Workshop Summary

Hydrogen and Governance

Exploring paths to a low-carbon society

16-18 October, 2005
University of Victoria

Rod Dobell (editor)
University of Victoria
July, 2006

Disclaimer: This report is based on an informal record of discussion as summarized by a variety of observers from the organizing committee. In its current form it has not been reviewed by workshop participants.

Executive Summary
Victoria Workshop, October 16-18, 2005

1. Overview

- This first workshop, as originally envisaged, centered on an exploration of the challenges involved in a social transition to a hydrogen-based economy. As the workshop program developed, the title of the event ("Hydrogen and Governance") was elaborated by the addition of a subtitle – "exploring paths to a low-carbon society". This broader context was reflected in the range of papers prepared for the workshop and in the discussion around them.
- The workshop consisted of three main segments – a keynote address by Ged McLean of Angstrom Power; three sessions outlining the evolution and current status of relevant technologies, and some implications (environmental, economic, cultural, legal) of social choices around large technological systems; and three sessions exploring the dynamics and challenges of such social choices, including institutional and procedural barriers. The last session addressed specific "crunch issues" meriting future work.
- iettof Angpharks, celecteespworkbthe ad8visa

of activities within targeted international initiatives and official development assistance.

- In the final workshop session, participants were asked to group their concerns, observations and suggestions for future work under a number of general headings. Although the time available precluded an exhaustive compilation of ideas, this summary exercise provided the basis for the structuring of future work proposed below.
- The final session confirmed the richness of the information and views generated at the workshop. The diversity of opinion reflected the deliberate

questions might be grouped under four broad themes: Timescales, technology and decision-making; Energy policy-making—governing instruments and federal-provincial relations; Local governments, local impacts, and cross-sectoral demonstration projects; Risk perceptions and safety standards—technological aspects of government decision processes.

3. Next Steps

- From the discussion at the workshop

Hydrogen and Governance:
Exploring paths to a low-carbon society
Victoria Workshop October 16-18

I. Introduction

With increasing demands for fuel and electrical power, Canada will need the security and sustainability of alternative forms of energy. The use of hydrogen as an energy carrier is foreseen as potentially playing a critical role in future energy plans nation-wide. The projected 30 to 50 year transition to a low-carbon society will bring difficult decisions to Canada and Canadians. To ensure the fluidity of this shift, the coherence and effectiveness of technology and all forms of institutions is essential. The Institute for Integrated Energy Systems (IESVic) and the Centre for Global Studies (CFGS), at the request of the Social Sciences and Humanities Research Council (SSHRC), organized a meeting entitled "Hydrogen Governance: Paths to a Low-Carbon Society" held in October, 2005. This was planned as the first of a proposed two-to-three-year series of workshops with several objectives:

- To increase awareness and understanding

might be goals that need to be set or clarified; challenges that need to be overcome; instruments or means to overcome them; or barriers to doing so. These lists suggest initial research agendas for working groups or commissioned analysis. Subsequent discussion may entail augmenting, correcting (or possibly putting aside) this starting frame.

A final section in this present report makes brief reference to three cross-cutting tasks

Generally speaking, neither government nor public opinion is technologically well informed on the topic of hydrogen. Those involved must be attentive to the particular Canadian context: different countries are facing different challenges and opportunities (e.g. Canada vs. China). It must be asked whether there is a technology gap or a policy gap that is preventing the wider use of hydrogen - a serious question in terms of guiding policies.

A fundamental challenge is that of providing useful, effective advice to governments about how to proceed.

large demand centres, with the goal being C02 reduction. Secondly, from a small-scale counterpoint; the role of small scale technology solutions (central generation of electricity is evolving into distributed generations, mostly due to transmission limitations (e.g. EU countries). Backlash issues were raised. There is uncertainty whether hydrogen will necessarily lead to a low carbon path come production end.
Current subsidies of the oil economy create an unfair playing field for other energy options, the cost of carbon emissions not included. (note – nuclear was not cost effective when first started, now is (close?) Subsidies for managing the end of cycle issues have not been accounted for. Competition for R&D funding dollars is an issue. Hydrogen may not directly compete against other fuel technologies, but it does compete for energy and other industry funding.
Management options were also discussed, resulting in the following suggestions:

- fiscal incentives/disincentives
- carbon taxes
- caps
- demand management route
- buying time -- starting with cost effective options

Session 3: What are the economic, political, legal and cultural challenges of moving toward a sustainable energy future?
There is a lack of a clear niche for hydrogen, which is unrecognizable without government intervention. The inertia of incumbent technologies, industries , economies and political relationships can be a barrier but can also evolve to create synergies with hydrogen energy technology, for instance the role of nuclear energy in alleviating climate change.
Public understanding of key reasons for change is not at a high enough level on topics such as security, health and global warming. A vision needs to be created for the public, decision-makers, government officials and investor

- Policy/decision makers' lack of understanding and mistrust of the public
- Institutional
  - media – slashing budget for S&T coverage
  - senior policy makers lacking technology background
  - organization of Canadian government cannot handle cross-cutting issues

Governmental time scale does not match with the urgency of problem; problems need to be framed so policy/decision makers can see relevance to the issue in their own time frame. Economics can not always lead policy decision-making processes.
In deconstructing science and policy, policy must lead but science can help. Science influences policy, which influences the type of science that receives funding. Scientists have a limited ability to 'sell' their decisions independently.
But, relying on a technological fix for social problems may alienate the public.

Involvement of Citizens/Public
How and when to engage the public must be considered. Is engagement needed at all in some situations? Once consulted, how can public views be transformed into policy (process)? The definition of "public engagement" varies – engagement vs. consultation, opinion mining vs. education, quality. Are there specific models that can be followed? For example, the nuclear industry public engagement process is lengthy, costly and intensive. Values and trade-offs must be examined.
Public consultation provides special insights, but complex issues are not always well absorbed by the public, therefore 'leading' may be required. The public may not always accept the outcome but it is important that the process is accountable and trustworthy. Trust and confidence are key to social acceptance.
Panicking the public into fast action may have adverse effects

Risks
What requirements do specific technologies have to live up to considering the varying values and desires of Canadian society? What trade-offs are people willing to accept? The human element in technology is a major element of risk.

Others
Distributed systems are at a scale that may better involve people than would large-scale centralized systems.

There is the possibility of regulatory failure, not necessarily market failure.

No coherent packaged energy or climate change strategy exists that can be delivered to the public for feedback and consultation. Regarding climate change, the public does not trust that any political action will follow any strategy formation.

Session 5: What roles should government, industry, civil society and universities play to enable a sustainable energy future?
Potential components of a government role in fostering progress towards a low-carbon society include the following: developing meaningful consultation; adjusting the tax system so as not to overly privilege incumbents; developing a medium to long-term

research portfolio; contributing to and taking full advantage of world scientific literature; developing standards appropriate for a large, sparsely populated, cold climate country. Governments need to begin thinking seriously about a carbon tax ; the use of nuclear technology in connection with the tar sands; and work internationally to prepare for the post-Kyoto world.

There is a need for a vision and a related long-term plan with regional, national and international aspects. A thorough systems analysis, which includes both technical and social factors, is necessary. New organizing structures within which to motivate people to achieve the vision must be set in place. Meaningful dialogue with affected

6. Citizen engagement, legitimate decision processes; confronting NIMTOF

Most of the suggestions for research or policy action could be organized under these headings.

1. Technological evolution and sequencing, as noted briefly above:

A. Action Items

- Establish a stable continuing budget to support the broad range of basic research needed to enable development of the technologies needed ultimately to introduce hydrogen-based energy systems and a low-carbon society;
- Establish a more balanced portfolio of federal support and expenditure on hydrogen technologies, alternative fuels and other programs outside the existing programs so heavily oriented toward hydro-carbon fuels.
- Create, probably at the federal level, the institutional capacity for ongoing systems analysis.
- Promote interdisciplinary networks and meetings, perhaps through SSHRC/NSERC/CIHR programs partnered with NGOs.
- Given the many roadmaps developed to describe the evolution of a range of different technologies, consider the development of a meta-Roadmap that could bring the sequencing of developments into an accessible integrated 'evergreen' living document or rolling plan, updated as new knowledge and information on innovations becomes available. Could such a meta-roadmap be interpreted as capturing some agreement on a general vision for social transition in this field?

B. Research Questions

- The nature of a massive R&D program required, including basic theory and modeling in materials science, for example with respect to safe and secure storage needs. [Suppose we had our wish, as above; on what should/would the money be spent??]
- We have, at the moment, a very brittle supply system; vulnerable to shocks; we need something much more resilient – how could such a system be developed?
- Massive and diverse very long-lived infrastructure requirements for the overall production, storage, distribution, service system represent a serious capital barrier to entry; how can this 'chicken and egg' problem be overcome without giving up the essential dynamics of decentralized decisions within a market-based system?
- In response to those barriers, the possibilities of beginning a transition to a hydrogen economy with a move early to distributed systems, with later development of more centralized production and storage if economic and commercial realities dictate, has been advocated; how could such a transition be facilitated?
- Explore existing capacity for production of hydrogen, and examine both opportunities for using existing excess supply and the potential for expansion of production capacities.
- How can carbon sequestration and storage be built into the process of technological transition to extend the effect life of existing hydrocarbon fuel

sources while contributing to attainment of goals with respect to emissions reduction and adaptation to anticipated climate change?

- Explore the commercial realities associated with 'pluggable hybrids' as one way of using electricity to fuel transportation and build acceptance of alternatives to combustion engines;
- Technologies for the production of hydrogen; recognize hydrogen as a carrier to store electricity produced by any means; how to make all this more efficient?
- Is it true that we "Cannot solve the GHG challenge without nuclear production"?
- In what direction should technologies for negative emissions be developed?
- Need to explore the dynamics of development/diffusion/adoption cycles further to identify opportunities for government intervention and facilitation consistent with the technological realities?
- More research is needed to address crucial features of 'scaleability' challenges.
- The technological dimensions of investments in rebalancing electrical grids, distribution systems, pipeline networks, need research now.
- Footprint analysis of various low carbon strategies?
- Examine the institutional adaptations in the research funding applications processes necessary to reduce the present massive barriers to developing proposals for such programs.
- A particular research theme: cost-effectiveness of wind power (taking account of the need for rebalancing of electrical grids and other infrastructure adaptations - necessary if large scale contributions of wind power to production of electricity is to be feasible);
- More generally, explore the substantial infrastructure requirements for the many interface structures that will be required to bring a range of alternative energy sources into an integrated carbon-neutral energy system.
- Comparative study of full life cycle analyses of competing complete energy systems (perhaps on the model of the well-known Inhaber analyses, but with greater research collaboration in order to aim at greater acceptance of the analysis?)
- Specific case studies of integrated analyses to test the feasibility of achieving any such agreement?
- Document case studies of successful penetration of particular market niches (such as small batteries) by fuel cell technologies, in order to explore the characteristics affecting social acceptance.

2. Safety concerns, risk perceptions, regulatory frames and standard setting to address risk concerns

A. Action Items

- To promote development and greater public acceptance of hydrogen fuel cell based technologies, invest in construction of demonstration projects for large facilities at fixed sites and document the experience as serious historical or anthropological case studies.

- Address institutional difficulties of standard setting, representation in the technical, regulatory and political processes of standard setting.
- Public acceptance issues paramount in standard setting exercises should be explored and documented to assist technical personnel.
- If it is accepted, as was asserted several times in the meeting, that any significant move toward a hydrogen economy would entail substantial appeal to nuclear power, then all the well-known difficulties associated with widely diverging perceptions of risk, and massive barriers to public acceptance, will have to be revisited as central social dimensions of regulatory policy and energy strategy. For this purpose, the nuclear industry itself will have to engage more directly with increasingly influential NGOs. Might a program with the NWMO, along the lines of its present work on waste disposal problems be commissioned by governments to address public concerns associated with the use of nuclear energy to produce hydrogen at a large scale?
- Academic engagement with NGOs should be a feature of studies and policy initiatives addressing this challenge with respect to nuclear energy in particular, and social transition to low-carbon technologies in general.
- Nevertheless, it will be crucial to steer the 'hydrogen agenda' as far away from any association with the nuclear industry as possible.

B. Research Questions

- Risks associated with technologies for carbon sequestration and storage will encounter probably greater public question than those associated with hydrogen fuel cell technologies; they should be explored in greater detail.
- The vast general literature on the treatment of risk, uncertainty and ignorance in the policy formation process should be brought into application to the specific cases of the technologies at issue here; the literature on boundary organizations and boundary work to facilitate the utilization of science and scientific evidence should be pursued with reference to these tasks. Could the network proposed

and emphasized in considering a global transition to more sustainable energy systems;

- The importance of urban and regional development strategies, reflecting these particularities, needs to be emphasized;
- The opportunities for Canada to lead in efforts to assist developing countries to leap-frog some of the problems of a massive embedded hydro-carbon dependency in industrial structure need to be noted and assessed as part of Canada's general goals in contributing to global developm

B. Research Questions

-

5. Local governments and local applications, demonstration projects; confronting NIMBY

A. Action Items

- Promote conservation through initiatives like the Netherlands experiments or the SDRI GHG personal calculator, enabling people to get a sense of the implications of their personal life-styles and the possible consequences of change; develop facilities for personalized communication to inform people of their personal success in attempting to reduce electricity or water consumption (or other material inputs?)
- tsumptioupg

- Reform the decision processes determining the incremental allocation of the marginal government dollars, recognizing that hydrogen-related research competes with all other claims on research dollars.
- Develop a program of public involvement around the philosophical and ethical issues involved in choice of a technological pathway, particularly the issues of intra-generational fairness and intergenerational equity.

B. Research Questions

- Examine barriers to the effective flow of science in policy, recognizing that the public is not sufficiently aware of issues to be able to press politicians appropriately; explore in particular the challenge arising from the fact (?) that the public prefers to get its science from media, not scientists.
- Review the literature exploring what kind of exchange, evidence, can be persuasive with politicians who must have evidence to justify decisions, and relate this literature to the social challenges of realizing preferred technological pathways.
- Explore the particular problem of incompatible timescales associated with research, technological transition, venture capital criteria, imperatives of commercialization as contrasted with public issue-awareness cycles, institutional reform cycles, bureaucratic decision cycles and political-electoral cycles;
- If catastrophes help to move governments to address these issues, how can current experience be enlisted to illuminate current choices?
- Undertake a survey of the vast literature on adaptation options in order to bring it more directly into assessment of options for adoption of hydrogen-related technologies.
- Address the adaptation challenge more effectively.
- Bring comprehensive footprint analysis into public discussion; assist people to recognize their responsibilities, the implications of their current action. (This might suggest an initiative to bring the hydrogen technology choices into backcasting models such as the SDRI QUEST model or similar models at a larger or smaller scale.)
- Examine the role of media in communication generally, and with respect to public consultation or deliberation exercises in particular. (Document a recommendation to sack the political advisors who are reading the media as revealing public opinion?)
- Again, do not forget the strong coupling of regional, national and global activity, through research networking, partnerships, trade, and intellectual property and through economic and community development.

III. 2005 Workshop General Themes

It seems clear that in the discussion at the exploratory workshop most people would urge attention to the broader discussion around the sub-title of the meeting (paths to a low-carbon society) rather than the more focused title (hydrogen and governance); indeed there were suggestions that the invitation to a meeting under that title might be considered false advertising in light of what was actually delivered in the workshop itself. Certainly some doubts were expressed about the extent or timing of massive reliance on

hydrogen itself as the central feature of a move to a low-carbon society (at least in the next few coming decades).

One evident consensus conclusion, indeed, seems to be that of course we are not talking about any single solution (at least through a very long transition period) to reducing carbon content and carbon-related emissions, but rather about an extensive portfolio of distinct technological options, with the composition evolving. Where we will finish a century from now may or may not be clear, but perhaps that does not matter so much for the decisions to be taken now. (On the other hand, it was also argued at the meeting that some overall vision is necessary to give orientation and suggest an end in mind to guide appropriate choices in the vast number of decisions to be encountered in a transition to new energy systems.)

But what does seem clear is that we have to ask explicitly what part of the portfolio of low carbon technologies might or should hydrogen-based technologies occupy, not take the presence of the hydrogen components for granted. The share of the portfolio will no doubt emerge over a long period. Nobody expects them to become the whole solution, and nobody expects it to play only an insignificant role.

So what might we be able to say about the process of social transition to the hydrogen economy elements of a low-carbon society?

First, **several drivers** forcing efforts to move to a low carbon society were mentioned. Many of these were identified by Ged McLean in his opening keynote address.

- Overarching all, the need to reduce GHG emissions (by reducing the use of fossil fuels) because of the threat of climate change driven by increasing atmospheric concentrations of GHG;
- The need to address threats to health from tropospheric ozone, particulates, and other air quality problems;
- The potentially very serious threat to human and global security arising from the projection of national force abroad in order to secure hydrocarbon energy supplies for domestic use;
- Unacceptable distributional consequences arising the inequitable burdens associated with rising prices as demand for (hydrocarbon) energy increasingly outstrips supply potential;
- The increasing concern for environmental quality (respecting rights of nature) or sustainability more generally (however interpreted), possibly linked particularly with concerns for water issues;
- Ambition to create a competitive Canadian export industry leading technology transfer worldwide (including export of expertise based on advanced intellectual property).

Second, there was a hint of a **hierarchy of governance responsibilities** emerging:

- Much, maybe most, of the decisions that need to be taken will be taken by individual producers developing choices to offer consumers, and consumers deciding on how to take up those choices, based on the value propositions offered,

- A further major step, also within current research with well understood technological opportunities, is to force more rapid reduction in carbon intensity in the energy systems or economy as a whole, through energy efficiency targets, through reduced material inputs and improved industrial ecology;
- Carbon management, through sequestration and storage, or with re-use of valuable CO_2, is already technologically feasible and could be commercially attractive in the relatively near term, opening up opportunities to reduce the carbon content in electricity production, extending the life of clean(er) hydrocarbons and coal as energy sources;
- Development of renewable sources of energy to produce both hydrogen and electricity can proceed in parallel;
- All of this buys the time to let the

I n the other direction, greater investment by Canada in the learning to be derived from international collaboration and participation in science and technology initiatives, and the domestic capacity to draw on the growing body of knowledge and experience elsewhere in the world was also urged.

IV. Cross-Cutting Institutional Activity

1.in thee othed experienrepnsitori

Appendix A: Some Illustrative Canadian Energy Programs

1. Federal Initiatives

Sustainable Cities Initiative (SCI)

SCI was established by the Government of Canada in 1999 following a recommendation by the National Round Table on the Environment and the Economy (NRTEE). The project, in which SCI partners with 16 cities worldwide, assists cities in obtaining their goals for sustainable development and quality of life. Areas of focus include clean water, waste management, clean energy, transportation, housing, capacity-building, urban planning, telecommunications, urban infrastructure projects and port development. SCI is a working example of a partnership between government, non-governmental organizations and the private sector, comprising over 1500 representatives. Partner cities are selected through consultation with such organizations as Industry Canada, the Department of Foreign Affairs and International Trade and the Canadian International Development Agency.

Hydrogen Early Adopters Program (h2EA)

Designed to demonstrate new hydrogen technology concepts, h2EA was launched in October 2003 through Industry Canada's Technology Partnerships Canada (TPC) – being replaced by the Transformative Technologies Program (TTP). Intentions are for h2EA to initiate efforts for the demonstration of new concepts such as 'hydrogen highways' and 'hydrogen villages'. The program's stated objectives are listed as: increased public, consumer and investor awareness and acceptance of hydrogen capabi

The plan, released in 2002, proposes means of achieving a clean, reliable energy future in the province of British Columbia. It outlines the provincial government's goals for promoting clean and renewable alternative energy sources and plan to aid the growth of the technological industry. The emphasis is placed on clean electricity sources, conservation and energy efficiency and on the support of the development of cleaner power sources, for example wind, wave, solar, micro-hydro and fuel cell power. The provincial government indicates its support of fuel cell projects, including the Vancouver Fuel Cell Vehicle Program (VFCVP) and the projected Hydrogen Highway. The Energy Plan lists incentives for efficient energy usage and research for both BC residents and businesses. These include: PST relief for alternative fuel cell vehicles, residential heating energy efficiency incentives, fuel tax exemptions (for biodiesel fuel) and provincial tax credits for scientific research and experimental development.

Task Force on Alternative Energy and Power Technology

The government of British Columbia task force on alternative energy and power technology published a report stating their objectives in April 2005. It is a ten year plan created to provide advice to government on how to research and implement an alternative energy strategy. As a plan to also expand BC's economy, the report projects a creation of government and industry jobs that supply sustainable power solutions and increased income (from export revenue) in addition to more jobs through power technology solutions. The stated goal of the task force is for the province to be able to access clean, secure, reliable and reasonably priced energy over the long-term, through the promotion of sustainable urban transportation and the application of fuel cells and hydrogen technology. The proposition is in place for th

At the University of Victoria, researchers and students with IESVic conduct research on potential future paths for sustainable energy systems. The development of new technologies and perspectives towards clean energy alternatives and methods for overcoming barriers to achieving these goals are the focus of IESVic. Specific areas of expertise include fuel cells, cryofuels, energy systems analysis and energy policy development.

The Hydrogen Research Institute (HRI)

HRI is a research centre at the Université du Québec à Trois-Rivières. Working under the assumption that hydrogen will play an important role as a future energy carrier, HRI strives to address challenges facing government regarding the environmental impact of new energy technologies. Researcher and student work is focused on four main areas: the storage, safety and uses of hydrogen and the Centre for inspection with ultrasonics (CIUS).

The Institute for Sustainable Energy, Environment and Economy (ISEEE)

ISEEE at the University of Calgary provides leadership and coordination for the development and implementation of local energy initiatives. ISEEE also serves as an interface between all levels of research groups and sponsors in the domains of energy,

Buildings – energy performance certified buildings; construction of “very low energy” houses;
Lighting systems and appliances – promotion of low-energy lighting and appliances;
Cooperation with developing countries; promotion and communication.

Through the development of a European-wide network, small and medium sized businesses will have the opportunity to cooperate and learn from the experiences of others in the industrial market. Enterprises, both public and private, can become “partners” of Sustainable Energy Europe and

It’s focus was on the non-technical barriers confronting hydrogen energy, more specifically on questions of public perception of hydrogen energy and the potential reactions of the public to its

transition (i.e., nuclear energy and public apprehension). Forum participants discussed the following issues concerning the public and hydrogen energy:

- The potentials of hydrogen are difficult to explain as there are many means of production and the product is not visible;
- Semantics are a problem – hydrogen is an energy carrier, not a fuel;
- Hydrogen benefits are numerous and complex, again complicating public explanations;
- From the public's point of view, the incoming hydrogen technology must be better than what it's replacing in order them to get on board.

U.S. Department of Energy; Energy Efficiency and Renewable Energy – Hydrogen, Fuel Cells & Infrastructure Technologies Program

The main objectives of the Hydrogen, Fuel Cells & Infrastructure and Technologies Program include:

- Overcoming technical barriers through research and development of hydrogen production, delivery, and storage technologies, as well as fuel cell technologies for transportation, distributed stationary power, and portable power applications;
- Addressing safety concerns and developing model codes and standards;
- Validating and demonstrating the use of hydrogen energy and fuel cells in real-world conditions;
- Educating stakeholders, public.

In order to address main public concerns regarding hydrogen energy a handbook of "Best Management Practices for Safety" is intended for publication by 2010. Its goal would be to ensure safety in hydrogen related actions and activities.

The program also intends to launch a public education campaign about the hydrogen economy and fuel cells by 2010. The campaign is directed at teachers, students, state and local government representatives, safety and code officials, commercial users. The website, http://www.eere.energy.gov/hydrogenandfuelcells/education/, provides information and resources to the interested public on such topics as the functioning and logistics of hydrogen and fuel cells, higher education and career opportunities in the field, student and teacher competitions, possible lesson plans for educators, and links to other informative sites in the internet.

Appendix C: Session Papers

Regulated Monopolies for Sustainable Energy Solutions?
Denis Connor, QuestAir Technologies
http://www.globalcentres.org/publicationfiles/DConnor.pdf

Some notes on the roles of government, industry, civil society and universities to enable a

British Broadcasting Corporation (BBC News). 2004. Climate legacy of 'hockey stick'.
http://news.bbc.co.uk/2/hi/science/nature/3569604.stm
http://www.globalcentres.org/publicationfiles/BBC.pdf

Cazaux, Geertrui. 2003. Constructing Nature: On Salmon, Mushrooms and Epistemic Cultures, *Journal of Contemporary Ethnography*, 32(5): 626-636.
http://jce.sagepub.com/cgi/reprint/32/5/626
http://www.globalcentres.org/publicationfiles/NatureandEpiCultures.pdf

Center for Science and Technology Policy Research. 2005. Is the "Hockey Stick" Debate Relevant to Policy?, Prometheus Archive.
http://sciencepolicy.colorado.edu/prometheus/archives/climate_change/000435is_the_hockey_.html
http://www.globalcentres.org/publicationfiles/Prometheus.pdf

Crok, Marcel. 2005. Kyoto Protocol Based on Flawed Statistics, *Natuurwetenschap & Techniek*.
http://www.uoguelph.ca/~rmckitri/research/Climate_L.pdf
http://www.globalcentres.org/publicationfiles/HockeyStickAgain.pdf

niekationfl

Giere, Ronald N. 2002. Discussion Note: Distributed Cognition in Epistemic Cultures, *Philosophy of Science*, 69: 1-8.

sequestration: how natural gas prices, initial conditions and retrofits determine the cost of controlling CO_2 emissions, *Energy Policy*, 32: 367-382.
http://www.globalcentres.org/publicationfiles/Johnson.pdf

Keith, David W. and Alexander E. Farrell. 2003. Rethinking Hydrogen Cars, *Science*, 301: 315-316.
http://www.globalcentres.org/publicationfiles/Keith.pdf

Kruse, Bjørnar, Sondre Grinna and Cato Buch. 2002. Hydrogen: Status and Possibilities. Report 6, Bellona Foundation.
http://www.bellona.no/data/f/0/26/97/0_9811_1/Hydrogen_6-2002.pdf
http://www.globalcentres.org/publicationfiles/Bellona.pdf

Legates, David R. 2004. Breaking the "Hockey Stick", National Center for Policy Analysis.
http://www.ncpa.org/pub/ba/ba478/
http://www.globalcentres.org/publicationfiles/legates.pdf

Lovins, Amory B. 2003. Twenty Hydrogen Myths.
http://www.rmi.org/images/other/Energy/E03-05_20HydrogenMyths.pdf
http://www.globalcentres.org/publicationfiles/E03-05_20HydrogenMyths.pdf

Marcon –DDM HIT. 2005. Transforming the Future: Moving Toward Fuel Cell Powered Fleets in Canadian Urban Transit Systems. Prepared for Natural Resources Canada, Ottawa.
http://www.nrcan.gc.ca/es/etb/ctfca/PDFs/english/Transit_Study_e_final.pdf
http://www.globalcentres.org/publicationfiles/Transit_Study_summary.pdf

McKitrick, Ross. 2004. Bringing Balance, Disclosure and Due Diligence into Science based Policymaking. Presented to :Public Science in Liberal Democracy: The Challenge to Science and Democracy", University of Saskatchewan.
http://www.uoguelph.ca/~rmckitri/research/McKitrick-PubSci-essay.pdf
http://www.globalcentres.org/publicationfiles/McKitrick.pdf

McKitrick, Ross. 2005. What is the 'Hockey Stick' Debate About? Conference Presentation, Australia.
http://www.climatechangeissues.com/files/PDF/conf05mckitrick.pdf
http://www.globalcentres.org/publicationfiles/05mckitrick.pdf

Muller, Richard. 2004. Global Warming Bombshell, *TechnologyReview.com*.
http://www.technologyreview.com/articles/04/10/wo_muller101504.asp?p=0
http://www.globalcentres.org/publicationfiles/muller.pdf

O'Keefe, William and Jeff Kueter. 2004. Politics and Science: Is Science Politicized? George C. Marshall Institute.
http://www.marshall.org/pdf/materials/213.pdf

http://www.globalcentres.org/publicationfiles/Marshall%20Institute.pdf

Pielke, Jr., Roger A.. 2005 (in press). Misdefining "climate change": consequences for science and action, *Environmental Science and Policy*.
http://sciencepolicy.colorado.edu/admin/publication_files/resource-479-2004.10.pdf
http://www.globalcentres.org/publicationfiles/RPielke.pdf

Row, Jesse and Carissa Wieler. The Pembina Institute. 2003. Environmental Labelling for Hydrogen in Canada. Prepared for Natural Resources Canada, Ottawa.
http://www.nrcan.gc.ca/es/etb/ctfca/PDFs/english/Environmental_Label.pdf
http://www.globalcentres.org/publicationfiles/Environmental_Label.pdf

(S&T)² Consultants Inc. 2003. The Addition of Coal and Biomass to Hydrogen Pathways to GHGenius. Prepared for Natural Resources Canada, Ottawa.
http://www.nrcan.gc.ca/es/etb/ctfca/PDFs/english/Final%20Coal%20and%20Biomass.pdf
http://www.globalcentres.org/publicationfiles/CoalandBiomass.pdf

(S&T)² Consultants Inc. 2003. Hydrogen Pathways Greenhouse Gas Emissions and Energy Use. Prepared for Fuel Cells Canada, Vancouver.
http://www.nrcan.gc.ca/es/etb/ctfca/PDFs/english/GHG-Energy-Use.pdf
http://www.globalcentres.org/publicationfiles/GHG-Energy-Use.pdf

Stirling, Andrew. 1999. On Science and Precaution in the Management of Technological Risk. European Commission Institute for Prospective Technological Studies.
ftp://ftp.jrc.es/pub/EURdoc/eur19056en.pdf
http://www.globalcentres.org/publicationfiles/AStirling.pdf

Taylor-Gooby, Peter. 2005. Social Divisions of Trust: Scepticism and Democracy in the GM Nation? Debate. *Journal of Risk Research*.
http://registration.yourhost.is/nopsa2005/papers/Social%20Divisions%20of%20Trust%20240605.doc
http://www.globalcentres.org/publicationfiles/taylor-gooby.pdf

Taylor-Gooby, Peter and Jens Zinn. 2005. Current Directions in Risk Research: New Developments in Psychology and Sociology, U.K.
http://www.kent.ac.uk/scarr/
http://www.globalcentres.org/publicationfiles/Taylor_Gooby_Zinn.pdf

The Hill Times, Monday, July 11, 2005.
http://www.thehilltimes.ca/policy_briefings/071105_pb.pdf
http://www.globalcentres.org/publicationfiles/HillTimes.pdf

Tseng, Phillip, John Lee and Paul Friley. 2003. Hydrogen Economy: Opportunities and

Challenges, Energy Technology Systems Analysis Programme, International Energy Workshop, Vienna.