NSW GOVERNMENT Department of Primary Industries

ITM POWER Energy Storage | Clean Fuel

Integrated Hydrogen Energy Systems for Agribusiness

27 - 29 August 2019 | Corowa, Finley ,Buronga

Neil Thompson | MD, ITM Power Pty Ltd

Charles Luo at Corowa

WHAT WE DO?

HYDROGEN ENERGY SYSTEMS

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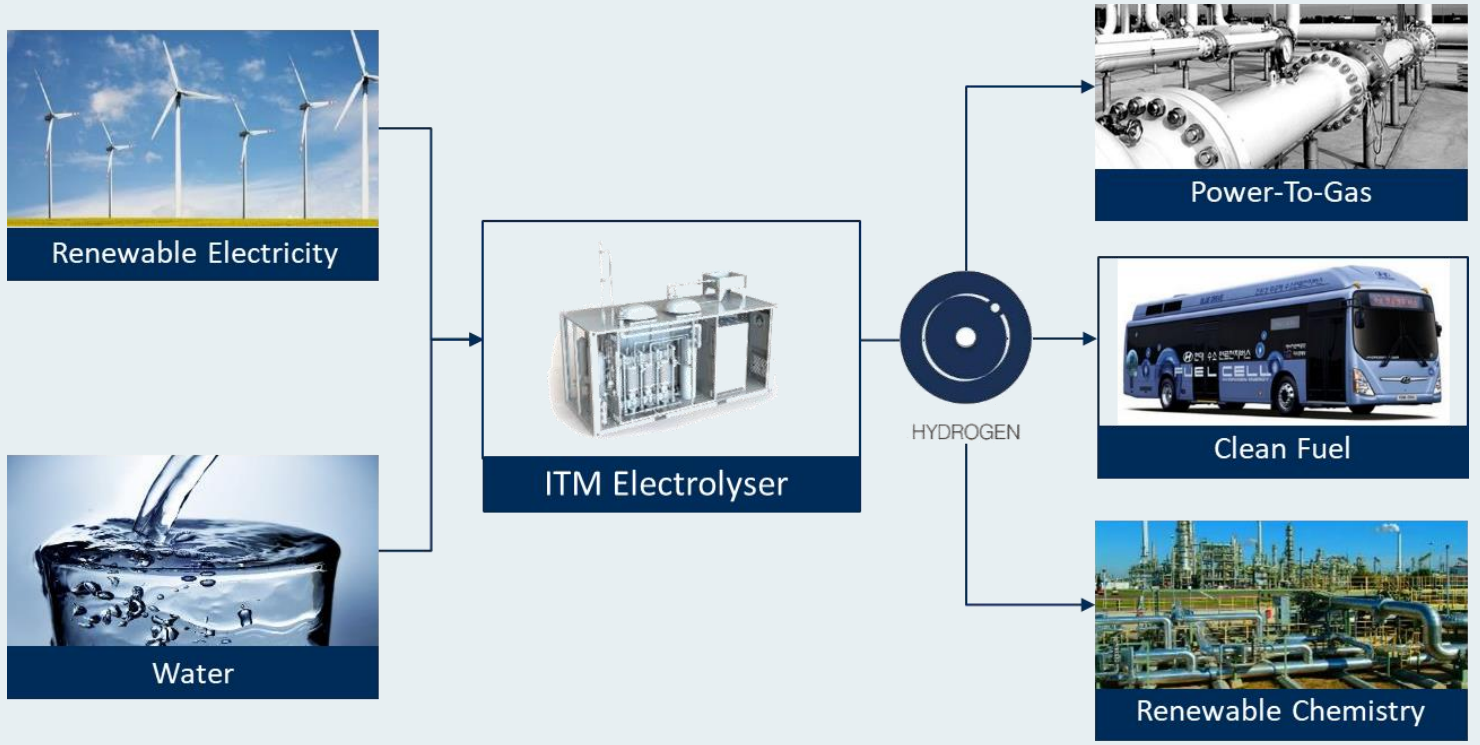

ITM Power manufactures integrated hydrogen energy systems

REGULATIONS, CODES & STANDARDS
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A leading role in shaping hydrogen deployment:

- Chair of BSI PVE/3/8
- Lead UK expert to ISO Technical Committee 197
- Secretary for ISO TC 197 working group for H_2 stations
- UK expert to ISO TC 197 working groups for electrolysers, dispensers and H_2 quality
- Lead UK expert to CEN/CENELC Technical Committee 6
- UK expert to CEN/CENELC TC 6 working groups
- Secretary of BCGA Technical Sub-Committee 9
- Blue Book H_2 Addendum with EI, APEA and BCGA
- IGEM H2 working group
- FCH JU RCS Strategic Co-ordination Group Chair

Code of Practice 41: H_2 Fuelling Stations
Design & Construction
Maintenance & Operation

ISO 19880-1: H_2 Fuelling Stations
ISO 22734: Electrolyser
ISO 14687: H_2Quality

BSI PVE/3/8: H_2 Systems Standardisation
Production & Storage
Transport, Measurement & Use

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SCALEUP FROM 5KW R&D TO WORLD'S LARGEST 10MW FOR SHELL

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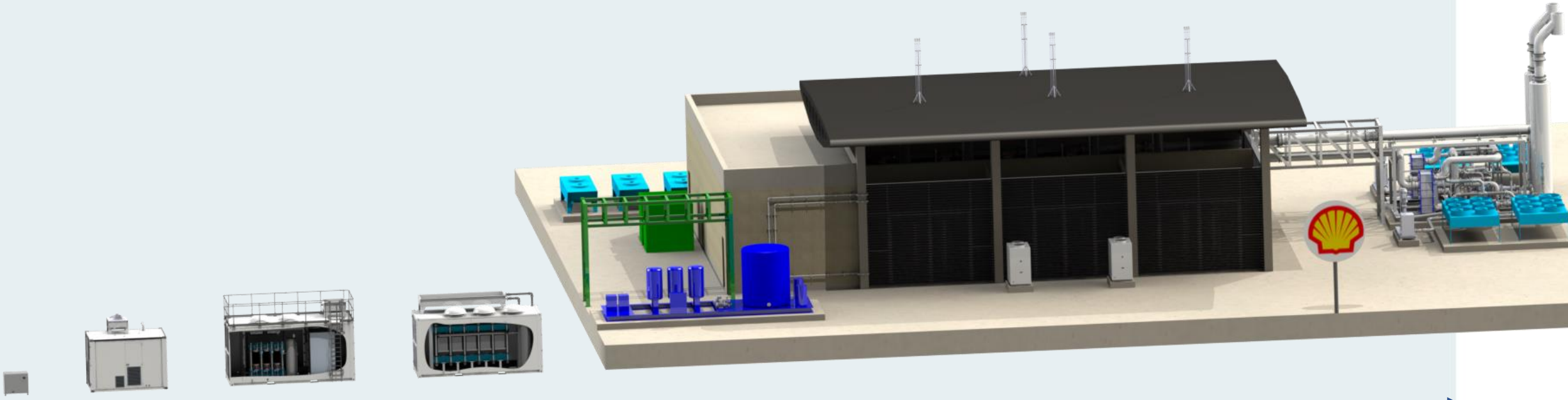

2011 2013 2015 2016 2017 2018

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ISD SYSTEM DESIGN PHILOSOPHY

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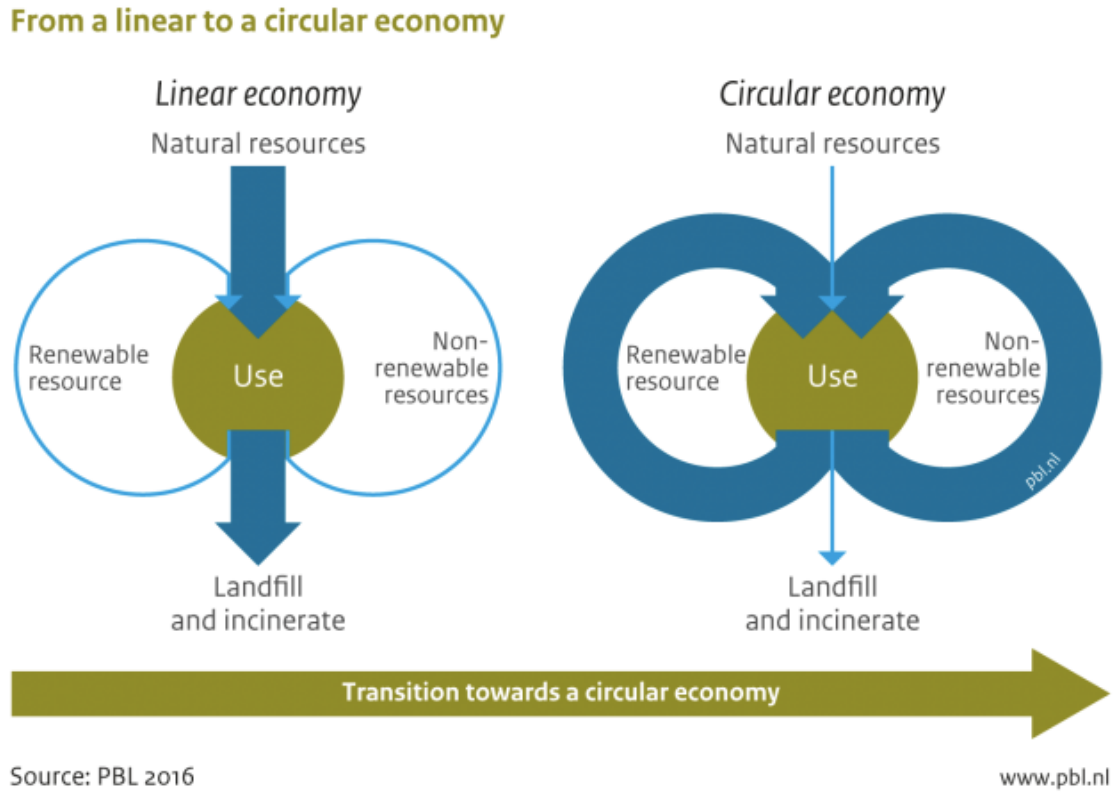
TRANSITION TO CIRCULAR ECONOMY

- Reduce & fix input costs for energy
- Reduce & fix waste output costs
- Create new farm revenues
- Integrated Sustainable Design (ISD)



Reducing input and waste costs / Generating new revenue

MULTI-SECTOR INTEGRATION

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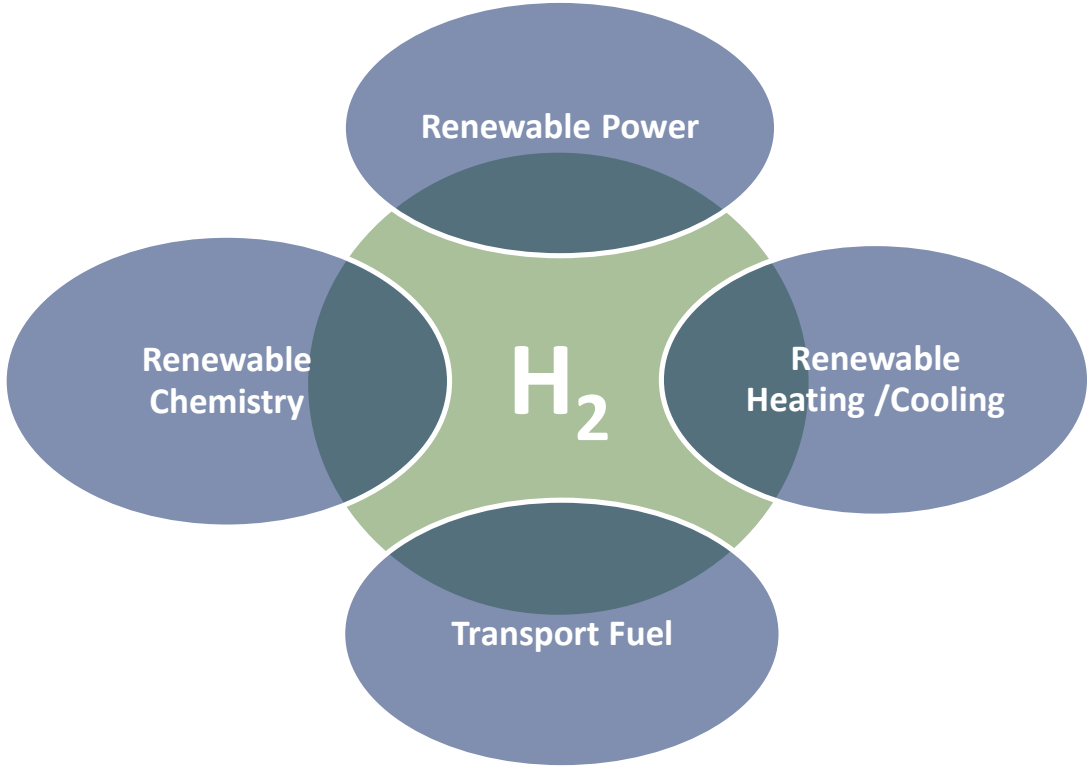
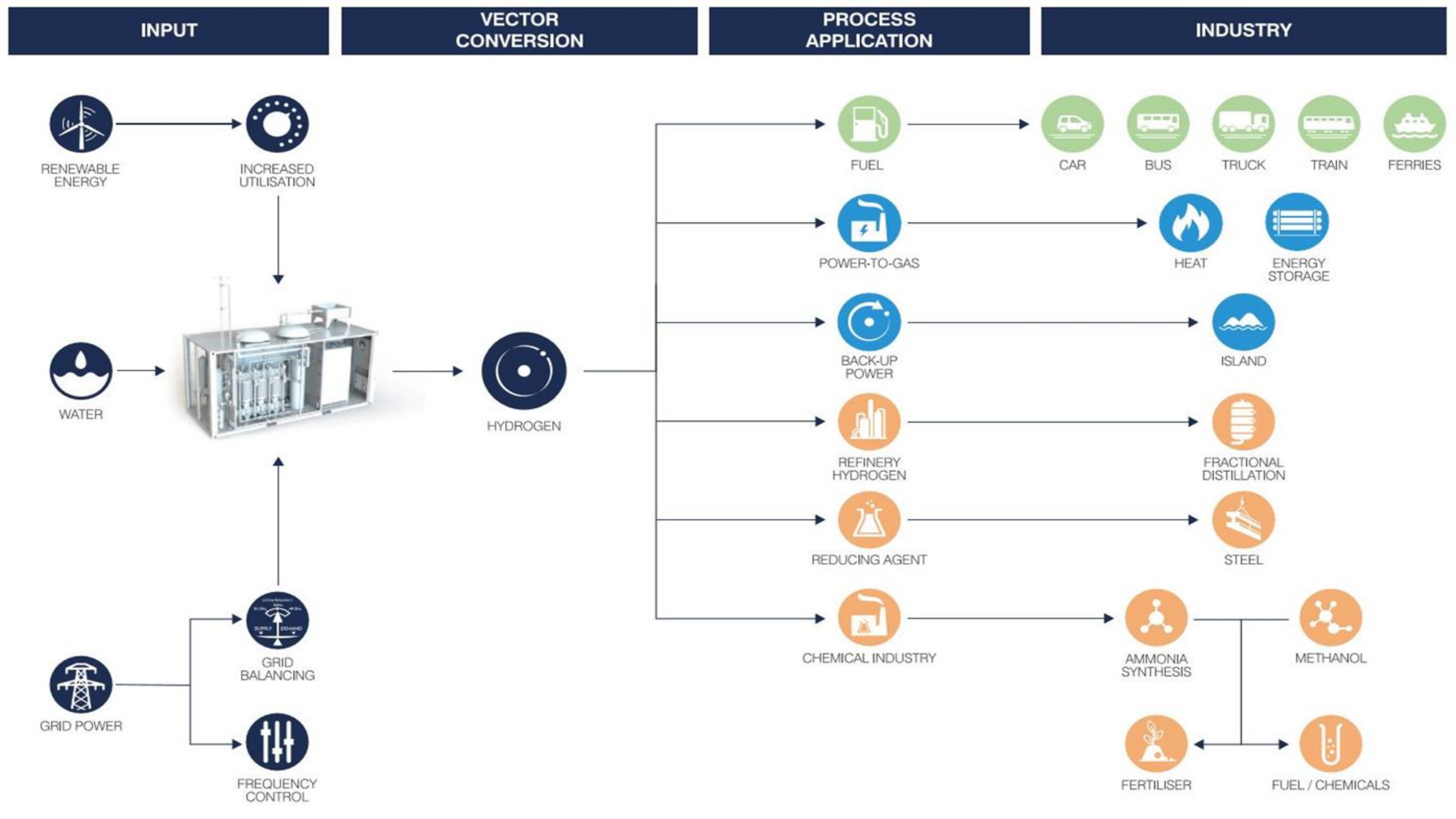
SECTOR COUPLING VIA HYDROGEN

- Renewable Power
- Heating / Cooling
- Mobility
- Commodities – oxygen, syngas, NH3



Sector Coupling


INPUT
VECTOR CONVERSION
PROCESS APPLICATION
INDUSTRY
RENEWABLE ENERGY
INCREASED UTILISATION
WATER
HYDROGEN
GRID POWER
GRID BALANCING
FREQUENCY CONTROL
FUEL
CAR
BUS
TRUCK
TRAIN
FERRIES
POWER-TO-GAS
HEAT
ENERGY STORAGE
BACK-UP POWER
ISLAND
REFINERY HYDROGEN
FRACTIONAL DISTILLATION
REDUCING AGENT
STEEL
CHEMICAL INDUSTRY
AMMONIA SYNTHESIS
METHANOL
FERTILISER
FUEL / CHEMICALS

OUR CLIENTS

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Local and international client base across Asia-Pacific, Europe and North America

AUSTRALIAN ACTICITY
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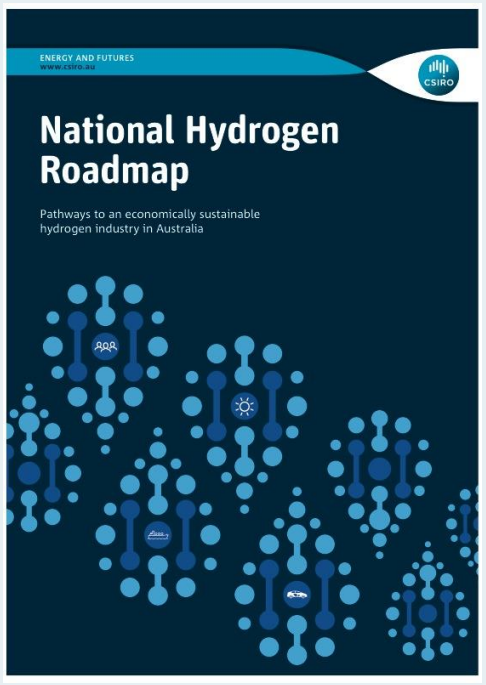

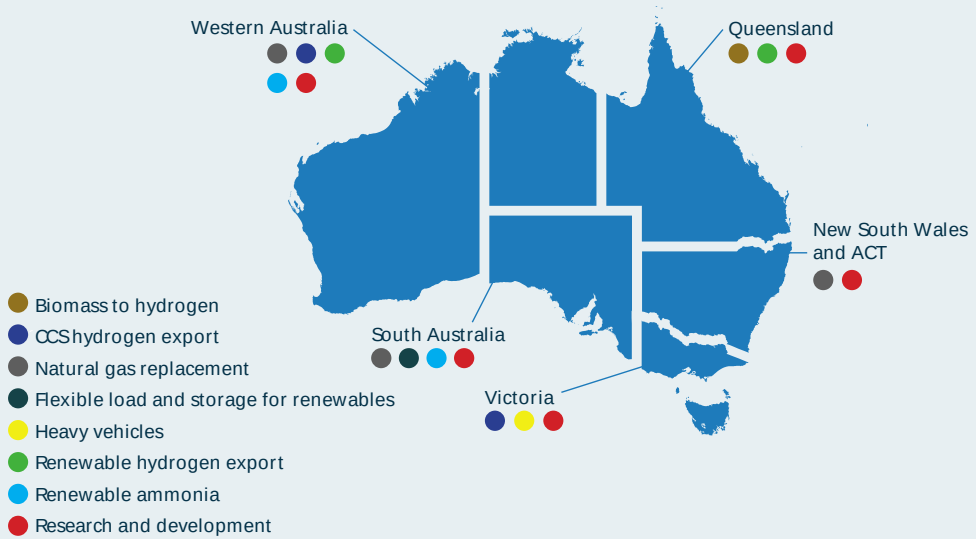

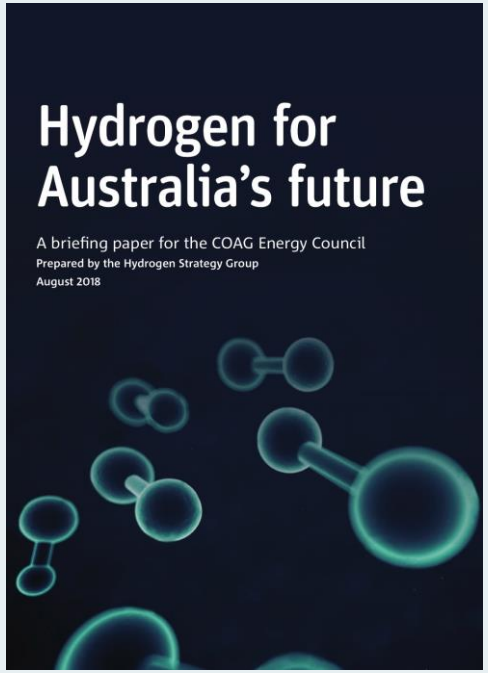

Federal road map launched Aug18 with consolidated States and Territories plan from COAG due Dec19

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Renewable energy sources on farm

PV | Wind | Anaerobic digestion |Organic Rankine Cycle (ORC)

INPUT RENEWABLE WATER SOURCES

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Renewable water sources on farm

Rainfall | Groundwater | Recycled water |Fuel cell stack recovery

CLEAN FUEL PRODUCED ON FARM

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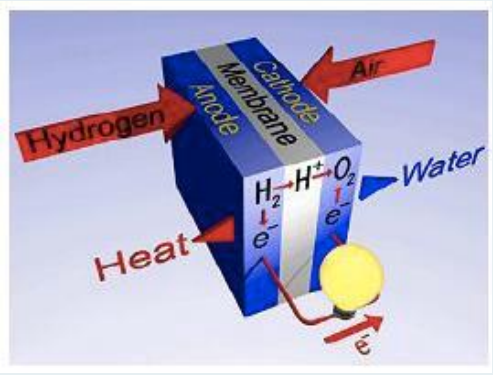
Typical fuel cell vehicles:

- Quad bikes
- Tractors
- SUVs
- Forklifts



Hydrogen fuel cell electric vehicles are better suited to agribusiness demands than battery electric

POWER TO GAS : ENERGY STORAGE / TRI-GENERATION

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Hydrogen gas for heating and cooling:

- Replace LPG and fuel oil for drying / heating
- Lower cost storage than batteries
- Re-convert to electricity via turbine or fuel cell
- Waste heat to cooling via absorption chillers
- Hot water as by-product for wash down

Stabilise electricity, heating and cooling costs via combined cycle tri-generation using fuel cell or turbine

RENEWABLE CHEMISTRY – NEW REVENUE STREAMS

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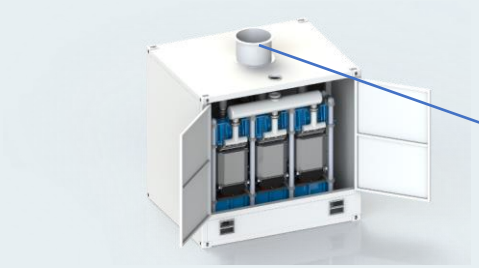
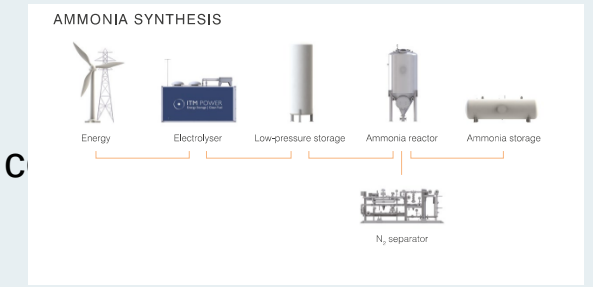
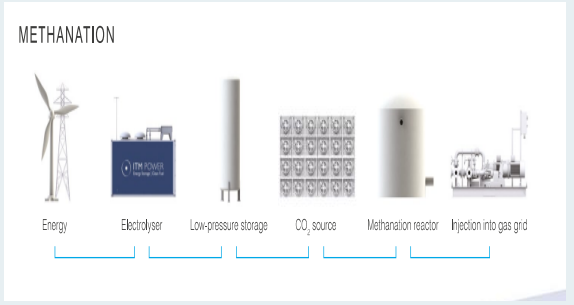
Create value-added products from waste:

- Renewable ammonia production via air separation / fuel c
- Create renewable methane via biogas / CO2 source
- Aquaculture opportunity via waste oxygen







Potential new revenue streams via farm waste integrated with renewable hydrogen source

GRID BALANCING SERVICES
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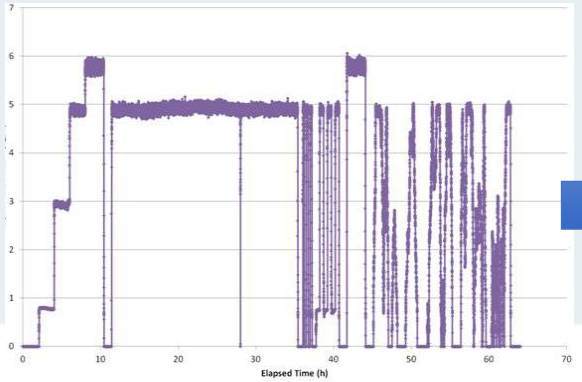
Create additional revenue via electricity network:

- PEM electrolysers can be turned on and off in < 1 second
- Remote control of system can be offered to electricity network
- Demand response & frequency control revenues



Dynamic	Supply Side Balancing Action	Demand Side Balancing Action
Rising Frequency	Turn OFF a generator	Turn ON a load
Falling Frequency	Turn ON a generator	Turn OFF a load

Frequency control market alone valued at A$10m's per annum and growing in NSW

CURRENT EXEMPLAR PROJECT IN AGRIBUSINESS

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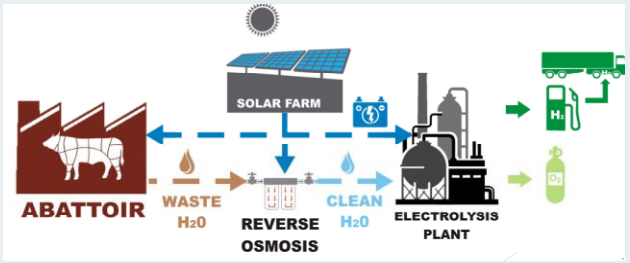
Closed-loop abattoir approved for Gladstone region:

- Solar PV, waste water, biogas and hydrogen make it self-suff
- Fuel cell trucks included from outset together with oxygen sal
- Production cost reduced from >A$300/head to <A$200/head
- Surplus hydrogen to be liquefied for export to Japan and Kore
- Pitt & Sherry provided closed-loop ISD expertise



pitt&sherry

Production cost reduced and fixed via use of integrated hydrogen energy system including transport

NEXT STEPS AFTER WORKSHOP

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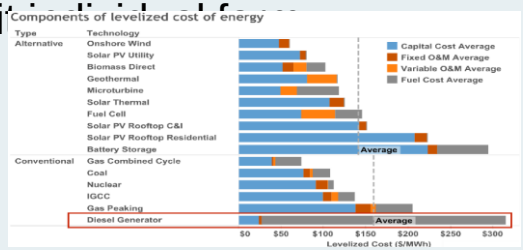
Customer Engagement → Feasibility Study → Front End Engineering Design → Procurement Decision

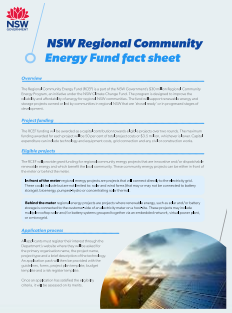
Staged process to assess integrated hydrogen energy systems:

- AS3598 audits using OEH funding to quantify stationary and motive energy usage
- Feasibility study to assess relative costs for various clean technology options
- Full FEED study for best options to inform funding application
- Project delivery via mix of grant / debt funding to suit individual [illegible] requirements

NSW GOVERNMENT | Office of Environment & Heritage

Standards Australia





Proven four stage process to successful integrated hydrogen energy system project delivery

THANK YOU – QUESTIONS?

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"Great things are not done by impulse, but by a series of small things brought together" – Van Gogh