Ryerson University

Program Proposal Brief
of the
Professional Master's Diploma
in
Energy and Innovation

Submitted to the
Ontario Universities Council on Quality Assurance

April 17, 2014

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1.0 INTRODUCTION

Description of the Proposed Diploma

The Professional Master's Diploma in Energy is intended to provide participants with the knowledge and skills required to function competently as officers, administrators, technicians, analysts, etc. in the field of Energy. Those wishing to seek external certification in Energy should be well advanced along this path as well. In addition to providing diverse, meaningful and lucrative career options to participants, the diploma program addresses recognized and pressing needs within the public and private sectors, for individuals qualified in these areas to assume a variety of operational, administrative and managerial roles. Representative job titles might include energy analyst, energy policy advisor and energy manager.

The PMD in Energy and Innovation requires 4 core courses and a Final Diploma Project

1. Smart Grids – Electricity, Petroleum, Infrastructure (new)

This course introduces the concept or promise of smart grids.

2. Demand Management and Conservation (new, complements CKEI 110)

This course shall describe various methods for peak demand reduction and conserving energy.

3. Energy Storage and Use (new)

This course shall survey and describe new and promising technologies for energy storage.

4. Electricity Markets (new)

Energy business is driven by economics and this course shall discuss various forms of electric energy and their economic characteristics for electricity sector.

5. Final Diploma Project

1.1 Near-term Development

A staged deployment of the diploma will most effectively meet the educational needs of participants while recognizing the resource limitations within Ryerson. We will leverage the talent and expertise of exceptional, non-academic practitioners for course rollout per semester. The curriculum discussed in this proposed diploma will be developed with the following roll-out planned for in class offerings.

- First Course: Fall 2014
- Second Course: Winter 2014
- Third Course: Winter 2014
- Fourth Course: Spring/Summer 2015
- Final Diploma Project: Spring/Summer 2015

As authorized, fully on-line versions should be available approximately twelve months after each in-class launch. The course entitled Smart Grids must be taken first. To ensure that both course content and delivery meet Ryerson's high standards, respected senior practitioners from the sector will be consulted regarding course development and content. In addition, guest lecturers with specific expertise will be sought, as appropriate, providing not only a change of pace and deep insight, but networking opportunities as well.

1.2 Longer-term Development

In the longer term, as new emerging knowledge becomes available and is added to the program, we anticipate maintaining curricular competency in this rapidly changing field by engaging in wide consultation with expert practitioners, business enterprise leaders and participants/alumni and by taking advantage of the nexus of curriculum, research and students that this diploma program will be able to provide. These longer-term development plans include the introduction of related topics, including big data computing for smart grids, IT for smart grids, specific energy storage solutions, etc.

This proposed PMD covers a vital area of professional knowledge and expertise required by private and public sector organizations in the 21st century. The proposed diploma satisfies the goals and learning outcomes for those professionals within organizations who are responsible for developing, managing, using energy and innovation in this sector.

The program continues the Ryerson tradition of combining the theoretical, technical and practical to provide participants with a broad, and where necessary, deep knowledge of the subject matter, as well as a real-world understanding of its application, legal and social contexts, economics and organizational impact. Furthermore, it addresses key topic areas of significant interest to the business community and legislators in a strongly interdisciplinary fashion, providing many opportunities for joint projects, research and the cross pollination of ideas.

1.3 Rationale

Our energy supply and delivery has changed in the last twenty years, in both the electricity and transportation sectors. New tools and solutions have emerged during these years which mandate that this sector's workforce is trained in these new tools and solutions. These include renewables, energy storage, change in power systems from regulated to deregulated operations, smart grids, etc.

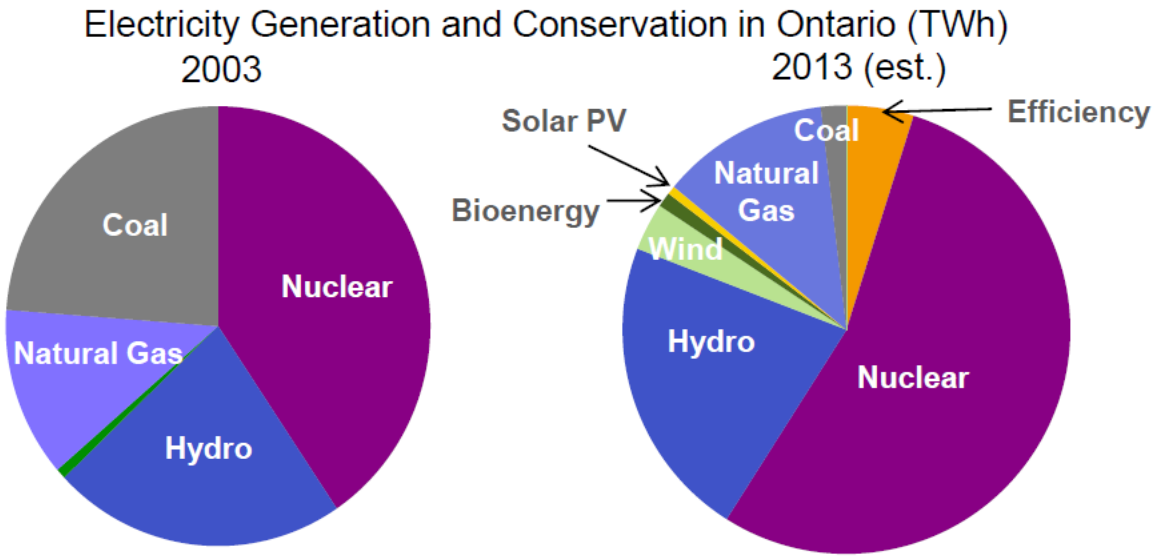

Fig. 1 Ontario's Generation Mix: Courtesy: Ontario Ministry of Energy

Fig. 1 clearly shows how the energy supply to the province is changing and shall continue to change in the next decade. This transformation is enabled through a variety of strategies such as adoption of renewables, use of new storage solutions, etc. All of this involves investment of tens of billions of dollars and the training of new manpower.

Key new technologies include: renewables, energy storage, conservation, transmission systems, generation systems, distribution systems, demand management, energy policy, energy innovation, etc. This program is geared towards enabling Ontario to prepare for this energy future by training engineers in new technologies such as smart grids, etc.

1.4 Societal Need

More than ninety per cent of the energy we use today as a society comes from polluting, fossil fuel and nuclear sources. During the period 1990-2004, improvement in energy efficiency was only half of that achieved by the energy shortage of preceding decades in the G8 countries. With the growing awareness and concern about global warming, there is a new demand for clean energy, renewable resources and sustainability.

The Office of Energy Efficiency (OEE) is a federal centre of excellence for energy efficiency and alternative fuels information. For over 15 years, it has raised awareness among Canadians about the importance of energy conservation in accordance with Canada's energy policy to help address global

warming. Incentives have been available to homeowners and corporations to reduce energy consumption. Local community-based renewable energy power generation projects have been encouraged through organizations such as the Toronto Renewable Energy Co-operative, which produced the wind turbine at Exhibition Place.

Scientists and citizens are joining forces in voicing the demand for action to governments worldwide. Standards (such as ASTM) and certifications (such as LEED) are demanding that products and buildings incorporate energy efficiency. What is needed now is technology leadership to produce innovative solutions that will help to bridge the enduring gap between consumption and restraint.

The Ontario curriculum at the primary and secondary levels includes strong emphasis on environmental awareness. Our next generation of leaders will have an innate understanding of the negative impacts of energy over-consumption. Environmental engineering programs have grown, and traditional engineering disciplines are acknowledging the emerging fields of alternative energy. Ryerson is a clear leader in this trend, with its Centre for Urban Energy, and prominent researchers, such as Dr. Bin Wu, NSERC Industrial Research Chair. It is now natural to create a formal academic program in which graduate students can draw on the rich learning environment available at Ryerson in this field, and produce innovations that are so desperately needed.

2.0 OBJECTIVES OF THE PROGRAM

This diploma directly addresses Ryerson's mission:

"The special mission of Ryerson University is the advancement of applied knowledge and research to address societal need, and the provision of programs of study that provide a balance between theory and application and that prepare students for careers in professional and quasi-professional fields".

The focus of the proposed diploma program is to deliver pertinent, practical, timely and effective education in the areas of energy and innovation. Each of these domains is widely recognized as having significant and growing societal importance with respect to electricity, natural gas, legal, financial, educational, research, public utility, local distribution companies, transmission companies, generation companies and energy institutions and infrastructure. Each is the subject of on-going intensive research and development, from the scientific, technology, legal, social and policy perspectives. Each offers its practitioners academic, professional and para-professional (technical) career opportunities and employment options.

This diploma may be earned in a flexible manner, taking into account the diverse life situations of its mature participants who will likely benefit from alternative forms of program delivery, including in-class and (eventually) distance learning options.

Notwithstanding the specific prerequisites, ideal incoming participants should have significant work experience (3+ years), general comprehension of energy technology, an acceptable level of professionalism and maturity, the ability to communicate effectively with peers, a basic understanding of business enterprise processes and organization, and a high level of integrity.

These are fundamental characteristics of successful practitioners in the areas Energy and Innovation and, whereas some of these attributes can be "taught", the diploma program is designed to emphasize knowledge and skills acquisition, and to develop relevant thinking skills.

In summary, the aims of the Program are to educate graduates about the:

- Evolving space of energy in terms of technology;
- End user role – demand management and conservation;
- Large-scale economics, politics and other interests in this space; and
- Role of innovation.

2.1 Consistency of the Program with the Institution's Mission and Academic Plan

The special mission of Ryerson University is the advancement of applied knowledge and research to address societal need, and the provision of programs of study that provide a balance between theory and application and that prepare students for careers in professional and quasi-professional fields. As a leading centre for applied education, Ryerson is recognized for the excellence of its teaching, the relevance of its curriculum, the success of its students in achieving their academic and career objectives, the quality of its scholarship, research and creative activity and its commitment to accessibility, lifelong learning, and involvement in the broader community.

- Ryerson University Mission Statement

The Ryerson University Academic Plan "Shaping the Future" for 2008-2013 emphasizes five areas; (1) High Quality, Societally-Relevant Undergraduate and Graduate Programs; (2) Student Engagement and Success; (3) Learning and Teaching Excellence; (4) Research Intensity; and (5) Reputation building. The proposed graduate program fits very well with all of these strategic priorities of the academic plan. The program will build upon the international reputation of the Centre for Urban Energy along with research and innovation activities happening in the Faculty of Engineering and Architectural Science academic departments.

Since 1948, Ryerson has built its reputation on the strength of its academic curriculum and its focus on applied research. Ryerson now offers more than 100 graduate and undergraduate programs, with a total enrolment of 39,500. In its most recent annual survey of Canadian universities, Maclean's magazine ranked Ryerson #1 for producing Leaders of Tomorrow, and #2 as Most Innovative. In recognition of the demands of society and industry, Ryerson is establishing a strong research capability in engineering. Ryerson University provides an ideal and highly supportive environment for engineering education, innovation and research. In recent years our major focus has been on establishing an environment for graduate students and professors to pursue world-class research aimed at solving problems of significant importance, and we are committed to enriching society by transferring knowledge and applying research findings quickly and effectively to provide clear social and economic benefit.

Research funding at Ryerson has been in a phase of accelerated growth for the past several years. In the last decade, research activity at Ryerson has increased five-fold. This year, externally-funded research has increased by 26% to almost $30 million, and the prior year recorded a 23% increase. In addition, Ryerson ranked #1 in publications growth for Canadian undergraduate universities, with a remarkable 171% increase between 2002 and 2007. To put this into perspective, it is almost seven times the rate of growth for the top 50 Canadian universities as a whole. Before this latest increase, Ryerson ranked 29th amongst those universities. This remarkable growth is largely due to Ryerson's heavy investment in supporting research and training of highly qualified personnel in the areas specified in the Strategic Research Plan. The Faculty of Engineering and Architectural Science has been a significant player in the transformation of Ryerson University as a comprehensive university with substantial research and graduate studies activities. The Faculty of Engineering and Architectural Science offers accredited undergraduate and graduate programs in engineering and architecture. In its strategic plan, the Faculty of Engineering and Architectural Science has identified building interdisciplinary programs. The proposed graduate program in Energy and Innovation is one such program which brings the different engineering disciplines within the Faculty of Engineering and Architectural Science together to offer a modern and relevant graduate program to meet industry and societal needs.

Graduate Diploma in Energy and Innovation
Ryerson University is in a unique position to offer this interdisciplinary graduate program in energy to meet the societal and technical needs of the industry. The program will provide a distinct focus on urban energy issues. The students will be exposed to an excellent training environment in various research labs in the engineering and architectural science programs, and in the Centre for Urban Energy. The students will also get exposure to innovation and entrepreneurial activities through the various innovation and incubator clusters/zones that Ryerson has been embarking on. Faculty members delivering the program are well known in their respective fields and have been recognized with prestigious awards and prizes for their research and scholarly contributions.

This Diploma program allows undergraduate degree graduates from science, environment and engineering to specialize in energy.

The proposed program will support the following priorities identified in the University's Academic Plan:

High quality, societally-relevant undergraduate and graduate programs
By meeting a critical need for more practical education opportunities to acquire expertise to manage, operate, oversee, evaluate and staff the functions of energy and innovation, the PMD in Energy and Innovation will constitute a significant and meaningful response to societal need and labour market demand.

Student engagement and success
With the development of a comprehensive program of education pertaining to aligning and integrating energy and innovation functions within corporate governance structures, the PMD in Energy and Innovation will provide an environment that fosters learner success. Our highly qualified faculty will support learners understanding, adopting and ultimately achieving best practices in both technical and leadership domains.

Learning and teaching excellence
Faculty members in the Department of Electrical and Computer Engineering are committed to excellence in teaching and many have received awards in recognition of their achievements in this area. Our Standing Academic Coordination Committee reviews course content to ensure currency, relevance, and overall quality. We are excited about creating a program through which aspiring current and future professionals will be able to access professionally developed and delivered education and support in the areas of energy and innovation.

SRC intensity
Our collaboration with external partners will create opportunities for new research activities. For example, the PMD in Energy and Innovation will bring together corporations and the department in their mutual support of learners during on-site fieldwork. Naturally, this will present research questions which will allow interaction between industry and program faculty. In turn, this will drive additional research and increase intensity.

Reputation
Our PMD in Energy and Innovation will build on our reputation as we further engage firms who share our commitment to integrating energy and innovation priorities with corporate governance best practices. As the areas addressed by this PMD are underserved, by necessity the reputation of the PMD will rise.

Alignment of Program Requirements and Learning Outcomes to Ryerson's GDLEs
The PMD in Energy and Innovation is closely aligned with the University's GDLEs while at the same time fulfilling Ryerson's mission of the advancement of applied knowledge and the integration of theory and practice to prepare students for socially relevant careers. The Department of Electrical and Computer Engineering's mission and diploma program outcomes reflect a broad based, evidence informed, collaborative approach to ethical energy and innovation professional practice that supports the advancement of the field. As such, the program learning outcomes of the proposed PMD in Energy and

Innovation are closely aligned with the University's mission and GDLEs. The program's requirements of four graduate courses meet the requirements of a Ryerson Professional Master's Diploma structure as set out by Ryerson University's Senate. To set the stage for demonstrating the alignment of the diploma program's associated learning outcomes with Ryerson University's Graduate Degree Level Expectations, the diploma's learning outcomes are articulated as follows:

Learning Outcomes of Core Courses

Note: CDM means Conservation and Demand Response

Course	Learning Outcomes
1. Smart Grids – Electricity, Petroleum, Infrastructure	The course teaches various new technologies for smart grids and applications. Successful candidates of this course shall be able to: a. Gain knowledge of new tools in smart grids b. Gain knowledge of details of communication systems c. Gain knowledge of details of data processing systems d. Gain an understanding of how energy systems may be better operated with smart grid technologies e. Recognize the role of innovation in developing smart grids f. **Smart Grid Lab**: as a part of this course, intern at the Schneider Electric Smart Grid Lab with instructions from faculty members and industry members (when possible)
2. Demand Management and Conservation (new, complements CKEI 110)	This course shall describe various methods for peak demand reduction and conserving energy. Successful candidates of this course shall be able to: a. Describe forms and methods of demand management and conservation b. Describe forms and methods of conservation c. Compute benefits of demand management methods d. Compute benefits of conservation programs / tools e. Cost various forms of CDM programs f. Explain and compare various forms of CDM programs g. Identify how innovation contributes to the reduction of peak demand reduction and conserving energy
3. Energy Storage and Use (new)	This course shall survey and describe new and promising technologies for energy storage. Successful candidates of this course shall be able to: a. Describe forms and methods of energy storage systems b. Quantify benefits from different types of storage and identify relevant applications c. Cost out various energy storage systems d. Compute efficiency and other performance parameters of energy storage systems e. Recognize the role of innovation in developing energy storage systems
4. Electricity Markets (new)	This course shall introduce candidates to electricity markets and explain characteristics of various types of energy sources. Successful candidates of this course shall be able to: a. Develop a electricity market model b. Analyze costs and benefits of different types of electricity systems c. Analyze and optimize electricity market models d. Undertake economic valuations of innovation in energy systems

Course	Learning Outcomes
5. Final Diploma Project	Concurrently with the final course, the final diploma project is completed. Final diploma projects are expected to be approximately 40 pages double spaced. The topics might include but are not limited to: • Energy Markets – understanding and analysis; • Techno-economic analysis of conservation programs; • Design of demand management programs; • Assessment of smart grid solutions such as smart meters The project is to comprehend new technologies in energy (innovation) in the context of economics enabling diploma students to make informed decisions in their workplace.

3.0 PROFESSIONAL MASTER'S DIPLOMA LEVEL EXPECTATIONS (GDLES), IN ENERGY AND INNOVATION

3.1 Program Learning Outcomes

The aim of this program is to educate a cohort on energy fundamentals and introduce new and emerging technologies required to develop, operate and maintain new energy systems. These include the fundamentals of energy. The program also offers a glimpse of major new technologies on the anvil that shall come to the forefront in the next phase of energy system roll out. This program shall well position the cohort of students to embrace and benefit from these new technologies and provide leadership.

In addition, the program provides a socio-political context to the energy spectrum as it is a highly sensitive and expensive / capital intensive domain. The program shall train students to work as energy analysts, energy managers, building managers, power systems / distribution system managers / operators. Foreign students may find the program useful in accelerating employer recognition of competencies developed abroad.

More specifically, these Program Learning Outcomes together with the Professional Master's Diploma Level Expectations (GDLEs) chart the individual Program Learning Outcomes addressing Ryerson University's enumerated, standard Graduate Degree Level Expectations as illustrated in the table below.

This diploma is awarded to students who have demonstrated:

		Which program outcomes address each DLE?
Depth and Breadth of Knowledge	A thorough understanding of a substantial body of knowledge that is at the forefront of their academic discipline or area of professional practice.	1–9, 12– 13 15, 18, 20-21
Research and Scholarship	a. The ability to conceptualize, design, and implement research for the generation of new knowledge, applications, or understanding at the forefront of the discipline, and to adjust the research design or methodology in the light of unforeseen problems; b. The ability to make informed judgments on complex issues in specialist fields, sometimes requiring new methods; c. The ability to produce original research, or other advanced scholarship, of a quality to satisfy peer review, and to merit publication.	10–11, 19
Level of Application of Knowledge	a. The capacity to undertake pure and/or applied research at an advanced level; b. Contribute to the development of academic or professional skills, techniques, tools, practices, ideas, theories, approaches, and/or materials.	14, 16-17
Professional Capacity / Autonomy	The qualities and transferable skills necessary for employment requiring: a. The exercise of initiative and of personal responsibility and accountability; b. Decision-making in complex situations; c. The intellectual independence required for continuing professional development; d. The ethical behaviour consistent with academic integrity and the use of appropriate guidelines and procedures for responsible conduct of research; e. The ability to appreciate the broader implications of applying knowledge to particular contexts.	10-11, 20
Level of Communication Skills	The ability to communicate complex and/or ambiguous ideas, issues and conclusions clearly and effectively.	11, 14, 18
Awareness of Limits of Knowledge	An appreciation of the limitations of one's own work and discipline, of the complexity of knowledge, and of the potential contributions of other interpretations, methods, and disciplines.	18

The Standing Academic Coordination Committee will discuss and decide annually whether it is necessary to augment the diploma's course content for currency with respect to technology advances, legislative changes and best practices.

a) *Appropriateness of Diploma Nomenclature*

It is appropriate that this Energy and Innovation program be a Professional Master's Diploma given the applied nature of this highly specialized and rapidly evolving professional Area of Practice (AOP). Clearly there is a paucity of university level opportunities for adults in Ontario and Canada to pursue a formal, structured program of advanced studies in this high-demand career field. The proposed diploma, between an undergraduate degree and a full master's degree is unique; it is well positioned as a professionally applied diploma within Ryerson University's mandate to differentiate itself as an institution versus other higher education institutions by its university level applied study and by its synthesizing of both:

- responsiveness and competencies required to address the needs of the energy sector; and
- proactive competencies and approaches to designing, implementing and renewing regularly, practices, strategies and techniques in the management of these energy systems.

A 4-graduate course professional diploma provides the necessary scope to do both.

3.2 Admission Requirements

a. Will have graduated from a four year accredited undergraduate university program in applied science or engineering or equivalent;
b. For the MEng and Professional Masters diploma a minimum of a 3.0 B standing or equivalent over all courses in the final half of the program; and
c. English language proficiency requirement similar to other graduate programs in engineering.

a) *Clarity and appropriateness of the program's admissions requirements for the learning outcomes established for completion of the program.*

Students should have an undergraduate degree in applied science or engineering or equivalent. Alternatively, students should have a four-year undergraduate university degree related to energy plus 3 or more years of relevant work experience. Students should preferably be strong and effective communicators, comfortable with information technology and have some supervisory or managerial (or leadership) experience.

Students may seek an exemption or permission for admission due to other circumstances (e.g., qualifications or credentials from outside of Canada), based on the results of a personal interview.

b) *Sufficient explanation of alternative requirements, if any, for admission in the diploma program.*

For the evaluation of foreign academic credentials, applicants must submit their application, complete with translated and notarized copies of all their academic transcripts and credentials.

3.3 Structure

a) *Appropriateness of the program's structure and regulations to meet specified program learning outcomes and degree levels expectations.*

The program consists of four (4) mandatory courses, the first of which is an introduction to the concept or promise of smart grids, titled *Smart Grids – Electricity, Petroleum*, *Infrastructure*. The second course, *Demand Management and Conservation*, addresses the various methods for peak demand reduction and conserving energy; Course three, *Energy Storage and Use*, shall survey and describe new and promising

technologies for energy storage; Course four, *Electricity Markets*, will discuss various forms of energy and their economic characteristics.

The appropriateness of the diploma's structure to meet specified program Learning Outcomes is illustrated in the mapping of individual courses to the Diploma Learning Outcomes, Teaching Methods and Student Assessment (see 1.6 Assessment of Teaching and Learning below).

b) *Program Length*

It is expected that diploma graduates will complete the program requirements in one academic year. The first course is taken in the Fall term; the second and third courses may be taken in the Winter term; the fourth course in the Spring/Summer term.

Candidates will have up to 6 calendar years to complete the diploma, if unforeseen circumstances arise.

The successful completion of all requirements with a cumulative grade point average of 3.00 or higher, is required for the diploma to be awarded. Participants must also complete and submit an Application to Graduate with a Diploma Form prior to the appropriate deadlines (see the information on Registration and Graduation from Diploma Programs at www.ryerson.ca/graduate and www.ryerson.ca/ce.)

3.4 Program Content

a) *Ways in which the diploma curriculum addresses the current state of the area of study*

The focus of the proposed diploma program is to deliver pertinent, practical, timely and effective education in the area of energy and innovation.

Each of these domains is widely recognized as having significant and growing societal importance with respect to the electricity sector, technical, commercial, legal, financial, educational, research, public policy and energy infrastructure. Each is the subject of on-going intensive research and development, including from the scientific, technology, legal, social and policy perspectives.

The proposed program provides an excellent opportunity to learn the fundamentals of energy and learn about the latest developments in energy and energy related innovation such as smart grids, demand response, energy storage, etc. This program shall help equip candidates with tools for a professional career in energy where elements are changing rapidly.

The program offers a rich set of courses. From these offerings, candidates have a selection of courses that will help shape their careers in the appropriate direction.

Target Participants

The program is drafted to cater to fresh graduates or experienced industry professionals from science, environment or engineering.

They may include:

- Graduates in science and engineering
- Environmental Scientists
- Power Systems Technicians
- Distribution System Technicians
- Building Engineers
- Mining Engineers
- Chemical Engineers
- Architects
- Etc.

For those participants seeking career advancement or change, the proposed program offers a variety of opportunities in a variety of dynamic, lucrative and challenging fields which are often in need of an expert. Graduates may apply for positions such as the following with the knowledge that the preparation they received will hold them in good stead:

- Energy analyst
- Energy trading
- Energy manager
- Energy technologist
- Power systems operator
- Power systems manager
- Distribution systems manager
- Distribution systems operators
- Building / facility managers
- Etc.

b) *Identification of any unique curriculum components*

Given that no graduate degree or diploma exists in Canada in the diploma's area of study, the course offerings and their curriculum are unique and timely in terms of identified industry need (see course descriptions in Appendix I).

The uniqueness of the curriculum arises from, and directly addresses (for the first time in Canada), the urgency for expert professional development at the graduate level in this area of interest.

Rapid developments in renewables, energy storage, conservation and demand management programs, Electricity Markets, etc. has made the demand for this program very high in the government and public and private sectors. Due to the uniqueness of the diploma's curriculum, graduates will be prepared for careers as: energy analyst, environmental analyst, power systems operators, power systems managers, distribution system operators, distribution system managers, technicians, building / facility managers, etc.

Energy and Innovation programs in the GTA

The University of Toronto through the Faculty of Applied Science and Engineering offers a combined Bachelor of Science and MBA and a standalone Master of Engineering program in Energy Systems Engineering. The University of Ontario Institute of Technology offers a PhD in Nuclear Power and Energy Applications through the Faculty of Energy Systems and Nuclear Science.

Smart Grid Laboratory in the Centre for Urban Energy at Ryerson University

It must be pointed out that the Schneider Electric Smart Grid Laboratory is a one-of-a-kind laboratory with state-of-the-art equipment in smart grids with a focus on distribution system automation. Via course#1 on smart grids, this professional masters diploma provides its students with a unique opportunity to intern and learn about utility systems with similar settings. With buy-in from industry professionals, this program and its internship is equal to enriched real world experience in an academic setting.

The following table provides a comparison of similar programs in Canada, USA and Europe:

	University	Program	Degrees Offered
Canada	Carleton University	*Sustainable Energy*	MASc. MEng. and MA
	University of Calgary	*Sustainable Energy Development*	MSc. MEng. MA
	University of British Columbia	*Clean Energy Engineering*	MEng.
	University of Waterloo	*No specific program from the engineering field (Please see next section for details)*	
USA	University of Dayton	*Renewable and Clean Energy Program*	MSc.
	University of Michigan	*Engineering Sustainable Systems*	Dual degree program in Engineering and Environmental Science
	University of Colorado - Boulder	*Options in renewable and sustainable energy*	
	Carnegie Mellon	*Energy Science, Technology and Policy*	MSc.
	University of Wisconsin - Madison	*Master of Engineering in Energy Systems*	MEngr.
	University of Texas at Austin	*Energy and Earth Resources*	MSc.
Europe	KTH: The Royal Institute of Technology (Sweden)	*Innovative Sustainable Energy Engineering*	MSc.
	Norwegian University of Science and Technology (NTNU)	*Innovative Sustainable Energy Engineering*	MSc.

c) *Research-focused graduate programs' suitability*

Not applicable. This diploma is not an academic research-focused graduate diploma program. It is an applied professional diploma program.

d) Evidence: minimum two-thirds of the course requirements are graduate level courses

The Diploma will consist of four new graduate level courses with evaluation of all student work carried out at the graduate level, including a final diploma project.

3.5 Mode of Delivery

a) *Appropriateness of the proposed mode of delivery to meet the intended program learning outcomes and degree level expectations.*

The Mode of Delivery for the diploma courses in the short term is face-to-face which is appropriate given the need to communicate currency and relevancy in expertise on a timely basis between faculty and students.

The plan in the longer term is to make all four courses and the graduate diploma fully online.

3.6 Assessment of Teaching and Learning

a) *Appropriateness of the assessment of student achievement of program learning outcomes and degree level expectations*

For individual courses in the diploma, each of the course assessments reports (midterm and final examinations, projects and research papers) has been identified and cross-referenced with graduate level expectations which will be used by faculty as the rubrics that comprise the marking scheme. These course assessments together with the deployment of the course-specific GDLEs when grading student learning and assessments ensure that learners have achieved the Program Learning Outcomes. The PMD's Standing Academic Coordination Committee, in considering, among other inputs, teaching evaluations submitted by the Graduate Program Director and learners, will decide annually whether it is necessary to augment the diploma's course content for currency with respect to professional changes and allied best practices.

The Program Learning Outcomes Chart and the Professional Master's Diploma Level Expectations (GDLEs) Chart below cross reference and illustrate the mapping of individual courses to the Diploma Program's Learning Outcomes, Methods and Assessment; and the charting of which individual Program Learning Outcomes address the enumerated, standard Professional Master's Diploma Level Expectations.

By the end of the diploma program, successful students should be able to:

Learning Objective	Course	Learning Outcomes
		Technical Knowledge
1	1	Gain knowledge of new tools in smart grids
2	1	Gain knowledge of details of communication systems
3	1	Gain knowledge of details of data processing systems
4	2	Describe forms and methods of demand management and conservation
5	2	Describe forms and methods of conservation
6	3	Describe forms and methods of energy storage systems
7	4	Describe forms and methods of energy storage systems
		Economic Knowledge
8	2	Compute benefits of demand management methods
9	2	Compute benefits of conservation programs / tools
10	2	Cost various forms of CDM programs
11	3	Quantify benefits from different types of storage and identify relevant applications
12	3	Cost various energy storage systems
13	3	Compute efficiency and other performance parameters of energy storage systems
14	4	Quantify benefits from different types of storage and identify relevant applications
15	4	Cost various energy storage systems
16	4	Compute efficiency and other performance parameters of energy storage systems
17	4	Analyze and optimize energy market models
		Policy, Legal, Regulatory
18	2	Explain and compare various forms of CDM programs
19	4	Develop mega-scale economic model
20	4	Analyze costs and benefits of different types of energy systems
21	1	Gain an understanding of how energy systems may be better operated with smart grid technologies
Learning Objective	**Course**	**Learning Outcomes**
		Innovation Knowledge
22	1	Recognize the role of innovation in developing smart grids
23	2	Identify how innovation contributes to the reduction of peak demand reduction and conserving energy
24	3	Recognize the role of innovation in developing energy storage systems
25	4	Undertake economic valuations of innovation in energy systems

b) *Completeness of documentation demonstrating the performance level of students, allied with Ryerson's GDLEs.*

The final diploma project is expected to analyze and provide an insightful assessment of a current and/or new solution in energy. This could address new sources of energy from renewables, new technology for energy storage, new methods for conservation, technologies and/or economics of demand management, and operation of energy markets. Final diploma project topics might include, but are not limited to:

- Energy Markets – understanding and analysis;
- Techno-economic analysis of conservation programs;
- Design of demand management programs;
- Assessment of smart grid solutions such as smart meters;
- Etc.

There is a great deal of flexibility built into the design of the final diploma project to meet customized professional needs, to be agreed upon between the faculty supervisor and the diploma candidate. Assistance and guidance can be sought from other faculty members by diploma students towards the project. Evaluation of student work in the final diploma project assessment will include the overlay of Ryerson University's GDLEs (in the form a rubrics' checklist) when grading student learning to confirm that learners have achieved the Program Learning Outcomes in their final diploma project for the diploma. The diploma's Standing Academic Coordination Committee, in considering, among other inputs, teaching evaluations and samples of student work, including final diploma projects, submitted by the Graduate Program Director, will review the courses and the specific GDLEs which they fulfill and will decide annually whether it is necessary to augment the diploma's course content and GDLEs' rubrics for currency with respect to best practices.

4.0 RESOURCES FOR THE PROPOSED PROGRAM (RESOURCES FOR ALL PROGRAMS)

a) *Adequacy of utilization of existing human, physical and financial resources*

As will be detailed below, Ryerson University commits the Deans, select faculty, and administrative teams of the Yeates School of Graduate Studies, the Faculty of Engineering and Architectural Science and The Chang School of Continuing Education and its centralized university-wide services to support the delivery of this diploma program.

b) Faculty Collaboration

This proposed diploma is a collaborative effort between the Faculty of Engineering and Architectural Science, the Department of Electrical and Computer Engineering and the Yeates School of Graduate Studies, together with The Chang School of Continuing Education. Further collaborations with Faculties and their faculty members will be on-going, with appropriate faculty invited to be members on the Standing Academic Coordination Committee.

c) Faculty Resources

Qualified instructors will be engaged to present curricular material. These may include faculty members, adjunct faculty members and others, as appropriate. Faculty members have been identified with the academic background and expertise to be able to provide the necessary instruction, guidance and leadership to make the proposed program a success. They are listed in the table below. To demonstrate their quality, their curriculum vitae are found in section 5.0 b) Quality and Other Indicators.

d) Laboratory Infrastructure

The Centre for Urban Energy is building the Schneider Electric Smart Grid Laboratory and its expected date of completion is October 2014. This laboratory shall offer internship opportunities for students enrolled in course #1: Smart Grids. There are no new funds required for this laboratory.

Diploma Faculty

Mr. Bob Singh, Manager, Hydro One Networks Inc.
Adjunct Professor, Department of Electrical and Computer Engineering, Ryerson University
Relevant Area of Expertise: Power Systems, Smart Grids, Energy Storage

Dr. David Xu, Associate Professor, Department of Electrical and Computer Engineering
Relevant Area of Expertise: Power Electronics, Smart Grids, Energy Storage

Dr. Bala Venkatesh, Professor, Department of Electrical and Computer Engineering
Academic Director, Centre for Urban Energy
Relevant Area of Expertise: Power Systems, Smart Grids, Energy Storage

Mr. Gary Thompson, Supervisor, Toronto Hydro
Relevant Area of Expertise: Power Systems, Smart Grids, Conservation and Demand Management

4.1 Physical Resources

Space and Laboratory Access
Room allocations, including specialized teaching and laboratory space, are available through the Faculty of Engineering and Architectural Science and across campus and will be administered through The Chang School of Continuing Education at Ryerson University. Diploma courses will be available to diploma candidates weekday evenings, and in intensive spring and summer sessions.
Further, laboratories, conference rooms and resources shall be made available from the Centre for Urban Energy.

Ryerson Library Resources
Collections
The Ryerson Library hosts over 600,000 monographs in electronic, print, audio and video form, subscribes to well over 56,000 online journal subscriptions and provides access to over 200 online databases that contain full text articles, abstracts, images, historical documents, global news sources and datasets. All told, the acquisitions budget totals over $4.4 million dollars.

The collection development philosophy is very much holistic in its intent. In response to the rise of interdisciplinary studies in the academy, the Library has ensured that librarians engage in collection development not motivated by strict subject silos, rather by the needs of all program areas. Collection decisions are made to improve resources for all users. Making new acquisitions available is the priority, and there is less concern about which subject area should pay for it. This has made the Library nimble in identifying areas in need of strengthening and lessening the bureaucracy involved in making collection decisions. All efforts are made to fulfil requests of faculty and students, within reason.

Similarly, a committee comprised of librarians representing all subject areas gets requests for new serials and electronic resources. The committee considers all requests and approvals are granted based on a myriad of factors, including usability, cost, access, and relevance to programs of study at Ryerson.

Where at all possible, the Library works with national and provincial consortiums, the Canadian Research Knowledge Network (CRKN) and the Ontario Council of University Libraries (OCUL) to negotiate licenses for electronic resources. This increases purchasing power, and allows for assurance that the content purchased is archived in perpetuity on servers housed at University of Toronto via the Scholarsportal initiative.

Interlibrary Loans
The Interlibrary Loan (ILL) service allows users to borrow items and obtain articles from other libraries through our ILL staff, if materials are not owned by the Ryerson University Library. This service is provided free of charge.

In Person Services
The Ryerson Library is aware of the needs of students of The Chang School, and has created a service model to respond to those needs. A librarian is available for consultation at the reference desk on evenings and weekends throughout the academic year, and the Borrowing and Lending Services team is dedicated to providing ready access to the resources at the library.

Online Services
The library provides access to online chat reference support via a province wide initiative called AskON. Librarians are available to chat with students to help them through the research process. AskON is open during evenings and weekends. Alternately, students can submit reference questions via email with a 24-hour turnaround time for response.

E-reserve services are available via Blackboard to provide access to course materials on a 24/7 basis. The Chang School's Digital Strategies Unit may provide additional support.

Drop-in Workshops
The Library provides a variety of drop-in workshops for students wishing to learn more about resources and services. These include sessions on mastering searching our electronic resources and using Refworks, a tool to manage bibliographic citations. These workshops are offered at varying times of the term, but there are always time slots available that are convenient to Chang School students.

Liaison with The Yeates School of Graduate Studies and The Chang School
Jay Wolofsky is the designate liaison librarian to ensure that the needs of The Chang School and its students are fulfilled. Further, there are subject specialist librarians available for in depth consultation. Their contact information is available online at: www.ryerson.ca/library/info/sublib.html

IT Resources
The Communications and Computing Services (CCS) Unit of Ryerson University will provide all the necessary information technology required of the program, the faculty and the diploma graduates.

4.2 Resources for Graduate Programs Only

a) *Evidence of faculty expertise to foster an appropriate intellectual climate*

Please see 4.3 c) and faculty curriculum vitae in 5.0 b) Quality and Other Indicators.

When required, appropriately qualified expert practitioners employed within the industry will also be recruited as Adjunct Faculty of the Yeates School of Graduate Studies and the Electrical and Computer Engineering Department of the Faculty of Engineering and Architectural Science to serve in a teaching capacity. Their academic and professional credentials, along with their references being checked, will be reviewed and they will undergo a formal interview. In-class faculty observations of Adjust Faculty will be conducted by the Graduate Program Director, Chair or a faculty member teaching in the diploma program.

b) *Financial Assistance*

This Professional Master's Diploma is a cost recovery program and its students will be eligible to access the University's institutional bursary program.

A bursary fund -The Gervan Fearon Award for Excellence in a Professional Master's Diploma - has been established at the G. Raymond Chang School of Continuing Education at Ryerson University.

c) Qualifications and Appointment Status of Faculty and Supervisory Loads

All instructors are appointed within the program and hold appropriate qualifications. This proposed diploma is a collaborative effort between the Faculty of Engineering and Architectural Science and the Yeates School of Graduate Studies, together with the Centre for Urban Energy and The Chang School of Continuing Education.

In addition to the Graduate Program Director's supervision of the diploma program, the program will also be overseen by the diploma's Standing Academic Coordination Committee. There is no direct graduate student supervision except within the context of a course or of the Final Diploma Project.

Standing Academic Coordination Committee (ACC)
This proposal, once approved, shall be governed by the provisions of the Senate's Framework for Professional Master's Diplomas, with respect to the composition and functioning of the Diploma's Standing Academic Coordination Committee.

The Standing Academic Coordination Committee shall consist of faculty members (RFA) from the teaching department(s) contributing curriculum to the diploma and 1 member of the Yeates School's Programs and Planning Committee.

The Standing Academic Coordination Committee will have primary responsibility for:
1. Coordinating program curriculum development;
2. Liaising with the relevant teaching departments and the Graduate Advisor for the diploma;
3. Ensuring the quality, currency, and content of constituent courses;
4. Assuring course staffing strategies are appropriate, including the recruitment and qualifications of diploma faculty;
5. Undertaking the on-going review of program objectives, learning outcomes, and career competencies, etc.

The Standing Academic Coordination Committee (ACC) is not limited to but will include:
- Alex Ferworn, (Chair), Director, Professional Graduate Diplomas, member of the Yeates School's Programs and Planning Committee, Yeates School of Graduate Studies
- Bala Venkatesh, Director, Centre for Urban Energy and Professor, Electrical and Computer Engineering
- Katerina Belazelkoska, Interim Program Director, Professional Master's Diplomas (ex-officio member)
- Anne-Marie Brinsmead (ex-officio member)
- Phil Walsh, Ryerson University
- Sean Conway, Ryerson University
- Bin Wu, Ryerson University
- Gary Thompson, Supervisor, Distributed Generation, Toronto Hydro-Electric Systems Limited
- Bob Singh, Manager, Assets, Hydro One Inc.
- Jenni Myllynen, Ontario Power Authority

Additional faculty members will be added to the Academic Coordination Committee at the time that academic curriculum development commences.

Meetings
The Standing ACC shall meet annually and may meet more often at the call of the Chair. At the meetings of the ACC, the Academic Coordinator will present reports which shall detail course registrations, diploma registrations, and diploma completion rates and/or any other business relevant to the state of the diploma.

Supervisory Load
The Director of the PMD will be the appointed from the Centre for Urban Energy / Department of Electrical and Computer Engineering in the Faculty of Engineering and Architectural Science with stipend. The GPD will serve as supervisor and advisor to diploma students and academic lead. The GPD may assign these roles to qualified designates as the program grows. The Graduate Program Council (GPC) bylaws will be modified to accommodate the new PMD in accordance with Ryerson Senate policy 112.

Resources for undergraduate programs only

Not Applicable.

5.0 QUALITY AND OTHER INDICATORS

a) *Definition and indicators that provide evidence of the quality of faculty expertise to contribute to the Diploma Program.*

This program will be jointly led and delivered by faculty and expert practitioners. The faculty designated to teach in the program are highly qualified and current in the area of Energy. Faculty members from the various Faculty of Engineering and Architectural Science departments will be delivering the curriculum. Expert practitioners from the industry have already been identified and will be interviewed for recruitment to provide appropriate additional expertise to contribute substantively to this graduate program. Expert practitioners from the field who are successfully recruited for teaching have the innovation and professional experience current for the diploma's curriculum and content. Please refer to the Faculty Curriculum Vitaes in 5.0 b) Quality and Other Indicators.
Resources identified earlier such as Mr. Bob Singh and Mr. Gary Thompson are recognized leaders in Energy and Innovation. Their inclusion in this program bring relevance and currency to the program.

b) *Evidence of a program structure and faculty research that will ensure the intellectual quality of the student experience.*

The diploma's program structure of four courses with evaluation of student work at the graduate level is commensurate with the advanced applied scholarship and research publications of the faculty members in the classroom teaching the diploma students, thus ensuring a superior quality student experience. Diploma teaching faculty's research is directly relevant to the intellectual quality this diploma program:

David Xu

- Bai, Zhihong; Ma, Hao; Xu, Dewei (David); et al., Control Strategy With a Generalized DC Current Balancing Method for Multimodule Current-Source Converter, IEEE TRANSACTIONS ON POWER ELECTRONICS Volume: 29 Issue: 1 Pages: 366-373 Published: JAN 2014.
- Wang, Jiacheng; Wu, Bin; Xu, Dewei; et al., Phase-Shifting-Transformer-Fed Multimodular Matrix Converter Operated by a New Modulation Strategy, IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS Volume: 60 Issue: 10 Pages: 4329-4338 Published: OCT 2013.
- Wang, Jiacheng; Wu, Bin; Xu, Dewei; et al., Indirect Space-Vector-Based Modulation Techniques for High-Power Multimodular Matrix Converters, IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS Volume: 60 Issue: 8 Pages: 3060-3071 Published: AUG 2013.
- Zhu, Ning; Xu, David; Wu, Bin; et al., Common-Mode Voltage Reduction Methods for Current-Source Converters in Medium-Voltage Drives, IEEE TRANSACTIONS ON POWER ELECTRONICS Volume: 28 Issue: 2 Pages: 995-1006 Published: FEB 2013.
- Wang, Zheng; Wu, Bin; Xu, Dewei; et al., A Current-Source-Converter-Based High-Power High-Speed PMSM Drive With 420-Hz Switching Frequency, IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS Volume: 59 Issue: 7 Pages: 2970-2981 Published: JUL 2012.
- Zhu, Ning; Kang, Jinsong; Xu, Dewei (David); et al., An Integrated AC Choke Design for Common-Mode Current Suppression in Neutral-Connected Power Converter Systems, IEEE TRANSACTIONS ON POWER ELECTRONICS Volume: 27 Issue: 3 Pages: 1228-1236 Published: MAR 2012.
- Li, Wuhua; Li, Weichen; He, Xiangning; et al., General Derivation Law of Nonisolated High-Step-Up Interleaved Converters With Built-In Transformer, IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS Volume: 59 Issue: 3 Pages: 1650-1661 Published: MAR 2012.
- Li, W.; Xu, D.; Wu, B.; et al., Zero-voltage-switching dual-boost converter with multi-functional inductors and improved symmetrical rectifier for distributed generation systems, IET POWER ELECTRONICS Volume: 5 Issue: 7 Pages: 969-977 Published: 2012.
- Wang, Jiacheng; Wu, Bin; Xu, Dewei; et al., Multimodular Matrix Converters With Sinusoidal Input and Output Waveforms, IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS Volume: 59 Issue: 1 Pages: 17-26 Published: JAN 2012.
- Li, Wuhua; Fan, Lingli; Zhao, Yi; et al., High-Step-Up and High-Efficiency Fuel-Cell Power-Generation System With Active-Clamp Flyback-Forward Converter, IEEE TRANSACTIONS ON INDUSTRIAL ELECTRONICS Volume: 59 Issue: 1 Pages: 599-610 Published: JAN 2012.

Bob Singh

- T. Xu, B. Venkatesh, C. Opathella and B. N. Singh, Artificial Neural Network Model of Photovoltaic Generator for Power Flow Analysis in PSSRSINCAL, IET Generation, Transmission and Distribution, 2013.
- C. Opathella, D. Cheng, B. N. Singh, B. Venkatesh, Intelligent Wind Generator Models for Power Flow Studies in PSSRE and PSSRSINCAL, IEEE Transactions on Power Systems, 28(2): 1149-1159, May 2013.
- S. B. Karanki, D. Xu, B. Venkatesh and B. N. Singh, Optimal Location of Battery Energy Storage Systems in Power Distribution Network for Integrating Renewable Energy Sources, IEEE Energy Conversion Congress and Exposition, Denver, Colorado, USA in Sept 2013.
- Co-authored "Sizing Energy Storage Facility for Voltage Regulation" with Mr. Sheraz Majid and Mr. David Curtis, 2012 CIGRE Canada Conference, Montreal, Quebec, September 24-26, 2012
- K.M. Farahani, B. Venkatesh, D. Xu, B. Singh, A. Lamp, A. Bukhari, PCC voltage control using flywheel system for large wind farm, 2012 IEEE 7th International Power Electronics and Motion Control Conference (IPEMC) – ECCE Asia, vol.2, pp. 1283 - 1286, June 2-5, 2012, Harbin, China
- Co-authored "Northern Micro-Grid Project – A Concept" with Mr. David Curtis, Paper No. 395, World Energy Congress, Montreal, September 2010
- June 2010 – August 2010: Taught "EE8604 – Analysis of Power Systems with DGs" to Master's students in the Electrical & Computer Engineering Department of Ryerson University, Toronto
- Co-authored "Non-Utility Generation Interface Protection Issues" with Mr. A. Boschetti, Electricity Today, June 1998
- Co-authored "Stray DC Transit Currents and their Effect" with Mr. G. A. Sheil, Paper No. 583, The NACE Conference and Corrosion Show (Corrosion '94), Baltimore, USA, 1994
- Consequences and Limits of Tolerance of Stray Direct Currents in Transformer Neutrals on the Distribution System and Need for, and Recommend Corrective Action (A. Sturton, G. Sheil, January 15, 1993) – Supervised the engineer and the consultant to examine issue of stray direct currents (in North York) in cooperation with the Toronto Transit Commission (TTC), identify corrective measures and recommendations.
- May 1986 – August 1986: Taught "Engineering 7832 – System Simulation" to final year students in the Electrical Engineering Department of the Memorial University of Newfoundland, St. John's
- May 1985 – August 1985: Taught "Engineering 7832 – System Simulation" to final year students in the Electrical Engineering Department of the Memorial University of Newfoundland, St. John's
- Master's Thesis "An Investigation of AC/DC Load Flow Analysis Using Newton's Method and Extensions", October 1983
- Co-authored " Generation Source Models in Optimum Operation of Power Systems" with Dr. M. E. El-Hawary, Proc. International Symposium on Simulation, Modeling and Decisions in Energy Systems, Montreal, 1978

Bala Venkatesh

- T. Xu, B. Venkatesh, C. Opathella and B. N. Singh, Artificial Neural Network Model of Photovoltaic Generator for Power Flow Analysis in PSS®SINCAL, IET Generation, Transmission and Distribution, 2013.
- K. Dadhania, B. Venkatesh, V. K. Sood and A. Nassif, Modeling of Doubly Fed Induction Generators for Distribution System Power Flow Analysis, Journal of Electrical Power and Energy System, 53: 576-583, 2013.
- N. Kurada, A. A. Dhanjal and B. Venkatesh, Evolving Perimeter Information Security Models in Smart Grids and Utilities, ISACA Journal (accepted for publications), 2013.
- P. Yu and B. Venkatesh, Fuzzy Security Constraints for Unit Commitment with Outages, IET Generation, Transmission and Distribution, Accepted, April 2013.
- Venkatesh, Feed-in Tariff, (invited article), McGraw-Hill Yearbook of Science & Technology 2014, Editor: Prof. M.E. El-Hawary.
- Opathella and B. Venkatesh, Managing Uncertainty of Wind Energy with Wind Generators Cooperative, IEEE Transactions on Power Systems, 28(30: 2918-2928, Aug 2013.
- Opathella, D. Cheng, B. N. Singh, B. Venkatesh, Intelligent Wind Generator Models for Power Flow Studies in PSS®E and PSS®SINCAL, IEEE Transactions on Power Systems, 28(2): 1149-1159, May 2013.
- R. Ghaffari and B. Venkatesh, Options based Reserve Procurement Strategy for Wind Generators – Using Binomial Trees, IEEE Transactions on Power Systems, 28(2): 1063-1072, May 2013.
- M. Dadkhah and B. Venkatesh, Cumulant based Stochastic Reactive Power Planning method for Distribution Systems with Wind Generators, IEEE Transactions on Power Systems, 27(4): 2351-2359, 2012.
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- P. Yu and B. Venkatesh, A Practical Real-time OPF method Using New Triangular Approximate Model of Wind Electric Generators, IEEE Transactions on Power Systems, 27(4): 2036-2046, 2012.
- Syed, A. Nassif, B. Wu and B. Venkatesh, Two-Layer Control Scheme for a Supercapacitor Energy Storage System coupled to a Doubly-Fed Induction Generator, Electric Power Systems Research, 86: 76-83, 2012.
- Y. He, B. Venkatesh and L. Guan, Optimal Scheduling for Charging and Discharging of Electric
- Vehicles, IEEE Transactions on Smart Grid, 3(3): 1095-1105, 2012.
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- Dukpa, B. Venkatesh and L. Chang, Fuzzy Stochastic Programming method: Capacitor planning in Distribution Systems with Wind Generators, IEEE Transactions on Power Systems, 26(4): 1971 - 1979 Oct 2011.
- Dukpa, I. Duggal, B. Venkatesh and L. Chang, Optimal Participation and Risk Mitigation of Wind Generators in an Electricity Market, IET Proceedings on Renewable Energy, 4 (2): 165-175, Mar 2010.
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- Dukpa, B. Venkatesh and M. El-Hawary, Application of Continuation Power Flow Method in Radial Distribution Systems, Electric Power Systems Research, 79 (11): 1503-1510, Nov 2009.
- Dukpa, B. Venkatesh and L. Chang, An Accurate Voltage Solution Method of Radial Distribution System, Canadian Journal for Electrical and Computer Engineering, 34 (1/2): 69 – 74, Win/Spr 2009.
- T. Zhang, A. Elkasrawy, and B. Venkatesh, A New Computational Method for Reactive Power Market Clearing, International Journal of Electrical Power and Energy Systems, International Journal of Electrical Power and Energy Systems, 31 (6): 285 – 293, Jul 2009.

- Venkatesh, P. Yu, H. B. Gooi and D. Choling, Fuzzy MILP Unit Commitment Incorporating Wind Generators, IEEE Transactions on Power Systems, 23 (4): 1738 - 1746, Nov 2008.
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- Venkatesh, A. Rost, L. Chang, Dynamic Voltage Collapse Index - Wind Generator Application, IEEE Transactions on Power Delivery, 22 (1): 90-94, Jan 2007.
- S. Chandramohan, R. P. K. Devi and B. Venkatesh, Radial system reconfiguration to minimize operating costs in markets, International Journal of Emerging Electric Power Systems, 8 (1): art. no. 2, Jan 2007.
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- Venkatesh and H. B. Gooi, Optimal Siting of UPFC, Electric Power Systems and Components, 34(3): 271-284, Mar 2006.
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- H. S. Lim and B. Venkatesh, An Efficient Local Search Heuristics for Asynchronous Multiuser Detection, IEEE Communication Letters, 7(7): 299-301, Jul 2003.
- S. Gunasekaran, B. Venkatesh and B. S. D. Sagar , Convergence Index for BPN Training, Special issue: Evolving Solution with Neural Networks - Edited by A. Fanni and A. Uncini in the Journal of Neurocomputing Letters, 55(3-4): 711-719, Oct 2003.
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- R. Ranjan, D. Das and B. Venkatesh, A new algorithm for power distribution system planning, Electric Power Systems Research, 62(1): 55-65, May 2002.
- B. Venkatesh, G. Sadasivam and M. A. Khan, An efficient multi-objective fuzzy logic based successive LP method for optimal reactive power planning, Electric Power Systems Research, 59(2): 89-102, Oct 2001.

Gary Thompson

TORONTO HYDRO ELECTRIC SYSTEM LIMITED, (THESL)
Asset Management – Capacity Planning
Supervisor, Distributed Generation & System Studies 2010 - Present
Transmission Capacity Coordinator 2009 - 2010

- Responsible for Distributed Generation Enabling and Connections. Also coordinating Transmission Lines and Stations Projects, Engaging with Hydro One management and personnel at all levels, and facilitating meetings and knowledge exchange between them and THESL, that enhance and sustain the capacity and reliability of THESL's incoming supplies.
- Current Member of OPA led Study on Distributed Generation & the Toronto Energy Supply
- Coordinated Systems Studies and Draft Recommendations for Distributed Generation Customers.
- Facilitated Protection and Control and Load Flow related activities for various projects related to Distributed Generation and Distribution Planning.
- Responsible for all matters related to enabling and connecting of Renewable Generation
- Facilitated submissions to the Ontario Energy Board including annual Rate Filling Submissions
- Represent THESL at engagements with Industry Stakeholders on Green Energy Act, FIT & MicroFit Programs.
- Manage the Long Term and Short Term Score Cards relating Hydro One's performance to THESL's Operations and Planning and corporate reporting on Distributed Generation.
- Plan and facilitate regular operational and planning meetings between both parties

Other: Evaluation Criteria in Addition to Those Specified in the Quality Assurance Framework

Once the program is implemented and delivered, in addition to standard university quality assurance processes and those being outlined under the umbrella of the diploma's Academic Coordination Committee's role, function and responsibilities, diploma alumni and employer feedback will also form the basis of a prospective quality assessment of the proposed diploma program on a bi-annual basis.

And of course, the PMD's Standing Academic Coordination Committee, in considering, among other inputs, teaching evaluations and samples of student work, including final diploma projects submitted by the Diploma Graduate Director, will decide annually whether it is necessary to augment the diploma's course content for currency with respect to new technologies and solutions for smart grids, energy storage, energy conservation, demand management, etc. and best practices of the industry in energy and innovation.

Institutional Approval
This diploma proposal was approved by Ryerson University Senate on _____.

6.0 APPENDIX I:

COURSE DESCRIPTIONS AND ASSESSMENT OF TEACHING AND LEARNING

Graduate Level Courses:

Evaluation (all courses)
All courses shall use tools such as assignments (30%), mid-term tests or projects (30%) and final test or projects (40%) in a suitable combination to evaluate students. The method of assessment shall be made available to students within two weeks of the start of the course. The test components would be administered in a manner that befits graduate programs.
Teaching Method (all courses)
In this program, all courses are lecture based interspersed with special lectures.

Course #1:
Smart Grids – Electricity, Petroleum, Infrastructure

Course Description
This course introduces the concept or promise of smart grids.

Suggested Reference Material
Readings and Reference material may be drawn from:

Smart Grid: Fundamentals of Design and Analysis, James Momoh, ISBN: 978-0-470-88939-8, March 2012, Wiley-IEEE Press.

Learning Outcomes
The course teaches various new technologies for smart grids and applications.

Successful candidates of this course shall be able to:
Gain knowledge of new tools in smart grids
Gain knowledge of details of communication systems
Gain knowledge of details of data processing systems
Gain an understanding of how energy systems may be better operated with smart grid technologies
Recognize the role of innovation in developing smart grids

Topics
Smart Grid Defined I (characteristics, communication, data privacy and security)
Smart Grid Defined II (policy and benefits)
The engineering and technological challenges
Smart Grid, Smart Meters and the Customer
Smart Grid Influence on Reliability
Studies Required to Enable the Smart Grid
Smart Grid and Asset Management
Smart Grid and Policy Challenges
Smart Grid Business Opportunities
Smart Grid Data Management and Data Analytics
The Smart Home

Laboratory
The students would intern in the Schneider Electric Smart Grid Laboratory for two sessions.

Course #2:

Demand Management and Conservation (new)

Course Description
This course shall describe various methods for peak demand reduction and conserving energy. The course shall develop models and methods for examining CDM methods.

Suggested Reference Material
Readings and Reference material may be drawn from:

Pollution Probe, Energy Primer, pp. 13-26.

http://www.pollutionprobe.org/energy/energyliteracy/docs/EnergyPrimer_LR.pdf
A. Meier, Fundamentals of Energy Efficiency: Understanding the Other Side of the Meter (UC Davis 2009), pp.13-61.

D. Elliot, Energy Society and Environment, (New York: Routledge, 2003), Chapter 2: "Energy and Environment." pp.19-45.

Learning Outcomes

The course shall describe various methods for peak demand reduction and conserving energy.

Note: CDM means Conservation and Demand Response.

Successful candidates of this course shall be able to:

- Describe forms and methods of demand management and conservation
- Describe forms and methods of conservation
- Compute benefits of demand management methods
- Compute benefits of conservation programs / tools
- Cost various forms of CDM programs
- Explain and compare various forms of CDM programs
- Identify how innovation contributes to the reduction of peak demand reduction and conserving energy

Topics
Introduction to Energy Efficiency and Demand Response
Demand Response as a Service
Types of Demand Response Programs
Ontario Case: Electricity System and Demand Response
Energy Conservation Mechanisms
Energy Conservation Methods
Energy Efficiency/Demand Response in Energy Planning
Evaluating Energy Efficiency/Demand Response Programs
Regulatory Perspectives in Energy Efficiency
Energy Efficiency Case Study: I
Energy Efficiency Case Study: II
Energy Efficiency Case study: III

Course #3:

Energy Storage and Use (new)

Course Description
This course shall survey and describe new and promising technologies for energy storage.

Suggested Reference Material
Readings and Reference material may be drawn from:

Energy Storage, Robert Huggins, Springer; 2010 edition.

Learning Outcomes
This course shall survey and describe new and promising technologies for energy storage.

Successful candidates of this course shall be able to:

- Describe forms and methods of energy storage systems
- Quantify benefits from different types of storage and identify relevant applications
- Cost various energy storage systems
- Compute efficiency and other performance parameters of energy storage systems
- Recognize the role of innovation in developing energy storage systems

Topics
Types of Energy Storage Technologies and Products
Uses of Energy Storage
Battery Storage
Flywheel Wheels
Compressed Air Energy Storage Systems with Potential for Adiabatic Methods
Pumped Hydro Storage
Fuel Cells
Ice Energy Systems
Economics of Storage
Examples

Course #4:

Electricity Markets (new)

Course Description
Energy business is driven by economics and this course shall discuss various forms of energy and their economic characteristics.

Suggested Reference Material
Readings and Reference material may be drawn from:

Electricity Economics: Regulation and Deregulation, Geoffrey Rothwell, Tomás Gómez, ISBN: 978-0-471-23437-1, February 2003, Wiley-IEEE Press.

Learning Outcomes

This course shall introduce candidates to mega-scale economics and explain characteristics of various types of energy systems.

Successful candidates of this course shall be able to:
Develop a mega-scale economic model
Analyze costs and benefits of different types of energy systems
Analyze and optimize energy market models
Undertake economic valuations of innovation in energy systems

Topics
Formation of Market and Nash Equilibrium
Game Theory
Optimization Basics
Electricity Market Formulation
Electricity Market Settlement
Ancillary Services
Electricity Market – Resource Procurement
Electricity Market – Fixed Tariffs
Real Power Dispatch
Unit Commitment

Course #5:

Final Diploma Project: Concurrently with the final course, the final diploma project is completed. Final diploma projects are expected to be approximately 40 pages double spaced. The topics might include:

Energy Markets – understanding and analysis;
Techno-economic analysis of conservation programs;
Design of demand management programs;
Assessment of smart grid solutions such as smart meters

The project is to comprehend new technologies in energy (innovation) in the context of economics enabling diploma students to make informed decisions in their workplace.

Learning Outcomes

This course shall enable students to focus on a specific topic of interest, analyze and report. The final project shall help shape their learnings and orient it to practical use.

Evaluation (Final Diploma Project)
The project shall be evaluated on a regular basis as below:

- [week 02] Project Scope and Outline (10%)
- [week 04] Literature Review and Basic Design and/or Analysis (20%)
- [week 08] Design and/or Analysis (30%)
- [week 12] Final Report (40%)