Professional *Curriculum Vitae*

D. GORDON HOWELL, P.Eng.

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EXPERIENCE SUMMARY (2008)

- 20 years experience in writing interactive design, data acquisition, and data analysis software.
- 24 years research experience in monitoring and evaluating energy efficiency and renewable energy, specializing in residential buildings and solar electric power systems (photovoltaics or solar PV).
- 18 years experience in the design and installation of computer-based data acquisition systems, specializing in remote, long-term, reliable, unattended systems.
- 27 years experience in giving public lectures and courses on energy efficiency, solar PV systems, and solar heating systems.
- 17 years experience in working on international committees that write PV systems' standards.
- 12 years experience in working on identifying and resolving barriers to the development of solar PV systems.
- 14 years experience on the design and installation of grid-connected solar PV systems.

EDUCATION

1975, B.Sc. Electrical Engineering, University of Alberta. Course emphasis on micro-processors, energy, and energy issues.
1977, "Solar Heating and Cooling of Residential Buildings", Faculty of Extension, University of Alberta.
1978, "Passive Solar System Design", Passive Solar Design Associates, Denver, Colorado.
1984, "WATSUN Solar Simulation Program", seminar sponsored by the University of Waterloo at the 1984 Solar Energy Society of Canada Annual Conference.
2000, Sustainable Building Symposium, Edmonton.
2002, Sustainable Building Symposium, Edmonton.
2004, "PV1", British Columbia Institute of Technology course on solar PV system design.
2004, Sustainable Building Symposium, Edmonton.
2005, "PV2", British Columbia Institute of Technology workshop on solar PV system installation.
2006, "PV Technical Training", SMA America at the CanSIA Forum.
2007, "PV2", British Columbia Institute of Technology course on solar PV system design.

Frequent attendance and participation at the annual Canadian Solar Industries Association and Solar Energy Society of Canada conferences. See Publications/Papers below.

Teach introductory solar energy courses through Edmonton Public Schools Metro Continuing Education and Trimline Training Centre. See Professional/Volunteer Activities below.

EXPERIENCE

Partner, Senior Project Development Engineer
Howell-Mayhew Engineering, Inc. Edmonton, Alberta. 1985 - present

- Consulting, developing, planning and implementing projects to utilise solar PV and solar heating systems, including feasibility studies, performance simulations, technology assessments.
- Developing, planning and implementing projects to monitor, analyse, and evaluate the *in-situ* field performance of technologies demonstrating energy efficient housing and solar PV systems.
- Conducting studies to identify and analyse barriers to solar PV and solar heating.
- Writing national and international standards on solar PV system testing, operation, and safety.

Partner, Senior Project Development Engineer (continued)
Howell-Mayhew Engineering, Inc. Edmonton, Alberta. 1985 - present

- Participating on committees to establish guidelines for the interconnection of PV systems.
- Giving public presentations, courses, and writing case studies on solar PV and solar heating technology.
- Consulting on innovative solutions to instrumentation problems.
- Developing and writing software for field monitoring and data analysis.
- Developing and writing software for PV system design.

Research Associate
Renewable Energy Systems Group,
University of Alberta, Edmonton. 1983 - 1985.

- Assembled and installed a computer-based monitoring system to evaluate PV system performance.
- Conducted contract research to analyse wind energy data.
- Taught undergraduate laboratory courses in digital design and electronics.

Research Engineer
Solar and Wind Energy Research Program,
Alberta Research Council, Edmonton. 1977 - 1983.

- Developed and wrote comprehensive software to analyse wind energy data.
- Designed and installed a monitoring system to evaluate the performance of a solar DHW system.
- Lectured throughout Alberta on residential solar design and energy conservation.
- Provided technical assistance to government departments, corporations and the public.
- Developed and wrote residential energy analysis software.
- Developed and wrote software to process data recorded by a solar and wind energy resource monitoring network.

SELECTED CLIENT PROJECTS

Projects: Consulting on the development of grid-connected solar PV and microwind systems around Alberta.

- Eleven projects installed
- 20 projects in the planning and development stages

Project: Micropower Grid-Connected Interconnection Manual for Alberta

- Developed the technical content of this manual, at www.gridconnect.ca, for the purpose of empowering people to safely interconnect micropower systems themselves, to illustrate the complexity of the present interconnection process, and to help guide regulators to reduce their contribution to its complexity.

Project: Canadian Solar Industries Association Grid-Connection Issues (2003)

- Wrote a section for the Canadian Solar Industries Association report that documents PV interconnection issues and barriers.

Project: Alberta Government Centre PV System Interconnection Approvals (2003)

- Guide the project through the technical and legal interconnection approvals process with the client and the Wires Owners. Develop and submit the approvals documentation.

Project: International Energy Agency Photovoltaic Power Systems (PVPS) Programme Task 1 on PV market information (2002-2004)

- Participating on international working group that develops national and international survey reports on PV market growth, and disseminates reports on the PV solutions developed by other PVPS Tasks.

Project: Spruce Meadows Equestrian Centre Interconnection Approvals (2002)

- Guide the project through the technical and legal interconnection approvals process with the client and the Wires Owners. Develop and submit the approvals documentation.

Project: EPCOR Utilities' Grid-connected Commercial PV System (1996 - 2001)

- Provide client with PV consulting services on the development of a 13.4 kW PV system on the roof of their 23-storey office building.
- Specify the monitoring requirements for the system.

Project: Joint HME/EPCOR Grid-connected Residential PV Demonstration System (since 1994)

- Design, assemble, and install a 2.3 kW grid-connected PV system on HME's Cold Climate Solar House in Edmonton.
- Instrument and monitor its performance for the purpose of evaluating the technology.
- Identifying and evaluating the barriers to the implementation of PV technology.

Project: Ideas Challenge C-2000 Demonstration Project (1997)

- Project Management: Serve as a field representative for Canada Mortgage and Housing Corporation and Natural Resources Canada and ensure that project objectives were achieved. The project consists of an 8-storey and 5-storey housing complex for seniors.
- Instrumentation: Participate in the development of an Instrumentation Protocol for C-2000 Building Performance Monitoring. (1994)
- Instrumentation: Develop criteria for selecting an energy management and control system for use in C-2000 performance monitoring. (1996)

Project: Field Monitoring of Heat Recovery Ventilator Performance (1988)

- Assess the field performance of a heat recovery ventilator installed in an Edmonton residence and provide verification and insight into the performance of the unit under cold climate operating conditions.
- Install and operate a computer-based monitoring system for investigating the performance of heat recovery ventilators in two R-2000 houses in the Yukon.

Project: Engineering Analysis, System Modelling Validation, and Monitoring of Photovoltaic 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.
- Compare actual performance with the simulations.

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

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

Project: Monitoring of a Direct Vent Gas-Fired Water Heating System (1985)

Design and monitor the performance of a fan-coil water heating system using a high efficiency water heater to supply both domestic water heating and space heating in an energy efficient home.

Projects: Miscellaneous

- Brief survey of the distribution structure for PV powered temporary road signs in Alberta.
- Write the chapter on PV monitoring for Natural Resources Canada's *PV Design Manual*.

Project: Adaptation of CoPilot™ Data Acquisition Software for use with Hewlett•Packard Equipment (1993)

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

Develop software which would assist in the sizing, optimization, and economic analysis of remote power supply systems including PV battery charging, genset battery charging, hybrid PV/genset battery charging and direct genset operation.

Project: Adaptation of Data Acquisition and Analysis Software for the Implementation of R-2000 Level B Monitoring (1986)

Project: Cold Climate Solar House (since 1987)

HME designed, built, and operates a fully instrumented R-2000 energy efficient solar PV house that serves as a facility to:

- Conduct multi-year research on the interaction of housing components;
- Identify and evaluate the barriers to and the performance of grid-connected solar PV system technology and net zero electricity homes;
- Test methods and products under field operating conditions;
- Transfer information and technology between basic and applied research organisations and the housing industry;
- Evaluate instrumentation appropriate for small system applications;
- Conduct tours for public awareness; and
- Contain the offices of Howell-Mayhew Engineering, Inc.

Project: CoPilot™: Integrated Data Acquisition and Management Software (1984-2000)

An integrated software package that acquires and manages system engineering and performance data, specializing in long-term, reliable, remote, unattended monitoring systems.

PROFESSIONAL VOLUNTEER ACTIVITIES

I recognise that I can lead far more effectively if I personally decide to do what I am encouraging, empowering and advising others to do. I recognise the importance of community development in the on-going health, sustainability, and growth of me, my professional work and my profession. To this end, I pursue the following volunteer activities:

Activity: International Electrotechnical Commission (IEC) Technical Committee 82 (Solar Photovoltaic Energy Systems) (1990 - present) www.iec.ch

- Representing Canada to develop world standards
- Working Group (WG3) – PV system standards, member
- Working Group (WG1) – Glossary standards, member
- Project Leader: IEC Document 61836-Ed. 2.0, "Glossary of Terms and Symbols"
- Project team for IEC Document 61723, "Safety Guidelines for PV Systems Mounted on Buildings"
- Co-authored IEC Document 61724, "Photovoltaic System Performance Monitoring – Guidelines for Measurement, Data Exchange and Analysis". Project leader on IEC Project 61723 under development, "Guidelines for Grid-Connected Photovoltaic Systems Mounted on Buildings"

Activity: Clean Air Strategic Alliance (2003 - 2006)

- Renewable and Alternative Energy Project Team, member
- Electrical Efficiency and Conservation Project Team, member

Activity: Distributed Generation Committees (2001 – 2006)

- Alberta Distributed Generation Interconnection Policy Committee, member
- Alberta Distributed Generation Interconnection Technical Committee, member
  - Sub-Committee on Micro Distributed Generation (Chairman)
- Alberta Safety Codes Council on MicroPower and the Canadian Electrical Code, member

- MicroPower Connect, member www.micropower-connect.org
  - Interconnection Guide development committee and writing sub-committee
- Measurement Canada
  - Working group on developing net metering standards, member

Activity: Canadian Standards Association www.csa.ca
- Canadian Electrical Code Section 50 (Solar Photovoltaics), member (since 2000)
- Technical Committee on Interconnection, member (2004 - 2006)
- SCOPEER (Strategic Committee on Performance, Energy Efficiency, and Renewables), SCC c400 (2000 - 2004), member
- Renewables Committee, TC c420 (2000 - 2004), member

Activity: Energy Awareness Week, Edmonton (2001, 2002)
- Organizing Committee, member

Activity: Canadian Solar Industries Association
- Member in good standing
- CanSIA SOLutions newsletter committee (2000 - 2004)
- Board of Directors (1999 - 2002)

Activity: Eco-Solar Home Tour, Edmonton (since 2000) www.ecosolar.ca
- Founder and member of the organising team

Activity: University of Alberta Solar Vehicle Project (1997 - 1998)
- Advisor

Activity: North Sun '99 International Conference on Solar Energy at High Latitudes, Edmonton
- Co-chair with EPCOR Utilities

Activity: Public awareness, between 1995 and 2008 February 29, ongoing
- 232 lectures, talks and presentations on solar PV and solar heating technologies to the general public, schools, University classes and specialised public and technical groups.
- 18 courses through Edmonton Public Schools Metro Continuing Education and the Trimline Renewable Energy Training Centre. Developer and instructor of "*Solar Energy: Practical Opportunities Now*". Presently working at getting professional development hours credit for it for the students from APEGGA, AAA and REIC.
- 103 media interviews – TV, radio, newspaper, magazines.
- Mentoring of University, NAIT and school students and their class and science fair projects – 8 people and groups.

Activity: Alberta Building Technical Council, Energy Codes Advisory Committee (1995 - 1998)
- Representing the Clean Air Strategic Alliance/Alternate Energy Producers to evaluate the impact assessment of the National Energy Code for Buildings.

MEMBERSHIPS

Canadian Solar Industries Association www.cansia.ca
Solar Energy Society of Canada www.solarenergysociety.ca
Alberta Electric System Operator Energy Trading System www.aeso.ca
– Micropower electricity generator participant, actively selling green solar power electricity to the grid
APEGGA www.apegga.com

Fusion Australia www.fusion.org.au
- Canada liaison (since 1994)

Fusion Canada Youth and Community Society www.fusioncanada.ca
- Founder and team member (since 2002)

St. Paul's Anglican Church (since 1985) www.stpauls-anglican.ca
- Community development specialist

Johann Strauss Foundation www.johannstrauss.ca
- Member of the Board of Directors (since 1997)
- Co-ordinator of Music at the Johann Strauss Ball (since 1998)

AWARDS

2002 Emerald Award for Environmental Excellence for Individual Commitment www.emeraldawards.com

ENGINEERING LINEAGE

Douglas P. Howell Father. Chemical Engineering. University of Alberta, Edmonton. 1949.
Charles M. Moore Maternal grandfather. Civil Engineering. Queens University, Kingston. 1919.

CORPORATE REPORTS

Howell-Mayhew Engineering, Verreterra Environmental Consultants, Ecomark Ltd. 2004. Micropower Distributed Generator Interconnection Manual for Alberta. Prepared for Climate Change Central, ATCO Electric, Solar Energy Society of Canada-Northern Alberta Chapter. Edmonton, Alberta. Web site.

Howell-Mayhew Engineering. 2003. The Feasibility of Solar Photovoltaics at Canada Place. Prepared for Public Works and Government Services Canada Western Region. Edmonton, Alberta. 158 pp.

Howell-Mayhew Engineering. 1997. Technical Feasibility of using DDC Systems for Building Performance Monitoring. Prepared for Holland & Associates, Architects-Planners. Edmonton, Alberta. 21 pp.

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.

Howell, D.G. and W.J. Mayhew. 1987. Energy Performance of Three Airtight Drywall Approach Houses. Prepared for Alberta Municipal Affairs. Edmonton, Alberta. 30 pp.

Howell, D.G. and W.J. Mayhew. 1987. Field Monitoring of Heat Recovery Ventilator Performance. Prepared for Canadian Home Builders' Association. Ottawa, Ontario.

Mayhew, W.J. and D.G. Howell. 1987. Monitoring of an Induced-Draft Water Heating System. Prepared for Ontario Research Foundation. Mississauga, Ontario. 19 pp.

Mayhew, W.J. and D.G. Howell. 1986. Survey of Medium and High Efficiency Furnaces. Prepared for Alberta Energy. Edmonton, Alberta. 49 pp.

PUBLICATIONS/PAPERS

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 3rd International Solar Cities Congress. Adelaide, South Australia.

Howell, G. and P. Robertson. 2004. *Micropower Grid-Interconnection Manual for Alberta*. Proceedings of SESCI 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 SESCI 2003 Conference, the 28th 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., and D.G. Howell. 1998. *Working towards a Sustainable Culture – Integrating it into a Utility*. 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.

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.

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, British Columbia.

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, British Columbia.

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.

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.

Sheaff, N.B. and D.G. Howell. 1990. *A PC-Based Integrated System for Data Acquisition, Analysis and Control*. Proceedings of the International Energy Agency Workshop "Field Monitoring For a Purpose", Gothenburg, Sweden. Vol II, pg 376-384.

Howell, D.G., W.J. Mayhew and T.L. Hamlin. 1988. *Field Performance of a Heat Recovery Ventilator*. Proceedings of the 14th Annual Conference of the Solar Energy Society of Canada, Inc. Ottawa, Ontario.

Morris, R.J. and D.G. Howell. 1984. *Wind Energy Analyses for Canada.* Proceedings of the 10th Annual Conference of the Solar Energy Society of Canada, Inc. Calgary, Alberta.

Howell, D.G. and G.M. Rekken. 1984. *Analysis of the Non-economic Benefits of Low-energy Passive Solar Housing - A Case Example.* Proceedings of the 10th Annual Conference of the Solar Energy Society of Canada, Inc. Calgary, Alberta.

Rekken, G.M. and D.G. Howell. 1983. *The Conservation/Solar Research House, ER-1: The Destratifying Air Recirculating System and The Non-ventilated Roof System*. Contract Report, Canada Mortgage and Housing Corporation, Housing Technology Incentives Program. Ottawa, Ontario. 24 pp. plus Appendices.

Rekken, G.M. and D.G. Howell. 1983. *Assessment of the Energy Saving Measures Used in the ER-1 Conservation/Solar Research House.* Contract Report, Alberta Department of Housing, Innovative Housing Grants Program. Edmonton, Alberta. 73 pp. plus Appendices.

Janz, B., D.G. Howell, and A. Serna. 1982. *Wind Energy in the Northwest Territories.* Contract Report #5, Science Advisory Board of the NWT. Department of Information, Government of the NWT. Yellowknife, NWT. 108 pp.

Howell, D.G. 1980. *Developments in Renewable Energy: A Brief Review.* Canadian Home Economics Journal. Vol. 30, No. 6: 212-215.

Howell, D.G. 1979. *Processing of Alberta Wind Data and Its Application to Wind Energy System Design.* Proceedings of the 5th Annual Conference of the Solar Energy Society of Canada Inc. Charlottetown, Prince Edward Island.