



# Grid-Connected Solar Electricity

## – Connecting to the Grid –

Energy Options Behind the Farm Gate  
Taber

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Gordon Howell, P.Eng.  
Edmonton

Phone: +1 780 484 0476  
E-mail: ghowell@hme.ca



Agriculture and Rural Development



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## Content of presentation

- Chapter 1
  - Solar Resource
  - Components
  - How does it work
- Chapter 2
  - Performance, size
  - Costs
  - Economics
- Chapter 3
  - Connecting to the grid
  - Steps to get your own solar power system
- Chapter 4 (your homework)
  - Get your electricity bills together
  - Download this presentation from [www.hme.ca/presentations](http://www.hme.ca/presentations)
  - Take steps to get your own system

# Who is who in Alberta's Electric Industry?

## Behind The Scenes

- **Electricity Generators**
  - Some 90 big electricity generating plants in the province
  - Owned by TransAlta, ATCO, ENMAX, EPCOR, Canadian Hydro Developers and many others
- **Alberta Electric System Operator (AESO)** [www.aeso.ca](http://www.aeso.ca)
  - Government agency that **manages** the transmission lines, and the wholesale electricity market
- **Alberta Utilities Commission (AUC)** [www.auc.ab.ca](http://www.auc.ab.ca)
  - The “**policeman**” that “makes sure” that everyone is co-operating
- **Alberta Department of Energy** [www.energy.gov.ab.ca](http://www.energy.gov.ab.ca)
  - Government department that makes the **policies** and **regulations** for the politicians

# Who is who in Alberta's Electric Industry?

## In Contact With You

- **Customer and Micropower System Owner**    [www.myspace.com](http://www.myspace.com)
  - most important player (that is you)
- **Electricity Delivery Companies**
  - **Runs** the delivery system,
  - **Delivers** your electricity,
  - **Maintains** the power lines, and
  - **Gets things fixed** during a power outage
- **Energy Retailers**
  - **Sells** you your electrical energy

# From where does Alberta's electrical energy come?

	Energy supply	Generating ability
● Coal	74%	49%
● Natural gas	17%	39%
● Hydro	4%	7%
● Wind	2%	4%
● Biomass and other	1%	2%
● Imports from BC and SK	2%	8%



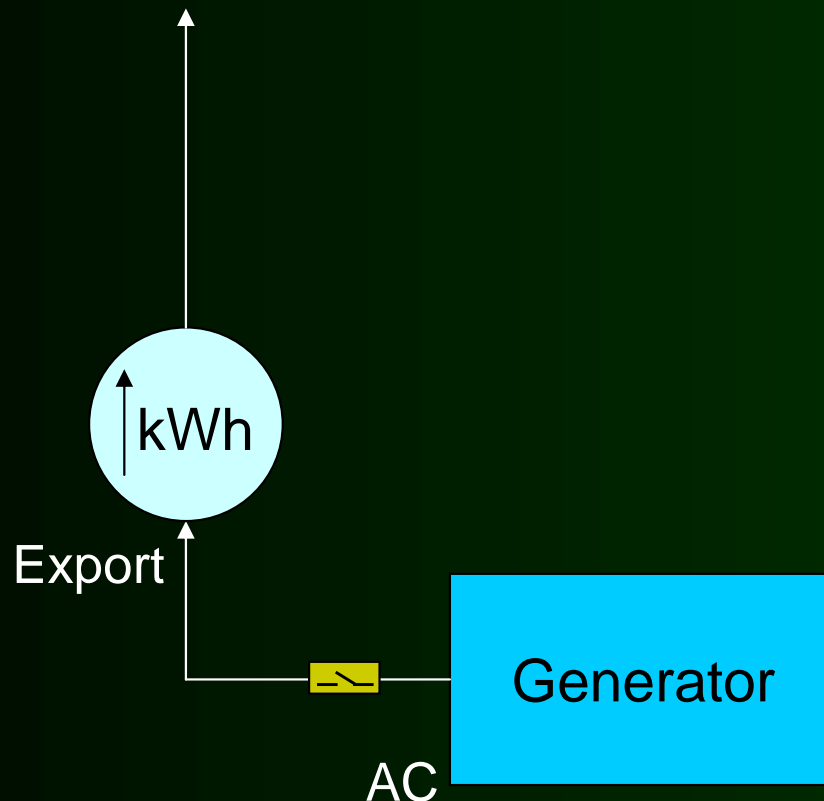
## Where does our electricity go? (as of 2006)

- Farm 3%
- Residential 16%
- Commercial 25%
- Industrial 56%
- plus
- UFE (unaccounted for energy) ~3% ?
- Transmission line losses ~8% ?
- Distribution line losses ~8% ?

# “Merchant Power” Generators

**Connection:** Electric Wires Company's distribution grid

**Energy sales:** AESO's wholesale electricity market



- Only sells to the grid.
- Services it can sell:
  - energy,
  - power (capacity),
  - spinning reserve,
  - voltage support,
  - power quality (power factor, *etc*)

Alberta's Micro-Generation regulations do not apply to Merchant Generators.

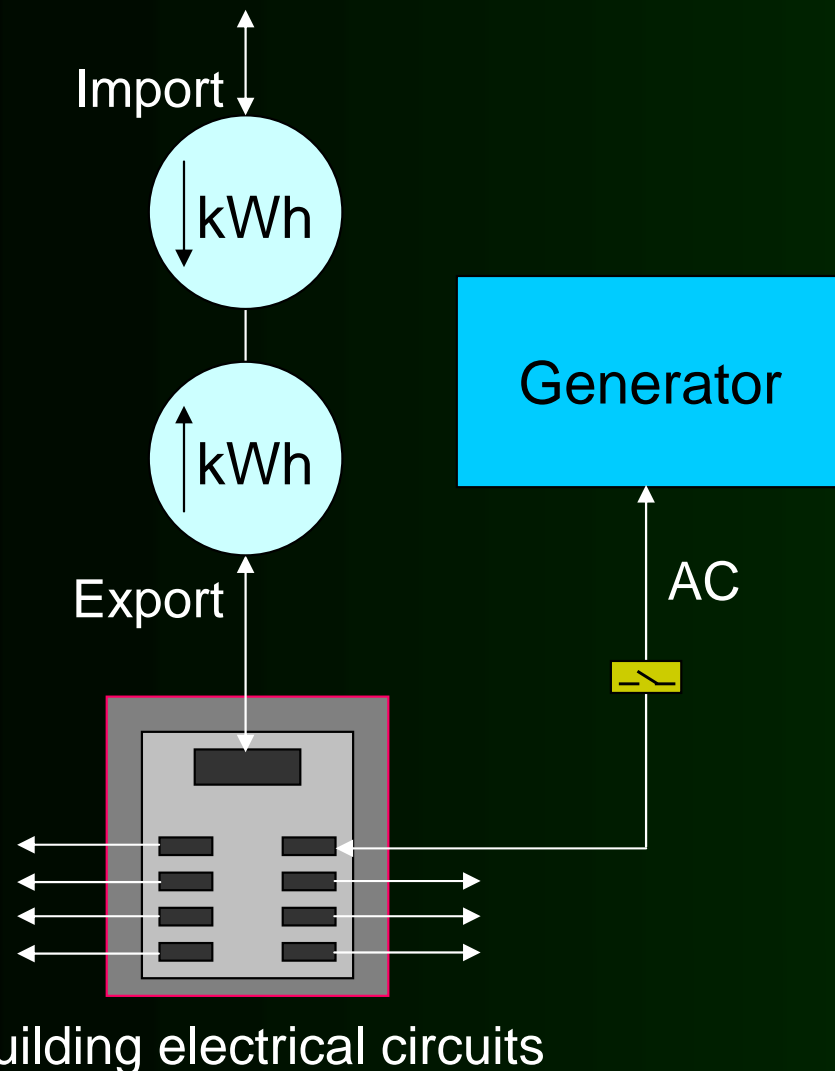
All merchant generators can always be connected under the standard connection regulations.



# “Load-Offset” Generators

**Connection:** Electric Wires Company's distribution grid

**Energy sales:** Energy Retailer (or electricity market if you are big enough)

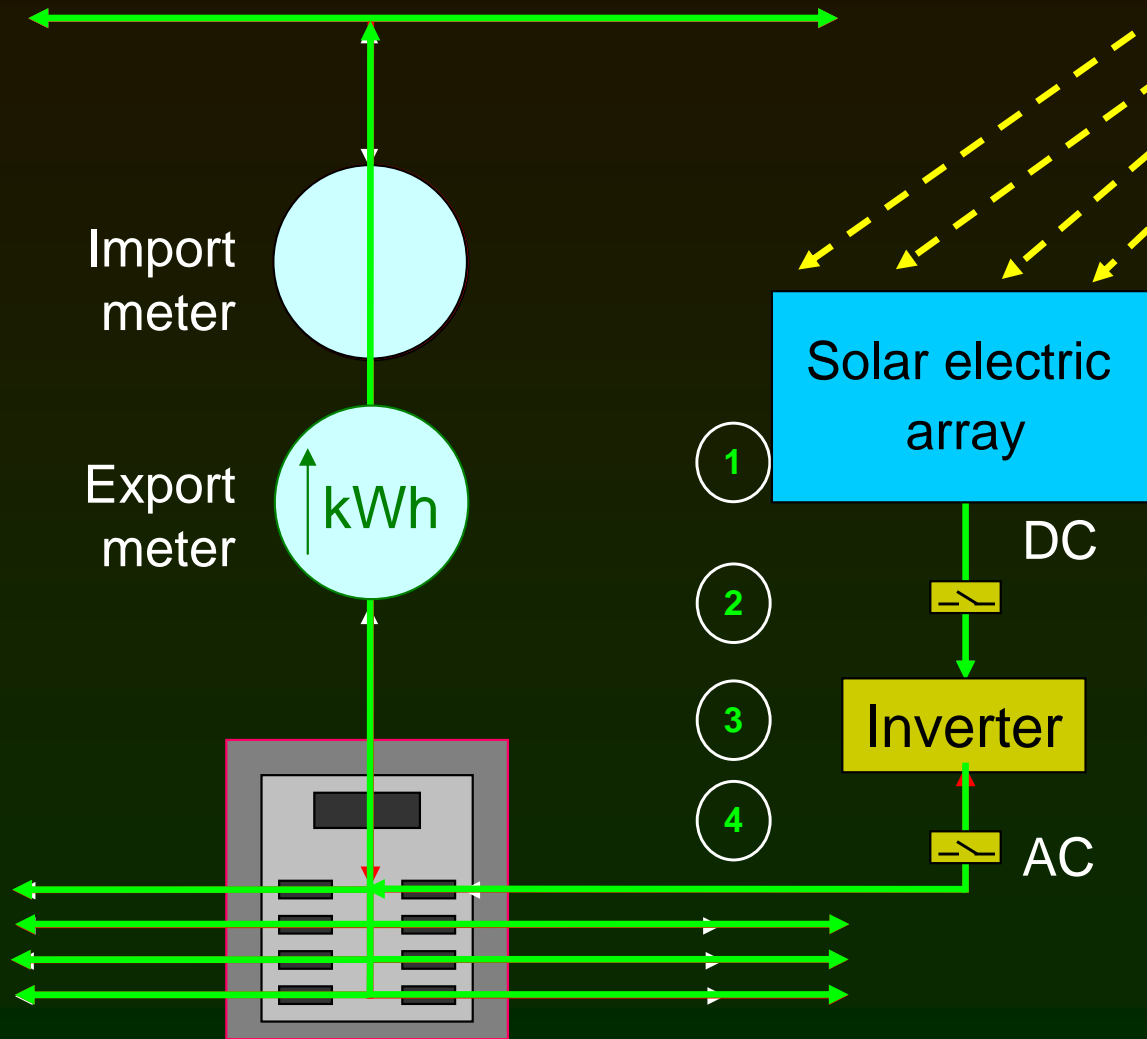


- Used to enhance site electrical security (if a battery bank or fuel generator is included).
- The generator can be considered as a back-up to the grid.
- Can sell to the grid.
- Can buy from the grid.

Alberta's Micro-Generation regulations are designed for load-offset systems only.



Electric Wires Company's  
electrical distribution grid

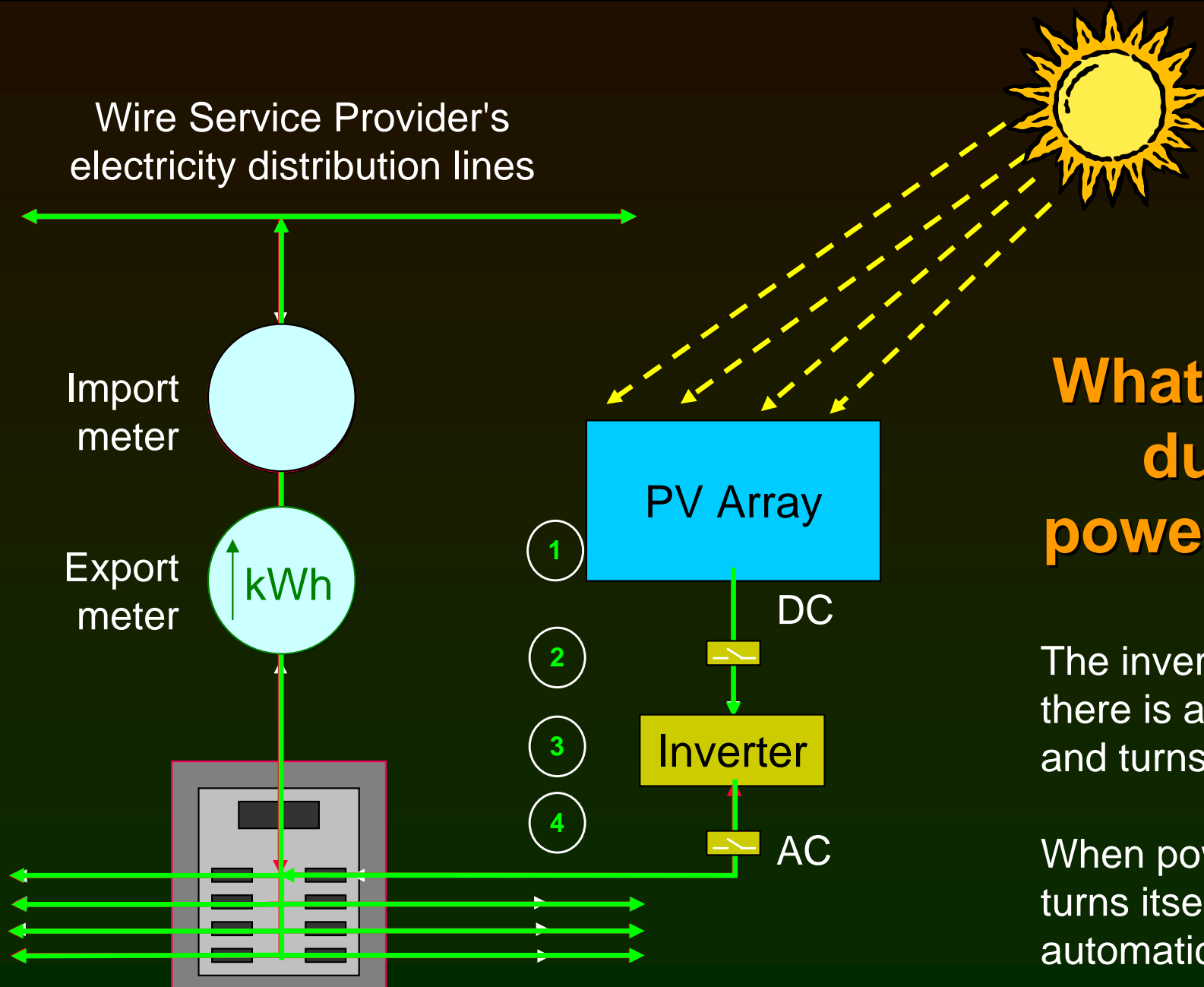


**How can you  
generate solar  
electricity into  
a house  
and also  
back into the grid?**

- Sells to the grid when there is a site surplus.
- Buys from the grid when there is a site shortage.

All electrical circuits in a house or building

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## What happens during a power outage?

The inverter senses that there is a power outage and turns itself off.

When power returns it turns itself on automatically.

All electrical circuits in a house or building

©1995-2009

Wires Owner's  
electricity  
distribution lines

Import  
meter

Export  
meter

kWh

PV Array

DC

Charge  
Controller

Battery Bank

Inverter/charger

AC

AC

Main breaker panel

Essential Circuits

How about  
energy security?

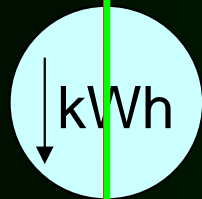
This configuration  
has a battery bank  
but it is not common.

You must skate to where the puck is going  
...not to where it is now.

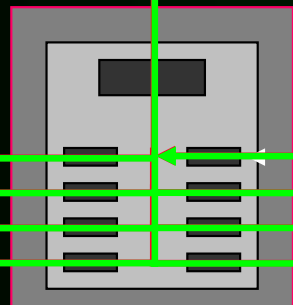
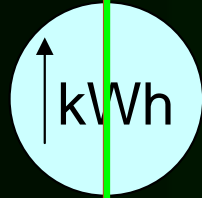
Wayne Gretzky

Wires Owner's  
electricity  
distribution lines

Import  
meter

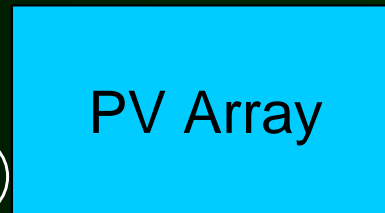


Export  
meter



Main breaker panel

1



DC

2



DC

3



4

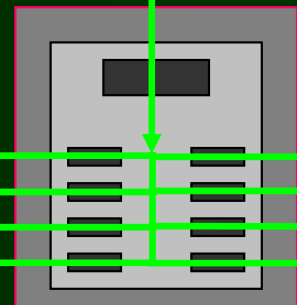
6

7



AC

AC



Essential Circuits

**During a  
power outage...**

The inverter senses that there is a power outage. It disconnects itself from the main breaker panel but continues to run the essential circuits.

# DC to AC Inverters

Fronius IG  
Austria  
grid-dependent  
2 kW to 5.1 kW

SMA Sunny Boy  
Germany  
grid-dependent  
0.7 – 6 kW

Xantrex ProSine  
Canada  
stand-alone inverter/charger  
2 kW, 2.5 kW, 3 kW

Xantrex SW  
Canada  
grid-connected  
inverter/charger  
2.5 kW & 4 kW

Inverters convert  
DC electricity (produced by the solar array)  
to AC electricity (used by any AC loads).

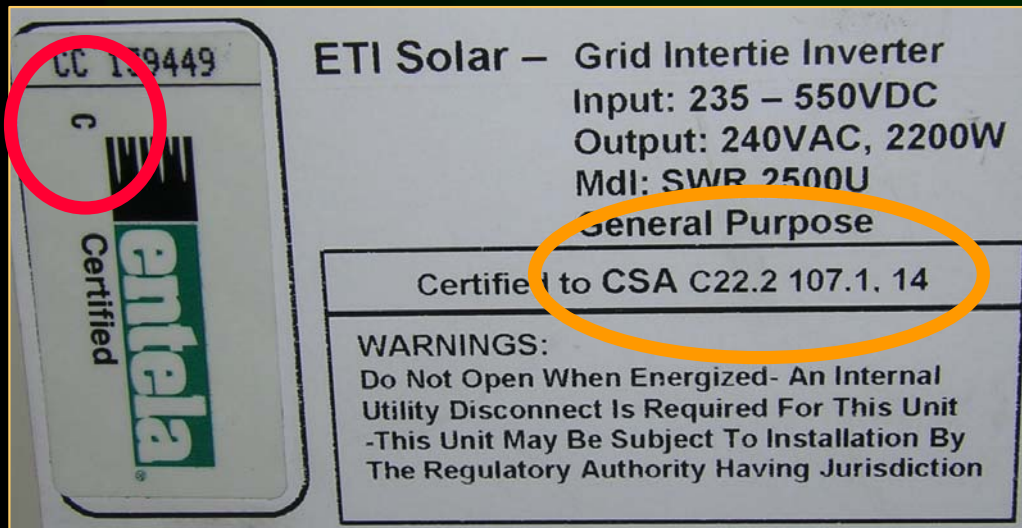
Outback FX  
America  
stand-alone inverter/charger  
2 – 2.5 kW

Xantrex GT  
Canada  
grid-dependent  
3.8 kW





## Certified Grid-Connected Inverters



- Requires certification to Clause 15 of CSA standard C22.2 No.107-1
- Some of them only say UL 1741, which is harmonised to the CSA standard
- Can be certified by a number of companies, such as CSA, UL, ETL, Enertek, TUV, KEMA



# Connecting to the Grid

## Alberta's Regulatory Process for connecting Micro-Generators (MG) to the electric grid

- brand new as of 2009 January 01
- 5 paperwork steps to receive approvals for a house-sized solar power system
  - the system is connected to your Electric Wires Company
- Another 1? step to sell your electricity
  - your electricity will be sold to your Electricity Retailer



# What are Alberta's Micro-Generation Regulations?

- 9 pages
  - (you normally don't need to read them)
- developed by Alberta Energy with comments and feedback from electric wires companies, energy retailers, the solar PV industry and others
- is part of the Electric Utilities Act. **Re-interprets** parts of the Act.
- regulates grid-connected load-offset renewable electricity generators up to 1000 kW of generating capacity
- applies everywhere except Medicine Hat
- download them from [hme.ca/mgregs](http://hme.ca/mgregs)

## APPENDIX

### Electric Utilities Act

#### MICRO-GENERATION REGULATION

##### Table of Contents

1	Interpretation
2	Notice to owner
3	Meters
4	Connection and operation
5	Load settlement
6	Exclusion from power pool
7	Compensation for micro-generation
8	Billing services
9	Application
10	Expiry

##### Interpretation

###### 1(1) In this Regulation,

- (a) "bi-directional cumulative meter" means a metering device or devices that measure the total electricity that has flowed in a circuit from one reading date to the next in each of 2 opposite directions, and that store in separate data registers the data respecting the flow of electricity in each direction;
- (b) "bi-directional interval meter" means a metering device or devices that measure the total electricity that has flowed in a circuit during defined intervals in each of 2 opposite directions, and that store in separate data registers the data respecting the flow of electricity;
- (c) "Commission" means the Alberta Utilities Commission;
- (d) "ISO" means the Independent System Operator established under section 7 of the Act;
- (e) "large micro-generation" means, subject to section 3(3), generation of electric energy from a micro-generation generating unit with a total nominal capacity of at least 150 kW but not exceeding 1 MW;
- (f) "load settlement rules" means the rules respecting load settlement established by the Commission pursuant to section 24.1 of the Act as amended from time to time;

# What do the Micro-Generation Regulations cover?

- Definitions and interpretations of key words
- The application process to be grid-connected
- The electricity metering and metering costs
- The billing and crediting of exported electricity
- The relationship dispute process
- Expiry date
  - 2013 December 31  
(which allows the government the option to also renew it or amend it)

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# Purpose of Micro-Generation Regulations

in my words...

- To simplify the grid-connection regulatory process
  - so that micropower systems deriving their electricity from renewable and alternate energy sources
  - will not have to go through the same complex (and appropriate) process as large generators in getting connected to the grid.
- To enable the new micropower technologies that are commercially available
- To not be so out-of-step with other provinces (BC, SK, ON, QU) and other countries (Japan, Germany, Austria, Spain, Italy, France, Australia...)

# What is new about it all?

- Lots
  - It is much simpler and clearer now
  - There is a good dispute resolution process
- Note that micropower systems have always (at least since 1994) been able to connect to the grid...
- It has just been that they have needed to have followed a very similar and complex process as for large generators.
- It is an excellent step for the province to take.

# What are AUC's Rules Respecting Micro-Generation?

- 3 pages
  - (you normally don't need to read them)
- AUC's rules describe the ways in which the AUC responds to and enforces the government regulations  
(which is good)
- download them from [hme.ca/mgrules](http://hme.ca/mgrules)



## Rule 024

### Rules Respecting Micro-Generation

The Alberta Utilities Commission (AUC/Commission) has approved this rule on June 17, 2008.

#### Definitions

##### 1 In these rules:

- (a) "Act" means the *Electric Utilities Act*;
- (b) "applicable owner" means the owner of an electric distribution system in whose service territory the relevant micro-generation unit and interconnection of that unit is located;
- (c) "Commission" means the Alberta Utilities Commission;
- (d) "customer" means a person purchasing electricity for the person's own use;
- (e) "inverter" means an electronic device that converts DC electricity into AC electricity;
- (f) "mini micro-generator" means a micro-generation generating unit of a micro-generator which is using an inverter, or a technology which has been proven by an independent third party to act like an inverter, and has a generation capacity of no more than 10kW of electrical energy and is generating or proposing to generate electric energy solely for the customer's own use;
- (g) "notice of application" means a notice provided by the customer to the applicable owner in accordance with section 2(1) of the regulation and in the form set out in Appendix A;
- (h) "notice of complaint" means a notice prepared by the customer and filed with the Commission in accordance with subsection 3(5) of the regulation and in the form set out as Appendix C;
- (i) "notice of dispute" means a notice prepared by the applicable owner and filed with the Commission in accordance with section 2(2) or section 4(3) of the regulation and in the form set out in Appendix B;
- (j) "owner" means the owner of an electric distribution system;
- (k) "regulation" means the *Micro-Generation Regulation*, Alta. Reg. 27/2008.



# What do the AUC's Rules cover?

- sets out the grid-connection application and approval steps
- sets out timelines for the Electric Wires Company to respond to grid-connection applications
- sets out the dispute and complaint process for
  - whether a micropower system qualifies under these regulations
  - who pays for “extraordinary” costs

## *Hydro and Electric Energy Act Requirements*

- 2 The customer must obtain approval from the Commission to construct and operate its proposed micro-generation generating unit pursuant to section 11 of the *Hydro and Electric Energy Act* unless the customer is proposing to generate within the meaning of section 13 of *Hydro and Electric Energy Act*.
- 3 The customer may use the notice of application form as its application form for *Hydro and Electric Energy Act* approval.
- 4 Section 2 of the rules does not apply to a customer who intends to install a mini micro-generator.

## Application to Supply Electric Energy

- 5 A customer who intends to supply electric energy to the interconnected electric system from a micro-generation generating unit shall complete a notice of application and shall serve the notice of application on the applicable owner.

## Qualification as a Micro-Generation Generating Unit

- 6 If, following receipt of a complete notice of application from a customer, the applicable owner considers that the customer's proposed generating unit will not qualify as a micro-generation generating unit, the applicable owner shall complete a notice of dispute.
- 7 Within 14 days following receipt of a complete notice of application, a copy of the notice of dispute shall be served by the applicable owner on the customer at the contact address and in the manner indicated in the notice of application.
- 8 The notice of dispute shall be filed with the Commission by the applicable owner within 14 days following receipt of a complete notice of application. On receipt of the notice of dispute, the Commission shall, within 30 days or such long period as the Commission considers necessary issue its decision in accordance with the provisions of subsection 2 (3) of the regulation.

## Costs of Interval Meter

- 9 If a customer has requested that a bi-directional interval meter be installed for its small micro-generation and the applicable owner declines the request, the applicable owner shall notify the customer of its decision within 14 days following receipt of this request.
- 10 The notice required under section 9 of these rules, declining the bi-directional interval meter request, shall be served on the customer at the contact address and in the

manner indicated in the notice of application, and shall indicate the contact address and manner in which the applicable owner may be served.

- 11 On receipt of a notice declining the bi-directional interval meter request, the customer may apply to the Commission for an order requiring the applicable owner to comply with the customer's request for the installation of a bi-directional interval meter by completing and filing with the Commission a notice of complaint.
- 12 The notice of complaint must be filed with the Commission within 14 days following receipt of the notice declining the bi-directional interval meter request.
- 13 A copy of the notice of complaint must be served by the customer on the applicable owner.

## Extraordinary Interconnection Costs

- 14 Following receipt of a complete notice of application from a customer, if the applicable owner considers the costs of connecting a customer's micro-generation generating unit to be extraordinary for the reasons set out in subsection 4(3) of the regulation, the applicable owner shall file a notice of dispute with the Commission within 14 days from the date in which the applicable owner finalizes its cost estimate.
- 15 A copy of the notice of dispute shall be served on the customer, by the applicable owner, at the contact address and in the manner indicated in the notice of application within 14 days from the date in which the applicable owner finalizes its cost estimate.

## General Provisions

- 16 With respect to any application or complaint filed with the Commission pursuant to the regulation or these rules, the Commission will determine the process it considers appropriate to follow given the subject matter before it.
- 17 AUC Rule 021, Settlement System Code, shall apply, as required, to all transactions conducted under the regulation.

# What is Involved to Connect to the Grid?

Two basic areas of work when connecting to the electricity grid:

1. Getting the **paperwork** done to permit its installation
  - This is on what we are focusing in this presentation...
2. Buying, **installing**, and operating the solar or microwind electric system
  - Most of this is not unique to grid-connected systems!



## Two Parts to the Paperwork Approvals

1. Getting approval to physically make electrical connection to the grid
  - Electrical connection to your Electric Wires Company
  - **Key factors of interest:** safety, power quality, flicker, harmonics, anti-islanding, power factor, phasing
2. Selling electrical energy (not power) to the grid
  - Sell to your Energy Retailer
  - **Key factors of interest:** price of energy sold to the grid



# Contacting your Wires Company

- #1. Phone your Electric Wires Company (EWC) and ask for their Micro-Generator grid-connection documents.
- The Electric Wires Company is to send you:
    - The AUC **Application Guide** with lots of great info in it;
    - The AUC **Application Form** with the EWC name on the top of it;
    - The EWC grid-connection **Operating Agreement**; and
    - The EWC **Terms and Conditions**.
  - Make sure they e-mail you all of these.
  - Do **NOT** phone:
    - your electric Energy Retailer;
    - the Alberta Government, Alberta Energy or Alberta Environment.  
I have found that you get incorrect and mis-leading information if you phone them  
– and besides, it is not with them that you need to develop your grid-connection relationship.
    - the Alberta Utilities Commission (AUC) (they know what they are doing)

# Electricity Delivery Companies



There are some 78 Electricity Delivery Companies...  
(maybe a bit fewer?)



- 2 **private** Wires Owners that are Wires Operators:
  - ATCO Electric, FortisAlberta
- 9 **municipally-owned** Wires Owners that are Wires Operators:
  - ENMAX Power, EPCOR D&T, Red Deer, Medicine Hat, Lethbridge, Cardston, Fort Macleod, Ponoka, Crowsnest Pass
- 6 **Rural Electrification Associations** that are Wires Operators
  - South Alta REA, Central Alberta REA, Battle River REA, Rocky REA, North Parkland Power REA, Lakeland REA
- 61 (?) Rural Electrification Associations that are Wires Owners only



# Costs to Connect to the Grid

- Your Electric Wires Company will let you know if there are any equipment costs to connect to the grid (such as transformers or line upgrades, *etc.*)
- For mini MG systems there should not be any costs.
- For larger systems there may be some costs (such as service or line upgrades).
- The Electric Wires Company's only choice is to send a Notice of Dispute to the AUC regarding any costs. The AUC will then decide on whether the costs are legitimate or not.
- If you have a complaint about the costs then you fill out a Notice of Complaint and submit it to the AUC for a decision.

# Why get your own solar system now?

- Why get your own solar PV system now if grid parity is coming soon...
  - important question... important answer...
- Society needs leadership in order for it to change
  - You are the most significant leader...
  - If you don't do anything, it's a sure thing that our governments won't do anything...
- You can get your own PV system now when there is sufficient supply, or in 2015 you can get in line when everyone else wants one and then wait 5 years for delivery...
- This is already happening
  - 2 years to buy a wind turbine, 5 years to buy a fuel efficient jet, some queues for solar PV

# Steps To Get Your Solar PV System .../1,2

## 1. **Getting started:** information you need to plan your system

- You can find this out from project development consultants and equipment suppliers.
- Much information is available (books, internet, designers, consultants, suppliers)
- How does it work? What can you expect from it? What is the potential for solar electricity? What new products are available?

## 2. Selecting a **designer**

- Is your supplier going to design it?
- Who is reliable? What is their service like? What are their prices?
- Do they know what they are talking about?
- What solid experience do they have?



# Steps To Get Your Solar PV System .../3,4

## 3. Designing a system

- What tilt and orientation of solar array?
- What location for the microwind turbine?
- What size to select? (solar array or microwind turbine, inverter, wiring, switches)
- What equipment brands to select?
- How much room will it take up (roof, basement, yard)?

## 4. Getting regulatory approvals

- Where from? See [hme.ca/connectingtothegrid](http://hme.ca/connectingtothegrid)
- How to fill them in?
- What costs?
- How much time to do this?



# Steps To Get Your Solar PV System .../5,6

## 5. Financing

- Using savings, income, deep pockets, or banks?
- How much does it cost? What is the price of its electricity? How does this compare with other prices?

## 6. Purchasing it

- Who is reliable? What are their prices? What is their service like?
- Do they sell equipment that is legal to sell???
- How do you know you are getting a good deal?
- **What are you buying:** separate equipment? whole system?  
energy supply? emissions reduction?
- **Only** buy solar and wind equipment from dealers who are members of
  - the Canadian Solar Industries Association [www.cansia.ca](http://www.cansia.ca) or
  - the Canadian Wind Energy Association [www.canwea.ca](http://www.canwea.ca)

# Steps To Get Your System .../7

## 7. Installing it

- How do you find a knowledgeable installer?
  - What relationship do they have with the supplier?
  - Your electrician will:
    1. Take out an electrical permit and pay the permit fees
    2. Wire up your micropower system
    3. Call for an electrical inspection
  - Notify your Electric Wires Company of completed installation
- Caution:
    - Find an electrician who knows about DC electrical wiring (for solar PV), grid-connection, and wiring electricity sources.
    - Make sure your electrical inspector is competent in knowing about equipment certification standards and installation, and the Canadian Electrical Code Sections 50 (solar PV) and 84 (grid-connection).

## Steps To Get Your System .../8,9

### 8. Commissioning it

- Does it really work? How do you know it is working?
- Hire your system designer or supplier to:
  - Turn on and commission your micropower system
  - Make sure it is working as designed and intended
- Make sure your purchase contract describes what you are wanting to buy: equipment? system? energy supply? emissions reduction? and thus what will need to be commissioned.

### 9. Operating it

- What do you need to do? – if anything!
- What maintenance is there?
- Who is supplying the documentation for your system?
- Who is supplying your operation and maintenance training?

# Celebrate and Watch Your Meter Spinning

(optional)

- Your leadership is very important...
- Invite colleagues, peers, local MPs, local MLAs, family and friends over to have a party  
to celebrate your leadership, vision, and perseverance in adding to Alberta's energy security and green advantage.
  1. Send an e-message to the media inviting them to cover your news story.
  2. Watch your micropower system generate electricity.

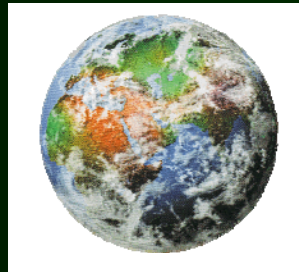
If not here...  
then where?

If not you...  
then who?

If not now...  
then when?



It's our **turn** now...  
It's our **choice**...



our wallet  
our community and children  
and the planet  
await us...





# The Tides are Changing, Everywhere...

...now, what is our task 

...where can our life make a difference 



Gordon Howell, P.Eng.  
Howell-Mayhew Engineering  
Edmonton  
Phone: +1 780 484 0476  
E-mail: ghowell@hme.ca

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One person can make a difference  
... and every person should try.

John Fitzgerald  
Kennedy