

## Company Profile – Solar Photovoltaic (PV) Systems

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

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 that few others have: in how systems actually work under rigorous field conditions. Our expertise and experience in interconnecting PV systems to the electrical grid allow projects to proceed without delay.

Our solar PV consulting services include:

- Consulting, project management, system design review, feasibility studies, price and product procurement and evaluation, turn-key system development and implementation;
- Technology assessment, product and system acceptance testing, preparation of utility interconnection documentation, regulatory approvals, codes and standards interpretation, and system commissioning;
- Working with architects to integrate PV into buildings (termed BIPV) in innovative ways; with electrical consultants to integrate PV into buildings' electrical designs, and with electrical contractors to install PV;
- Performance simulation, monitoring system design, installation, acquisition of data, and analysis of system and component performance;
- Barrier identification and resolution, stakeholder value analysis, case study development and writing, preparing and presenting training material, operating manuals, reports, promotional speeches, and other material for PR, project development, and the media;
- Review and development of design and evaluation software.

Howell·Mayhew Engineering's offices are in the company's Cold Climate Solar House in Edmonton – a facility designed and constructed in which to experience and evaluate the performance and characteristics of energy efficient housing and PV systems. We live and work with the technology in which we consult.

In 1994, HME partnered with EPCOR Utilities to develop a grid-connected PV system on the Cold Climate Solar House to gain experience in implementing and operating this type of system, and to identify the barriers to this application of the technology. This system incorporates 2.3 kW of roof-mounted PV modules with a grid-dependent inverter connected to the house's electricity distribution panel. In bright sun, the system backfeeds into the power lines and sells to the Alberta Electric System Operator's Energy Trading System. 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.

Our projects have ranged across Canada and into the Arctic. We have considerable experience in field instrumentation of PV systems and energy efficient houses, and in implementing all phases of data acquisition and system performance evaluation in remote sites and in cities.

Mr. Gordon Howell, BScEE (1975, Alberta), P.Eng., Partner and Senior Project Development Engineer, is the lead engineer responsible for PV systems.



## Selected Solar PV Projects

Project: Riverdale NetZero Project (2006-)

- Work with the project proponents to develop the house. Model the solar photovoltaic system and the net zero energy characteristics, obtain grid connection approvals, work with the media, give presentations.



Avalon Net Zero Electricity Home

Project: Avalon Master Builder (2005-2006)

- Model the performance of the Discovery II Net Zero Electricity show home in Red Deer using RETScreen, HOT-2000 and Excel estimates.

Project: Peter Bull residence, Edmonton (2004-2005)

- Prepare the documentation for, provide consulting on, and obtain grid-interconnection approvals for a 2.5 kW grid-interactive residential PV system with battery bank.



Peter Bull residence

Project: Stephan Welk residence, Sundre (2004)

- Prepare the documentation for, provide consulting on and obtain grid-interconnection approvals for a 1.8 kW grid-dependent residential PV system.

Project: Normandeau Cultural and Natural History Society, Red Deer (2003-2004, 2006)

- Develop, manage, design, procure, and install a 2.5 kW grid-dependent PV system on the Kerry Wood Nature Centre.
- Expand this system to 5 kW.



Kerry Wood Nature Centre

Project: Eric Steeden residence, Edmonton (2003)

- Develop, manage, procure and install a 2 kW grid-dependent residential PV system.

Project: EcoMark Ltd, Edmonton (2003-2004)

- Develop and prepare a micropower distributed generation interconnection manual for Alberta.

Project: Public Works and Government Services Canada, Edmonton (2003)

- Study of the feasibility of grid-connected PV systems on a government building in Edmonton.



Eric Steeden garden



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- Project: Alberta Environment, Edmonton (2002-2003)
- Prepare the documentation and obtain grid-interconnection approvals for a 2.9 kW Alberta Government Centre PV system.



Alberta Government Centre

- Project: Natural Resources Canada, CANMET Energy Technology Centre-Varenes, Montréal (2002 ongoing)
- Represent Canada on the International Energy Agency's PV Power System programme Information Dissemination Task (Task I).

- Project: Interconnection of the Spruce Meadows Solar PV system, Calgary (2002)
- Prepare the documentation and obtain grid-interconnection approvals for a commercial 2.5 kW grid-dependent PV system.



Spruce Meadows

- Projects: City of Edmonton (2001)
- Supply, install, and commission a PV system at the Composter Facility's Proof Load Scale.
  - Supply and commission two off-grid PV lighting systems at the Waste Transfer Station.

- Project: EPCOR Utilities' Grid-connected Commercial PV System, Edmonton (1996-2001)
- Provide PV consulting and project development services on a 13 kW building-integrated grid-dependent PV system on the roof of EPCOR's 23-storey headquarters.



EPCOR's headquarters

- Project: Joint HME/EPCOR Utilities' Grid-connected Residential PV Demonstration System, Edmonton (1995-ongoing)
- Manage, design, procure, install, instrument, monitor, and evaluate the performance of a 2.3 kW grid-dependent PV system on HME's Cold Climate Solar House.
  - Identify and evaluate the barriers to implementing grid-connected PV systems.



Cold Climate Solar House



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

- Simulate the performance of 14 PV systems installed in remote locations across Canada. System configurations included PV stand-alone, Diesel hybrid, PV-Diesel hybrid, grid-connected, and batteryless PV water pumping.
- Install monitoring systems at each site; collect, and analyse the performance data; and compare it with the simulations.

Project: PV/Diesel System Monitoring at the Tarryall Resort (1986)

- Monitor and evaluate the performance of a PV-Diesel hybrid system at the Tarryall Resort fishing lodge near Kenora, Ontario.

Project: Development of Advanced PV System Design, Simulation and Optimization Software (1990)

- Develop software for sizing and optimizing remote power supply systems including PV charging, genset charging, PV-genset hybrid charging, and direct genset operation.

Projects: Miscellaneous

- Brief survey of the distribution structure for PV powered temporary road signs in Alberta.
- Author of a chapter on PV monitoring for Natural Resources Canada's *PV Design Manual*.
- For the 1999 Edition of the Canadian Renewable Energy Guide, author of Chapter 3, the Case Study for EPCOR's Capital Square, and the Case Study for the HME PV system.

### Committee Work

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.iaa-pvps.org](http://www.iaa-pvps.org)

- Represent Canada on the PV Power System (PVPS) Programme, Task I (market data collection and analysis, and PVPS information dissemination)
- Participation sponsored by Natural Resources Canada, CANMET Energy Technology Centre-Varenes and the Program on Energy Research and Development (PERD)

Committee: Alberta Safety Codes Council (2002)

- Represent PV on the Task Force on MicroPower and the Canadian Electrical Code
- Participation sponsored by Howell-Mayhew Engineering

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
- Participation sponsored by Climate Change Central [www.climatechangecentral.com](http://www.climatechangecentral.com)

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
- Travel expenses sponsored by NRCAN, CANMET Energy Technology Centre-Varenes



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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
- Empower other cities and towns to promote their own leaders and examples of energy efficiency, solar, and sustainability.

Committee: Canadian Standards Association (2000 ongoing) [www.csa.ca](http://www.csa.ca)

- Represent the PV industry on the Strategic Committee on Performance, Energy Efficiency, and Renewables (SCOPEER, SCC c400)
- Represent the PV industry on the Renewables Committee (TC c420)
- Represent the PV industry on the Canadian Electrical Code Section 50 (Solar PV)
- Represent the PV industry on the Technical Committee to convert the MicroPower Connect DG interconnection guide into a CSA standard.

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 standards for safety, reliability, testing, and operation of PV systems and components.
- Represent Canada on the PV Glossary Working Group (WG1) of TC82, to develop international standards for the definition and use of PV technology terms.
- Canadian Sub-Committee on TC82
- Co-author, IEC Project 61724, "*Photovoltaic System Performance Monitoring – Guidelines for Measurement, Data Exchange and Analysis*".
- Project leader, IEC Project 61723, "*Guidelines for Grid-Connected Photovoltaic Systems Mounted on Buildings*".
- Project leader, IEC Project 61836-Ed. 2.0, "*Solar photovoltaic energy systems – Terms and symbols*".

### PV Publications/Papers/Speeches

Has given 232 talks to various technical and public groups on solar PV and solar thermal systems.

Taught 18 public courses on an introduction to solar energy, given 41 school presentations.

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*.



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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.

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.

Howell, D.G., R.L. LaPlace and A.M. Robinson. 1991. *Remote PV/Genset Hybrid Power Systems*. Proceedings of the 17th Annual Conference of the Solar Energy Society of Canada, Inc. Toronto, Ontario.

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.

### Corporate and Professional Membership

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

Member: Alberta Electric System Operator's Energy Trading System [www.aeso.ca](http://www.aeso.ca)

Member: Solar Energy Society of Canada [www.solarenergysociety.ca](http://www.solarenergysociety.ca)

Member: APEGGA [www.apegga.com](http://www.apegga.com)