Australian Activities in Clean Hydrogen from Coal & Natural Gas

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Outline

• Characteristics of “energy” in Australia
• “Energy” responses
• Clean Hydrogen from Coal and Natural Gas
• Close
Australian Energy

- Plentiful reserves of high quality, available black and brown coal
- Increasing proven gas reserves – natural gas and coal seam methane
- Declining indigenous oil
- High solar thermal, wind and hot rock potential
- No nuclear power
- Limited hydro power

Cost – effective energy supply sector
High GHG emissions intensity
Awareness of the need for a “low emissions” response
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Energy Responses / Initiatives

• National Research Priority – reduce and sequester carbon dioxide emissions from transport and stationary energy
  – The cooperative Research Centre program
    • the CRC for Coal in Sustainable Development
    • the CRC for Clean Power from Lignite
    • the CRC for CO$_2$ management
  – COAL21
  – The Queensland Low Emissions Technology Centre
  – CSIRO’s Energy Transformed Flagship Program
  – National Hydrogen Study
  – Proposed Hydrogen CRC
  – Range of University R&D programs in production and storage of hydrogen
  – Australian membership of the CSLF and IPHE
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Hydrogen from Fossil Fuel Activities (1)

Main activity through COAL21 (Commenced March 2003)

• Partnership between the coal and electricity industries, federal governments and the R&D community

• Objective to create a national plan to scope, develop, demonstrate and implement near zero emissions coal fired power

  Provides the umbrella organisation for the advancement of near zero emissions technology in Australia

  Effectively a long term plan for generation of hydrogen from Australian coal
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Hydrogen from Fossil Fuel Activities (2)

Organisations working with COAL21

- CCSD – providing coal gasification technology
- CO$_2$ CRC – Capture and sequestration technology (from coal gasification and natural gas)
- Queensland LET Centre – coal gas processing (gas cleaning, processing, separation)
- The CSIRO Energy Transformed Program – works through
  - the CRCs and independently on aspects of CO2 capture, CO$_2$ sequestration, hydrogen production and applications

The route to the hydrogen economy in Australia is likely to be dominated by fossil fuels
Hydrogen from Fossil Fuel Activities (3)

Source: CO₂ CRC
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Hydrogen from Natural Gas

Solar Thermal

Fossil Fuel (CH₄)

CO/H₂/CO₂

Water Gas Shift Conversion

CO + H₂O(ℓ) → H₂ + CO₂ + 3 KJ

H₂/CO₂

CO₂ Recovery

CO₂ to disposal / sequestration

H₂ - fuel

Advanced Power Generation

• Fuel cells
• Gas turbines
• Cogeneration etc

Solar hydrogen production for:
Fuel cell electricity generation from hydrogen transport applications (eg hythane™)
Hydrogen for refining of heavier crude oils

CH₄ + H₂O(ℓ) + 250 KJ → CO + 3H₂
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Hydrogen from Natural Gas (2)
Hydrogen from Natural Gas (3)
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Closing

• The main driver for hydrogen activities in Australia is GHG intensity reduction

• The hydrogen agenda is likely to be initially controlled by the development of low emission fossil fuel development

• The prospectivity for hydrogen production using renewable energy is high, but cost is a major barrier

• International partnerships are being sought for coal to hydrogen and gas to hydrogen technologies
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Contact Information

- COAL21
- CRC for Coal in Sustainable Energy
  www.ccsd.biz
- CRC for Clean Power from Lignite
  www.cleanpower.com.au
- CRC for CO2 Management (CO2 CRC)
  www.co2crc.com.au
- The CSIRO Energy Transformed Flagship Program
  www.energytransformed.csiro.au
- The Queensland Low Emission Technology Centre
  cliff.mallett@csiro.au
- The National Hydrogen Study
  www.industry.gov.au
- Australian Institute of Energy
“Back-up” slides
Who Are We?

“By igniting the creative spirit of our people, we deliver great science and innovative solutions for industry, society and the environment”
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What We Do – Divisional Research

IT, Manufacturing & Services
- Textile & Fibre Technology
- Mathematical & Information Sciences
- Molecular Science
- Telecommunications & Industrial Physics
- Manufacturing & Infrastructure Tech.
- Australia Telescope National Facility

Environment & Natural Resources
- Marine Research
- Entomology
- Land and Water
- Sustainable Ecosystems
- Atmospheric Research

Sustainable Minerals & Energy
- Minerals
- Exploration & Mining
- Petroleum Resources
- Energy Technology

Agribusiness & Health
- Food Science Australia
- Forestry & Forest Products
- Health Sciences & Nutrition
- Livestock Industries
- Plant Industry

Multi-Divisional Flagship Programs
- Healthy Country
- Wealth from Oceans
- Climate
- Agri-Food Top 5
- Light Metals
- Clean Coal Syndicate
- Preventative Health
- Energy Transformed
- Secure Australia
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Who Are We?

You may know us already…

- CSIRO ranks in the top 1% of world scientific institutions in 11 of 22 research fields
- 60% of our staff hold university degrees
  - >1800 doctorates
  - > 430 masters’ degrees
- 6300 staff located at 65 sites
  - 3 overseas labs
  - 7 international locations
- 3500 patents granted or pending
- Citations per publication are 30% above world average
- More than 163 companies are based on CSIRO intellectual property
The Opportunity

A $30b+ opportunity for new technology implementation

Many existing plants still operating in 2030

Supply from Existing Plant
Demand (ESAA)
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Energy Tension

Economy
- GDP growth
- Competitive industry
- Expanding exports

Energy Tension

Energy Technology
- Technology
- Roadmaps

Environment
- Clean air
- GHG emissions

Clean, Internationally Competitive, Reliable and Secure Energy Services

- Cost, quantity, quality of supply
- Generation efficiency
- Fossil fuel usage

- Generation efficiency
- Fossil fuel usage
Energy Transformed Roadmap: Taking the Emissions out of Stationary Energy and Transport

Theme 1: Energy Futures
- Development & reporting of a National Energy model
- Update of model with feedback to R&D strategy and energy policy requirements
- Optimum routes to the Hydrogen Economy
- Identification of optimum energy pathways

Theme 2: Low Emission Electricity
- Feasibility of CO₂ storage in coal strata / aquifers
- New IP in gas processing / CO₂ capture
- Facilitation / involvement in zero emissions – coal to H₂ pilot plant
- Large scale H₂ from fossil fuels
- Cost effective electricity meeting Australia’s GHG commitments

Theme 3: Low Emission Transport
- Mild hybrid vehicle development
- Series hybrid development, ITS Systems developed
- Intelligent transport / H₂ fuel cell cars implemented
- Transport innovations meeting cost and emission targets

Theme 4: Low Emissions Distributed Energy
- Innovative waste heat utilisation IP
- Decentralised power with information feedback
- Remote controlled, 80% efficiency heat / power / cooling supply systems
- Supply options based on H₂
- Distributed Generation solutions to GHG emissions
Sites for CO₂ Sequestration Potential

- 102 sites analysed
- 65 proved viable CO₂ storage sites
- 22 sites not viable; 15 regional basin overviews

All Sites Examined by GEODISC Program

Source: APCRC, GEODISC, Geoscience Australia
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GHG Emissions Sources 2000

Annual Growth in GDP and Primary Energy Consumption

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<th>Year</th>
<th>Economic Growth</th>
<th>Energy Consumption</th>
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Growth in energy consumption

PJ

Source: ABARE