RESEARCH REPORT

SMALL-SCALE RENEWABLE ENERGY SYSTEMS, GRID-CONNECTION AND NET METERING: AN OVERVIEW OF THE CANADIAN EXPERIENCE IN 2003

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Small-scale Renewable Energy Systems, Grid-connection and Net Metering: An Overview of the Canadian Experience in 2003

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Abstract

This report documents the experience of small-scale grid-connected renewable energy power producers in Canada and provides an overview of the grid-connect and net metering policies of electric utilities across the country as of March 2003. It also provides background and resources for those who are interested in establishing their own grid-connected systems. For the purposes of this study, renewable energy systems were defined as: Photovoltaics (PV), Building Integrated Photovoltaics (BIPV), Wind and Microhydro. Also, hybrid systems (any combination of the latter four) were included. The system sizes were limited to what a homeowner or a small to medium size commercial venture might install cost-effectively.

Executive Summary

This report documents the experience of small-scale grid-connected renewable energy power producers in Canada[1], and provides an overview of the current grid-connect and net metering policies of electric utilities across the country. It also provides some background and resources for those who are interested in establishing their own grid-connected systems. For this study, renewable energy systems were defined as: Photovoltaics (PV), Building Integrated Photovoltaics (BIPV), Wind and Microhydro. Also, hybrid systems (any combination of the latter four) were included. The system sizes were limited to what a homeowner or a small to medium size commercial venture might install cost-effectively:

PV and BIPV: 10kW or less
Wind: 100 kW or less
Microhydro: 100 kW or less

We have attempted to create a 'snapshot' of grid connection and net metering policies in place at utilities across Canada as they existed at the end of March 2003. Policies and standards are being developed through several avenues at a rapid pace, so the information gathered during the term of this project can be used as a benchmark only. As far as we know, this has been the first attempt in Canada to systematically catalogue how the major utilities deal with request from small-scale renewable energy producers to feed power into the service grid. Through contacts made during the course of this study, there will be opportunity to continue tracking the adoption and implementation of grid connect and net metering policies for utilities across the country.

To carry out the work proposed for this project, two surveys were developed. One survey documents the experience of the small-scale energy producer and the grid-connection process, while the other catalogues the utility policies in place that support the grid-connection process. According to the literature, in the US, most of the main obstacles to grid connection are technical, such as extra meters and manual disconnect issues; extra insurance requirements were also cited as a major obstacle (Starrs, 2000). Similar problems were expected to be encountered in Canada, and indeed, to a large extent they were, although they were cited primarily by the system owners and not the utility representatives.

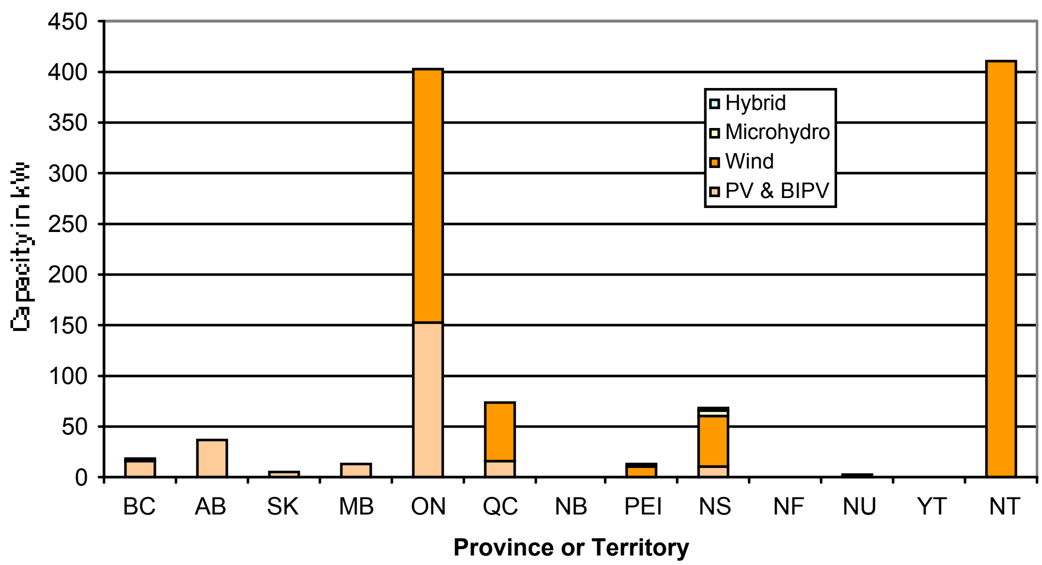
During the course of the survey (October 2002 through March 2003) one hundred and fifty-nine renewable electricity installations were identified, with 42 responses from system owners and designers.

[1] Initially, the study used the term Independent Power Producer (IPP), which was a common term in the resource material coming out of the US, and refers to non-utility owned power production at any scale. However, in Canada, the term IPP, as interpreted currently by most major utilities, refers to much larger-scale producers than those included in this study. So, after discussion with consultants and others active in the field in Canada, we have settled on the term "small-scale renewable energy producer."

(Compare this total to solar installations alone in Japan, where there is a formal program with policies that support the use of grid-connected PV systems. There, over 17,500 PV rooftop systems under 10kW were installed on homes between 1993 and 1999. By 2002, 36,000 of a 70,000 system program had been installed[2] (IEA-PVPS).

The survey results reflect a much broader cross-section of the current grid-connect experience than the 42 responses suggest, as several of the respondents are designers/installers of multiple systems and have worked with several utilities. Discussions with these industry leaders have been very informative and have helped shape the results of this study. Many other pioneers have, on their own initiative, helped establish RE sources in the mix of distributed generation in Canada. Their efforts should be applauded and recognized as vital in shaping the immediate future of Canada's renewable energy industry.

Chart 4.1.2: Identified Grid-Connected RE Capacity (kW) by region



Nearly 70% of all systems identified are small (100W to 5kW) residential installations, accounting for only 9% of the installed capacity. Over 75% of the installed capacity is found in the 20 commercial systems identified. Installed capacity of grid-connected RE systems in Canada as identified by this survey is just over 1.04 MW.

One of the factors not accounted for in the study was the preponderance of 'guerilla' systems: systems connected to the grid without the official approval of the utility and/or inspection to meet the CE Code.

2 Other countries with formal grid-connected PV system programs are: Germany (100,000 systems), Netherlands (60,000 systems), Italy (10,000 systems), South Korea (a new 30,000 system), Switzerland, Austria, Great Britain, America and Australia.

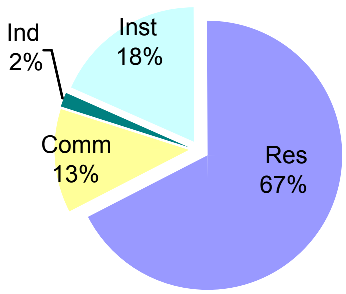


Chart 5.0.1: Proportion of Small-scale RE Producers by Market Segment

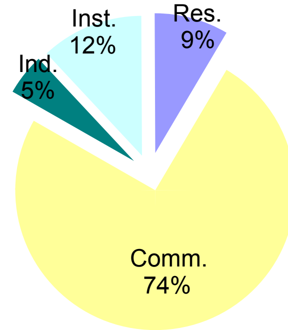


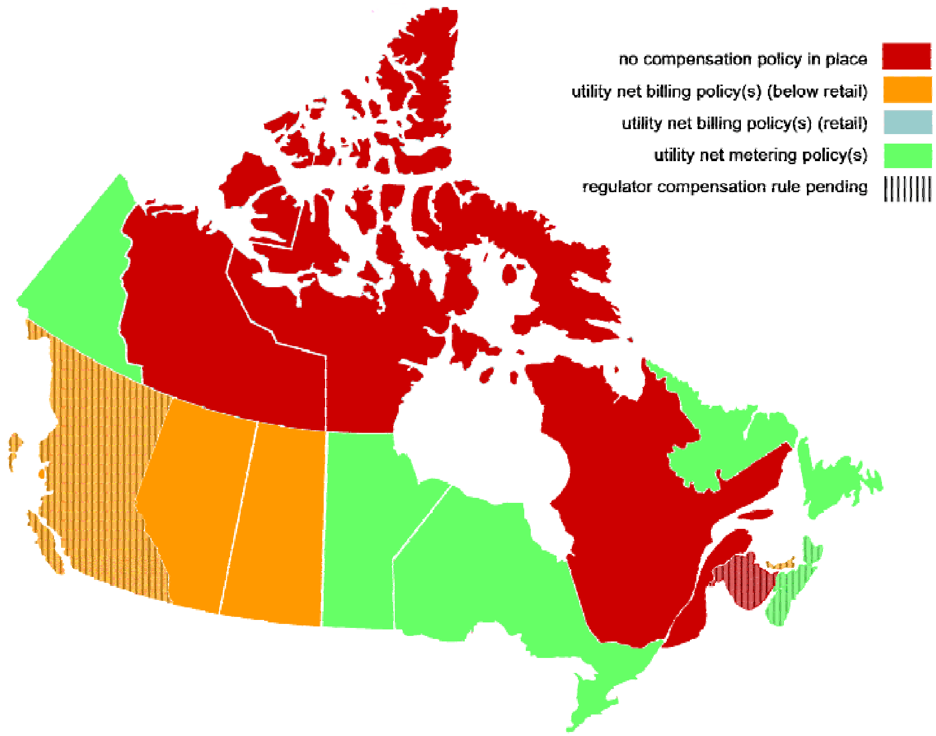
Chart 5.0.2: Installed Capacity of Small-scale RE Producers by Market Segment

There were thirty-six guerilla systems identified across Canada during the course of this study, the generation sources were mainly PV and microhydro. It is also likely many others exist which were not identified.

System owners cited their main obstacle as being difficulty in communicating with the utility: time delays tracking down a policy, a person or a process, and personnel accustomed to dealing with large-scale generators added dramatically to the cost of some systems. In other jurisdictions, there were no problems, even though 'official' policies were not in place at the time of the installation. Safety standards for equipment and interpretations of the Canadian Electrical Code were also at issue.

Twenty-four of the major Canadian utilities were contacted to participate in the second survey – at least one in each province and territory – with fourteen responding to our request. The final 'snapshot' includes responses from at least one major utility in every province and territory with the exception of Manitoba, New Brunswick, the North West Territories and Nunavut.

Every utility surveyed stated it had a grid-connection policy specifically governing the technical issues for systems under 100kW, even in the cases where no such systems are currently attached to their service grid. The existence of a technical policy does not necessarily mean a policy specifying economic arrangements exists: of the 14 utilities that responded, two did not have any buy-back policy in place. Only six of the respondents had an actual net metering policy in place. An additional two respondents indicated that a net metering policy might be in store in the near future. For the purposes of this study, net metering was defined as any program that allowed customers retail rate (monetary or credit) for at least some of their excess power production.



Last updated, March 2003

Net metering policies are in place at seven utilities in Canada, to date: Yukon Electric, Newfoundland and Labrador Hydro, Nova Scotia Power, Hydro Ottawa, Toronto Hydro, Waterloo North Hydro and Manitoba Hydro. Of the utilities that allow feed-in but *don't* allow net metering, Alberta utilities seem to provide the best price to small RE producers. Since under recent Alberta law (Howell, 2003) all certified electricity producers are allowed to sell to the power pool they are guaranteed the wholesale market price which changes as supplies fluctuate. In other provinces without net metering the best small producers can hope to earn for their excess power is the fixed avoided-cost rate (the same situation as in the US under PURPA), irregardless of what time of day the power was fed onto the grid[3].

However beneficial the Alberta power pool system may be compared to buy-back schemes in other provinces, net metering may be even more desirable from a small-scale RE producer perspective. The Alberta power pool system is not incompatible with net metering, it's just that no net metering policies currently exist. However, since the electricity market sector is now unbundled, only the electricity retailers are in a position to adopt a net metering policy because they are the only companies which charge retail rates for electricity. It is difficult to imagine how a policy could be conceived whereby companies that are strictly wire owners or generators could adopt a net metering program.

[3] Nova Scotia Power is a notable exception to this policy because small-scale renewable energy producers have been permitted to gain time of use pricing for their production as well as consumption under certain conditions.

Canada is already home to a healthy group of individuals and industry professionals dedicated to building the renewable energy market in the country, with a growing list of experts in small grid-connected systems. Technology is in place, energy needs are expanding and successful examples of interconnection standards and policies that take into consideration technical, safety, contractual and other issues are available worldwide. Harmonized interconnection regulations and policies would help bring the per Watt cost of RE systems in Canada down to a viable option for residential and small-scale commercial operations. We now have the opportunity to establish guidelines and policies that support the widespread implementation of small-scale RE systems. Initiatives that are aimed at increasing this market will not replace the need for power generation at large installations by traditional utilities. Nevertheless such investments off benefits not shared by large central installations:

1. New technologies often offer cost-effective, efficient solutions with significant environmental benefits.
2. There is a huge market potential worth billions of dollars and thousands of jobs.
3. Distributed generation improves the reliability of electricity power at the site and delays infrastructure upgrades to the existing network (MPC, 2001).

Canada's investment in RE in general is dismal in comparison with other countries such as the US, Germany and Japan. This is reflected in the numbers: Canada has a total of 8836 kW of installed PV (341 kW grid-connected), the US has 167,800 kW of installed PV (40,600 kW grid-connected). US public funding of PV in 2001 was over 60 times that of Canadian funding. Japan's spending was almost double the US funding. Small-scale grid-connected RE offers many benefits to both system owners and utilities, and can make a positive impact on Canada's Kyoto Protocol commitments. To do this, Canada needs financial commitment to a national grid-connection program and harmonized utility and electrical code regulations governing low-voltage, small-scale systems. Work is underway to develop the harmonized regulations through the MicroPower Connect Project and through the Alberta Safety Codes Council's Task Force on MicroPower and the CE Code.

Résumé

Ce rapport décrit l'expérience des petits producteurs d'énergie renouvelable du Canada qui sont reliés au réseau[1], et donne un aperçu des politiques actuelles des compagnies d'électricité du pays en matière de connexion au réseau et de facturation nette. Il fournit aussi quelques données documentaires et ressources à ceux qui souhaitent créer des systèmes reliés au réseau. Aux fins de cette étude, on a défini comme suit les systèmes d'énergie renouvelable : les panneaux solaires intégrés ou non aux bâtiments, le matériel de conversion d'énergie éolienne en électricité et les microcentrales hydroélectriques. On s'est aussi penché sur les systèmes mixtes (toute combinaison des quatre systèmes précédents). On a limité la taille des systèmes à ce qu'un propriétaire-occupant ou une entreprise de taille moyenne pourrait installer de manière rentable :

panneaux solaires intégrés ou non aux bâtiments : 10 kW ou moins
matériel de conversion d'énergie éolienne en électricité : 100 kW ou moins
microcentrales hydroélectriques : 100 kW ou moins.

Nous avons tenté de prendre un « instantané » des politiques des compagnies d'électricité canadiennes en matière de connexion au réseau et de facturation nette, à la fin de mars 2003. L'évolution des politiques et des normes étant très rapide, l'information recueillie dans le cadre de ce projet ne peut servir que de repère seulement. Autant qu'on sache, il s'agit de la première tentative au Canada de cataloguer systématiquement la façon dont les principales compagnies d'électricité traitent les demandes des petits producteurs d'énergie renouvelable qui souhaitent alimenter leur réseau. Les contacts effectués au cours de cette étude permettront de suivre l'adoption et la mise en oeuvre des politiques des compagnies d'électricité du pays en matière de connexion au réseau et de facturation nette.

La réalisation de ce projet a nécessité l'élaboration de deux enquêtes. L'une d'elles documente l'expérience accumulée par les petits producteurs d'énergie ainsi que le processus de connexion au réseau, et l'autre catalogue les politiques courantes des compagnies d'électricité qui sous-tendent le processus de connexion au réseau. D'après la documentation recueillie, les principaux obstacles à la connexion au réseau sont de nature technique aux É.-U. (comme l'installation de compteurs additionnels et les questions de déconnexion manuelle). Les

[1] Au début, on a utilisé pour l'étude « producteur d'énergie indépendant ». Il s'agit d'un terme qui figurait couramment dans la documentation provenant des É.-U. et qui se rapporte à la production d'énergie à toute échelle par d'autres que les compagnies d'électricité. Toutefois, la plupart des grandes compagnies d'électricité du Canada attribuent présentement cette désignation à des producteurs de bien plus grande taille que ceux qui ont été retenus pour l'étude. Après discussion avec des consultants et d'autres intervenants du secteur au Canada, nous avons convenu d'employer le terme « petit producteur d'énergie renouvelable ».

exigences additionnelles en matière d'assurance ont aussi été citées parmi les obstacles majeurs (Starrs, 2000). On prévoyait relever des problèmes semblables au Canada, ce qui s'est confirmé dans une large mesure. Toutefois, ce sont surtout les propriétaires de systèmes, et non les représentants des compagnies d'électricité, qui en ont fait état.

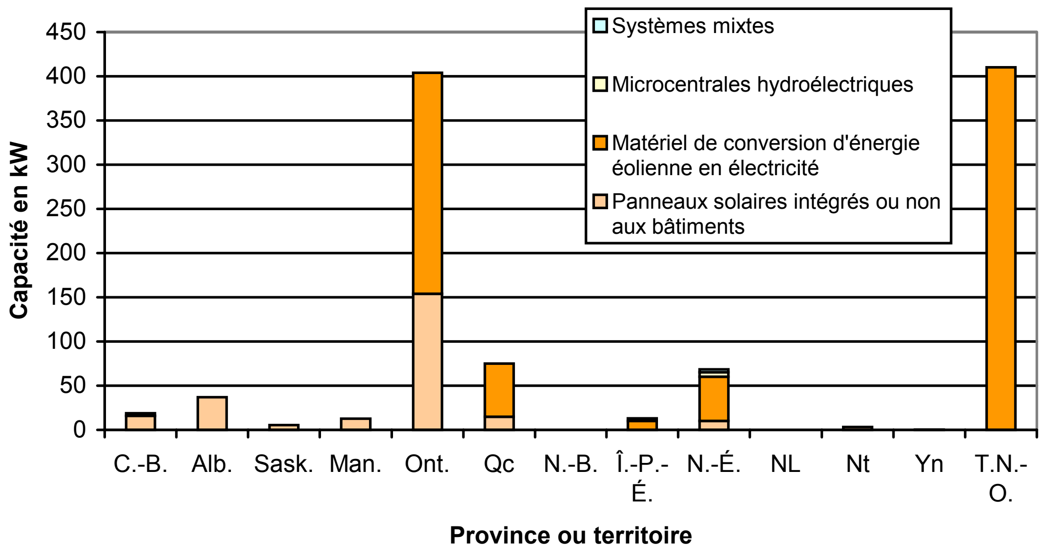
L'enquête qui a duré d'octobre 2002 à mars 2003 a permis de recenser 159 installations de production d'électricité sur une base renouvelable; 42 réponses provenaient de propriétaires et de concepteurs de systèmes.

(Comparons ce total avec les installations solaires du Japon où l'on retrouve un programme formel ainsi que des politiques encourageant l'utilisation de systèmes de panneaux solaires connectés au réseau. Dans ce pays, plus de 17 500 systèmes de panneaux solaires de moins de 10 kW ont été installés sur les toits des résidences entre 1993 et 1999. En 2002, on avait réalisé 36 000 installations sur les 70 000 prévues par le programme[2] (IEA-PVPS).

Les résultats de l'enquête reflètent un échantillon représentatif des installations connectées au réseau qui dépasse de beaucoup ce que les 42 réponses recueillies laissent entendre car plusieurs répondants sont des concepteurs ou des installateurs de systèmes multiples ayant travaillé avec plusieurs compagnies d'électricité. Les discussions avec ces chefs de file du secteur nous ont appris beaucoup et ont contribué à façonner les résultats de l'étude. Bien d'autres pionniers dans le domaine ont aidé, de leur propre initiative, à déterminer les sources d'énergie renouvelable parmi la variété d'installations connectées aux réseaux du Canada. Leurs efforts sont louables car ils ont joué un rôle essentiel dans le façonnement à court terme du secteur de l'énergie renouvelable du Canada.

[2] Les pays suivants possèdent des programmes formels d'installation de panneaux solaires connectés aux réseaux : l'Allemagne (100 000 systèmes), les Pays-Bas (60 000 systèmes), l'Italie (10 000 systèmes), la Corée du Sud (nouveau programme de 30 000 systèmes), la Suisse , l'Autriche, la Grande-Bretagne, l'Amérique et l'Australie.

Tableau 4.1.2 : Puissance recensée de l'énergie renouvelable connectée au réseau (kW) selon la région



Près de 70 % des systèmes recensés appartenaient à la catégorie des petites installations résidentielles (de 100 W à 5 kW), ce qui ne représentait que 9 % de la puissance installée. Plus de 75 % de la puissance installée est générée par les 20 systèmes commerciaux relevés. Selon l'enquête, la puissance installée des systèmes d'énergie renouvelable connectés aux réseaux du Canada est à peine supérieure à 1,04 MW.

L'étude n'a pas tenu compte de certains facteurs dont la prépondérance des systèmes indépendants qui sont connectés au réseau sans l'approbation officielle de la compagnie d'électricité ou qui n'ont pas fait l'objet d'inspections en vertu du Code canadien de l'électricité.

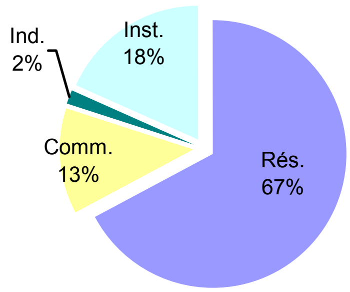


Tableau 5.0.1 : Proportion de petits producteurs d'énergie renouvelable selon le segment de marché

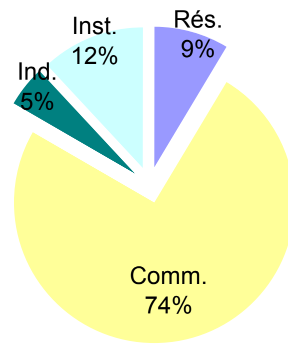


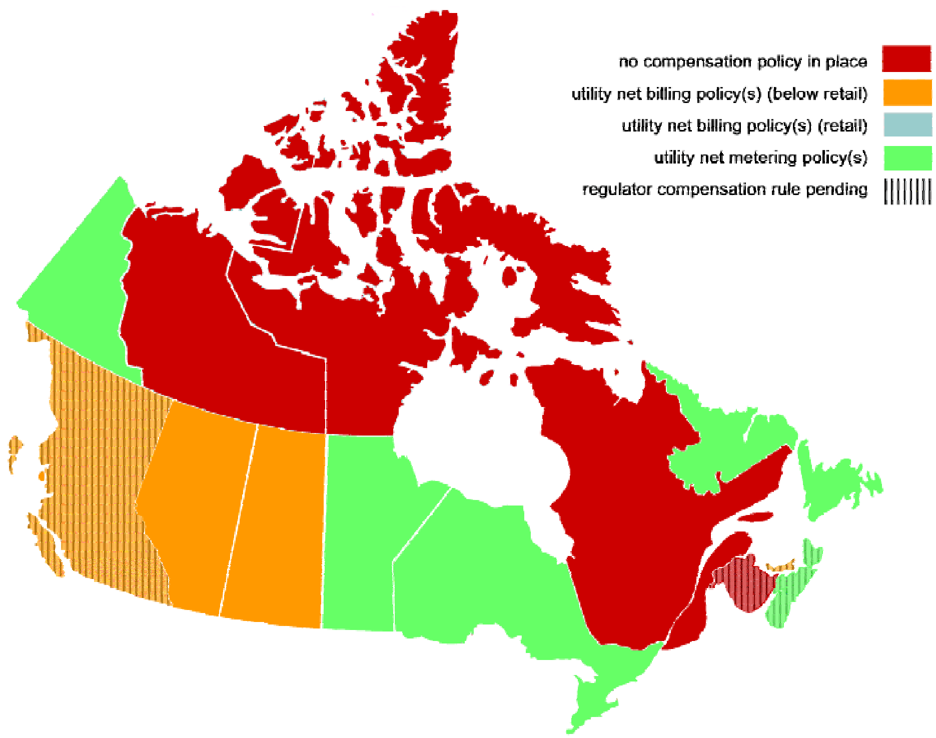
Tableau 5.0.2 : Puissance installlée des petits producteurs d'énergie renouvelable selon le segment de marché

Trente-six systèmes indépendants ont été recensés au Canada pendant l'étude, les principales sources de production d'électricité étant les panneaux solaires et les microcentrales hydroélectriques. On présume que de nombreuses sources additionnelles sont restées indéterminées.

Selon les propriétaires de systèmes, les communications avec la compagnie d'électricité constituent le principal obstacle. Les délais nécessaires pour repérer les politiques, les personnes ou les processus appropriés et l'embauche de personnel habilité à traiter avec les producteurs importants faisaient augmenter substantiellement les coûts de certains systèmes. Dans certaines entités, on ne relevait aucun problème, même s'il n'existait pas de politique officielle au moment de l'installation. Les normes de sécurité applicables à l'équipement et l'interprétation du Code canadien de l'électricité constituaient aussi un problème.

On a communiqué avec vingt-quatre des principales compagnies d'électricité canadiennes pour qu'elles participent à la deuxième enquête, c.-à-d. au moins une dans chaque province et territoire : quatorze d'entre elles ont acquiescé à notre demande. « L'instantané » final comprend des réponses d'au moins une grande compagnie d'électricité de chaque province et territoire à l'exception du Manitoba, du Nouveau-Brunswick, des Territoires du Nord-Ouest et du Nunavut.

Chaque compagnie recensée possédait une politique de connexion au réseau régissant particulièrement les questions techniques se rapportant aux systèmes de moins de 100 kW, même s'il n'existait aucune connexion à ce moment-là. Les politiques techniques ne s'accompagnent pas nécessairement de politiques économiques : des 14 compagnies d'électricité qui ont répondu à l'enquête, deux ne disposaient d'aucune politique de rachat. Seulement six répondants avaient mis en place une politique de facturation nette. Deux autres répondants ont indiqué qu'ils pourraient adopter prochainement une politique de facturation nette. Aux fins de l'étude, on a défini la facturation nette comme tout programme accordant aux clients un taux de détail (en argent ou en crédit) pour une partie, du moins, de leur surproduction d'électricité.



Last updated, March 2003

Aucune politique d'achat
Compagnies d'électricité ayant adopté une politique d'achats nets (en deçà du prix de détail)
Compagnies d'électricité ayant adopté une politique d'achats nets (prix de détail)
Compagnies d'électricité ayant adopté une politique de facturation nette
Territoires où l'on attend une décision de l'organisme de réglementation concernant l'achat
Dernière mise à jour : mars 2003

Jusqu'ici, sept compagnies d'électricité canadiennes ont adopté des politiques de facturation nette : Yukon Electric, Newfoundland and Labrador Hydro, Nova Scotia Power, Hydro Ottawa, Toronto Hydro, Waterloo North Hydro et Manitoba Hydro. Des compagnies d'électricité qui acceptent l'énergie excédentaire sans appliquer la facturation nette, celles de l'Alberta offrent probablement le meilleur prix aux petits producteurs d'énergie renouvelable. En vertu d'une loi adoptée récemment dans cette province (Howell, 2003), tous les producteurs d'électricité certifiés peuvent vendre de l'énergie au consortium qui leur garantit un prix du marché de gros fluctuant avec l'offre. Dans les autres provinces n'appliquant pas la facturation nette, le coût éludé fixe est le montant le plus élevé que les petits producteurs peuvent espérer recevoir pour leur surproduction d'électricité (une situation identique à celle qui prévaut aux É.-U. en vertu de la PURPA), peu importe le moment de la journée auquel ils ont alimenté le réseau[3].

En dépit de ce que le consortium d'électricité de l'Alberta semble offrir par rapport aux plans de rachat des autres provinces, la facturation nette est probablement plus avantageuse pour les petits producteurs d'énergie renouvelable. Le système de consortium d'électricité de l'Alberta n'est pas incompatible avec la facturation nette, le problème découle plutôt de l'absence de politique à cet effet. Cependant, comme le secteur du marché de l'électricité est maintenant dégroupé, seuls les détaillants d'électricité peuvent maintenant adopter une politique de facturation nette étant donné qu'ils sont les seules entreprises à exiger des taux de détail pour l'électricité. Il est difficile d'imaginer une politique en vertu de laquelle des compagnies qui ne sont que des propriétaires de câbles électriques ou des producteurs d'électricité pourraient adopter un programme de facturation nette.

Le Canada possède d'ores et déjà un groupe important de personnes et de professionnels du secteur qui se consacre à l'établissement d'un marché de l'énergie renouvelable, avec l'aide d'une liste de plus en plus longue d'experts en petits systèmes connectés au réseau. La technologie est en place, les besoins énergétiques sont à la hausse et il existe des exemples à l'échelle mondiale de normes et de politiques d'interconnexion qui tiennent compte des questions techniques, sécuritaires, contractuelles et autres. L'harmonisation des règlements et des politiques d'interconnexion pourrait abaisser les coûts au watt des systèmes d'énergie renouvelable du Canada de manière à en faire une option viable pour les résidences et les petites exploitations commerciales. Nous avons maintenant l'occasion d'établir des directives et des politiques permettant la mise en oeuvre généralisée de petits systèmes d'énergie renouvelable. Les initiatives visant à élargir ce marché ne remplaceront pas la production électrique dans de grandes installations gérées par les compagnies d'électricité traditionnelles. Néanmoins, ces investissements produisent des avantages qu'on ne retrouve pas dans les grandes installations centrales :

[3] La Nova Scotia Power fait exception à cette politique étant donné que les petits producteurs d'énergie renouvelable ont obtenu la tarification au compteur horaire pour leur production et leur consommation moyennant certaines conditions.

1. Les nouvelles technologies offrent souvent des solutions efficientes qui s'accompagnent d'avantages importants pour l'environnement;
2. Il existe un marché potentiel immense valant des milliards de dollars et susceptible de créer des milliers d'emplois;
3. La répartition de la production améliore la fiabilité de l'alimentation électrique sur l'emplacement et permet de reporter la modernisation du réseau existant (MPC, 2001).

Les investissements du Canada dans le secteur de l'énergie renouvelable sont minimes comparativement à ceux d'autres pays comme les É.-U., l'Allemagne et le Japon. Les chiffres traduisent bien la réalité : le Canada produit une puissance installée de 8 836 kW au moyen de panneaux solaires (dont 341 kW servent à alimenter le réseau) comparativement à 167 800 kW aux É.-U. (dont 40 600 kW servent à alimenter le réseau). En 2001, les É.-U. affectaient 60 fois plus de fonds publics aux panneaux solaires que le Canada. Quant au Japon, ses dépenses étaient presque deux fois supérieures à celles des É.-U. L'alimentation du réseau par de petits producteurs d'énergie renouvelable comporte de nombreux avantages, tant pour les propriétaires de systèmes que les compagnies d'électricité, et peut aider le Canada à respecter les engagements qu'il a pris par rapport au Protocole de Kyoto. Or, le Canada a besoin d'engagements financiers qui permettront de créer un programme national de connexion au réseau et d'harmoniser la réglementation des compagnies d'électricité et les codes de l'électricité concernant les petits systèmes à basse tension. Des travaux sont en cours sur l'harmonisation de la réglementation par l'entremise du projet MicroPower Connect et du groupe de travail sur les micro-centrales et le Code canadien de l'électricité du Safety Codes Council de l'Alberta.

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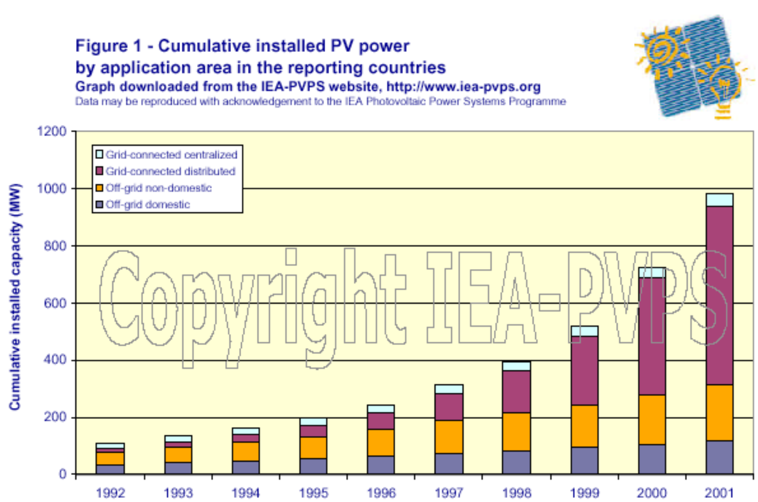
1.0 Introduction

The North American electricity sector is undergoing unprecedented changes. New technologies, market opportunities, consumer expectations, and environmental concerns are resulting in a rapidly evolving political and economic landscape. As industry players grapple to meet these challenges, many jurisdictions, organizations, and individuals are asking what role renewable energy will play in the new energy economy.

A surge in small-scale Green Power production and incentives as a result of electricity deregulation in the US has been well documented. It seems that the niche for small-scale distributed electricity generation is developing across North America. The role of renewable energy in this niche continues to grow in the US, and there is evidence that suggests it is catching on in Canada. Still there are big questions looming: What rate of growth is in store for renewable energy in Canada? What proportion of the renewable energy already being produced in Canada is in grid-connected versus stand alone applications? What kind of regulations and policies are in place to encourage investment in grid-connected renewable energy systems and how do they differ from jurisdiction to jurisdiction? What kind of arrangements exist to compensate small power producers for feeding excess electricity into the grid? These are some of the questions that inspired this study.

A robust small-scale renewable energy (RE) industry in Canada is desirable from both an economic and environmental perspective. Judging from experience in other countries it seems the potential exists for such a goal to be realized. Certainly the technology is available and proven, as shown by the recent proliferation of interconnected systems world wide (see table below for growth of PV installations). Internationally, acceptance – and implementation – of 'Green Power' is widespread (Aitken, 2000).



Worldwide, Green Power (i.e., solar, wind and microhydro) production is estimated to provide about 2% of the total grid-supplied energy (Flood, 2001). Specific interconnection policies, standards, and incentive programs have been vital in the growth of the small-scale renewable energy industry. European nations, the US and Japan currently lead the world in grid-connected RE capacity. The success of these nations was largely a result of clear policies and generous incentives made clear the general public from the onset. In the US, for example, the success of their small-scale RE industry may largely be attributed to the many programs which exist to promote small-scale residential and commercial systems. In Canada, it seems likely that the growth of a renewable energy industry is dependent on the establishment of similar standards and incentive programs.

One example of an incentive program that has proved effective in countries with thriving small renewable power industries is net metering. The policy is widely used in Europe and Japan, and is now in existence in 34 states (Starrs, 2001). Though other compensation arrangements exist, we have chosen to look specifically at net metering in a Canadian context for this paper due to its international popularity.

Two crucial roadblocks have been identified in the US as blocking the widespread uptake of Green Power initiatives and a small-scale renewable energy industry:

1) Lack of consistency in standards and policies regulating the implementation of interconnection and net metering across the country
2) Reluctance of utilities (who are, by and large, both producers and suppliers of power) to allow other producers to ‘share the lines’ (Flood, 2001).

Combined, these roadblocks contribute to a stagnation in the domestic RE source system industry, with the costs of components and systems holding at prohibitive prices – even though production costs are lower and system efficiencies are higher (CMHC, 2001). The question then naturally arises: What are the crucial roadblocks slowing the widespread uptake of renewable energy in Canada? Are they the same as the US?

This report documents the experience of small-scale grid-connected renewable energy power producers[4] in Canada to the end of March 2003, and provides an overview of the current grid-connect and net metering policies of electric utilities across the country. It also provides some background and resources for those who are interested in establishing their own grid-connected systems. For the purposes of this study, renewable energy systems were defined as Photovoltaics (PV), Building Integrated Photovoltaics

[4] Initially, the study used the term Independent Power Producer (IPP), which was a common term in the resource material coming out of the US, and refers to non-utility owned power production at any scale. However, in Canada, the term IPP, as interpreted currently by most major utilities, refers to much larger-scale producers than those included in this study. So, after discussion with consultants and others active in the field in Canada, we have settled on the term “small-scale renewable energy producer.”

(BIPV), Wind and Microhydro. Also, hybrid systems (any combination of the latter four) were included. The system sizes were limited to what a homeowner or a small to medium size commercial venture might install cost-effectively:

PV and BIPV: 10kW or less
Wind: 100 kW or less
Microhydro: 100 kW or less

We have attempted to create a ‘snapshot’ of grid connection and net metering policies in place at utilities across Canada at the end of March 2003. Policies and standards are being developed through several avenues at a rapid pace, so the information gathered during the term of this project can be used as a benchmark only. As far as we know, this has been the first attempt in Canada to catalogue how the major utilities deal with request from small-scale renewable energy producers to feed power into the service grid. Through contacts made during the course of this study, there will be opportunity to continue tracking the adoption and implementation of grid connect and net metering policies for utilities across the country.

To carry out the work proposed for this project, two surveys were developed. One survey documents the experience of the small-scale energy producer and the grid-connection process, while the other catalogues the utility policies in place that support the grid-connection process. According to the literature coming out of the the US, most of the biggest obstacles to grid connection are technical, such as extra meters and manual disconnect issues; extra insurance requirements were also cited as a major obstacle (Starrs, 2000). The intent of this study was to try to determine the extent to which the problems encountered by grid-connected renewable energy pioneers in Canada were similar. We expected to encounter comparable problems in Canada, and indeed, to a large extent that was the case.

2.0 Objectives & Methodology

2.1 Objectives

The objectives of this study were fourfold:

1. To identify and document the experience of small-scale grid-connected renewable energy (RE) system owners in Canada.
2. To identify obstacles to the widespread adoption of small-scale grid-connected renewable energy systems.
3. To identify policy at Canadian utilities with respect to these systems.
4. To identify obstacles to the formulation of policy at Canadian utilities with respect to these systems.

To meet these objectives two surveys were conducted over a six-month period from October 2002 to March 2003: one of system owners and the other of electrical utility representatives.

2.2 Survey of Small-scale Grid-connected RE Systems

The study focus is on RE system sizes that a homeowner or a small to medium size commercial venture might install cost-effectively:

Photovoltaic (PV)	10kW or less
Building Integrated Photovoltaics (BIPV)	10kW or less
Wind	100 kW or less
Microhydro	100 kW or less
Hybrid systems (any combination of the above)	

RE system owners were identified through industry associations, utility contacts and government agencies dealing with renewable energy. Canada's first small-scale grid-connected RE "system owner survey" was delivered online via a database-integrated web application to capture the largest possible sample of the target group. Respondents were granted anonymity by the issuance of password access codes to the survey forms. A paper version of the survey was also available, for those without access to a computer.

The system owner survey addresses the following issues:

4. Why system owners chose a RE system
5. The type of energy source and the capacity of their grid-connect system
6. The type of equipment installed
7. Whether net-metering (one form of measured compensation for supplying electricity to the grid) is/was an available option for them
8. What inspections did the local utility office require
9. What obstacles system owners felt hampered the process
10. What suggestions system owners have to improving and/or streamlining the process of becoming an small-scale renewable energy producer

See Appendix VI: Small-scale Renewable Energy Producer Questionnaire

2.3 Canadian Electric Utilities Survey

A survey of the nation's electric utilities was developed to create a 'snapshot' of grid-connect and net metering policies for small-scale renewable energy systems. Respondents were asked to identify factors which motivated the formulation of their policy and/or factors which hindered the adoption of a policy. Documentation (paper or URL) of existing policies was also requested. Where no policies were currently in place, a query was made as to the status of a policy, and possible implementation dates. No attempt was made in conducting the survey to create policy or suggest regulations.

Canadian electric utilities were identified by online inventory (www.utilityconnection.com) and by membership in the Canadian Electricity Association (www.canelect.ca). Utility contact information was also made available by some system owner survey respondents. The utility survey was delivered by phone interview. Specific areas investigated included:

1. Utility Profile – vertically integrated or wires owner only, generation base (current mix of power producers)
2. Small-scale Energy Contracts – grid-connection, metering arrangements, buy-back policy
3. Obstacles and Motivations – for grid connect and/or net metering/buy-back policy

See Appendix VII: Utility Grid Connection/Net Metering Policy Questionnaire

2.4 Definition of Terms & Abbreviations

AC: alternating current.

Avoided cost: The rate of payment that reflects how much a utility didn't have to spend on the energy produced by the system owner (typically doesn't include transportation and distribution costs).

DC: direct current.

Building Integrated Photovoltaics (BIPV): A PV system mounted on, or incorporated into a building structure.

Dispatchable power: Energy output that can be planned on and typically provides a continuous power output. Solar and wind power are not dispatchable without some other power or storage mechanism. Hydrocarbon based power plants or nuclear plants are dispatchable. Can microhydro be dispatchable? Some would say yes if there were a small reservoir.

Distributed generation (DG): The generation of energy close to the point of use, as opposed to central systems that supply electricity to grids. A residential PV system is a distributed system. See Section 3.2

Electrical grid: A network for electricity distribution across a large area.

Full net metering: Simple net metering with monetary compensation for excess generation at the end of each billing period or a rolling credit allowing customers to carry over excess credit from billing period to billing period. See section 3.7.

Greenhouse gas (GHG): The combination of gases that has been indicated in accelerating climate change.

Grid-interactive: A small-scale renewable energy system with battery storage.

Grid-dependent: A small-scale renewable energy system without battery storage.

Guerrilla system: A system connected to the grid without official approval or inspection.

Inverter: Also known as 'static inverter', converts DC electricity into AC. Often includes other electronic components required to optimize the power output and regulate the power quality.

Islanding: The situation when there is a general power outage on the grid system but there are local 'islands' of power resulting from distributed generators, creating potential hazards for repair crews.

Net billing: Two electricity meters separately track electricity drawn from and fed into the grid. The two meters assign the electricity different prices (if both meters are signed the same price the situation is two-meter net metering. See section 3.7.

Net metering: Any metering arrangement which allows system owners to obtain retail value for at least some of the excess electricity they feed to the grid.

Variations include: simple, full with rolling credit and full with buy-back. See section 3.7.

Photovoltaic (PV) cell, module, array: the components of the system which converts sunlight into electrical energy with no moving parts, emissions or noise.

Renewable energy (RE): Energy produced by solar, wind or hydro sources. Energy produced from clean and relatively inexhaustible supply sources.

Simple net metering: A single bi-directional meter giving system owners retail value for excess electricity fed into the grid within a single billing period. See section 3.7.

System owner: the small-scale grid-connected renewable energy producer

Two-meter net metering: A technical arrangement using two meters (like net billing) which allows for the same economic implications as net metering (unlike net billing).

Utility: The owner of power generation sources, wire transmission/ distribution and retail supplier, or, in a deregulated market any individual one of these.

Vertically integrated model: The business model where one entity owns all levels of supply and distribution to an industry (i.e., an electrical utility that owns both generation source and distribution grid).

Wire owner: The grid owner, with little or no power generation source, buys power from utilities and other generation sources.

3.0 Background

There are several aspects of this study that may or may not be familiar. The purpose of this background section is to introduce the reader to the concepts that the study focuses on – renewable energy sources, distributed generation and net metering – and how they relate to each other.

3.1 Why Small, Grid-connected Renewable Energy Systems?

RE systems are relatively clean sources of electricity. They do not increase greenhouse gas (GHG) emissions when they generate power (or other pollutants NO_x, SO_x, mercury, etc.). Sun, wind and flowing water are "renewable" in contrast to fossil fuels in that the resources they use to create electricity are relatively inexhaustible.

Currently, individuals and families produce 31% of Canada's GHG emissions just from day-to-day activities like heating our homes, driving our cars and using electricity. On average each Canadian produces five and a half tonnes of GHG emissions every year.[5] The challenge put forward by the Government of Canada is to effect a 20% reduction or 1 tonne of emissions per person per year (over four years).[6] As one of its initiatives, the government of Canada's Kyoto plan aims for the retrofit of 20 per cent of Canada's houses and commercial/industrial buildings by 2012, and to make all new homes conform to federal efficiency standards by 2010.[7]

Right now across Canada, 100 million tonnes of carbon dioxide are emitted annually from fossil fuel-fired thermal power plants.[8] The burning of fossil fuels to generate electricity leads to approximately 1kg of CO_2 emissions for every kilowatt generated (depending on the fuel source and plant efficiencies, and not including line loss and other demand side inefficiencies).[9] The potential adoption of grid-connected RE systems to help meet this challenge is significant. A residential PV installation for example, could displace up to 900 kg/year of CO_2 emissions from a coal-fired generating plant per kilowatt of rated capacity, (depending on the location). This means that a homeowner investing in a 1kW PV system would be meeting up to 90% of one year of the four-year reduction challenge immediately.

Small RE systems when connected to the electrical grid, can be a part of a distributed generation (DG) system. This can help reduce infrastructure costs for utilities, reduce environmental damage related to power generation from burning fossil fuels and provide greater security of supply in the event of energy

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[5] Climate Change Solutions, URLs: www.climatechangesolutions.com/english/individuals
www.climatechange.gc.ca/plan_for_canada/summary/index.html
[6] Climate Change Action Plan for Canada page 4, URL: www.climatechange.gc.ca
[7] The Kyoto Protocol byPhilip Saunders, CBC News Online | Updated Sept. 23, 2002
[8] From Environment Canada's website URL: www.mb.ec.gc.ca/info/publications/ce00s01.en.html, June 2003

shortages (Wan, 1998). Several published papers indicate a viable market for 'green power' and a fledgling industry that can benefit Canada's economy.[10] In light of Canada's signing of the Kyoto Protocol, small-scale RE systems, along with strong energy efficiency measures, can be part of an integrated approach to our personal and corporate GHG reduction strategies.

Small-scale RE systems are among the most easily accessible ways of becoming grid-connected for everyone from individual homeowners to large corporations. The modular nature of these systems means they can be sized to carry a portion of the electrical load and expanded at will to carry more load or even the entire load. Where power-banking programs are available, the system can be sized to be an annual net energy producer.

Typical household systems for photovoltaic (PV) systems range between 1kW and 5kW, with some distributors offering grid-connect 'kits' for residential applications. Small wind generators for household use range from 1kW to 10 kW. Figures for grid-connected microhydro in Canada are harder to find than those for PV and wind systems. Microhydro systems identified in this study average about 1kW.

Energy sources that utilize fossil fuels have both up-front costs and ongoing costs (i.e. the cost of purchasing oil, gas), which means that a substantial part of their total costs are spread over time. In contrast, the cost of financing is critical to renewable energy sources. RE systems typically have high installation costs but minimal ongoing operating and maintenance costs. This means that a low cost of finance amortized over the life of the equipment/capital investment can vastly enhance the economics of renewable energy.

See Appendices II and III for information on RE equipment and Canadian industry resources.

[9] www.climatechangesolutions.com/english/industry/stories/electricity/enmax2.htm
[10] Clean Power at Home (May 1999); Green Energy Study for BC Phase 2: Mainland Building Integrated Photovoltaic Solar and Small-Scale Wind (Oct 2002); Natural Selection: Evolving Choices for Renewable Energy Technology and Policy (2002); Clean Energy: Jobs for America's Future (Oct 2001); Added Values of Photovoltaic Power Systems (March 2001). Please see References and Resource list for full citations and URLs for pdf downloads.

3.2 Benefits of Grid-connected Renewable Energy Systems

Grid-connected, grid-tie, grid-intertie are all terms that refer to small-scale power producers that have the capability to feed electricity into the electrical distribution system, commonly called ‘the grid’. A grid-connected system has a power source and a means of transferring energy to and from the grid. RE systems and other small-scale generators all rely on a piece of equipment called a static inverter to carry out the task of energy transfer. The inverter changes the DC (direct current) generated by the RE system into the ‘standard’ low-voltage AC (alternating current) that most household and office equipment runs on. This AC power can then be used on-site by the owner of the system, with excess generation being fed into the grid. Inverters for grid-connection installations have to meet certain international standards, as there are technical and safety issues related to feeding energy back into the grid. A comprehensive list of these standards can be found at www.solarbuzz.com/ProductCertifications.htm. A list of grid-tie inverters can be found at Appendix II.

Benefits to the owner of a grid-connected system in contrast to an off-grid system may include:

A. Reduced capital cost (batteries are unnecessary with a grid backup)
B. Reduced maintenance due to fewer balance of system components
C. Back-up power if either the grid or the private system fails
D. Reduced amortization period if the utility offers a buy-back program

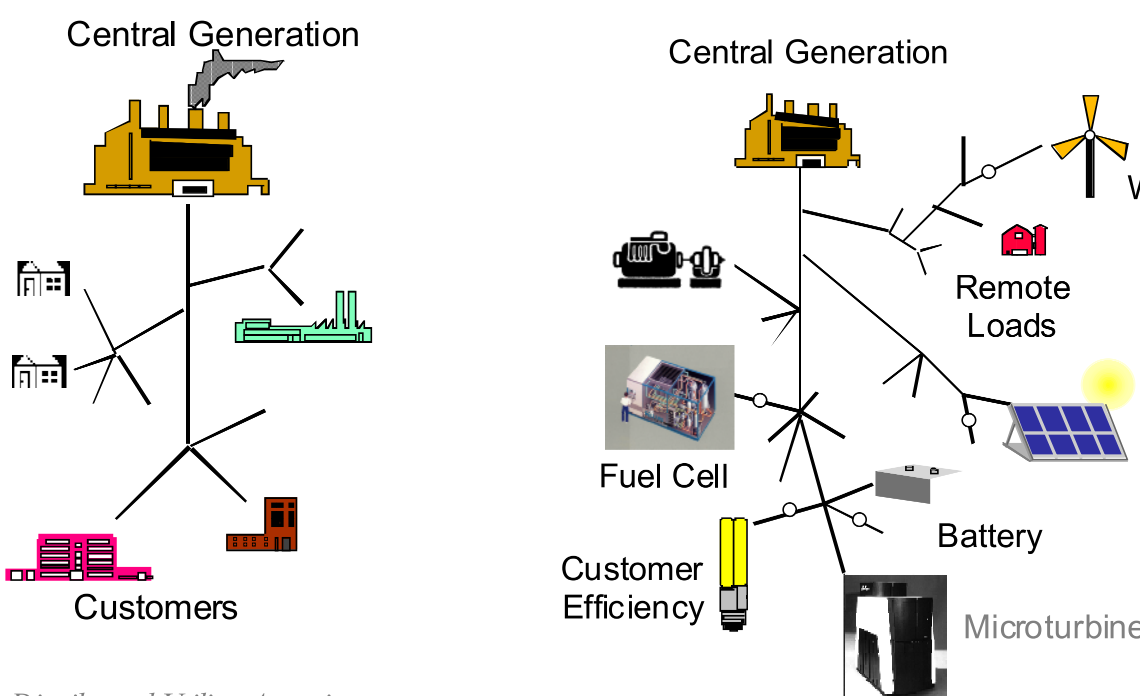
Allowing the interconnection of distributed RE systems can also provide benefits to the utility. For example, distributed generation can reduce stress on transmission and distribution infrastructure, extending the useful life of infrastructure like distribution transformers (Shugar, 1993), and reduce line losses by supporting voltage in distribution or transmission lines (San Martin, 1990; NEPDG, 2001). Because of the distributed nature of small renewable systems, their connection to the main power grid can also help eliminate transmission/distribution restraints (San Martin, 1990; Leng, 1994; NEPDG, 2001), and in some cases allow for the delay of generation infrastructure expansion (Lovins, 2003).

Perhaps more significant is the fact that, small renewable power producers can feed power into the grid during periods of peak demand thus providing valuable load management services (San Martin, 1990; Leng, 1994 NEPDG, 2001). Many American utilities as far north as New England have already proven that PV and other small grid tied systems are effective for peak load management (NEPDG, 2001; San Martin, 1990; Leng, 1994; Bzura, 1995; Hoff, 1987). Most of these benefits arise from the use of distributed resources whether or not the local utility has adopted a net metering program, or any other buy-back policy.

3.3 Distributed Generation

The central generation model is made up of large (500 to 3000 MW) plants usually located a significant distance away from where the energy is consumed. In the 20th century, vast distribution grids were developed to carry electricity from these large-scale, centrally managed power plants. In this 'vertically integrated' model, utilities typically own the generating plants, transmission system and distribution lines.

Distributed Generation (DG) is the generation of energy close to the point of use. The DG model has power supplied by generators ranging from 1 kilowatt to 5 megawatts in capacity, in contrast to traditional large-scale power plants. Today, with deregulation and changing market trends, the DG model is becoming more widely accepted, with small and medium sized power producers spread throughout the distribution network in homes, farms, factories, office buildings and small community facilities.



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Joe Iannucci

Renewable energy technologies are well suited to the DG model, as the modular nature of small renewable energy systems allows:

1. Close proximity installation
2. Installation in small increments to match the load customer requirements
3. An increase in generation capacity as required

PV for example, is a good fit with daily load peaks where summer air conditioning is required and does not need to be "dispatchable"[11] as it can pass surplus power back to the grid during the day, while drawing on the grid at night. This approach maximizes the value, while minimizing the cost of solar-generated electricity. Similar advantages can be attributed to wind systems and micro hydro systems. Concern over intermittent power production is one of the stumbling blocks along the path towards widespread acceptance of grid-connected RE systems, even though modern electrical grids can carry up to 20% or more of their capacity from intermittent sources with no detrimental effects (UNEP, 2000).

[11] An energy supply is "dispatchable" when it is guaranteed or predictable.

3.4 Photovoltaics

Photovoltaics (PV) is the direct conversion of the energy in sunlight into electricity. Typically, slices or ‘cells’ of a silicone-based product are sandwiched in a single layer between glass to create a module. The module, which typically generates anywhere from 20 to 150 Watts, is the basis of the PV ‘array’, where several modules are wired together. The amount of energy produced by PV systems is dependent on the amount of light hitting the surface of the cells in the modules and the temperature of the cells themselves. The success of PV in Canada to date has been in stand-alone systems for remote locations. See chart below, which compares the scope of PV applications in various countries in 2001. Note that Germany and Japan show the highest percentages of grid-connected PV installations.

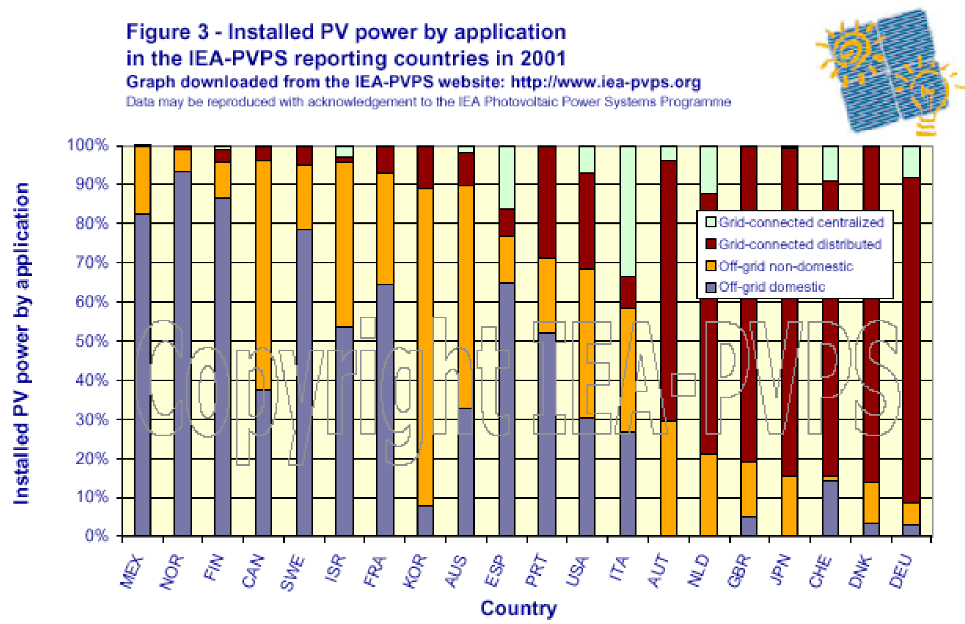


Figure 3 - Installed PV power by application in the IEA-PVPS reporting countries in 2001
Graph downloaded from the IEA-PVPS website: http://www.iea-pvps.org
Data may be reproduced with acknowledgement to the IEA Photovoltaic Power Systems Programme

Unlike other renewable energy source technologies, such as wind, which are built for larger power generation capacity, the smaller size of PV modules, means the technology is inherently consumer-focused. They also provide electricity, and, could, over the lifetime of the product (typically 30 years) pay for themselves at least once whether through deferred energy costs or through a formal buy-back program with the local utility. PV systems can be integrated into landscaping or into a building, and can be included in new construction or in retrofit projects. The opportunity for businesses and institutions to include building integrated photovoltaics (BIPV) into their new construction or retrofit plans is remarkable. These are truly elegant design solutions, they provide protection from the weather, daylighting and shading.

Roof shingles, standing seam metal roofing, atrium glazing and curtain walls assemblies are some options. Canopies assembled from PV panels can provide shading. Roofs of bus shelters, covered walkways, shopping cart corrals – there are numerous surfaces that become available for small-scale energy generation. In many applications, incorporating BIPV may add value far beyond the actual electricity generated, for example, covering a parking area with a PV array where the value of shade and shelter from snow might of equal or greater value than the energy flowing from the roofing (Eiffert, 2000).

One point that can't be emphasized enough is the fact that the value of PV systems — and the point at which the technology becomes economically viable — is very different from the standpoint of the consumer than that of the large power producer or electricity retailer. For instance, a 300 W grid-connected system, costing approximately $10/W, or $3000 for the system, can carry from 10 to 20% of a the electrical load of a standard Ontario home (without electric heating).[12] This translates into a measurable difference in electricity costs with a foreseeable payback for the homeowner. For the utility, it means little or nothing in terms of income lost or generated.

[12] Allen, 2003

3.5 Wind Power

Wind is a mature and modular technology for both grid and stand-alone applications. Small-scale-wind power (100 kW or less) is much closer than PV to being competitive with current utility rates across most of the country. Small and medium size turbines can be installed on marginal land such as grazing land and highway verges. Most wind turbines are being installed in ‘wind farms’ where multiple units of 500kW or more produce enough power to run many homes or even entire neighborhoods. Wind resources are intermittent, but are highly predictable when measured over a significant period of time. Safety issues around the tower require a large footprint to be left open. Smaller turbines are practical for farms or industrial settings. Wind is not suited to many urban or suburban sites that would be accessible by typical homeowners or businesses, but can add value to marginal land, as noted above.

There is a robust wind energy industry in Canada, but the size of each of installations is many times that of this study’s parameters. For example, Cowley Ridge, Canada’s first commercial windplant located in the southwest corner of Alberta, consists of 57 turbines with a total capacity of 21.4 MW. Cowley Ridge produces enough electricity annually to power 7,500 typical Canadian homes. The completion of Cowley Ridge North and Sinnot Wind Plant in 2001 added another 26 MW (each of these 1.3MW turbines, flying only approximately 35 minutes will generate enough electricity to power a typical home for a month)[13]. Large wind projects are also located at Gull Lake, SK (5.9 MW)[14], ‘Le Nordais’ wind farm in the Gaspé Region, QC (100MW)[15] and the North Cape Wind Farm on Prince Edward Island (5.3 MW). For a full listing of current large-scale wind production, go to http://www.canwea.ca/CanadianProduction.html

[13] http://www.cowleyridge.com/history.htm
[14] http://www.saskpower.com/aboutus/genfac/cypress.shtml
[15] http://www.axor.com/axor-en.htm

3.6 Microhydro

Microhydro systems work in two major configurations: high head/low volume (lots of height, little water) or low head/high volume (not much height, lots of water). There are turbines suited to various combinations of water flow and 'head'. There are impulse turbines that work in several ranges. Reaction turbines work best in low head, battery-charging systems. Another style of turbine has a propeller that sits directly in the creek and spins with the current of the water.[16] Seasonal waterways can be used to produce a significant amount of power. Small turbines placed in seasonal or year-round waterways run "24/7", and often generate more power than the homeowners who have installed these systems can use (CMHC, 2001). In BC, microhydro potential actually exceeds solar and wind potential (Pape, 1999). Very small, single family run-of-river systems tend to be non-production models, but larger systems (suitable for a small subdivision or low-rise residential complex) are available as off-the-shelf models, complete with CSA or UL approvals (Henderson, 2001). A 2kW system running at 60% can meet the power needs of an average BC home without electric space heating (Pape, 1999).

[16] For an excellent on-line course on microhydro design and installation, go to www.energyalternatives.ca/

3.7 Net Metering – What Is It?

Electricity is a valuable commodity. When coming up with interconnection policies, utilities must not only decide on a technical standard but also ask: should excess electricity from small suppliers that is fed into the grid receive compensation? If so, to what extent should they be compensated? What form should the compensation take? What is fair for the producer, other rate payers and the utility itself? Ironing out these details seem to be subject to more disagreement than the technical questions associated with grid-connection. As a result, there is a wide range of responses as to what is fair.

Excess power generated by the small-scale RE producer can be:

- Granted to the utility with no buy-back
- Purchased by the utility at the avoided cost[17]
- Purchased at the average retail rate.
- Where time-of-use programs are in place, customers get higher retail rates if the excess generation is fed into the grid during peak load periods.
- Purchased at a premium rate[18]

In the broadest sense, the term 'net metering' refers to any policy that allows system owners to obtain retail value for at least some of the excess electricity they feed into the grid. This is done using a single electrical meter that turns backward when there is more on-site generation than demand, and forwards where there is more demand than on-site generation. It is an arrangement which is especially useful for intermittent or seasonal renewable energy technologies.

A utility must have a technical interconnection policy in place before a system owner can feed excess power into the grid. A compensation policy must be in place before a system owner can receive any type of credit for excess power fed into the grid. No matter which type of buy-back agreement is put in place some method of tracking the electricity fed into and taken from the grid is required. The only readily available accounting tool is an electricity meter. The type and number of meters chosen will have implications for any buy-back scheme, so a familiarity with the technical aspects of metering options is needed. But, in the end, net metering — or any other billing/compensation arrangement — has nothing to do with the technical and safety issues associated grid-connection, it is simply a way to transfer the ownership of electricity (Howell, 2003).

[17] Avoided cost is a rate that reflects how much the utility didn't have to spend on the energy produced by the system owner.
[18] Common in Europe

As adopted in the US and Europe, net metering has been shown to encourage direct consumer investment in RE technologies by allowing a customer to gain retail value for a higher proportion of the excess power their system generates (Wan, 1998; Starrs, 1999; UCS, 2000). Other goals include stimulating local economic growth, diversifying energy resources and improving the environment (Wan, 1998). In both simple net metering and full net metering arrangements (explained below), a single electrical meter turns backward when there is more on-site generation than demand, and forwards where there is more demand than on-site generation.

Net metering is not the only buy-back arrangement possible. Other metering/buy-back arrangements may ultimately prove more desirable from a small-scale renewable energy producer or utility perspective, for example net billing, 4-quadrant interval metering, real-time metering or time-of-use metering (or any of these used in combination with a single bi-directional meter). Though there are various definitions of net metering in use, and not all definitions are consistent, for the purposes of this study, a policy is considered a net metering policy, if is has one, two, or all three of the following characteristics:

A. Simple Net Metering: A customer is allowed to use a single bi-directional meter to measure both electricity fed into the grid as well as electricity taken from the grid within the same billing period. If a customer requires additional electricity, they pay the retail rate for it. If there is a net excess of electricity fed into the grid at the end of the billing period, the customer receives no compensation. This method does not allow seasonal excesses to be used to offset seasonal shortages.

B. Full Net Metering with Buy-back: A customer receives retail rate or more for each kilowatt-hour of electricity or excess electricity it feeds to the grid, in the form of a monetary credit on their bill. One bi-directional meter runs backwards and forwards as in characteristic A, but in addition, at the end of the billing period, the customer is paid or credited a retail $/kWh rate for each excess kWh that was fed to the grid.

C. Full Net Metering with Rolling Credit: A customer is allowed to ‘bank’ excess generation in the form of a credit measured in kilowatt-hours and carried from billing period to billing period (and thus season to season). The customer gets the kWh credit but they don’t receive cash for the electricity they generate above their needs. If the carry-over is allowed to continue indefinitely the customer will effectively receive retail rate for all the power they generate. Often such credit carry-overs, however, are nullified at the end year. In combination with characteristic B), however the customer can receive retail value for all the power they generate over an entire year.

All three of the above characteristics have one thing in common: they allow the customer to gain retail credit for a portion of the electricity they generate. In combination they allow a customer to obtain retail price for all of the electricity they produce (in dollars or in kilowatt-hour credits).

So net metering program has the possibility of offering additional benefits to both the customer and the utility above and beyond those derived from either a policy which simply allows grid-connection, or one that purchases excess generation at avoided cost rate. In situations where customers are grid-connected yet no net metering is in place, two meters are often employed to keep track of electricity being fed into the grid and electricity being taken from the grid. A net metering policy eliminates the need to purchase a second meter and reduces the costs of administering energy transactions for both parties, as the single meter does all the accounting.

From the system owner's perspective, net metering means a greater percentage of their excess generation is bought at the retail rate, allowing the capital investment to be more quickly amortized. It should be noted that utilities can also benefit from arrangements such as net metering. Encouraging distributed generation through a net metering policy allows utilities to improve their distribution voltage profile, reduce system losses and provide other benefits explained in section 3.2. and 3.3

Net metering also creates an incentive for customers to invest in systems which more closely match their average demand for electricity, which can benefit both the customers and the utility. Without net metering, electricity generated at a time when it is not immediately needed is wasted. This can lead small-scale RE producers to shift their electricity use to their period of peak production, when their on-site production can be used (Starrs, 1998). Quite often, peak production periods for RE sources also coincide with peak usage periods for the utility – defeating any potential for peak shaving or clipping, which is one of the major benefits RE systems can offer utilities.

A commonly perceived argument against net metering from the perspective of utilities is that a compensation arrangement will result in lost revenues. In actual fact, the cost to the utility for offering small-scale RE producers retail rate net metering can be equated to the customer reducing their energy use by investing in energy efficiency measures such as compact fluorescent lighting and energy efficient appliances (UNEP, 2002).

We are using the term 'net metering' in a broader sense than it is typically employed in the US, where only policies with characteristic B and/or C (ie, a single or double meter arrangement with buy-back or rolling credit) would be considered net metering. In the US, the federal Public Utilities Regulatory Policies Act (PURPA) , enacted in 1978, legally guarantees that generators of any scale are permitted to feed electricity into the grid and receive compensation (Wan, 1998; Starrs, 1998, Andrews 2001). Likewise

PURPA states that utilities cannot be forced to pay more than their avoided costs for power from system owners. Simple net metering, described as Characteristic A above, does not meet PURPA's legal requirement because any excess power at the end of the billing period is not bought at avoided cost. Because of this utilities typically employ two meters for each account, one for incoming and one for outgoing electricity. These types of net billing arrangements, where system owners receive avoided cost for 100% of their excess energy, are thus preferred by American utilities, and indeed are common (Wan, 1998; Starrs, 1998).

In order for a policy to be considered net metering in the US, customers must be allowed to bank electricity and receive a monetary payment for any excess electricity at the end of each billing period. American net metering advocates are asking that small qualifying facilities be allowed to use simple net metering (only one meter), with avoided cost buy-back at the end of the billing period. This would allow excess power to be 'used' before the meter is read at the end of the billing period, and thus a higher percentage of a systems' output would be valued at retail rate. It appears that net metering advocates in the States have been effective because practices now exist in at least 34 states (Starrs, 2001). In some cases a state has enacted a law requiring net metering and other cases utilities have adopted policies voluntarily.

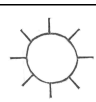
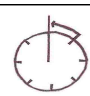
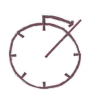
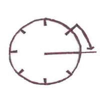
Canadian law does not require utilities to purchase excess power from small-scale producers, regardless of generation source. As a result, the term net metering has sometimes been interpreted differently in Canada than in the US. The way we have chosen to use the term, even a situation with no buy-back at all can be considered net metering as long as the small-scale renewable energy producer is gaining retail credit for excess electricity it generates and uses within each billing period. This has also been the way others in Canada have interpreted the term net metering. (Howell 2003). Newfoundland and Labrador Hydro, have taken net metering to mean simply a scheme where electricity can be banked within a single billing period (simple net metering).

So, Canadians are struggling for a minimum compensation arrangement which is taken for granted by American net metering advocates. This legislative difference may also result in net metering being more attractive to US utilities from the start. In the US utilities must purchase electricity from qualifying facilities in any case so the reduced administrative costs resulting from net metering compared to buy-back schemes may be more immediately obvious compared to a similar situation in Canada. Today net metering programs have been adopted voluntarily by utilities in 5 Canadian provinces: Manitoba, Ontario, Nova Scotia, Newfoundland & Labrador and the Yukon.

3.7.1 Simple Net Metering

If customers are allowed to meter electricity in both directions usinga single meter (which ensures both in and out going electricity is valued at the same $/kWh rate), they can then use electricity generated at one moment to displace their electricity demand at a later time during the same billing period. Such an arrangement ensures the higher percentage of customer-generated electricity is valued at retail rate, even though the utility never actually issues a dollar payment to the customer for the electricity. This could be called simple net metering as illustrated in Table 3.7.1. Such an arrangement is clearly desirable from a small-scale RE producer perspective and can also be more cost-effective for utilities. However, an actual buy-back scheme is an even more desirable option for small producers.

Table 3.7.1: Simple Net Metering, One Meter (retail, $0.08/kWh)

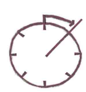
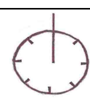
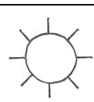
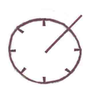
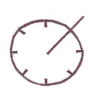
Day	Weather	Position of meter 1 at day's end	Position of meter 2 at day's end	Load (electricity used day's end), kWh	Electricity generated on site, kWh	Load met with power from grid, kWh	Load met with onsite power, kWh	Total kWh from grid day's end	Total kWh to grid day's end	Running total excess generated, kWh	Meter reading(s) at day's end, kWh	Running total of bill at day's end $
1			n/a	1	0	1	0	1	0	0	1	1x$0.08 = $0.08
2			n/a	1	2	0	1	0	1	1	0	0x$0.08 = $0.00
3			n/a	1	0	1	0	1	0	0	1	1x$0.08 = $0.08
4			n/a	1	0	1	0	1	0	0	2	2x$0.08 = $0.16
FOUR DAY TOTAL				4	2	3	1	3	1	0	2	$0.16

Note, in the US this would not be considered net metering unless customers were allowed to carry over excess electricity until the next billing period (i.e. if it were also sunny on day 4 they could use that electricity on any day of the next billing period), or unless excess electricity at the end of the four day billing period was actually purchased at retail rate (this is further discussed below in the net metering section).

3.7.2 Net Billing

Another common approach of reimbursing small-scale power producers is to pay them using the avoided cost rate for power fed into the grid. Avoided cost is equivalent to how much it would have cost the utility to generate an equal amount of electricity (kWh) for its customers had the small power producer not been able to provide those kWh to the grid. The avoided cost calculation does not include transmission and distribution costs, marketing, utility profits etc. (Wan, 1998). This method is widely used in the US, and in Canada. For this buy-back rate both the electricity taken from the grid and electricity fed into the grid must be separately tracked, most often two separate meters, but a single sophisticated meter can also be employed. A typical avoided-cost buy-back, or ‘net billing’ arrangement is illustrated in Table 3.7.2.

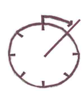
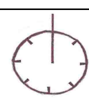
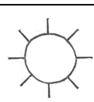
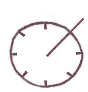
Table 3.7.2: Net Billing: Incoming Retail $.08/kWh; Outgoing Avoided Cost $.04/kWh Two meters

Day	Weather	Position of meter 1 at day's end	Position of meter 2 at day's end	Load (electricity used day's end), kWh	Electricity generated on site, kWh	Load met with power from grid, kWh	Load met with onsite power, kWh	Total kWh from grid day's end	Total kWh to grid day's end	Running total excess generated, kWh	Meter reading(s) at day's end, kWh	Running total of bill at day's end $
1				1	0	1	0	1	0	0/0	1/0	(1x 0.08)-(0x 0.04)= $0.08
2				1	2	0	1	0	1	0/1	1/1	(1x 0.08)-(1x 0.04)= $0.04
3				1	0	1	0	1	0	0/1	2/1	(2x 0.08)-(1x 0.04)= $0.12
4				1	0	1	0	1	0	0/1	3/1	(3x 0.08)-(1x 0.04)= $0.20
FOUR DAY TOTAL				4	2	3	1	3	1	0/1	3/1	$0.20

3.7.3 Two-Meter Net Metering

Some utilities employ two meters to track electricity production and use. They often refer to their policy as net metering (illustrated in Table 3.7.3), even though the two meter technique accomplishes the same objectives as a single meter (Table 3.7.1 and Table 3.7.3 have the same bill at the end of the four day billing period). This naming practice confuses the meaning of the term “net metering”. The term net metering should be reserved for only those policies that employ a single meter. For situations where two meters are used to track electricity production (at one price) and use (at another price) the term “net billing” is preferred. For situations where two meters are used to track electricity production and use (at the same price) the term “two-meter net metering” is suggested. Two meters are sometimes required by utilities to ensure accuracy in metering in either direction.

Table 3.7.3: Net Metering: Incoming Retail $.08/kWh; Outgoing Retail $.08/kWh Two meters

Day	Weather	Position of meter 1 at day's end	Position of meter 2 at day's end	Load (electricity used day's end), kWh	Electricity generated on site, kWh	Load met with power from grid, kWh	Load met with onsite power, kWh	Total kWh from grid day's end	Total kWh to grid day's end	Running total excess generated, kWh	Meter reading(s) at day's end, kWh	Running total of bill at day's end $
1				1	0	1	0	1	0	0/0	1/0	(1x 0.08$)-(0x 0.08)= 0.08$
2				1	2	0	1	0	1	0/1	1/1	(1x 0.08$)-(1x 0.08)= 0.00$
3				1	0	1	0	1	0	0/1	2/1	(2x 0.08$)-(1x 0.08)= 0.08$
4				1	0	1	0	1	0	0/1	3/1	(3x 0.08$)-(1x 0.08)= 0.16$
FOUR DAY TOTAL				4	2	3	1	3	1	0/1	3/1	0.16$

3.7.4 Treatment of Net Excess Generation

Three different approaches exist to treat any excess kilowatt-hours that have been fed to the grid at the end of the billing period. KWh can either be granted to the utility, purchased by the utility, or granted as credit to the next billing period, (if power is purchased at any of three prices: avoided cost, retail or premium).In theory, each of these approaches can be used with either a situation which uses one meter (net metering) or two meters (net billing or two meter net metering).

PART TWO: SYSTEM OWNER SURVEY RESULTS

4.0 System Owner Survey Results

The survey of grid-connected RE system owners (the system owner survey) was conducted over a six-month period (October 2002 to March 2003). Forty-two survey respondents together identified a total of one hundred and fifty-nine systems attached to the grid in Canada. Several survey respondents were the designers, installers or distributors of the systems, as many system owners were neither available for comment nor conversant in technical issues. There is in fact, a small pool of experts in this field in Canada. Their numerous projects figure largely in this survey, explaining the fact that we ended up with 122 system descriptions out of the 159 projects identified, yet there were only 42 survey responses.

We are confident we have identified over to 90% of the documented small-scale grid-connected RE systems in Canada as of March 2003. Note this includes all documented installations and yet may not include a number of installations in process or guerrilla systems for which no documentation exists.

Some installations that exceed the capacity limits initially set for the study, were included anyway, as they fell within the intent of the study, that is: to examine systems that could be installed cost-effectively by a homeowner, a business or an institution. The largest of the PV systems is 42 kW, with other large PV and BIPV systems between 12 and 16 kW. Two wind installation of 2-80kW turbines were included as well.

With the exception of three installations, all systems are *grid-dependent*, (i.e., there is no battery storage bank). Those with batteries, referred to as *grid-interactive* systems, include: a hybrid residential system on PEI; a BIPV residential system in Ontario; and a residential PV installation, also in Ontario.

4.1 Small-scale Grid-connected Renewable Energy Systems across Canada

Geographically, the bulk (89) of the systems identified are in Ontario. This includes 37 - 200W residential systems that were installed in 1999 in Toronto by Greenpeace under their 'Solar Pioneer' Program. Even when these 37 are seen as one project (a bulk-buy purchase), PV systems tend to be most prominent in the RE mix country-wide. Modular elements, availability and the size of package systems offered by PV distributors lend themselves to a wider market than other technologies. On the other hand, Building Integrated PV, which is relatively new to the market, will no doubt will see substantial future growth as it becomes more cost-effective. Wind systems are readily available, and yet small-scale installations may not be well suited to urban or suburban sites. Microhydro systems are dependent on favorable geography. System distribution by type and province is shown in Table 4.1.1. Total system capacity by type and province is shown in Table 4.1.2

Table 4.1.3 it indicates the number of installations identified in the course of the study and the number of installations where system capacity was also identified. Ontario and Northwest Territories currently have over 2/3 of small-scale renewable energy capacity on-grid (38.5 and 39.2, respectively), with Ontario's capacity primarily made up of 76 smaller PV and BIPV systems while Northwest Territories' capacity is found in five larger wind installations.

Table 4.1.1: Distribution of System Installations by Province (Number of systems/installations)

	BC	AB	SK	MB	ON	QC	NB	PEI	NS	NF	NU	YT	NT	**Total**
BIPV	4	1		1	8									**14**
PV	4	15	4	10	76	1			1		1	1		**113**
Wind	1				4	1		1	1				5	**13**
MH	11				1	1	1		1					**15**
Hybrid	1							1	2					**4**
Totals	**21**	**16**	**4**	**11**	**89**	**3**	**1**	**2**	**5**		**1**	**1**	**5**	**159**

Table 4.1.2: Distribution of Generation Capacity by Province in kW

	BC	AB	SK	MB	ON	QC	NB	PEI	NS	NF	NU	YT	NT	**Total**
BIPV	8.66	13.4		12.6	19.9									**54.56**
PV	7.1	23.7	5.3		134	15			10		3.2	0.5		**198.8**
Wind	3				250	60		10	50				410	**783**
MH	n/a				n/a	n/a			5					**5**
Hybrid	n/a							2.9	3.6					**6.5**
Totals	**18.76**	**37.1**	**5.3**	**12.6**	**403.9**	**75**	**n/a**	**12.9**	**68.6**	**n/a**	**3.2**	**0.5**	**410**	**1047.86**

Note: Rated capacity only (capacity factor not taken into consideration). Does not include all grid-connected capacity because 37 owners did not include capacity rating in their responses: 159 system identified, 37 with no capacity indicated = 122 systems.

Chart 4.1.2: Distribution of RE Generation Capacity (kW) by region

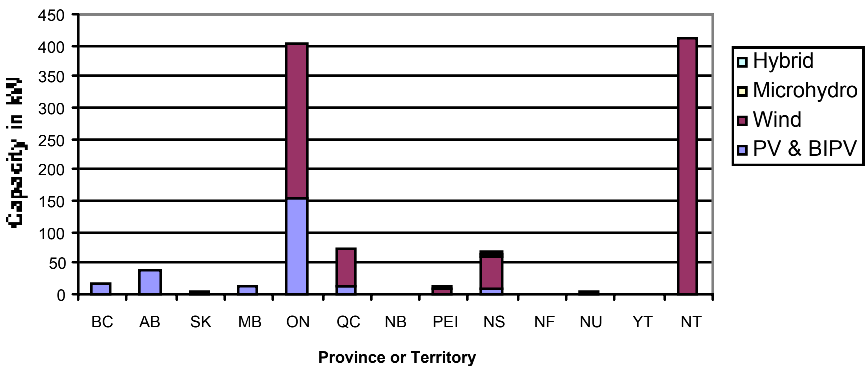


Table 4.1.3: Identified Small-Scale Grid-connected Renewable Generation Capacity by Province

Province	Number of installations identified	Number of installations w/identified capacity	% National Installed Capacity
BC	21	9	1.8%
AB	16	16	3.5%
SK	4	3	0.5%
MB	11	1	1.2%
ON	89	76	38.5%
QC	3	3	7.2%
NB	1		n/a
NS	5	5	6.6%
PEI	2	2	1.2%
NF			n/a
YT	1	1	negligible
NT	5	5	39.2%
NU	1	1	0.3%
TOTAL	159	122	100.0

4.2 PV System Capacities

One hundred and thirteen photovoltaic systems were identified, ranging from 100W to 42kW. The majority of available technologies are represented in the survey mix — from monocrystalline cells to amorphous thin film; from standard arrays on standard steel mounts to roofing shingles, metal roofs and curtain wall applications.

Capacity (the load the system can carry under optimum conditions) was supplied for only 91 of the standard PV installations (refer to table 4.2). Missing capacity records are for PV guerrilla systems or in-process projects identified with partial survey responses. All but 3 of the 91 systems are under 10kW. Both of the 10kW installations are institutional, one in Ontario and one in Nova Scotia. The 15kW system is in Quebec, while the 25kW and the 42kW systems are in Ontario. The 25kW system, on the Hugh MacMillan Rehabilitation Centre in Toronto, was, at one point, the largest PV installation in Canada, at 52kW installed. Problems with power conditioning equipment scaled back the working capacity to 25kW.

The inclusion of the Toronto Solar Pioneer Program (37-200W) skews Table 4.2 in favour of small systems. Allowing for this, the more typical size for residential systems is between 1 and 2.5 kW.

Table 4.2: PV Capacity

PV Capacity	No. of Systems
< 0.5 kW	43
> 0.5 kW	8
≥ 1.0 kW	13
≥ 2.0 kW	13
≥ 3.0 kW	4
≥ 4.0 kW	3
≥ 5.0 kW	2
≥ 10.0 kW	2
≥ 15.0 kW	1
≥ 25.0 kW	1
≥ 40.0 kW	1
Total	91

4.3 BIPV System Capacities

BIPV systems in the survey range in size from an 86W shingle demonstration project to a curtainwall installation of more than 13 kW. In total 14 systems were identified (see Table 4.3). The range of applications includes three different residential roof products, curtain walls, skylights and cantilevered canopies. Some applications were clearly BIPV – actual products designed to be incorporated into the building or structure. Others were standard flat-plate modules integrated into the assembly, as a canopy for instance.

Table 4.3: BIPV Capacity

BIPV Capacity	No. of Systems
<1 kW	3
≥ 1.0 kW	2
≥ 2.0 kW	2
≥ 3.0 kW	2
≥ 4.0 kW	1
≥ 5.0 kW	2
≥ 10.0 kW	2
Total	14

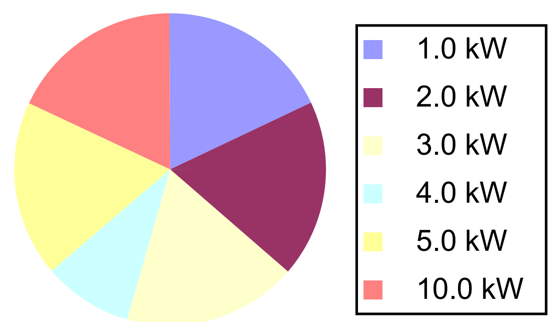


Chart 4.3: Grid-Connected BIPV Systems

4.4 Wind System Capacities

Canadian wind installations follow the general pattern of wind installations around the globe, where larger scale installations are more cost-effective. Mid-sized wind installations (50kW or so) are more probable for community projects or commercial ventures. Household wind power is 10kW or smaller. There are two grid-connect (and utility owned) systems with a total capacity of 160kW each (2 x 80kW units) in Canada. One of these systems is in the Northwest Territories and the other is in Ontario. It should be noted that there are many small-scale off-grid or stand-alone wind installations across the country, this sample only indicates grid-connected, wind installations.

Table 4.4: Wind Capacity

Wind Capacity	No. of Systems
3 kW	1
10 kW	2
20 kW	1
30 kW	1
50 kW	3
60 kW	1
80 kW	1
100 kW	1
160 kW	2
Total	13

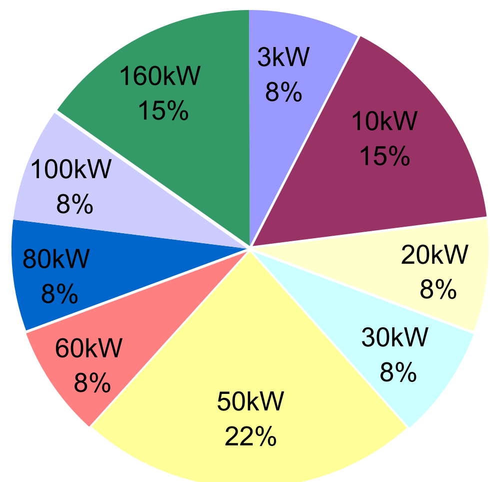


Chart 4.4: Grid-connected Wind Capacity

4.5 Microhydro System Capacities

With the exception of one system, a 5 kW-rated project built in the early 1980s in Nova Scotia, the fourteen microhydro systems identified were guerrilla systems. Suppliers suggest that an average size for these systems would be about 1kW. Note again that as with small-scale wind energy systems, there are many off-grid or stand-alone microhydro installations across the country.

4.6 Hybrid Systems Capacities

Three of the four hybrid systems identified in the survey were wind and PV/BIPV combinations. The fourth system, a microhydro/wind hybrid, was a guerrilla system for which we were unable to get more details. Two of the three wind/PV systems had a 2.0 kW PV array with a 1kW wind turbine, while the third of these systems was much smaller, 300W for each of the PV and wind generators. All three of the wind/PV systems were designed to meet the total load of the house, showing that a net energy-producing house can be achieved, even with a 600W system.

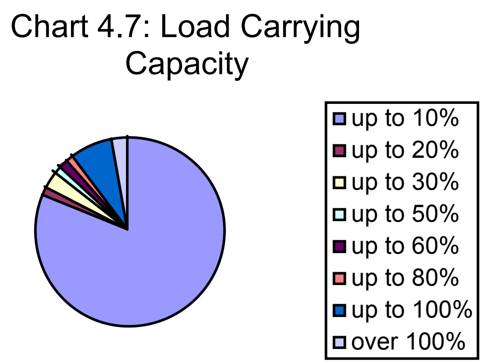
Many off-grid or stand-alone systems are hybrid, as there is typically a seasonal match for each RE technology. For example, the west coast of British Columbia has a great seasonal match for rainy season/continuous runoff in drainage ditches — excellent for microhydro — and high incidence of sun and/or wind in the dry season — good for solar/wind installations.

4.7 Load-carrying Capacity

In terms of the load-carrying capacity (i.e., how much of the total electrical demand is met by the RE system), the systems covered the whole range, providing from 3% to over 100% of the power load. Of the fourteen respondents who indicated power load percentage, six were in the 1-10% range. The remaining were scattered as seen in Table 4.7. Although most commercial and institutional owners did not include the power load percentage carried by the system, most would not exceed 10% of the typical total building load. We can say this based on the knowledge that the typical load of an institutional building is several times larger than any of the system capacities identified. The percentages supplied to residential loads were more widely spread. Depending on the lifestyle of the homeowner, the same size system could meet from 10 to 50% of the overall load in different households.

Table 4.7: Load-carrying Capacity

Load-carrying Capacity	No. of Systems
1-10%	56
11-20%	1
21-30%	2
41-50%	1
51-60%	1
71-80%	1
81-100%	5
101-110%	2
Total	69



One of the keys to effectively sizing a renewable energy production system is to ensure that the load it carries is minimized. This means reducing the typical electrical load of a building by many kilowatts. Space heating, water heating and any other ‘thermal resistance’ electrical application (i.e., any appliance, big or small that uses electricity to generate heat) should be eliminated. If these energy loads cannot be eliminated, care should be taken to find the most energy efficient appliance possible. We can benefit from the many lessons learned in off-grid housing, where the electrical load makes or breaks the homeowner’s budget (CMHC, 2001).

The key lesson is: if there is any other energy source that can do the job, use it instead of electricity. Electricity is a ‘high-end’ energy source – it’s always less expensive to save a Watt than it is to make a Watt – for every dollar spent on using electricity, five were spent generating electricity[19]. Once space and water heating are taken out of the electrical load, the primary energy users are refrigerators and water pumps. Where urban and suburban homes don’t typically have water pumps, the next energy users are fans of any sort – furnace, air conditioners – that run on a fairly constant basis.

[19] www.energyalternatives.ca/conservation/

4.8 System Components

Not all systems identified had complete information. The following tables indicating the make and model of generation sources and inverters currently in use in Canada, as identified by survey respondents. The PV and inverter industry has recently gone through a series of buy-outs, amalgamations and mergers which have ended up in some products being re-named or discontinued. For example, Siemens is now Shell Solar, Solarex is now BP Solar and Trace, Heart Interface and StatPower are all now part of Xantrex. Advanced Energy is no longer in business. A list of the available grid-connect ready inverters can be found at Appendix II. For an up-to-date listing of solar panels, visit www.solarbuzz.com.

The most commonly identified PV modules were Astro Power and Siemens (now Shell Solar) models, if the Greenpeace Toronto bulk-buy choice of the Siemens 50W panel is considered to be the specification for one project. The newest applications listed here are the Unisolar roofing products and the St.Gobain glazing and spandrel panels. None of the products listed here are Canadian-made. ATS Spheral is currently developing a Canadian thin-film product that will be market-ready by Fall 2003.

Table 4.8.1: PV Modules used, by project

Manufacturer	# of Projects	Model	Module Rated Capacity	Array Type	PV Technology Type
ASE America Ltd.	1	ASE100	100W	PV	polycrystalline
	1	ASE250	250W	PV	polycrystalline
Astro Power Canada	1	N/A	N/A	PV	monocrystalline
	1	APC-40	40W	PV	
	2	AP- 110	110W	PV	
	3	AP-120	120W	PV	
BP Solar	1	BP50	50W	PV	polycrystalline
	1	BP85	85W	PV	
	1	BP100	100W	PV	
Energy Photovoltaics	1	EPV40 Custom	40W	glazing	copper indium gallium diselenide (CIGS) thin-film
Kyocera	1	KC-120	120W	PV	polycrystalline
PhotoWatt	1			PV	polycrystalline
	2	PW1000	100W	PV	
St. Gobain Glass (PhotoWatt cells)	1	Prosol	133W	spandrel panels	polycrystalline
	1	Prosol	108W	PV	polycrystalline
St. Gobain Glass (Kyocera cells)	1	blau PFC 150	945W	glazing	
Siemens (now Shell Solar)	1	SP100	100W	PV	monocrystalline
	1	SP150	150W	PV	
	37*	SR50	50W	PV	
	1	SR100	100W	PV	
	1	PC4-JF	75W	PV	
Solarex (now BP Solar)	1	MSX120	120W	frameless modules	polycrystalline
	1	MSX60	60W	PV	
	1	VLX-50	60W	PV	
Solec	1	SD100	100W	PV	monocrystalline
	1	TPK	33W	BIPV roofing	
Unisolar	1	US 64	64W	PV	amorphous silicone thin-film
	1	SH17	17W	roof shingles	
	1	SSR128	128W	structural metal roof	
Total Projects w/identified PV modules	69				
Total PV module types identified	29				

* Greenpeace Toronto bulk-buy program

Note: The only projects included are those which supplied appropriate information. Thus the difference in totals between 69 and 113 (from Table 4.1.1) and 91 (Table 4.2)

The most commonly identified wind turbines were AOC's 15/50 and the Lagerway 18/80 models. Bergey is identified in only one installation, but this long-standing wind manufacturer is well known in the off-grid world. There is one Canadian manufacturer of small wind turbines, WestTech Energy Systems in BC. WestTech is in the process of developing a 1kW turbine for the Canadian residential market.

Table 4.8.2: Wind Turbines used, by project

Manufacturer	# of Projects	Model	Rated Capacity
AeroWatt	1	LM10	10kW
		Air 303-12	300W
Atlantic Orient Canada (AOC)	3	15/50	50kW
Bergey	1	N/A	10kW
Bonus	1	N/A	60kW
Lagerway	3	18/80	80kW
Whisper	1		1kW
Total Wind turbines identified	9		

The only microhydro turbine identified in the survey was a Thompson & Ashe model.

Table 4.8.3: Microhydro Turbines used, by project

Manufacturer	# of Projects	Model	Rated Capacity
Thompson & Ashe	1	Dependable Turbine	5kW
Total Microhydro turbines identified	1		

By far, the most commonly identified inverters were Trace (now Xantrex) models, if the Greenpeace Toronto bulk-buy choice of the NKF OK4 is considered to be the specification for one project. Although Sunny Boy is listed only twice here, there are over 3,000 Sunny Boy inverters installed in the US (www.fronius.com). Arise Technologies' GX-5000 and Sustainable Energy Technologies' Pulsed Step Inverter are both made in Canada – Arise is located in Ontario and Sustainable Energy Technologies is located in Alberta.

Table 4.8.4: Identified Inverters
NOTE: some projects used more than one inverter (ie, the Greenpeace 200W systems used two 100W capacity NKF-OK4 inverters). This table identifies the number of projects in which each model of inverter was specified, it does not indicate the total number of inverters in use.

Manufacturer	# of projects	Model
Advanced Energy	2	n/a
Arise	12	GX-5000
NKF	*37	OK4
OKE	1	OK4U
Omion	4	n/a
Prosine	1	5000GT
Trace	3	4024 SW
Trace	3	Microsine
Trace	1	SW4000
Trace	2	2512 SW
Sustainable Energy Technologies	1	Pulsed Step Inverter
SunnyBoy	2	2500U
Vanner	1	RE4500
Xantrex	4	Suntie
Xantrex	3	SW 4048 UPV
Xantrex	2	Suntie 2500
Total projects w/identified inverters	77	
Total inverter types identified	16	

* Greenpeace Toronto bulk-buy program

4.9 Metering Equipment

Metering equipment requirements and buyback programs vary from region to region and installation to installation within some provinces and jurisdictions as shown in the Table 4.9. Where guerrilla systems are in place, typically a standard kWh meter runs backwards when there is excess generation and runs forwards when there is a demand larger than the owner's system can supply. In some jurisdictions, there is concern over the accuracy of the readings on standard meters when they run backwards. In other areas, this does not seem to be an issue.

Also in some jurisdictions two meters are required by the utility, or chosen by system owners. Two meters (or a single four-quadrant meter) is required to keep track separately of incoming and outgoing electricity and assigning a different price to each. Although net metering is possible with two meters, a single meter is ideal. However as pointed out in Section 3, net metering is not necessarily the best compensation arrangement from the perspective of the system owner: for example, a net billing situation where green power earns a premium would be preferred.

Only 25 respondents included details on the metering equipment that was employed to keep track of electricity earning compensation from the utility. In most cases however, it is safe to assume that multiple installations in the same jurisdiction will have to meet the same requirements for net metering equipment.

Table 4.9: Metering Equipment in Place, by Region

Prov	Utility	RE Type	Size (kW)	Owner Type	Additional Metering Equipment	Buyback/Net Metering Arrangement	Excess Purchase Price
BC	BC Hydro	BIPV	1.0 2.0 3.0	Institution (BCIT)	none required	No buyback, system does not exceed building loads	n/a
BC	BC Hydro	BIPV	2.66	BC Gov't	none required	No buyback, system does not exceed building loads	n/a
AB	EPCOR	PV	2.4	Residence	none required	No buyback, system does not exceed building loads	n/a
AB	EPCOR	PV	13.4	Utility-owned	none required	No buyback, system does not exceed building loads	n/a
AB	EPCOR	PV	0.1	Residence	2 latched interval meters	No buyback, system does not exceed building loads	n/a
AB	EPCOR	PV	2.5	Spruce Meadows Equest. Ctr.	none required	No buyback, system does not exceed building loads	n/a
AB	EPCOR	PV	2.8	AB Gov't	none required	No buyback, system does not exceed building loads	n/a
AB	EPCOR	PV	0.5	Residence	2 latched interval meters	Power Pool price for exported electricity	±$ 0.06
AB	EPCOR	PV	2.3	Residence	2 latched interval meters	Power Pool price for exported electricity	±$ 0.06
AB	EPCOR	PV	0.1	Residence (guerrilla)	none	Single meter effectively net meters house	±$ 0.06
AB	ENMAX	PV	0.6	Residence (guerrilla)	none	Single meter effectively net meters house	retail rate
AB	ENMAX	PV	2	commercial	none	No buyback, system does not exceed building loads	n/a
AB	UtiliCorp	PV	2.6	Residence	bi-directional meters	not known	
SK	SaskPower	PV	1.92	Residence	digital kWh meter	Buyback @ avoided cost	not supplied
MB	Manitoba Hydro	BIPV	12.6	Red River College	none required	Buy-back being negotiated, system will not often exceed building loads	TBA
ON	Vaughan Hydro	BIPV BIPV BIPV Wind	0.86 1.0 4 10	Kortright Conservation Centre	bi-directional meter	Net metering	not supplied
ON	Mississauga Hydro	PV	2.0	Residence	none required	Net Metering @ retail rate	$0.06
ON	Toronto Hydro	PV	2.0	Toronto Healthy House	Time-of-Use meter	Net metering @ time-of-use rates	$0.04 - $0.16
ON	Veridian Connections	PV	2.3	Residence	none required	Net Metering @ retail rate	$0.06
ON	Waterloo North Hydro	PV	5.0	Residence	additional meter	Buyback @ avoided cost	not supplied
ON	Hydro One	PV	42	Commercial	none required	Buy-back being negotiated, system will not often exceed building loads	TBA
NS	NS Power	MH	3.4	Residence	additional meter	Net Metering @ retail rate	$0.0835
NS	NS Power	H	3.0	Residence	additional Time of Use meter	Net Metering @ Time-of-Use rate	$0.004 – 0.016
YT	Yukon Electrical Co.	PV	0.5	Residence	GE kV dial-up installed	Net Metering @ retail rate	buy @ $0.11, sell @ $0.067

5.0 Small-Scale RE Power Producer Types

The majority of the systems identified across the country are residential PV and BIPV systems. This is due to several factors. Number one being that PV can easily be sized to meet budget constraints (i.e., a 'base' system with 100W capacity can be expanded module by module as the owner's budget allows — provided an inverter is in place that can handle the additional capacity). Small system packages are offered by some distributors. In addition, a PV system can be placed on a roof, on a wall or in the landscape, among other locations, where as wind requires a certain 'safety' zone and noise buffer, and microhydro, of course is tied to a watercourse.

Of the thirteen respondents who included reasons for investing in the systems, nine indicated that energy production was their primary reason and four indicated that demonstration and research was the prime reason. Secondary reasons cited included (in order of occurrence): industry leadership, greenhouse gas reduction, interest in the technology and identifying barriers, green market supply and PR for supplier. Backup for power outage was also noted in two cases (one of these was a *grid-interactive* system with a battery bank for power in the absence of wind). In discussion with suppliers and installers, (but not included in survey responses), industry leadership and demonstration/research were highest on the list of reasons for investing in the systems. This priority is reflected in the fact that there are 17 official demonstration and research projects across the country that are promoted on the internet or are otherwise available to the public for viewing. See Appendix I for a complete list of demonstration project websites and sites that can be visited.

Table 5.0.1: Small-Scale RE Producers by Market Segment: Number of Systems/installations
Note: Figures in parentheses are the demonstration/research projects only. The first figure in each cell is the market segment total and includes demonstration/ research projects.

	BC	AB	SK	MB	ON	QC	NB	PEI	NS	NF	NU	YT	NT
Res.	16(1)	9	3(1)	10	61(1)	1	1	2(1)	3			1	
Comm.	1	5(2)			7(2)	1			1(1)				5
Indus.					3								
Inst.	4	2	1	1(1)	18(8)	1			1		1(1)		
Total	21(1)	16(2)	4(1)	11(1)	89(11)	3	1	2(1)	5(1)		1(1)	1	5

Total Residential	107 (4)	68%
Total Commercial	20 (5)	12%
Total Industrial	3	1%
Total Institutional	29 (10)	19%
TOTAL IDENTIFIED	**159(19)**	100%

Legend for Small-Scale RE Producers by Market Segment

Residential: individual households
Commercial: apartment/office blgs/retail/wholesale/distributor outlets
Industrial: manufacturing/refining/processing plants
Institutional: hospitals/schools/not-for-profit organizations

Table 5.0.2: Identified Grid-connected Renewable Generation Capacity by Province (kW)

	BC	AB	SK	MB	ON	QC	NB	PEI	NS	NF	NU	YT	NT	Total Segment Capacity
Res.	7.6	18.3	2.5		39			12.9	8.6			0.5		**89.4 (8.5%)**
Comm.		21.9			242	60			50				410	**783.9(74.8%)**
Indus.					48.9									**48.9 (4.7%)**
Inst.	8.66	4.8	2.8	12.6	68.6	15			10		3.2			**125.66 (12.6%)**
Total	**16.26**	**45**	**5.3**	**12.6**	**398.5**	**75**		**12.9**	**68.6**		**3.2**	**0.5**	**410**	**1047.86**

Legend for Small-Scale RE Producers by Market Segment

Residential: individual households
Commercial: apartment/office blgs/retail/wholesale/distributor outlets
Industrial: manufacturing/refining/processing plants
Institutional: hospitals/schools/not-for-profit organizations

The charts below show the difference between the number of small-scale grid-connected projects in Canada and the capacity of those same projects by market segment. Although residential systems make up over 68% of the total number of systems identified, they only account for 8.5% of the total installed capacity. On the other hand, commercial projects, while making up only 12% of the total number of systems identified represent almost 75% of the total installed capacity. Industrial and institutional installations are slightly closer in numbers and capacity.

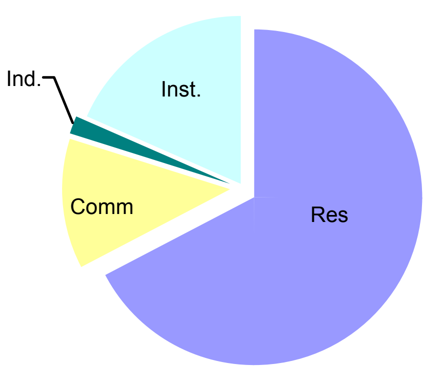


Chart 5.0.1: Proportion of Small-scale RE Producers by Market Segment: Number of Systems/Installations

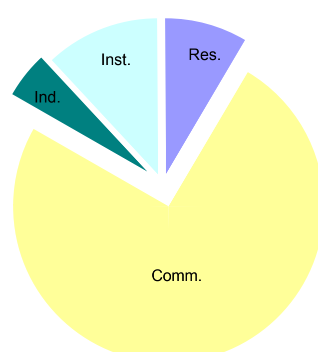


Chart 5.0.2: Installed Capacity of Small-scale RE Producers by Market Segment: kW Capacity

5.1 Residential

Of the 159 installations identified, 107 or 68% are residential. These systems range from 100W to 5kW. Of the residential installations, 99 were PV and 8 were BIPV. All of the microhydro systems identified served residential loads and were rated below 10 kW. There were no single-source residential wind systems, but three of the four hybrid systems identified were wind/PV. The fourth hybrid system was wind/microhydro. Four of the residential installations are on-going demonstration projects with monitoring in place. However, none of the houses are formally open for public visits, and details of the residential locations are not included here out of respect for the privacy of the homeowners. There is, however, information on several of these projects available on-line, please see Appendix I for URLs and other contact information.

5.2 Commercial

Twenty installations are associated with commercial ventures, including nine utility-owned installations. The term commercial as used here does not mean that the system owner is in the business of selling electricity but rather that a business (as opposed to a homeowner, institution or industrial enterprise) has recognized RE as a worthwhile investment in terms of reducing overhead, providing good advertising etc. In other words the system itself is not necessarily in and of itself a commercially viable operation (i.e., that it makes the owner a profit, or that the system capacity will always outweigh the building load for an official ‘buyback’). Installations by commercial ventures run the gamut from less than 1kW PV installations to two 160 kW wind installations.

Five of the commercial installations in Table 5.2 are demonstration projects with public access (indicated with *). See Appendix I for URLs and other contact information. Projects that have public information about their RE installations on-site are:

- Airdrie Recycling Centre, outside Calgary
- EPCOR (Edmonton Power Corporation), Edmonton
- OPG Evergreen, Toronto
- CN Tower, Toronto
- Atlantic Orient Canada, Woodside Industrial Park, Dartmouth

Table 5.2: Commercial Installations

Business Name	City/Town	Prov	Building/System description	Size (kW)
Telus	Vancouver	BC	Farrell Building, Retrofit, PV powers ventilation system not easily seen	2.5
Edmonton Power Corporation (EPCOR)*	Edmonton	AB	Head Office, Rooftop BIPV	13.4
Spruce Meadows Equestrian Centre	Edmonton	AB	British House, wall-mounted PV array	2.5
Airdrie Recycling Centre*	Airdrie	AB	Roof-mounted PV array	2
Banff Operations Centre	Banff	AB	PV array	1
CN Tower*	Toronto	ON	PV array	1
Ontario Hydro	Kipling	ON	PV array	0.7
OPG Evergreen*	Toronto	ON	Head Office, Rooftop PV Array	4.8
Ontario Power	Blind River	ON	2 * 80 kW wind turbines	160
Ontario Power	Kasibonika	ON	Wind turbine	30
Community Grid	Big Trout Lake	ON	PV array	10
Community Grid	Big Trout Lake	ON	Wind turbine	50
Hydro Quebec	Kuujjuaq	QC	Wind turbine	60
NT Power Corp	Kuglugtuk	NT	2 * 80 kW Wind turbines	160
NT Power Corp	Rankin Inlet	NT	Wind turbine	100
NT Power Corp	Sachs Harbour	NT	Wind turbine	50
Dutch Industries	Cambridge Bay	NT	Wind turbine	80
Atlantic Orient Canada*	Dartmouth	NS	Wind turbine	50

Airdrie Recycling Centre, 2kW rooftop PV installation. Airdrie, AB (photo source: ASH Consulting)

5.3 Industrial

There are only three industrial installations in Canada to date, all three of which are PV systems located in Ontario. For the purposes of this study, 'industrial' is defined as a manufacturing or processing plant. These industrial sites include two PV industry installations, both for ATS (Automated Tooling Systems), and a very interesting project that is part of the Niigon First Nations sustainable development project at Moose Deer Point. Please see Appendix I for URLs and other project information.

Table 5.3: Industrial Installations

Company Name	City/Town	Prov	Building/System description	Size (kW)
ATS	Cambridge	ON	PV array	1.5
ATS	Cambridge	ON	PV	5.4
Niigon Technologies	Moose Deer Point	ON	Roof-mounted PV array (South side of 'sawtooth' roof profile, North side of roof profile is a 'clerestory' for daylighting	42

5.4 Institutional

Institutional installations include provincial government buildings, schools and not-for-profit organizations. There are eighteen projects noted here, although there are twenty-nine identified institutional projects. The projects listed in Table 5.4 are public buildings and can be visited without invitation, although not all installations are easily visible or accessible. The eleven systems not included in the table have inadequate detail to include here (i.e., the system was identified, but there was no response to the survey). The following table gives the installation location, type and size. Further details on demonstration projects that can be visited can be found in Appendix I.

BC Ministry of Health, Pandora Wing of the Blanchard Building
BIPV Curtain Wall Installation, Victoria BC (photo: Gordon Howell)

Table 5.4: Institutional Installations

Institution	City/Town	Prov.	Building/System description	Size (kW)
British Columbia Institute of Technology (BCIT)	Burnaby	BC	"Power Tower" training structure for electricians	7.68
			Technology Centre, mounted vertically on wall	1.0
			Discovery Place, BIPV curtain wall	2.88
			House 2000, BIPV roof glazing (30° tilt)	1.94
BC Ministry of Health	Victoria	BC	Pandora Wing of the Richard Blanchard Building BIPV curtain wall	2.66
Alberta Government	Edmonton	AB	Central Power Plant Building, rooftop array	2.8
Banff Operations Centre	Banff	AB	PV array	1
Sask. Science Centre	Regina	SK	PV	2.8
Red River College	Winnipeg	MB	Princess Street Campus, curtain wall facade	13
Kortright Centre for Conservation	Downsview	ON	BIPV system	1
			PV Canopies on Living Machine Building	4
			BIPV roof shingles, demonstration	0.86
			Wind turbine	10
Ontario Place	Toronto	ON	PV	3
Hugh MacMillan Rehabilitation Centre	Toronto	ON	Three rooftop PV systems, not all in operation total capacity = 52kW	25
CTEC- Varennes	Varennes	QC	NRCan's PV research lab	15
DalTech (FNA TUNS)	Halifax	NS	Rooftop PV	10
NT Public Works	Igloolik	NT	Wind turbine	20

6.0 Small-scale RE Power Producers and the Grid-Connection Process

The current issues with developing small-scale RE production in North America are not in the *methods* in which electrical power is generated, but in the *mechanisms* for sharing it. The technology, the equipment and methods are all available, and, in other parts of the world, the mechanisms – regulatory, technical and contractual – are in place and working successfully.

Two obstacles to the widespread deployment of and investment in small-scale grid-connected RE systems have been identified by the system owners:

1) Lack of consistency in implementing standards and policies that may exist to regulate grid-connection and net metering in Canada.
2) General reluctance of electric utilities to allow other producers to “share the lines” (Flood, 2001).

In combination, these barriers may contribute to a stagnation in the domestic RE industry, with the costs of components and systems holding at prohibitive prices. Ironically, this appears to be the case even though technology is advancing, production costs are decreasing and system efficiencies are increasing (CMHC, 2001).

In some ways, it is puzzling why RE systems are not being adopted in at a quicker pace. The technology is available and there are examples of successful programs from around the world. There also seem to be many convincing arguments in their favour as noted throughout this report. The Union of Concerned Scientists (UCS) identifies the four main issues responsible for the slow North American uptake of renewable energy source systems as:

1. Commercialization barriers

Like all emerging technologies, renewable energy systems must compete at a disadvantage against the entrenched industries. They lack infrastructure (marketing/distribution), and their costs are high because of a lack of economies of scale, as noted in the KPMG report entitled: “Solar Energy, From Perennial Promise to Competitive Alternative”, commissioned by Greenpeace in 1999:

> The question Greenpeace put to KPMG was: "Can the large scale production of solar panels lower the price of solar energy to such an extent that solar energy can compete economically with conventional forms of energy? And if it can, what action is necessary on the part of government, customers and industry to break through the current impasse?"
>
> The conclusion from KPMG is clear: "Scaling up the production of solar panels is technologically feasible using current technology. To achieve a reduction in the price to the level of conventional energy, production needs to be scaled up to 500 MWp per

year. There are costs involved in creating the required market size, and either industry, government, or energy users will have to pick up the cost of transition."[20]

2. Distortions in tax and spending policy

Studies in the US have established that federal and state tax and spending policies tend to favor fossil-fuel technologies over renewable energy systems. Canadian studies show similar results (OECD Outlook, 2001). Little or no value is placed on the public benefits of renewable energy. Many of the benefits of renewable energies, such as reduced pollution and greater energy diversity, are not reflected in market prices, thus eliminating much of the incentive for consumers to switch to these technologies.

3. Other market barriers

Other market barriers include: lack of information by customers; institutional barriers (regulatory and utility side); the small size and high purchase prices of many renewable energies; and high financing costs. Split incentives among those who make energy decisions and those who bear the costs as well as high transmission costs can also be barriers to development of a viable RE industry.

4. Green Market Limits

Surveys show that many customers are willing to pay more for renewable energies. But given the barriers to fair competition in the marketplace, "green markets" are likely to develop slowly. Pilot programs have shown promising results. The most optimistic expectations are that 20 percent of residential customers and 10 percent of commercial customers will choose green power suppliers within five years of customer choice being made available. (UCS, 2001a) Note: Enmax (Calgary), Epcor (Edmonton) Aquila Networks (Alberta and BC) and OPG Evergreen (Ontario) are among Canadian utilities that have taken on a Green Power program. VisionQuest Electric allows Canadians in any province to purchase green energy ‘credits’ from Alberta’s wind patch.

Table 6.0 shows Communities & Utilities with Existing Small-Scale RE Producers on Grid, by province across Canada. The opening of the electricity market in Ontario has meant that some smaller utilities have been absorbed into larger entities, and so, where some systems were interconnected under one utility, it is not clear that new systems in the same area would also be allowed, or would be under the same connection/compensation policy. For example, Kanata Hydro allowed connection but is now part of Ottawa Hydro. The original connection in Nepean was made with assistance from Ontario Hydro which no longer exists, but Nepean is now also included in Ottawa Hydro. Other small-scale system owners may now be dealing with a local utility or Hydro One depending on exact location. Tracking down the utilities and policies over the period of drastic change in the Ontario market has proven to be a challenge.

[20] summary from www.energyalternatives.com/resources

Table 6.0: Communities & Utilities with Existing Small-Scale RE Producers on Grid

Province	Community	Utility
BC	Burnaby	BC Hydro
	Clearwater	
	Kaslo	
	Kelowna	
	Vancouver	
	Victoria	
AB	Airdrie	Enmax
	Banff	Aquila Networks
	Calgary	Enmax
	Edmonton	EPCOR
	Kathryn	UtiliCorp
SK	Humbolt	SaskPower
	Moose Jaw	
	Regina	
	Saskatoon	
MB	Winnipeg	Manitoba Hydro
ON	Belleville	Veridian Connections
	Big Trout Lake	Community Mini-Grid
	Blind River	Hydro One
	Cambridge	Cambridge & North Dumfries Hydro
	Guelph	Guelph Hydro
	Kanata	Ottawa Hydro
	Kasibonika	Hydro One
	Kingston	Utilities Kingston
	Kipling	Hydro One
	Mississauga	Hydro Mississauga
	Moose Deer Point	Hydro One
	Napanee	Hydro One
	Ottawa	Ottawa Hydro
	Thunder Bay	Thunder Bay Hydro
	Toronto	Toronto Hydro
	Waterloo	Waterloo North Hydro
	Woodbridge	Vaughan Electric
NS	Dartmouth	Nova Scotia Power
	Halifax	
	Kentville	
	Mabou	
	Yarmouth County	
YK	Whitehorse	Yukon Electric Company
PEI	Belfast	Maritime Electric
NT	Cambridge Bay	NT Power Corporation
	Igloolik	
	Kuglugtuk	
	Rankin Inlet	
	Sachs Harbour	
NU	Iqaluit	Community Grid

6.1 Factors Influencing the Choice to Install A Grid-connected RE System

One of the goals of this study is to attempt to understand the motivations behind an individual's decision to invest time and energy into incorporating RE to their home and document their experience of the grid-connection process. The factors, which influenced system owners to decide to install their systems, are as varied as the individuals themselves. Nevertheless, some general conclusions are apparent from the results submitted during the system owner survey. The main motivations cited by respondents are summarized in Table 6.1.

Table 6.1: Factors Cited by System Owners as Motivating System Installation

Note: because of the way respondents answered, the results from the survey sections on reasons for investing and the factors influencing the decision to install the RE system have been amalgamated for a simpler discussion.

Province	Anticipation of growing market share of DG	Anticipation of growing market share renewables	Reduction of carbon emissions (environmental reasons)	Technological Demonstration and or Research Purposes	Production of Power/Reduction of electricity bill	Community Education with Outreach	Community Leadership	Need for Generation Capacity	Public relations for supplier	Anticipation of financial incentive to sell carbon credits	Tax write-off	Government commitment to obtain 20% of electricity from green sources by 2005	Power Reliability/Quality of Power
BC	1	1	1	6	15		1	1					1
AB	1	3	4	4	4	2	5		1				6
SK	1	3		2	3	1							
MB				1	11								
ON	1	42	44	15	61	7	6	3		1	1	1	1
QC	1	1	1	1									
NB													
NS	1	1	3	1	3	1	1		1		1		1
PEI				2	2	1	1						
YK	1		1		1			1		1	1		1
NT		5						5					
NU		1	1	1		1							
Total	7	57	55	33	100	13	14	10	2	2	3	1	10

By far, most respondents said the main motivation behind the system installation was to produce at least some of their own electricity. Most of those also indicated that it was important for them to produce clean energy (reduction of carbon emissions/environmental reasons). Another large block of respondents indicated that anticipation of a growing market for such technologies in the future (anticipation of growing market share of DG was cited seven times and anticipation of growing market share renewables was cited fifty-seven times, for a total of 64). At first this may seem puzzling: “I went ahead with the project because more projects like it will go ahead in the future”. The results start to make more sense however when one remembers that many of the survey respondents were industry stakeholders.

The next most commonly mentioned motivation for going ahead with the projects was for research and demonstration purposes. Seven respondents stated they hoped their system would contribute to the technical understanding of RE in Canada, even though they weren’t ‘official’ demonstration or research sites. Similarly, there were thirteen responses in total indicating public education was an important reason for choosing to develop a grid-connected RE installation. So education and learning appear to already be an integral part of grid-connected RE investments in Canada.

Another factor which was cited by many respondents as important was the environmental benefits that a grid-connected RE system entails. Fifty-five respondents from seven different provinces said that concerns over GHG emissions played a role in their decision to go with grid-connected RE. It is likely that reduced electricity bills, increased independence, and curiosity in the technology played a large role in motivating the installation of guerilla systems, but of course owners of unapproved systems connected to the grid were hesitant to respond to the survey.

The only other motivating factor that may be of note, according to the results of this survey, was the desire of system owners to show a good example to the larger community. Some expressed the desire to prove that generating part of your own power in homes and/or businesses, which already have access to electricity, is possible and has many benefits. This desire for community leadership along with education and environmental concerns may all be grouped together perhaps. They seem to all have in common a non-monetary value which suggests that simple personal values may be a common motivating factor for these types of projects (see box 6.1.1).

It is also interesting to note that some factors were considered important motivating factors by very few or no respondents. Only a few respondents said the *need* for generation capacity was a factor which lead them to invest in their system, whereas 100 indicated that they wanted RE systems for power production to reduce their electricity bill – a significant difference: need vs. desire. This is perhaps the single most important lesson to remember when discussing small-scale renewable technologies.

Other factors which judging from the results play less of a role in inspiring grid-connected RE. These include: the ability of RE to reduce tax burdens; the desire for good press to which a RE system entitles the investor; the anticipation of being able to generate carbon credits which could be sold to more polluting generators, and, from a industry stakeholder perspective, the fact that the Canadian government has promised to buy 20% of its electricity form green power producers. However, with national policies and incentives in place, the importance of these factors in influencing the decision to install a grid-connected RE system may change radically.

Box 6.1.1 A Matter of Personal Values

One survey respondent, Gordon Howell of Howell-Mayhew Engineering, has an interesting perspective on reasoning commonly used to determine the true value of a grid-connected RE system. Renewable energy systems investments are often judged by “pay-back period”. His position is that investments should more often be based on an analysis of personal values, in contrast to the bottom-line accounting process, which insists that a 5 year or less payback period is required before a renewable energy system is economically viable.

Gordon uses the analogy of buying a car as the basis of his cost-analysis. Most people don’t buy a vehicle based on bottom-line accounting. Instead the choice is made based on personal values. We value the qualities of a certain type of vehicle for personal reasons, and no one really calls into question the personal values behind the choice. After all, they are personal (eg: I like a certain manufacturer, I feel more comfortable in a big car, I love the colour, I want to be able to go really, really fast, etc.). Gordon question then is: “Why should there be any difference between the value-laden choice of a personal vehicle and the value-laden choice of energy production?”

We don’t need a fancy car, just as we don’t need an expensive grid-connected RE system. Yet when someone buys a car it is rare that people ask: “How long is it going to take before you see payback on the extra money you spent on that car?” Gordon also notes that there isn’t the same onus placed on utilities to adhere to a similar ‘reasonable’ payback period on the construction of a new large-scale fossil-fuel or hydro generation plant. Of course full-cost accounting used for large-scale thermoelectric or hydro projects would give a very different picture of what is ‘affordable’.

The values we hold as individuals and how they influence our personal choices are completely valid. Thus, with a ‘full-cost’ accounting analysis, that gives a monetary value to such factors as personal satisfaction, community leadership, interest in technology, passion for the environment and so on, it is easy to come up with a valid payback. This type of analysis can be transferred over to commercial and institutional arenas as well, where the value of leadership and community profile is more readily accepted as part of the decision-making mix.

6.2 Barriers and Obstacles Experienced by Region

The second major goal of the system owner survey was to try to get an idea of what types of obstacles and challenges were discouraging individuals or businesses from investing in grid-connected RE systems. The section was included to try to answer questions such as: were there some obstacles that were specific to individual jurisdictions? Were some obstacles likely to be encountered in many jurisdictions? As with factors which motivated system owners, the perception of a barrier or an obstacle can be personal, so it was expected that they would differ from jurisdiction to jurisdiction. Also the regulatory framework and legal system of each region plays a role in creating difficulties or facilitating the process grid-connection. Despite the diversity of jurisdictions in which the respondents were based, the diversity of the systems included, as well as the diversity of the respondents themselves, it is possible to draw some conclusions from the survey responses. The main challenges cited by respondents are summarized in Table 6.2.

One main issue seems to emerge in most of the jurisdictions – a lack of communication with the utility. Twenty-four respondents cited “No established interconnection practices” as a problem, nine said there was “no easily identifiable utility contact person” and eighteen indicated there was “no interconnection standard or policy” in place at time they were installing their system. In five provinces (Alberta, the Yukon, Ontario, Quebec, and Nova Scotia) system owners encountered all three of these obstacles. The four main themes to this obstacle identified by respondents were:

A. No established interconnection practices, including no easily identifiable utility contact person and long delays in receiving paperwork and/or approvals
B. Unnecessary technical and safety requirements imposed by the utility
C. No interconnection standard or policy in place at time of installation
D. Electrical inspectors are unfamiliar with small-scale, low-voltage equipment and the utility’s requirements for the inspection of such equipment

Most Canadian electric utilities have neither standard procedures nor staff designated to facilitate grid-connection requests (IREC, 2000). The most notable exception to this is SaskPower. On the website (www.saskpower.com), there is a three-paragraph outline of their grid-connect and metering policies and requirements as well as the contact information for the individual responsible for processing the application. There are several other utilities that have taken interest in the grid-connect process for small producers and who have been supportive and pro-active in the process. See Table 6.0 for listing of utilities where grid-connect systems have been supported or at least allowed-to-be-connected. Regulatory bodies in the US have tried to remedy the problems caused by paperwork and approval processes by establishing time limits on various steps and by requiring utilities to designate a certain representative to handle grid-connection or net metering related queries.

Table 6.2: Types of Obstacles Encountered during Grid-Connection Process Cited by System Owners

Province	No established interconnection practices	No easily identifiable utility contact person	Unnecessary technical/safely requirements imposed by utility	No interconnection standard or policy (at utility at time of installation)	Low commodity price (reduces incentive to invest in RE system)	Local permitting issues (zoning, issues, property delineation and covenants)	Inspectors unfamiliar with small-scale low voltage technology	Multiple Interpretations of CE Code	Extra fees/tariffs imposed by utility (backup/uplift tariffs, franchise rules, anti-bypass discounts)	Competition Transition Charges (exit fees, etc.)	Onerous Market Rules (wire service charges, size limits, ISO rules etc.)	Environmental permitting
BC	5		3	1	1	1	4		1			
AB	7	2	7	6	2	1	5	5	5			
SK				1								
MB	1			1								
ON	5	2	5	3	2	1						
QC	1	1	1	1		1						
NB												
NS	3	2	3	3	2	2	3	3				
PEI	1			1								
YK	1	1	1	1	1		1					
NT												
NU												
Total	24	9	20	18	8	6	13	8	6	0	0	0

After the lack of established interconnection practices, the next most often cited challenge to connecting their RE system to the grid were the "unnecessary technical/safely requirements imposed by utility". This obstacle of course is closely related to the problem of poor communication with the utility if not the same. Respondents in six jurisdictions felt that the utility had required redundant equipment to be installed, commissioned unnecessary safety and engineering studies etc. A major stumbling block for grid-connection and net metering appeared to be safety concerns over the use of static inverters and the quality of power generated. The major safety concern here has been with "islanding", where small-scale DG systems could still be producing power during a power outage on a grid system, creating potential hazards for repair crews. Today's inverters, however, offer protective functions needed to synchronize safely and reliably with the utility grid, protecting utility power quality and preventing backfeeding during a utility power outage. These functions are automatic and most new inverters comply with internationally recognized codes and standards (Starrs, 2001, Howell, 2003). See Appendix II for list of inverters approved for grid-connect projects. Interestingly there seemed to be a correlation between jurisdictions where system owners experienced unnecessary safety and technical requirements and jurisdictions where owners had difficulty communicating with the responsible utility. Though not cited as often, a similar obstacle to unnecessary technical and safety requirements was that of extra fees and tariffs imposed by the utility which six respondents pointed out as a problem.

A number of owners also mentioned the issue of inspectors and the interpretation of the Canadian Electrical Code (CE Code). A major difficulty may come in to play for the small-scale grid-connect project when one realizes that the interpretation of the CE Code is frequently left up to the individual inspector. This can lead to varying levels of ease of interconnection within provinces and at times even within the same utility jurisdiction. This problem is noted in the construction industry as well, where many parts of the building codes can be interpreted in various ways by 'the authority having jurisdiction', i.e., the local building inspector. As in the case of a builder wanting to include an energy-efficient detail that is not covered specifically in the building code, or a wall assembly that is outside 'standard practice' for the inspector's territory, the small-scale RE producer will find that there is a fair amount of play in the interpretation of the corresponding code, depending on the inspector's training, background and interest in what is being proposed. Sometimes some resource information will suffice to put a project through, yet with other inspectors, all the barriers and obstacles included in this survey — and more — may be thrown in the path of the system owner.

Another technical issue at hand pertains to the inverter, which is the interface between the RE system and the grid. As stated above, a whole range of today's inverters have control functions that meet safe operation standards internationally. However, these same inverters and other equipment such as PV modules that have US and other international safety approvals, do not necessarily have CSA approvals. This is because the Canadian market is so small there is little incentive for manufacturers to make the investment in the approval process. Assessing how the equipment meets the CE Code requirements hinders wide-spread acceptance of inverter technology, as CSA-approved equipment is required by the Canadian Electrical Code. However, there are now CSA listings for both inverters and PV modules that are harmonized with international standards. The standard for grid-connected inverters is CSA 22.2 No. 107.1, Section 15: General Use Power Supplies. The standard for PV modules is Can/CSA-C61215:01: Crystalline Silicone Terrestial Modules.

Inspectors in all jurisdictions are bound to follow the Canadian Electrical Code (CEC) when dealing with grid-connect systems, specifically Section 50 (Solar PV) and Section 84 (Interconnection). Section 84 was designed around the interconnection of large scale, high voltage generators, and doesn't differentiate between high-voltage, multi-megawatt projects and a homeowner with a low-voltage 100 Watt PV system.

As a result, some of the requirements are onerous and can add to the cost of the installation. Because of those barriers survey results show an increase in cost of between 10 and 50%.

The next most commonly cited obstacle which system owners felt was preventing more investment in grid-connected RE system was cheap electricity. Eight respondents from five jurisdictions felt this was the case. It is not entirely clear if the respondents meant it made them hesitate to invest in a grid-connected system or if it was a major obstacle preventing others from buying systems while living in an area with an existing power grid. Either way it is clear that this is an important factor preventing investment in small RE systems where grids are present. If indeed respondents were referring to others (and not themselves) when they submitted this response, it is possible this is the most important obstacle.

Local permitting issues were the next biggest concern with a total of five respondents citing issues such as having to have their property rezoned or special building permits issued. These are issues that must be worked out with municipal officials and the number of respondents citing permitting issues suggest efforts could be coordinated to more effectively communicate with municipalities in various jurisdictions.

It is important when interpreting these results to remember that though the responses were collected in 2003 the systems to which the respondents were referring were not all installed in the same year. This means that utility policy, government regulations etc. may have changed between the time when the system was installed and the time the responses were submitted. It is possible therefore that if respondents were to document the installation of a similar system today their answers to the same survey questions may be quite different. It may be interesting to attempt, in a future study, to document how the interconnection experiences have changed over time in various jurisdictions.
It is also difficult to generalize from region to region based on the results. For example it appears from table 6.2 that Saskatchewan and New Brunswick respondents may have experienced few obstacles based on the fact that respondents from neither jurisdiction cited obstacles. Yet no responses were received from New Brunswick and only 4 were received from Saskatchewan.

Box 6.2.1 Tired of Waiting

One phenomena which was not anticipated at the beginning of the study was the existence of many “guerrilla” grid-connected systems across Canada — people who have not received formal permission from the utility to have their systems feed electricity back to the grid. This came to light through discussion with distributors and other industry players, where individuals have simply connected an RE system to their existing power system and their standard kilowatt-hour electrical meter turns backwards, comes to a stand-still or turns extremely slowly, when their system feed power into the grid. Guerrilla system owners, naturally, are less than forthcoming with system information.

It is impossible to gauge exactly how many guerrilla systems are connected to the grid. However, all of the guerrilla systems included in this survey were tagged as very small residential systems, no larger than 1.5 kW (most well below that). A rough estimate of the ratio of guerrilla to ‘accepted’ residential installations is 36 of the 107 residential installations. This represents a third of the identified residential systems in Canada, with 10 microhydro, one hybrid microhydro and the remainder PV. Thirty-three percent is significant for the survey sample, and perhaps symptomatic of the obstacles to grid connection faced by some Canadian homeowners.

At the same time 36 or more households represents a drop in the bucket for any utility’s residential customer base. One RE system distributor suggested that perhaps the reason the utilities tend to turn a blind eye on guerrilla systems is to minimize exposure. By avoiding exposure — positive or negative — regarding a policy or position on grid-connection and net metering issues, customer interest in small-scale RE generation remains minimized and the need to create a policy that covers small-scale grid-connection and net metering issues may be avoided. Since the MicroPower Connect Project is now coming close to a final draft of grid-connect guidelines, perhaps utilities will be able to reference existing policies and standards, and thus feel more comfortable creating policies that work for small-scale RE producers.

6.3 The Pivotal Hurdles to the Grid-Connect Process

Survey participants were asked to include some details concerning what they felt was the pivotal obstacle — the part of the process of having their system connected to the grid that stood out as being the most difficult, frustrating or confusing.

According to respondents (and our experience in contacting utilities for the second part of this study), finding the contact person within the utility organization proved to be the most difficult task. Often it meant several phone calls or phone transfers between departments and individuals to find the person with knowledge of the utility's grid-connect and/or net metering policy — or even an awareness of what is being requested. Survey responses and subsequent discussions with designers and installers indicated that there were concerns that the system owner (or their designer/installer) would be required to educate the utility on their own policy.

The next pivotal obstacle in several instances was the electrical inspector. Across the country, there are differing regulations and regulatory bodies who administer the Canadian Electrical Code, but the inspectors are seen as 'the authority having jurisdiction', just as building inspectors have the right (and responsibility) to make judgments in the field in regards to Code compliance. And, just like the Building Code, there are some areas in the CE Code that are open to interpretation. This means there are specific areas where getting approval for a grid-connect system is much more difficult – and costly – than in other parts of the country. Again, when there is a point of discussion, it seemed the onus fell upon the system owner, or the designer/installer to research and present background information on both equipment and precedents for CE Code interpretations to the inspectors to support the grid-connection process.

For the most part, designers and installers reported that electricians are interested and willing to learn about a new technology. Where they could use support is in more in-depth training on DC wiring and related issues. One interesting problem of note was with a particular union contractor who believed that responsibility for installing BIPV modules in the curtain wall should have been theirs rather than the glaziers.

It is noteworthy that there were regional differences noted in the extent this was a problem, from province to province as well as from jurisdiction to jurisdiction in the same province.

British Columbia
"Generally inspectors have been easy to deal with. We have had to educate them about PV systems, but they have respected our expertise on the subject and used the opportunity to learn. It is always a good

idea to get them involved early if it is their first PV project. There have been only two issues raised by inspectors that I know of:

1) CEC Rule 50-012 (3) was interpreted by one inspector such that we had to provide a disconnect means between series connected modules. We didn't argue with him, but subsequent discussions with others suggest that this was not the best interpretation of the rule.
2) In curtain walls where we are using the mullions as raceway, the inspectors have been concerned about equipment bonding of the mullions and whether this was an allowable use of the mullions.

“The BC Hydro PV interconnection requirements are presenting a small barrier. They refer specifically to Section 84 of the CEC, but their interpretation of Rule 84-026 is much stricter than the CE Code Handbook. BC Hydro requires a disconnect switch near the utility meter that has a "visible break". Whereas the CEC only requires that it "have contact operation verifiable by visible means". The visible break requirement means purchasing an outdoor rated, disconnect switch which can cost a few hundred dollars versus other options such as motor control switches for $30 to $60.”

Alberta

In Alberta, most of the experiences were frustrating, but one respondent indicated no problems were encountered. There seemed to be a significant difference in the experience of those in Calgary and those in Edmonton. In Calgary system owners seemed to have a smoother ride through the process with Enmax, (the local utility) being very supportive.

Manitoba

Although Manitoba Hydro has had a grid-connection policy in place for almost 20 years, there was only one response to the survey from that province: the Red River College Princess Street Campus project. This curtain wall project is in the final stages of completion. The respondent did not elaborate upon the process.

Ontario

Measured by survey responses, Ontario utilities, both before and after deregulation, seem to have best taken up the challenge of small-scale RE grid-connection. Vaughan Hydro, the utility to which the Kortright Centre for Conservation is connected, has been “very supportive” of the Centre’s RE endeavors. Homeowners in Mississauga and other areas have met with minimal obstacles. According to Per Drewes, of Sol Source Engineering in Newmarket, getting the Ontario Electrical Authority’s approval is the main hurdle. Per writes about the grid-connect process in an case study report on a house in Mississauga, which is indicative of his experience with over 25 grid-connect projects in Ontario:

> "[The] system was started in the summer 2001. Start-up may even be considered as a non-event. With the installation of the last breaker panel, the inverter was simply switched on by the builder and photovoltaic system installer. All components functioned as designed and the construction crew continued with other business.
>
> Given the unfamiliarity with photovoltaic technology on the part of most people, the planning and installation of the system for Mississauga House has been successful. It is certainly in the interest of any building integrated photovoltaic project to explain the technology to all people involved. Most people are very responsive to photovoltaics and take an interest in being part of a new and innovative project.
>
> There were no major concerns with the photovoltaic system. Although there are few standards in place in Canada dealing with this technology, inspectors from the [Ontario] Electrical Safety Authority simply used existing electrical regulations plus some common sense to approve the system. There were some concerns about battery venting, but again, these were resolved through cooperation amongst all involved (Drewes, 2001)."

Nova Scotia

In Nova Scotia, there was a range of experiences with Nova Scotia Power from totally exasperating to no problem. One possible explanation for this has to do with the broad range of time between system connections and corresponding changes in management at the utility. For example, although Nova Scotia Power has a retail buy-back policy for small-scale RE producers up to 10 kW, when a home builder in the Annapolis Valley area applied for interconnection of a demonstration house in 2001, he was turned down. The regional representative was completely unfamiliar with the equipment and the policy of the utility, and required an engineer's stamp and a performance bond for an off-the-shelf Trace Suntie system before he would allow the project to proceed. (Watters, 2001). Nova Scotia is in a unique situation. Some of the policies of the old government corporation have carried through into the private corporation and provide a basis for RE development. It will be interesting to see how all this fits together in the future.

Following are some comments from survey respondents organized by province from which the response came:

BC: "The lack of CSA standards for grid-tie inverters and PV modules required special approvals." ***This is no longer the case. CSA listings, harmonized to international standards are now in place for both inverters and PV modules***

"The utility requirement for a manual reconnect in the event of grid failure under the terms of the Local Operating Order, has resulted in greater system down time than expected." ***BCHydro has since changed this requirement in their interconnection standard, but the system has not been changed to take advantage of the new standard.***

AB: "The CE Code was made for giant systems not tiny ones. These rules have been imposed on this PV system resulting in it NOT being interconnected 2.5 years after its installation."

"Lack of education of the inspectors and Wire Owners."

"CE Code hassles."

"Only barrier was that the utility did not allow net metering."

"No barriers encountered because this is a guerrilla system!"

"Complexity of the legal interconnection agreements and the time and expertise involved in working through them."

"Inappropriate CE Code interconnection rules."

"Inability of the CE Code inspectors to accept the simple disconnect mechanisms and instead require the exact wording of the CE Code to be followed."

ON: "Had to convince the utility of the safety of the equipment."

"No leadership at Ontario Hydro, so no policy with respect to PV. No leadership from Ontario Government so no policy with respect to PV grid tied systems."

"This was the first grid tie system in the area so it took considerable foot work to bring all parties up to date."

"The PV system has been inspected and approved by the Ontario Electrical Safety Authority. There was some concern about battery venting requirements (this is a grid-interactive system) but installing wiring for house loads in a straw bale wall was more of an issue. The PV system has not been connected to the utility to date. However, Mississauga Hydro has another PV system connected since 1987 and indicated a positive response to queries about connecting this house."

QC: "No backfeed allowed. Hydro-Quebec required protection (relays) against backfeeding the grid (in 1992)."

NS: "No policy, no contacts, very difficult to find utility representative willing to take on responsibility."

"Excessive difficulty, excessive liability, excessive cost, etc. are very good reasons for an owner not to bother (at least from most points of view). The are a lot of people that see benefits to developing and encouraging microgeneration. The problem is they are not in the boardroom."

"Was first one to do it, so just normal complications."

"I have been chasing the "Green Energy Program" for over 2 years. I have dealt with probably half a dozen different people in this program that have either been fired or transferred. The "Green Energy Program" seems to have boiled down to simply signing up to buy electricity, at an inflated rate, that is produced by one of NSP's wind generators."

YK: "Not in rate base. Reluctance of utility to allow interconnect primarily due to lack of knowledge. No one had time to research and review interconnect details."

"No real knowledge at utility company of interconnect systems and operation."

NU: "Communities in the Far North are not connected to the North American electrical grid. Instead each community or cluster of communities has its own local grid, usually relying on diesel gensets. Because of the remoteness of the sites and the high cost of transportation, diesel fuel can be extremely expensive. Displacing some of the electricity generation by PV is an attractive option. In fact, assuming moderate reductions in the cost of PV technology, the use of grid-tied PV systems in Canada's North is expected to become cost-effective within 12 to 20 years. The project has two main objectives: gain experience in the construction, monitoring and maintenance of a northern grid-connected PV system and serve as a demonstrator of the use of PV in the far North."

"Over the past five years (since 1995) the system has demonstrated with success the potential of grid-connected PV for the far North. As economic barriers to the widespread use of PV in the North progressively fall down, lessons learned from the monitoring of the system will help duplicate this achievement for other systems."

6.4 Lessons Learned

Lessons learned, both from survey respondents and from further discussion with designers and installers of small-scale RE producing systems focus on the lack of awareness on the part of utilities, regulatory bodies and inspectors of these systems and how they operate. Many discussions have focussed around the issue of awareness, and the fact that it should not be up to the homeowner or small-scale system owner to educate the regulatory bodies and inspectors, but that ends up being the case in most instances. Increasing the profile of RE systems, as well as the need for grid-connection and net metering/net billing standards, policies and regulation is the territory of RE industry associations and interest groups, among others. Currently, the work of all these players is fragmented both by industry and by region. This is most likely due to the fact that the Canadian RE industry is still in its infancy, in terms of grid-connection.

Following are some comments from the survey participants:

BC: “This system uses ten small 100 W grid-tie inverters connected individually to each PV module. The availability of this system has been very high and we have been impressed with the performance and ease of installation of this type of grid-tie system using micro-inverter or AC modules.”

“Government talks a lot but talk is cheap, more government support is needed to build and market green energy in Canada.”

AB: “Lots of lessons learned! Which have affected all the utility regulations.”

“We don't need net metering! We need net billing, with a high price for green electricity.”

“Don't tell the Wire Owner what you are doing!”

ON: “Work with the utility - don't try to go around them - be patient.”

“Law should require green power to be accepted if safe.”

YK: “This interconnect is awkward. The meter is dialup capable and I have to supply a phone connection at my cost. The utility is reluctant to provide me with software or meter information to help them decide what would be useful to measure.”

“Utilities should not try to make special cases for small-interconnect systems. Meter should be read as normal and user pays the difference. Business as usual for the utility reduced monthly bills for user.”

Part Two, The Utility Perspective

7.0 Utilities and Grid Connection Policies

In Canada off-grid renewable electricity applications are well established as clearly the most economic choice compared to other options in many remote locations. However, because of our abundant natural resources, conventional grid-supplied electricity is relatively inexpensive in the more populated areas of Canada. As a result, where the grid already exists there is little financial incentive for investing in on-site renewable capacity. Yet more and more Canadian individuals and small businesses are investing in RE systems with the hopes of connecting them to the utility grid.

In the case of PV, world-wide grid-connected capacity now exceeds off-grid capacity, and in recent years growth in the grid-connected sub-sector of the PV industry has far outpaced growth of off-grid applications (IEA, 2003), as indicated in the chart on page 14 of this report. Though in Canada grid-connected PV applications are still trailing far behind residential and commercial off-grid applications, the interest in grid-tied renewable applications continues to grow (Dignard-Bailey, 2001). This trend can perhaps partially be attributed to decreasing costs of small RE systems, but more likely is that it is their non-financial benefits that are appealing to investors, such as a sense of independence, environmental responsibility, etc.

Unlike US legislation, Canadian federal law does not guarantee access to the grid to small-scale electricity producers, nor does it guarantee that the electricity fed to the grid from small producers must be purchased by the utility. Provincial legislators are ultimately responsible for electricity law and regulation, but the actual authority to approve interconnection policies and buy-back arrangements/ rates etc. is imposed upon provincial review tribunals. In turn, decision-making power is granted to the utilities themselves. As a result, an individual or small business desiring to produce a percentage of their electricity from a renewable system and draw the remaining percentage from the grid, must first seek approval from the local utility. Many utilities have explicit guidelines or policies for dealing with such requests, but before a utility can adopt a new policy or amend an existing one it must first seek the consent of the review board.

Grid connection policies are nothing new in Canada; some utilities, such as Newfoundland & Labrador Hydro and Manitoba Hydro have had one since the early 1970’s. Yet not all utilities which were contacted during this study had small-scale grid-connection policies in existence. This is perhaps not too surprising given the responsibility decision makers are charged with and the many factors which must be considered prior to implementing a policy allowing small-scale RE producers to connect to their grid. In considering a proposal from a small power producer to interconnect to the electricity grid, the utility must consider both the proposal's technical and economic considerations. As a result, utilities typically have two distinct policies: one dealing with the technical requirements of grid-connected systems and one to deal with the economic implications of such systems (or a single policy which deals with each in turn).

In most jurisdictions a single organization or utility is bound by law to ensure the grid operates in a safe, and efficient manner. For small-scale RE producers to feed power into the grid smoothly and safely, a policy must be carefully designed to address possible technical related concerns. For example, it must be ensured that power being fed into the grid is synchronized to the same voltage and frequency ranges, as well as minimizing harmonic distortion, voltage flicker etc (MPC, 2001). Of course the utility must also ensure that the small producer's system does not create any safety hazards. So, from a technical perspective, there are specific requirements which must be in place to ensure that all safety concerns are met, and that power service is not unfairly disrupted, which could result in the utility requiring to pass increased costs to other customers. Currently technical guidelines which are in place in Canada have been drafted independently by each utility. The majority of utilities surveyed had technical guidelines in place. Work, however, is underway on a standardized national guideline for technical grid connection issues in a Canadian context through both the MicroPower Connect Project and the Alberta Safety Codes Council's Task Force on MicroPower and the CE Code. Once a national standard is established this aspect of grid connection policy should be greatly simplified.

7.1 Summary of Utilities with Grid-Connection Policies

Twenty-four major Canadian utilities were contacted during the course of this study, including at least one in each province and territory. Of the 24 companies contacted, 14 utilities submitted responses, resulting in responses from a major utility in every province and territory but Manitoba, New Brunswick, the North West Territories and Nunavut.

Table 7.1.1: Utility Responses to Survey

Province	Utilities Contacted	Responded	
		Yes	No
BC	BC Hydro	✓	
BC	Columbia Power Corp		✓**
BC/AB	Aquila Networks	✓	
AB	Atco Electric		✓
AB	Enmax	✓	
AB	EPCOR		✓
SK	SaskPower	✓	
MB	Manitoba Hydro		✓
ON	Canada Niagara Power		✓
ON	Hydro One		✓
ON	Hydro Ottawa	✓	
ON	Ontario Power Generation		✓**
ON	Toronto Hydro	✓	
ON	Waterloo North	✓	
QC	Hydro Quebec	✓	
NB	New Brunswick Power		✓
PEI	Maritime Electric	✓	
NS	Nova Scotia Power	✓	
NF	Newfoundland Power Inc.	✓	
NF	Newfoundland & Labrador Hydro	✓	
YT	Yukon Energy Corp.	✓	
YT	Yukon Electric Company Ltd.	✓	
NT	Northwest Territories Power Corp.		✓
NU	Nunavut Power		✓
	Total	14	10
** Utilities which do not partake in electricity retailing and thus were unable to respond to the survey.			

Every utility that responded stated it has at least some independent power producers[21], which are feeding power to their grid, and a technical guideline is prerequisite to grid-connection. Indeed, every utility surveyed stated it had a grid-connection policy specifically governing the technical issues of grid tie-in of systems under 100kW, even in the cases where no small renewable systems (under 100kW) are currently attached to their service grid (such as Hydro-Quebec).

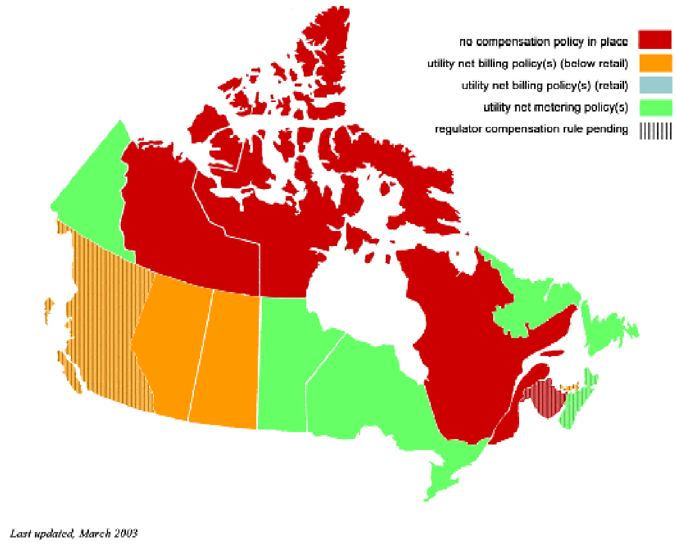
As stated in the above section it is important to understand that the existence of a technical policy does not necessarily mean a policy specifying economic arrangements exists. Of the 14 utilities that responded, two, Hydro-Quebec and Yukon Energy Corporation did not have buy-back policies in place. Hydro-Quebec stated it has no system owners attached to its service grid, and so a policy could be seen as redundant. Yukon Energy Corporation, is primarily a electricity wholesaler (with only 1500 retail customers) but stated nevertheless that a policy allowing small-scale RE producers to connect to their grid is expected to be released by January 1st 2004 (YEC, 2003).

The remaining 12 utilities which responded had policies in place which allowed system owners to feed their excess power to the grid. Manitoba Hydro, with a long-standing policy for grid-connection did not respond to the survey.

[21] not necessarily small system owners that were of interest to us in the survey

7.2 Summary of Net Metering/Buyback Policies

According to our definition of net metering (for discussion of net metering, please refer to section 3.7), only six of the respondents had an actual net metering policy in place. An additional two respondents indicated that a net metering policy might be in store in the near future. Utilities with net metering programs were from four provinces: the Yukon, Ontario, Nova Scotia and Newfoundland and Labrador.



Simple Net Metering:

Newfoundland and Labrador Hydro neither permits banking from billing period to billing period, nor compensates customers that feed electricity into their grid at retail rate if there is any net production at the end of a billing period. This policy would not be considered net metering according to a typical American definition but nevertheless allows simple net metering: electricity generated by customers is worth retail rate when it offsets future utility purchase during the same billing period.

Full Net Metering with Rolling credit:

Four of the six utilities which had existing net metering policies, Toronto Hydro, Waterloo North, Nova Scotia Power, and Yukon Electrical, had arrangements which did allow small-scale RE producers to bank excess power in one billing period to offset power purchases in the next billing period. As explained in the above section, allowing power to be carried over from billing period to billing period indefinitely means all the electricity customers generate can be used to offset purchases at the retail rate, and is thus is in effect worth the market price for electricity. Hydro Ottawa indicated that it was still undecided if small-scale RE producers should be allowed to bank excess power from billing period to billing period. Its net metering policy, however, stated that excess power in a single billing period is purchased from small-scale RE producers at the real-time retail market price.

Full Net Metering, Buy-back:

Hydro Ottawa, Waterloo North, and Yukon Electric were the three utilities that actually paid a monetary compensation to small-scale RE producers (presumably in the form of a cheque) for excess electricity. Waterloo North, allowed banking and also rewarded retail rate for every kilowatt hour of electricity which couldn't be banked. Yukon Electric Company also allowed banking and paid small-scale RE producers for

power not used in one billing period or banked to offset loads in the next period. Yukon Electric, however, awarded avoided cost for such power as opposed to retail rate.
Nova Scotia Power currently allows smaller systems to net meter, informally. There is no definitive policy or written standards. The rule of thumb is: retail rates are paid by NSPower to the small-scale RE producers for systems with less than 10kW installed capacity, and wholesale rates are paid for systems over 10kW installed capacity

There is currently a committee of stakeholders meeting to prepare recommendations on how changes to provincial electricity regulations would be best handled. Hopefully changes can be completed within a year or so. [22] A draft of these recommendations was completed in the Spring of 2003, however we were not able to obtain a copy of the document or disclose any information that came out in discussions.

From the perspective of the small-scale RE producer, the five existing net metering programs in Canada, ranked from most compensation for power to least compensation, would be:

Table 7.2.2 Ranking of Canadian Net Metering Programs

Rank*	Utility	Characteristics
1	Waterloo North	A, B, C
2	Yukon Electric	A, B
3	Hydro Ottawa	A, B
3	Manitoba Hydro	A, B
4	Nova Scotia Power	A, C
4	Toronto Hydro	A, C
5	Newfoundland & Labrador Hydro	A, B

Characteristics are described in Section 3.7
A = Simple Net Metering
B = Full Net Metering with Buy Back
C = Full Net metering with Rolling Credit

* It is important to point out that this ranking system is somewhat arbitrary. The reason characteristic B was thought to be more desirable for small power producers than C is because presumably all excess kWhs are bought, whereas with a banking system some excess may eventually be lost if there is still a net excess when the meter reading is netted after 12 billing periods.

It also warrants mention that although survey responses were not received by Manitoba Hydro or New Brunswick Power, Manitoba Hydro has long had a policy in place and there is some evidence that New Brunswick Power will soon have a policy. According to several sources Manitoba Hydro established a net metering policy in 1989, which allows small-scale RE producers (up to 2000kW capacity) to bank power

[22] Email from Brian Hayes, Energy Engineer with NS Department of Natural Resources Energy Utilization Division blhayes@gov.ns.ca Tue, 30 Jul 2002

until the next billing period and also receive the avoided cost for any additional electricity fed onto the grid (Salmon, 1999; McCue, 2002). Unfortunately no representative from Manitoba Hydro was able to confirm the existence of such a policy nor was any mention of such a policy found on the Manitoba Hydro website.

In the case of New Brunswick power several individuals suggested that provincial legislation is expected soon in New Brunswick which would require all electricity retailers to adopt a net metering policy for any customers interested in generating a portion of their own power. Evidence does exist in government documents which suggests that net metering legislation is at least being considered (NB, 2001; NBMDC, 2002). On the New Brunswick website a statement was found stating NB Power supports the recommendations of the market design committee to adopt net metering policy and remove associated market barriers (NB, 2003).

Table 7.2.1 Grid-Connection/Net Metering Arrangements of Survey Respondents

Province	Utility	Feed-in	Banking	Rate Type	Net Metering
BC	BC Hydro	Y	N	negotiated/avoided	N
BC/AB	Aquila Networks	Y	N	realtime wholesale	N
AB	Enmax	Y	N	realtime wholesale	N (tba)
SK	SaskPower	Y	N	average variable cost	N
MB	Manitoba Hydro	Y	Y	avoided cost	Y
ON	Hydro Ottawa	Y	tba	realtime	Y
ON	Toronto Hydro	Y	Y	no buy-back	Y
ON	Waterloo North	Y	Y	realtime	Y
QC	Hydro Quebec	N	N	n/a	N
PEI	Maritime Electric	Y	N	avoided cost	N
NS	Nova Scotia Power	Y	Y	no buy back	Y
NF	Newfoundland Power Inc.	Y	Y	avoided cost	N
NF	Newfoundland & Labrador Hydro	Y	N	avoided cost	Y
YT	Yukon Energy Corp.	N	N	n/a (tba)	N (tba)
YT	Yukon Electric Company Ltd.	Y	Y	avoided cost	Y
	Total	12	4	n/a	6

Of the utilities that allow feed-in but *don't* allow net metering, Alberta utilities seem to provide the best price to small RE producers. Since under recent Alberta law (Howell, 2003) all certified electricity producers are allowed to sell to the power pool they are guaranteed the wholesale market price which changes as supplies fluctuate. In other provinces without net metering the best small producers can hope to earn for their excess power is the fixed avoided-cost rate (the same situation as in the US under PURPA), irregardless of what time of day the power was fed onto the grid[23].

This means that Alberta residential PV operators, for example, can feed power to the pool during the afternoon when power is at a premium (i.e. real-time wholesale prices are higher), and production is at it's peak. They can then draw from the grid during the nights when wholesale prices are lower, though when they draw from the grid of course they pay retail price. The benefits may not be as obvious for small wind producers as peak wind periods may tend to coincide more with customer loads. Despite the lack of net metering programs, the Alberta power pool pricing system may allow small-scale RE producers to amortize their power investments more quickly than similar systems bought in other jurisdictions which do not currently offer buy-back schemes.

However beneficial the Alberta power pool system may be to small-scale RE producers compared to buy-back schemes in other provinces, net metering may be even more desirable from a small-scale RE producer perspective. The Alberta power pool system is not incompatible with net metering, its just that no net metering policies currently exist. However since the electricity market sector is now unbundled, only the electricity retailers are in a position to adopt a net metering policy because they are the only companies which charge retail rates for electricity. It is difficult to imagine how a policy could be conceived whereby companies that are strictly wire owners or generators could adopt a net metering program.

Box 7.2.1 An example of a user-friendly, transparent process for interconnection

The System Owners Policy (at www. saskpower.com/services/nug/under100.shtml) is SaskPower's response to customers who wish to install small-scale wind and solar-powered facilities and other viable generation source systems for the purpose of offsetting power that would otherwise be purchased from SaskPower. Customers may interconnect a generating facility up to 100 kW in size to SaskPower's electricity distribution system, if safety, power quality and grid system security requirements are met (these are laid out in pdf format at http://saskpower.com/services/nug/NUG25kV.pdf).

SaskPower will purchase excess energy based on the average variable cost of electricity from all sources. This rate is updated annually, using information from SaskPower's annual report. Two-way metering is also required to measure the energy the customer provides to the grid and the energy SaskPower provides to the customer.

[23] Nova Scotia Power is a notable exception to this policy because small-scale renewable energy producers have been permitted to gain time of use pricing for their production as well as consumption under certain conditions.

7.3 Barriers and Obstacles to Grid-connection and Net Metering

Utilities and customers each perceive barriers to grid-connection. Those perceived (and real) barriers do not necessarily coincide. As well, there is a distinction between the barriers hindering grid-connection and the obstacles preventing the adoption of net metering programs. This section will focus on what barriers to grid-connection and net metering were perceived by the utilities contacted during the study.

Before writing the survey, we tried to compile a list of all the possible obstacles to grid-connection that an utility could conceive. The list was based on existing research as well as a sense of of potential obstacles gained from talking to representatives of both the Canadian electricity industry and the RE industry. The survey can be found at Appendix VII.

The first question was phrased: “Please indicate whether the factors are of ‘high’, ‘medium’ or ‘low’ importance in hindering the adoption of a standardized policy allowing small-scale renewable energy producers to sell excess electricity to the grid.” Any obstacle that was rated ‘medium’ or ‘high’ importance was deemed to be a factor hindering a buy-back policy.

This question encompasses both the technical obstacles to grid-connection in general as well as the economic policy obstacles to buy-back programs in general, including net metering. We then took the results and separated whether the various obstacles indicated were impeding grid-connection itself, a buy-back program such as net metering, or both. The results are shown in Table 7.3.1.

Of the fourteen utilities that submitted surveys, seven utilities cited obstacles to adopting grid-connection policies, as did an additional three Alberta utilities that did not submit survey responses. In total, ten utilities indicated obstacles of concern for them. Hydro Quebec and Yukon Energy both cited obstacles, yet currently have no small-scale renewable energy producers connected to their service grid. Therefore their responses should perhaps be given the most consideration, seeing as the obstacles they cited have not yet been overcome. Even from the eight responses from the utilities with existing grid-connection policies we can gain insight into the concerns that had to be overcome before the utilities drafted their policies.

Table 7.3.1 Policy Hindrances

Province	Utility	Lack of customer demand	Concerns about safety (islanding)	Concern for revenue losses	Lack of awareness of net metering within organization	Difficult to compete with non-renewable micropower	Lack of universal standards	Lack of awareness of distributed renewables within organization	Current generation results in few carbon emissions	Lack of government leadership	Concern over ability to accurately predict loads	Intermittent nature of renewable resources	Other (Lack of net metering among public)	Other (Technology will be needed to manage extra data)	Other (Current electricity is cheap)	Other (Concerns about cross-subsidization)	Other (Lack of leadership on part of regulator)
BC	BC Hydro	✓		✓						✓						✓	
BC	Columbia Power *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BC/AB	Aquila Networks																
AB	Enmax			✓						✓			✓	✓			
AB	Epcor									✓							
AB	Transalta									✓							
AB	Atco Electric						✓			✓							
SK	Saskatchewan Power			✓												✓	
ON	Hydro Ottawa																
ON	Ontario Power Generation	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
ON	Toronto Hydro																
ON	Waterloo North	✓													✓		
QC	Hydro Quebec	✓		✓		✓				✓					✓		
PEI	Maritime Electric																
NS	Nova Scotia Power																
NF	Newfoundland Power Inc.																
NF	Newfoundland & Labrador Hydro																
YT	Yukon Energy Corp.	✓	✓						✓	✓							✓
YT	Yukon Electrical Company Ltd	✓							✓								
	Total Number of Times Cited	**5**	**1**	**4**	**0**	**1**	**1**	**0**	**2**	**7**	**0**	**0**	**1**	**1**	**2**	**2**	**1**

By far the most common obstacle cited was lack of government leadership. Indeed, three Alberta utilities claimed that a government imposed market system, the Alberta Power Pool, left them ill equipped to even participate in the survey. Atco Electric, Transalta and Epcor, all declined to participate in the study citing that the re-regulated[24] Alberta electricity industry made questions regarding grid-connection and net metering irrelevant to their companies[25]. Enmax cited similar concerns in its survey responses. Likewise, BC Hydro, Hydro-Quebec, and Yukon Energy all stated that lack of government leadership was an important obstacle that was hindering them from developing a standardized policy allowing small-scale RE producers to sell excess electricity to the grid.

The second most commonly cited obstacle to a grid connection policy was lack of customer demand. Five out of the 14 survey respondents cited this an obstacle to grid connection. This is puzzling considering, that with the exception of Newfoundland and Labrador Hydro, and Newfoundland Power (where it was unclear if customers had ever approached them with requests to interconnect or not) every utility responded “yes” to the survey question: “Have customers ever approached your organization interested in selling excess power to the grid?”. Waterloo North cited lack of customer demand as a major obstacle to a grid-connect/buy-back policy but also cited the presence of customer demand as an important factor which led to the development of their policy. Lack of *sufficient* customer demand to interconnect their systems to the grid is clearly an important obstacle preventing utilities from establishing standardized policies.

Four utilities cited concerns over revenue losses as one reason they were hesitant to establish a policy allowing small-scale RE producers to sell excess electricity to the grid. Hydro-Quebec, Saskatchewan Power, Enmax and BC Hydro all stated that the development of a policy allowing small-scale RE producers to their grid could cost them revenues due to power purchases which would be displaced by on-site generation.

Two separate factors that were not listed in the survey were both added in the ‘other’ option by two different utilities. The fact that conventional electricity is currently very cheap was cited by both Waterloo North and Hydro-Quebec as an important factor hindering policy adoption. This concern seems tied to the ‘lack of customer demand’ factor included on the survey, i.e.: the fact that electricity is cheap provides little incentive for customers to invest in their own power systems which are usually far more expensive than conventionally generated on a straight price per kilowatt-hour basis. Perhaps more significant however, was the concern cited by both BC Hydro and Saskatchewan Power, that allowing small-scale

[24] The term deregulation is misleading because the industry is still regulated, just regulated in a different way.
[25] Similar arguments have been raised by utilities in Texas: since utilities have been broken up into generation, wires companies and retailers. Some utilities have argued that a pre-existing public utility review board rule mandating net

RE producers to sell electricity to the grid results in cross-subsidization issues. Small-scale RE producers producing their own electricity and receiving retail rate for the power produced are obtaining the benefits of the grid, (because they are using it as a way to store electricity for free), but are not paying the full rate for the power they draw from the grid.

From the utility's perspective, when a customer feeds power onto the grid, effectively 'storing' the power for free, and later draws it from the grid, the customer is avoiding paying any portion of the fixed costs which were paid by the utility for constructing and maintaining the distribution infrastructure. (Even though RE generation costs were originally accrued by the customer.) Other rate payers then must make up for the difference of lost revenue. Had this been included in the list of options on the survey, more utilities may have cited it. This concern may be more widespread than the survey results suggest.

An additional seven concerns were cited once each by different utilities. Yukon Energy Corporation cited safety concerns – this response was not unexpected given the fact that Yukon Energy Corporation was one of two utilities responding to the survey which have yet to establish a technical grid-interconnection policy. Though Hydro-Quebec does not yet have a technical policy in place it is apparently not because of safety issues that cannot be overcome. ATCO Electric, though it did not respond to the actual survey, indicated that lack of universal interconnection standards was hindering the adoption of a policy. Hydro-Quebec cited that renewable distributed resources are not competitive with non-renewable distributed resources. Enmax cited a lack of awareness of net metering among the public, and a need for expensive new technology as reasons preventing a standardized policy from being adopted. The present supply of electricity from low emission sources was said to be a contributing factor to the slow policy development by both the Yukon utilities. Finally, Yukon Energy Corporation stated that lack of a clear position statement on behalf of the territorial regulator was preventing the adoption of a policy.

Four of the possible obstacles in our list were not cited by any utility as a concern at all. Lack of awareness of net metering or distributed RE within the utility organization for example are apparently not hindering the adoption of a standardized policy allowing small-scale RE producers to sell excess electricity to the grid. Likewise, somewhat surprisingly, not a single utility cited the intermittent nature of distributed renewables or anticipated complications distributed renewables may cause in load predicting as an obstacle in the adoption of a policy.

metering for vertically integrated organizations no longer applied to companies specializing in only one sector of the electricity industry (Forsyth, 2002).

7.4 Motivations for adopting a Grid-Connection / Net Metering policy

As with the obstacles preventing utilities from adopting a policy, the motivations driving the utility to adopt policy are going to differ from those driving the small-scale RE producer who requires the policy. There may be some overlap, but the motivations will not necessarily coincide. And the distinction must be made between motivations behind adopting a technical grid-connect policy and the motivations behind the adoption of net metering program or other compensation policy. Again, we compiled a list of all the possible motivations to grid interconnection based on what others had cited in existing research as well as what we sensed from talking to representatives of the electricity industry here in Canada. See Appendix VII for the survey.

The question was phrased: “Please indicate whether the factors were of “high”, “medium” or “low” importance in leading to the adoption of a standardized policy allowing small-scale RE producers to sell excess electricity to the grid?” A separate question was also included to emphasize factors motivating a policy relating to renewable electricity. It was phrased: “Please indicate whether the factors are of “high”, “medium” or “low” importance in hindering the adoption of a standardized policy allowing small-scale producers using *renewable* energy technologies to sell excess electricity to the grid?” To simplify the discussion we have combined the responses to both questions and summarized them in Table 7.4.1 below. Like the obstacles section, any issue which was cited as being of “medium” or “high” importance was deemed to be a “factor” for the purposes of this study.

Unlike the hindrances and obstacles to policy formulation, in the case of motivating factors no single factor stood out. In total 16 different factors were cited by the utilities. Three was the maximum number of times any factor was cited. Nevertheless, it should be possible to draw some conclusions as to the factors which actually motivate utilities to adopt policy.

Some issues cited could be grouped. For example, there were five factors which dealt with some form of demand side management (DSM); three which dealt with anticipated market growth; four factors which related to the presence of customer demand; and another four which related to reducing air emissions. By looking at factors cited both individually as well as grouped into these rough categories some useful insights can be gained. For example, three utilities cited customer demand from residential customers as a motivating factor; another three cited industrial customer demand, one cited commercial customer demand and another cited institutional customer demand. In sum, customer demand cited to eight times clearly appears to be the most important motivating factor behind a standardized policy allowing small-scale RE producers to sell excess electricity to the grid. Three separate utilities cited customer demand in more than one customer class as a factor.

Further economic factors tended to be the next most influential motivations for adopting a grid-connection policy with buy-back. Hydro Ottawa cited the reduced cost of administering many small power producer accounts a motivating factor for their net metering policy. Newfoundland Power Inc. and Newfoundland and Labrador Hydro both cited the anticipation of a growing market share of renewables as a motivating factor behind their policies. The former also cited anticipation of increased demand for green power as a result of the federal government's commitment to buy 20% of their power from such sources.

The DSM potential of distributed renewables did not generally appear to be recognized as an important motivating influence in adopting policy. The two Newfoundland and Labrador utilities were the only two that cited base load cost deferment as an issue and only Newfoundland and Labrador Hydro cited reduced transmission losses as a factor. Transmission and distribution cost deferment, peak load shifting and peak load clipping were not pointed out by a single utility as being important factors. Newfoundland Power Inc. indicated the DSM potential of its policy to mitigate short term avoided costs.

Reduction in carbon emissions appeared to be a similarly unimportant factor in policy establishment. Only three utilities cited the desire for emission reductions to be important. Aquila Networks suggested that government pressure to reduce emissions played a role in the implementation of its policy whereas, Yukon Electric Company and Toronto Hydro cited public pressure as playing a role.

Two utilities cited the anticipation of an evolving electricity regulation in their jurisdictions as a motivating factor. Maritime Electric as well as Newfoundland and Labrador Hydro both stated that the anticipation of stricter government regulations led in part to the adoption of their policy, whereas Hydro Ottawa suggested their policy provided a hedge on provincial restructuring.

Table 7.4.1 Motivations for Adopting Policies

Prov	Utility	DSM* - Base load infrastructure cost deferment	DSM* - T&D infrastructure cost deferment	DSM* - Peak load shifting/clipping	DSM* - Reduced transmission losses	Reduced administration cost for non-utility generators	Anticipation of growing market share for RE	Anticipation of stricter government regulations	Anticipation of growing market share of DG	Anticipation of federal purchases of 20% Green Power by 2005	Residential customer demand	Commercial customer demand	Industrial customer demand	Institutional customer demand	Government pressure to reduce carbon emissions	Public pressure to reduce carbon emissions	Financial incentive to reduce carbon emissions	Other (Importance of generation cost)	Other (Provincial restructuring)	Other (DSM short run avoided costs)	Other ("Our rates are based on delivered energy only."
BC	BC Hydro																				
BC	Columbia Power *	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
BC/AB	Aquila Networks												✓		✓						
AB	Enmax																				
SK	Saskatchewan Power										✓	✓									
ON	Hydro Ottawa					✓													✓		
ON	Toronto Hydro															✓					
ON	Waterloo North																				✓
QC	Hydro Quebec																				
PEI	Maritime Electric							✓			✓			✓							
NS	Nova Scotia Power Inc.																				
NF	Nfndland Power Inc.	✓					✓			✓	✓		✓							✓	
NF	Nfndland & Lab. Hydro	✓			✓		✓	✓					✓					✓			
YT	Yukon Energy Corp.																				
YT	Yukon Elect'l Co. Ltd															✓					
Total Number of Times Cited		**2**	**0**	**0**	**1**	**1**	**2**	**2**	**0**	**1**	**3**	**1**	**3**	**1**	**1**	**2**	**0**	**1**	**1**	**1**	**1**

8.0 Conclusions

Canada is already home to a healthy group of individuals and industry professionals dedicated to building the RE market in the country, with a growing list of experts in small grid-connected systems. Technology is in place, energy needs are expanding and successful examples of interconnection standards and policies that take into consideration technical, safety, contractual and other issues are available worldwide. Harmonized interconnection regulations and policies would help bring the per Watt cost of RE systems down to a viable option for residential and small-scale commercial operations. Deregulation (or re-regulation) of the electricity sector in North America provides the opportunity to establish guidelines and policies that support the widespread implementation of small-scale RE systems. These will not replace the need for power generation at large installations by traditional utilities, but compliment them. Initiatives that are aimed at increasing this market are threefold:

1. New technologies often offer cost-effective, efficient solutions with significant environmental benefits.
2. There is a huge market potential worth billions of dollars and thousands of jobs.
3. Distributed generation improves the reliability of electricity power at the site and delays infrastructure upgrades to the existing network (MPC, 2001).

In this study, we anticipated that the major factors inhibiting the wider acceptance of small-scale grid-connected RE systems would be similar to those documented in the US and other countries: lack of perceived demand; low energy costs and safety/technical concerns. We anticipated that the major obstacles on both sides of the meter that made investors hesitant to buy grid-connected RE systems, would be safety and technical issues. This was only partly the case. The seven major obstacles to grid-connection, as identified by system owners were:

1. excessive safety/technical concerns on the part of utility
2. no easily accessible utility contact
3. no interconnection standard or policy at utility
4. no established interconnection practices (i.e., protocols/guidelines for inspectors, standard agreements, etc.)
5. lack of support from government to encourage the use of RE in the power generation mix
6. local permitting issues (environmental or other)
7. cheap electricity

These results were more or less the type of responses we expected. However, the four major factors hindering policy development and/or customer uptake of policy as identified by utilities did not match our assumptions. Instead, they were as follows:

1. lack of government leadership
2. lack of customer demand
3. low energy costs
4. cross-subsidy concerns

As noted, ten of the fourteen utilities that responded to the survey have grid-connection policies in place to serve small-scale power producers. As a result, and contrary to the assumptions made at the beginning of the project, safety and technical concerns were low on the list of obstacles identified by the utilities – with a policy in place. They have addressed the perceived safety and technical issues already. However, modern electrical grids and the standards governing them are geared to large-scale, high voltage production, and some of these standards simply do not apply to small-scale, low-voltage installations. A prime example of this is where visible disconnects are required, even though inverters approved for grid-connection through international standards are 'smart' and have control functions that meet safe operation requirements. These include automatic disconnect as soon as the inverter senses an interruption in the power from the grid (the inverter draws its power from the grid), and has an adjustable delay prior to re-engaging with the grid. In some regions, system owners have had to increase the cost of their systems by including visible disconnects as part of the safety requirements of the Canadian Electrical Code as interpreted by individual inspectors. As a result, the most commonly noted obstacle to the grid-connection process on the part of most system owners was 'safety and technical concerns on the part of the utility'.

Also, where Canadian Standards Association (CSA)-approved equipment is called for under the Canadian Electrical Code, potential system owners have found a problem: there are no CSA-approved inverters. There are several inverter modules that have met international standards, yet these standards are not always accepted as 'equivalent'. The small Canadian market for this equipment is mainly to blame for this situation: although there is a CSA-approval listed for inverters, manufacturers are not likely to put resources into gaining CSA-approvals until the market looks like it warrants that level of economic effort. It needs to be emphasized that the CSA listing for inverters (CSA C22.2 No. 107.1 section 15) is harmonized with the requirements of the US standard UL 1741. Therefore, the UL 1741 approval sticker in place should be considered equivalent to meeting the Canadian standard.

Up until recently, there has not been a CSA listing for PV modules, and this has meant that grid-connected PV systems have required a Special Inspection under the CE Code. There is now a CSA standard for PV modules (Can/CSA-C61215:01: Crystalline Silicone Terrestrial Modules). Now that this standard is in effect, no PV distributor selling to Canadian dealers should be allowing the modules to leave the warehouse without the CSA sticker in place. Other safety standards are also acceptable: UL, ULc and TUV (Germany).

It is interesting to note that although 10 of the 14 utilities replying to the survey had policies allowing feed-in to the grid, it seems having a policy in place has not resulted in increased customer interest in grid-connected systems. The majority of the system owners who responded indicated that they felt the biggest obstacle encountered was the utility. Whether the system was connected ten years ago or within the last year, the bulk of system owner responses in regards to obstacles were directly related to the utility, regardless of a policy being in place or not. Many individuals across the country felt that the onus for educating the utility and electrical inspectors in small-scale, low-voltage grid-connected systems was somewhat unfairly on their shoulders. In almost every region, there was difficulty in identifying the personnel to approve the system. In some regions there have been delays of up to two and a half years for approval of the tiniest (100W) systems, that will, in all likelihood, never feed back into the grid. In some cases, the categorization of these small-scale systems as ‘commercial’ generators under regional policies has resulted in levies and taxes that are several times that of the potential income from excess generation. Where homeowners are looking at small systems that may never feedback to the grid, and are using the systems as an energy efficiency measure (i.e., dropping 10% from their energy bill), the annual cost of the taxes outweighs the savings possible from a small capacity system.

When the results of the two surveys are combined, we find that there are six smaller utilities within Ontario which have small-scale systems attached to their grid. According to the system owners, there are no policies in place. The six utilities (Guelph Hydro, Mississauga Hydro, Cambridge and North Dumfries Hydro, Utilities Kingston, Vaughan Electric and Veridian Connections), however were not approached for the utility survey, so we cannot ascertain whether there are policies in place as of March 2003. System designers and installers who work in these regions indicate there are no policies in place as of yet, but also indicate that the utilities have been supportive of small-scale grid-connected installations to date. Likewise, three of the utilities which did participate in the utilities survey had grid-connect policies in place yet we received no responses from system owners within their jurisdiction (Newfoundland & Labrador Hydro, Newfoundland Power Inc. and Yukon Energy Corporation). In addition, with the opening of the Ontario electricity market, there were several community utilities that were merged into other, larger entities and it is unclear the state of policies which were in existence prior to the merging.

From our survey results, we conclude there are, in fact, only a few utilities with clear, useable policies, technical standards and a more or less streamlined process in place for small-scale, low-voltage power generation. Of the surveyed utilities, this includes BCHydro, with a PV policy in place, and SaskPower, with a three paragraph outline of the grid connect and compensation policy, the process and metering requirements and a direct utility contact provided for the SaskPower small power producers' program. This was more or less verified by the survey results because the system owners in BC (at least PV system owners) and Saskatchewan indicated little or no problem in getting connected. BC Hydro has no buy-back policy, while SaskPower offers avoided cost.

However, in general, there is a 'disconnect' between the grid-connect policy and how it is implemented. The most likely reason for this is the lack of market demand has left most utilities unwilling to put resources into developing and streamlining the technical standards: creating standard documentation and developing field protocols or guidelines for utility personnel and electrical inspectors. The grid-connected RE market will not flourish without this support for grid-connect policy, regardless of whether there is a net metering (or other compensation) policy as well. So, the fundamental obstacles to small-scale grid connection is perhaps not a lack of policy per se, but poor *implementation* of the policy: a lack of guidelines and/or standardized technical requirements that make the process simple, streamlined and cost-effective for both utility and system owner. This is in the process of changing, thanks to the concerted efforts of the ElectroFederation of Canada, Industry Canada and Natural Resources Canada under the MicroPower Connect Project[26] and the Alberta Safety Codes Council's Task Force on MicroPower and the CE Code.

There is a vast potential market among homeowners and small business operators for these 'green' small RE sources. As noted in the report, RE source systems have the potential to improve air quality, reduce environmental damage related to fossil fuel-based power generation, and provide greater security in the event of energy shortages. In addition, connecting small, privately-owned small-scale RE producers to the public power system has many benefits for Canada's economy, including delaying the need for new large-scale power generation plants, thus avoiding otherwise necessary expenditures. As efficiencies have increased (some PV cells are now at 30% efficiency according to the Green Power Network website (www.eere.energy.gov/greenpower/) and the technologies have improved over the years, new, exciting and expansive options have emerged.

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[26] See: The MicroPower Connect Interconnection Guideline - For inverter based micro-distributed generation (DG) systems connected to 600 volt or less distribution systems, Draft 7, dated February 18, 2003 is now posted on the MPC website.

View here http://www.micropower-connect.org/standards/MPCIntConnGuide.pdf

This Guideline is the result of the work of the MicroPower Connect Technical Committee. This committee includes 25 members representing various stakeholders and has been working towards establishing a national consensus among all industry members on the technical requirements for the interconnection of micro-distributed generation systems.

Access to the electricity grid for the sale of excess electricity is one of the key drivers for the development of a strong competitive electricity industry in Canada. Distributed generation must play a growing role in the industry's future. The scale of power generation anticipated by the utilities — and corresponding regulators — is of concern to small-scale grid-connected power producers of all types (renewable energies, co-gen, biomass, etc.). Most jurisdictions in Canada provide access to the grid for transmitting power to wholesale customers (i.e., electricity distribution companies), but not to retail customers (i.e., electricity consumers). Electricity is a commodity of great value, and regardless of the scale of generation, there should be some compensation for supply. Net metering, where one meter measures the difference between the electricity produced and fed to the grid and the electricity used from the grid, increases the cost-effectiveness of small-scale RE systems, as shown in the Japan, where 20,000 small rooftop PV systems were installed in 2001[27].

Currently in Canada, there is a hodge-podge of compensation programs for excess generation. Only half of the 14 utilities replying to the survey had clear economic policies that benefited the small-scale RE producer. There is a whole range of rates, metering arrangements and billing policies, from avoided cost to time-of-use net metering; single or double meter requirements; 'banking' of energy credits from one billing period to another vs. no banking. Nearly every permutation can be found in the handful of utilities with compensation agreements already in place for small power producers.

Net metering is perhaps the simplest compensation agreements, and has clear benefits to both system owners and utilities. It consists of one meter that runs backwards when there is excess generation from the small-scale system, and runs forwards when there isn't enough power being generated by the small-scale system. It is best used when in combination with a rolling credit.

There are three major reasons for net metering:

1. Increasing numbers of small-scale RE systems require a simple, standard protocol for connecting into the electrical grid to ensure safety and power quality. Net metering is a simple, inexpensive and easily administered mechanism for encouraging the use of RE sources, providing important local, national and global benefits.

2. Many residential customers are not home during the day when their systems (esp. PV and wind) are producing power. Net metering allows for the full value of the electricity produced to be captured without installing expensive battery storage systems. Customers can use their existing meter without any additional regulation or equipment.

[27] Gordon Howell, as part of a presentation on grid-connected PV systems and total cost accounting at the Canadian

3. Annual 'netting' allows an owner to take full advantage of the seasonal nature of some RE sources. Customers on annual netting benefit by having excess production 'banked' until those months when their system does not generate at peak capacity (Starrs, 2001).

The existence of a net metering program might not be the single most important factor influencing investors' decisions to go ahead with their project but an attractive compensation policy certainly helps. More lucrative policies[28] than net metering exist in some American and European jurisdictions but net metering likely remains the most popular compensation arrangement, likely owing its growing international attractiveness due to its simplicity.

It is interesting to note that most of the small-scale RE producing systems identified do not make up much more than 10% of the load required to operate the building (or other end use) with which they are associated. The commercial, institutional and industrial PV applications, (with the possible exception of the 42 kW system on the Niigon Technologies Plant), will probably never feed back into the grid. They do lower the electrical costs incurred by the building, however, with a grid-connection arrangement, ensuring power generated when the building loads are minimal is 'banked'. Residential systems, on the other hand, could easily feed back into the grid many times during a year if homeowners are away during the day when the PV system reaches its peak capacity and there is minimal loading.

Canada can learn from the experience of European countries, the US and Japan, where small-scale RE systems have flourished under clear policies backed up by strong government support and incentives to build a viable small-scale RE industry and distributed generation system. Most countries with a history of grid-connected RE systems have simplified their standards and done away with redundancies in safety and technical requirements. The most telling of these simplifications is removing the requirement for a manual, or external, AC disconnect in conjunction with the automatic disconnect contained within the inverter (Howell, 2002b).

Currently, Canada has roughly 1.04 MW of small-scale grid-connected RE capacity, whereas total national energy production capacity, including all technologies and scales of facilities, was around 112,600 MW in 1997 (NRCan, 2000, p.112). This means that small grid-connected renewable electricity systems account for about 0.001% of Canada's total generation capacity. The International Energy Association's PV program indicates that there is a great discrepancy between Canada, the US, Japan and Germany, in both PV capacity in place and public funding for building the PV industry. In 2001, (the latest year for compiled data from all four countries), the IEA indicates that Canada had a total of 8836

Solar Industry Association AGM, November 8, 2002. Ottawa kW of installed PV, with 341kW being grid-connected[29], for an average of 0.28 installed Watts per capita. In the US, the figures were 167,800 kW total PV installed, with 40,600 kW grid-connected, for approximately 0.60 installed Watts per capita. In the same year, Canada spent a total of $1,950,000US on R&D ($1,241,000), Demonstration Projects ($305,000) and market stimulation ($403,000). The total US public funding for PV in 2001 was $119,600,000US – over 60 times that of the Canadian funding. (R&D = $35,000,000 and Market Stimulation = $84,600,000). Japan's spending was almost double the US at $255,860,000US (R&D = $50,954,000, Demonstration = $16,507,000 and Market Stimulation = $188,389. Germany's spending was less, at $64,846,000.

With these figures in mind, it is clear that investment is needed if a national RE industry is to take flight. A national program to raise awareness of RE will also help drop the costs associated with a small market. Appropriate technical standards need to be in place to allow for consistent manufacturing and installation practices, and to help reduce the costs, paper work and safety issues that now prevent many people from using and investing in these new technologies.

[28] premium price for green power, or instantaneous spot market feed in options
[T]Total grid-connected PV capacity found by this study is 253.4 kW

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Shugar, D., Hoff, T. 1993. *Grid-Support Photovoltaics: Evaluation of Criteria and Methods to Assess Empirically the Local and System Benefits to Electric Utilities*, Progress in Photovoltaics: Research and Applications, 1, pp. 233-250.

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Starrs, 1998. Net Metering: An update of legal and Regulatory Issues.

UNEP, 2000.

Wan, Y., 1998. *Current Experience with Net Metering Programs*. NREL, Golden Colorado, USA.

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Appendix I: Demonstration Project On-Line Resources

British Columbia
BCIT:
House 2000: www.tc.bcit.ca/pv/projects/home2000.shtml
Power Tower: www.tc.bcit.ca/pv/projects/pwer.shtml
Technology Place: www.tc.bcit.ca/pv/projects/techplace.shtml
Technology Centre Building: www.tc.bcit.ca/pv/projects/array.shtml

Soltek Powersource, Victoria House:
Natural Life magazine article, www.life.ca/nl/75/solar.html
Canadian Newswire press release, www.newswire.ca/releases/August2001/28/c2949.html

Alberta
Airdrie Recycling Centre: an MP3 file of a radio profile, www.207.176.133.150/ecofile/293.html

EPCOR rooftop array:
www.epcor.ca/Environment/What+is+Green+Power/Where+does+Green+Power+come+from/default.htm#Solar%20Power www.climatechangesolutions.com/english/industry/stories/electricity/epcor.htm

Saskatchewan
Saskatchewan Advanced House: www.buildingsgroup.nrcan.gc.ca/projects/adv_houses_det_e.html

Manitoba
Red River College, Princess Street Campus: www.rrc-pscampus.com/

Ontario

ARISE Technology/Cook Homes: background on 'TEAM' project
www.vcr-mvr.ca/registry/out/P0035-ARISETECH-02-DOC.pdf

Blind River: www.climatechangesolutions.com/english/municipal/stories/energy/blindriver.htm

CN Tower: www.cntower.ca/faqs/l3_faq_coolstuff_solarpanels.htm

Kortright Conservation Centre: www.trca.on.ca/parks_and_attractions/places_to_visit/kortright_centre/
an excellent article outlining the projects: www.life.ca/nl/79/kortright.html

OPG Evergreen:
about connecting to the grid w/opg evergreen:
www.opg.com/healeyfalls/e_greenpower_solarcasestudy.asp
view the real-time performance of the rooftop system www.ascensiontech.com/RTD/framepage.htm

Mountain Equipment Co-op (MEC) Toronto:
www.mec.ca/Main/content_text.jsp?FOLDER%3C%3Efolder_id=618973&bmUID=1056917726093
www.climatechangesolutions.com/english/sme/stories/mec.htm

Quebec
CETC-Varennes

Prince Edward Island
PEI Advanced House: www.buildingsgroup.nrcan.gc.ca/projects/adv_houses_det_e.html
Avalon House: www.avalonhouse.ca/shelter/aah/index.htm

Nova Scotia

EnviroHome 2000: www.oee.nrcan.gc.ca/awards/housing_crowell.cfm?PrintView=N&Text=N

Nunavit
Monitoring Report for Arctic College, www.cetc-varennes.nrcan.gc.ca/eng/publication/r1998-16-52e.html

Appendix II: List of Grid-Connect Inverters Currently Available in Canada

Fire, Wind and Rain Technologies LLC
3850 East Huntington Drive,
Flagstaff, Arizona 86004, USA
Tel:1 928 526 1133
Fax: 1 928 527 4664
URL: www.firewindandrain.com 4-100kW Inverters and 500W Grid Tied Inverters

Mastervolt Solar BV
Snijdersbergweg 93, Amsterdam, The Netherlands 1105 AN
Tel: 31 20 342 2180
Fax: 31 20 342 2188
E Mail: solar@mastervolt.com

SMA Regelsysteme GmbH (Sunny Boy)
Hannoversche Strasse 1-5, 34266
Niestetal, Germany
Tel: 49 561 95 22 - 0
Fax: 49 561 95 22 - 100
URL: www.sma.de

Solapak Ltd (part of Intersolar Ltd)
Magdalen Centre, Oxford Science Park, OX4 4GA, UK
Tel: 44 1865 784 670
Fax: 44 1865 784 681
ULR: www.solapak.com

Solarix (brand of Fronius Vertrieb GmbH & Co. KG)
Buxbaumstrasse 2, PO Box 264,
A-4602, Wels, Austria
Tel:43 7242 241-0
Fax: 43 7242 241-394
URL : www.fronius.com

Sustainable Energy Technologies
Suite 200, 422 - 11th. Ave. SE
Calgary,Alberta,Canada T2G 0Y4
Tel: 403 508-7177
Fax: (403) 205-2509
E Mail: info@sustainableenergy.com
URL: www.sustainableenergy.com/SET-PV-grid/SET-PV-grid.html

Xantrex Technology Inc (Trace, Statpower and Heart Interface)
8999 Nelson Way Burnaby, BC
Canada V5A 4B5
Tel: 1 360 435 8826
Fax: 1 604 420 1591
URL : www.xantrex.com

Appendix III: Canadian Grid-connected RE Design, Installation & Equipment Sources

ARISE Technologies Corporation (PV) 321 Shoemaker Rd. Kitchener, Ontario N2E 3B3	Contact: Ian MacLellan Tel.: (519) 725-2244 Fax: (519) 725-8907 Email: info@arisetech.com URL: www.arisetech.com
Atlantic Orient Wind Canada (Wind) 780 Windmill Road, Suite 302 Dartmouth, Nova Scotia Canada B3B 1T3	Contact: Paul Pynn Tel.: 902 468-1621 Fax: 902 468-6865 Email: ppynn@aocwind.ca
Avalon House (PV & Wind) RR#1 Belfast, Prince Edward Island Canada C0A 1A0	Contact: Kevin Jefferies Tel.: 902 659-2790 Fax: 902 659-2790 Email: kjeffery@isn.net URL: www.avalonhouse.ca
Bennison Holdings Ltd. (Wind) 2315 36th Street North Lethbridge, Alberta Canada T1H 5I1	Contact: Darren Pepin Tel.: 403-320-6228 Fax: 403-320-6225 Email: Windtech@Telus.Net
Canadian Wind Power (Wind) 101 East Street #25 Bobcaygeon, Ontario Canada K0M 1A0	Contact: Doug Thompson Tel.: 1-866-633-2633 Fax: 1-866-633-2633 Email: doug@canadianwindpower.com URL: www.canadianwindpower.com
Cooke & Associates Inc. (Wind) PO Box 203 Lion's Head, Ontario Canada N0H 1W0	Contact: David Cooke Tel.: (519) 793-3290 Fax: (519) 793-3290 Email: david@dcooke.com URL: www.truenorthpower.com
Energy Alternatives (PV, Wind & Water) 8 –6782 Veyaness Road Victoria, British Columbia Canada V8M 2C2	Contact: Kevin Pegg Tel.: 250 544-0488 Toll-free: 1 800-265-8898 Fax: 250 544-0478 Email: kpegg@energyalternatives.ca URL: www.energyalternatives.ca
Enersave Inc. (Wind) 2076 Sherobee Road, Unit 605 Mississauga, Ontario Canada L5A 4C4	Contact: John Trikola Tel.: 905-848-0832 Fax: 905-848-9082 Email: john@ener-save.com URL: www.ener-save.com

Busby Architects (PV)
1220 Homer Street
Vancouver, British Columbia
Canada V6B 2Y5

Contact: Peter Busby
Tel.: 604 684 5446
Fax: 604 684 5447
Email: pbusby@busby.ca
URL: www.busby.ca

Enermodal Engineering (PV)
Kitchener, Ontario
650 Riverbend Drive,
Kitchener, Ontario
Canada N2K 3S2

Contact: Steve Carpenter
Tel: (519) 743-8777
Fax: (519) 743-8778
Email: scarpenter@enermodal.com
URL: www.enermodal.com

Frank's Alternate Energy (PV & Wind)
RR # 3
Thunder Bay, Ontario
Canada P7C 4V2

Contact: Frank Ilczyszyn
Tel.: (807) 964-2050
Toll-free: (888) SUN WIND (786-9463)
Fax: (807) 964-2050
Email: sunwind@norlink.net
URL: www.sunwindwater.com

Free Breeze Energy Systems (PV & Wind)
9185 SR 7 RR#2
Harriston, Ontario
Canada N0G 1Z0

Contact: John Hogg
Tel.: 519-338-3149
Fax: 519-338-3174
Email: freebreezeenergy@aol.com
URL: www.freebreeze.com

Generation PV Inc. (PV & Wind)
611 Granite Court
Pickering, Ontario
Canada L1W 3K1

Contact: Eric Kalmbach
Tel.: (905) 831-6111
Fax: (905) 831-6936
Email: ekalmbach@generationpv.com
URL: www.GenerationPV.com

Howell-Mayhew Engineering (PV)
15006 - 103 Ave.
Edmonton, Alberta
Canada T5P 0N8

Contact: Gordon Howell
Tel.: (780) 484-0476
Fax: (780) 484-3956
Email: ghowell@compusmart.ab.ca

Mitsubishi Canada Limited (Wind)
2800-200 Granville Street
Vancouver, British Columbia
Canada V6C 1G6

Tel.: (604) 654-8061
Fax: (604) 654-8223
Email: robert.coelho@mitsubishicorp.com
URL: www.mitsubishicorp.com

Mott Electric Ltd.
7008-14th Avenue
Burnaby, British Columbia
Canada V3N 1Z2

Tel: 604-522-5757
Fax: 604-524-3531
Email: info@mottelectric.com
URL: www.mottelectric.com

Phantom Electron Corporation (PV)
110 Ash Street, 2nd floor
Whitby, Ontario
Canada L1N 4A9

Contact: Leonard Allen / Ben Rogers
Tel.: (905) 430-6512
Fax: (905) 666-1188
Email: solar@phantomelectron.com
URL: www.phantomelectron.com

Positive Power Wind Sun Water (PV & Wind)
4160 Concession 7 RR4
Uxbridge, Ontario
Canada L9P 1R4

Contact: Tom Parvianen
Tel.: 905-852-4035 or 1-888-244-9990
Fax: 905-852-7482
Email: tom@positivepower.ca
URL: www.positivepower.ca

Saskatchewan Research Council (PV & Wind)
125 - 15 Innovation Blvd.
Saskatoon, SK
Canada S7N 2X8

Contact: Rob Dumont
Tel.: (306) 933-5400
Fax: (306) 933-7446
Email: info@src.sk.ca
URL: www.src.sk.ca

Sol Source Engineering (PV)
66 Lewis Drive
Newmarket, Ontario
Canada L3Y 1R7

Contact: Per Drewes
Tel.: (905) 898-0098
Fax: (905) 898-1668
Email: perdrewes@rogers.com

Solar Solutions (PV)
6-130 Midland St
Winnipeg, Manitoba
Canada R3E 3R3

Contact: Tim Yishushen
Tel.: 1.204.632.5554
Fax: 1.204.632.5577
email: solar@solarsolutions.ca
URL: www.solarsolutions.ca

Soltek Powersource Ltd (PV)
#2 - 745 Vanalman Avenue
Victoria, British Columbia
Canada V8Z 2B6

Contact: David Egles or Mike Cannon
Tel.: 1 800 667-6527
Fax: 1 800 727-2135
Email: sps@spsenergy.com
URL: www.spsenergy.com

Synergy Renewable Energy Solutions (PV)
25 Selwyn Cres.,
Kanata, Ontario
Canada K2K 1N9

Tel.: 1.613.592.2588
Fax: 1.613.592.2588
Email: Info@SynergyRenewableEnergy.com
URL: www.SynergyRenewableEnergy.com

Quantum Renewable Energy Inc ***(PV & Wind)***

27 Robert Wallace Dr.
Kingston, Ontario
Canada K7M 1X7

Contact: Rick Rooney
Tel.: (613) 546 2326
Email: info@quantumenergy.ca
URL: www.quantumenergy.ca

Vergnet Canada Ltd. (Wind)
PO Box 413
Fergus, Ontario
Canada N1M 3E3

Contact: Philippe Quinet
Tel.: (519) 856-0744
Fax: (519) 856-0755
Email: vergnet.canada@sympatico.ca
URL: www.vergnet.fr

WestTech Energy Systems ***(PV & Wind)*** 1699 Ross Road, Unit #221 Kelowna, British Columbia Canada V1Z 1L8	Contact: Rick(RJ) West Tel.: 250-769-2157 Fax: 250-769-2157 Email: west1999@telus.net
Xantrex Technology Inc. (PV & Wind) 8999 Nelson Way Burnaby, British Columbia Canada V5A 4B5	Contact: Ezra Auerbach Tel.: 604.422.8595 Toll-free: 1-800-670-0707 Fax: 604.420.1591 Email: info@xantrex.com URL: www.xantrex.com

Appendix IV: On-line Utility Information about Grid-Connect & Net Metering Policies

Final list to be confirmed

BCHydro

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Green Energy

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SaskPower: http://www.saskpower.com/services/rural/smallprod.shtml

"The system owners policy is SaskPower's response to customers who wish to generate up to 100 kiloWatts (kW) of electricity for the purpose of offsetting power that would otherwise be purchased from SaskPower. This policy applies to wind and solar-powered facilities and other viable generating sources. Customers may interconnect a generating facility up to 100 kW in size to SaskPower's electricity distribution system, if standard requirements are met.

SaskPower will purchase excess energy based on our average variable cost of electricity from all sources. This rate is updated annually, using information from SaskPower's annual report.

A customer-owned generating facility must meet safety, power quality and grid system security requirements before it can be connected to SaskPower's grid. Two-way metering is also required to measure the energy the customer provides to our grid and the energy SaskPower provides to the customer."

Nova Scotia Power: http://www.nspower.ca/GreenPower/greenlinks.shtml

"Nova Scotia Power is reviewing its policies and procedures for the supplemental generation of renewable energy by residential and commercial customers. More information will soon be available."

Appendix V: Web-based Resources for Grid Connection and Renewable Energy

Organizations and Information Sources

Canadian Association for Renewable Energies (CARE): www.renewables.ca

Canadian Distributed Resources Association (CANDRA)
www.ceatech.ca/special_groups.html

Canadian Renewable Fuels Association
www.greenfuels.org

Centre for the Analysis and Dissemination of Demonstrated Energy Technologies (CADDET)
www.caddet-ee.org
An international information network for managers, engineers, architects and researchers on renewable energy and energy-saving technologies.

Centre for Renewable Energy and Sustainable Technology: www.solstice.crest.org
The Internet information service of the Renewable Energy Policy Project and the Center for Renewable Energy and Sustainable Technology (REPP-CREST)

Citizens for Renewable Energy:
www.web.ca/~cfre/index.html

David Suzuki Foundation www.davidsuzuki.org
Explores human impacts on the environment, with an emphasis on finding a balance between social, economic, and ecological needs.

Electro-Federation Canada
www.electrofed.com

Energy Efficiency and Renewable Energy Network www.eren.doe.gov/
Access to more than 60 links and 80,000 documents.

GAIA Project www.gaiaproject.bc.ca/
Includes a sustainable living bus that travels from community to community demonstrating alternative technologies.

International Energy Assocation
www.iea.org

MicroPower Connect Project
www.micropower-connect.org

Natural Resources Canada Renewable Energy Division www.nrcan.gc.ca/es/erb/reed/
This site contains information on specific projects and incentives that the Canadian Government is currently offering.

Pembina Institute for Appropriate Energy
www.pembina.org
An independent, citizen-based think tank, an activist public interest organization and a nonprofit consulting group with a solid reputation for technically reliable and innovative results.

Solarbuzz www.solarbuzz.com
Solarbuzz aims to become 'a premier source of independent and comprehensive solar energy information on the internet.' The website provides a good introduction to solar technologies and has a good news section, as well as many links to companies and other useful websites worldwide.

Solar Assocations

Canadian Solar Industries Association:
www.cansia.org
Solar Energy Society of Canada (SESCI):
www.solarenergysociety.ca
Solar Nova Scotia: www.solarns.ca
Energie Solaire Quebec: www.esq.qc.ca
American Solar Energy Society: www.ases.org

Wind Assocations

Canadian Wind Assocation: www.canwea.org
American Wind Association: www.awea.org
British Wind Assocation: www.bwea.org
European Wind Association: www.ewea.org

Microhydro Associations

Small Hydro International www.small-hydro.com/

On-line Grid-Connect policies in Canada

British Columbia

www.micropower-connect.org/members/dg connect requirements 35 kV below.pdf
www.micropower-connect.org/standards/SolarPV_Mar03.pdf

Alberta

www.micropower-connect.org/members/interconnection/Alberta Distributed Generator Interconnection Guideline, 2001 09 14, Rev. 10.pdf

Saskatchewan
www.micropower-connect.org/members/interconnection/NUG Interconnection Requirements 25 kV and Below (2000-10-17).pdf

Quebec
www.micropower-connect.org/members/interconnection/HydroQuebecE1201.pdf

US Grid-Connect/Distributed Energy Documentation

California Distributed Energy Resource Guide
www.energy.ca.gov/distgen/interconnection/interconnection.html

Interstate Renewable Energy Council (IREC):
www.irecusa.org/

New York Public Service Commission Electric Topics:
www.dps.state.ny.us/distgen.htm

New York State Standardized/Interconnection Requirements For Distributed Generators 300 Kilovolt-Amperes or Less Connected In Parallel With Radial Distribution Lines
www.dps.state.ny.us/distgen.htm

San Diego Gas & Electric Tariff Book Rules:
www.sdge.com/tariff/elec_rules.shtml
see Rule 21: Interconnection Standards for Non-Utility Owned Generation

Texas PUC DG Interconnection Manual:
www.puc.state.tx.us/electric/projects/21965/21965.cfm

International Grid-Connect Initiatives (on-line resources)

USA
www.millionsolarroofs.com

Canadian and International Industry links

Alberta Power Pool
www.powerpool.ab.ca

CANMET Energy Diversification Research Laboratory
www.cedrl.mets.nrcan.gc.ca

The Independent Electricity Market Operator (IMO)
www.theimo.com/imoweb/guides/techinterface.asp

Independent Power Producers Society of Ontario
www.ippso.org

Independent Power Producers Society of Alberta
www.ippsa.com/

Northeast Power Coordinating Council
www.npcc.org

Ontario's Independent Electricity Market Operator
www.iemo.com

Toronto Renewable Energy Co-operative
www.trec.on.ca/

Ontario Energy Network
www.ontarioenergynetwork.org

Edison Electric Institute:
www.eei.org/

international Electrotechnical Commission (IEC)
www.iec.ch

National Assoc. of Regulatory Utility Commissions (NARUC):
www.naruc.org/

National Renewable Energy Laboratory (NREL):
www.nrel.gov/

NRECA (National Rural Electric Cooperative Assoc.) TechNet DG Documentation:
www.technet.nreca.org/distribgen.asp
(Especially the "Application Guide for DG Interconnection")

NRECA DG Toolkit:
www.nreca.org/leg_reg/DGToolKit/

New York Public Service Commission Electric Topics:
www.dps.state.ny.us/electricNews.html

(Especially, the pages on Residential PV Generating Facilities and Electrical Interconnection Requirements)

Pacific Gas & Electric Tariff Book: www.pge.com/customer_services/business/tariffs
(Especially Electric Rule 21 at bottom of page: Generating Facility Interconnections)
Grid-Connect and Distributed Generation Technical Publications
Downloadable reports from IEA's PV Power Systems Group,

available at www.oja-services.nl/iea-pvps/products/download.htm

IEA Task 5. Grid interconnection of building integrated and other dispersed photovoltaic power systems:

Probability of islanding in utility networks due to grid-connected photovoltaic power systems, September 2002

Evaluation of islanding detection methods for photovoltaic utility-interactive power systems, March 2002

Risk analysis of islanding of photovoltaic power systems within low voltage distribution networks, March 2002

Grid-connected photovoltaic power systems: Power value and capacity value of PV systems, February 2002

Impacts of power penetration from photovoltaic power systems in distribution networks, February 2002

International guideline for the certification of photovoltaic system components and grid-connected systems, February 2002

PV System Installation and Grid-Interconnection Guidelines in Selected IEA countries, November 2001

Grid-connected photovoltaic power systems: Summary of IEA/PVPS Task V activities from 1993 to 1998, March 1999

Demonstration test results for grid interconnected photovoltaic power systems, March 1999

Utility aspects of grid-connected photovoltaic power systems, December 1998

Proceedings of the International IEA Workshop on Existing and Future Rules and Safety Guidelines for Grid Interconnection of Photovoltaic Systems, Zurich, 15-16 September 1997

Information on electrical distribution systems in related IEA countries, July 1996

Grid-connected photovoltaic power systems: Status of existing guidelines and regulations in selected IEA member countries, July 1996

IEA Task 7. Photovoltaic power systems in the built environment

Designing with solar power - A source book for building integrated photovoltaics (BIPV), 2002

Building Integrated Photovoltaic Power Systems. Guidelines for Economic Evaluation, October 2002

Market deployment strategies for PV systems in the built environment – An evaluation of Incentives, Support Programmes and Marketing Activities, September 2002

Potential for building integrated photovoltaics, July 2002

Reliability study of grid-connected PV systems: Field experience and recommended design practice, March 2002

Innovative Electrical Concepts, 2001

Building with PV - New product opportunities. Proceedings of the Workshop held at Amsterdam RAI, Wednesday 9 May 2001

PV in non building structures - a design guide, April 2001

Photovoltaics in the built environment. Proceedings of the 2nd World Solar Electric Buildings Conference: Sydney, Australia 8th-10th March 2000

Literature survey and analysis of non-technical problems for the introduction of building integrated photovoltaic systems, March 1999

Photovoltaic building integration concepts. Proceedings of the IEA PVPS Task VII workshop 11-12 February 1999, EPFL, Lausanne, Switzerland featuring a review of PV products

Low Impact Renewable Energy - Options for a Clean Environment and a Healthy Economy: a booklet produced by the renewables and energy efficiency sectors to address climate change. www.canwea.com/pdfs/LIRE-Options.pdf

Lost Opportunities - Canada and Renewable Energy: A press release and downloadable PDF document produced by The Pembina Institute. www.pembina.org/press/cre.htm

Generating Investment in Ontario Final report of the renewables task team, presented to Steve Gilchrist, Commissioner of Renewable Energy, Dec, 2002. (Also, see Addendum) www.canwea.com/pdfs/Investing_in_Ontario_Final_dec_11_2002.pdf

Several presentations and reports of note are included at this page. Titles include: www.micropower-connect.org/reports/index.htm

Overview of Distributed Generator Interconnection Guide and Standards Development

New Era Workshop, Calgary - MicroPower Distributed Generation in Alberta

International ElectroTechnical Commission - Standardization Management Board

"Institutional Distributed Energy Interconnection Barriers" Scott Castelaz, Vice President, Corporate Development & External Affairs ENCORP Inc.

"It Must Be Safe" Mike Mazur, Applications Marketing Capstone Turbines Corporation

"For a Safe Ontario" Ted Olechna, Provincial Code Eng., Electrical Safety Authority

"IEEE Standard P1547 - Status Report" William Feero, Consulting Eng., Reedsville, PA

"Grid-Related Interconnection Issues and Concerns – Solar PV Systems –" Gordon Howell, P.Eng., Howell-Mayhew Engineering, Inc.

Solar Publications

The Canadian Renewable Energy Guide, published by SESCI www.solarenergysociety.ca/publications.htm

Solar Information Bulletins published by CanSIA www.cansia.ca/SolarApp.html

Wind Publications

Small Wind EnergySystems, a publication of the Minnesota Department of Public Service (DPS), download in PDF at www.commerce.state.mn.us

"Wind Vision for Canada - 10,000 MW of Wind Power by 2010 for Canada." Recommendations for Achieving Canada's Wind Energy Potential. www.canwea.com/pdfs/CanWEA-WindVision.pdf

IEA publications on wind deal mainly with wind farm and large installations go to this site for IEA R&D tasks www.afm.dtu.dk/wind/iea/

Microhydro on-line Resource

System Design information and Microhydro system design course www.energyalternatives.ca/SystemDesign/hydro1.html

Appendix VI: Canadian Independent Power Producers' Survey

Canadian Independent Power Producers' Survey - Part 1

*	Indicates required information
Type of Installation*	- Select -
Contact First Name*	
Contact Last Name*	
Email address*	
Telephone One*	(area code) Ext
Telephone Two	(area code) Ext
Fax	(area code)
Company Name	
Mailing Address*	
City/Town*	
Province/Territory*	- Select Province -
Postal Code*	
Installation Location	(if different from the mailing address above)
City/Town	
Province/Territory	- Select Province -
Click here to submit	Submit

Canadian Independent Power Producers' Survey - Section 2.2

SYSTEM DESCRIPTION

For hybrid installations please rate systems from largest to smallest capacity.

SYSTEM #1: Energy Source

○ Wind ○ PV ○ BIPV ○ Microhydro

Generation Source	horizontal axis turbine If other specify

Generation Source Manufacturer

Generation Source	Model Number	Size per Unit (Plate Capacity in kW)	# of Units	Total Capacity

Static Inverter	
Inverter Manufacturer	
Inverter Model	
Is this the only inverter?	○ Yes ○ No

Net Metering Equipment (if any)

If other please specify

Canadian Independent Power Producers' Survey - Section 2.3

GRID CONNECTION DESCRIPTION

Which of the following best describes the pricing policy for excess energy generation under the net metering policy of your Utility?	○ no buy back ○ real time ○ premium to you ○ retail rate ○ avoided cost ○ other If other please explain
Which of the following best describes the net metering billing policy of your Utility?	○ monthly ○ annual ○ n/a
Which of the following standards (if any) were required by your utility for grid connection of generators with capacity > or < than 100kW?	○ IEEE ○ CSA ○ ISO ○ none ○ other If other please explain
How much per kWh does the utility offer you for excess generation ($/kWh)	per kWh
Is there a limit to the amount of excess generation the utility will purchase annually at this rate?	○ yes ○ no ○ n/a If yes what is the limit? kWh per year kWh per month
Will the utility purchase further excess generation?	○ yes ○ no If yes at what rate?
Is there a limit to the amount of excess generation the utility will purchase annually at this second tier rate?	○ yes ○ no If yes what is the limit? kWh per year kWh per month
Will the utility purchase further excess generation ?	○ yes ○ no If yes at what rate? per kWh
What percentage of your total power load is carried by your grid-connected systems?	percent

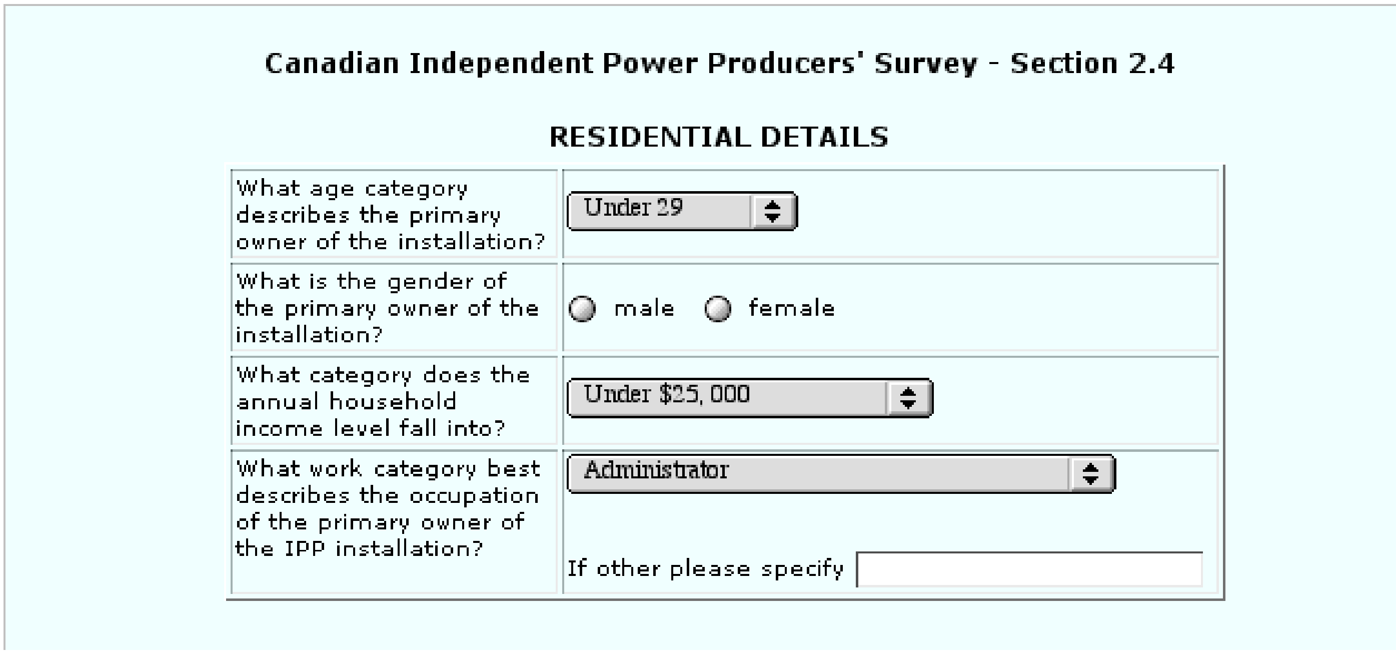
Is there a limit to the amount of excess generation the utility will purchase annually at this second tier rate?	yes no If yes what is the limit? kWh per year kWh per month
Will the utility purchase further excess generation ?	yes no If yes at what rate? per kWh
What percentage of your total power load is carried by your grid-connected systems?	percent
What were the three main factors for investing in the system? Three choices only please.	Power Quality Reliability Peak Clipping Energy Production Green Market Supply CHP (Combined Heating & Power) Demonstration Research other If other please specify
Please rate (in order of importance) the factors influencing your choice to become a renewable energy source IPP. Please rate each between 1 and 7, with #1 being the most important.	1 Anticipation of growing market share of DG 1 Anticipation of growing market share of renewables 1 Anticipation of government commitment to obtain 20% of electricity from green sources by 2005 1 Reduction of carbon emissions 1 Anticipation of financial incentive to sell carbon credits 1 Tax write-off 1 Other (please specify):
Does your utility have an official policy for net metering for systems under 100kW capacity?	yes no

Please rate (in order of importance) the types of barriers you encountered during the grid-connection process. Please rate each between 1 and 12, with #1 being the most important.	1	Safety: 'Islanding', Manual Disconnect (Utility concern for lineworker safety during power outages)
	1	Power Quality: Utility concern over voltage and frequency ranges, harmonics, 'power factor', 'DC injection', voltage flicker.
	1	No interconnection standard or policy at utility
	1	No established interconnection practices (resulting in delays because of customized application, etc)
	1	Low Commodity Price (including monopoly buy-back rates)
	1	Costs due to monopoly on power distribution including: monopoly discounting (where utility offers discount to IPP to NOT connect), backup tariffs (extra charges from the utility for the option to purchase power), uplift tariffs (extra charge to bring IPP on board) and franchise rules
	1	Market Rules including: system size limits, transmission charges, ISO rules, ancillary service charges, scheduling and loss imputation
	1	Competition Transition Charges
	1	Local permitting issues
	1	Environmental Permitting
	1	Other - please specify

Please briefly describe the details of the pivotal obstacle	
Percentage increase in cost to overcome the barrier compared to the cost of the project without the barrier.	If over 200% please specify
Other comments/concerns	
Lessons Learned and Proposed Solutions	

Please proceed to Operation Details, Section 2.4

Submit and Continue



Canadian Independent Power Producers' Survey - Section 2.4

RESIDENTIAL DETAILS

What age category describes the primary owner of the installation?	Under 29
What is the gender of the primary owner of the installation?	male female
What category does the annual household income level fall into?	Under $25, 000
What work category best describes the occupation of the primary owner of the IPP installation?	Administrator If other please specify

Canadian Independent Power Producers' Survey - Section 2.4

COMMERCIAL DETAILS

What category best describes the type of ownership of your enterprise?	Sole Proprietorship If other please specify
What year was the business started?	
What year was the grid-connected system commissioned?	
What is the total number of employees in this enterprise?	1-2
Number of employees involved in IPP operations	1-2
Is energy production the primary source of income for this enterprise?	yes no
What category of business activity best describes this enterprise	Energy Production If other specify
What category does the annual total business income fall into?	Under $500,000
What percentage of the annual income is derived from energy production?	n/a percent
If renewable energy production does not make up a portion of the actual income of the enterprise, what portion of operating costs are offset by the operation of your renewable energy systems?	n/a percent

Canadian Independent Power Producers' Survey - Section 2.4

INDUSTRIAL DETAILS

What category best describes the type of ownership of your enterprise?	Partnership If other please specify
What year was the business started?	
What year was the grid-connected system commissioned?	
What is the total number of employees in this enterprise?	1-10
Number of employees involved in IPP operations	1-10
Is energy production the primary source of income for this enterprise?	yes no
What category of business activity best describes this enterprise	Energy Production
What category does the annual total business income fall into?	Under $500,000
What percentage of this income is derived from energy production?	n/a

Canadian Independent Power Producers' Survey - Section 2.4

INSTITUTIONAL/GOVERNMENT DETAILS

What category best describes the type of ownership of your institution?	Partnership If other please specify
What year was the institution started?	
What year was the grid-connected system commissioned?	
What is the total number of employees in this institution?	1-10
Number of employees involved in IPP operations	1-10
Is energy production the primary source of income for this institution?	Yes No
Which category best describes this institution?	Elementary School If **Not-for-profit** please specify If **Other** please specify
What category does the annual total business income fall into?	Under $500,000
What percentage of this income is derived from energy production?	n/a

Thank you for taking the time to complete this survey!

Submit

Appendix VII: Utility Grid Connection/Net Metering Policy Questionnaire

See word document: regulator survey 07-28.doc