Presentation to the Standing Senate Committee on Energy, the Environment & Natural Resources

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David B. Layzell, PhD, FRSC, Executive Director,
Institute for Sustainable Energy, Environment and Economy
University of Calgary

Thank you, Mr. Chair, for the opportunity to be here today. I congratulate you and this Committee for the **comprehensive** approach that you have chosen to use to address issues that are **at the centre of Canada's future** for energy, our environment and the economy of the nation.

Let me begin by introducing the Institute for Sustainable Energy, Environment and Economy (ISEEE). **ISEEE** is a multi-Faculty research and teaching organization at the University of Calgary that has a mandate to develop cost-effective solutions to address the environmental challenges of energy production and use.

We work with about 120 engineers, scientists and social scientists at the U of C to develop the **human capacity** and **research delivery vehicles** needed to provide the critical technologies and insights that will **inform** energy-environment policy and investment decisions by Canadian governments and industry.

One thing that ISEEE has done over the past 18 months has been to build '**Carbon Management Canada',** a national university research organization focused on managing carbon in the fossil fuel sector. Our work, and that of our partner organization – **The Canada School of Energy and Environment** - paid off this morning when the **Networks of Centres of Excellence** (NCE) program announced **$25M** in federal funding for our 'Carbon Management Canada' initiative.

Over the next 5 years, Carbon Management Canada will focus on research to **reduce the greenhouse gas** emissions associated fossil fuel recovery and processing, and **develop the technologies and insights** to capture and safely store carbon dioxide emissions in geological reservoirs.

With Carbon Management Canada now officially launched, ISEEE is focusing its attention on building a new, **interdisciplinary research capacity** that will work to **understand and make recommendations** regarding future North American energy systems that will take us on the path towards sustainability.

Today, I would like to talk with you about some of my thinking in this area.

About 3 weeks ago, on November 10th, the **International Energy Agency** released their 2009 World Energy Outlook report. This 691 page tome highlighted two scenarios for future energy systems and the resulting implications for global greenhouse gas emissions as shown in **Chart #2** of the document that you have in front of you:

- **The Reference Scenario** assumes 'Business-as-usual' energy policies for the next 40 years, and predicts a **58% increase** in GHG emissions between now and 2050. Such a scenario would likely have devastating effects on our global climate system, with serious implications for the world economy and the health of its citizens.
- **The 450 scenario**, shown at the bottom of Chart #2 and recommended by IEA, **summarizes the trend** in global GHG emission required to limit global warming to 2°C; a temperature that should prevent '**dangerous' or 'run-away'** climate change.

Chart #3 shows the **commitment** that the Canadian government has made to a global effort to **mitigate climate** change including a 20% reduction in GHG emissions by 2020, and a 65% reduction by 2050.

Only a small part of this commitment could be met by reductions in non-energy GHG emissions such as those from landfill sites, animal production systems, or deforestation. The **majority** of the emission reductions will need to come from the energy sector that currently accounts for about 80% of Canada's GHG emissions.

Initiatives to reduce energy emissions include:

- **Efficiency and conservation** through the entire energy system - from the **production** of energy to the **use** of that energy - effectively reducing the **'per capita' market size** for primary energy in Canada;
- The implementation of low carbon **Renewable and Alternative Energy** including biomass, wind, solar, geothermal and nuclear;
- The **capture and storage of fossil carbon** emissions, in either geological and biological storage systems.

All **three** of these strategies for reducing **energy** emissions will require major changes in the **market size and market share** for energy production and use in Canada.

In effect, we need to see close to a **2% change in market share** for each and every year over the next 40 years. This represents a **massive energy transformation** as shown in Chart #4 (*which I don't have time to dwell on here*).

Chart #5 shows the history of market share transitions in primary energy in the USA over the past 200 years. Over this period, there have been **two major energy transitions** (gray shading) – one in the **late 19th century** when the US went from biomass to coal, and one right **after the 2nd world war** with the rise of oil and gas.

Please note three things about this chart:

1. The relative market share (MS) for primary energy sources has been unusually **stable** for the past 40 yrs;
2. **Before** a primary energy alternative (like coal, oil or gas) started to take **serious market share** from other sources, there was a long '**incubation period'** (~40 yrs) for MS to increase from 1%→10%. This has **sobering implications** for many renewable energy sources that today account for less than 1%.

3. The **maximum rate** of market share change was 1-2% per year. Recall that in the next 40 years, we need close to a 2% market share change per year.

So **what** are the factors that **favour rapid** energy transitions, and how does our situation today compare with the **conditions that drove** past energy transitions?

In short, current conditions are not very favourable in North America. We are"

- **not** likely to have rapidly growing demand in North America,
- the alternatives tend to be **more expensive**, not less,
- we **don't** have resource depletion, especially in Canada, and
- **many** of the alternative technologies have **not** been proven for large scale deployment.

The only real driver for an energy transition is **government policy** whether it is at the **regional, national and international** level. Clearly, the **next** energy transition is going to be **more** difficult and **more** policy dependent than past energy transitions.

So what **are** the policy instruments that could be implemented **NOW** to ease this transition?

I would argue that governments need to **focus their policy** instruments to achieve **optimal results** over three distinct periods in the next 41 years, as summarized in Chart #6:

- For results in the **Short Term** (next 14 years) we need to encourage **efficiency and conservation** across our energy systems *(- that is our low hanging fruit -),* as well as the **widespread deployment** of low carbon energy technologies that **integrate** with our existing energy infrastructure;
- For results in the **Medium Term**, we need to **set up and demonstrate** large scale deployment of **known** low carbon energy technologies (such as CCS, nuclear energy, electric vehicles), **and** we need to **fund R&D** that is focused on **reducing costs or removing barriers**; and

- For results in the **Longer Term** (approaching 2050), we need to invest **now** in **fundamental**, highly innovative research that has the potential to provide '**game-changing' energy production and conversion technologies**. I don't think we yet have the technologies to get us where we need to be by mid century.

Doing this effectively requires a **national energy strategy** that will address concerns about **energy security and climate change**, but not transfer problems to other areas such as **food production, water use or biodiversity**. I am encouraged that the work of your committee may help to move us in that direction.

Thank you for this opportunity.