Hydrogen & Governance

Exploring paths to a low-carbon society

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

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Hydrogen Transition Timeframe

A discussion on the governance tools that should be brought to bear on the Hydrogen transition needs to take into account the likely timeframe and impact of the hydrogen economy deployment, and of the socio-environmental problems due to climate change and deterioration in urban air quality. Under the optimistic scenario that 10% of the road vehicles replaced each year after 2010 will be hydrogen fuel cell vehicles (FCVs), and based on an average life of 12 years, only 8% of the road vehicle fleet will be FCVs by 2020. Similar considerations for other energy service sectors, as well as much more elaborate analyses, lead to the conclusions that a substantial transition to hydrogen is unlikely before 2050.

Urgent measures will likely be required much earlier than that. These can be on two possible "technology" fronts: improved energy efficiency (i.e. a reduction of KWh/unit of service, which I refer to as Q_E below); and reduced CO_2 emissions (more precisely a reduction of amount of CO_2/ KWh, which I refer to as q_{CO2}). The table below outlines some of the options.

Towards a lower carbon Society

Energy System Shift	***Energy/CO_2***	***Socio-techno-economic change***	***"Solutions"***
No Change in Primary Energy System	Maintain Q_E Maintain q_{CO2}	engineer climatic countermeasures	• CO2 removal from atmosphere • Suppression of solar energy flux
		Adapt to global warming	• Change in socio-economic infrastructure
		Capture CO2 at source	• Underground sequestration • Ocean
Improved Energy Efficiency	Reduce Q_E Maintain q_{CO2}	Improved Energy Efficiency	• Reduced use/waste • Improved technology
Low carbon energy systems	Maintain Q_E Reduce q_{CO2}	Substitute to low carbon sources	• Hydrogen (lower C/H) • Renewable Energy • Nuclear

The hydrogen economy *is* our best bet for a sustainable *long term future*. But we need to manage the transition period to get there. If we are to have substantial action and impacts within a generation, hydrogen can only be one part of a comprehensive action plan that will include:

- underground sequestration and possibly ocean sequestration of CO_2. This requires mostly advances in science and engineering
- a reduction in use and "waste" of energy. This requires behavioural changes
- adoption of more efficient energy conversion technology (e.g. fuel cells)
- transition to hydrogen (lower C/H ratio)
- greater penetration of Renewable Energy
- increased reliance on Nuclear Power Generation

There is a strong possibility that even with a successful deployments on all these fronts, CO2 emission will continue to rise significantly (although at much lower rates), and we will thus have to *adapt to a higher carbon society.* I am not sure what such adaptation will exactly entail, but Government and Universities should undertake the scenario developments and analyses to assess socio-economic impacts, and to guide the policy and technology developments needed to adapt and minimize negative impacts.

A related issue is the mismatch between timescales over which government, industry and universities programs take place and the hydrogen economy timescales.

Articulating the Potential Benefits

The "marketing" of the hydrogen economy based on its long term potential to lead to a sustainable energy system has had relatively limited success, perhaps because of the prevalent link between hydrogen and fuel cells, and the slow progress toward commercialization of the latter. A broadening of the discourse on "economics" and "risk" is necessary for society to embrace the major social project that is the hydrogen economy.

In the field of energy systems, integrated approaches such as well-to-wheel and life cycle analyses have been broadly adopted in the last decade to assess environmental impacts. Approaches that account for all the processes in economic and risk analysis are also required.

For instance, the benefits FCVs in terms of emission reductions are often understated. Tools that account for the economic benefits of improved air quality and health due to the reduction of NOx, volatile organic compounds, particulates, CO etc. could be very effective for a more comprehensive assessment of hydrogen systems and for guiding related policy development.

Universities have a key role to play in fulfilling the need for vertically integrated research that covers the continuum "technology-economy-economy-policy-social impacts" in the local and global settings. This need can best be met by systematically fostering interdisciplinary projects and engaging young researchers in them.