retailer or user, and replaced it by a declaration of intent to monitor developments about this issue [ECP-79, p. 9]. This was criticized by a number of parties during the public review period, arguing that a certified green power product would not be worth the money paid for it without passing on the ownership of its greenness [ECP 2002, pp. 11ff.]. TerraChoice's Green Leaf™ Tradeable Renewable Certificate Program Standard, however, stipulates that the environmental attributes of green tags are passed on to the end user [TCES 2002, p. 8]. Ontario's emissions trading regulations do not address the possible double sale of attributes as allowances and green power, but Ontario Power Generation sees these options as mutually exclusive [OPG 2002b].

Figure 5.12 shows how an electronic platform for green tags trading might work in Canada. Each unit of production could be traded in 1 MWh increments, representing one certificate. Each certificate would have several dimensions (attributes). Trades could either happen with whole certificates or with the single attributes, as markets for them exist.

The system could be designed to be open to imports and exports of certificates between provinces, but also internationally. Eligibility criteria for international tags could, for example, be defined requiring power generation in an airshed affecting Canada in order to exclude the arbitrary use of foreign tags for compliance with RPS requirements in Canada.

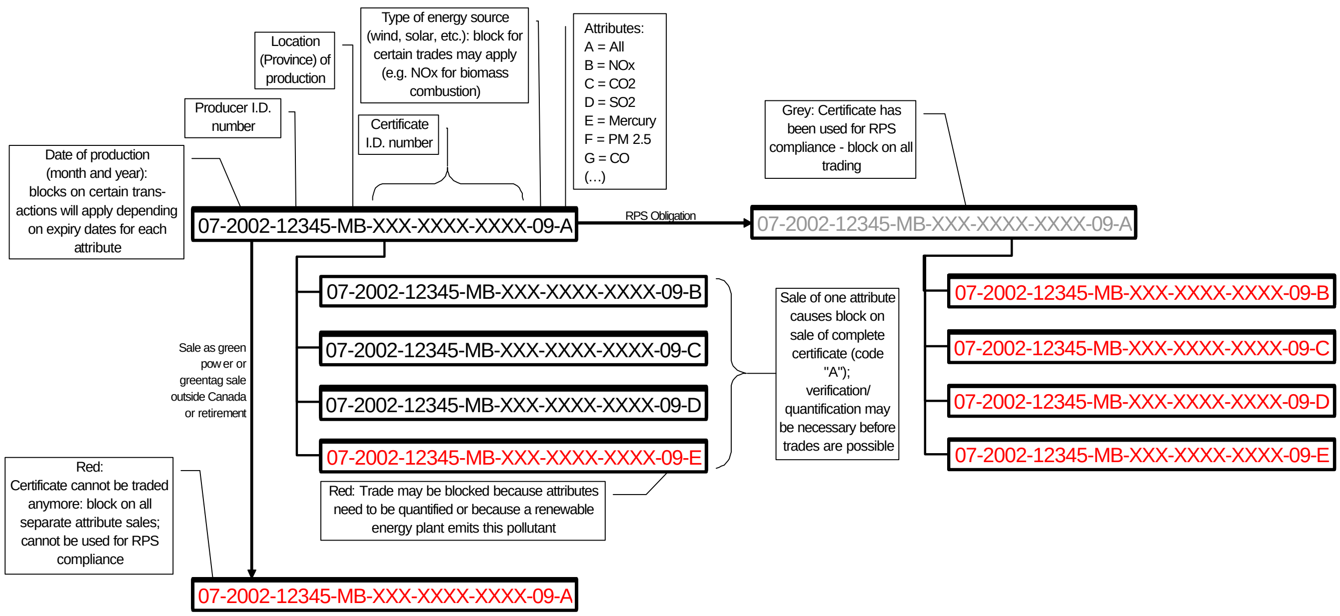



**Figure 5.12 — Proposal for a Certificate Numbering System and Electronic Trading**

Notes:

- By convention, a certificate can represent a unit of production, normally 1 MWh. A certificate is created when a third party takes meter readings.
- Whole certificates and single attributes may have different expiry dates, depending on the rules for each market.
- An electronic platform could integrate trades for RPS compliance, allowance trading, and trades in voluntary markets. It can link up with similar databases in Canada and the US.
- Some environmental attributes can be quantified through rulemaking (e.g., per definition 1 MWh could correspond to 1.5 lb of NOx emissions). Other attributes, especially $CO_2$, may have to be quantified by a third party before they can be traded.
- An international sale of whole certificates would mean a retirement of the attributes for the Canadian system.
- The sale of a green tag with null electricity as bundled green power always means the retirement of the whole certificate.
- Use of a certificate for RPS compliance means the retirement of the whole certificate. If single attributes of the tag, or the whole tag, have been sold into another market the certificate cannot be used for RPS compliance.
- The trading platform could, but does not have to, be set up to cover actual financial transactions. Alternatively, certificate producers would prompt the platform administrator to transfer certificates to another account once they have received payment from a bilateral transaction.

# 6. Budget Considerations

## 6.1 Extending the Wind Power Production Incentive (WPPI)

One of the measures considered in this report is to increase the WPPI to 2.8 ¢/kWh, and to extend it to all renewable power sources in need of support. Currently, the government only provides the Wind Power Production Incentive, with a budget of $260 million over 15 years, or $156 million net, assuming a 40% corporate income tax rate (to compare, the US tax revenue loss due to the Production Tax Credit was US$100 million for fiscal year 2001 [CRS 2001b]). According to Table 4.23, between 1.7 and 7.0 TWh a year of renewable electricity generation would be added to Canada's portfolio under the proposed RPS. Table 6.1 shows the annually added power generation and the annual expenses of a production incentive of 2.8¢/kWh covering the entire range of eligible renewable power sources. Such an incentive would exceed the $1 billion mark after ten years, taking inflation into account — a budget similar to Canadian spending on energy efficiency in the 1990s (see Figure 4.9). Given that Canada consumes about 600 TWh of electricity per year, an SBC of 0.1¢/kWh would produce an annual budget of $600 million — enough to finance the proposed production incentive without putting too large a burden on Canadian consumers. Phasing out the incentives over time or reducing the support for technologies, such as onshore wind, as they become able to compete in the market by themselves are options to reduce the budget necessary to support renewables.

**Table 6.1 — Annual Budget Required for an Extended Power Production Incentive**

| Year | Added Generation | Cumulated New Generation at End of Year | Annual Budget in Million $* |
|---|---|---|---|
| 2004 | 1.75 TWh | 1.75 TWh | 24.5 |
| 2005 | 3.5 TWh | 5.2 TWh | 98.0 |
| 2006 | 3.5 TWh | 8.7 TWh | 195 |
| 2007 | 3.5 TWh | 12.2 TWh | 293 |
| 2008 | 3.5 TWh | 15.7 TWh | 391 |
| 2009 | 3.5 TWh | 19.2 TWh | 489 |
| 2010 | 3.5 TWh | 22.7 TWh | 587 |
| 2011 | 7.0 TWh | 29.7 TWh | 734 |
| 2012 | 7.0 TWh | 36.7 TWh | 930 |
| 2013 | 7.0 TWh | 43.7 TWh | 1,126 |
| 2014 | 7.0 TWh | 50.7 TWh | 1,273 |

* assuming that projects are started up through-out the year, thus applying half the added generation for that year to the required budget

## 6.2 Other Government-Funded Support Measures

R&D support should be given in similar amounts as is happening in other countries. The United States provides an annual research budget of US$420 million for renewables. The U.K.'s annual R&D budget is about C$50 million a year, and Germany's about C$90 million (see Table 4.11). Based on population, Canada should strive to have a budget of between $25 and 40 million a year for renewable power technologies to match the countries leading the renewable power field. Chapters 4.5.2 and 4.7.2 also consider fiscal changes, such as the inclusion of capital investments in the Canadian Renewable Conservation Expense. As it is reasonable to assume that no significant investments would take place without an incentive, the incentive should not be viewed as a tax loss; rather, it will yield tax income in the long run, after the incentive runs out.

# 7. Greenhouse Gas Reduction Relevance of Proposals Made

Table 7.1 shows how the Renewable Portfolio Standard discussed in this study could contribute to Canada's national GHG reduction goals. Based on Table 4.17, the baseline scenario assumes that new generation will be added with a share of about 50% for natural gas, one-third for large hydro and 10% for coal-based technology. Taking into account that the Wind Power Production Incentive is supposed to bring 1,000 MW of wind power generation on-line over the coming 5 years, and assuming that twice this capacity of new non-large hydro renewables will be added due to voluntary initiatives, such as Hydro Québec's 1,200 MW program, and green power programs, it is assumed that 3,000 MW of new renewables are added to the grid by 2010 under the base scenario, and another 4,000 MW by 2020. For the RPS scenario, the renewables shares given in Table 4.23 were used. For both scenarios, they are assumed to displace all conventional projects equally, weighted according to their share of added generation in Table 4.17. For more data and assumptions used for this table, see Appendix G.

Whereas total $CO_2$ emissions under the RPS scenario would still increase due to growing electricity demand and the fact that more than half of newly added capacities will be natural gas-based, the accelerated growth of non-large hydro renewables can reduce the

**Table 7.1 — Expected Reduction in $CO_2$ Emissions from the Implementation of the Proposed RPS**

| **Year** | | | **2000** | **2010** | **2020** |
|---|---|---|---|---|---|
| Projected Electricity Demand [TWh] | | | 600 | 705 | 820 |
| **Base Scenario** | Electricity background mix [%] | Hydro | 61 | 56.7 | 53 |
| | | Coal | 17 | 16 | 15 |
| | | Oil | 7 | 6 | 5 |
| | | Natural Gas | 3.6 | 10.5 | 16 |
| | | Nuclear | 10 | 8.5 | 7.3 |
| | | Renewables | 1.4 | 2.4 | 3.7 |
| | Electricity Sector $CO_2$ emissions | | 145 Mt | 178 Mt | 212 Mt |
| **RPS Scenario** | Electricity background mix [%] | Hydro | 61 | 55.6 | 49.6 |
| | | Coal | 17 | 15.6 | 14 |
| | | Oil | 7 | 6 | 5 |
| | | Natural Gas | 3.6 | 8.9 | 10.8 |
| | | Nuclear | 10 | 8.5 | 7.3 |
| | | Renewables | 1.4 | 5.8 | 13.5 |
| | Electricity Sector $CO_2$ emissions | | 145 Mt | 171 Mt | 187 Mt |
| **$CO_2$ Emission Reduction** | | | **0 Mt** | **7 Mt** | **25 Mt** |

increase by 20% until 2010 and by 37% until 2020. Canada has made a commitment to reduce its greenhouse gas (GHG) emissions by 6% compared to 1990 levels by 2012. As emissions have increased since the baseline year, this has been estimated to require a reduction of 240 Mt [WWF 2002]. By 1999, the electricity sector had increased its $CO_2$ emissions by 24% above 1990 levels [EC 2002], and Table 7.1 shows that this trend will continue. Although the results given above should only be taken as a rough estimate, they clearly show that a growing share of renewables can substantially reduce the growth in Canada's $CO_2$ emissions.

# 8. Conclusions, Observations and Recommendations

## 8.1 Conclusions

The following conclusions have been reached based on the research conducted for this report:

With respect to renewable power this report asserts that:

- The environmental benefits of energy generation from renewables compared to fossil-fuel based generation are large, but uncertainty exists about the ecological effects of some emerging renewable technologies.
- Europe is leading the renewable power field, both technologically and with respect to installed generation capacity.
- Renewables currently play a small role in Canada's plans for generation capacity expansion and the replacement of obsolete power plants.
- Canada's renewable resources are not evenly distributed across the country, but the highest potentials appear to exist in coastal Provinces, with ocean-based resources leading the field, followed by wind and small hydro.
- Many renewable resources can be tapped at generation prices approximately 2–3¢/kWh more than combined-cycle gas power.
- Renewable power technologies tend to have stable operating costs relative to fluctuating fossil fuel prices; if renewables enter electricity markets in substantial quantities, they might form an effective hedge against unstable and increasing electricity prices due to changing demand patterns and international developments.

Green power was found to:

- Capture a small niche market among green buyers (around 1% of the customer base in most countries, but 13% in the Netherlands where ecological tax reform is the main driver).
- Have difficulties penetrating the market due to a low awareness level among customers.
- Have high marketing costs, resulting in small financial benefits for renewable power producers.
- Be most successful when green power is offered at a discount to conventional energy sources, whereas market penetration is low if customers have to pay a premium (i.e., the market beyond motivated green buyers is price-driven).
- Have most potential among large industrial and commercial consumers due to their higher energy use and smaller marketing costs.
- Have a low penetration rate, or even to collapse, if the default service price was set too low at the outset of deregulated markets, or if rising wholesale prices reduced the margins companies could obtain from mixed green power products.
- Have little effect on customer education when offered at a discount as many consumers simply chose the cheaper product without making conscious decisions to help improve the environment.

With respect to policies used by the countries examined to foster green power generation, the following was observed:

- Tendering schemes resulted in small increases in renewable power generation capacity, but the cost of renewable power generation was considerably lower than feed-in tariffs.

- Feed-in tariffs were most successful in deploying new renewable generation capacity, but were more costly to utilities and, consequently, to power consumers.

- Countries most supportive of renewable power reaped the largest benefits from it in terms of manufacturing capacities for renewable power technologies, resulting in high export activity and employment.

- Single policies were not effective by themselves. Successful policies were used in concert with other measures in favour of renewables, such as low-interest loans, clear and fair rules for grid access, and priority transmission access.

- Net metering had limited success, by itself, in increasing investment in distributed renewable power generation in amounts that would significantly change the generation portfolio of a jurisdiction. Buy-down programs in combination with high electricity retail prices improved success rates of net metering programs.

- Renewable portfolio standards (RPS) have only started to be used in recent years, but seem to have become the policy of choice both in Europe and in North America. Initial experience with Texas' RPS indicates that an RPS is able to combine the advantages of deploying new renewable generation effectively and rapidly, while at the same time providing market incentives to reduce the overall cost. The reduced price for natural gas due to reduced demand because of the RPS can offset the extra cost incurred by adding non-large hydro renewables to the national generation mix.

- It is very important that government policies and measures are stable and foreseeable. The risks for investors investing in renewable power technologies will be sufficiently reduced to create flourishing markets only when long-term strategies are used. This conclusion concerns every aspect of policy, including tax exemptions, subsidies, R&D support, and the duration of contracts granted to renewable power producers. A ten-year time horizon seems necessary to make renewable power markets attractive.

- Mapping and assessing renewable resources is as important as giving policy support. Without knowing how many resources a country has and where they are, both policy makers and investors are limited in the action they can take. Mapping will also assist municipalities and provinces to set aside areas for renewable power development and to accelerate permitting procedures.

- An RPS creates long-term financial stability for renewable power generators and provides independence from temporary support measures, such as tax credits or production incentives, that may be needed initially to support the renewables sector.

- A 15% share of intermittent power sources in the overall generation portfolio was considered to be possible without special measures concerning back-up power or storage in the Netherlands. Larger amounts of intermittent power sources would require such measures to maintain continuous and secure power supply.

- Grid expansion and strengthening are necessary to support the rapid deployment of renewable power, as existing structures are often not capable of accommodating new generation from locations that were not foreseen in planning based on conventional energy sources (e.g., Texas, Portugal). Government support may be necessary to alleviate the cost of grid improvements.

With respect to financial incentives, it was found that:

- Emissions credit/allowance/offset trading
  - currently only provides marginal income to green power providers as these markets are at an early stage of development; and,
  - may provide important incentives if multiple emissions credits can be traded *and* if $CO_2$ offset prices increase substantially.

- Past government subsidies for the energy sector concentrated on conventional technologies; however, the support for renewable power in Canada was larger in the 1980's (in the aftermath of the oil crisis) than it is now.

- Moderate tax incentives, such as including capital investments in accelerated depreciation schemes, can make many renewable power projects cheap enough to compete with natural gas as a power source.

- Income tax exemptions on gains from renewables can lead to citizens investing in renewable power projects, which can in turn improve local acceptance (e.g., Denmark).

- Ecological tax reform that increases the tax load on fossil fuel-based energy sources and that exempts and supports the renewables sector, could create a stable and flourishing market for green power (e.g., the Netherlands).

- Incentives given to a renewable power project must continue over long periods of time (i.e., ten years or more) in order to create continuing support and financial security.

- Government support for renewable power investments (e.g., grants, low-interest loans, tax exemptions or accelerated depreciation) is especially important to lower the financial risks related to this new technology sector, as investors are generally not familiar with renewable power technologies, their financial performance and their reliability.

- Generous support for the renewable power business will increase internal rates of return, attracting a variety of private investors.

- System benefits charges are being used by several jurisdictions to raise important amounts of money needed to support the renewables sector, similar to levels of funding used in the most successful countries (e.g., one billion dollars in California over five years).

Green tags, or the separation of environmental and social attributes from the electricity produced by renewable power sources, are already a reality in Canada (Ontario, Alberta, British Columbia). They provide the benefit of reaching customers without direct access to bundled green power products, and are also used as administrative and market tools in the implementation of RPS requirements. Some concerns exist about potential double sales of either the aggregated green attributes of green power production, or of disaggregated benefits, such as carbon or other emissions credits based on the same unit of production. A centralized tracking system based on green tags could reduce these concerns greatly and is necessary when an RPS with RECs trading is introduced. As of today, there are no laws in any country with respect to ownership of the green attributes represented by green power production, and contractual agreements are the only means to define it. Current practice is to separate markets for green benefits from renewable power generation. Emissions trading, green power sales and RECs trading towards RPS obligations are options to obtain extra revenue from the greenness of renewable power. However, they must be seen as mutually exclusive ways to market green attributes, as their combination would result in double or triple counting if based on the same unit of production.

## 8.2 Observations

This report has documented efforts made in other countries to promote green power. It has drawn conclusions based on the experiences of these countries and has given comparative information and analysis on the situation in Canada. This section contains observations on what Pollution Probe believes could be achieved in Canada, given the international learning curve that has developed so far. The following observations and comments reflect Pollution Probe's opinions on directions Canada could take:

1. Green power marketing initiatives around the world have had limited impacts, in and of themselves, on increasing the market share of renewable electricity.

2. There are, however, small but viable niche markets for consumers, and Canada should support its own green consumer market. Convincing consumers to buy green power requires significant marketing efforts and usually also requires incentives.

3. Jurisdictions that have had the most success with increasing the share of green power in their power generation portfolios have put in place significant financial incentives to achieve these market shares. Incentives must be sustained over considerable periods of time in order to develop and hold renewable electricity markets. Incentives should be large enough to be meaningful and should have a sufficiently long time horizon to allow renewable power technologies to enter the market and expand their market share, in order to help them reduce electricity generation costs over time.

4. Canada has considerable green power generation potential in a number of areas. Since conventional energy sources are relatively cheap in Canada, compared to most developed countries, it will take relatively large technology development incentives to develop these energy resources in the short term. However, the longer-term economic benefits of developing these resources for the future can be significant and could be a source of economic advantage in a Kyoto and post-Kyoto world. Policies that foster responsible development of these resources should be an immediate priority for Canada.

5. Due to the improvement of non-large hydro renewable power technologies over the past decades and the resulting cost reductions, Canada is in a situation in which it can implement renewable power generation quickly and at a reasonable cost. There are still good opportunities to catch up with international developments in some areas of the green power sector.

6. Research and development spending by Canada in the green power sector is among the lowest of the industrialized countries. The Canadian Wind Power Production Incentive (WPPI) is unlikely to provide a large enough incentive to deploy wind power capacities similar to those installed in the most successful countries. The WPPI amounts to only 25% of the US incentive, after tax. An incentive at least equivalent to the US incentive will be needed if Canada hopes to remain competitive.

Pollution Probe believes that Canada should have a national goal for renewable power that is built upon and supports provincial-based renewable portfolio standards. A national goal of an additional 3-6% of power generation from renewables by 2010, and 13–16% by 2020, is readily achievable in Pollution Probe's opinion, assuming the existence of meaningful incentives that encourage the development and use of emerging technologies. This will require a concerted, cooperative effort by all levels of government and all regions of Canada.

## 8.3 Recommendations

The following recommendations are grouped in sections. They target different federal ministries, provinces and territories, as well as municipalities and utilities.

### Financial Incentives

1. The federal government should expand the Wind Power Production Incentive so that it matches the amount of subsidy paid in the United States, and apply it to all low-impact renewable sources of energy.

2. The federal government should inaugurate a 5-year program providing grants and/or low-interest loans to emerging renewable power projects, such as wave and tidal power and offshore wind, to reduce their initial investment costs and help them penetrate the market.

3. The federal government should reform its tax regime to support low-impact renewable energy projects that have high capital investments (compared to conventional energy projects with lower capital costs, such as many fossil fuel-based power generation projects). Extending the Canadian Renewable Conservation Expense with flow-through shares to all emerging technologies (including emerging ocean-based technologies) and to all capital investment costs would be one way to do this.

4. In order to attract private investment, gains from renewable power projects should be made tax exempt for a period of ten years, and investments should be tax deductible, not only for companies, but also for private individuals. This will create conditions under which co-operatives can thrive and will enhance both local acceptance and financial involvement in renewable power projects.

5. All financial aid should be long-term and the rules must be transparent in order to have a stabilizing effect on the market for renewable technology. A ten-year time horizon is recommended, during which a gradual reduction or phase-out of aid may occur. Short-term phase-ins and phase-outs of financial aid provisions should be avoided as they can be detrimental to the market.

### National/Provincial Renewable Portfolio Standard

6. The federal government should work cooperatively with other levels of government to set a national renewable power generation target.

7. Provinces and territories should define appropriate regional Renewable Portfolio Standards (RPS). For all of Canada, an RPS should start with a requirement for an additional 0.5% of renewable electricity generation in the first years, increasing by 1% per year from 2010 onwards. This would augment the renewables share in Canada's electricity generation portfolio from 2.8% in 2002 to at least 6.8% by 2010 and to 16.5% or greater by 2020.

8. Provincial RPS' should include a nationally coherent green power certificate trading scheme in order to reach the set portfolio goal at the lowest cost, and should interface with similar markets in the United States.

9. To the extent possible, the same RPS should be applied to each province. With international certificate trading, utilities and Independent Power Providers can trade certificates among each other without having to develop all required renewables inside their own service area or province.

### Planning and Cooperation

10. In order to achieve the national RPS goal, close cooperation among provinces, territories and municipalities will be necessary. Provincial planning authorities should be engaged in mapping of renewable energy resources and the identification of potential sites for renewable power generation (especially for wind power) in order to create local support for renewables and to facilitate and accelerate permitting procedures.

11. Utilities and grid operators must participate in long-term planning and the identification of suitable sites for renewable power generation, as grid capacity can be a limiting factor for the expansion of renewable power. Government aid should be provided, where necessary, to increase grid capacities quickly to allow for the deployment of new renewable energy sources.

12. A preliminary assessment of Canada's renewable power potential has been attempted in the present study. Knowing the location and quantity of these resources is imperative both to foster private investment and to make informed policy decisions. A detailed resource assessment should be carried out to map both the potentials and the best sites for wind power, wave energy, tidal stream and biomass in Canada. The government should also give financial support to encourage test drilling to assess British Columbia's geothermal resources.

13. It is necessary to address secure long-term supply issues since some renewable power sources produce electricity intermittently. With respect to the development of Canada's energy portfolio over the coming decades, it may be preferable to support certain renewable power sources more than others in order to maintain overall grid and supply stability. This can be done through the definition of separate RPS goals for each type of energy, or through targeted financial incentives, among others.

14. Renewable power sources should be given priority access to the electricity grid, and the cost of grid access should be borne by all electricity consumers.

### Research and Development

15. Research and development for renewable power is underfunded in Canada. Significant initial government investment is necessary in order to launch technologies, such as offshore wind, wave and tidal energy, and some biomass schemes, such as energy crops.

16. Some uses of biomass energy are controversial to public interest groups and the general public. The federal and provincial/territorial governments (and municipalities) should study this issue and develop clear policies related to the use of this energy resource and the engagement of the public.

17. It is imperative to assess the long-term environmental impact of renewable power. The Canadian government should pay special attention to assessing the cumulative environmental effects of renewable power production.

### Green Tags

18. Canada should work with other countries directly and through international organizations to develop trading rules for the international exchange of the green attributes of renewable electricity. In this context, special attention should be given to the concept of ownership of green attributes and the compatibility of certificate trading schemes with national and transnational emission allowance and/or offset trading mechanisms.

19. A study of the many green power support mechanisms and incentives that exist or could be used should be done to assess the degree to which various incentives complement or conflict with each other (e.g., potential for double-counting) and to propose incentive packages that work well together.

# 9. References


AAFC 2002 Stumborg, Mark: Personal communication. Agriculture and Agri-Food Canada, July 22, 2002

ABB 1998 Renewable Energy — Hydro, Wind Solar, Biomass, Geothermal, Ocean — Status and Prospects. ABB, Environmental Affairs Department, 1998, quoted in http://watercouncil.org/Vision/Documents/Energy-report.PDF

AUS 2000 Renewable Energy (Electricity) Act 2000. No. 174, 2000 (Australia)

AUS 2001 Green Power in Australia – 2000/2001 Annual Audit Highlights. Australian "Green Power" website, www.greenpower.com.au/images/dl/ANNUALAUDIT00-01Highlightsv3.pdf, accessed on May 23, 2002

AGE 2001 Suncorp Has GIO Insights. Newspaper article, The Age, Melbourne, Australia, June 15, 2001, www.theage.com.au/business/2001/06/15/FFX9JUXEXNC.html, accessed on May 24, 2002

AGO 2002a Renewable Energy Map of Australia. Excel data sheets, The Australian Greenhouse Office, www.agso.gov.au/renewable/, accessed on May 23, 2002

AGO 2002b Jende, John: Personal communication. Australian Greenhouse Office, Sustainable Energy Group, Australia, June 18, 2002

AGO 2002c Support for Renewable Energy. Australian Greenhouse Office, www.greenhouse.gov.au/renewable/, accessed on June 18, 2002

APCC 2002 Hutchinson. John: Ontario's Emission Trading System. GLOBE 2002 presentation, Ontario Ministry of the Environment, Air Policy and Climate Change Branch, March 2002

ASMUS 2002 Asmus, Peter: Gone With the Wind – How California Is Losing Its Clean Power Edge Against … Texas??! The Energy Foundation, San Francisco, CA, August 7, 2002

ATCO 2002 Gunn, John: personal communication. Senior VP, ATCO Power, Alberta, June 14, 2002

AWEA 2001 Wind Project Database/Pennsylvania. American Wind Energy Association, www.awea.org/projects/pennsylvania.html, accessed on May 6, 2002

AWEA 2002 Global Wind Energy Market Report. American Wind Energy Association, March 2002

BARK 2002 — Barkanic, Robert J.: Building a Renewable Energy Market in Pennsylvania. Presentation for the GLOBE 2002 conference, Pennsylvania Department of Environmental Protection, March 2002

BC 1998 — Public Attitudes on Environmental Issues. BC Government, September 1998

BC 2001 — Strategic Considerations for a New British Columbia Energy Policy – Interim Report of the Task Force. November 30, 2001

BCH 2001 — Executive Report on the Green Energy Study for British Columbia – Phase 1: Vancouver Island. Report #PSE 389, Green & Alternative Energy Division, BC Hydro, July 2001

BCH 2002a — BC Hydro: Green Energy. Flyer, Vancouver, March 2002

BCH 2002b — McKenna, Joanne: personal communication. BC Hydro, Green & Alternative Energy Division, Vancouver, March 21, 2002; July 2, 2002

BMU 2002 — Die Ökologische Steuerreform - der Einstieg und ihre Fortführung. Bundesministerium für Umweltschutz, Berlin, Germany, January 2002, www.bmu.de/sachthemen/steuer/oekosteuerreform.php?vers=text

BOLIN 2001 — Bolinger, Mark and Wiser, Ryan: Clean Energy Funds: An Overview of State Support for Renewable Energy. Environmental Energy Technologies Division, Ernest Orlando Lawrence Berkeley National Laboratory, Berkeley, CA, April 2001

BTM 2001 — International Wind Energy Development — World Market Update 2000. BTM Consult, Denmark, March 2001

BWE 2002 — Statistics on Wind Power, Bundesverband WindEnergie e.V., www.wind-energie.de/informationen/informationen.htm, accessed on April 18, 2002

BWEA 2001 — Dauncey, Guy: Windpower — An Overview. www.earthfuture.com/seconomy/sei20.asp, accessed on July 2, 2002

BWEA 2002 — Hill, Alison: Personal Communication. British Wind Energy Association, London, U.K., June 28, 2002

CAAC 2002 — US Experience With Emissions Trading. Report for the Domestic Emissions Trading Working Group, Clean Air Action Corporation, Canada, January 22, 2002

CAN 2000 — Wagner, Andreas: Germany's New Renewable Energy Law. Climate Action Network Europe, Brussels, 2000

CARE 2002a — Letter to the Joint Meeting of Energy and Environment Ministers, Charlottetown, May 21, 2002. Clean Air Renewable Energy Coalition, May 16, 2002

CARE 2002b Backup Slides on the Canadian Wind Industry. Clean Air Renewable Energy Coalition, Canada, May 2002

CARE 2002c Eggertson, Bill: Personal communication. Canadian Association for Renewable Energies, Ottawa, June 2002

CARE 2002d Working Together to Advance Renewable Energy. Backgrounder, Clean Air Renewable Energy Coalition, February 2002

CARE 2002e Fact Sheet 5 – Low Impact Hydroelectric Power. Clean Air Renewable Energy Coalition, September 2002

CCPA 2000 Electricity Sector in Canada. Canadian Clean Power Coalition website, www.canadiancleanpowercoalition.com/customer/ccpc/ccpcwebsite.nsf/AllDoc/3E61D8F07D09EE068725697E0080F309!OpenDocument, accessed on June 13, 2002

CEA 2001 2002 Federal Budget — Prebudget Consultations. Canadian Electricity Association, Ottawa, October 15, 2001

CEA 2002 Cleland, Mike: personal communication. The Canadian Electricity Association, Ottawa, June 14, 2002

CEC 2001 Vaughan, Scott et al.: Environmental Challenges and Opportunities of the Evolving North American Electricity Market. Working paper, North American Commission for Environmental Cooperation, October 22, 2001

CEC 2002a 2002–2012 Electricity Outlook Report. California Energy Commission, P700-01-004F, February 2002

CEC 2002b Electricity in California, General Information. California Energy Commission, http://www.energy.ca.gov/electricity/index.html#generation, accessed on May 1, 2002

CEC 2002c Miller, Sandy: personal communication. California Energy Commission, June 10, 2002

CEC 2002d Environmental Challenges and Opportunities of the Evolving North American Electricity Market. Secretariat Report to Council under Article 13 of the North American Agreement on Environmental Cooperation, June 2002

CEC 2002e Orta, Jason: Personal communication. California Energy Commission, Renewable Energy Program, April 26, 2002

CEERT 2002 Wind Power. http://www.ceert.org/ip/wind.html, accessed on April 9, 2002

CEI 2002 Leading Environmentalist Agrees With Free-Market Institute on Wind Power — Subsidies No Longer Needed, Technology ‘Commercially Proven.’ Environmental News Network news item, Competitive Enterprise Institute, March 01, 2002, www.enn.com/direct/display-release.asp?id=6316

CETC 1992 Rangi, Raj: Canadian Wind Energy Technical and Market Potential. The CANMET Energy Technology Centre, Energy Technology Branch, Department of Natural Resources Canada, Ottawa, October 1992

CETC 2001 Ayoub, Josef et al.: Photovoltaics for Buildings — Opportunities for Canada. CETC Number 2001-123 (TR), CANMET Energy Diversification Research Laboratory, Department of Natural Resources Canada, Varennes, Quebec, December 2001

CEM 2001 Margolick, Michael: Electricity in Canada: Prospects and Policies. Conference presentation, Council of Energy Ministers, Meeting in Quebec City, September 2001

CFA 2001 Cooper, Mark N.: Electricity Deregulation and Consumers: Lessons from a Hot Spring and a Cool Summer. Consumer Federation of America, August 30, 2001

CFR 2002 Renewable Energy Production Incentives. Code of Federal Regulations, Title 10, Vol. 3, US Government Printing Office, revised as of January 1, 2002

CFS 1999 Hatton, Terry: Canada's Wood Residues: A Profile of Current Surplus and Regional Concentrations. Canadian Forest Service, Industry, Economics and Programs Branch, March 1999

CGP 2002 Cleaner and Greener Program — Emissions Trading 101. Leonardo Academy, Madison, WI, 2002, www.cleanerandgreener.org/environment/moreinfo.htm, accessed on June 17, 2002

CH 1998 Dunsky, Philippe: :L'énergie éolienne — Choix stratégique pour une quote part québecoise. Centre Hélios, Montréal, QC, May 1998

CH 2002 Former Shell boss touts green energy solutions. Calgary Herald news item, January 19, 2002, www.web.ca/~aen/news/news020121/eg-jan21a.txt

CMUR 2000 Mitchell, Catherine: The England and Wales Non-Fossil Fuel Obligation: History and Lessons. Center for Management under Regulation, University of Warwick, U.K., Annu. Rev. Energy Environ. 2000. 25:285–312

CNA 1998 Andseta, S. et al.: CANDU Reactors and Greenhouse Gas Emissions. Canadian Nuclear Association, May 1998

CNFAQ 2002 Whitlock, Jeremy: The Canadian Nuclear FAQ — Cost and Benefits of Nuclear Power. www.ncf.carleton.ca/~cz725/cnf_sectionC.htm, accessed on June 14, 2002

CREST 2002 Singh, Virinder: Biomass: FAQs. www.crest.org/articles/static/1/1004994679_6.html, accessed on April 1, 2002

CRS 2001a Renewable Energy Credits Trading: The Potential and the Pitfalls. Draft discussion document, Center for Resource Solutions, California, 2001

CRS 2001b Sissine, Fred: Renewable Energy: Tax Credit, Budget, and Electricity Production Issues. CRS Issue Brief for Congress, Congressional Research Service, Library of Congress, November 29, 2001

CRS 2002 Hamrin, Jan and Wingate, Meredith: Recommendations for the Development of an American Certificate Tracking and Verification Network, Center for Resource Solutions, California, May 13, 2002

CWEA Low Impact Renewable Energy — Options for a Clean Environment and Healthy Canadian Economy. Canadian Wind Energy Association (& others), undated

CWEA 2002 Quick Facts. Canadian Wind Energy Association, www.canwea.ca/quickfacts.htm, accessed on June 12, 2002

CRS 2002 TRC Standard — Green-e Renewable Energy Certification. Center for Resource Solutions, San Francisco, CA, 2002

CSE 2001 Hoerner, Andrew and Bosquet Benoît: Environmental Tax Reform: The European Experience. Center for Sustainable Economy, Washington, DC, February 2001

DE 2002a Productie groene stroom voor 550.000 gezinnen. News item, Duurzame Energie Informatiecentrum, April 2, 2002, www.duurzame-energie.nl/nieuws/index.php?id=1284, accessed on May 24, 2002

DE 2002b Beleid. Duurzame Energie Informatiecentrum, www.duurzame-energie.nl/de/de/de_beleid.html, accessed on May 24, 2002

DE 2002c REB: Regulerende Energiebelasting. Duurzame Energie Informatiecentrum, www.duurzame-energie.nl/fin/fr_REB.php, accessed on May 24. 2002

DEFRA 2001 The Climate Change Levy. Department for Environment, Food & Rural Affairs website, www.defra.gov.uk/environment/ccl/intro.htm, accessed on June 7, 2002

DOE 2002 Estimates of Renewable Energy Developed to Serve Green Power Markets, Department of Energy Green Power Network website, http://www.eren.doe.gov/greenpower/new_gp_cap.shtml, accessed on May 2, 2002

DSARE 2002 Jenkins, Jack: Evaluation of Wisconsin's Public Benefits Renewable Energy Pilot. http://www.wifocusonenergy.com/renewable/reports.html, accessed on April 18, 2002

DSAREII 2002 Jenkins, Jack: Interim Evaluation of Demand Side Applications of Renewable Energy. State of Wisconsin, Department of Administration, Division of Energy, August 17, 2001

DSIRE 2002 Database of State Incentives for Renewable Energy, Summary Maps. www.ies.ncsu.edu/dsire/, accessed on June 25, 2002

DTI 2002a Regional Renewable Energy Assessments — A Report to the DTI and the DTLR. OXERA Environmental, Department of Trade and Industry, U.K, February 6, 2002

| | |
|---|---|
| DTI 2002b | Capital Grants — Offshore Wind, Energy Crops and Biomass Heat/CHP. Department of Trade and Industry, www.dti.gov.uk/renew/eoi.htm, accessed on June 11, 2002 |
| DTI 2002c | Hyde, Adrian: personal communication. Sustainable Energy Policy Unit, Department of Trade and Industry, UK, June 14, 2002 |
| DTI-EU | Introduction to EU n&re policy. UK government website, at: www.dti.gov.uk/renewable, accessed March 19, 2002 |
| DWIA 2001 | Kjaer, Christian: That Was Then – This Is Tomorrow. Danish Wind Industry Association, September 2001, www.windpower.dk/articles/grcertif/thennow.htm |
| EC 2000 | Landfill Gas Utilization – Technical Bulletins. Environment Canada website, www.ec.gc.ca/nopp/lfg/bulletin/indexe.htm, accessed on June 17, 2002 |
| EC 2002a | David, Alain: personal communication. Environment Canada, Sustainable Consumption Division, June 13, 2002 |
| EC 2002b | Canada's Greenhouse Gas Inventory – Electricity and Petroleum Industries (Factsheet 2). Environment Canada, Greenhouse Gas Division, Hull, QC, January 2002 |
| ECC 1998 | Canada's Electricity Sector. Energy Council of Canada, www.energy.ca/ELECTRIC.html, accessed on June 12, 2002 |
| ECP-79 | Guideline on Renewable Low-Impact Electricity. Discussion Draft ECP-79, Canada, December 8, 2001 |
| ECP 2002 | Public Review of the Draft Guideline for ECP-079: Low-Impact Renewable Electricity — Commentary Report A: Public Comments Pertaining to Specific Sections, Definitions and Criteria Contents. Terra Choice, June 2002 |
| EDIE 2001 | Energy Minister Admits that Renewable Energy is Suffering Under NETA. News item, EDIE Weekly Summaries, October 19, 2001 |
| EDIE 2002 | Electricity Trading Rules to Aid Renewables. News item, EDIE Weekly Summaries, April 12, 2002 |
| EEA 2001 | Renewable Energies — Success Stories. Issue Report no. 27, European Environment Agency, Copenhagen, 2001 |
| EHI 2002 | McLennan, David: Personal communication. Energie Highland Inc., Kirkland, QC, March 12, 2002 |
| EIA 2002 | Impacts of a 10-Percent Renewable Portfolio Standard. Energy Information Administration, Report SR/OIAF/2002-03, US Department of Energy, February 2002 |

ENER 1998 Spain — Overview Table. Final Report of the Ener-Iure Project, Altener Programme, RES Legislation in Spain, Last Update 10/26/98

ENER 2001a Ruchser, Matthias: Report Concerning Electricity in Germany. ENER-IURE Project Phase III, Analysis of the Legislation Regarding Renewable Energy Sources in the EU Member States, Energetic Consulting, Bonn, December 14, 2001

ENER 2001b Table "Germany". ENER-IURE Project Phase III, Analysis of the Legislation Regarding Renewable Energy Sources in the EU Member States, Energetic Consulting, Bonn, December 2001

ENS APR25 Senate Passes Renewable Energy Tax Incentives, News report on Environment News Service AmeriScan, April 25, 2002, ens.lycos.com/ens/apr2002/2002L-04-25-09.html#anchor2, accessed on May 1, 2002

ENS 2001 Environmental Nonprofits Creatively Finance Wind Power to Cut Carbon Dioxide. News report on Environmental News Service, September 11, 2001

ENV 1999 Public Attitudes Towards Green Electricity. Public Opinion Omnibus Research, Environics International, Toronto, July 1999

EPA 1999 Guidance on Establishing an Energy Efficiency and Renewable Energy (EE/RE) Set-Aside in the NOx Budget Trading Program. Office of Atmospheric Programs, Office of Air and Radiation, US Environmental Protection Agency, Washington, D.C., March 1999

EPA 2000 Developing and Updating Output-Based NOx Allowance Allocations - Guidance for States Joining the NOx Budget Trading Program under the NOx SIP Call. US Environmental Protection Agency, May 8, 2000

EPA 2002a Diem, Art: personal communication. US Environmental Protection Agency, Environment and Energy Integration, NOx Set Aside, May 16, 2002

EPA 2002b Allowance Tracking Fact Sheet. US Environmental Protection Agency, http://www.epa.gov/airmarkets/tracking/factsheet.html#what, accessed on July 4, 2002

EPRI 1997 Renewable Energy Technology Characterizations. Topical Report (TR-109496), Energy and Power Research Institute and Department of Energy, Washington, December 1997

EREN 2002(1) Net Metering Rules, http://www.eren.doe.gov/state_energy/policy_content.cfm?policyid=26, accessed on April 9, 2002

EREN 2002(2) System Benefits Charges, http://www.eren.doe.gov/state_energy/policy_content.cfm?policyid=29, accessed on April 9, 2002

EREN 2002(3) Prototype Tidal Power Plant Installed Off U.K. Coast. EREN Network News, U.S. Department of Energy, Energy Efficiency and Renewable Energy Network, September 18, 2002

ERCOT 2002 McCoy, Roy: personal communication. Electric Reliability Council of Texas, Inc, May 31, 2002

ERI 2002 Energy Info Source: Green Tag Report. First Ed., February 2002

ERT 2002 EcoPower Program, Environmental Resources Trust, http://www.ert.net/ecopower/full.html, accessed on March 25, 2002

ETSU 2000 Mitchell, Catherine and Anderson, Teresa: The Implications of Tradable Green Certificates for the UK. ETSU project number TGC K/BD/00218, March 2000

ETSU 2002 Capacity of, and Electricity Generated from, Renewable Sources. Digest of United Kingdom Energy Statistics 2002, UK Department of Trade and Industry, 2002, www.dti.gov.uk/energy/inform/energy_stats/renewables/index.shtml

EU 2001 Directive 2001/77/EC of the European Parliament and of the Council of 27 September 2001 on the promotion of electricity produced from renewable energy sources in the internal electricity market. Official Journal L 283, 27/10/2001 P. 0033 - 0040

EWEA 2002 Wagner, Andreas: Wind Energy Development and Market Introduction Schemes in Europe. Conference presentation, European Wind Energy Association, Tokyo, April 17, 2002

EWG 2002 Choosing Green Energy: A Consumer's Guide to Sustainable Electricity. Tables A1 and A2, Environmental Working Group, www.ewg.org/reports/choosinggreenenergy/appendix.html, accessed on April 1, 2002

FERC 2002 Remedying Undue Discrimination through Open Access Transmission Service and Standard Electricity Market Design (Notice of Proposed Rulemaking). Docket No. RM01-12-000, U.S. Federal Energy Regulatory Commission, July 31, 2002

FINCan 2001 See Department of Finance Canada website, www.fin.gc.ca/budget01/bp/bpch6e.htm

FIRE 1998 Langniss, Ole (Editor): Financing Renewable Energy Systems — Final Report. German Aerospace Center, Institute of Technical Thermodynamics, Stuttgart, Germany, 1998

FJ 2002 Hünnekes, Christoph: PV Technology status and Prospects. Forschungszentrum Jülich GmbH, Germany, www.euronet.nl/users/oke/PVPS/ar00/germany.htm

FOE 2001 G8 Taskforce Report Lays Global Blueprint for Renewable Energy. Friends of the Earth press release, July 12, 2001, www.foe.org/act/task.html, accessed on June 11, 2002

FOE 2002 Fact Sheet: League Table of UK Green Electric Tariffs. Friends of the Earth Trust, London (UK), 2002

| | |
|---|---|
| Fraenkel 1999 | Fraenkel, Peter: Flowing Too Slowly — Performance and Potential of Small Hydro Power. Renewable Energy World, March 1999 |
| FUB 2001 | Reiche, Danyel: The meaning of Vertical and Horizontal Policies for Renewable Energies. Conference contribution, Free University of Berlin, December 7-8, 2001 |
| GB 1999 | Department of Trade and Industry (UK): New & Renewable Energy — Prospects for the 21st Century. DTI/Pub 4024/3k/3/99/NP. URN 99/744, March 1999 |
| GCB 2002 | The Green Certificates System in a Nutshell. Groencertificatenbeheer, The Netherlands, www.groencertificatenbeheer.nl/UK/method/methodUK.html |
| GEF 1996 | The Outlook for Renewable Energy Technologies, Strategic Considerations Relating to the GEF Portfolio, and Priorities for Targeted Research. The Scientific and Technical Advisory Panel of the Global Environment Facility, September 16, 1996 |
| GP 2002a | Denmark Withdraws Subsidies from Wind Energy. Greenprices news item, March 27, 2002 (source: ENDS), www.greenprices.com/eu/newsitem.asp?nid=318 |
| GP 2002b | Renewable obligation scheme from April 1st. Greenprices news item, March 27, 2002, www.greenprices.co.uk/uk/newsitem.asp?nid=314 |
| GP 2002c | Dutch Boom of New Products and New Suppliers. Greenprices news item, April 23, 2002, www.greenprices.com/de/newsitem.asp?nid=334 |
| GP 2002d | Ministry of Finance in the Netherlands Wants to Revise the Exemption of Green Energy Tax. Greenprices news item, May 31, 2002, www.greenprices.com/de/newsitem.asp?nid=364 |
| GP 2002e | Dutch Government Presents New Regulations Stimulation Green Electricity. Greenprices news item, September 17, 2002, www.greenprices.nl/nl/newsitem.asp?nid=en&nid=454 |
| GREENS 1996 | Lee, Susan and Greens, Austin: True Costs of Nuclear Power. Earth and Sky Women's Peace Caravan for a Compassionate Society, web.greens.org/s-r/11/11-09.html, accessed on June 28, 2002 |
| HAAS 2001 | Haas, Reinhard, et al.: Review Report on Promotion Strategies for Electricity from Renewable Energy Sources in EU Countries, Institute of Energy Economics, Vienna University of Technology, Vienna, Austria, June 2001 |
| HCEAC 2002 | A Sustainable Energy Strategy? Renewables and the PIU Review. House of Commons Environmental Audit Committee, Fifth report of session 2001-2002, Volume I, London, U.K., July 22, 2002 |
| HE 2002 | Wind Energy Study in British Columbia. Helimax Energy Inc., Montréal, Summer 2002 |

| | |
|---|---|
| HMT 2001 | Supplementary Memorandum from HM Treasury. Select Committee on Environmental Audit, UK, May 3, 2001 |
| HOLT 2000 | Holt, Edward et al.: Understanding Non-Residential Demand for Green Power. Report Draft 2, prepared for American Wind Association and the National Wind Coordinating Committee, November 2000 |
| HQ 2000 | Gagnon, Luc: Comparing Power Generation Options — Energy Payback. Hydro Québec, April 2000 |
| HQ 2002a | Gagnon, Luc: Personal communications. Senior Advisor, Climate Change, Hydro Québec, July 3, 2002 and September 12, 2002 |
| HQ 2002b | Gagnon, Luc: The International Rivers Network Statement on Emissions from Hydro Reservoirs, a Case of Misleading Science. Environment Committee, International Hydropower Association, September 12, 2002 |
| HQ 2002c | Chainé, Eric: Personal communication. Senior Advisor, Strategic Environmental Matters, Hydro Québec, September 16, 2002 |
| HQ 2002d | Call for tenders for 1,200 MW — Hydro-Québec Distribution announces the selected bidders and announces other calls for tenders. Press release, Hydro Québec, October 4, 2002 |
| IEA 1998a | Benign Energy? The Environmental Implications of Renewables. International Energy Agency, October 1998 |
| IEA 1998b | Renewable Energy Policy in IEA Countries — Volume II: Country Reports. International Energy Agency, 1998 |
| IEA 1999 | The Evolving Renewable Energy Market. International Energy Agency, June 1999 |
| IEA 2000 | Implementing Agreement for Hydropower Technologies and Programmes, Volume II (Main Report), Annex III — Hydropower and the Environment: Present Context and Guidelines for Future Action, International Energy Agency, May 2000 |
| IEA 2002 | International Small-Hydro Atlas. International Energy Agency, www.small-hydro.com |
| IEPE 2001 | Menanteau, Philippe et al.: Prices Versus Quantities: Environmental Policies for Promoting the Development of Renewable Energy. Institut d'Economie et de Politique de l'Energie, Grenoble, France, May 2001 |
| IOU 2002 | Falls, Dr. Robert: personal communication. International Offsets Unlimited, Inc., Vancouver, Canada, May 27, 2002 |

| | |
|---|---|
| JLS 2001 | Sawin, Janet L.: The Role of Government in the Development and Diffusion of Renewable Energy Technologies: Wind Power in the United States, California, Denmark and Germany, 1970-2000. Doctor's thesis, The Fletcher School of Law and Diplomacy, Medford, MA, September 2001 |
| JLS 2002 | Sawin, Janet L.: Losing the Clean Energy Race. Greenpeace USA, February 2002 |
| KNAPP 2000 | Knapp, Karl and Jester, Teresa: Initial Empirical Results for the Energy Payback Time of Photovoltaic Modules. Siemens Solar Industries and Energy and Environmental Economics, Inc., September 2000 |
| KRT 2002 | California Passes Renewable Energy Bill; State Utilities Face New Requirements. Knight-Ridder Tribune Business News, September 1, 2002 |
| LIREC 1999 | Low Impact Renewable Energy — Options for a Clean Environment and Healthy Canadian Economy. Low-Impact Renewable Energy Coalition, September 1999 |
| MA 2002 | ATTACHMENT: FINAL REGULATIONS, 310 CMR 7.00, et al. Massachusetts Bureau of Waste Prevention, Air Program Panning Unit, 728reg.PDF |
| Marubeni | Marubeni Corporation: First Japanese company to launch electricity and renewable energy business in Britain. Press release, February 12, 2002. http://www.marubeni.co.jp/english/news/nl/nl011016.htm |
| MEZ 2002a | Investeren in energie, keuzes voor de toekomst — Energierapport 2002. Ministerie voor Economische Zaken, Den Haag, February 26, 2002 |
| MEZ 2002b | van der Heul, Willem: personal communication. Ministerie voor Economische Zaken, Directoraat-Generaal Marktordening en Energie, Dena Haag, June 7, 2002 |
| Moomaw 2002 | Moomaw, William R.: Assessing Barriers and Opportunities for Renewable Energy in North America. Presentation for a workshop of the North American Commission for Environmental Cooperation, Fletcher School, Tufts University, Medford, MA, February 2002 |
| Morris 2000 | Morris, David and Nelson, Jessica: The Burning Question. In: THE CARBOHYDRATE ECONOMY, Volume No. 2, Issue No. 4, Spring 2000, www.carbohydrateeconomy.org/library/admin/uploadedfiles/Burning_Question_The.htm |
| NAAG | National Association of Attorneys General: Environmental Marketing Guidelines for Electricity. Environmental Marketing Subcommittee of the Energy Deregulation Working Group, Scottsdale, Arizona, December 1999 |
| NASEO 2002 | Henning, Bruce B.: Natural Gas and Electricity Generation: Market and Operational Convergence. 2002 NASEO Annual Energy Outlook Conference, National Association of State Energy Officials, Washington, D.C., February 12, 2002 |

NCCEI 1998 Winneg, Kenneth et al.: Summary Report — Baseline Survey: Consumer Knowledge, Practices and Attitudes Electric Utility Deregulation and Consumer Choice. The National Council on Competition and the Electric Industry, January 1998

NE 2002 Timberland and Cleann Air — Cool Planet, Partner to Fight Global Warming with Winds of Change. News item, www.nativeenergy.com/news021102.html, February 11, 2002

NEPDG 2001 National Energy Policy. Report of the National Energy Policy Development Group, Washington, D.C., May 2001

NESCAUM 1999 Tatsutani, Marika: Generation Performance Standards Model Rule — Draft Background Information Document. Northeast States for Coordinated Air Use Management, Boston, MA, October 7, 1999

NH 2000 New Hampshire leads Northeast & Mid-Atlantic states in reducing smog forming NOx emissions. Press release, Issued by the State of New Hampshire Department of Environmental Services Public Information & Permitting Office, New Hampshire Department of Environmental Services, Concord, NH, March 27, 2000

NH 2002 House Bill 284-FN. State of New Hampshire, January 2, 2002

NHDES 2002 Fontaine, Joe: personal communication. New Hampshire Department of Environmental Services, May 17, 2002

NJ 2002 McNevin, Tom: personal communication. New Jersey Department of Environmental Protection, Air Quality Management. May 21, 2002

NL 2002a REB: Regulerende Energiebelasting. Duurzame Energie Projectbureau, http://www.duurzame-energie.nl/fin/fr_REB.php, accessed on May 24, 2002

NOVEM 2002b de Bruijne, Ruud: personal communication. Nederlandse Onderneming voor Energie en Milieu, Utrecht, The Netherlands, May 31, 2002

NOVEM 2001 Electriciteitsproductie in GWhe per Duurzame Energiebron, gedetailleerde uitsplitsing, per 1990, 1995, 1999, 2000 en eerste halfjaar 2001. Nederlandse Onderneming voor Energie en Milieu, www.novem.nl/algInfo2001tbl5.doc, accessed on May 24, 2002

NPGC 2002 MacLeod, Kenneth: personal communication. North Pacific GeoPower Corp., Vancouver, BC, June 18, 2002

NRCan 1992 Rangi, Raj: Canadian Wind Energy Technical and Market Potential. The CANMET Energy Technology Centre, Energy Technology Branch, Energy Sector, Department of Natural Resources Canada, Ottawa, October 1992

NRCan 2000 Resource Assessment. Natural Resources Canada, Canren website, www.canren.gc.ca/resou_asse/index.asp, accessed on June 13, 2002

NRCan 2001 Dignard-Bailey, Lisa: Photovoltaic Technology Status and Prospects — Canadian Annual Report 2000. Natural Resources Canada, Ottawa, 2001

NRCan 2002a Natural Resources Canada and Environment Canada: Market Incentive Program for Distributors of Emerging Renewable Electricity Sources. Consultation Document, March 2002

NRCan 2002b Request for Letters of Interest — Market Incentive Program for Distributors of Emerging Renewable Electricity Sources, Government of Canada, 2002 (available on the NRCan website).

NRCan 2002c Energy in Canada 2000. Natural Resources Canada, Energy Sector, Ottawa, www.nrcan.gc.ca/es/ener2000/online/html/chap3f_e.htm, accessed on June 13, 2002

NRCan 2002d Tung, Tony: personal communication. Natural Resources Canada, June 17, 2002

NRCan 2002e Renewable Energy in Canada — Status Report 2002. Natural Resources Canada, Office of Energy Research and Development, March 2002

NREL 1997 Mann, Margaret K. and Spath, Pamela L.: Life-Cycle Assessment of a Biomass Gasification Combined-Cycle System. National Renewable Energy Laboratory, NREL/TP-430-23076, December 1997

NREL 1999a Wiser, Ryan et al.: Green Power Marketing in Retail Competition: An Early Assessment. National Renewable Energy Laboratory, NREL/TP.620.25939, February 1999

NREL 1999b Goldstein, Larry et al.: Grid-Connected Renewable-Electric Policies in the European Union. National Renewable Energy Laboratory, NREL/TP.620.26247, May 1999

NREL 1999c Spath, Pamela et al.: Life Cycle Assessment of Coal-Fired Power Production. National Renewable Energy Laboratory, NREL/TP.570.25119, June 1999

NREL 2000 Porter, Kevin and Wiser, Ryan: A Status Report on the Design and Implementation of State Renewable Portfolio Standards and System Benefits Charge Policies. National Renewable Energy Laboratory, May 3, 2000

NREL 2001 Wiser, Ryan et al.: Forecasting the Growth of Green Power Markets in the United States. National Renewable Energy Laboratory, NREL/TP-620-30101 LBNL 48611, October 2001

NREL 2002 Bird, Lori et al: Green Power Marketing Abroad: Recent Experience and Trends. National Renewable Energy Laboratory, Golden, CO, NREL/TP-620-32155, April 2002

NRG 2002 Heuser, Ben: personal communication. NRG Energy, Minneapolis, MN, May 29, 2002

NRRI 2000a Rose, Kenneth: The California Electric Restructuring Meltdown and the Fallout in Other States. National Conference of State Legislatures, AFI/ASI Joint Winter Meeting, The National Regulatory Research Institute, Ohio State University, December 13, 2000

NRRI 2000b Rose, Kenneth: Electric Restructuring Issues for Residential and Small Business Customers. The National Regulatory Research Institute, Ohio State University, June 2000

NRRI 2002 Rose, Kenneth: Wholesale and Retail Market Overview. Presentation at the NARUC Winter Committee Meetings, Committee on Electricity, Washington, DC, February 11, 2002

NWCC 2001a Rackstraw, Kevin and Palmisano, John: Credit Trading and Wind Power: Issues and Opportunities. National Wind Coordinating Committee Resource Document, Washington, DC, January 15, 2001

NWCC 2001b Consensus NWCC Credit Trading Opportunities and Guidelines, National Wind Coordinating Committee, US, May 2001

NY 2002 New York State Energy Plan. New York State Energy Research and Development Authority, June 2002

NYSERDA 2002 Michael, Karl: personal communication. New York State Energy Research and Development Authority, May 28, 2002

NZ 2001 New Zealand Ministry for the Environment: National Energy Efficiency and Conservation Strategy — Towards a Sustainable Energy Future. September 2001

OAG 2000 2000 Report of the Commissioner of the Environment and Sustainable Development (Chapter 3) — Government Support for Energy Investments. Office of the Auditor General of Canada, Ottawa, ON, 2000

OC 2001 Martin, David H.: Canada Continues With Nuclear Folly. Ottawa Citizen, June 21, 2001, www.sierraclub.ca/national/nuclear/reactors/nuclear-folly.html

OCA 2002 A Residential Consumer's Shopping Guide. Pennsylvania Office of Consumer Advocate, http://www.oca.state.pa.us/elecomp/pricecharts.html, accessed on May 13, 2002

OFREG 2001 Equality Scheme — Consultation to Assist Consideration of Which OFREG Policies and Activities Will Be Subject to Equality Impact Assessment. Office for the Regulation of Electricity and Gas, Great Britain, August 3, 2001

OK 2002 Kriterien für das Gütesiegel für Ökostrom“ok power“. EnergieVision e.V., January 2002

OPG 2002a Paterson, Murray: Personal communication. Ontario Power Generation, Business Development Green Energy, Toronto, June 27, 2002

| | |
|---|---|
| OPG 2002b | Coates, Dave: Personal communication. Ontario Power Generation, Emissions Trading, Toronto, July 3, 2002 |
| PA 2002a | Taken from the Department of Energy, PJM-ISO and Department of Health websites: http://www.pjmiso.com/market_system_data/downloads/Book1.xls; http://www.eia.doe.gov/cneaf/electricity/wholesale/backissues.html; http://www.ncat.org/neaap/news/panews.htm, accessed on May 7, 2002 |
| PA 2002b | Pa. Sustainable Energy Funds Invest in a Clean Energy Future. Pennsylvania Department of Environmental Protection, http://www.dep.state.pa.us/update/default.asp?ID=5537, accessed on May 6, 2002 |
| PA 2002c | Largest Solar Electric Power Plant in Western Pa. Unveiled. Pennsylvania Department of Environmental Protection, http://www.dep.state.pa.us/update/default.asp?ID=4932, accessed on May 7, 2002 |
| PA 2002d | Campbell, Kerry: personal communication. Pennsylvania Department of Environmental Protection, June 10, 2002 |
| PAPE 1999a | Pape, Andrew et al.: Lost Opportunities: Canada and Renewable Energy — A Cross-Country Comparison of Government Support for Renewable Energy. The Pembina Institue for Appropriate Development, Drayton Valley, AB, September 1999 |
| PAPE 1999b | Pape, Andrew: Clean Power at Home. David Suzuki Foundation, Vancouver, May 1999 |
| Pembina 2000 | Raynolds, Marlo and Pape, Andrew: The Pembina Institute Green Power Guidelines for Canada. Drayton Valley, AB, July 2000 |
| PEM 2001 | Pape-Salmon, Andrew et al.: A Smart Electricity Policy for Alberta — Enhancing the Alberta Advantage. Pembina Institute for Appropriate Development, Drayton Valley, Alberta, March 2001 (footnote, page 9). For Manitoba estimate, see weblink: http://216.239.39.100/search?q=cache:ge0ns1Ve-CoC:www.proxyinformation.com/xcelfact2002.pdf+%22wind+resources%22+canada+manitoba&hl=en&ie=UTF-8&e=619, accessed on June 29, 2002 |
| PEM 2002 | Dogterom, Jonathan et al.: Green Power Marketing in Canada — The State of the Industry. Pembina Institute for Appropriate Development, Drayton Valley, Alberta, March 3, 2002 |
| PLATTS 2001 | REC Prices Expected to Rise. Renewable Energy Report, Issue 32, www.platts.com, October 2001 |
| PLATTS 2002 | Generators passing on extra cost of ‘green’ obligations. Platts news item taken from the London Financial Times, August 28, 2002, www.platts.com/pressroom/ft.shtml |

PP 2002 Pollution Probe: Renewable Energy Primer (draft). Toronto, 2002

PT 2002 Bhuyan, Gouri: Personal communication. Powertech Labs, Surrey, BC, June 20, 2002

PT 2001 Bhuyan, Gouri: Wave Energy — A Technology Status Report. Powertech Labs, Surrey, BC, January 2001

PUCT 2000 2000 Annual Update of Generating Electricity Utility Data. Public Utility Commission of Texas, Market Oversight Division, December 2000

PUCT 2002a New Electric Generation Plants in Texas. Public Utility Commission of Texas, January 2002, www.puc.state.tx.us/electric/reports/gentable.pdf, accessed on May 29, 2002

PUCT 2002b Schubert, Eric: personal communication. Public Utility Commission of Texas, May 30, 2002

RAP 1999 It's the Market Stupid!, The Regulatory Assistance Project, Green Pricing Newsletter #7, April 1999, www.rapmaine.org/gpnews7.htm, accessed on May 2, 2002

RAP 2001 Harrington, Cheryl and Lazar, Jim: Improving State Electricity Taxation — Making a Revenue Neutral Tax Shift a Part of Electric Industry Restructuring. The Regulatory Assistance Project, May 2001

RADER 1998 Rader, Nancy: Green Buyers Beware — A Critical Review of "Green Electricity" Products. Public Citizen's Critical Mass Energy Project, Washington DC, October 1998

RADER 2001 Rader, Nancy and Hempling, Scott: The Renewables Portfolio Standard — A Practical Guide. Prepared for the National Association of Regulatory Utility Commissioners, February 2001

RC 2002 Questions & Answers. Renewable Choice Energy, www.renewablechoice.com/q-and-a.html, accessed on June 28, 2002

RE 2002 Benson, Derek: Personal communication. Reliant Energy, Renewables Department, Texas, June 20, 2002

REAP 1999 Samson, R. et al.: The Implications of Growing Short-Rotation Tree Species for Carbon Sequestration in Canada — Final Report. Resource Efficient Agricultural Production, Ste. Anne de Bellevue, Quebec, April 1999

REAP 2001 Jannosch, Rupert et al.: Switchgrass Fuel Pellet Production In Eastern Ontario — A Market Study. Resource Efficient Agricultural Production, Ste. Anne de Bellevue, Quebec, 2001

REAP 2002a Jannosch, Rupert: Personal communication. Resource Efficient Agricultural Production, Ste. Anne de Bellevue, Quebec, June 25, 2002

REAP 2002b Creating Ecological Energy, Fibre and Food Production Systems. Resource Efficient Agricultural Production, Ste Anne de Bellevue, Quebec, Canada, July 2002

RECS 2002 RECS website, Renewable Energy Certificate System, www.recs.org, accessed on July 1, 2002

REEF 2002 Renewable Energy Equity Fund. AusIndustry, www.auinsdustry.gov.au

REID 2002 Renewable Energy Industry Development Grants Program — Guidelines for Applicants. The Australian Greenhouse Office, 2002

REF 2002a Wisconsin Utility Commits to Renewables. REFOCUS Weekly, Issue 4, July 18, 2002

REF 2002b Scotland Seeks Support for Target of 40% from Renewables. REFOCUS Weekly, Issue 10, August 28, 2002

REF 2002c Government audit criticizes green power program in Los Angeles. REFOCUS Weekly, Issue 12, September 11, 2002

REF 2002d Neighbours of Windfarms Should Receive Price Break for Power. REFOCUS Weekly, Issue 13, September 18, 2002

REPP 1999 Moore, Curtis and Ihle, Jack: Renewable Energy Policy Outside the United States. Renewable Energy Policy Project, 1999, crest.org/repp_pubs/articles/issuebr14/

REPP 2000 Wooley, David R.: A Guide to the Clean Air Act for the Renewable Energy Community. Renewable Energy Policy Project, 2000, www.repp.org/repp_pubs/articles/issuebr15/

REPP 2002 Beck, Fredric et al.: Renewable Energy for California — Benefits, Status & Potential. Renewable Energy Policy Project, Research Report No. 15, Washington, D.C., March 2002

REU 2002 Danish wise men say wind power now profitable. Reuters news report, published on Yahoo, May 28, 2002, dk.biz.yahoo.com/020528/49/wxml.html

RFF 2002 Burtraw, Dallas et al.: The Effect on Asset Values of the Allocation of Carbon Dioxide Emission Allowances. Discussion Paper 02-15, Resources for the Future, Washington, DC, March 2002

RMI 2002 Lovins, Amory et al.: Small Is Profitable — The Hidden Economic Benefits of Making Electrical Resources the Right Size. Rocky Mountain Institute, Snowmass, CO, 2002

RT 2002 Renewable Trading Ltd. website, www.renewabletrading.com, accessed on June 3, 2002

RYP 2002 Philmore, Christine: personal communication. Attorney with Rath, Young and Pignatelli, New Hampshire, May 17, 2002

SA 2002 Green Mountain Power, Clean Air-Cool Planet Team Up for RE, Solar Access news item, www.solaraccess.com/news/story?storyid=1979, May 14, 2002

SCAFS 2002 Final Report. Select Committee on Alternative Fuel Sources, Legislative Assembly of Ontario, June 2002

SCAN 2001 Canadian Statistics. Statistics Canada, as of July 1, 2001, www.statcan.ca, accessed on June 28, 2002

SKM 2002 Redding, Graham: Personal communication. Sinclair, Knight and Merz, Australia, June 1, 2002

SLOAN 2000 Sloan, Mike: Renewable Energy Credits: a success in Texas. Article in Environmental Finance, April 2000

SLOAN 2001 Sloan, Mike: Texas Renewables 2001: A Very Good Year. Virtus Energy Research Associates, Presentation at the Sixth National Green Power Marketing Conference, Portland, Oregon, July 2001

SSDE 2002 Ökosteuer Aktuell. www.stromsteuer.de, accessed on June 27, 2002

SUN 2002 Burtt, Marlie: Personal communication. Suncor, Alberta, July 9, 2002

TCES 2002 Green Leaf™ Tradeable Renewable Electricity Certificates (TRCs) Program Standard. TerraChoice Environmental Services, Inc., Ottawa, July 5, 2002

TCT 2002 Ashford, Michael: Personal communication. The Climate Trust, Oregon, April 2002

TRI 2002 Tarbotton, Michael: Personal communication. Triton Consultants, Vancouver, July 2, 2002

TUD 2000 Meyer, Niels and Nielsen, Kim: The Danish Wave Energy Programme Second Year Status. Technical University of Denmark, Institute of Buildings and Energy, Lyngby, Denmark, 2000

UCS 1999 Nogee, Alan et al.: Powerful Solutions — 7 Ways to Switch America to Renewable Energy. Union of Concerned Scientists, Cambridge, MA, January 1999

UCS 2001a Clemmer, Steven, et al.: Clean Energy Blueprint — A Smarter National Energy Policy for Today and the Future. Union of Concerned Scientists, Cambridge, MA, October 2001

UCS 2001b State Minimum Renewable Energy Requirements. Union of Concerned Scientists, USA, October 2001

UCS 2002 Hempling, Scott and Rader, Nancy: Comments of the Union of Concerned Scientists to the Commission for Environmental Cooperation In response to its "NAFTA Provisions and the Electricity Sector" Background Paper to its October 22, 2001, Working Paper Entitled "Environmental Challenges and Opportunities of the Evolving North American Electricity Market." Union of Concerned Scientists, January 31, 2002

UK 2002 Electricity, England and Wales — The Renewables Obligation Order 2002. Revised Draft January 24, 2002

WEC 1993 Strange, Donald: Ocean Energy — Report Section 6. World Energy Conference, Committee of Renewable Energy Resources Opportunities and Constraints, July 1993

WEC 2001 Extract from the Survey of Energy Resources 2001 — Canada. World Energy Council, 2001, www.worldenergy.org/wec-geis/edc/countries/Canada.asp, accessed on July 24, 2002

WEDK 1998 Vindeløv, Stig: Breaking the Waves — Current status of the Danish wave-energy programme. Association for the Promotion of Wave Energy, Denmark, 1998, www.waveenergy.dk/wave_forside/4english/papers/patras98_SV.html

WISER 1999 Wiser, Ryan H.: The Role of Public Policy in Emerging Green Power Markets: An Analysis of Marketer Preferences. Environmental Energy Technologies Division, Ernest Orlando Lawrence Berkeley National Laboratory, University of California, Berkeley, California, August 1999

WISER 2000 Wiser, Ryan H. et al.: Customer Choice and Green Power Marketing: A Critical Review and Analysis of Experience to Date. Lawrence Berkeley National Laboratory, University of California, Berkeley, California, August 2000

WISER 2001 Wiser, Ryan and Langniss, Ole: The Renewables Portfolio Standard in Texas: An Early Assessment. Lawrence Berkeley National Laboratory, Berkeley, California 94720, November 2001

WM 2002 Oil and Gas Pricing Tables — Weekly Average Prices to Wednesday June 12, 2002. The WebMarket.com, www.thewebmarket.com/Oil_and_Gas/Pricing_Chart.htm, accessed on June 14, 2002

WPTF 2002 Ontario Wind Power Task Force Industry Report and Recommendations. February 2002

WRBEP 1998 Williams Lake Generating Station, BC, Canada. Western Regional Biomass Energy Program, www.westbioenergy.org/lessons/les12.htm, accessed on June 28, 2002

WWF 2002 The Bottom Line on Kyoto — Economic Benefits of Canadian Action. Policy Briefing Paper, World Wildlife Fund, David Suzuki Foundation, April 23, 2002

WWS 1999 Strategies for Promoting Innovative Energy Technologies in the Electric Power Sector. Woodrow Wilson School of Public and International Affairs, Princeton University, February 20, 1999

XEN Reed, Glenn and Houston, Ashley H.: Status of the US Market for Green Power. XENERGY Inc., in: Deregulation of the Utility Industry and Role of Energy Services Companies (ESCOs)

# Endnotes

[1] A literature review carried out by Hydro Québec has shown that net emissions may not change substantially through the addition of a dam as rivers naturally emit greenhouse gases caused by carbon sources carried in the water. Even counting in the loss of plants functioning as carbon sinks through flooding may not change this picture [HQ 2002b].

[2] According to a SolarAccess news report of April 2002, Sharp will launch 2 kW solar panels based on organic pigment technology, which will only cost half as much as those manufactured today (*Sharp to Introduce New, Cheaper Solar Panels*, April 2002)

[3] The first full-fledged ocean energy power plant was commissioned in Scotland in 2001; wave energy pilot plants are planned for British Columbia and Washington State for the coming years.

[4] Source: The Burning Issues with Biomass: Part Four of Pennsylvania Environmental Network's series on Green Energy (March 2000).

[5] www.eren.doe.gov/RE/bioenergy.html.

[6] www.greenpower.com.au/GPFaq.shtml#RE1; www.seda.nsw.gov.au.

[7] For updates, see DOE website at www.eren.doe.gov/greenpower/topten.shtml.

[8] At the time, 880 MW was accepted as the official number, but 901 MW is the more accurate number.

[9] Separate obligations have been set up for the remainder of the UK: the Scottish Renewable Order (SRO) and the Northern Ireland Non-Fossil Fuel Obligation (NI-NFFO).

[10] Delivered Net Capacity means that the capacity of intermittent sources is discounted by the capacity factor, i.e. the nameplate capacity is larger than the DNC. 1 MW DNC of wind roughly equals 1 MW of thermal electricity production, whereas 1 MW of installed wind capacity is only 30–40% of 1 MW of a gas power plant.

[11] Exempting renewables from this levy contrasts with Ontario regulations, which require an amount of money to be paid to cover the debt incurred through past nuclear, hydro, and coal plant investments, and this is imposed on all electricity, including that from renewable sources.

[12] Prices are forecast to rise beyond the (AUS)$40 price cap. This is possible because this penalty, like all fines, is not tax deductible, whereas the purchase of RECs is deductible. RECs may sell as high as (AUS)$57, depending on the particular company's tax position in any given year [SKM 2002].

[13] This requirement is the most stringent in the world. For example, the US Green-*e* program only requires 5% new for the 1st year, and 25% after 5 years. Germany's three accreditation programs require less than 25%, and the Future Energy scheme in the UK simply requires 'significant new generation' [AUS 2001].

[14] See also a recent news item: *Senate panel to investigate California energy market*, http://enn.com/news/wire-stories/2002/05/05102002/reu_47188.asp.

[15] A Platts press release of May 1, 2002 gives a lower estimate of only 8% of US households — see *Platts completes 1st ever benchmarking research of utilities' green energy pricing programs*, www.platts.com/pressreleases/index.shtml.

[16] Connecticut, Delaware, Massachusetts, Maryland, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island.

[17] Fossil-fuel plants with this emission level cannot obtain planning permission in certain airshed management areas, such as the Zone de gestion des polluants atmosphériques (ZGEP) in Québec, which prefers combined cycle gas-fired plants with even lower emissions (0.000035 t/MWh) [HQ 2002c].

[18] This 4 MW landfill gas project would have obtained $2,000 if a market value of $1,000 per allowance is assumed, which would compute to a subsidy of 0.14 (US) cents per MWh over the summer months, or 0.06 (US) cents per MWh over a year.

[19] This effect could be reduced by only including newly constructed large hydro projects, but due to the large capacities of such projects caution would have to be taken to ensure that enough allowances are available for non-large hydro renewables, which need to be supported due to their currently still higher generation costs.

[20] See APX website at www.apx.com.

[21] Arizona (used for RPS implementation only), California, Connecticut, Delaware, Illinois, Massachusetts, Montana, New Jersey, New Mexico (to start in 2007), New York, Ohio, Oregon, Pennsylvania, Rhode Island, and Wisconsin. [BOLIN 2001].

[22] California pays a production incentive of about (US) 1.0¢/kWh for renewable energy from its SBC.

[23] France replaced tendering by feed-in tariffs in 2001, and the UK introduced an RPS with certificate trading in 2002.

[24] Planning permission was identified as a major obstacle by the Ontario Select Committee on Alternative Fuel Sources. The Select Committee recommends setting aside zones for wind and solar power in development plans to alleviate this problem [SCAFS 2002, p. 31].

[25] Grid access was identified as one of the main barriers to renewable energy deployment in Canada in a 2000 report of the Commissioner of the Environment and Sustainable Development [OAG 2000, p. 21].

[26] Although some argue that such a tax would deprive industry of the funds needed to make the investments needed to reduce carbon intensity.

[27] For a complete overview of US incentives for renewable energy, see www.eren.doe.gov/consumerinfo/refbriefs/la7.html.

[28] This can be confirmed with experience from other countries: for example, with the Danish pension funds, important long-term investors were found to avoid renewable energy projects due to the lower rates of return [FIRE 1998, p. 27].

[29] Flow-through shares are equity shares issued to new investors. Investors receive an equity interest in the company and income tax deductions associated with new expenditures incurred by the company on exploration and development. Flow-through shares can be issued by public companies, but are of greater benefit to non-taxpaying junior companies.

[30] Most Government of Canada expenditures in support of renewable energy occurred in the early 1980s, when it allocated about $100 million per year to expedite the development of technologies and encourage their market penetration [NRCan 2002e, p. 4].

[31] For updates, see www.eren.doe.gov/greenpower/netmetering/nmtable.shtml.

[32] In some provinces, such as Québec, the "avoided cost" of adding on additional conventional power generation capacity cannot be based on natural gas only as there are cheaper large hydro resources. Quebec's grid operator only pays 3¢/kWh to landfill gas projects, far below the price of natural gas-based electricity [EHI 2002]. On the other hand, Hydro Québec pays 5.8¢/kWh to wind power projects, and is launching additional RFPs for different technologies, which may obtain higher prices than the actual avoided cost [HQ 2002a].

[33] Many Canadian utilities are Crown Corporations, and therefore exempt from this tax — this should be noted in the context of emission allowance trading and RECs trading as well.

[34] Some existing schemes are not as generous: BC Hydro, for example, pays 4.9¢/kWh to many small hydro projects, which is a premium of about 0.5¢/kWh over natural gas. The crown corporation indicates it is ready to pay more for electricity from different renewable technologies.

[35] Although a tax effect would occur in the case of a higher premium, even in such a case companies would usually not allocate the power price between the wholesale power value and green power attributes unless there is a value for rights or entitlements coming with the power purchase that is separate from the power itself. These rights would have a determinable value for tax purposes at the time of acquisition.

[36] A government task force report for British Columbia projects electricity prices to go up to 5¢/kWh due to the higher cost of electricity from combined cycle power plants. This report assumes slightly higher current prices for natural gas-based electricity than above, between 4.8 and 5.2¢/kWh [BC 2001, p. 21].

[37] As Australia's energy consumption is growing by 2.4% a year [AGO 2002b], the target of 2% added renewable generation by 2010 is actually more important than it seems in a Canadian context (1.2% annual growth).

[38] As the response to BC Hydro's RFP has been overwhelming, the company is now considering raising the requirement to 30% [PEM 2002, p. 22].

[39] See *greenprices* news item of April 23, 2002 at: www.greenprices.nl/nl/newsitem.asp?lid=en&nid=329.

[40] Some of the forest residue is most probably not used because of transport cost, making it expensive for energy uses. Much of the agricultural waste potential is currently proposed for bioethanol production.

[41] Based on common conversion factors this number should be far higher. The NRCan report suggests that either the statistics are flawed, or production is only sporadic.

[42] These numbers agree well with those given for the U.K.: with a shorter shoreline than Canada's, the technically feasible generation potential in the U.K. has been estimated to be 50 TWh per year, whereas the overall technical potential is given as 600 TWh per year [HCEAC 2002, p. 13].

[43] To be published 10/02, see www.bchydro.com/environment/greenpower/greenpower1652.html.

[44] See http://rredc.nrel.gov/wind/pubs/atlas/ and http://www.energyatlas.org/ for the West.

[45] This will result in both economies of scale and foreign investment, creating employment and manufacturing capacities inside Canada. For example, Danish wind turbine manufacturer Vestas indicated that it would consider building a Canadian manufacturing plant at an annual installation rate of at least 100 MW of wind capacity [WPTF 2002, p. 42].

[46] The terminology around green tags is not yet completely fixed. In this report, green tags is the overarching term used for tradable environmental attributes, whereas renewable energy certificates (RECs) are green tags that are traded for compliance under renewable portfolio standards. This is done here to facilitate the discussion, although the term RECs is also used for non-RPS tags (e.g. T-RECs in the US and Canada).

[47] World Wide Green; www.worldwidegreen.com.

[48] The sale subsidizes the construction of more wind farms and will 'retire' 2,400 tons of carbon dioxide, enough to offset Timberland's carbon emissions produced from two years of normal electricity use.

[49] Green tags have been traded in the context of hydro deals between Nuon and ewz of Switzerland and Eneco and Vattenfall of Sweden, as well as a green certificate deal between Nuon and a landfill gas facility in New Jersey. (For details, see: www.greenprices.nl/nl/newsitem.asp?nid=197, August 17, 2001.)

# Appendix A — Source Data for Figure 2.1 and Table 2.1

**Table A1 — Life-Cycle Air Emissions** [Source: IEA 1998a unless indicated otherwise]

| g/kWh | CO2 | SO2 | NOx |
|---|---|---|---|
| Nuclear | 3-15 [CNA 1998] | 0.03 [EWG 2002] | 0.03 [EWG 2002] |
| Coal-best practice | 955 | 11.8 | 4.3 |
| Coal-FGD&LowNOx | 987 | 1.5 | 2.9 |
| Clean Coal | 741 [NREL 1999c] | 0.72 [NREL 1999c] | 0.54 [NREL 1999c] |
| Oil | 818 | 14.2 | 4 |
| Gas | 430 | 0 | 0.5 |
| Diesel | 772 | 1.6 | 12.3 |
| Energy crops — current practice | 17–27 | 0.07–0.16 | 1.1–2.5 |
| Energy crops — future practice | 15–18 | 0.06–0.08 | 0.35–0.51 |
| Small Hydro | 9 | 0.03 | 0.07 |
| Large Hydro | 3.6–11.6 | 0.009–0.024 | 0.003–0.006 |
| Solar PV | Current: 98–167<br>Future: 50 [HQ 2002a] | 0.20–0.34 | 0.18–0.30 |
| Solar Thermal | 26–38 | 0.13–0.27 | 0.06–0.13 |
| Wind | 7–9 | 0.02–0.09 | 0.02–0.06 |
| Geothermal | 79 | 0.02 | 0.28 |

Note: For the graphs in this study, medium values were chosen in cases where ranges are given in this table.
FGD: Flue gas desulphurization

**Table A2 — Land Use** (Source: EWG 2002 unless marked otherwise)

| | **Land Use in ha/1000 GWh annual** | **Comments** |
|---|---|---|
| Nuclear | 48 | Estimate includes nuclear power plant construction (22 ha) and fuel extraction (26 ha), but does not include land needed for disposal of uranium tailings produced during mining, the waste produced during electricity generation, or the land requirements involved in the eventual decommissioning of the reactor. |
| Coal | 363 | Estimate includes coal power plant construction (33 ha) and coal fuel extraction (330 ha), but does not include land needed for disposal of coal mine tailings or ash produced during combustion. |
| Natural Gas | 25–200 | Estimate including extraction. Source: Swiss Environment Report, Energy (Chapter 26), Swiss Agency for the Environment, Forests and Landscape, 1997 www.buwal.ch/e/themen/partner/energie/ek26u00.pdf |
| Oil | 25–200 | Source: Swiss Environmental Report, see above |
| Waste-to-Energy | 445 | Source: North West Power Planning Council: Fourth Northwest Conservation and Electric Power Plan - Northwest Power in Transition: Opportunities and Risks. Document 96-5, dated May 23, 1996 |
| Energy crops | 60000 | Source: IEA 1998a |
| Forest surface set aside for sustainable forestry | 132,000–220,000 | Estimate is based on the amount of natural forest that would have to be permanently set aside for sustainable forestry. If energy crops were grown, the amount of land required would drop to the still very high number of 132,000 ha. |
| Large Hydro | 75,000 | Average of a random sample of 50 large hydropower reservoirs in the US, ranging from 482 ha to 763,000 ha. The amount of land flooded depends on the particular topography of the region. |

| | **Land Use in ha/1000 GWh annual** | **Comments** |
|---|---|---|
| Run-of-River Hydro | 28 | Source: Swiss Environmental Report, see above under Natural Gas |
| Solar PV | 2,000 | Estimate includes land covered by a photovoltaic electricity generating facility. The 2700 ha number is based on an actual PV electricity plant with an overall 7.5% efficiency. This is somewhat an overestimate of the land required because the PV panels on the market have efficiencies of up to 15%, and those under development have efficiencies of up to 30%. A more modern PV plant, therefore, would cover about 1350 ha. |
| Solar Thermal | 250 | Source: IEA 1998a |
| Wind | 11,666/233 | It takes more than 11,500 ha of land to space out enough wind turbines such that they can produce a billion kWh of electricity. However, 233 of these hectares are actually taken up by the turbines themselves, or by access roads for their construction and maintenance. An offshore wind farm would avoid terrestrial impacts altogether. |
| Geo-thermal | 3,750 | Source: IEA 1998a (based on 80% availability) |

Note: All source data have been converted to ha/1000 GWh

**Table A3 — Water Use** (Source: EWG 2002 unless marked otherwise)

| | **Water Use [m3/GWh]** | **Comments** |
|---|---|---|
| Nuclear | 3.6–5.7 (consumptive) 995,000 (non-consumptive) | Nuclear reactions generate large amounts of heat, and therefore require large amounts of water for cooling purposes. |
| Coal | 2.8–4.3 (cons.) 730,000 (non-cons.) | The amount of water depends on the technology and type of coal used. |
| Natural Gas | 1.1 (cons.) 730,000 (non-cons.) | |
| Oil (CCCT) | 1.3 (cons.) | Source: North West Power Planning Council: Fourth Northwest Conservation and Electric Power Plan — Northwest Power in Transition: Opportunities and Risks. Document 96-5, dated May 23, 1996 |
| Forest surface set aside for sustainable forestry | 11.8 | This water is used in a wood-fired steam electric plant. Energy crops that require irrigation would consume much higher levels of water. |
| Energy crops | >11.8 | Higher than wood if irrigated. |
| Small Hydro | 81,500,000 | Calculated for small hydro plants (in this case, assumed to be less than 65 feet); non-consumptive. Even though the water is not consumed, because all organisms must be screened out before use, the impacts of this water use are large. |
| Large Hydro | 2,700,000–33,600,000, average 16,100,000 | Source: ga.water.usgs.gov/edu/tables/dlhy.html, accessed on April 1, 2002 |
| Solar PV | 0.14 | The small amounts of water for PV-produced energy are used for periodic washing of the panels; the water used during construction is negligible. |

| | Water Use [m3/GWh] | Comments |
|---|---|---|
| Solar Thermal | ~4.2 | Source: www.powerscorecard.org/tech_detail.cfm?resource_id=9. Systems using conventional steam plant to generate electricity will have a requirement for cooling water. This could place a significant strain on water resources in arid areas. |
| Wind | 0 | The water consumed during construction and operation of wind turbines is negligible (USDOE, 1983). However, if pumped hydro were used to store wind-generated energy, the water utilization would be much higher. |
| Geothermal | 0 | Geothermal plants do not require water cooling. However, groundwater can be depleted under certain circumstances in high temperature geothermal fields. A cold ground water zone usually overlays most such systems and, in certain cases, cold water may flow downwards into the field, leading to a drop in the ground water level. This effect can be avoided by maintaining the reservoir pressure. The groundwater level may also fall as a result of breaks in the casing of disused wells, but the effect of this can be minimised by monitoring the condition of such wells and repairing them promptly. Some plants inject water in order to increase steam generation. |

# Appendix B-1 — Source Data for Figure 2.6

**Table B1 — A Comparison of Electricity Prices from Different Energy Sources**

| Energy Form | Price: US¢/kWh | Price: ¢CDN/kWh | Source |
|---|---|---|---|
| Nuclear | | 3.4–4.0 | NRCan, Comparative Cost of Electricity Generation — A Canadian Perspective; nuclear.nrcan.gc.ca/Comparative_Costs(e).pdf |
| Coal | | 3.4 | NRCan |
| Gas (comb. cycle) | | 4.37–5.0 | (see chapter 4.7.2) |
| Biomass combustion | | 5.5–11 | REAP 1999, p. 45 |
| Biomass co-firing (10% to 15%) | 4 | | CREST 2002 |
| Landfill gas | | 6–7 | PT 2002 |
| Micro Hydro | | 12 | Environmental Youth Alliance: Micro Hydro — Information Booklet. Micro-Hydro Energy.PDF, www.eya.ca |
| Small Hydro | 3–8.5 | | EWG 2002, Table 2 |
| Large Hydro | 2–8 | | ABB 1998 |
| Solar PV | | 25 | CARE 2002c |
| Solar Thermal* | 10–12 | | IEA 1999, p. 22 |
| Wind | | 6.91–8.91 | CARE 2002b |
| Geothermal | | 6 | NPGC 2002 |
| Wave Energy | | 4.5–8.2 | PT 2002 |
| Tidal Stream | | 6–10 | TRI 2002 |
| Tidal Barrage | | 4.9–7.6 | WEC 1993 |

* cost for parabolic trough units; cost for other technologies (power tower or dish engine) could reach 4–6 if commercially produced

# **Appendix B-2 — REAP Biomass Cost Estimates for Canada** [REAP 1999, p. 45]

**Table 4.2. Estimated cost of electricity for various biomass feedstocks and selected biomass cost.**

| Biomass | Transportation Distance | Cost | Direct Fired Technology | | Gasification Technology | |
|---|---|---|---|---|---|---|
| | Km | $ odMg$^{-1}$ | ¢ kWh$^{-1}$ [b] | | ¢ kWh$^{-1}$ [b] | |
| | | | 25 MW | 50 MW | 25 MW | 50 MW |
| Mill Residues | 40 | 15.79 | **5.5** | **6.7** | **6.4** | **6.3** |
| | 100 | 19.28 | **5.9** | **7.0** | **6.7** | **6.5** |
| Logging Residues[a] | 40 | 31.38 | **7.4** | **8.3** | **8.0** | **7.4** |
| | 100 | 35.21 | **7.8** | **8.6** | **8.4** | **7.7** |
| Peat sods | 40 | 84.92 | 13.0 | 12.7 | 13.0 | 10.9 |
| | 100 | 89.89 | 13.5 | 13.1 | 13.4 | 11.3 |
| MSW | 40 | 47.14 | 10.9 | 11.0 | 11.0 | 9.5 |
| | 100 | 51.47 | 11.4 | 11.5 | 11.4 | 9.8 |
| Straw | 40 | 39.37 | 8.7 | 9.1 | 8.8 | 7.8 |
| | 100 | 45.53 | 9.2 | 9.8 | 9.4 | 8.3 |
| Energy Crops | 40 | 56.38 | 10.4 | 10.7 | 10.5 | 9.1 |
| | 100 | 60.21 | 10.9 | 11.1 | 10.9 | 9.4 |

Adapted form Rouleau (1995).

[a] road side

[b] cost of electricity is set to provide a return equivalent to the weighted average cost of capital employed to finance the project.

# Appendix C —Assumptions and Calculations to Estimate Canada's Potential Electricity Generation from Biomass

## SWITCHGRASS

The agricultural surface available for switchgrass production in Ontario has been determined to be 282,000 ha [REAP 2001], and the yield per hectare has been 10 t in test plantations. A yield of less than 10 tons can be expected on the long run [AAFC 2002], and 8 t/ha is assumed here.

Switchgrass only grows well in Ontario and Manitoba, with yields in Manitoba somewhat reduced to only 5–6 t/ha, but with a larger surface available for its production, so that about the same annual yield as for Ontario can be assumed. Further West and East of Ontario, either willow or other kinds of grass could be grown instead of switchgrass. These species do, however, require pre-drying, which reduces their total energy yield [AAFC 2002]. The potential yield can be assumed to be as high as Ontario's for Alberta, Saskatchewan, Quebec and the Atlantic Provinces together, leaving out BC because of its small arable land surfaces [REAP 2002a].

Ontario yield: 282,000 ha x 8 t/ha,year = 2.26 million tons/year
Canada's yield: 3 x Ontario's yield, or 6.77 million tons/year

**Possible electricity production from energy crops:**
Switchgrass energy content = 17.5 GJ/ton
If the crops are used instead of coal for co-firing or dedicated biomass power plants, a 28% conversion factor from heat content to electricity can be assumed [AAFC 2002].
17.5 GJ/ton x 28% = 4.9 GJ/ton converted into electricity
1 GJ is the same as 0.28 MWh à 4.9 GJ/ton yield 1.37 MWh/ton
1.37 MWh/ton x 6.77 million tons = 9.27 TWh, or 1.5% of Canada's 2002 electricity consumption (600 TWh)

## WOOD RESIDUES

It is estimated that Canada's forest product mills currently produce 17.7 million bone dried tonnes (BDts) of wood residues per year. Approximately 12.3 million BDts per year (or 70 percent) of residues are utilized in various forms (energy production and value-added uses) and 5.4 million BDts per year (or 30 percent) are surplus to current production needs (see Table C-1). This number should be reduced by 30% to account for contaminants [AAFC 2002]. An energy conversion factor of 35% is assumed.

**Table C1 — Wood Residues in Canada**
[CFS 1999, p. 5]

| Province/Country | Surplus [mBDt] |
|---|---|
| British Columbia | 2.06 |
| Alberta | 0.90 |
| Saskatchewan | 0.05 |
| Manitoba | 0.02 |
| Ontario | 0.45 |
| Québec | 1.64 |
| New Brunswick | 0.18 |
| Nova Scotia | 0.06 |
| Prince Edward Island | n/a |
| Newfoundland | 0.02 |
| **Canada** | **5.4** |

**Possible electricity production from wood residues:**

5.4 million tons/year – 30% = 3.8 million tons (available biomass)
Energy content: 10.4 GJ/ton (wood chips)
10.4 GJ/ton x 35% = 3.64 GJ/ton converted into electricity
1 GJ is the same as 0.28 MWh à 3.64 GJ/ton yield 1.02 MWh/ton
1.02 MWh/ton x 3.8 million tons = 3.9 TWh, or 0.6% of Canada's annual electricity consumption (600 TWh)

## AGRICULTURAL WASTE

An assessment of the potential for energy production from agricultural wastes in Eastern Canada has been completed by the (REAP) in July 2002 [REAP 2002b]. Table C-2 summarises the information in this report and adds additional data extrapolated from Ontario to the Western Provinces, based on crop production and livestock statistics. The REAP report assumes bio-ethanol production from crop residues and on-farm electricity production from manure gasification; for this estimate it has been assumed that crop residues would be entirely used for electricity production. Crop residues can have far higher ash contents than wood residues (10% vs. 1%), which can negatively affect its use as fuel. Therefore, a conversion factor of only 25% is assumed here. Based on Statistics Canada data, manure potentials were extrapolated following potentials determined for Ontario (Table C2).

The total for Canada results in 32 TWh. This is an even larger amount than the potentials for biomass from forest residues and energy crops, and amounts to 5.3% of Canada's current electricity consumption. According to the World Energy Council, Canada has 45 million tons of crop residues available per year [WEC 2001]. At an energy content of about 18 GJ/t, this would result in a gross energy generation of 225,000 GWh, or over 56,000 GWh at an energy conversion factor of 25%. This is roughly twice as much as the above estimate of 30,000 GWh in Table C3, which can therefore be taken as a low estimate.

**Table C2 — Extrapolation of Ontario Data to Western Provinces Based on Livestock and Harvest Statistics** [SCAN 2001]

| | ON [t] | Gross El. Produc-tion in GWh/a | MB [t] | PEP | SK [t] | PEP | AB [t] | PEP | BC [t] | PEP |
|---|---|---|---|---|---|---|---|---|---|---|
| Pigs | 3,272,600 | 127 | 2,379,000 | 92 | 1,202,000 | 47 | 2,032,700 | 79 | 150,000 | 6 |
| Sheep | 281,500 | 1.1 | 78,800 | 0.3 | 122,700 | 0.5 | 234,300 | 0.9 | 70,000 | 0.3 |
| Chickens | 191,481,000 | 79 | 27,911,000 | 12 | 20,021,000 | 8.3 | 58,718,000 | 24 | 96,796,000 | 40 |
| Turkey | 8,422,000 | 40 | 1,319,000 | 6.3 | 793,000 | 3.8 | 1,713,000 | 8.1 | 2,152,000 | 10 |
| Beef | 405,000 | 76 | 560,000 | 105 | 1,175,000 | 220 | 1,870,000 | 351 | 275,000 | 52 |
| Milk Cows | 371,000 | 280 | 50,000 | 38 | 29,000 | 22 | 98,000 | 74 | 86,500 | 65 |
| TOTAL | | 602 | | 254 | | 302 | | 537 | | 173 |
| Corn | 4,480,000 | 9660 | 260,000 | 561 | - | 0 | - | 0 | - | 0 |
| Oats | 66,000 | 3069 | 996,000 | 14,670 | 1,403,000 | 46,140 | 794,000 | 31,030 | 51,000 | 117 |
| Wheat | 836,000 | | 3,827,000 | | 13,048,000 | | 6,845,000 | | - | |
| Barley | 435,000 | | 1,568,000 | | 5,650,000 | | 5,879,000 | | - | |
| Hay | | 1039 | | 1000 | | 1000 | | 1000 | | - |

*PEP: Proportional electricity production potential in GWh/a (extrapolated from Ontario figures based on feedstock); for plant residues: gross energy content, to be reduced by conversion factor*
*Other sources used:*
*Oats statistics: http://www.oatgrower.com/oatsfree/cdnprod.htm*
*Wheat & Barley: http://www.agric.gov.ab.ca/economic/update/update11.html*
*Wheat & Barley Ontario: http://www.gov.on.ca/OMAFRA/english/stats/crops/history_metric.pdf*
*Hay: assumption = Prairie Provinces have at least the same hay residue as Ontario*

**Table C3 — Possible Annual Electricity Production from Agricultural Waste in Canada in GWh** (based on [REAP 2002b] and Table C2)

| Residue | BC | AB | SK | MB | ON | QC | Atlantic Prov. |
|---|---|---|---|---|---|---|---|
| Straw | 117 | 31,030 | 46,140 | 14,670 | 3,069 | 1,994 | 326 |
| Corn Stover | 0 | 0 | 0 | 561 | 9,660 | 5,667 | 29 |
| Hay | 0 | 1,000 | 1,000 | 1,000 | 1,039 | 1,003 | 243 |
| Crops Gross Total | 117 | 32,030 | 47,140 | 16,231 | 13,768 | 8,664 | 598 |
| Crops Net Total* | 29 | 8,008 | 11,785 | 4,058 | 3,442 | 2,167 | 150 |
| Manure** | 173 | 537 | 302 | 254 | 602 | 566 | 95 |
| TOTAL | 202 | 8,545 | 12,087 | 4,312 | 4,044 | 2,733 | 245 |

* *Assumed electricity conversion factor: 25%*
** *Assumed electricity conversion factor: 20%*

# Appendix D — US Restructuring and Renewables: An Overview of Definitions

**Table 3: Eligible Fuel Sources within Proposed or Enacted State Restructuring Legislation**

| | Solar | Wind | Hydro | Fuel Cell | Geo-thermal | Tidal Ocean Wave | Biomass | Landfill Gas | Sewage Digester Gas | Municipal Solid Waste | Waste Tire Comb | Cogen | Other Criteria |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Arizona** | X | X | <5 MW | | X | | In-state | X | X | | | | |
| **Arkansas** | X | X | | | | | X | X | | X | | | |
| **California** | X | X | <30 MW | | X | X | X | X | X | X[5] | X | | |
| **Connecticut** | X | X | X[2] | X | | | X[6] | X | X | X | | | |
| **D.C.** | X | X | X | | X | X | X | | X | | | | |
| **Delaware** | X | X | X | | X | | X | X | | | | | |
| **Illinois** | X | X | X[3] | | | | X[7] | | | | | | |
| **Iowa** | X | X | <100 MW | | X | | X | | | X | | | |
| **Kansas** | X | X | X | | | | X | X | | | | | |
| **Maine** | X | X | X | X | X | X | X | | | X | | X | All <100 MW |
| **Maryland** | X | X | X | | X | X | X | X | | X | | | |
| **Massachusetts** | X | X | Run-of-river | X | | X | Low-emission | X | | X | | | |
| **Michigan** | X | X | X | | X | | X | X | | X | | | |
| **Missouri** | X | X | | | | | X | X[9] | | | | | Low-impact + sustainable |
| **Nevada** | X[1] | X | | | X | | In-state | | | | | | |
| **New Jersey** | X | X | <30 MW | X | X | X | X[6] | X | | | | | |
| **New Mexico** | X | X | X | X[5] | X | | | X | X | | | | Low/zero emissions |
| **Oklahoma** | X | X | X | | X | | X[6] | X[8] | | X | | | |
| **Pennsylvania** | X | X | Low-head | | X | | X[6] | X[8] | | X | | | |
| **Rhode Island** | X | X | <100 MW[3] | X | | | X[6] | | | | | | |
| **South Carolina** | X | X | Low-head | | X | | X[6] | X[8] | | X | | | |
| **Texas** | X | X | X | | X | X | X | X | | | | | |
| **Vermont** | X | X | <80 MW[4] | | | | X[7] | X | | | | | All <80 MW |

Source: NACEC electricity database.

1 Except for solar thermal.
2 Licensed under CWA or CEAA.
3 No new construction or expansion.
4 Licensed and water quality certified .
5 Non-fossil fuel.
6 Sustainable.
7 Agriculture, crops, silviculture waste.
8 And mine-based.
9 And lagoon.

*Source: Environmental Challenges and Opportunities of the Evolving Continental Electricity Market Working Draft: Background Note for the First Meeting of the Advisory Board, North American Commission for Environmental Cooperation, January 16, 2001*

# Appendix E — Green Premiums in the United States and Canada

**Table E1 — Selection of Green Premiums for Bundled Green Power Products**
(in US$ and C$)

| **Company/Product** | **Price per kWh** |
|---|---|
| Cambridge and North Dumfries Hydro (discontinued) | 0.84¢ (CDN) |
| Ontario Hydro | 3–4¢ (CDN) |
| EPCOR (100% option) | about 7¢ (CDN) |
| Go-Green.com (green 100) | 1.98¢ |
| Commonwealth Edison GreenSmart | - 0.12¢ (discount) |
| Edison Source, EarthSource 2000 | 3.47¢ |
| Edison Source, EarthSource 100 | 3.07¢ |
| Green Mountain Energy Resources, Wind for the Future | 2.1¢ |
| Keystone Energy Services, EarthChoice 100 | 2.46¢ |
| PG&E Energy Services, Clean Choice 100 | 2.29¢ |
| CT Energy Coop, EcoWatt | 1.00¢ |
| Conectiv, Nature's Power 100 | 0.79¢ |

*Most the information in this table comes from a 1999 NREL report, Green Power Marketing in Retail Competition: An Early Assessment*

# Appendix F — States with Set-Aside for EE/RE in NOx Budget Rules

| State | EE/RE Set-Aside?<br>Rule Status | SIP Status | Start Date of Set-Aside: Size of Set-Aside | Allocations to date | State Contact | EPA Regional Contact |
|---|---|---|---|---|---|---|
| MA | Yes. 310 CMR 7.28 EE/RE allocation methodology reserved.<br>Rule Final. | Final Approval | 2003: 643 allowances (5%) | NA | Edward Szumowski 978-661-7792 | Region I: Dan Brown 617-918-1532 |
| NH | Yes. Multi-purpose set-aside. EE/RE shared with other purposes.<br>OTC — Rule Final. | OTC — Final Approval (?)<br>SIP Call — NA | 1999 — 445 allowances 2000–2005 — 445 allowance minus adjustments | 1999 — 9<br>2000 — 7 | Joe Fontaine 603-271-6794 | |
| NJ | Yes.<br>Rule Final. | OTC Phase II — Final Approval<br>SIP Call — Proposed Approval | 1999 — Unlimited<br>2003 — 410 allowances (5%) | 1999 — 67<br>2000 — 89<br>2001 — 69 | Tom McNevin 609-984-9766 | Region II: Rick Ruvo 212-637-4014 |
| NY | Yes.<br>Rule Final. | OTC Phase II — Final Approval<br>SIP Call — Proposed Approval | 1999 — 115 allowances (0.25%)<br>2003 — 1241 allowances (3%) | 1999 — 0<br>2000 — 0<br>2001 — 0<br>2002 — 60 tons certified | Bob Billowa 518-402-8396<br>Carl Michael, NYSERDA 518-862-1090 ext 3324 | |
| MD | "clean air projects" set-aside<br>Rule Final. | Final Approval | 2003 — 436 allowances (3%) | NA | Duane King 410-631-4178 | Region III: Christina Fernandez 215-814-2178 |

*Information gathered by: Art Diem diem.art@epa.gov , US EPA, Office of Atmospheric Programs, Global Programs Division, State and Local Capacity Building Branch, 202-564-3525 (updated in 2002 by the author)*

# Appendix G – Data and Assumptions for Table 7.1

Assumptions made for Table 7.1

- Figure 4.18 was used to determine the current power mix.
- The share of power generation technologies will grow according to their shares of planned capacities as shown in Table 4.17 (natural gas, 52.3%; large hydro, 33.6%; coal, 10.2%). The category "Others" from that has been left out and is assumed to be amalgamated in the growing renewables share. Growth for oil and nuclear based technologies is assumed to be zero (implying an error as Ontario is planning on bringing some nuclear capacity back on-line). All growth technologies (natural gas, large hydro and coal) will be displaced equally by other renewable power projects.
- Growth of non-large hydro renewables under base scenario: 3000 MW (2800 MW wind, 100 MW small hydro, 100 MW biomass) by 2010; 4000 MW (3600 MW wind, 200 MW small hydro, 200 MW biomass) from 2010 to 2020.
- Growth of non-large hydro renewables under the RPS scenario is based on Table 4.23.
- $CO_2$ emissions for conventional technologies as in Table A1. For renewable technologies, the emissions for 2000 were calculated assuming 200 MW of wind and the remainder coming from biomass (for simplicity, a value of 16.6 g/kWh of net emissions was used for all biomass sources). Emissions for 2010 and 2020 were assessed based on Table A1 and the shares in newly added capacity as given in Table 4.21, with the numbers given in that table reduced by a fixed percentage to meet the somewhat lower numbers used in the recommendations in Table 4.23 (i.e., 45% for 2010 and 57% for 2020).

As no life-cycle emission data could be found for emerging ocean-based technologies, it was assumed that these emissions are equal to those of wind turbines.

**Table G1 — Life-Cycle Annual $CO_2$ Emissions from Canada's Electricity Production Sector, Base Scenario, in 1000 metric tons**

| | **2000** | **2010** | **2020** |
|---|---|---|---|
| Nuclear | 900 | 900 | 900 |
| Coal | 97,410 | 107,724 | 117,465 |
| Large Hydro | 2,782 | 3,038 | 3,303 |
| Natural Gas | 9,288 | 31,831 | 56,416 |
| Oil | 34,356 | 34,356 | 34,356 |
| Renewables | 111 | 196 | 323 |
| Electric Sector Emissions | 144,847 | 178,289 | 211,943 |

**Table G2 — Life-Cycle $CO_2$ Emissions from Canada's Electricity Production Sector, RPS Scenario, in 1000 metric tons**

| | 2000 | 2010 | 2020 |
|---|---|---|---|
| Nuclear | 900 | 900 | 900 |
| Coal | 97,410 | 105,031 | 109,634 |
| Large Hydro | 2,782 | 2,979 | 3,091 |
| Natural Gas | 9,288 | 26,980 | 38,081 |
| Oil | 34,356 | 34,356 | 34,356 |
| Renewables | 111 | 580 | 1,611 |
| Electric Sector Emissions | 144,847 | 170,826 | 187,673 |