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# Hydrogen Industry Fundamentals

Learn about hydrogen industry fundamentals, including its uses in the process industries and its production methods, sources, costs, and logistics in this hydrogen course.



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# Course Information

Face to Face Training	MELBOURNE	13 - 14 February 2024   17 - 18 October 2024
	BRISBANE	20 - 21 February 2024   31 Oct-1 November 2024
	SYDNEY	14 - 15 March 2024   14 - 15 November 2024
	PERTH	23 - 24 April 2024   28 - 29 November 2024
	CANBERRA	7 - 8 May 2024   12 - 13 December 2024

Live Online Training	May 2024								
	Part1	13 May	Part2	14 May	Part3	15 May	Part4	16 May	1pm - 5pm AEST
	September 2024								
	Part1	3 Sep	Part2	4 Sep	Part3	5 Sep	Part4	6 Sep	1pm - 5pm AEST

## Key Learning Objectives

- How hydrogen is currently produced and its cost of production
- How hydrogen may be produced from renewable sources – electrolysis, bio fuels, photolysis and estimated cost of production
- How hydrogen can be stored and estimated storage costs
- Understand possible future transport methods and international trade costs – as compressed gas, as liquid or via ammonia or naphthenes
- How hydrogen is transported by pipeline and the cost of transport
- Learn how hydrogen is used in fuel cells for stationary and vehicle applications
- Analyse the cost of hydrogen to a consumer from different production, storage and transport scenarios
- Analyse how hydrogen will compete with conventional fuels for stationary and vehicle applications
- Develop an understanding of the key hurdles in developing a hydrogen economy

## Who Will Benefit

The main aim of a hydrogen economy is to replace fossil fuels with hydrogen as the fuel source. This hydrogen course is aimed at:

- Persons with an interest in fostering and developing a large-scale hydrogen industry in Australia and, potentially, in promoting and developing international trade in hydrogen.
- Industry and government commercial managers, economists and engineers interested in gaining and understanding the costs of the hydrogen economy and the relative costs of various production, storage and transport costs to local and distant markets.
- Business professionals interested in developing commercial opportunities in any emerging hydrogen industry.
- Research and development engineers and scientists interested in identifying key hurdles, which could benefit from further R&D activities to reduce costs to the consumer.



# Course Information

## About the Course

Hydrogen replaces fossil fuels in power generation and transport. Hydrogen is widely used in the process industries and is a fuel that produces no carbon dioxide emissions. It is typically produced at a considerable scale and often transported through pipelines from producers to users.

Our Hydrogen Industry Fundamentals training can provide you with a comprehensive perspective and understanding of the hydrogen economy. The coverage and level of detail make it one of the best hydrogen courses online.

The first modules of our hydrogen training program will review the current production and uses of hydrogen in the process industries, which may be used as a basis for an emerging hydrogen economy.

The modules on hydrogen production from renewable sources will outline the technology and costs of alternative approaches to the production of hydrogen. The cost will be critically compared to conventional production methods as they presently stand and with the incorporation of carbon capture and storage.

A hydrogen course module will address storage options and costs for small and large-scale storage as gas or liquid hydrogen.

Modules will address the approach to the transport of hydrogen and the unit cost of the various options over short and long distances. The principal options considered will be by pipelines, as compressed gas or liquid, or via an intermediate product such as ammonia or naphthene. The costs of transporting hydrogen over long shipping distances to markets in North Asia will be estimated for various options.

The use and productivity of hydrogen fuel used in fuel cells for stationary and vehicle applications will be explained and the competitive advantages for hydrogen identified.

The cost position of hydrogen versus conventional fuels will be estimated to set an outline price for a target landed price of Australian produced hydrogen in NE Asia. Scenarios to meet this target will be discussed.

A final hydrogen training module will develop case studies for hydrogen versus conventional fuels in various locations of interest for a fully developed hydrogen economy.

## Meet Your Course Director



**Dr. Duncan Seddon** industrial career started with ICI on Teesside in the UK where he worked on the production of plastics and fibres. He moved to the Billingham Works where he was responsible for the energy management of a large integrated chemical complex. He moved to ICI Australia in 1980 and worked on the conversion of natural gas to methanol and olefins. In 1983, he moved to BHP and worked on gas to liquids (GTL).

Since 1988, Duncan has practiced as an independent consultant offering a broad range of services to companies and government bodies with an interest in refining and petrochemicals processes. He has a particular interest in the production of chemicals and fuels from gas and coal and the technology and economics for producing fuels from renewable sources.

Duncan is the author of over 120 papers, patents, including several papers on the production cost of hydrogen and its competitive position versus conventional fuels.

He has written two books - "Gas Usage and Value - The Technology and Economics of Natural Gas Use in The Process Industries" (PennWell, 2006) and "Petrochemical Economics - Valuing and Selecting Technology in a Carbon Constrained World" (ICP press, 2010). He is the co-editor (with Bo Zhang) of "Hydroprocessing Catalysts and Processes- The Challenges for Biofuels Production" (World Scientific, 2018).

Duncan is a Fellow of the Royal Australian Chemical Institute and a Member of the Society of Petroleum Engineers.

# Course Outline

## THE MARKET FOR HYDROGEN

- Introduction: Approach to cost estimation in the hydrogen process industry
- The Use of Hydrogen in the refinery operations
- Production and use of hydrogen in petrochemicals industry
- The use of hydrogen in the production of methanol
- The use of hydrogen in the production of ammonia
- The use of hydrogen in reducing metal ores - green steel

## METHODS OF HYDROGEN PRODUCTION

- The production of hydrogen from coal and biomass
- The production of hydrogen from natural gas - steam methane reforming, partial oxidation
- The purification of hydrogen - membranes, pressure swing absorption
- Hydrogen Production from the hydrocarbon process industry
- Hydrogen Production from the chlor-alkali Industry
- Hydrogen in natural gas

## THE COST OF HYDROGEN PRODUCTION FROM FOSSIL FUELS

- The cost of hydrogen production from natural gas
- Cost of hydrogen mass production from a large central facility
- Impact of scale of operation
- The cost of hydrogen from coal
- Greenhouse gas emissions from natural gas and coal
- Cost of carbon capture
- Cost of carbon dioxide geo-sequestration

## THE PRODUCTION OF HYDROGEN FROM RENEWABLE SOURCES

- The production of hydrogen by electrolysis
- High temperature electrolysis
- Comparison of electrolysis performance of different cells - alkaline versus PEM
- Approaches to reduce power demand
- Impact of solar radiation variation on electrolysis

- Costs of hydrogen production by electrolysis
- Safety issues and oxygen production
- Photochemical water splitting
- Hydrogen production from biomass
- Summary comparative costs of production methods

## THE COST OF HYDROGEN STORAGE AND TRANSPORT

- Storage of hydrogen as compressed gas
- Storage of hydrogen as liquid
- Storage in salt caverns
- Storage as hydrides
- Hydrogen compression and compression costs
- Hydrogen transport by pipelines
- Hydrogen transport in natural gas pipelines
- Hydrogen leakage in pipelines
- Hydrogen pipeline safety issues
- Comparison of costs of hydrogen transport as compressed gas, liquid, and pipelines

## THE LOGISTICS AND COSTS OF MASS SHIPPING OF HYDROGEN

- Cost of Ships and Shipping
- Cost of production of liquid hydrogen
- Storage and shipping of liquid hydrogen
- Regasification of liquid hydrogen
- Costs of hydrogen transport as compressed gas
- Transport of hydrogen as an Intermediate - ammonia or naphthene
- Ammonia production and costs of shipping and cracking - green ammonia versus blue ammonia
- Spera Process for transporting hydrogen - costs of the logistics train

## COMPETITIVE POSITION OF HYDROGEN VERSUS FOSSIL FUELS

- Fuel cells basic operation
- Different types of fuel cells and comparative performance
- Fuel cell applications
- Competitive position of hydrogen fuel cells in stationary applications

- Competitive position hydrogen and fossil fuels in vehicles
- Summary of international support for hydrogen production and use

## CASE STUDIES FOR THE HYDROGEN ECONOMY

*Case Study 1: Hydrogen production and use in a domestic setting*

*Case Study 2: Hydrogen from large scale solar power*

*Case Study 3: Comparison of alternatives for remotely produced hydrogen shipped to Northeast Asia.*

- As liquid hydrogen
- As ammonia/Spera Process
- As LNG then carbon capture and disposal
- Mass carbon dioxide disposal in saline aquifers

*Case Study 4: Hydrogen from Victorian lignite to Northeast Asia*

- Carbon dioxide disposal in Bass Strait

Additional Modules as May Be Requested (Extra Day)

## CARBON CAPTURE TECHNOLOGIES

- Membranes
- Pressure Swing Absorption
- Adsorption Processes
- Liquid Absorption Processes
- Amines Processes
- Benfield Process
- Rectisol Process
- Ryan Holmes Process
- Emerging technologies
- Carbon capture from air

## CARBON DIOXIDE TRANSPORT

- By truck
- By pipelines
- By Ship
- Cost of shipping carbon dioxide

# Hydrogen Industry Fundamentals

Easy Ways to Register



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## Hydrogen Industry Fundamentals

Course Code	Location/ Format	Course Dates	Early Bird price valid until		Standard price valid after	
			ME - 26 Jan 24 BR - 2 Feb 24 SY - 23 Feb 24 PE - 15 Mar 24 CB - 19 Apr 24 ME02 - 27 Sep 24 BR02 - 11 Oct 24 SY02 - 25 Oct 24 PE02 - 8 Nov 24 CB02 - 22 Nov 24	ME - 26 Jan 24 BR - 2 Feb 24 SY - 23 Feb 24 PE - 15 Mar 24 CB - 19 Apr 24 ME02 - 27 Sep 24 BR02 - 11 Oct 24 SY02 - 25 Oct 24 PE02 - 8 Nov 24 CB02 - 22 Nov 24		
P24GR30ME	Melbourne	13 - 14 February 2024	\$2,995.00 + \$299.50	<b>\$3,294.50</b>	\$3,095 + \$309.50 GST	<b>\$3,404.50</b>
P24GR30BR	Brisbane	20 - 21 February 2024	\$2,995.00 + \$299.50	<b>\$3,294.50</b>	\$3,095 + \$309.50 GST	<b>\$3,404.50</b>
P24GR30SY	Sydney	14 - 15 March 2024	\$2,995.00 + \$299.50	<b>\$3,294.50</b>	\$3,095 + \$309.50 GST	<b>\$3,404.50</b>
P24GR30PE	Perth	23 - 24 April 2024	\$2,995.00 + \$299.50	<b>\$3,294.50</b>	\$3,095 + \$309.50 GST	<b>\$3,404.50</b>
P24GR30CB	Canberra	7 - 8 May 2024	\$2,995.00 + \$299.50	<b>\$3,294.50</b>	\$3,095 + \$309.50 GST	<b>\$3,404.50</b>
P24GR30ME02	Melbourne	17 - 18 October 2024	\$2,995.00 + \$299.50	<b>\$3,294.50</b>	\$3,095 + \$309.50 GST	<b>\$3,404.50</b>
P24GR30BR02	Brisbane	31 Oct-1 November 2024	\$2,995.00 + \$299.50	<b>\$3,294.50</b>	\$3,095 + \$309.50 GST	<b>\$3,404.50</b>
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P24GR30CB02	Canberra	12 - 13 December 24	\$2,995.00 + \$299.50	<b>\$3,294.50</b>	\$3,095 + \$309.50 GST	<b>\$3,404.50</b>

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Course Code	Location/ Format	Course Parts	Course Dates	Standard Price		Great Savings:
P24GR30AUV	Live Digital	All 4 Parts	13 - 16 May 2024	\$2,395 + \$239.50 GST	<b>\$2,634.50</b>	
P24GR30AU02V	Live Digital	All 4 Parts	3 - 6 September 2024	\$2,395 + \$239.50 GST	<b>\$2,634.50</b>	

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