Hydrogen Technology Roadmap for Australia

Presentation to

IPHE Implementation-Liaison Committee

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Background

- On the 13 April 2007, the Council of Australian Governments (COAG) announced four energy technology roadmaps would be developed.
  - Coal-gasification, geothermal, hydrogen and high-temperature solar thermal.
- Objectives of the hydrogen roadmapping process:
  - To assess Australia's hydrogen and fuel cell research capabilities and strengths; and
  - To identify what actions Australia could take to prepare for the possible emergence of a hydrogen economy
    - Including, among other outputs, the suggested role of Australian governments, industry and researchers in enabling and facilitating the development of a hydrogen economy in Australia.

Methodology

- Bottom-up data gathering though consultation with stakeholders by one-on-one interviews and workshops
- Desk-top research
  - Review of national and international literature
  - Modelling of costs in Australia of production of hydrogen and of stationary power generation using fuel cells to provide a forecast of uptake of each in competitive markets here
  - Identifying, at a high level, the international and national intellectual property (IP) landscape for hydrogen and fuel cells
- Analysis of data and writing of roadmap, including testing of draft with key stakeholders

Hydrogen and fuel cells

- Hydrogen as an energy carrier
  - Clean and green production routes for hydrogen are possible – but less-developed and higher cost fuel
  - Hydrogen is complementary and competitive to other major energy carriers – electricity and liquid fuels
  - Hydrogen does not need fuel cells for its utilisation – ICEs and gas turbines work well
- Fuel cells as energy converters
  - Fuel cells are complementary and competitive to conventional means of electricity and heat production
  - Emergence of a substantial fuel cell market does not need the development of a hydrogen fuelling network

Supporting H_2 and FCs to market

- Governments and industry sectors have options available to them to deliver low GHG emission energy services to consumers.
  - Hydrogen and fuel cells are undergoing significant consideration and development overseas as one option.
  - Investments are being made by governments and industry to address:
    - Technical and market barriers in order to build a hydrogen delivery infrastructure in various countries
    - Develop safety codes and standards
    - Educate decision-makers, customers, and the future workforce about hydrogen and fuel cell technologies.

Alternate market views

- There are other options to deliver the energy services consumers demand that can achieve the same or better GHG abatement than H_2 and FCs in many applications
  - Hydrogen has multiple losses of efficiency from production through delivery and storage to point of end use.
    - Why use (particularly renewable) electricity to make hydrogen that then is used to make electricity?
  - MIT study on drive-trains for LDVs concluded that the *evolution of battery and fuel-cell technology over the next 10-20 years will likely dictate whether the plug-in hybrid or the fuel-cell vehicle succeeds the hybrid vehicle. ..... The fuel-cell, which faces significant technical and infrastructure hurdles, is likely to have minimal impact over the 30-year time horizon of this study, even with successful development.*

H_2 and FCs – Australia

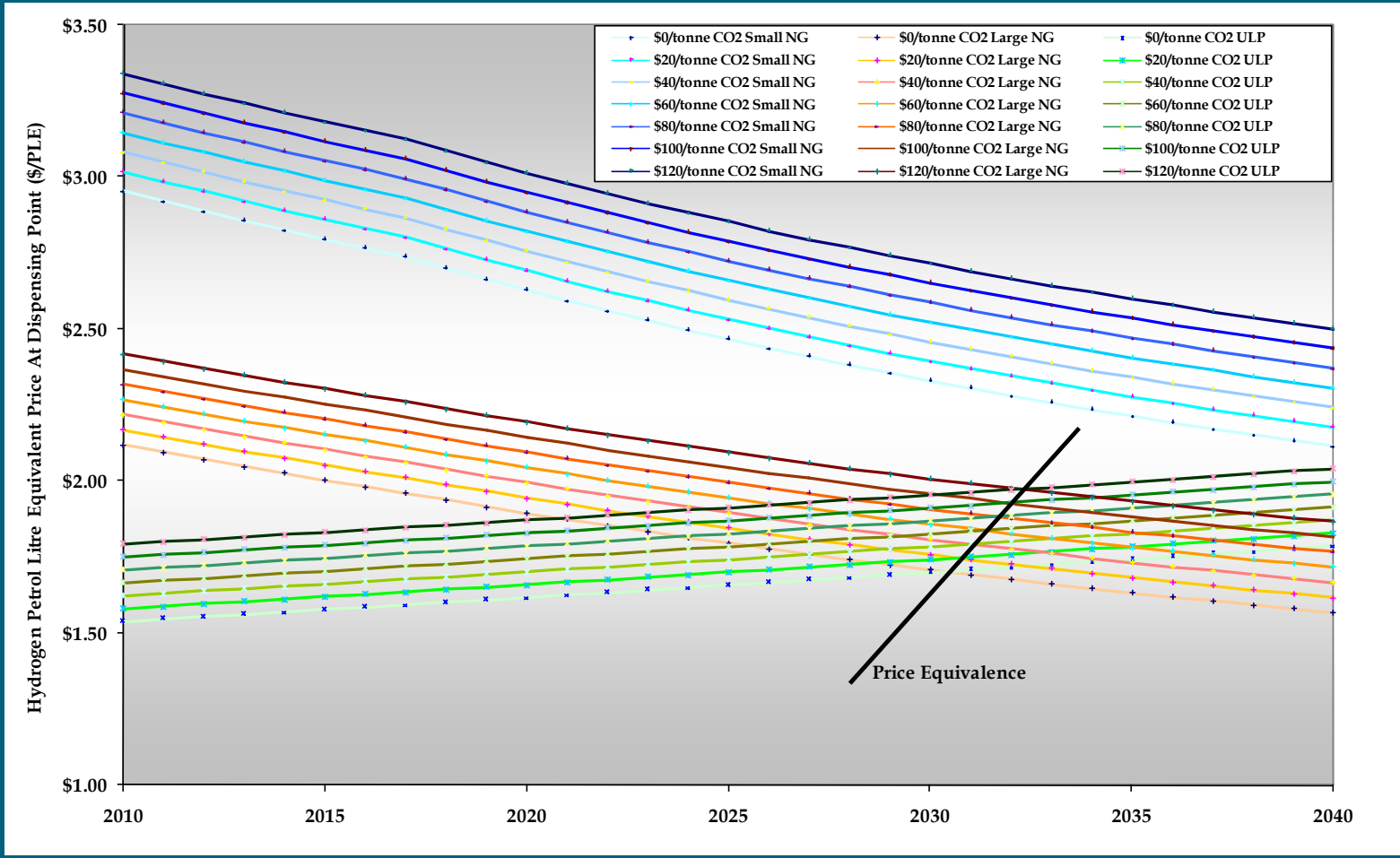
- Captive uses of hydrogen here mirror global uses
  - Fertilisers, explosives and refining
- Very small local industry base
  - Fragmented representation
- Wide, but rarely deep, R&D activities
  - CFCL, CSIRO, NHMA (and its members)
  - Australian Academy of Sciences review:
    - Found ARC funding from 2002 to 2008 of $22,642,712 for 48 projects and four fellowships.
    - Concluded that R&D profile in Australia for hydrogen and fuel cells is not strong — notwithstanding that there are pockets in Australia of world-class research and researchers
- Only a few demonstrations undertaken so far

IP Landscape in Australia

- Global level of IP activity in hydrogen technologies is rapidly increasing, particularly in the area of fuel cells.
  - Australia does not feature highly in the number of global patent applications.
  - What IP we have is currently scattered with no national cohesion.
  - However, Australia does have some useful IP in hydrogen production and storage as well as fuel cells.
- There are no broad constraints to development and use in Australia of H_2 and FC products.
  - Main IP barrier to entry for any new players to the market is on a technology-solution basis.

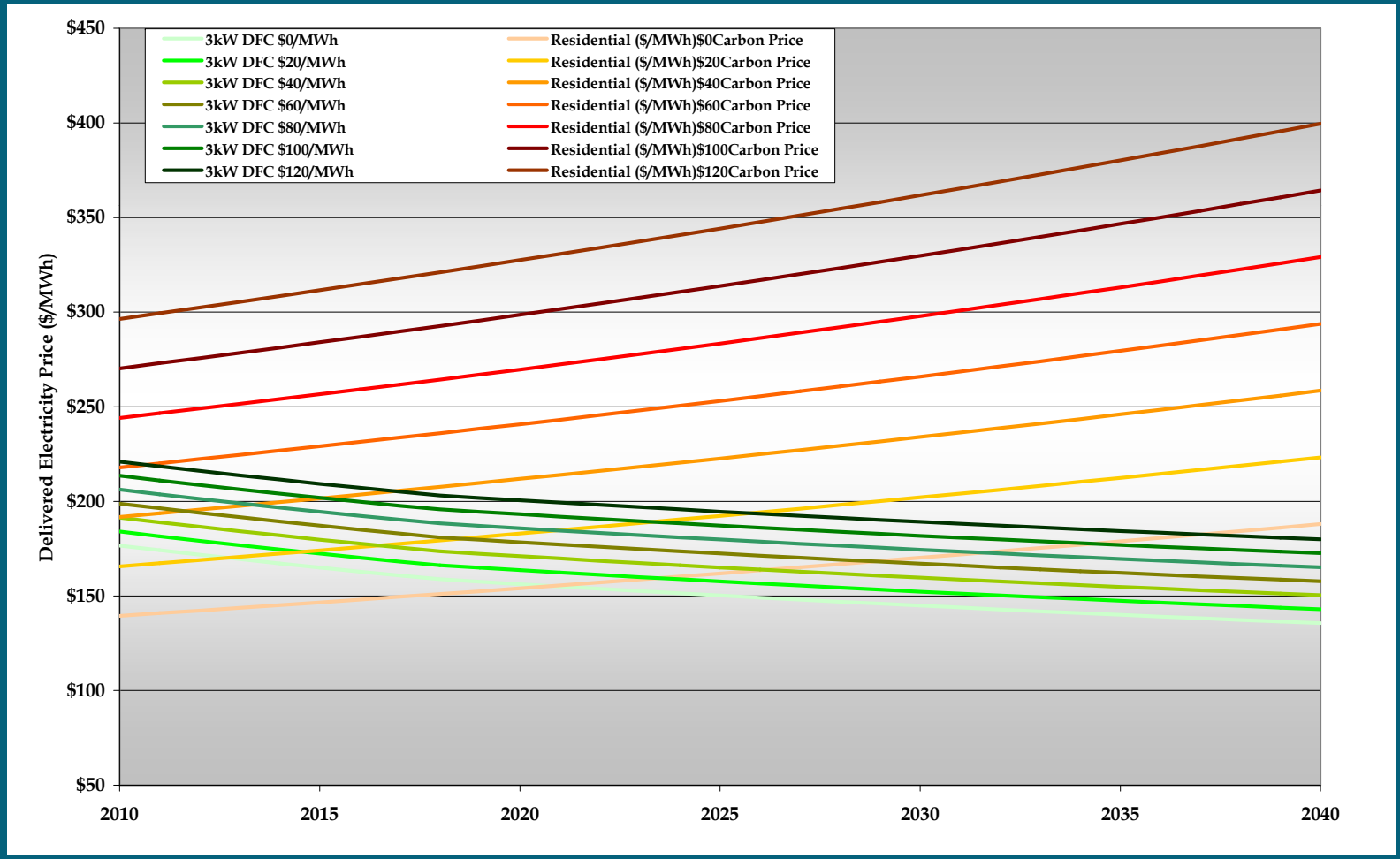
H_2 cost perspectives - Australia

- Delivered hydrogen under varying $CO_{2\text{-}e}$ prices



FC DG cost perspectives - Australia

- FC residential stationary under varying $CO_{2\text{-}e}$ prices



FC DG cost perspectives - Australia

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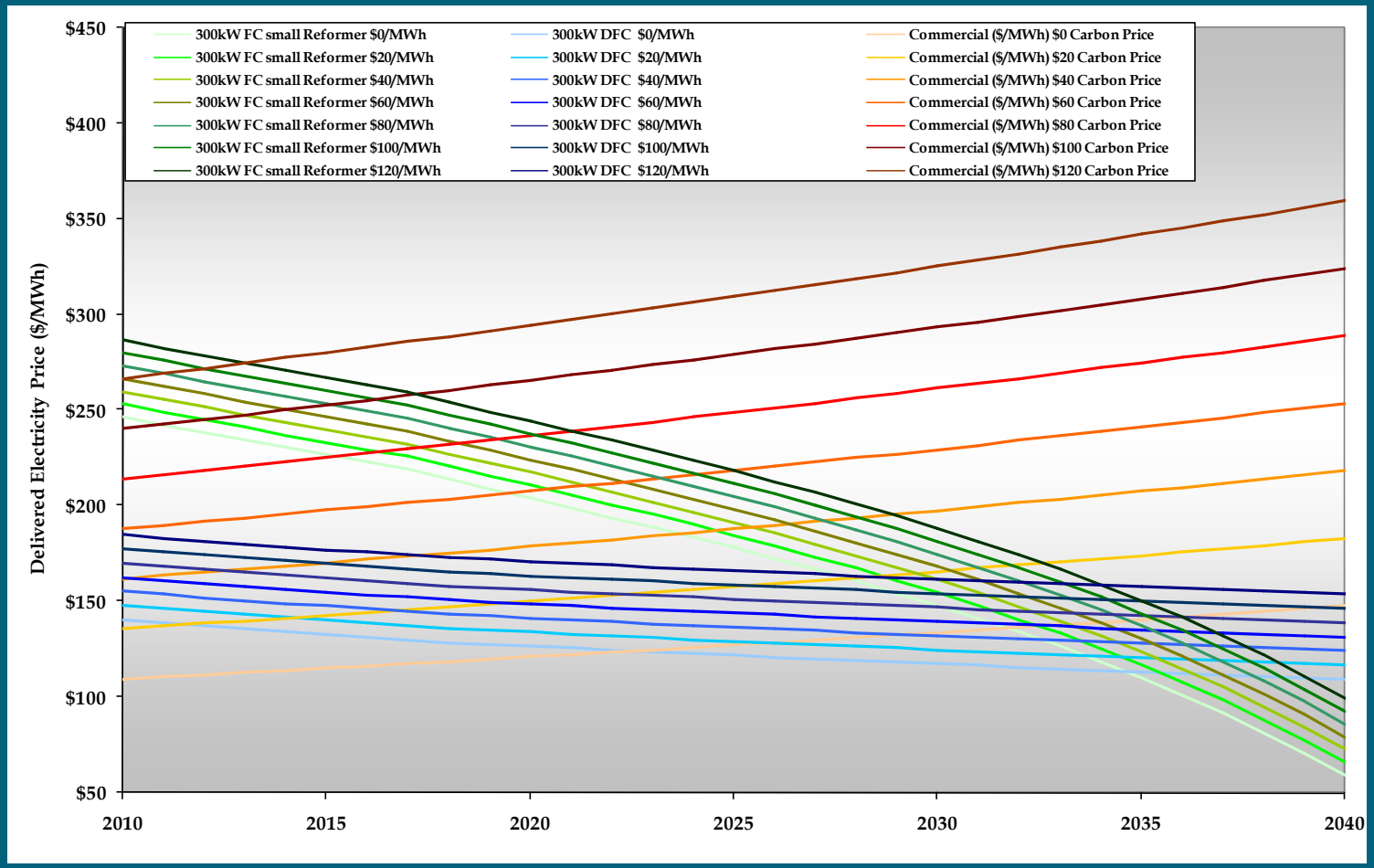
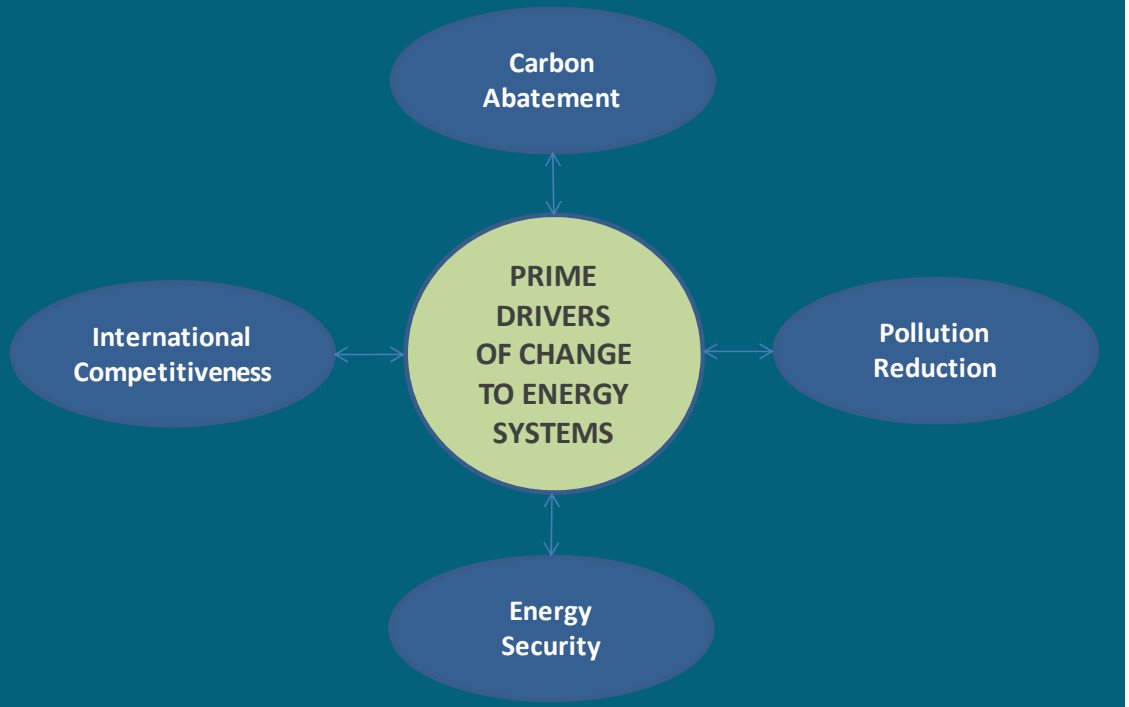


Conclusions from the analysis

- With the imminent introduction of an emissions-trading scheme in Australia, fuel-cell stationary power systems for distributed generation applications may become a technology-of-choice in the residential and commercial sectors.
- Demonstration projects for production and captive use of hydrogen in large-scale IGCC power generation will proceed — albeit in the absence of CCS, at least initially.
- There appear to be prospects for portable energy applications and some niche transport energy applications for fuel cells and hydrogen.
- It is likely that other advanced economies will develop significant sectors based on one or both of hydrogen and fuel cells.
- Australia risks significant competitive disadvantage in these global hydrogen and fuel cell areas if it is simply left to natural market forces to prepare for their introduction locally.

Need for H_2 and FCs in Australia

- Carbon abatement — HIGH
- Pollution reduction — LOW
- Energy security — LOW, except in specific liquid fuels where it is HIGH
- International competitiveness — HIGH



Need for H_2 and FCs in Australia

- Primary need for Australia – *at least in the near to medium terms* – is to ensure that both are actively maintained as an option to enable full exploration of potential in Australia's long-term energy positioning.
  - Embracing or rejecting the move to a 'hydrogen economy' requires compelling arguments either way
  - "Actively maintained" means Australian governments, industry, researchers and the broader community collaborating and co-investing:
    - To prepare technically and socially for possible widespread deployment.
    - To foster local industry development opportunities as they arise.

Roadmap vision and strategies

Economic benefits

- The economic benefits of early preparation, as proposed in the roadmap, are likely to exceed the costs because:
  - Australia will be prepared to move earlier and more efficiently to benefit economically and environmentally from deployment of products and services based on fuel cells and/or hydrogen; and
  - Australian companies and researchers will be better positioned to participate successfully in global supply chains for hydrogen and fuel cell components, systems and technology.

Proposed next steps

- Implementation would require a long term commitment from the public, private and research sectors.
- Recommendation for establishment of a High-level Coordination Group (HCG) comprising Australian government, industry and research sector representatives
  - Oversight the start-up and progress of the activities under this roadmap so that by 2020 credible conclusions about the future of hydrogen and fuel cells in Australia's energy mix can be made, taking into account competing options.