

## Company Profile – Solar Photovoltaic (PV) System Services

Howell·Mayhew Engineering (HME) specializes in the design and development of solar electric generating (photovoltaic or PV) systems. Solar PV systems convert sunlight directly into electricity using solid-state semiconductor-based solar PV cells.

Mr. Gordon Howell, BScEE (1975, Alberta), P.Eng., Managing Partner, is the lead engineer responsible for solar PV systems.

We have key contacts and detailed knowledge of the Canadian and international solar PV industry and its technology. We provide our clients with all the services necessary to develop and promote PV systems and projects. Our detailed evaluation work gives our company important experience and knowledge in how systems actually work under rigorous field conditions. Our expertise and experience in connecting PV systems to the electrical grid allow projects to proceed without regulatory delays. Our design projects have included Alberta, BC, Yukon, and Northwest Territories. We are often given projects that have very challenging designs, schedules, logistics and regulatory issues.

Our solar PV development services include:

- **Turn-key** PV system development, implementation, definition, co-ordination, consulting, promotion, project management, system design review, feasibility studies, due diligence evaluation, 3<sup>rd</sup>-party review of PV proposals, price and product procurement and evaluation, system inspection, commissioning, economic analyses;
- **Full system** electrical design, working with architects and designers to integrate PV into buildings, envelopes, cladding and features (termed BIPV) in innovative ways; working with electrical engineers to integrate PV systems into buildings' electrical systems, working with structural engineers to integrate PV arrays into a building's structure, selecting and working with electrical and civil-works contractors to install PV systems and working with electric utility companies to integrate PV systems into their service territory;
- **Equipment specifications**, procurement, sales and supply, preparation and acquisition of electrical utility regulatory approvals, acquisition of development and building permits, development of regulations, codes, standards, policies and protocols;
- **Energy performance** simulation, field performance instrumentation and monitoring, data interpretation, and analysis of system and component performance;
- **Barrier identification** and resolution, stakeholder value analysis, development and writing of case studies, preparing and presenting training material, operating manuals, reports, promotional speeches, and other material for public relations, project development, and the media; and
- **Public outreach** including presentations on solar PV to any groups, any size.

In 1994, EPCOR Utilities hired HME to develop a 2.3 kW grid-dependent PV system on HME's Cold Climate Solar House (and engineering offices) in Edmonton to gain experience in implementing and operating this type of system, and to identify the barriers to the connection of PV systems to the grid. This grid-connected PV system was the 1<sup>st</sup> west of Toronto, the 12<sup>th</sup> in Canada and the 4<sup>th</sup> on a house in Canada. Today, this house is likely Canada's 1<sup>st</sup> net-zero electricity home as it generates 100% of its electricity consumption on an annual basis.

## Selected Representative Solar PV Projects

HME has been involved in various aspects of 136 PV projects over 34 years including the design of 58 projects and obtaining 69 grid-connection approvals.

HME has provided the following PV services to the selected projects below, shown using the letter codes: D (development), M (performance modelling), E (engineering design), S (specification writing), R (regulatory approvals), T (tendering process), P (equipment procurement), Q (equipment supply), I (system installation), C (commissioning) and A (performance analysis).

Projects: grid-connected PV systems on commercial buildings

- 43 kW, university, Edmonton (in progress) (DMERICA)
- 238 kW parking canopy plus 398 kW rooftop, shopping mall, Edmonton (in progress) (DMESRTCA)
- 456 kW, office building, Edmonton (in progress) (DMESRTCA)
- 128 kW, school, Spruce Grove (in progress) (DMESRTCA)
- 200 kW, school, St Albert (in progress) (DMESRTCA)
- 58 kW + 50 kW, university, Edmonton (in progress) (DMESRTICA)
- 13 kW + 13 kW, community hall, Edmonton (2015, 2016) (DMERPQICA)
- 122 kW, Canada's largest building-integrated PV system, performing arts centre, Camrose (2013) (DMERPQICA)
- 154 kW, office building, Edmonton (2013) (ERC)
- 18 kW + 17 kW, recycling centre, Edson, Alberta (2013, 2016) (DMERPQIA)
- 21 kW, building-integrated PV on a research building, Edmonton (2013) (DMERPQICA)
- 4 kW, planetarium, Watson Lake, Yukon (2011) (DMERPQIC)
- 12 kW, research building, Old Crow, Yukon (2010) (DERPQC)



Camrose Performing Arts Centre



UofA Balmoral Cyclotron



Evansdale Community League



## HME Services and Projects Profile – Solar Photovoltaic (PV) Systems

- 3 kW, national park operations centre, Old Crow, Yukon (2008) (DERPQC)
- 3 kW + 2 kW, nature centre, Red Deer (2003, 2006) (DERPQI)

Projects: grid-connected PV systems on family houses

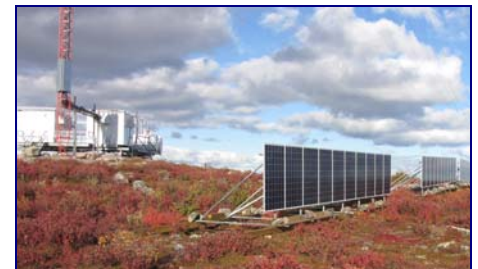
- 2 x 10 kW, Edmonton (2017) in progress (DMERPQICA)
- 10 kW, Edmonton (2014) (DMERPQCA)
- 9 kW, Grand Forks BC (2014) (DMERPQA)
- 5 kW, rural Alberta (2014) (DMERPQIA)
- 8 kW, Vernon BC (2013) (DMEPQ)
- 12 kW, Edmonton (2012) (DMERPQICA)
- 21 kW, Slave Lake, Alberta (2011) (DMERPQICA)
- 4 kW, rural Alberta (2011) (DMERPQ)
- 4 kW, Edmonton (2010) (DMERPQIC)



Grand Forks house

Projects: off-grid PV systems

- 8 x 15 kW, very-challenging remote telecom sites, Yukon and NWT (2013, 2014) (DMEPSIA)
- 7 kW, house, rural Alberta (2011) (M)
- 2.8 kW, house with grid-connection, rural Alberta (2011) (DMERPQIC)
- 200 W, truck weigh scale, Edmonton (2002) (DEPQ)
- 200 W, two PV lighting systems at waste transfer station, Edmonton (2001) (DEPQI)



MacKay Lake telecom, NWT

Project: Riverdale NetZero Project, Edmonton (2006-2010)

- set up and work with the project team to develop one of Canada's first 12 net-zero energy houses (DMRA)
- modelled the net zero energy goal and solar PV system, obtained grid-connection approvals, managed media outreach, gave presentations and tours.



Riverdale NetZero Project

Project: Engineering Analysis, System Modelling Validation, and Monitoring of PV Systems (1988)

- modelled the performance of 14 PV systems installed in remote locations across Canada
- systems included off-grid PV, PV-Diesel hybrid, grid-connected, PV water pumping
- installed monitoring, collected and analysed performance data, compared with simulations



### PV Outreach – Committee Work

Committee: Eco-Solar Home Tour (2000, ongoing) [www.ecosolar.ca](http://www.ecosolar.ca)

- organise an annual public tour of energy efficient and solar homes in the Edmonton area

Committee: Canadian Standards Association [www.csa.ca](http://www.csa.ca)

- vice-chair, Integrated Committee on PV (2013, ongoing)
- represent the PV industry on the CSA's Canadian Electrical Code Section 50 (Solar PV) (2000 to 2011)
- represent the PV industry on the Technical Committee to develop a DG interconnection standard. (2003 to 2005)
- represent the PV industry on the Renewables Committee (TC c420) (2002 to 2004)
- represent the PV industry on the Strategic Committee on Performance, Energy Efficiency, and Renewables (SCOPEER, SCC c400) (2000 to 2004)

Committee: International Electrotechnical Commission (IEC) (1990 ongoing) [www.iec.ch](http://www.iec.ch)

- represent Canada on the PV Systems Working Group (WG3) of the IEC's Solar PV Technical Committee (TC82), to develop international PV standards
- represent Canada on the PV Glossary Working Group (WG1) of TC82, to develop international standards for the definition and use of PV technology terms

Committee: Clean Air Strategic Alliance (2003-2006)

- participate in the Renewable and Alternative Energy Project Team
- participate in the Electrical Efficiency and Conservation Project Team

Committee: International Energy Agency (2002-2003) [www.iea-pvps.org](http://www.iea-pvps.org)

- represent Canada on the PV Power System (PVPS) Programme, Task I (market data collection and analysis, and PVPS information dissemination)
- sponsored by Natural Resources Canada, CANMET Energy Technology Centre-Varennes

Committee: Alberta Safety Codes Council (2002)

- represent PV on the Task Force on MicroPower and the Canadian Electrical Code

Committee: Alberta Distributed Generation (DG) Interconnection Committees (2001, 2002)

- represent the PV industry on the Policy Committee
- represent the PV industry on the Technical Committee
- chair of the Micro-DG Sub-Committee to simplify the DG guidelines for the interconnection of micro-DG systems

Committee: MicroPower Connect (2001-2004) [www.micropower-connect.org](http://www.micropower-connect.org)

- represent the PV industry to develop Canadian DG interconnection guidelines
- represent the PV industry to develop net metering standards



## PV Outreach – Presentations, Publications and Papers

HME publishes a monthly update of tables and graphs on the increase in solar PV systems in Alberta, using data obtained from Alberta Energy.

Gordon Howell has delivered 482 talks to technical and public groups over the last 22 years on solar PV, solar thermal, net-zero-energy houses and connecting to the grid.

Gordon Howell has taught 18 public courses on an introduction to solar energy and given 41 presentations to schools.

Brostrom, M., and Howell, G. 2008. *Challenges of Designing and Building a Net Zero Energy Home in a Cold High-Latitude Climate*. Proceedings of the 3<sup>rd</sup> International Solar Cities Congress. Adelaide, South Australia.

Howell, G. and P. Robertson. 2004. *Micropower Grid-Interconnection Manual for Alberta*. Proceedings of SESCO 2004, the 29th Annual Conference of the Solar Energy Society of Canada, Inc. Waterloo, Ontario.

Sheriff, F., and G. Howell. 2003. *International Energy Agency PV Power Systems Agreement: A Review of 2002 Achievements*. Proceedings of the SESCO 2003 Conference, the 28<sup>th</sup> Annual Conference of the Solar Energy Society of Canada, Inc. Kingston, Ontario.

Howell, D.G. 2000. *PV GAP – Managing Investment Risk with PV Quality Manuals*. Article in the Canadian Solar Industries Association Newsletter. Spring 2000. Ottawa, Ontario.

Tamizhmani, G., Dignard-Bailey, L., Thevenard, D., and D.G. Howell. 1998. *Influence of Low-light Module Performance on the Energy Production of Canadian Grid-Connected PV Systems*. Proceedings of the Renewable Energy Technology in Cold Climates '98 Conference, the 24th Annual Conference of the Solar Energy Society of Canada, Inc. Montréal, Québec.

Thevenard, D., Ross, M., and G. Howell. 1998. *A Checklist for PV System Monitoring*. Proceedings of the Renewable Energy Technology in Cold Climates '98 Conference, the 24th Annual Conference of the Solar Energy Society of Canada, Inc. Montréal, Québec.

Nodelman, J.R., Tupper, T.J., Dinwoodie, T. and D.G. Howell. 1997. *EPCOR'S Building-Integrated, Grid-Connected PV System in Edmonton*. Proceedings of the 23rd Annual Conference of the Solar Energy Society of Canada, Inc. Vancouver, BC.

Howell, D.G. and C.R. Price. 1997. *New Standards Prepare the Way for Business Opportunities in Photovoltaics*. Proceedings of the 23rd Annual Conference of the Solar Energy Society of Canada, Inc. Vancouver, BC.

IEC 61724. *Photovoltaic system performance monitoring – Guidelines for measurement, data exchange and analysis*. Published standard of the International Electrotechnical Commission's Technical Committee 82 (Solar Photovoltaics). 1998. 38 pg.

Howell, D.G., S. Marsh and M. Oprisan. 1996. *Edmonton Power's Grid-Connected Photovoltaic System*. Proceedings of the 22nd Annual Conference of the Solar Energy Society of Canada, Inc. Orillia, Ontario.



## HME Services and Projects Profile – Solar Photovoltaic (PV) Systems

Howell·Mayhew Engineering. 1996. *Engineering Analysis, System Modelling Validation, and Monitoring of Photovoltaic Energy Systems*. Prepared for Natural Resources Canada/CANMET/Energy Diversification Research Laboratory. Varennes, Québec. 480 pp.

Usher, E., G. Jean and G. Howell. 1994. *The Use of Photovoltaics in a Northern Climate*. Solar Energy Materials and Solar Cells 34. pp 73-81.

Robinson, A.M. and D.G. Howell. 1991. *Instantaneous Versus Average Solar Radiation Measurements*. Proceedings of the 17th Annual Conference of the Solar Energy Society of Canada, Inc. Toronto, Ontario.

LaPlace, R.L., D.G. Howell and A.M. Robinson. 1991. *Photovoltaic/Diesel Generator Hybrid Power Systems for the North*. Presented at the 1991 International Symposium on Cold Region Development. Edmonton, Alberta.

### PV Outreach – Social Media

Operate the following Facebook groups for the purpose of providing a forum for people to ask questions, get them answered and discuss solar topics of interest.

- Solar Energy in Edmonton [www.facebook.com/groups/solaredmonton](http://www.facebook.com/groups/solaredmonton)
- Solar Energy in the Yukon [www.facebook.com/groups/solarenergyintheyukon](http://www.facebook.com/groups/solarenergyintheyukon)
- Net-Zero-Energy Homes in Edmonton [www.facebook.com/groups/nzehomesinedmonton](http://www.facebook.com/groups/nzehomesinedmonton)
- Micro-Generation in Alberta [www.facebook.com/groups/albertamicrogen](http://www.facebook.com/groups/albertamicrogen)
- Solar PV Installers in Alberta [www.facebook.com/groups/solarpvinstallersinalberta](http://www.facebook.com/groups/solarpvinstallersinalberta)
- Solar PV Farms in Alberta [www.facebook.com/groups/solarpvfarms](http://www.facebook.com/groups/solarpvfarms)
- Solar PV on Alberta's Farms [www.facebook.com/groups/solarpvonalbertafarms](http://www.facebook.com/groups/solarpvonalbertafarms)
- Solar Energy In Alberta's Aboriginal Communities [www.facebook.com/groups/1732997693681140](http://www.facebook.com/groups/1732997693681140)
- Lasso the Sun -- Careers in Alberta's Solar Patch [www.facebook.com/groups/lassothesun](http://www.facebook.com/groups/lassothesun)
- Workers in Alberta's Solar Patch [www.facebook.com/groups/workersinthesolarpatch](http://www.facebook.com/groups/workersinthesolarpatch)
- Alberta Solar Project Bids and Quotes [www.facebook.com/groups/albertasolarbids](http://www.facebook.com/groups/albertasolarbids)
- Your Electricity Bill -- Whazzup with it [www.facebook.com/groups/myelectricitybill](http://www.facebook.com/groups/myelectricitybill)

### Corporate and Professional Membership

Member: The Association of Professional Engineers and Geoscientists of Alberta (APEGA) [www.apega.ca](http://www.apega.ca)

Member: Canadian Solar Industries Association [www.cansia.ca](http://www.cansia.ca)

Member: Solar Energy Society of Alberta [www.solaralberta.ca](http://www.solaralberta.ca)