

CEQB Environment and Sustainability Committee

Final Report EIC Climate Change Technology Conference 2006 September 2006

1. Background

The Engineering Institute of Canada (EIC) together with its member technical societies organized and held the first Climate Change Conference 2006 (CCC2006), from May 10-12, 2006 at the Ottawa Congress Centre. Members of CEQB's Environment and Sustainability Committee (E&SC) attended this very successful conference and have prepared this briefing note for the CEQB, the CCPE Board of Directors and CCPE's Constituent Members (CMs). Further information on the conference, including available papers and presentations, is available at www.ccc2006.ca.

The primary objective of the conference was to advance the understanding and application of engineering to meet the challenges and solutions needed to mitigate and adapt to climate change and its associated social and environmental consequences in the 21st century. The aim was to raise awareness in the engineering community of the issues surrounding climate change.

Prior to the start of the conference, a day-long seminar consisting of three tutorial sessions was held. The first day of the conference was comprised of three plenary sessions, with a slate of high quality, prominent speakers and experts drawn from a variety of backgrounds and constituencies.

The final two days consisted of parallel track sessions where technical papers and presentations were presented. These were organized into the following themes:

- Track 1: Policy, Strategy and Regulations
- Track 2: Monitoring and Standards
- Track 3: Engineering for Mitigation
- Track 4: Engineering for Adaptation
- Track 5: GHG Markets and Risk Management
- Track 6: Modeling and Analysis
- Track 7: GHG Education Programs and Strategies

The full program is provided in Appendix A.

The conference attracted over 200 submitted abstracts, resulting in 145 accepted publications (papers/presentations). There were 31 accepted papers and presentations on the Engineering for Adaptation Track Session. Adaptation is the focus of CCPE's Climate Change Impacts and Adaptation Action Plan. Over 375 people were in attendance, consisting of engineers, scientists, researchers, and policy and planning personnel. A significant proportion of the delegates were from outside Canada, including the United States, United Kingdom, as well as from several European and Asian countries.

The conference attracted over 40 sponsors, who contributed over \$150,000 in sponsorship, helping ensure it would be a financial success. The level and diversity of the sponsorships was a strong indicator of the keen interest in the subject area, and recognition of the role and contributions that can and will be made by engineers.

1.1 CCPE Participation

The EIC created two committees to plan the conference:

- Organizing Committee (OC), chaired by J. Grefford, P.Eng.;
- Technical Program Committee (TPC), chaired by J. S. McConnach, P.Eng.

David Lapp, P.Eng., Manager, Professional Practice, represented CCPE on the OC, while Bob Dunn, P.Eng., Member of the CEQB E&SC was the CCPE representative on the TPC. Both individuals provided back up to each other for teleconference meetings of the OC and TPC so that one representative from CCPE was always in attendance. Monthly teleconference meetings of these two committees commenced in June 2004 and continued through to April 2006.

Bob Dunn also served as the Track Session Chair for the Engineering for Adaptation technical sessions. Through the E&SC, a separate subcommittee on the Engineering for Adaptation Track Session was formed to assist in the planning and development of the adaptation sessions, reviewing submitted abstracts and papers and making recommendations.

There was full and very active participation in the conference by all members of the E&SC. All members participated in the formal review process of the papers submitted for the Engineering for Adaptation sessions, each reviewing two or three papers submitted for the Engineering for Adaptation track sessions. All attended the conference and prepared notes of the sessions each attended. Some members also chaired individual adaptation track sessions.

CCPE contributed \$ 5,000 as a Gold Level Sponsor of the conference; the benefits included CCPE's logo on the conference kit bag and prominent display of the CCPE logo at the Plenary Session and the conference exhibit area.

CCPE also delivered a presentation on the work of the Public Infrastructure Engineering Vulnerability Committee (PIEVC) at one of the Engineering for Adaptation sessions.

2. Key Messages by Conference Theme

E&SC members participated in a post-conference, facilitated session to define the key messages from themes identified on the basis of their attendance at the technical sessions.

2.1 Engineering for Adaptation

- Small changes in climate have profound changes/impacts.
- Engineers need to determine the best way to incorporate extremes in future designs.
- Northern issues are important and need to be dealt with now.
- There is a need to enhance the resilience of existing communities and infrastructure.
- There is a need to adapt at the design stage as well as considering retrofit strategies.
- One strategy is to build in some provisions for adaptation in initial design/build to enable less expenditure for adaptation later e.g. expansion.

- The concept of “staged design” should be introduced to provide flexibility later.
- Engineers should undertake sensitivity analysis especially when applying climate change predictions.
- A major issue is how to bridge future changes with the decision-makers – what are the roles, how do engineers organize the right people to do the right thing;
- It was suggested that the CCPE propose the formation of an advisory committee to Environment Canada to update Intensity, Duration and Frequency (IDF) rainfall curves.

2.2 Engineering for Mitigation

- Carbon storage is coming – it will require new infrastructure to be designed by engineers.
- There is a big debate about the use of coal.
- Biomass is coming to serve as a power source that would help deal with environmental problems e.g. farm wastes.
- Take mitigation measures into account in the costs of designs.
- Buildings are an important source of GHGs – engineers need to take a bigger role in managing emissions from this sector.
- Need for distributed smaller power projects e.g. consumer point of production, co-generation.
- Innovative transformative technologies will be required.
- Improvements needed in regulatory permitting regime.

2.3 Policy, Strategy and Regulations

- Engineering profession must become engaged in policy discussions.
- All strategies (mitigation, adaptation, energy efficiency, alternative energy and sustainability) need to be implemented.
- Specify climate change requirements in RFPs, also look at efficiencies
- Renewable and non-renewable fuels need to contribute to the supply of power.
- Need to look at lead impact and lowest cost – optimization.
- More international discussions are turning towards technology solutions.
- Technology is the way forward but also need to involve social sciences in deciding on responses.
- Requires a holistic approach that includes socio-economic aspects.
- Expanded effort needs to be directed towards the education of industry.
- Further discussion with industry is required.
- Educate the educators.
- Need for innovation – think outside the box.
- Major shifts required, not just incremental improvements.
- Look at transformative technologies.
- More consideration of life cycle costing is required.

2.4 Monitoring and Standards

- There is still work to be done on sector specific standards (e.g. electricity sector), as this is an emerging area. There is also work to be done in the development of standards for specific growth technologies, such as wind and solar generation, as these reach maturity and beyond.

- Undertake better quality monitoring of water resources, especially in urban areas.
- Review regulatory environment for climate change, renewable energy and energy efficiency.
- Institute environmental accounting.
- Look at design standards, codes to revise/add.
- It is evident that much work has been done to develop and approve a sound grounding of international and national umbrella standards and protocols for GHG accounting for both entities and projects for all sectors.

2.5 Education

- Need for undergraduate education on climate change (courses currently given at Concordia and Caribou College).
- Continuing Professional Development (CPD) for engineers should be extended to include education on climate change for P.Engs.
- Need to promote cross-fertilization between disciplines to tackle a multi-disciplinary problem.
- How to educate at the high school level.
- Education of the public and clients of engineers also urgently required.

2.6 GHG Markets and Risk Management

- Canadian government is not willing to buy carbon credits in Canada and will not fund development in Canada.
- Canada cannot buy its way out of its GHG obligations – it must take responsibility with made-in-Canada solutions.
- GHGs reduction must be related to other benefits – do not judge on their own merits.

2.7 Modeling and Analysis

- Engineering community needs to understand the “state-of-the-art” in climate modeling;
- Models will change due to assumptions being revised or due to different assumptions being used between models.
- Need to show reliability of output, perhaps show 10% and 90% lines along with the average to show the range of possibilities – will help to establish uncertainty.
- Municipalities will need to choose a line – that’s how they do it now.
- Need to develop a standardized methodology for the use of models.
- Trends from the last 30 years could be extrapolated to cover the next 30 years rather than relying on models for the shorter design period?
- Need to understand the effects of basic changes in climate on the models.

3. The Engineering Declaration

Prior to the conference, EIC and its technical member societies drafted a declaration that would be issued as an outcome of the conference. It was overwhelmingly approved with only three opposed.

The text of the declaration is provided in Appendix B. The declaration has been forwarded to the Constituent Members of CCPE for their review with the aim of a potential endorsement by the CCPE Board of Directors.

4. Pre-Conference Seminar and Field Visits

The seminar consisted of three tutorial sessions including:

- Tutorial #1: Background for Engineers
- Tutorial #2: RETScreen – Clean Energy Software
- Tutorial #3: Response to Climate Change

In addition three field visits were arranged as follows:

1. CANMET Renewable Energy Technology Center
2. National Research Council Laboratories
3. IOGEN Straw-to-Ethanol Conversion Plant

One of the E&SC members (D. Lovely, P.Eng.) attended the tutorial sessions, as someone not versed in Climate Change issues. The tutorial achieved its purpose of providing a picture on the whole climate change issue and the required background to better appreciate the papers presented at the conference. The following are a few of the highlights from each of the sessions, extracted from his report.

Tutorial #1: Background for Engineers

Natural factors influencing climate change include such things as: solar variability (11 year sun-spot cycle), volcanic dust (in atmosphere for 2-3 years), internal variability (movement in Earth's core over 10,000 years) and geological effects (plate movements measured in millions of years).

Human factors related to climate change are not as numerous and are mainly confined to greenhouse gasses (CO₂, CH₄, NO_x, SO_x, H₂O), aerosols and surface albedo.

Natural changes in the radiance of the sun can explain about 30% of current warming trend that has occurred over the last 50 years. The other 70% is largely attributed to increases in CO₂ (a greenhouse gas) levels in the atmosphere. The level of CO₂ is now higher (360 ppm) than it has been over the last 650,000 years, with most of the increase occurring over the last 100 years.

It was pointed out that the "greenhouse effect" is not all bad. If there were no greenhouse effect, then based on energy flux considerations, the surface temperature of the Earth would be around 30 °C cooler. However, it does appear that human activity is increasing the effect.

Finally, the subject of climate models was discussed. These sophisticated computer models use data from the past to predict conditions in the future. There are about 20-30 different models employed throughout the world and all agree quite closely regarding temperature predictions. However, they are not as consistent with regard to precipitation forecasting.

Presentation on Peak Oil and Gas

Oil and gas are very convenient sources of energy that couple high density (~36 MJ/L) with an ease of extraction. However, this source of 'easy' energy took about 100 million years to produce and will be gone in 100 years!

At present oil and gas account for about 61% of Canada's energy, with hydro, coal and nuclear contributing 30%, leaving only 9% from alternate sources.

US production of oil peaked in 1970 (as predicted by Hubbard) at around 9.64 MB/day, which led to OPEC forming the cartel that led to the 1973 oil crisis. Current US production is now at about 50% of the peak and is comparable to production levels in 1950.

A similar trend has been observed in the UK with regard to the development of the North Sea that came on line around 1967. From start to finish, oil and gas production will be about 30-40 years – North Sea production has also passed its peak.

Since 1980 the worldwide discovery of new oil is less than we are using. There are also diminishing returns with regard to exploration costs. It is costing more and more to find and extract less and less oil! It is expected that worldwide oil will peak around 2010.

There is a similar scenario with gas, especially in Canada. In the Western Canadian Sedimentary Basin more and more drilling is finding less and less gas. In the east, it is predicted that offshore gas will be exhausted in 2010. Overall gas production in Canada peaked in 2001. Supply is declining at a rate of about 3% per year.

There is no good supply answer. Coal and nuclear will be pushed. Biofuels are incapable of replacing oil at anywhere near the current supply rate.

Tutorial #2 – RETScreen – Clean Energy Software

An overview of a software tool that has been designed to assist in project management of "Renewable Energy Technologies" was presented. While initially appearing as a plug for some software, the fact that the tool is supplied free-of-charge negates this assumption.

The software is based on Excel (package of macros written in VBasic) so the learning curve is easy provided you are familiar with the Microsoft product. Several demonstrations of the Version 3 software were given. The current software is being used in 213 countries worldwide, with projects ranging from a wind farm in Ireland to a photovoltaic water pumping system in Africa.

The software provides a five-step analysis of a proposed system to assess viability. These steps are: Energy model, Cost analysis, GHG analysis, Financial summary and Sensitivity & risk analysis. The tool is supported with an extensive database of commercial parts and products to aid in the design of a variety of systems.

A new version (4) is undergoing beta testing at present and will be available for general release later this year (2006). Added features include a worldwide weather database (useful for such features as expected wind speed etc.) and multi-language support (21 languages). This last feature permits rapid interaction between multi-national partners that can each work on a project and share analyses through the spreadsheet.

Tutorial #3: Response to Climate Change

The first presentation was largely an overview of the Kyoto Agreement and how various countries have approached the goals. The Kyoto Protocol was an attempt to provide a legally binding agreement to reduce GHG emissions to 8% below that of 1990 levels by the year 2012. Although 84 countries signed on to Kyoto (most developed countries) not all ratified the agreement by 2005 when the protocol became legally binding. Noticeable non-participants in Kyoto are the US and China; these two countries are responsible for 40% of all GHG emissions.

In general Europe is doing well with the Kyoto goals. In fact UK, Germany and France are on track to meet the -8% figure by 2010, two years early. At present (2006), **Canada is producing 24% more GHG emissions than in 1990**, with a projected level of +40% by the end of Kyoto in 2012. However, it appears that Kyoto has no teeth since there are no repercussions if targets are not met. What happens after 2012 is yet to be determined, but discussions are underway.

5. Summary of Plenary Sessions

On Day 1 of the conference there were three plenary sessions:

Plenary 1: The Big Picture
 Plenary 2: Engineering for Mitigation
 Plenary 3: Engineering for Adaptation

The following provides some of the highlights and key points arising from these sessions.

Plenary Session #1: The Big Picture

The presentations in this session included:

Plenary Chair and Opening Keynote Speaker: Dr. Arthur Carty, National Science Advisor, Canada

Donna Cansfield, Minister of Energy, Ontario

Simon Laddyckuk, Vice-President, EHS FIRST and Sustainability, Alcan Inc.
" Material and product solutions towards a more sustainable world "

Duncan Hawthorne, President & CEO, Bruce Power
" Nuclear Power, Friend or Foe ? "

Pierre Alvarez, President, Canadian Association of Petroleum Producers
" The Oil & Gas Industry's role in a Climate Change Strategy for Canada "

The highlights from A. Carty's presentation included:

- Crude oil alternatives face barriers which include costs, lack of accessible infrastructure (access, availability and safety) as well as technical issues, including material use;
- Stationary applications for power generation will be the first wide use of hydrogen fuel cells, since wide scale use in transportation is unlikely by 2030;

- Gas hydrates are the single largest source of untapped hydrocarbons – vast potential but environmental problems;
- There is no unique solution to future fuel needs – an integrated approach is required;
- Biofuels are being pursued by more than 60 companies in Canada, IOGEN is a world leader in production technology;
- Alberta and Quebec have the biggest capacity for wind power generation.

The key points from the Ontario Minister of Energy's presentation included:

- From 1993-2003 demand for energy in Ontario grew 8.5% while supply dropped by 6%;
- Need for clean reliable diversified energy supply but also focus on energy efficiency and conservation;
- Ontario is encouraging alternative power development with offers of fixed price long-term contracts;
- Vision for an east-west power grid – discussions with Manitoba and Quebec;
- Expect to develop 1350 MW in clean energy by 2007;
- Expect to reduce government demand for power by 5% by 2007; 10% by 2010.

Alcan's presentation focused on sustainable solutions to product development

- Second largest aluminum producer in the world – \$20B company;
- Global leader in engineered hi-tech products and packaging (food, pharmaceutical and cosmetic);
- Largest manufacturer of aerospace products in Europe;
- Alcan is a large emitter of GHGs – committed to reduce environmental footprint while maintaining production;
- Use best practices with existing technologies;
- Further R&D underway to reduce intensity of GHGs;
- Target GHG reduction of 10% between 2006 and 2010;
- Aluminum is one of the world's most recyclable metals – takes 5% of energy to recycle vs. original production;
- Use of aluminum cans is increasing.

Bruce Power made the following points in their brief presentation:

- 50% of Ontario's power is nuclear power;
- Every nuclear plant in Ontario will reach the end of its original service life by 2018 - \$30B investment is required;
- Suggested nuclear is the long-term power solution to support oil sands production, since the steam required is generated through natural gas, which will run out.

The CPPA made the following comments in their presentation:

- Energy consumption will continue to increase by an average of 1.5% per year to 2030 – we will need all forms of energy;
- All forms of energy are needed but oil remains the leading fuel;
- Coal will remain as a fuel because of abundance and low cost;
- CO2 capture and storage is an essential technology for GHG control;
- GHG emissions will increase fastest in developing countries.

Plenary Session #2: Engineering for Mitigation

This session consisted of several national and international speakers covering a broad range of topics as follows:

Plenary Chair and Opening Speaker: Richard Normandin, Vice President, National Research Council

" NRC - Canada's Partner for a Sustainable Future "

Dr John Grace, Director Fluidization Research Center, University of British Columbia

" Some Challenges and Technical Issues in Reducing Greenhouse Gas Emissions: a Canadian Perspective "

Prof. Martin Hoffert, New York University

" An Energy Revolution for the 21st Century "

Pierre Anctil, Executive Vice President, SNC Lavalin

" GHG Abatement in the Energy Sector "

Alan A. Johnson, former Managing Director, ZECA Corporation

" Clean Coal Technology "

David Deacon, Deputy Chairman and Executive Vice President, Azure Dynamics

" Commercialization of Environmental Technology: The Tipping Point "

The highlights of the NRC presentation included:

- NRC is a Federal institution with over 4000 employees, 1200 visitors, 150 research associates and 250 post-Doctorate Fellows;
- It operates the Canadian Institute for Science and Technology Information (CISTI) located in Ottawa;
- Operates 19 research institutes across Canada involved in technology that is important to the Canadian economy;
- Priorities for R&D include environmental technology, bioproducts, hydrogen power, biofuels, health and wellness
- Administers the National Building Code;
- Have NRC Industry Partnership Initiatives underway with 112 companies.

Some of the challenges in reducing GHG emissions were explained as follows:

- Canada has 0.5% of the world's population, but contributes 3.5% of the world's production of CO₂;
- To achieve the 6% reduction target for complying with Kyoto, Canada must reduce its emissions by 29% below "business as usual";
- Technical and non-technical changes are needed;
- Need to develop cleaner types of combustion, and biomass offers an opportunity;
- Challenge to capture CO₂ so that it can be sequestered – brief review of technological possibilities.

The presentation from SNC-Lavalin focused on strategies to reduce GHG emissions from power generation:

- SNC is an owner and operator of infrastructure as well as a consulting engineering company – therefore has a need to know and implement GHG reduction strategies for its own interests as well as for its clients;
- Electrical power contributes 19% of GHG emissions in Canada, 34% in the U.S.;
- Demand for power is expected to grow 1-1.5% annually in Canada, 6% in developing countries;
- Wind power supplies less than 1% of electricity now, but will grow by 10X by 2015 – unit costs are down to 8-12 cents/kwh which is getting to the range that power utilities are willing to pay;
- Canada is the #1 hydro-power producer in the world – exceptional flexibility and reliable source of power through freshwater management and energy storage;
- There is 118,000 MW of hydroelectric capacity still available for development in Canada;
- Only about 1/3 of the world's hydro potential has been developed to date;
- The barriers to development are community, social and financial issues, not engineering ones;
- Nuclear power plants are a necessary part of the energy mix – fuel is widely available;
- There are 42 Nuclear Power Plants (NPP) worldwide that generate 17% of the world's supply of power;
- Canada has 6 NPPs that generate 12% of Canada's power production;
- Coal has the highest intensity of GHG emissions at the present;
- The costs of CO2 capture and storage for coal will raise the costs of a currently cheap source of energy;
- CO2 capture and storage will not develop without a CO2 emissions trading system;
- Gas fired plants require less land area, shorter lead times and lower construction costs to develop;
- Gas fired plants could be part of the problem or the short to medium term solution for power needs and reduced GHG emissions depending on social costs;
- Canada needs to evolve a more diversified energy mix.

Plenary Session #3: Engineering for Adaptation

This session was chaired by CCPE. It consisted of four presentations:

Plenary Chair and Opening Speaker David Lapp, P.Eng., Manager Professional Practice, CCPE

" Adapting to Climate Change, An Engineering Perspective "

Dr John Stone, Canadian Representative IPCC, Director General Environment Canada - retired.

" The Role of Engineering in Addressing Climate Change - Experience from the Intergovernmental Panel on Climate Change "

Dr. Don Lemmen, Research Manager, Natural Resources Canada

" Meeting the Adaptation Challenge in Canada "

Paul Kovacs, Executive Director, Institute for Catastrophic Loss Reduction
" Building resilient communities -- adapting to the growing threat of high impact weather "

The CCPE presentation consisted of the following:

- Rationale for engineer's involvement in climate change as it threatens the ability of engineers to safely and effectively design infrastructure;
- CCPE's position on climate change;
- Brief description of CCPE's Climate Change Impacts and Adaptation Action Plan;
- Information on the national engineering assessment of the vulnerability of infrastructure to climate change through PIEVC;
- Use of the vulnerability information by CCPE, the CMs and individual engineers.

J. Stone who is a Canadian representative on the International Panel on Climate Change (IPCC) presented their experience in assessing technologies for mitigation and adaptation:

- Briefly reviewed the scientific evidence for, and the threat of, climate change;
- Historical background on the work of the IPCC and the salient details from the three published climate assessment reports;
- An update on the fourth assessment report, due to be published in 2007;
- Brief summaries of several IPCC Special Reports on: Aviation and the Global Atmosphere, Technology Transfer, Ozone and Climate and Carbon Capture and Storage.

D. Lemmen delivered a presentation that included:

- An overview of regional issues of concern across Canada– more than just extreme events;
- Climate projections and the issues around managing risk;
- Planning considerations and technologies for adaptation.

There is need to shift from science-driven to industry/user-driven research that focuses on existing challenges. Actions must involve key communities of practice including engineers, planners architects etc. An enabling environment must be created for adaptation that improves data, information, expertise and collaboration. Technology investment decisions should be guided by an understanding of the capacity to adapt.

In summary adaptation is building resilience into our infrastructure systems by:

- Increasing our ability to deal with the current climate;
- Preparing to take advantage of new opportunities; and,
- Reducing risks and costs of future climate change impacts.

The Institute for Catastrophic Loss Reduction (ICLR) spoke of their efforts in safety research, public outreach and infrastructure renewal. ICLR's primary audiences are community leaders, homeowners and small business. Statistics were presented on the number and costs of disasters from natural events in Canada and globally. Public investment trends in infrastructure were presented with an argument on the cost-effectiveness of infrastructure renewal, which should take climate change into account.

Copies of these presentations are available from CCPE.

6. Engineering for Adaptation Track Sessions

The Adaptation Track attracted a total of 31 papers and presentations, which were organized into seven (7) thematic sessions:

- Transportation;
- Climate Change Impacts on Engineering Structures;
- Infrastructure;
- Engineering Assessment and Solutions;
- Communities and Climate Change;
- Drainage and Run-Off;
- Water Resources/Coastal.

All sessions attracted between 45 and 70 delegates. The delegates rated all sessions good to excellent. The following are some of the highlights from the thematic sessions:

Transportation

- Besides linking our cities and communities, road transport supports many of our economic activities and even a small change in climate can have a major affect on our economy. Even modest changes in climate may have implications for the long-term maintenance of the Canadian road networks. In the prairies where transportation is the foundation of the economy, technologies are being developed to allow for adaptation and more aggressive real-time knowledge-based harmonization and rationalization of seasonal weight limits in a world of changing climatic conditions.
- Climate change has already had a big impact on the roads in northern Canada. Even a small temperature change has a significant on road trafficability and durability of ice roads.
- There is considerable evidence suggesting that road pavement infrastructure is sensitive to climate, principally through deterioration processes of thermal cracking, rutting and frost heave and thaw settlement. It is anticipated that climate change will lead to increased road maintenance costs, even in the lower latitudes of Canada.
- In permafrost areas, most of the settlement occurs along the edges of the road embankment. Engineers are working on the designs that will minimize these impacts.
- Drought conditions can cause shrinkage of clays, which can result in land surface subsidence and slumping.

Climate Change Impacts on Engineering Structures

- To cope with the new sources of uncertainty related to climatic change, structures can be designed for conditions anticipated to prevail in the mid-future, 15 to 20 years after commissioning, leaving the possibility for adjustments after a few years of operation, when climatic trends are quantified with less uncertainty.

- The last 30 years have exhibited increased warming trends in the north and continued warming will result in increased ground temperatures and thaw of the permafrost.
- Northern issues related to climatic change are important and need to be dealt with now.

Infrastructure

- Infrastructure is becoming increasingly vulnerable to the changing climate. The evidence can be seen in the exponential increases in worldwide losses from natural catastrophes, many related to infrastructure failures under extreme events. It is expected that infrastructure will be impacted both through gradual changes in weather patterns (e.g. increasing freeze-thaw cycle frequencies) and through increasing variability of extreme events.
- The many implications of the changing climate will require a structured approach for the updating of climate design values, codes and infrastructure standards.
- Adaptation to climate change will require that planners, their agencies, the engineering community and community decision-makers consider timeframes beyond statutory requirements and even beyond the lifetime of most individuals.
- When designing a project that has a service life in excess of 100 years, such as a hydroelectric project, it is essential that climate change be taken into account. It is very difficult to reliably predict the long-term climate trends, and it is often not cost effective to construct a hydroelectric project that will be efficient in one hundred years time. For these reasons, some engineers are designing structures that they anticipate will be effective for the next 20 years, and incorporating design features that would enable future modifications, when required.

Engineering Assessment and Solutions

- Most infrastructure built during the last century has been designed using the hypothesis that past climatic conditions for a given region are representative of future climatic conditions and hence can be used to design safe and efficient infrastructure. This hypothesis is clearly challenged by climate change, and the engineering community is gradually becoming more concerned with this issue.

Communities and Climate Change

- According to Infraguide, (the National Guide to Sustainable Municipal Infrastructure) infrastructure best practices in the future could include considerations for climate change impacts when dealing with repair or renewal of existing infrastructure as well as for planning the installation of new infrastructures.

Drainage and Run-Off

- One paper (J. Bruce) took a practical look on how to incorporate climatic change conditions and its uncertainty into the design of infrastructure systems.

- Paper by Arisz et al (Urban Drainage Infrastructure Planning and Design Considering Climate Change) discussed the strategies and concepts behind major and minor drainage systems to handle routine drainage and stormwater events.

Water Resources/Coastal

- Flood frequency analyses have shown that high intensity storms are becoming more frequent. For example, a 1: 100 year flood flow in the Grand River valley, Ontario, that was calculated using traditional methods, may be reduced to a 1:25 year event.
- Lowering of Great Lakes water levels due to climate change would have a significant impact on commercial navigation. Lower levels would decrease water depths and force vessels to reduce loads.
- Managing basin resources will become more important in the future as they are impacted by climatic change.

7. Conclusions and Recommendations

The EIC Climate Change Conference 2006 was very successful in the quality and diversity of the technical papers and presentations. It provided CCPE with 31 new papers on engineering for adaptation that can be used for outreach and education initiatives that are an important part of the CCPE Climate Change Impacts and Adaptation Action Plan. It is recommended that:

7.1 CCPE write a letter to EIC to congratulate them on a successful conference and to indicate our support for a second conference in two years time that would have engineering adaptation to climate change as one of its main themes.

CCPE was not responsible for the overall organization and did not have the financial responsibility for the conference. However, CCPE was a sponsor and actively contributed to its organization, including participation on the organizing and technical program committees. There was good value for the human and modest financial resources expended by CCPE through the CEQB Environment and Sustainability Committee. Therefore it is recommended that:

7.2 CCPE provide a similar level of financial support and organizational involvement for a second EIC climate change conference, provided it includes engineering adaptation to climate change as one of the principal themes.

The conference placed a heavy emphasis on technical content, with nearly 150 papers and presentations over three days. In many sessions there was limited time for questions or discussion with presenters in order to maintain the conference schedule.

Although there were many good presentations, there was little time available for discussion of the “big picture” around climate change, alternate energy development, strategies and policies around climate change adaptation, mitigation and energy development. The next conference should allocate a portion of the time for such discussions in a facilitated plenary session or through breakout groups. Therefore it is recommended that:

7.3 In its letter to EIC, CCPE should indicate the need to plan more time for questions and discussions between presenters and delegates at the next conference. The next conference should include one or more facilitated plenary or breakout discussions of climate change and sustainability policies and strategies, focusing on their development and implementation.

The conference provided a wealth of information and material that has been summarized in this report. The CEQB Environment and Sustainability Committee was able to summarize the key messages from the conference that need to be communicated to Canada's professional engineers.

7.4 E&SC recommends this briefing note be distributed to the Constituent Members of CCPE for information, and recommend it be forwarded to their environment and sustainability committees and support staff. Furthermore, the report should be submitted to the CCPE Board of Directors as well as other CCPE committees for information and as a record of CCPE's participation in the event.

More detailed information, including copies of many of the papers and presentations are available on the website (www.ccc2006.ca).

Prepared by:

CEQB Environment and Sustainability Committee

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September 2006

Appendix A – EIC CCC2006 Program Listing

**EIC CLIMATE CHANGE TECHNOLOGY CONFERENCE 2006
DETAILED PROGRAM**



Track 1: Policy, Strategy and Regulations Capital Hall 1B

Track 1: Paper Session One– “Global Greenhouse Gas Management” Capital Hall 1B Thursday, May 11, 8:00 AM, Chair: Ravi Seethapathy (TBC)		
6453 Presentation	Incentives for low carbon technology innovation and commercialisation – a Carbon Trust perspective	David Vincent, Technology Director, The Carbon Trust, London, UK
1389	A Strategy for Adequate Future World Energy Supply and Carbon Emission Control	H. Douglas Lightfoot, Global Environmental Climate Change Centre (GEC3) McGill University
7801	The Kyoto Protocol and Beyond – Policies and Strategies	S. Suresh Kumar, Scientist & Head, Planning & Evaluation, Regional Research Laboratory (CSIR), India
9001 Presentation	Swedish Climate Change Policies	Mr. Mikael Eriksson, Swedish Embassy in Ottawa
9022 EDAS 9943 Presentation	Oxy Combustion for CO2 Capture – Reducing Coal Fired Utility Boiler’s Emissions to Nearly Nothing	Keith B Rivers, Babcock & Wilcox, Canada

Track 1: Panel Session Two: “Greenhouse Gas Management Policies and Engineering” Thursday, May 11, 10:30 AM, Chair: Dr Anda Kalvins, Ontario Power Generation		
7499	Climate Change Policy: Targets, Commitments, and Energy Technology	Christopher Green, Professor of Economics, Maryam Dilmaghani, PhD Student, McGill University
3407	Kyoto and Beyond: Development of Sustainable Policy	Duane Pendergast, Principal Scientist, Computare, Lethbridge, Alberta, Canada
2973 Presentation	Public Attitudes toward Geological Disposal of Carbon Dioxide in Canada	Jacqueline Sharp, Mark Jaccard, School of Resource and Environmental Management, Simon Fraser University, David Keith, University of Calgary
4244	The Sustainability For A Change Initiative	Steven Davis-Mendelow, Markets and Airline Analysis, Regional Aircraft, Bombardier, Downsview, Ontario

Track 1: Paper Session Three: “Transferring and Enabling Technology” Capital Hall 1B Thursday, May 11, 1:30 PM, Chair: Sergei Podobed		
7611	Hydrogen Systems: A Canadian Opportunity for Greenhouse Gas Reduction and Economic Growth	Matthew Fairlie, Canadian Hydrogen Association, Melissa Dyck, Roderick Stewart McMillan, Vesna Scepanovic, Natural Resources Canada
2950	Renewable Energy As A Tool To Assure Continuity Of A Low Emission Brazilian Electric Power Sector	Oswaldo Soliano Pereira, Ph.D. Professor, Universidade Salvador – UNIFACS, Salvador, Brazil. (plus 4 other authors)
8191	Towards A Framework Of Clean Energy Technology Receptivity	Steve Thorne Director of Technology Receptivity South South North, Cape Town, South Africa
9002 Presentation	Technology Transfer in Large Energy Projects	Romney Duffey et al, Principal Scientist, AECL, Canada

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9003 Presentation	Products and Processes for Sustainability	Jack Jeswiet, Queen's University Kingston, ON
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Track 1: Panel Session Four: "Provincial and Sector Strategies" Capital Hall 1B Thursday, May 11, 3:30 PM, Chair: John C Luxat, President Canadian Nuclear Society		
6767	Evaluation of Greenhouse Gas Reduction Strategies: Provincial Perspective	Bassam G. Hamwi, M.Eng., P.Eng., MITE, Principal & Senior Transportation Planner, Morrison Hershfield Limited, Ontario
3452	Assessing the Bioenergy Option for Industrial Sustainability in the Great Lakes Region: Policy Decisions and Strategy Results	James D. Stephen, BIOCAP Canada Foundation, Queen's University, Ontario
3005 Presentation	Renewable Energy Supply and Fiscal Policy Instruments: What are the Trade-offs?	Paul Robillard, and Dave Sawyer Principal Marbek Resource Consultants Ltd., Ontario
2986	Ontario's Electricity Future. Technology, Economics, Environment	J. T. Rogers, Ontario
3448	Green Energy for Energy Security and Sustainable Development	Xianguo Li, Green Energy and Fuel Cells Research Group, Department of Mechanical Engineering, University of Waterloo, Waterloo, Ontario

T1-T3 Joint Paper Session: "Policy, Strategy and Mitigation" Capital Hall 5B Developing Mega-Engineered Greenhouse Gas Management Friday, May 12, 11:15 AM, Chair: Duane Pendergast		
6023	Energy and Long Term Greenhouse Gas Management	Duane Pendergast, Computare, Alberta
1487	Alternative Space-Based And Earth-Based Geo-Engineering Techniques As Supplemental Technologies For Mitigating Global Climate Change: What Can We Learn By Examining Such Technologies?	William B. Mills, Tetra Tech Inc., Lafayette California
2910 Presentation	Sustainable Fossil Fuels: Multi-Attribute Comparison of our Global Energy Options	Dr. Mark Jaccard, Professor, School of Resource and Environmental Management, Simon Fraser University, British Columbia
1426	Nuclear Fission Fuel is Inexhaustible	H. Douglas Lightfoot, Global Environmental Climate Change Centre, McGill University; Wallace Manheimer, Naval Research Laboratory, retired; Daniel A. Meneley, Engineer Emeritus, AECL; Duane Pendergast, Computare; George S. Stanford, Argonne National Laboratory, retired.

Track 2: Monitoring & Recording GHG Emissions and Climate Indicators.

Track 2: Paper Session: "Monitoring & Recording GHG Emissions I" Capital Hall 2B Thursday May 11, 8:00 AM, Chair: Malcolm Wilson, Director ITC for CO2		
9004 Presentation	Activities of ITC in combating Climate Change	Malcolm Wilson, Director, International Test Centre for CO2
1485	GHG Emissions from Light Duty Vehicles under a Variety of Driving Conditions	Lisa A. Graham, Research and Measurement Division, Environment Canada
1650	"Light Duty Hybrid Vehicles - Influence of Driving Cycle and Operating Temperature on Fuel Economy and GHG Emissions"	Lisa A. Graham, Research and Measurement Division, Environment Canada, Martha Christenson, Deniz Karman, Carleton University

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9005 Presentation	Using A Life Cycle Approach for GHG Measurement and Reporting	Duncan Noble, Five Winds International
1476	Russian Long Distance Gas Transmission Pipelines: Methane Losses, Mitigation Options, and Policy Issues	Stefan Lechtenboehmer, Carmen Dienst, Manfred Fishedick, Thomas Hanke, Wuppertal Institute, Roger Fernandez, US EPA, Don Robinson, Ravi Kantamaneni, Brian Gillis, ICF Consulting
1772	Selection of Climate Change Monitoring Indicators for the National Parks of the Northern Bioregion	Natalie Cooper, M.Sc., P. Biol ⁽¹⁾ ; Julia Krizan, Ph.D. ⁽²⁾ , and Bette Beswick, M. E. Des., P.Biol., Principal ⁽¹⁾ , Golder Inc.

**Track 2: Paper Session: “Monitoring & Recording GHG Emissions II” Capital Hall 2B
Thursday May 11, 10:30 AM, Chair: Dr Nader Mahinpey, University of Regina**

8442	Smart Communication Platform For Remote-Monitoring And Remote-Control	Prof. Chan-Wang Park, Université du Québec à Rimouski, Electrical Engineering, Quebec
1368	New Analytical Techniques for CO₂ Capture Solvents	Fatemeh Pouryousefi and Raphael O. Idem, Process System Engineering Laboratory, Faculty of Engineering, University of Regina
1521	Assessing Net and Gross Storage of CO₂ in the Subsurface and the Implication for CO₂ Credits	Jitsopa Suebsiri, Dr. Paitoon Tontiwachwuthikul University of Regina, Malcolm Wilson, International Test Centre for CO ₂
9006 Presentation	Reducing risk and quantifying uncertainty in terrestrial carbon sequestration projects	Karen Updegraff, South Dakota School of Mines and Technology, Rapid City, SD

Track 3: Engineering for Mitigation

**Track 3A, Paper Session I: “GHG Capture/Storage/Removal I “ Capital Hall 3B
Thursday May 11, 8:00 AM Chair: Dr. John Grace, UBC**

2704	Towards a Long-Term Solution To Carbon Dioxide Storage	Kamiel S. Gabriel, Huawei Han, University of Ontario Institute of Technology
2955	How <i>MicroSludge</i>[™] Can Lower GHGs at Wastewater Treatment Plants	Dr. Rob Stephenson, Krissy Price, Paradigm Environmental, Vancouver, BC,
2969	Regional Energy and CO₂ Integration For Reduction Of Greenhouse Gas Emissions And Local Air Quality Impact	Xiaotao (Tony) Bi, Department of Chemical and Biological Engineering, University of British Columbia, Vancouver, BC
1488	The Roles of O₂ and SO₂ in the Degradation of Monoethanolamine during CO₂ Absorption from Industrial Flue Gas Streams	Raphael Idem, Paitoon Tontiwachwuthikul, Faculty of Engineering, University of Regina, Teeradet Supap, Chintana Saiwan, Chulalongkorn University

**Track 3A, Paper Session II: “GHG Capture/Storage/Removal II” Capital Hall 3B
Thursday May 11, 10:30 AM Chair: Dr Xiaotao Bi, UBC**

2515	Pre And Post-Combustion Capture Of Carbon Dioxide Via Hydrate Crystallization	Rajnish Kumar, Praveen Linga, and Peter Englezos, Department of Chemical and Biological Engineering, University of British Columbia
2989	Carbon Dioxide Absorption Characteristics of Blended Monoethanolamine and 2-Amino-1-methyl-1-propanol	Anindo Dey, and Adisorn Aroonwilas Faculty of Engineering, University of Regina
2964	Mass Transfer in a Spray Column for CO₂ Removal	Jeffery Kuntz, and Adisorn Aroonwilas Faculty of Engineering, University of Regina
3009	Mitigating Human Enhanced Water Emission Impacts on Climate Change	Bruce Peachey, MCIC, P.Eng. President, New Paradigm Engineering Ltd, Edmonton, Alberta

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Track 3A, Paper Session III: “GHG Capture/Storage/Removal III” Capital Hall 3B Thursday May 11, 1:30 PM Chair: Dr John Grace, UBC		
2971	Mass-transfer Performance of CO ₂ Capture by Aqueous Hybrid MEA-Methanol in Packed Absorber	Phairat Usuharatana, Amornvadee Veawab, Adisorn Aroonwilas, and Paitoon Tontiwachwuthikul, Faculty of Engineering, University of Regina
2972	Kinetics of CO ₂ Capture by Blended MEA-AMP	Roongrat Sakwattanapong, Adisorn Aroonwilas and Amornvadee Veawab Faculty of Engineering, University of Regina
2967	Parametric Analysis of Mass-Transfer Performance in CO ₂ Absorber Using Aqueous MEA and MEA/MDEA	Anothai Setameteekul, Amornvadee Veawab, and Adisorn Aroonwilas, Faculty of Engineering, University of Regina
1515	Reduction of sulphur gas emissions using activated carbon	R. Azargohar and A. K. Dalai*, Catalysis and Chemical Reaction Engineering Laboratories, Department of Chemical Engineering, University of Saskatchewan,

Track 3A, Paper Session IV: “Industry” Capital Hall 3B Thursday May 11, 3:30 PM Chair: Hanan Jibry, OSPE		
7526	GHG Reduction and Economics of Scaleable Concentrating Solar Co-Generation Systems	Dave Gerwing, President, Menova Energy Inc., Kanata,
2035	Mitigation of Environmental Hazards Through Use of Post-Consumer Glass as a Cementing Agent in Mine Backfill	Euler De Souza and Jamie F. Archibald, Department of Mining Engineering, Queen’s University
7118	Inter-seasonal Underground Thermal Energy Storage Application in Canada	Bill Wong, Larry McClung, SAIC Canada, Aart Snijders, IF Technology International
8322 Presentation	Canada’s Clean Coal Technology Roadmap	Bill Pearson, Fossil Fuels and Climate Change Group, CANMET Energy Technology Centre

Track 3B, Paper Session I-B: “Renewables I” Capital Hall 4B Thursday May 11, 8:00 AM Chair: Marc Rosen		
1253	Economic aspects of greenhouse gas emissions reduction by utilisation of wind and solar energies to produce electricity and hydrogen	Mikhail Granovskii, Ibrahim Dincer* and Marc A. Rosen, Faculty of Engineering and Applied Science University of Ontario Institute of Technology
2434	Small Hydro as Green Power	Fred Schwartz, Mohammad Shahidehpour, Intellergy Corporation
1934	Potential for Electricity Generation from Emerging Renewable Sources in Canada	Morel Oprisan, Deputy Director S&T, Renewable Energy Technologies CANMET Energy Technology Centre
2947	Application of micro-hydropower Technology for Remote Regions	Ghanashyam Ranjitkar, Jinxing Huang, Tony Tung, CANMET Energy Technology Centre, NRCan

Track 3B, Paper Session II-B: “Renewables II” Capital Hall 4B Thursday May 11, 10:30 AM Chair: Dan Meneley		
9995	Progresses in Wind Energy Technology with a Focus on the Canadian Context	Antoine Lacroix, Wind Energy Engineer, CANMET Energy Technology Centre – Ottawa
2988	Hydrogen Production from Renewable Energy Sources	Julie Bastien, Cynthia Handler, Renewable Energy Technologies, NRCan

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3008	Life Cycle Analysis of Bio-Ethanol Production Using Effluent Irrigated Plantations as Feedstock	Monique Wismer, Mark Johnston, Ian Judd-Henrey, Saskatchewan Research Council
2987	Renewable Energy and Agriculture: GHG Mitigation and Waste Management Strategy	Claude Faucher, Julie Bastien, CANMET Energy Technology Centre – Ottawa, Natural Resources Canada,
2905	Future Hydrogen Production Using Nuclear Reactors	<u>Ramesh R. Sadhankar</u> , Jintong Li, Hongqiang Li, Donald K. Ryland and Sam Suppiah, Atomic Energy of Canada Limited, Chalk River Laboratories, Chalk River Ontario

**Track 3B, Paper Session III-B: “Transportation” Capital Hall 4B
Thursday May 11, 1:30 PM Chair: Nigel Fitzpatrick, Azure Dynamics**

2706	Life Cycle Assessment of Transportation Fuels and GHGenius	Vernel Stanciulescu, Jesse S. Fleming, Transportation Energy Use Division Office of Energy Efficiency Natural Resources Canada
2185	Greenhouse Gas Emissions from Gasoline, Hybrid-Electric, and Hydrogen-Fueled Vehicles	Robert E. Uhrig University of Tennessee
1908 Presentation	K9 APU - Locomotive Idle Reduction System	Ed Arts, Chris Gotmalm, Rafiq Qutub, EcoTrans Technologies Inc., Ontario
3889	Biodiesel Productions from vegetable Oils Using Heterogeneous Catalysts and Their Applications as Lubricity Additives	A.K. Dalai, M.G. Kulkarni and L.C. Meher, Catalysis and Chemical Reaction Engineering Laboratories, University of Saskatchewan

**Track 3A, Paper Session V: “Generation” Capital Hall 1B
Friday May 12, 9:15 AM Chair: Timo Makinen, Shell Canada**

7886	Energy from Waste/Gas Turbine Hybrid Combined Cycles and Their Potential for GHG Emissions Reduction	Kuanrong Qiu, Skip Hayden and P Sears CANMET Energy Technology Centre-Ottawa
3566	The Potential of Direct Hydrocarbon Fuel Cells for Improving Energy Efficiency¹	Marten Ternan, EnPross Inc.,
1588	High Efficiency Combined Heat and Power Solutions	David Villarroel, Manfred Klein, Oil, Gas and Energy Branch, Environment Canada
1633	Biopower Generation in British Columbia: An Opportunity for Greenhouse Gas Mitigation	Amit Kumar, Peter Flynn, University of Alberta Shahab Sokhansanj, University of BC
1751	Canadian solutions to global energy and environment challenges: green atoms	Dr. Romney B. Duffey, David F. Torgerson Alistair I Miller, Jerry Hopwood AECL, Ontario

**Track 3A, Paper Session VI: “Buildings” Capital Hall 1B
Friday May 12, 11:15 AM Chair: Dr. Loretta Li, UBC**

2951	Sustainable District Heating System: A Multi-Actor Perspective	Anish Patil, Austin Ajah, Paulien Herder, Delft University of Technology, Netherlands
1511	Reducing GHG Emissions through Efficient Water Heating Technologies	M. Thomas, A.C.S. Hayden, and D. MacKenzie Integrated Energy Systems Lab., CETC-Ottawa, NRCan
1884	A New CO₂ Sequestration Process via Building Products Production	Yixin Shao, Sean Monkman and Xutong Zhou, Department of Civil Engineering, McGill University
2929	Material and Operational Environmental	Paul Seguin, Mark w Lucuik, Adam Reid,

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	Impacts of Building Insulation: How much is Enough?	Morrison Hershfield Limited
2667	Cost Effective High Performance (Sustainable) Buildings for Reduced Greenhouse Gas Emissions in New Commercial Construction	Giuliano Todesco, CET Energy Systems, Jacques Whitford, environmental consultants.

Track 3A, Paper Session VII: “Buildings and Industry” Capital Hall 1B Friday May 12, 2:00 PM Chair: Nigel Fitzpatrick, Azure Dynamics		
3609 Presentation	Solar Buildings Research Network	Meli Stylianou, Network Manager
9025	Process Integration for Plant-Wide Energy Optimization and GHG Emission Reduction	Alain Legault CANMET Energy Technology Centre - Varennes Natural Resources Canada
1907	GHG Emission Reductions Using Solid Oxide Fuel Cells for Pollution Abatement	Gordon M. McAlary Fuel Cell Technologies Ltd.
2787	Environmental Benefits of Green Concrete	Abdelgadir Abbas, Fathifazl Gholamreza, Burkan Isgor, Ghani Razaqpur, Carleton University, Benoit Fournier, Canmet – MTL, Simon Foo, Pwgsc

Track3: Engineering for Mitigation: Poster Session Congress Hall		
1376 Poster	Aqueous 2-amino-2-hydroxymethyl-1,3-propanediol as Potential Carbon Dioxide Capture Solutions	David Le Tourneux ¹ , Maria Iliuta ¹ , Sylvie Fradette ² , Faiçal Larachi ¹ 1:Department of Chemical Engineering, Laval University, Québec, 2:CO2 Solution Technologies Inc., Quebec
9024 FC8-14 Poster	Utilization of 'green' energy in secondary processing of beef meat	Ignaci Victoria Thiagarajan, University of Saskatchewan

Track 4: Engineering for Adaptation

Track 4: Session One: “Transportation” Capital Hall 5B Thursday May 11, 8:00 AM Chair: Dennis Becker, President Canadian Geotech. Society		
1475	A Study on Adaptation Strategies for Road Embankments on Permafrost Affected by Climate Warming	German A. Ciro and Marolo C. Alfaro, The University of Manitoba
8244	Using Intelligent Transportation Systems to Adapt to Potential Climate Change Impacts on Seasonal Truck Weight Limits	Jeannette Montufar, Ph.D., P.Eng Department of Civil Engineering University of Manitoba Montufar@cc.umanitoba.ca
1734	Climate Change and the Performance of Pavement Infrastructure In Southern Canada: Context and Case Study	Brian Mills, Adaptation and Impacts Research Group, Meteorological Service of Canada, Environment Canada, Brian.Mills@ec.gc.ca
8258	Permafrost Thawing Impacts and Adaptations of Roads and Airfields In Nunavik	Guy Doré, ing., Ph.D. Department of Civil Engineering, Pavillon Pouliot, Université Laval, Québec, (Québec), G1K 7P4, guy.dore@gci.ulaval.ca
1491	The Use Of Convective Heat Flow In Road Designs For Northern Regions	Lukas Arenson, Dave Seago, Greg Newman University of Alberta, Department. of Civil and Environmental Engineering, Edmonton, AB, Greg

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Track 4: Session Two: “Climatic Change Impacts on Engineering Structures” Thursday May 11, 10:30 AM Chair: Dr John Stone Capital Hall 5B		
2494	Coping with Climate Change in the Design of Hydraulic Structures	Christian Guillaud, Department Head, Hydraulics, Hydrology, SNC-Lavalin, Energy Division
1479	Évaluation des impacts hydrologiques des changements climatiques au bassin versant de la rivière Péribonka (Québec) et proposition de mesures d'adaptation pour les opérations du système hydrique	Marie Minville, Francois Brissette, Robert Leconte, Département de génie de la construction, École de technologie supérieure, Montréal, Québec
8267	Rationalizing Climate Change for Design of New Structures on Permafrost	D. W.(Don) Hayley and W.T.(Bill) Horne, EBA Engineering Consultants Ltd., Edmonton, Canada
8307	Potential Cost Impacts For Adaptation of Building Foundation Infrastructure in the Northwest Territories	T. Edward Hoeve, P.Eng Principal Consultant, NT/NU, EBA Engineering Consultants Ltd, Yellowknife, NT, Canada
1440	Arctic Climate Impact Assessment: Impacts of a changing climate on Infrastructure: Buildings, Support Systems, and Industrial Facilities	Arne Instanes, Doctor of Engineering Instanes Svalbard AS / OPTICONSULT consulting engineers, Bergen, NORWAY

Track 4: Session Three: “Infrastructure” Capital Hall 5B Thursday May 11, 1:30 PM Chair: Pam Kertland, Natural Resources Canada		
8255	Changing Weather Patterns, Uncertainty and Infrastructure Vulnerability	Heather Auld and Don MacIver Adaptation and Impacts Research Group, Meteorological Service of Canada, Env. Canada
8253	Weathering of Infrastructure and the Changing Climate: Adaptation Options	Heather Auld Adaptation and Impacts Research Group, Meteorological Service of Canada, Environment Canada
8254	Adaptation Options for Infrastructure Under Changing Climate Conditions	Heather Auld Adaptation and Impacts Research Group, Meteorological Service of Canada, Environment Canada
8276	Mainstreaming Climate Change for Disaster Management: An Engineering Challenge	Dr. Monirul Mirza, Adaptation & Impacts Research Group (AIRG) Environment Canada c/o-Centre for Environment University of Toronto
8277	Planning for Atmospheric Hazards and Disaster Management Under Changing Climate Conditions	Heather Auld, Don MacIver, Joan Klaassen, Neil Comer, Environment Canada, Toronto, Ontario

Track 4: Session Four: “Engineering Assessments And Solutions” Capital Hall 5B Thursday May 11, 3:30 PM Chair: Dr Marolo Alfaro, University of Manitoba		
8266 Presentation	L’impact Des Changements Climatiques Et Quelques Implications Sur Le Génie	Alain Bourque, Ouranos, Directeur Impacts et Adaptation, Montréal, Québec
8310 Presentation	Addressing Climate Change in Municipal Infrastructure Best Practices	Justin Brule, Technical Advisor, Environmental Protocols, National Guide for Sustainable Municipal Infrastructure, Ottawa, Ontario
8274 Presentation	The Vulnerability of Canadian Infrastructure to the Changing Climate - The Role of the Engineering Profession	Joel R. Nodelman, P.Eng., Secretariat - Public Infrastructure Engineering Vulnerability Committee, St. Albert, Alberta To be presented by David Lapp
8271	The Implications Of Predicted Climate Changes On The Stability Of Geotechnical Infrastructure: A Case Study Of Field	Hughes, D. A. B., (Corresponding author), School of Civil Engineering, Queen’s University Belfast, Belfast. UK

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	Monitoring And Modelling Of Pore Water Response	
8311 Presentation	Climate Change Affecting Soil Dehydration and Building Settlements	Murray G. Sarafinchin, M.A.Sc., P.Eng. SARAFINCHIN Consulting Engineers Toronto, Canada

Track 4: Session Five: “Communities And Climatic Change” Capital Hall 2B Friday May 12, 9:15 AM Chair: Don Lemmen, Natural Resources Canada		
8257	Incorporating Climate Change Adaptation into InfraGuide Type Decision Making	Cameron Ells, P.Eng., Project Engineer / Manager, Cameron Consulting Incorporated
8305	Climate Change Considerations For The Port Hope Area Initiative May not be presented	J. Tamm, Atomic Energy of Canada Limited M. Morassutt Climet Systems J. Kirkaldy, P Coutts and D Chambers SENES Consultants Limited
8259 Presentation	Climate SMART – Mainstreaming Climate Change Considerations Into Municipal Decision Making	Rob Young, M.Sc., P.Geo. Associate, Dillon Consulting Limited, Halifax, Nova Scotia (To be presented by Cameron Ells)
2033	Estimation of Future Crop Water Requirements for 2020 and 2050, Using CROPWAT	Doria, R., Madramootoo, C. A., and Mehdi, B. B. McGill University, Montreal, Quebec

Track 4: Session Six: “Drainage and Runoff” Capital Hall 2B Friday May 12, 11:15 AM Chair John Manson, City of Langley, BC		
8262	Urban Drainage Infrastructure Planning And Design Considering Climate Change	Hans Arisz, P.Eng., Senior Associate, and Brian Burrell, Senior Engineer, Hydro-Com Technologies (a Division of R.V. Anderson Associates Limited), Fredericton, NB
1584	Climate change impacts on the performance of urban drainage systems for Southern Quebec	Alain Maihot, Sophie Duchesne, Eve Nantel, Jean- Pierre Villeneuve, Institut national de la recherche scientifique - Centre Eau, Terre et Environnement (INRS-ETE), Université du Québec, Gilles Rivard Aquapraxis inc., Laval Quebec, Daniel Caya, Consortium Ouranos, Montreal Quebec
8270	Methodology for Adapting Design Standards of Drainage Infrastructure	Dr. Paulin Coulibaly, Department of Civil Engineering, McMaster University, Hamilton, Ontario
8275	Changing Design Criteria For Heavy Rainfalls	James P. Bruce, Ottawa, Ontario

Track 4: Session Seven: “Water Resources/Coastal” Capital Hall 2B Friday May 12, 2:00 PM Chair: Dr Habib Rahman, NRC		
8273	Can We Adequately Quantify The Increase/Decrease Of Flooding Due To Climate Change?	Leconte R., DRAME Research Group, École de technologie supérieure, Université du Québec Montreal, Quebec
8260	Water in a Changing Climate: Understanding & Adapting at the Basin Scale	J. Fennell, Komex International Ltd., Calgary, AB
8263	Possible Locations for Adaptation to Climate Change by Canadian Commercial Navigation on the Great Lakes	Dr. Frank Millerd, Department of Economics , Wilfrid Laurier University, Waterloo, Ontario

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Track 5: GHG Markets and Risk Management Capital Hall 3B

Track 5: Paper Session One: “GHG Markets & Risk Management” Capital Hall 3B Friday May 12, 9:15 AM Chair: Pat Concessi, Deloitte		
9010 Presentation	The Role of Capital Markets in Adaptation to Climate Change	Craig A. Hart, Ph.D. candidate, Interdepartmental Doctorate, Massachusetts Institute of Technology
8161 Presentation	Macro and Micro Economic Principles of Kyoto - RESULT - “Making Money”	Andre Mech and Scott Rouse, Ontario
9012 Presentation	Environmental and Preservation Rights- An Ecological Stock	Vicente Rappaccioli N., M.B.A. Consultant.Professor of Sustainability. Founder, Harmonic Alliance. San José, Costa Rica.

Track 5: Panel Session Two: “GHG Markets” Friday May 12, 11:15 AM, Chair: Pat Concessi, Deloitte		
Panel 9013 9014 9015	Industry Panel Session on GHG Markets	Len Eddy, AgCert Bob Page, TransAlta Paul Vickers, NatSource

Track 5: Panel Session Three: “Focus on CDM Projects” Friday May 11, 2:00 PM Chair: Pat Concessi, Deloitte		
9017 Presentation	Developing a Risk Management Strategy for GHG Emissions Compliance and Carbon Market Trading	Patricia A. Hoyte CEO, Caiteur Group Inc., Toronto, Ontario
2942 Presentation	Sensitivity & Risk Analysis of GHG Projects using RETScreen Software	Gregory J. Leng, Section Head, RETScreen International, Natural Resources Canada (NRCan) CANMET Energy Technology Centre – Varennes, Varennes, Quebec
9018 Presentation	A risk-based approach to climate change adaptation decision-making	David Noble, Ontario

Track 6: GHG Education Programs & Strategies Capital Hall 5B

Track 6 Session: “GHG Education Programs & Strategies” Friday May 12, 9:15 AM Chair: Annette Bergeron, Director of First Year Studies, Queen’s University and Past Chair of Ontario Society of Professional Engineers		
8242 Presentation	Meeting the One-Thousand Tonne Challenge	Kevin R. Hydes, Canada Green Building Council, Rosamund Hyde and Kevin Courneya Stantec, North Vancouver, BC
1474	Environmental Advocacy Groups’ Perspectives on Carbon Capture and Storage	Jennie C. Stephens, and Preeti Verma, Clark University, Worcester, MA
8243 Presentation	Educating the Next Generation of Energy Professionals	George T. Bereznaï, Marc A. Rosen and William R. Smith, University of Ontario Institute of Technology
8246 Presentation	Strategies Required to Address Education Issues in the Fields of Efficiency and Renewable Energy	Steve Lapp, and Don Smith, Energy Systems Engineering Technician and Technologist Program, St. Lawrence College, Ontario

Track 7: Standards and Protocols Capital Hall 2B

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Track 7: Session One: “Standards & Protocols for GHG Markets” Capital Hall 2B Thursday May 11, 1:30 PM Chair: Michael Gerbis, President, The Delphi Group		
3043 Presentation	“Overview of ISO GHG Standards Development (ISO 14064 and ISO 14065)”	Kevin Boehmer Secretary, ISO TC207 Working Group 5, Climate Change, Secretary, Joint ISO CASCO/TC207 Working Group 6, GHG Validation/Verification Bodies, Canadian Standards Association, ON
3458 Presentation	“The WRI/WBCSD Greenhouse Gas Protocol for Project Accounting”	Derik Broekhoff, Senior Associate, World Resources Institute, Climate, Energy and Pollution Program, Washington, DC USA
4509 Presentation	“Practical considerations in applying standards for greenhouse gas measurement for quantification”	Steven B. Young, PhD, Peng, President www.GreenhouseGasMeasurement.com
7362 Presentation	A Comparison of the GHG Protocol for Projects and the ISO 14064-2 Standard	Patrick Hardy, DNV, Ottawa Canada.
9019 Presentation	“Development of TEAM Sector Specific Protocols and Lessons Learned”	Jiyoung Yu, Greenhouse Gas Technology Officer-Measurement & Reporting TEAM Office, NRCan Ottawa, Ontario

Track 7: Session Two: “GHG Guidelines” Capital Hall 2B Thursday May 11, 3:30 PM Chair: Jim McConnach, TPC Chair, EIC-CCC06		
3440 Presentation	“IEEE Standard Project P1595 for GHG Projects in the Electricity Sector”	James McConnach, Chair of IEEE-PES Task Force P1595
7355	Advancing Global Consistency in Estimating Greenhouse Gas Emissions from Oil and Gas Industry Operation	Karin Ritter American Petroleum Institute
9020 Presentation	The Development of Canadian Wind Energy Standards	Cynthia Handler, Analyst, Renewable Energy Technologies, NRCan
9021 Presentation	Quantifying Greenhouse Gas Emissions at the Project Level – Balancing Rigour with Practicality	Stephan Wehr, M.A.Sc. Manager – GHG Services The Delphi Group, Ottawa

Track 8: Modeling and Analysis Capital Hall 4B

Track 8 Session One: “GHG Emissions from Large Point Sources” Capital 4B Thursday May 11, 3:30 PM Chair Marc Rosen		
7889	An Exergy-Based Method for Allocating Carbon Dioxide Emissions from Cogeneration Systems “Part I: Comparison with Other Methods	Marc A. Rosen, Past President, Canadian Society for Mechanical Engineering and Professor and Dean Faculty of Engineering and Applied Science University of Ontario Institute of Technology, Ontario
7890	An Energy-Based Method for Allocating Carbon Dioxide Emissions from Cogeneration Systems “Part II: Justification for Exergy Basis	Marc A. Rosen, Past President, Canadian Society for Mechanical Engineering and Professor and Dean Faculty of Engineering and Applied Science University of Ontario Institute of Technology, Ontario
1753	Integrating Large-Cycle Co-Generation of Hydrogen and Electricity from Wind and nuclear sources	A.I. Miller and R.B. Duffey, ¹ Office of the Principal Scientist, CRL, Atomic Energy of Canada Limited

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1667	Improved Thermal Efficiency of Coal-Fired Power Station: Monte Carlo Simulation	T.Sanpasertparnich, A. Aroonwilas, and A. Veawab, Faculty of Engineering, University of Regina, Regina, Saskatchewan
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Track 8, Session Two: “Climate Change Modeling –I” Capital Hall 4B Friday May 12, 9:15 AM Chair: Dr A J Masys, Dept of National Defence		
1611	Uncertainty Analysis of Humidity and Precipitation Changes using Data from Global Climatic Models with a Case Study	Junaid Rafi Chaudhary, Tahir Husain, Faculty of Engineering and Applied Science, Memorial University of Newfoundland
3550	Understanding Climate Change through Modelling and Simulation: A Case for Verification, Validation and Accreditation	A.J. Masys, Department of National Defence Synthetic Environment Coordination Office (SECO), Canadian Forces Experimentation Centre (CFEC), Ottawa, Ontario
0411	Climate Change Effects on Timber Yields and Soil Expectation Values in Northern Saskatchewan	Mark Johnston, Saskatchewan Research Council
2496 Presentation	Analyse des enjeux Technologie et changements climatiques	Kochbati Héla, Tunisia

Track 8, Session Three: “Climate Change Modeling –II” Capital Hall 4B Friday May 12, 11:15 AM Chair: Anatoly Kurkovsky		
7753	Simulation Approach for Managing Emissions Trading Systems	Anatoly Kurkovsky, USIP, USA
2459	The Effects of Mass Transfer Parameters on the Modeling of A PEM Fuel	Nader Mahinpey, Arulkumar Jagannathan, Raphael Idem, Faculty of Engineering, University of Regina, Regina, SK
2970	Environmental Assessment of the Integration of Amine-based CO₂ Capture Unit to Coal-Fired Power Plants for Greenhouse Gas Mitigation	Bhurisa Thitakamol, Amornvadee Veawab, and Adisorn Aroonwilas, Faculty of Engineering, University of Regina, Regina, Saskatchewan
2937	Life-cycle assessment, an essential tool to highlight the true potential of energy technologies	Luc Gagnon, Senior Advisor, Climate Change, Hydro Quebec
8911	On the Use of Multi Site Generated Meteorological Input Data for Realistic Hydrological Modeling in the Context of Climate Change Impact Studies	M Khalili, Robert Leconte, Francois Brissette, École de technologie supérieure, Montréal, Canada

Track 8, Session Four: “Life Cycle Analysis” Capital Hall 4B Friday May 12, 2:00 PM Chair: Deniz Karman, Carlton University		
1952	Life Cycle Analysis of GHG Emissions from Transportation Projects	Deniz Karman, Department of Civil and Environmental Engineering, Carleton University
1728	Modeling Intelligent Transportation Systems and Their Implications for Climate Change	Jennifer Armstrong, Morrison Hershfield Ltd., Ontario, Ata Khan, Carleton University
1407	Modeling Social-Economic-Climatic Feedbacks For Policy Development	Evan G.R. Davies, Slobodan P Simonovic University of Western Ontario
2944	Life Cycle Analysis Approach to Green House Gas Emissions in Electric Arc Furnaces	Mohamed Boutazakhti, Howard Goodfellow, Joe Maiolo, Techint Goodfellow Technologies Inc., Techint Goodfellow Technologies Inc., Alak Chanda, Unisearch Associates Inc., Murray J. Thomson, University of Toronto

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Track 8 Poster Paper		
9023	"The role of multiscale analysis and complexity measures applied to climate change data"	W. Kinsner, A. Faghfour, and M. Potter, University of Manitoba

Errata:

Paper number 3407, "Kyoto and Beyond; Development of Sustainable Policy", by Duane Pendergast in Track 1, Session Two, contains an error. Section 3.3 mistakenly indicates one tonne of carbon would yield 16 tonnes of methane when combined with hydrogen. The correct amount is 1 1/3 tonnes of methane.

Appendix B – Engineering Declaration

Climate Change Technology Conference
 Engineering Challenges and Solutions in the 21st Century
 May 9 - 12, 2006 - Ottawa, Ontario, Canada

THE ENGINEERING OBLIGATION
A DECLARATION BY THE ENGINEERING INSTITUTE OF CANADA,
ITS TEN MEMBER SOCIETIES AND OTHER
PARTICIPANTS OF THE 2006 CLIMATE CHANGE TECHNOLOGY CONFERENCE
PREAMBLE

The Engineering Institute of Canada (EIC) and its member societies took action to stimulate awareness and activity within the Canadian engineering community with respect to climate change by holding a three-day conference with the theme "Climate Change: Engineering Challenges and Solutions in the 21st Century". The conference attracted engineers of many disciplines as well as other specialists working on climate change monitoring, mitigation and adaptation. Representatives from a broad spectrum of interests (including industry, manufacturing, academia, government agencies and regulators, consulting firms, and special interest groups) participated in discussions concerning the application of Engineering to (a) meet the challenges posed by a changing climate and (b) provide the solutions needed to mitigate climate change and adapt to its associated social and environmental consequences.

This Declaration is a statement arising from the conference. It states the view of the Engineering Institute of Canada and its member societies, and represents a consensus of the majority of conference participants.

PROCLAMATION

Whereas:

Changes in the composition of the atmosphere have been measured;

Considerable scientific evidence exists that the global climate has changed during the 20th century and will continue to change during the 21st century;

There is consensus among scientists that climate change could detrimentally impact human health, safety, and economic livelihood, and the survivability and vitality of natural ecosystems;

The possibility of negative impacts of climate change and due prudence imply that remedial action be most seriously reviewed now, despite remaining uncertainties over their nature, magnitude and timing;

Engineering measures that mitigate or adapt to climate change could also be beneficial regardless of the nature, magnitude and timing of climatic change;

Environmental protection, enhancement, and sustainability are fundamental to all areas of engineering practice;

All engineers bear a responsibility through their decisions and actions to contribute to the sustainability of our environments; and

Recognizing that engineering and technology are vitally important in addressing the impacts of climatic change, the Engineering Institute of Canada and its member societies, in accordance with the spirit and substance of The Shanghai Declaration on Engineering and The Sustainable Future, make the following Proclamation.

The Engineering Profession

Engineers should realize that climate change affects our environments and challenges their ability to plan, design and construct infrastructure and systems that can protect people from harm and maintain acceptable standards of economic well being.

Engineers have a duty to improve human social infrastructure, including the preservation of the environment. Accordingly, they should include scientific knowledge of climate change in their engineering practice. Engineers have an obligation to meet the needs of current and future generations by maintaining the environment and its ecosystems, and creating sustainable development.

Engineers should obligate themselves to consider measures to manage potential effects on climate during the conception, design, manufacture, construction, operation, and remediation/disposal of engineered facilities and products, whenever possible and the life cycle of their works should be evaluated in the context of global impacts.

Role of Engineering Organizations

Canadian engineering organizations need to emphasize the potential effects of climate change as an important consideration in the planning, design, manufacture, construction, maintenance and operation of reliable products and sustainable infrastructure. As learned societies involved with the exchange of engineering information, the Engineering Institute of Canada and its constituent societies will continue efforts to inform the engineering community about climatic change.

Canadian engineering organizations need to create greater public understanding and awareness of the role of engineering in social and economic development. Furthermore, they need to promote public and private support for engineering education, continuing education and professional development, and capacity building within the engineering profession to deal with emerging problems related to climate change.

Canadian engineering organizations need to disseminate their knowledge to external engineering organizations and learned societies.

PARTICIPANTS' CALL TO ACTION

We, the participants at the Climate Change Technology Conference, CCC2006, commit ourselves and call upon all engineers, engineering organizations, and international engineering bodies to acknowledge the challenges posed by climate change and to adopt actions, precautionary or otherwise, to give practical expression and impetus to the development of solutions to these challenges. We recognize that this declaration may help guide our profession in its partnerships with other stakeholders for the purpose of ensuring the sustainability of our environment.