Integrating Sustainable Generation Technologies in the Canadian Energy Portfolio

Bernard Saulnier, senior research scientist

Expertise, Mécanique, métallurgie et civil
Direction principale R&D - IREQ, Hydro-Québec
1800 boul. Lionel Boulet, Varennes, Qc J3X 1S1
fax: 514-652-8309, e-mail: saulnier@ireq.ca

SUMMARY

The structure of the energy industry and the planning of electrical networks are experiencing rapid changes under the combined action of social, technico-economical, environmental and trade pressures. Given the widening diversity of competing (demand and supply) options being offered to consumers, energy policy makers must establish a fair and consistent technico-economic methodology to compare the sustainability and natural synergies of energy options. Such an approach towards energy issues should allow renewable energies, energy efficiency and storage technologies to build strong alliances with information technology and take a major place in the long-term energy portfolio of societies.

With examples of recent projects involving significant penetration of wind energy in electrical grids in Canada and abroad, the author presents the rationale for technico-economic comparison indicators that canadian policy makers need to take into account so as to bring the full advantage and value of promising renewable energy technologies to the canadian energy market. The merits of expanding the pace of the current Canadian GHG reduction program by granting all provinces, irrespective of their electricity market structure or generation mix, an equal opportunity to invest in RE projects contributing to the national goal are presented. In this regard, the limitations of the prevailing accounting rules found in the Canadian GHG reduction program are analysed and corrections are proposed.

1- ISSUES AND TRENDS

The dynamics of the changes in the electrical markets are driven by new trends in energy demand and supply. They create new opportunities in the design of energy systems and challenge the current architecture of energy networks. Four groups of issues are at play behind the energy scene: Social, Technico-economical, Environmental and Trade.

Recent evidence of the detrimental impacts of present dominant schemes of energy consumption on global warming and climatic changes are acknowledged by all major energy stakeholders today. The discussion on the true value of energy options at the international level generate growing pressures on jurisdictions to integrate more sustainable energy technologies in their portfolios. As a result, new energy markets that call for an environmentally sustainable use of resources at the distribution and retail levels grow steadily, leading to a noticeable shift in the planning of energy production, distribution infrastructures and services.

1.1 Social

At the present rate of growth, world population will have doubled in 50 years. Coupled with the strong emergence of asiatic countries, the global demand for energy will increase substantially and exert huge pressures on the supply chain.

- world energy demand grows at 5- 10 %/year in certain countries. From 1993 to 2002: 550 GW additional power was needed; that is 5.5 times the installed electrical capacity in place in Canada)
- around 2010, world oil production is expected to decline, driven by resource constraints.
- 2001, 90% of the energy consumed comes from fossil reserves; 2 billion people without electricity.
- 2050: 10 billion people, 15-20 GTOE / year;

1.2 Technology and costs

The evolution of annual energy intensity (GJ per unit of GNP) over time is a measure of the energy efficiency of end-use processes/technologies and of the impact of transportation networks on markets development. Over the period 1850-2000, energy intensity has shown two clear steps in performane improvements in trend, corresponding to the early 1900 industrial boom and following the petroleum crisis of 1973. Also, it has been shown that population growth rate tends to be inversely proportional to energy consumption per capita (1), illustrating how the set of issues described in this section are closely interlinked. Because of the versatile and flexible nature of electricity, when energy intensity is referenced to electrical rather than thermal energy units, renewable energy sources and demand side options are key players in the long-term energy needs of communities.

Reducing energy intensity favors an increased closeness between production and consumption, changes the energy production paradigm from centralized (constructed) to distributed, modular (manufactured) projects. Overall, as the costs for new conventional centralized energy options increases, that of renewables and many end-use technologies become more attractive at the distribution level (2). Distributed generation helps to avoid investments in new transmission capacity. Embedded generation help to reduce transmission and generation losses and/or bypass some transmission and distribution costs. Storage technologies further enhance the value of distributed/embedded supply and demand side options.

Markets for autonomous energy systems and products are in rapid expansion. Autonomous hybrid electricity systems using local renewable resources, batteries, diesel back-ups, gradually emerge and offer competitive alternatives to central grids in isolated or rural areas. Technology leapfrogging is coming in regions of Africa, India, China that exert strong pressures on cost reduction of many technologies including renewables and generate increased appeal for these energy sources in developed countries. Technology drives the competition into a new energy paradigm. Power electronics, PLC and telecom networks will be an important part of the energy services in the making.

1.3 Environment

The environmental dimension of the energy problem has had so far very little weight in project analysis. Questions like resource management (fossil reserves, biomass management, water supply, etc), climatic impacts on biosphere (greenhouse gases, air quality, etc), biodiversity liabilities and environmental rights are hard questions for financial analysts. Yet there is an international recognition today (Kyoto 1997) that major efforts are needed to include them in the global financial analysis of projects. The re-insurance companies claim to have clear facts to substantiate that requirement (3). As well, in view of these growing economic externalities associated with energy combustion, consumer is every day more inquisite about the utilization of his taxdollars spent on energy-related programs and subsidies. Three mechanisms are frequently found as market and regulatory incentives.

1.3.1 Green marketing vs public policy

The reshaping of the energy industry will be influenced to a great extent by citizens environmental concerns that suggest a need for more energy efficiency measures and more renewable energy projects. Green energy marketing is a method that certainly has its merits in tapping this niche market of « green » customers. However, the rationale of leaving the environmental quality depend on voluntary contributions clearly has its limitations. Such an approach could prevent promising and competitive technologies like wind energy to contribute a significant part of the new electrical demand.

1.3.2 The Renewable Portfolio Standard (RPS)

A plan, initially put forward in march 1998 by the Clinton administration, recognizes the value of a RPS that prescribes that 7,5% of electrical energy consumption be supplied by renewable energy (excluding hydro power) in year 2010. This RPS features a renewable energy credit trading mechanism as a certification tag for energy retailers and distributors.

This plan implicitly recognizes the value of some environmental and synergetic aspects of energy management that are not valued in present markets rules. It has been a highly debated subject in the USA in the past years, and will continue to be, even more so, under the Bush administration. In the recent years, the relative stability of a federal « Production Tax Credit » has triggered a significant volume of wind projects in the USA. The PTC has the advantage of sending a simple, clear signal all across the USA; any State can choose to enhance the prospects of the PTC by bundling his own program of incentives towards renewable energy so as to attract developers as the large wind developments in construction in the Northwest of the USA (BPA) and in... Texas have demonstrated recently.

1.3.3 A Renewable Energy Feed-in Tariff (REFIT)
Over the last 10 years, Germany has built a major wind industry mainly through the leverage of the REFIT system adopted in the early 90's. This law that sets the minimum price that utilities have to pay for wind energy have created a stimulating environment that have allowed German companies to introduce major innovation in the design of modern wind turbines. Rainer Raake, head of the federal environment ministry of Germany was quoted saying recently that "Phasing out of nuclear power (75000 MW by 2010) goes hand in hand with phasing in more wind power (15 000 MW by 2010, 40 000 MW by 2030) (4). Enercon will be installing this fall a prototype version of its E-112, a machine in the 5 MW range, with a rotor diameter of 112 meters for offshore wind farms projects.

In June 2001, France has chosen to follow the wind industry roadmap established and successfully tested by Germany (5). Specified Buyback Tariffs Law, with no established quota; a very simple mechanism.

1.4 Trade and restructuring

The reshaping of the electricity industry is driven by the economic opportunities perceived by the major energy stakeholders. It should be reminded that the gas industry has been an active stakeholder in the continental restructuring of the energy market. Open access rules is the direct result of legislative decisions to introduce competitive processes in established monopolies and to offer consumers a choice of energy services. By leading the energy markets into a functional separation between GenCo's, TransCo's and DistCo's and ESCo's, the consequences for future energy infrastructures will be enormous (6,7,8). Over and above the fact that electricity is traded in the new market as any other commodity (a commodity of a synchronous nature one should bear in mind) , the trends observed in the reshaping of the energy industry are manifold;

- shift from mutually exclusive monopolies towards fully merged energy (gas-electric) groups;
- shift from centralized least-cost electricity planning towards continental « spot » energy trading market; impacts on ancillary services, plant operational guidelines and reserve margins, etc
- increased focus on portfolio of energy services and demand-side products as an alternative to peaking plants;
- gradual levelling-off of inter-regional energy costs (end result of open access ruling).
- regulation on minimum green power sources for all distributors (RPS) is likely to increase as well;

A diversification of their portfolio appears to be the strategy of choice for large competitors. The merging of competing energy industries is a risk minimization process that the large energy players seek as an insurance against potential economic threats in the new competitive environment. It is important to observe that the gradual departure from least-cost planning comes as a direct consequence of competition and modifies in a major way the traditional base on which projects were, by convention, compared and ranked. The evolution of the electricity industry reshaping will depend on:
1) market access rules (wholesale vs retail),
2) technology competition (Renewable/gas/coal energy price differential),
3) transmission costs (the location of a new generation equipment or the sale of additionnal blocks of energy may involve building a new line and obtaining right-of-ways through increasingly litigious procedures)
4) environmental impact regulation (energy technology characteristics vs cost of associated environmental damages)

Although new business opportunities will sprout also for many smaller energy stakeholders as the retail market opens up, at this time, the market power of the restructured commercial utilities still dominate the bulk of the electricity trade. And, as the California experience has shown in the spring 2001, everybody noticed that the rules of electricity restructuring from the GenCo to the DistCo must be made very consistent if citizens are to see the benefits expected from electricity restructuring. It turned out that Californians had to pay the unexpected GenCo's loss out of their Tax base.

2- CHARACTERIZATION OF ENERGY GENERATION OPTIONS

It will take some time before the fine tuning of the new electricity market is satisfactory to all stakeholders, starting with the consumer. In the same way the electricity restructuring must skillfully dissect the costs of each component of delivering electricity to consumers, it will learn progressively to put a price on other aspects/value of energy supply that are presently externalized from energy or generation projects cost analysis. Sustainability ios one of them. The new market may not be able to value it yet, however, this aspect will help to consolidate prospective energy consumers who care about minimizing both losses in the overall system and environmental impacts.

One of the key idea behind energy sustainability has to do with the value of the thermodynamic efficiency and the synergy between various energy options as they are connected to the electrical grid. There are efficiencies (and money) to gain in having resources work together at the right place and time. Obviously, the energy-as-a-commodity market will one day value efficiency at the generation side, an aspect presently largely ignored, even if the new rules of restructuring tend to have a negative impact on it. Some examples taken from the wind energy sector will help to picture this view.

2.1 Wind-Hydro alliance (Canada)

For example, the monthly windspeed on the St-Lawrence shores, like for most locations in the northern hemispheres, closely follows the monthly electrical demand. While the water inflows in the hydraulic reservoirs are six months out of phase with demand, wind and hydro, thanks to the hydraulic reservoir, power become natural allies in Québec. Winter electrical demand is dependant on the presence of winds that wind turbines can convert, locally, into electricity, thereby offseting local wind-induced load and reducing at the same time the water flow at the hydro plant far away. Recent studies by Lafrance have shown that this natural alliance may be valued in terms of additional export potential (9).

2.2 Wind-Gas alliance (Midwest, USA)

Cogeneration is obviously an improvement over peak generation gas turbine. In 2000, Northern Energy Alternative, an energy developer based in Minnesota, won a competitive bid issued by Northern States Power, a MidWest utility, with a proposal where 100 MW of wind were coupled to 550 MW of gas turbines (10). Obviously, the wind resource is not always there, but it is predictable to a point where an IPP can foresee economic gains in understanding how and when the technology works for him.This scheme provided the least financial cost to him compared with an all-gas situation. The concept simply takes advantage of the fact observed by the promoter that the cycle of demand, the cost of gas and the wind resource are all in phase. This project is under commissioning and proves again the importance of valuing the natural synergy of resources over and above the fact that one may too often be inadvertently discarded because of its intermittent character. This example also raises the question: what are the limits to wind penetration in a grid ?

2.3 Wind Penetration in grid : The instructive case of ELTRA (Jutland, DK)

ElTra is the operator of the electricity transmission grid in the western part of Denmark, just North of Schleswig-Holstein, a lander of Germany. ElTra is at the center of the highhest density of installed wind capacity in the world. As an operator in the NordPool Transmission area where open market rules apply, ElTra has reported that more than 20% of the annual energy delivered in its transmission area comes from wind power (11). On certain weeks wind provides more than 35% of the weekly energy total and some hours have seen wind supplying as much as 70% of the hourly demand. With the Danish law prioritizing wind energy on the grid, operators do not see technical difficulties in accepting wind energy provided complemetary resources like that of Norway's hydro power are available and the forecasting models continue to assist in the generation planning. As to the Schleswig-Holstein land, wind penetration exceeded 15% in 2000.

2.4 Valuing synergies among energy options

These characteristics need to be taken into account to assess the impacts of power technologies development schemes. A few examples of the incremental value of an energy technology are given in Table 1 (criteria for comparison of energy options). Other resources , renewable (landfill gases, agricultural waste, biofuels, sewage, etc) or non-renewable (fossil, fuel cell, nuclear, etc) could be analysed in this fashion. Other criteria can be added as well (net energy balance of energy options, GHG emissions, etc).

It is obvious that these criteria help to raise the case for renewables and sustainables energy sources. Taking them into account challenges the energy planning methods and processes of all stakeholders over the medium term. It also suggest that financial incentives and regulatory policies at provincial and federal levels are devised in a manner that value this synergetic characterization.

3- STORAGE: ENERGY SERVICES, POWER QUALITY

Storage technologies will also be key players in making the transition towards an open energy market. Energy storage is useful at different scales and can be applied to different type of loads with appropriately designed storage media. Today, the preferred energy storage media for most transportation purposes is fuel; electrochemical batteries are normally used for lighting or communications; fossil fuel or wood for heating, propane is good for cooking purposes.

At a small scale of application where a central grid is not available, picoelectrification is another area where renewables and storage are combined to supply the needs of small meteo, telecom and light electrical loads. At a macro scale, the role of storage is well illustrated with the example of hydro reservoirs. These huge « batteries », replenished every year by nature allow to resolve the problem of the annual cycle of electrical demand being out of phase with water supply inputs. These water «batteries » presently constitute in Quebec, Manitoba and BC the storage medium from which most of the electrical energy sales come from. As we have seen, hydro reservoirs can also be managed so as to improve the combined yield of two intermittent sources of energy like wind and rainfall compared to the case where both resources are considered as unrelated for the purposes of supplying load.

Utilities are also exploring how other storage technologies at distribution sub-stations can provide a more flexible alternative to traditional investments for handling sub-station peak load growth. These storage technologies can maximize the capacity of existing sub-stations by opening power quality differenciation services to classes of customers, favoring the integration of renewables at distribution level, or improving power factor correction and system stability.

Distributed storage in the electrical grid will be a critical vehicle for materializing new energy growth at regional levels. Batteries, super-capacitors, flywheels, superconducting-magnetic energy storage, compressed air, hydraulic reservoirs, thermal underground storage, fuels, hydrogen storage are other types of storage technologies. Storage can be useful to deal with generation, transportation and distribution problems: Power quality (low energy / high power), energy shift: (high energy, high power storage media for load and generation displacement) and renewable/diesel systems with or without storage for off-grid or distributed energy supply options.

One technology is worth noting here. It is marketed under the name Regenesys by Innogy, a subsidiary of National Power, U.K (12). The technology targets the distribution grid where it can increase the flexibility of classical power plants operating in the competitive electricity market. This modular storage technology works like a rechargeable battery. It uses a reversible electrochemical process to handle large amounts of energy at significant power level. After succesful tests on a prototype unit, Innogy has announced the construction this year at Little Belford of a first commercial unit of 120 MWh capacity (10 MW nominal -15 MW peak) that will be used in coordination with a thermal plant. The combined system will take advantage of the opportunities existing on the free market of electricity in England while postponing the investment of extra lines. Discussions are advanced with TVA (Tennessee Valley Authority), Mississipi to install a second commercial plant in 2003 for similar purposes (13). Such a technology points towards the possibility of supplying village power electricity economically from intermittent energy resources like wind. The technology will be commercially available in 3-5 years.

The introduction of storage and demand-side technologies introduces new ways of reducing investment risks by allowing electricity quality to be tailored to specific end-uses. Let's not forget that storage can open new opportunities for many end-uses as well: City transportation efficiency could be vastly improved by the use of a regenerative braking with flywheel storage; for heating, phase change material or district heating systems could help to manage home cogen packages; for lighting, batteries recharged daily by PV shingles; for cooking and small appliances, off-peak-recharge/high rate of discharge batteries;

The increasing competitiveness of these storage media will further prepare consumer to ask for refined energy services and use an increased set of options at the end-user level. It is obvious that the availibility of « intelligent » energy and power controls at the consumer level will greatly contribute to improve end-use energy efficiency and set up attractive service quality packages. The impacts on the electrical bill may not be as high as one might at first think. In fact, since these emerging technologies and services target most classes of ratepayers, their level of economic competition is set at the level of distribution retail price of energy in niche markets that have been traditionally captive. Clearly the opportunities for distributed and embedded renewables generation options can only increase.

Ultimately, as greater importance is given to the use of local resources, storage technologies will take a greater importance in the energy systems design. Gradual implementation of these technologies should lead naturally to a better energy efficiency in the overall electrical grid and ground transportation systems.

Figure 1 illustrates how distributed systems and technologies offer flexibility to traditional electrical grid planning.

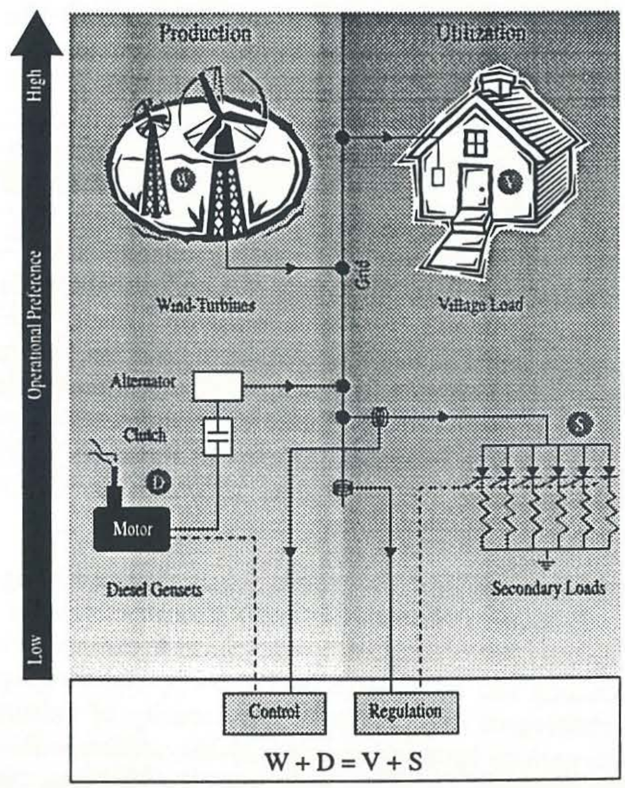
4- INTEGRATING DIVERSITY AND EFFICIENCY (SUPPLY + DEMAND SIDES)

As we turn our attention towards village power, numerous energy scenarios need to be evaluated to minimize costs to the ratepayers. Each scenario must take into account the characteristics of existing energy infrastructure, local energy supplies and demand. When one considers on one hand the wide variety of energy supply and demand options commercially available today and, on the other hand, the large market for rural/village electrification in the world that needs to be addressed, it is unlikely that one single scenario will apply to all cases. There are many situations to cover and many solutions can be worked out.

Therefore, a new engineering field labelled Integrated Energy Systems Engineering is needed to come up with diversified energy supply and services providing power quality appropriately tailored to specific end-users and communities. Autonomous systems, decentralized systems, multi-energy systems are generic labels of that emerging engineering field. The selection process will require detailed specification of the energy needs, a good understanding of the characteristics of the resources and technologies, and take into account synergetic and long-term sustainability criteria.

It is useful to introduce hybrid systems starting with the simple autonomous diesel genset. In a sample of 10 countries surveyed (14), a market study estimated that there are more than 100 000 Diesel generator sets in sizes up to 1 MW, 75 % of them up to 75 kW that cover a variety of village power and commercial loads. 15 000 MW of existing diesel gensets could consider hybrid systems retrofit. Also, the new village electrification potential where wind-diesel coupling could be used exceeds 26 000 MW in the 10 countries investigated (class 5-7 winds). The government of Brazil recently announced investment of 25 billions US$ to provide renewable electricity for rural areas without electrical services (15). There is no doubt that such programs will bring key developments and significant cost reductions in numerous hybrid systems components.

High-Penetration No-Storage Wind-Diesel Scenario



One example of hybrid system at the village scale has been demonstrated with the development by Hydro-Québec of the High Penetration No Storage Wind Diesel scenario (HPNSWD). The system allows the diesels to be stopped when the winds are strong enough to supply all the electrical demand of a village. The diesels run in their normal operating range (for example between 30 and 100 % of nominal power) or are stopped. The excess wind energy is dispatched to secondary (or interruptible) loads or is dumped.

The HPNSWD scenario is the simplest scenario that allows the diesels to be stopped. The HPNSWD scenario is particularly interesting for remote networks because of its simplicity and for its economic advantages, enhanced even further if the excess wind energy is used to displace heating fuel. Typically, a northern Quebec village requires 3 times as much energy for space heating as it does for electricity production, giving ample room to absorb excess wind energy. In that sense, at high penetration, the HPNSWD scenario is more an energy (cogeneration) plant rather than an electrical plant. A first commercial application of this technology was commissioned in June 1999 on the island of St-Paul, Alaska (16). Similarly, other environments could present other opportunities for the use of the excess energy (desalination, refrigeration, process heat, etc).

Such concepts naturally are not limited to small grids; higher wind penetration of renewable resources in main grid is also technically feasible. In this regard, the danish goal of providing 50% of its electricity production from wind by 2030 comes as a credible argument that it is likely to happen.

4.1 The hydrogen vector

It is anticipated that, in the medium term, hydrogen and fuel cell will become an increasingly competitive alternative to diesel gensets. However, one should not forget that Hydrogen is an energy vector, not an energy resource; Hydrogen is produced by breaking up atomic links in water or hydrocarbon molecules ; doing this work requires energy. Therefore, the Hydrogen-economy future is intimately linked to an efficient use of energy both on the demand and supply sides. The hydrogen, produced by electrolysis driven by renewables, will be stored to be used when demand exceeds renewable generation.

Some automobile manufacturers have recently made strategic moves towards fuel cells; this is likely to open significant markets where electricity will begin to replace fossil fuels in ground transportation systems. The US DOE issued a sollicitation for financial assistance applications to support a five-year demonstration program on « Integrated Renewable/Hydrogen utility systems » (17). DOE will provide up to 2,5 M$/yr (excluding the cost of the renewable energy sources) to that end.

5- THE INNOVATION CYCLE

All technologies follow a well-known path of rise and fall that has been extensively documented. Any technology eventually ends up being displaced by one that improves the conventional way of delivering a given service. Also, every technology that is now mainstream has gone through a certain maturation process. It is useful to analyse these disruptive business patterns from the perspective of the innovation cycle.

By looking at the general perception of dominant vs promising vs useless vs risky-but-potentially-valuable technologies in a given epoch provides a contrasting background to understand the ways of technical evolution and business practices of societies in time.

If we attempt to find the common characteristics of technological wisdom in years 1880, 1945, or 2000, we obtain a useful hindsight on the role of R&D. By looking at different « photographs » of technological status taken at different times over the last century, we get a sense of the powerful leverage that technological innovation exerts in the economic sphere. It shows very clearly the seeding role of R&D in building the business framework for the next economic wave. The airplane, perceived as an impossible dream in the 1880, have become the basis of a huge industry today. Examples abound.

5.1 The return of wind energy

One of the « pearls » re-discovered by the energy analysts over the last 10 years is clearly the wind industry. Since the turn of the 1800, the technology revolution caused the rapid disappearance of windmills from the energy portfolio to favour fossil fuels. Wind is actually now making a return, building on all possible modern technologies and materials. Whoever looks back at the last 20 years of wind technology development must recognize that this industry has come a long way from the the time the first modern 50 kW machines came out of the agricultural industry of Denmark in the 80'S. The story of this rebirth was no coincidence nor magic; it was done with surprisingly low subsidies, but a very strong and well crafted political framework that pulled together investors, industry, citizens, utilities and research organizations towards the task of creating a new industry. The wind industry of today has grown up on a solid technological base, and has shown since its inception a phenomenal industrial growth and well documented continuous decrease in energy costs. Countries like Denmark, Germany, with the limited quality of their wind resource, have now demonstrated the value of their vision and efforts.

Their well-crafted and sensible market approach to wind energy has shown remarkable results for industry, investors, taxpayers, citizens and the GNP (JOBS). More than 20 GW of wind capacity is installed in the world today. The annual growth rate in installed capacity averaged above 30% over the last 6 years and is expected to continue on that trend. The average power of turbines installed last year in Germany was above 1 MW. As a consequence of this growth in scale and volume of business, the cost of wind energy shows continuous reduction in price; as low as 3,2 UScents per kWh (including a PTC) are expected for upcoming large projects this year (Oregon-Washington 300MW). Because of the huge improvements in the performance and reliability of the technology, other countries joined the bandwagon, namely India and Spain some time ago. France has analysed the process and legislated market rules that tell clearly of an industrial growth market.

Considering the huge wind resource potential existing and accessible coast to coast, Canada should take notice of the action and take a second look at the full economic perspectives of making place for this promising technology in its energy portfolio.

6- CANADA GHG REDUCTION GOALS

There is a recurrent debate between canadian energy stakeholders as to what are the best methods to foster the fledgling renewable energy industry in Canada: a general carbon tax? a plain voluntary GHG reduction? a binding target of tradable credits market for GHG reductions? a Renewable Portfolio Standard? A quota with open bid process capable of generating enough demand to support industrial growth? Business-as-usual free-market? A quiet wait-and-watch for an international CO2 trading market? Or like in Europe, a minimal price system (like the REFIT enforced in Germany in 1990 and adopted recently in France) that has opened the way for strong industrial growth while stimulating innovation and financial opportunities for the wind sector?

6.1 What qualifies as a 'green' kWh

While the discussion is not over yet, Canada has so far taken a noticeably slow path to enrol a promising and abundant resource like wind in its strategy to reduce GHG. Its strategy counts primarily on voluntary efforts (private or corporate). With a goal of greening 20 % of its own electricity consumption by 2010, the federal buildings intend to use public money to pay for the surplus cost of green energy generation. The wind projects that have been built in Canada through the federal mechanisms of voluntary efforts and investment tax credits for renewable energy hardware mostly fit for small IPP projects. have not generated a volume of projects that can stimulate the interest of the industry enough to build a manufacturing plant in Canada.

Unfortunately, present rules of accounting in the federal GHG reduction program are, to a certain extent, discriminatory to more than half of the country jurisdictions who are effectively told to rely on their sole resources to contribute their share to this important national goal. The present accounting rules are written in such a way that the only provinces or territories that can take advantage of them have to balance every kWh with a 'black' kWH (one who would have otherwise been emitted by a thermal or fossil-fueled generator) from their territory. Besides, by giving more business opportunities to 'brown' provinces while excluding all the "greener" ones from the marketplace is in effect excluding a significant part of the taxpayers from eventual benefits. One cannot help but to notice that such rules hardly match with the position defended by Canada during the Kyoto negociations in support of joint implementation accounting across North America as a mechanism for GHG reduction.

At face value, a green kWh, generated anywhere « from Coast to Coast » should figure in the canadian book of GHG reduction accounts. In fact, a Canadian GHG reduction program should be based on the equal opportunity principle to all constituencies. Accordingly, the funds devoted to a national goal should be made available nationally and accessible universally. By so doing, the federal would acknowledge the fact that the distinct energy profiles of the provinces and territories should not prevent them to contribute their share towards the national GHG reduction goal. Sadly, provinces that have a strong hydroelectric base are presently virtually excluded from the canadian Green Procurement program. Moreover, the present accounting rule is obviously downplaying the value of promising technologies like wind for canadians. Considering the huge potential of the Canadian wind resource and the proven track record of this technology today in a growing number of electrical grids of the world, one is forced to note that the federal approach towards its GHG reduction target lacks the framework creativity ınd determination that other countries have lemonstrated on that front, all to their economic ›enefit. The broad-base public support for renewable :nergy calls for a much stronger mechanism.

;.2 In search of a Coast to Coast tool

Considering the growing gap between the advocated GHG reduction goals of Canada and the weakness of the mechanisms to reach them, the realism of the program is questionable. A simple approach like the PTC should generate a great deal more green 'canadian' kWhs, all accountable in the nation's books of GHG achievements. With a PTC mechanism, BC, Manitoba, Québec, NFL could easily contribute their share to reduce the overall canadian GHG emissions through the development of their abundant wind resource that can integrate easily with their distinct electricity generation and demand profile.

As we have reported above, simple mechanisms, well proven in Europe and USA, are capable of putting in gear the long-term benefits of this technology for Canadians while correcting the recurrent and permanent bias that this technology has suffered over the last 10 years as a consequence. It seems reasonable in the circumstances to suggest that a 10-year federal production tax credit would be a better catalyst for the deployment of sustainable generation technology in Canada. A federal production tax credit for developing sustainable resources has three advantages:

1) It is consistent with the goal,
2) It is simple, and fiscally neutral.
3) It will accelerate the recognition of environmental costs of energy in the energy market.

A PTC will properly internalize in the energy market a cost to society that is already paid anyway by the taxpayer, although through non-energy or indirect-energy related budgets. The result of a federal PTC for renewable energy aims at raising the energy market sensitivity to environmental costs related to combustion and prepare the transition towards more energy accounting transparency in the market. Over the last century, large fossil fuel companies have dominated world energy supply with the help of national legal frameworks and policies that have led to a market with unproper account of the true cost and value of energy consumption. Choosing a PTC mechanism has the advantage of being very simple to manage through certification agencies and sends a strong signal to investors that unaccounted environmental/social costs of energy unlegetimally prevent proven sustainable generation technologies to enter the market. In many regards, a PTC should be looked as a market stimulus akin to the exploration investments funds that the oil companies obtain from private investors who get tax breaks and credits in exchange of their share in a project. The efficiency of this exploration mechanism financed with public money minimizes the investor's risk and brings many benefits to the operations of oil and gas producers by financially protecting the most critical area of their supply chain. These tax breaks are, in a nutshell, a subsidy to the oil industry that contribute to keep fossil fuel prices at artificially low prices. The Production tax credit for sustainable energy technologies will provide a similar simple and efficient mechanism to stimulate investments in renewable energy projects.

Furthermore, it is also very easy for people to understand the rationale behind such an incentive. The PTC is a mechanism to help renewable industry growth so that it can be allowed to compete on equal grounds on the energy market. The amount of the PTC (on a per kWh basis) needs to be adjusted periodically during the period it will be supported so as to provide en efficient impetus for renewable to compete in the market and favour a smooth transition towards a self-supporting portfolio of sustainable energy supply.

A federal PTC accessible to all jurisdictions would wake up a lot of big players. All provinces would hear the call on the green front and it would be up to them to show their sense of economic opportunity towards cleaner air, long-term energy supply and industrial diversification. Moreover, the PTC would allow all jurisdictions in Canada to voluntarily add their own resources to the federal PTC as they see appropriate to implement GHG reduction energy projects that fit their specific energy profile, electrical power mix, and vision of a sustainable future.

7- CONCLUSIONS

With the global economic battle heating up, global warming and climate change are scientifically and politically recognized as a reality, a reality that has some of its roots in energy consumption schemes. Technological evolution are, as always, right at the heart of the sweeping changes that the world is experiencing. At a time where the energy market restructuring appears to create generation overcapacity, many assumptions behind the existing models used for planning energy infrastructures still need to be revisited.

The bottom-up approach to market developments is taking over from the deterministic public monopolies approach thas has dominated the last 40 years. Intelligent-grid, multi-functional metering, energy efficiency, storage technologies, power electronics, huge potential for distributed, embedded and local renewable energy generation sources will bring significant mutations in grid architectures and energy management practices. This growing diversity and complexity of the competing supply and demand sides options that are made available to consumers require a good understanding of the natural synergies among energy sources. This challenges the traditional planning methods and force energy policy makers and system operators to develop a fair and consistent technico-economic methodology to value the sustainability and natural synergies of all the energy options. Such an approach towards energy issues should allow renewable energies, energy efficiency and storage technologies to build strong alliances with information technology and take a major place in the long-term energy portfolio of societies.

As the links between energy consumption and sustainability are properly acknowledged, new business opportunities for energy services on both supply and demand sides will appear. On its road towards sustainable diversification of its energy portfolio, Canada must demonstrate its stewardship by expanding the pace of its current GHG reduction program. By granting all provinces, irrespective of their electricity market structure or generation mix, an equal opportunity to invest in RE projects contributing to the national goal. By enforcing simple, fiscally neutral mechanisms to that end, Canada could signal the beginning of an effective harnessing of the huge potential of new renewable energy sources, ensuring long-term economic benefits for Canada as well as closing the growing gap between Canada's GHG reduction targets and its lagging achievements. As has been demonstrated in European countries and in the US, the window of economic opportunity is nowhere more promising today than in the wind energy sector. A canadian PTC should become a priority in the GHG reduction action plan.

REFERENCES

1- Sheffield, J., The role of energy efficiency and renewable energies in the future world energy market, Oak ridge Lab, Renewable energy, vol 10 # 2/3, pp. 315-318, 1997.

2- Weinberg, Carl. J., Renewable energy policy: How will clean energy services be provided in the future?, Renewable energy Policy Institute, Renewable energy, vol 10 # 2/3, pp. 423-431, 1997.

3- Ross, A., Climate claims and the concerns of the re-insurance Industry, Sorema ind., 13th annual CanWEA conference, October 19-22, 1997.

4- Knight, S., "German environment ministry heads offshore with big plans" WPM, July 2001.

5- Chabot, B., "Fair and efficient Tariffs for wind energy: principles, method, proposal data and potential consequences in France" 2001 European Wind Energy Conference, Copenhagen, 2-6 July 2001.

6- Moving to Competition: A guide to Alberta's new electric industry structure, Alberta Department of Energy, Electricity Branch, policy division, 1996,

7- Zeltmann, E.W., 77th National Conference of Regulatory Utility Commission Engineers, June 1999.

8- Utilities, Energy and Sustainability, Carl J. Weinberg, Weinberg Associates, Proceedings of the Canadian Wind Energy Association, 21 sept 1993, pp 363-378.

9- Lafrance, G. & al, "Hydro-Québec Reservoir Management with Wind Energy", International Workshop on Decision & Control in Management Science, Montréal, Oct 19-20 2000

10- O'Bryant, M., "Contracts value Distributed Wind ", Wind Power Monthly, dec 2000, pp21

11- Mortensen, P. "ELTRA, Transmission System Operator in Jutland", European Wind Energy Special topic Conference 2000, "The Challenge of High Wind Power Penetration for the New Energy Markets", Nice, France, march 2000

12- Millborow, D., "Revolutionary Potential", Wind Power Monthly, p. 43-45, oct 2000

13- Flessner, D., "TVA to use 1st fuel cell plant in U.S", The Times & Free Press, November 10, 2000

14- King, W.R. & Johnson III,B.L., WorldWide Wind/Diesel Potential, Independant Energy magazine, sept 1991.

15- $25 billion earmarked for renewables in Brazil, Trends in Renewable Energies, #90, July 1996.

16- Mott, L., Commercial wind-diesel project, St-Paul island, Alaska , Windpower 99, Burlington, Vermont.

17- Hydrogen Program 1998-2003: « Integrated Renewable/Hydrogen utility systems », Department of Energy, USA, june 1997.

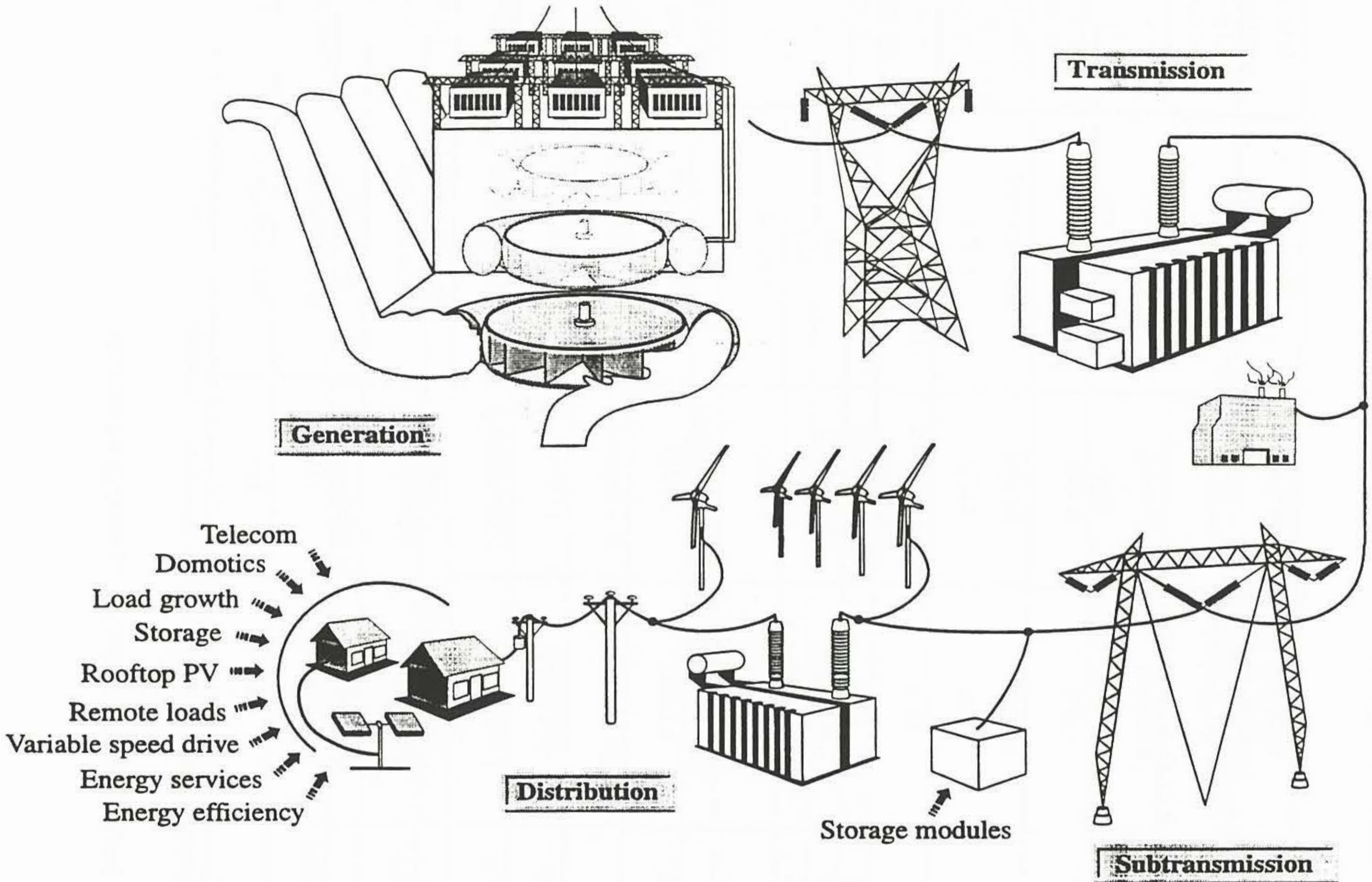


Figure 1. SCHEMATIC OF DISTRIBUTED/EMBEDDED GENERATION

	Hydro (large reservoirs & plants)	Wind plants	Solar PV (small power)	Solar thermal	Biomass (cogeneration)	Petroleum (commodity)
Major integration level	Centralized	Distributed, embedded, central	Residential, distributed	Residential	Distributed	Global distribution networks
Major form of utilization	Electricity,	Electricity	Electricity	Heating	Electricity	Transportation,
Major natural cycle	Year	Year	Year	Year	1-50 years*	50 * 106 years
Yearly variability	± 15% (site specific)	± 7%(site specific)	± 8%	± 15%	vs climate & management	Geo-political/ economic, crisis
Future availability	Weather	Weather	Weather	Weather	*to be managed	@1990 rate, proven stocks: 50 years (coal: 275; gas: 80)
Time unit for inflows	Monthly	Weekly	Daily	Daily	Yearly	
Inflows coherence (Qc) vs monthly demand	6-months out of phase	In phase	N/A	Architectural sensitivity	inventory & resource mngmnt	inventory management
vs heating demand	plant dispatch	wind induced	N/A	sun reduced	Bi-energy	Bi-energy
vs cooling demand	plant dispatch	wind reduced	In phase	sun induced	N/A	N/A
vs lighting demand	plant dispatch	Partial	out of phase	N/A	N/A	N\A
Synergy of operation with Hydro plants	management of inflows and outflows	Positive	Weak	Positive	back-up	back-up
Resource distribution	valleys, slopes	very large	large (housing)	large (housing)	large	highly centralized
Production/end use distance	100m - 2000 kms	100 m - 40 kms	≤ 100 m	≤ 30 m	*to be managed	very large
Project land used (% of land area)	100%	3%	low (housing)	low (housing)	*to be managed	to be managed
Peak capacity per area of land	1-10 MW/km2	4 -10 MW/km2	4 MW/km2	1 kW/m2	*to be managed	very high
Energy density per area of land	5,2 GWh/km2/yr	5-10 Gwh/km2/yr	1 GWh/km2/yr	2 kWh/m2/day	*to be managed	10 kWh/liter
Marginal cost of energy	increasing	decreasing	decreasing	decreasing	*to be managed	increasing
Cost of energy ¢/kWh (lifetime)	4-10 (50 yrs, site)	4-12 (25 yrs, site)	20-30 (30 yrs)	20-25 (10 yrs)	*to be managed	6-20 (?)
Resource Potential	300 MW micro	>20 GW	house surfaces	house surfaces	3-500 MW	0
Major obstacles to projects	environment & market	Visual/avian/noise	cost	cost	sites & resource	Climatic changes
Environnemental Impacts	low	lowest	low	low	*to be managed	worst

• Invites to a distinction based on energy resources regeneration management: renewables (biomass), sustainables (wind,solar, hydro)

Table 1: Useful criteria for valuing the synergy of energy resources