

Australia - South Korea Renewable Energy Partnership  
Renewable Ammonia – Hydrogen Energy Carrier

Solar energy – the next global energy commodity

# Renewable Ammonia – Hydrogen Energy Carrier

## Industrial scale NRE supply - Pilbara Region, Western Australia

South Korea

100% carbon-free, industrial-scale, 24/7 renewable energy system, powered by Renewable Ammonia



EV



FCV

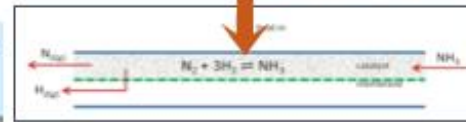


Engine

Turbine

Fuel cell

Waste heat



International shipping via existing technology - fully refrigerated ammonia and LPG vessels



Pilbara Region



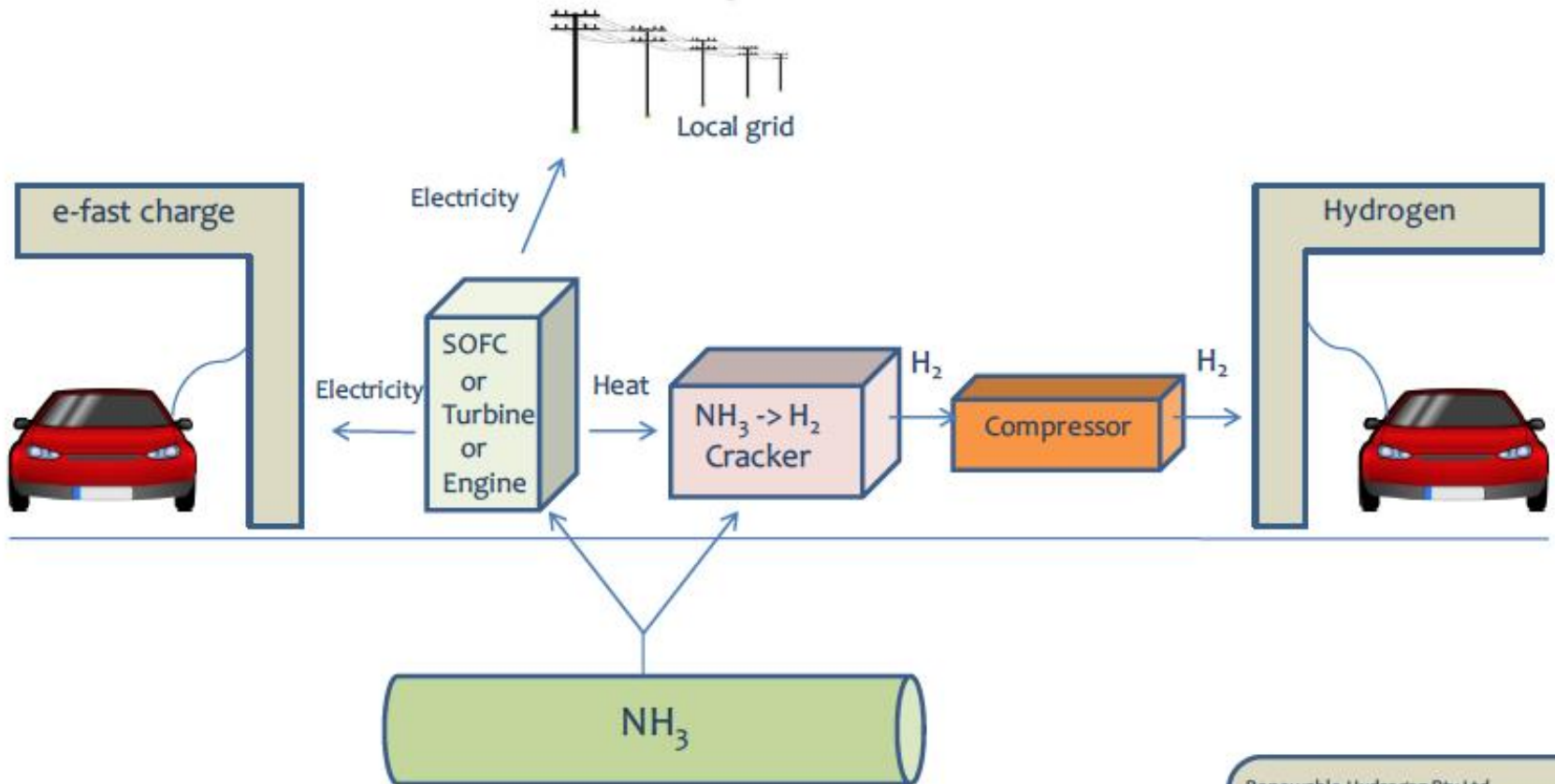
Area: 502,000 km<sup>2</sup>, Population: 60,000  
Solar resource 50% greater than Korean average  
Solar-hydrogen production at unprecedented scale and low cost

Australia



# DEHPRA

(Distributed Energy Hub Powered by Renewable Ammonia)



100,000 litre underground tank contains aprox 70 tn of liquid ammonia which comprises aprox 12,500 kg H<sub>2</sub>

Renewable Hydrogen Pty Ltd  
 Mr Brett Cooper  
[brett.cooper@renewablehydrogen.com.au](mailto:brett.cooper@renewablehydrogen.com.au)  
 Ph +61 419 438 827  
 Mr Andrew Want  
[andrew.want@renewablehydrogen.com.au](mailto:andrew.want@renewablehydrogen.com.au)  
 Ph +61 408 956 210

Pilbara Renewable Ammonia - Hydrogen Energy Carrier Project  
How renewable Hydrogen demand growth drives solar capacity

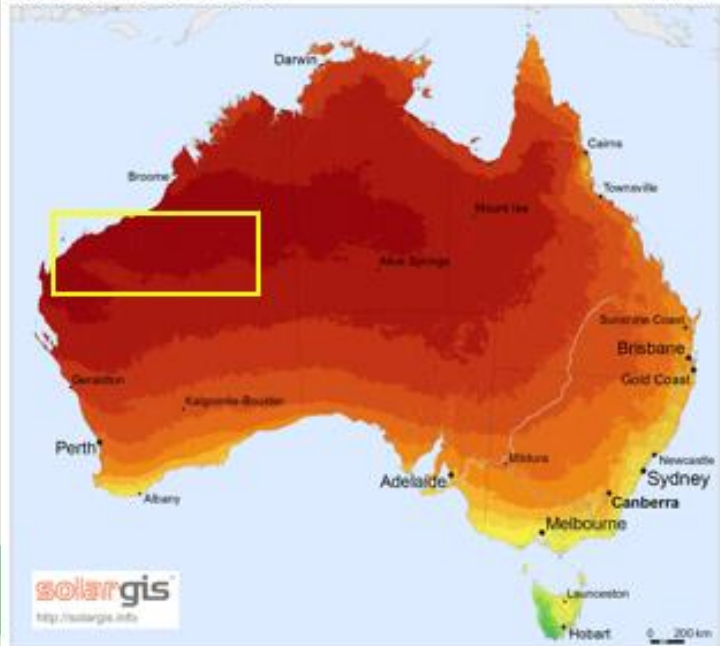


Pilbara Solar Resource 2,200-2,400 kWh/m2/pa  
2,200 MWh pa

2025 Renewable H<sub>2</sub>  
Fleet of 30,000 FCVs

Renewable H<sub>2</sub>  
Fleet of 8,000 buses

Global Horizontal Irradiation Australia



Average annual sum, period 2007-2012  
< 1100 1300 1500 1700 1900 2100 2300 > kWh/m<sup>2</sup>

SolarGIS © 2013 GeoModel Solar



Daily demand (kgs)	24,658	264,000	
Annual demand (kgs)	9,000,000	79,200,000	
Annual demand (t)	9,000	79,200	
Daily demand (MWh)	1,681	18,000	
Annual demand (MWh)	613,636	5,400,000	
<b>MW capacity of Solar PV</b>	<b>279</b>	<b>2,455</b>	<b>2,733</b>
<b>Land required (ha)</b>	<b>558</b>	<b>4,909</b>	<b>5,467</b>

Korea's Solar Resource 1,400kWh/m<sup>2</sup>/pa  
 1400 MWh pa



Hyundai's 10MW solar PV installation

2025 Renewable H<sub>2</sub>  
 Fleet of 30,000 FCVs



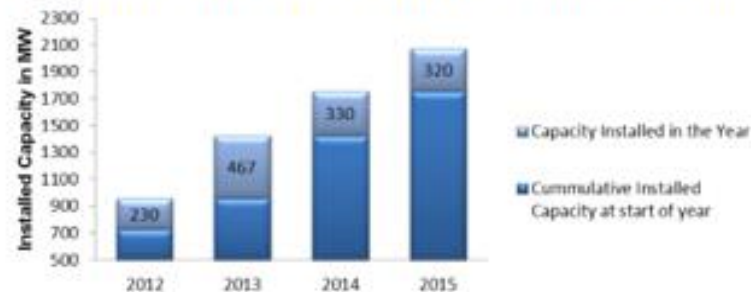
Renewable H<sub>2</sub>  
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MW capacity of Solar PV	438	3,857	4,295
Land required (ha)	877	7,714	8,591

South Korea's installed capacity of solar PV as at 2015 was estimated as 2,100MW  
 NRE Plan requires 14.1% of electricity supply from solar PV by 2035



Renewable Ammonia production capacity is modular.  
Scale-up is progressive, automated & aligned to demand growth

Pilot Phase 1  
Demonstration

2.5MW

2.5MW solar PV and electrolysis constructed at the existing Yara Pilbara Fertilisers (YPF) ammonia plant, Dampier WA

Pilot Phase 2  
Initial Scale-up

200 to 400 MW

Solar generation inland; transmission by AC/HVDC to 400MW electrolysis capacity located on the coast, adjacent to Port of Dampier and YPF

Phase 3 - Full  
Commercial  
Scale

4GW to 20 GW

Renewable Ammonia production expansion at industrial sites on the Pilbara coast, each supported by very large (~4GW) inland solar generation facilities

Stage 4 -  
Industrial Scale,  
including  
'Floating RNH<sub>3</sub>'

400 to 500 GW

Multiple Renewable Ammonia plants are supported by massive (10,000 km<sup>2</sup>; 500GW) solar generation capacity located in northern Pilbara, supporting 100 MTPA exports with a value \$US60 -70 billion pa

Over a 40 year project life, just 800,000ha in the Pilbara would produce solar power equivalent to 12 billion BOE.

# 2.5MW Demonstration Plant (Pilot Phase 1) Target operational commencement late 2018

Pilbara Region, Western Australia – unprecedented scale + strategic location



Yara Pilbara Ammonia Plant - Dampier, Western Australia

- Australia-Korea partnership to realise the value of Australia's immense solar resources
- Industrial scale, zero-carbon energy security for Korea and the Asia/Pacific region
- Enables Korea to reduce reliance on oil (and USD exposure)
- Advances the Basic Energy Plan and New & Renewable Energy Plan
- Supports and accelerates expansion of Korea's solar and hydrogen industries
- Major business benefits flow back to Korean business, economy and environment
- Complements LNG and coal, builds on existing energy partnership success
- The logical next phase of development in the Australia-Korea energy partnership

## Port of Dampier – bulk liquids (ammonia) export facility





# Thank you



Andrew Want  
Director  
Level 3, 35 Lime Street  
Sydney NSW 2000  
AUSTRALIA  
M: +61 408 956 210  
E: [Andrew.Want@RenewableHydrogen.com.au](mailto:Andrew.Want@RenewableHydrogen.com.au)



Pierre Herben  
Chief Technology Officer  
Corporate Management  
Corporate Research and Innovation  
Corporate Village, Aramis Building  
Da Vincilaan 1  
B-1935 Zaventem,  
BELGIUM  
M: [+32477750035](tel:+32477750035)  
Office: [+3227735201](tel:+3227735201)  
E: [pierre.herben@yara.com](mailto:pierre.herben@yara.com)