Edson and District Recycling Depot

Solar Electricity
...from Dreamer’s Paradise
...to Everyday Use

Alberta CARE
www.albertacare.org

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Gordon Howell, P.Eng.

howell-mayhew engineering, inc.
Edmonton
Outline...

- Edson and District Recycling Depot’s solar-electric systems
  - grid-connected
    - on the main building
  - off-grid demonstration
    - on the new Take-It-or-Leave-It building

- Solar electricity
  - how does it work
  - what does it look like
  - how much does it cost
  - what is happening to the technologies
• I am a professional engineer

• I am a solar electric system project developer
  – working with solar energy since 1977; solar electricity since 1983

• I develop, design, supply and commission solar electric systems
  – consulting on policy development, system feasibility, procurement
  – chair, Edmonton’s Renewable Energy Task Force

• I have no vested interests in any one solar electric technology

• I want you to make your decisions
  with your eyes wide open
  so that you can decide
  what may be right for you…

Every great movement must experience three stages: ridicu, discussion, adoption.

John Stuart Mill
Solar for the Edson and District Recycling Depot...

- Operated by the Edson and District Recycling Society
  - Anne Auriat, manager

- Main building
  - offices, recycling bins, sorting operations, baling machines

- Building electricity consumption
  ~44,000 kWh per year – same as 6 average households
South roof space

- clear view to the sun – no shading
- not optimum for solar, but definitely acceptable
- tilted at 18° or 4:12 pitch (48° to 60° is best)
- faces 26° east of south (due south is best)
- many small roof obstructions to work around
  (6 attic ventilation turbines, 2 light tubes, plumbing stack, furnace chimney)
Solar-Electric System

- 54 solar-electric modules
- 13.5 kW rated DC capacity
- Generate 12,700 kWh per year
  - = 29% of annual building consumption
  - = same amount as approx. 2 households
- Est. 55% of electricity is used on site,
  45% exported to the grid and sold
- Value of solar electricity: $1700 per year
- Reduce emissions by 8200 kg per year
  - = $124 per year (if emissions could be sold)

Graphic: Rae-Anne Wadey
Costs, Economics

- Cost approx. $47,000 for solar-electric system (TBC)
- Simple payback: 23 years (not including increase in electricity bills)
- Actual payback: 16 years
- Based on 4% increase in electricity prices
- Internal rate of return (IRR)
  - 4% if no-cost financing
  - 0% if 2.5% loan interest rate
Public Engagement

- Public engagement is very important
  - to inform people
  - to dispel myths and fears that we see being spread around by some electric utility companies
  - to help people see what really can be done

- Will have an outdoor monitor screen showing
  - Recycling Depot web site
  - performance of solar-electric system
  - public messages from the recycling depot

- Public tours, presentations
New Take-It-or-Leave-It Building…

- New Take-It-Or-Leave-It building
  - under construction

- Off-grid solar-electric system – for demonstration
  - normally for houses that are far from the electricity grid
  - for lights, microwave, coffee pot, overhead fans, outlets for equipment testing
  - consists of solar-electric modules, battery bank, charge controller, 24 VDC to 120 VAC inverter
  - budget: approx. $15,000 (TBC)
Development of the Two Solar Projects

- Anne Auriat
  - dreamed of someday having a world-class solar-electric system installed at the Edson and District Recycling facility
  - was intimidated and overwhelmed with the process as to how to develop a meaningful cost-effective programme
  - not knowing who to approach professionally.

- Since it was a demonstration for the whole region, the system needed to be of high quality and at a reasonable cost.

- The Recycling Council of Alberta connected Anne Auriat (Edson and District Recycling Society) with Gordon Howell (Howell Mayhew Engineering)

One person can make a difference ... and every person should try. — John Fitzgerald Kennedy
Funding for the Recycling Depot Solar System

- Recycling Depot solar-electric system
  - funding came from Talisman Energy
  - Recycling Depot sent a request letter
    - pitched the system as a tool for public engagement, education and promotion of solar energy
  - Talisman liked the monitoring, outreach and web site because public education has an ongoing effect for the money spent
  - have a good working relationship with Talisman Energy
    - Talisman helped out with Environment Week in Edson and with prior expansion of the Recycling Depot

You must skate to where the puck is going 
...not to where it is now. 
Wayne Gretzky
Funding for the Take-It-or-Leave-It Building

- New Take-It-or-Leave-It building (including the solar-electric system)

- Alberta Department of Culture
  Community Facility Enhancement Program (CFEP)
  - assist in fostering Alberta's communities
  - revenues from provincial lotteries
  - empower community organizations to respond to local facility enhancement needs
  - work with community groups and volunteers

- Shell Oil
  - applied locally for a grant

- Town of Edson and County of Yellowhead
  - help with on-going operational expenses and various capital projects

Our self-interest is also the self-interest of the community & environment within which we operate.
We have no choice but environmental and social responsibility.
Anonymous
Solar Electricity
Solar Electricity – used everywhere!

From calculators and watches to large generating stations.

1. **Off-grid** stand-alone
2. **Hybrid**: off-grid + generator or wind
3. **Grid-connected**
Solar Electricity

The technology is called "photovoltaics", but we only call it "PV".

Solar PV Cell

PV can generate any amount of electricity. Large PV systems = more PV modules.

Solar PV Module

Solar PV Array

5,000 modules
1000 kW

170,000 modules (200 W ea.)
34,000 kW PV array

30,000 modules, 6000 kW
Solar Photovoltaic (PV) System Components

1. Array of solar PV modules
2. DC disconnect switch
3. DC to AC Inverter
4. AC disconnect (sometimes)
5. Customer service box and panelboard
6. Electrical utility wires
7. Distribution transformer (dedicated or shared with other customers)

© 2011 Jim Dunlop Solar (modified)
PV Module Technologies

- Technologies:
  - single-crystal silicon (Si)
  - multi-crystalline silicon (Si)
  - amorphous silicon (no crystalline structure)
  - thin-film (CdTe/CdS, CIGS, CIS, GaAs..)
PV Mounting – on a Roof

- Usually mounted on aluminum rails
- Manufactured product
  - Unirac SunFrame
  - Conergy SunTop
  - Unistrut
  - Kinetic
  - Zep
  ++ many more
- Attaching to roof
  - Roof penetrations
  - Ballast weights
  ++many new products

- New products are making it simpler and cheaper including integrated module bonding and wiring
PV Array Mounting – on the Ground or other Structures

- **Ground**
- **Trellis, canopy**, or other structures
- **Wooden, metal**, manufactured
PV Array Mounting – on a Pole

- Need space for this
- Likely will never be used in a city
- Would work well on a farm
# DC to AC Inverters

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

<table>
<thead>
<tr>
<th>Inverter</th>
<th>Type</th>
<th>Country</th>
<th>Capacity Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fronius IG</td>
<td>grid-dependent</td>
<td>Austria</td>
<td>2 kW to 5.1 kW</td>
</tr>
<tr>
<td>Enphase</td>
<td>grid-dependent</td>
<td>America</td>
<td>0.2 kW</td>
</tr>
<tr>
<td>SMA Sunny Boy</td>
<td>grid-dependent</td>
<td>Germany</td>
<td>3 to 8 kW</td>
</tr>
<tr>
<td>Xantrex GT</td>
<td>grid-dependent</td>
<td>Canada</td>
<td>3.8 kW</td>
</tr>
</tbody>
</table>

Xantrex GT
Canada
grid-dependent
3.8 kW
What does it look like?
Edmonton: my house 1995

2.3 kW
36 small PV modules
1st system west of Toronto in 1995
12th system connected to the grid
Cost of system: $40,000 in 1995, $9,000 today
Generates $250 of electricity per year
Edmonton: retrofit 2001

Size: 1.44 kW. 12 AstroPower 120 W modules
Cost of solar PV system: $8,000 (today)
Generates $150 of electricity per year
36 modules, 200 W each = 7.2 kW
Cost of solar PV system: $25,000 (today)
Generates $900 of electricity per year
Edmonton: Donsdale – new

Size: 2 kW. 38 GE tile modules
Cost of solar PV system: $9,000 (today)
Generates $200 of electricity per year
Belgravia Green Net-Zero-Energy House

Size: 12.5 kW. 55 Sanyo modules
Cost of solar PV system: $40,000 (today)
Generates $2200 of electricity per year
Socialism collapsed because it did not allow the market to tell the economic truth. Õystein Dahle
Capitalism may collapse because it does not allow the market to tell the ecological truth. Exxon Norway
Edmonton: Brentwood Affordable Apartments

Size: 33 kW (2011)

Never doubt that a small group of thoughtful and committed citizens can change the world. Indeed, it is the only thing that ever has.

+Margaret Mead, Anthropologist
Edmonton: Inglewood – retrofit

Size: 2 kW. 16 AstroPower 120 W modules
Cost of solar PV system: $9,000 (today)
Generates $180 of electricity per year

Cities grow great... when old men plant trees
in whose shade they know they will never sit in.
Acreage Near Devon – new

Size: 5.6 kW. 28 Sanyo 200 W modules
Cost of solar PV system: $20,000 (today)
Generates $650 of electricity per year
Integrated into unused land rights-of-way, highways, railways, polluted lands

100 kW PV, Switzerland

100 kW PV, Italy

California
340 kW, California tracks the sun’s azimuth angle across the sky

Parking lots are becoming Solar Generating Plants
Placed on Roof-Tops

2.9 kW, Alberta Legislature

85 kW, Germany

120 kW, Berlin

1300 kW, Netherlands
30 kW, Netherlands

45 kW (340 m²), Netherlands. ©Saint-Gobain Glass Solar.

Integrated into Glazing for Natural Lighting
Classroom space

Photo Credit
Gerry Kopelow

Integrated into Curtain Walls

Inside of PV curtain wall

Photo Credit:
Corbett Cibinel Architects

Red River College, 13 kW, Winnipeg

Photo Credit:
Corbett Cibinel Architects

Photo Credit:
Corbett Cibinel Architects
Integrated into Building Structures

Railway station Canopy, Switzerland. © EPEL-LESO
Integrated into Roofing Materials

- With concrete roof tiles
- With metal roofs: Dow PowerHouse shingles in 2012
- With slate tiles
Buildings are becoming Solar Electric Plants!

- 1000 kW, Munich
- 8 kW, Red Deer
- 6000 kW, Germany

Aachen, Germany
Neighbourhoods are becoming Solar Electric Plants!
Cities are becoming Solar Electric Plants

Ota City, Japan
2200 kW, 500 homes
Fields are becoming Solar-Electric Plants

Geiseltalsee Solarpark
Germany
4000 kW, 24,864 PV modules
**Biggest in the world (2011)**

- Sarnia, Ontario
- 97 MW DC
- Will generate 120 GWh per year
- 465 ha (1150 acres)

Over 1000 systems greater than 2 MW around the world now

Biggest being planned are 2000 & 3000 MW in China and India
Declining Solar PV Prices, Increasing Grid Prices

Solar Electricity Price
- unsubsidized
- no environmental side-effects

Grid-Electricity Price
- huge environmental effects
- highly subsidized
- fossil fuelled electricity does not pay for the damage it causes to the environment and to our health care budgets

Grid parity: Utility Solar Assessment Study
since solar PV has reached price parity with the electricity grid, we need to be making all our houses, buildings and infrastructure

“solar PV ready”

- **Ready** to accommodate solar PV in the near future
- Ensure that the design decisions being made now do not prevent or encumber solar PV being installed in 10 short years…

Where there is a will, there is a way…
It's not about economics. It is about a will.
America’s SunShot Programme: $1/W by 2020

Reaching cost reduction targets will require advances in all PV system components

2010 (estimated) $3.40
- Power Electronics $0.22
- BOS/Installation $1.48
- Module $1.70

2016 (current goal) $2.20
- Power Electronics $0.18
- BOS/Installation $0.97
- Module $1.05

$1/Watt
- Power Electronics $0.10
- BOS/Installation $0.40
- Module $0.50

Utility System (Non Tracking) Cost Example

Credit: America’s Department of Energy
Solar PV is a Booming Global Industry

48% per year growth for 19 years

Worldwide production of solar PV cells [MW]

Credit: America’s Department of Energy
Energy and Emissions Payback

- Solar PV is zero-emission electricity.

- Payback for emissions and energy used in its manufacture, transportation and installation:
  - 1 to 4 years depending on its application.

In contrast, what is the energy payback for a coal- or gas-fired electric generating station?

(no-one seems to ask... but it is just as important... if you build them too fast then you increase your energy issues, not decrease them)
Recommendations

- Solar PV is now an affordable and economically-viable source of electrical energy

- Key elements in doing it correctly:
  - Awareness and learning
    - to ensure people don’t get led astray – it has to be done well
  - Demonstration project
    - very little experience with the technology (450 systems in Alberta)
    - People need to understand the economics (not get rich overnight)

- Need municipalities to support:
  a) incentives for residents & businesses to install solar electricity
  b) a solar-electric system of their own

- See Edmonton’s Renewable Energy Task Force report for ideas on how to facilitate renewable energy in your own municipality
Solar Photovoltaic Energy
Simple – Clean – Reliable – Affordable
Local ... Equitable ... Democratic ... Now

We welcome any feedback, questions, suggestions, comments and challenges to anything we present.

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

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