Towards A Carbon Free Future
The Challenges & Opportunities

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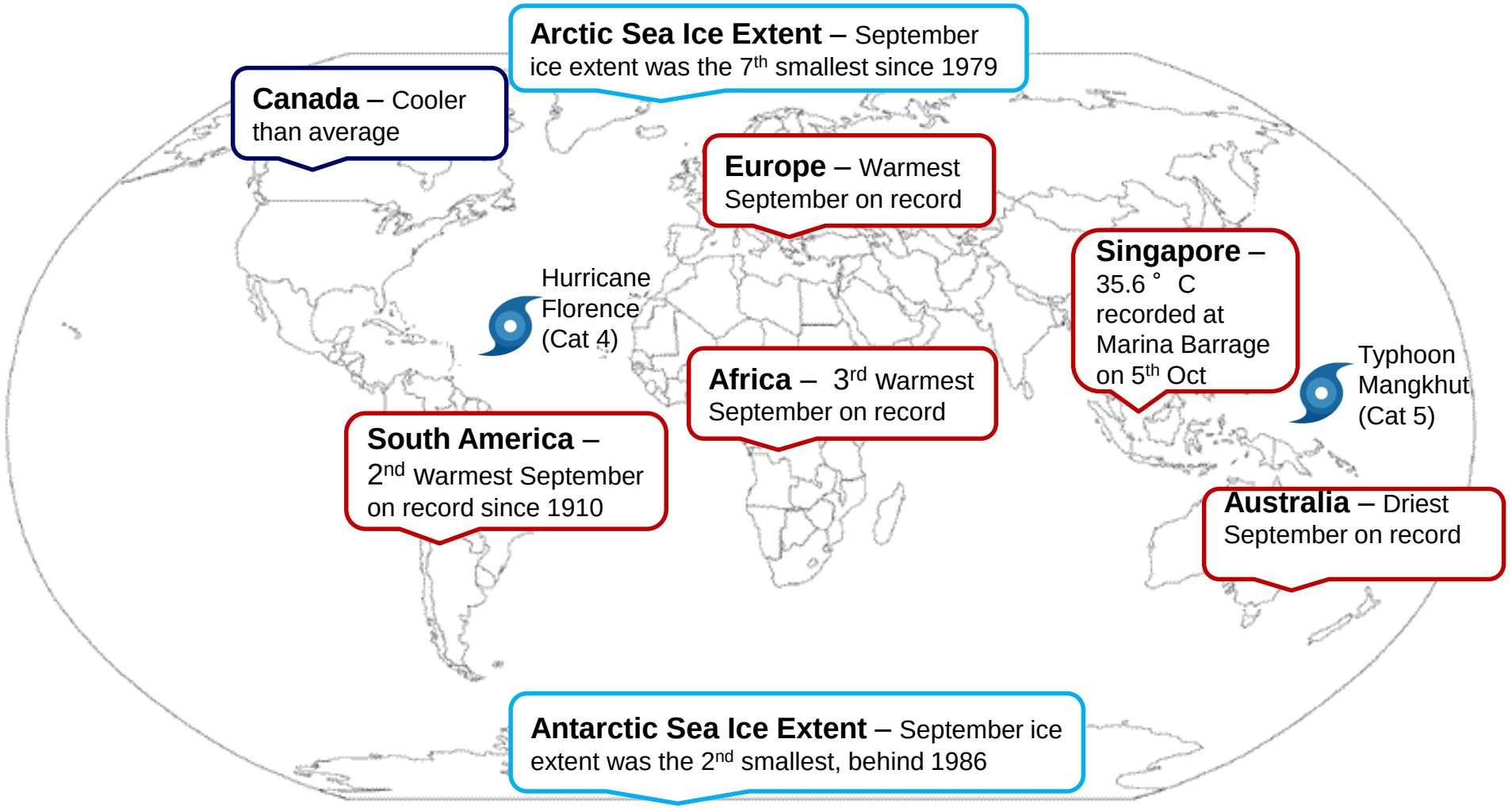
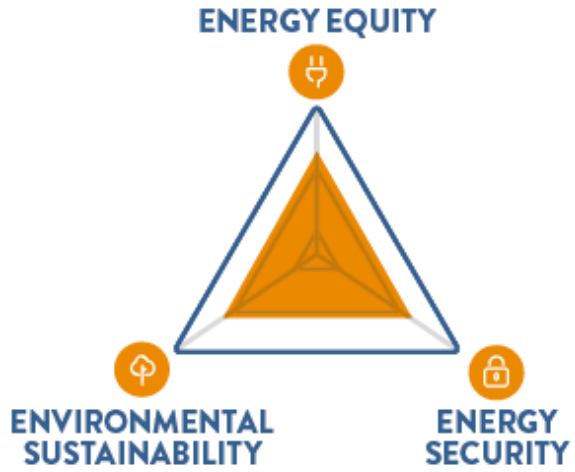
Selected Recent Climate Anomalies and Events



IPCC recent report states that the planet could surpass 1.5 ° C marker as early as 2030 and no later than mid-century

Sources: 1. Adapted from NOAA's State of the Climate Reports, 2. Mothership.org, October 2018

Energy Trilemma Index



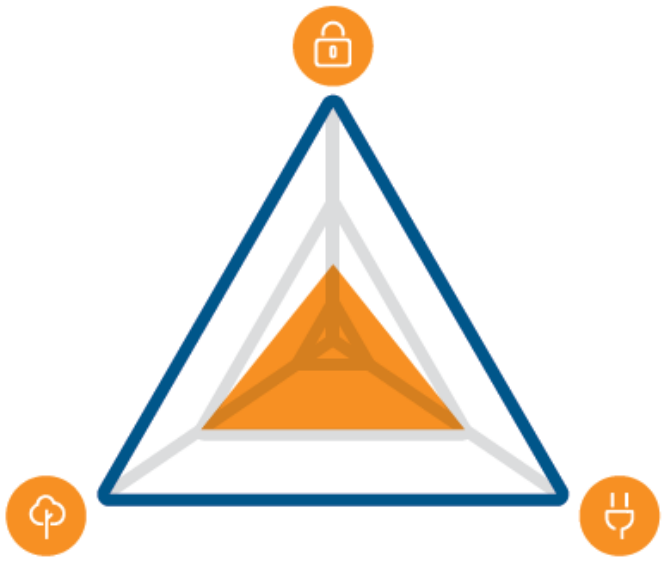
Energy security: Effective management of primary energy supply from domestic and external sources, reliability of energy infrastructure, and ability of energy providers to meet current and future demand.

Energy equity: Accessibility and affordability of energy supply across the population.

Environmental sustainability: Supply- and demand-side energy efficiencies, and development of energy supply from renewable and other low-carbon sources.

Contextual performance: Elements that enable countries to effectively develop and implement energy policy and achieve energy goals

Energy Trilemma Index - Asia

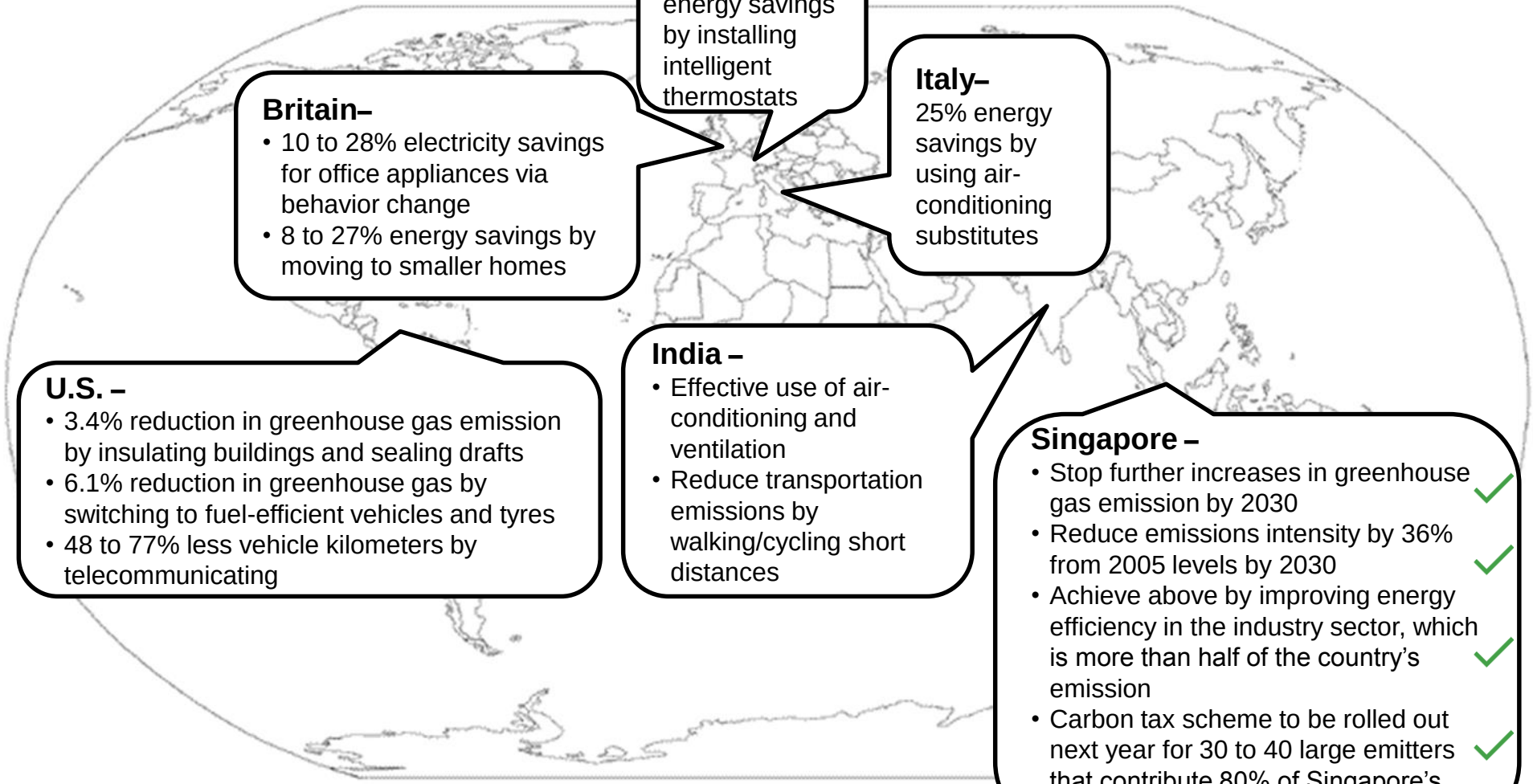


Asian Countries			
Australia (38)	Japan (30)	Pakistan (103)	Azerbaijan (27)
Kazakhstan (72)	Philippines (74)	Bangladesh (107)	Korea (35)
Singapore (19)	Cambodia (117)	Malaysia (37)	Sri-Lanka (89)
China (78)	Mongolia (111)	Tajikistan (92)	Hong Kong (34)
Nepal (118)	Thailand (75)	India (88)	New Zealand (8)
Vietnam (83)	Indonesia (71)		

- Asia accounts for ~ one-third of global GHG emission (more than EU and US combined)
- Asia has the world second largest population without access to electricity
- Rapidly growing energy demand, import dependence, trade policies and weather change raises concerns for energy security and energy sustainability
- Singapore ranks 19 out of 125 countries, scoring C A A

Source: World Energy Trilemma Index 2018, World Energy Council

IPCC Recommendations



Germany–
21 to 26% energy savings by installing intelligent thermostats

Britain–
- 10 to 28% electricity savings for office appliances via behavior change
- 8 to 27% energy savings by moving to smaller homes

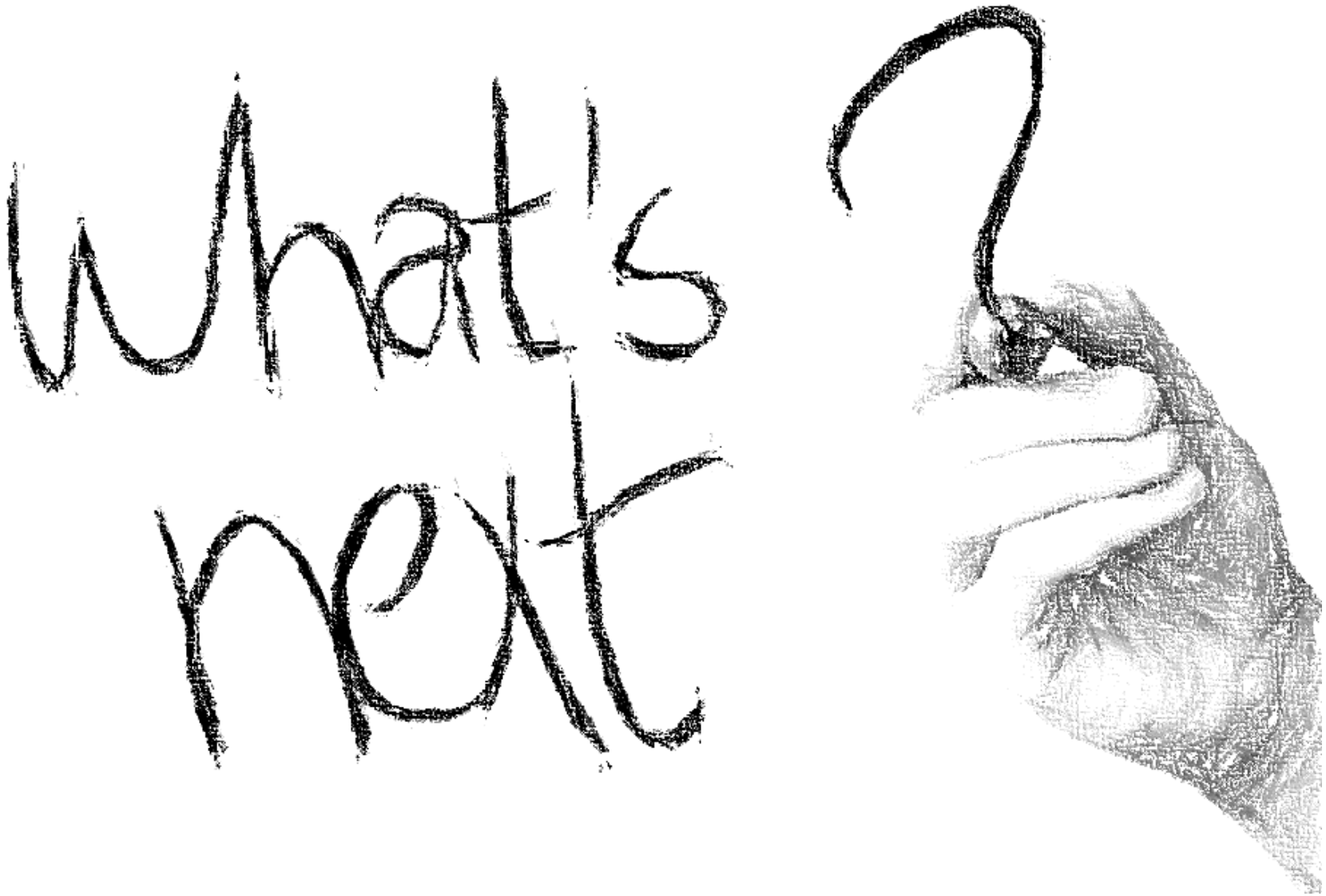
Italy–
25% energy savings by using air-conditioning substitutes

U.S. –
- 3.4% reduction in greenhouse gas emission by insulating buildings and sealing drafts
- 6.1% reduction in greenhouse gas by switching to fuel-efficient vehicles and tyres
- 48 to 77% less vehicle kilometers by telecommunicating

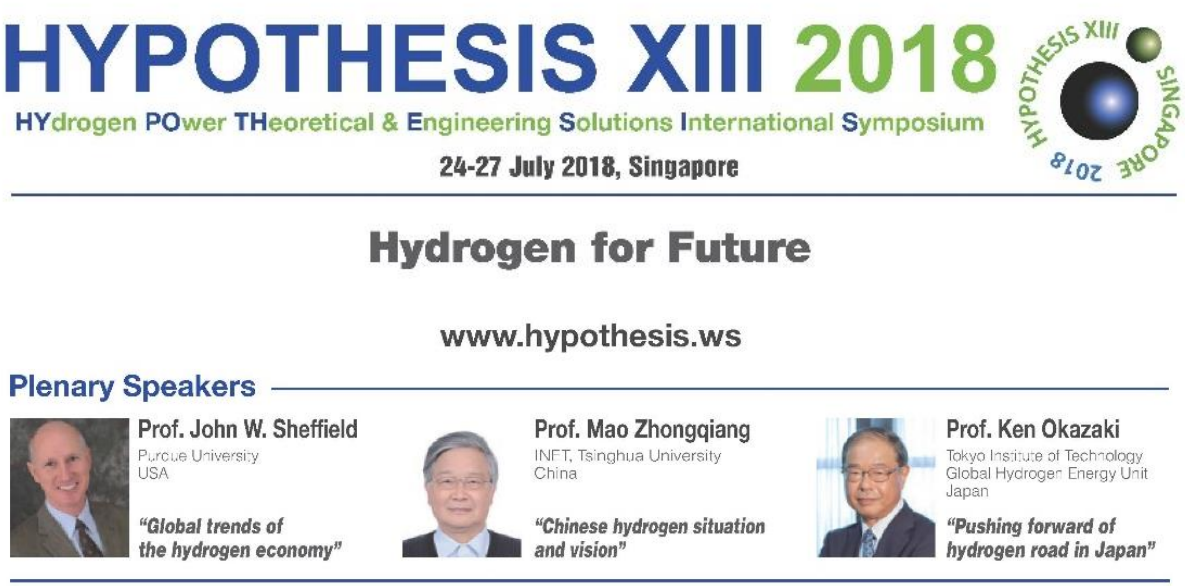
India –
- Effective use of air-conditioning and ventilation
- Reduce transportation emissions by walking/cycling short distances

Singapore –
- Stop further increases in greenhouse gas emission by 2030 ✓
- Reduce emissions intensity by 36% from 2005 levels by 2030 ✓
- Achieve above by improving energy efficiency in the industry sector, which is more than half of the country's emission ✓
- Carbon tax scheme to be rolled out next year for 30 to 40 large emitters that contribute 80% of Singapore's greenhouse gas emission ✓

Source: Adapted from https://www.straitstimes.com/world/key-points-of-ipcc-report



Recent Events

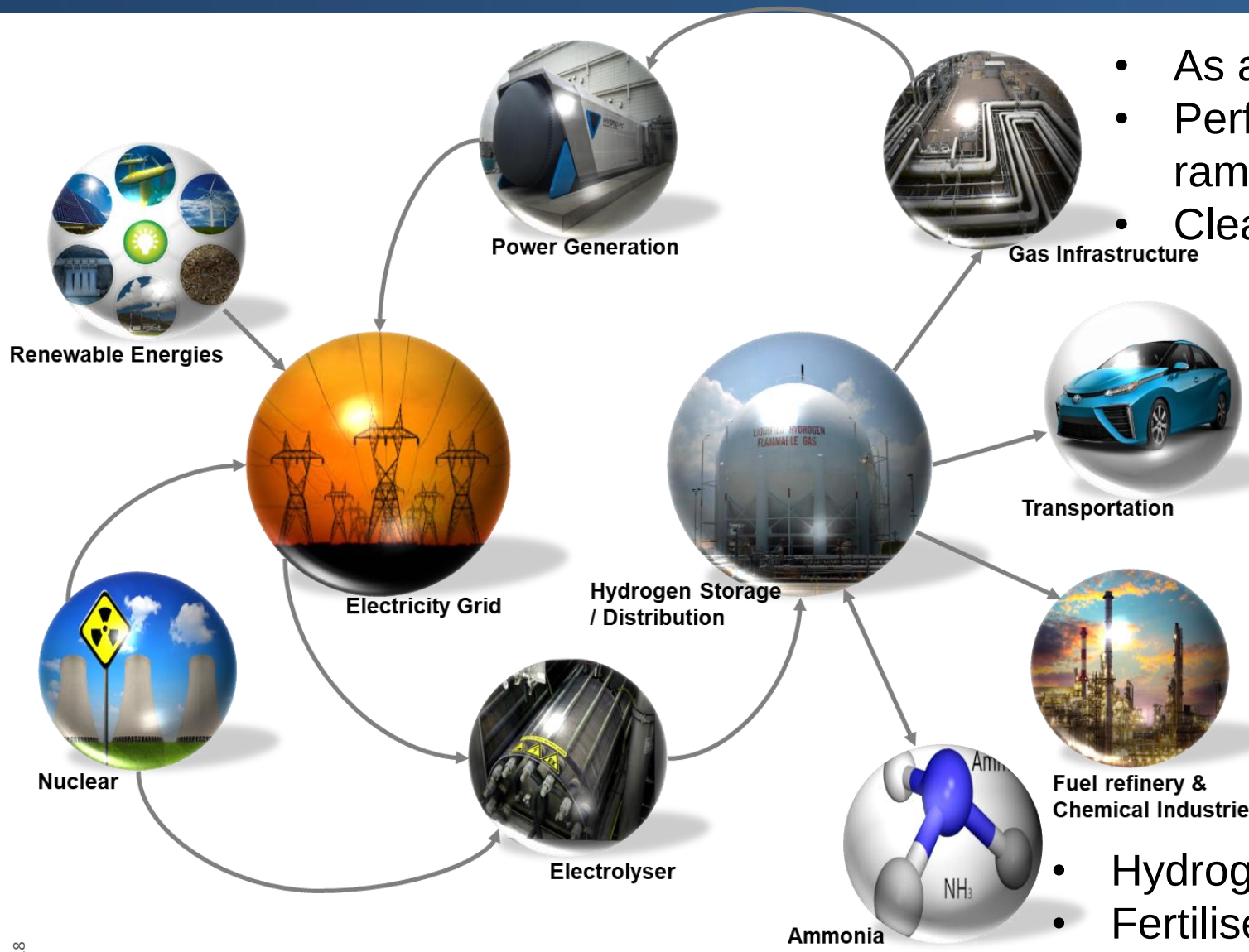


International Symposium

4-Party MOU Signing

Hydrogen is back!
It's only a matter of time when the use of hydrogen will be widespread.
But how do we adapt to our existing infrastructure?

Hydrogen - A Universal Energy Carrier with Multiple Applications



- As a large scale energy storage
- Perform grid services (frequency control, ramping etc.)
- Cleaner cooking and CHP applications

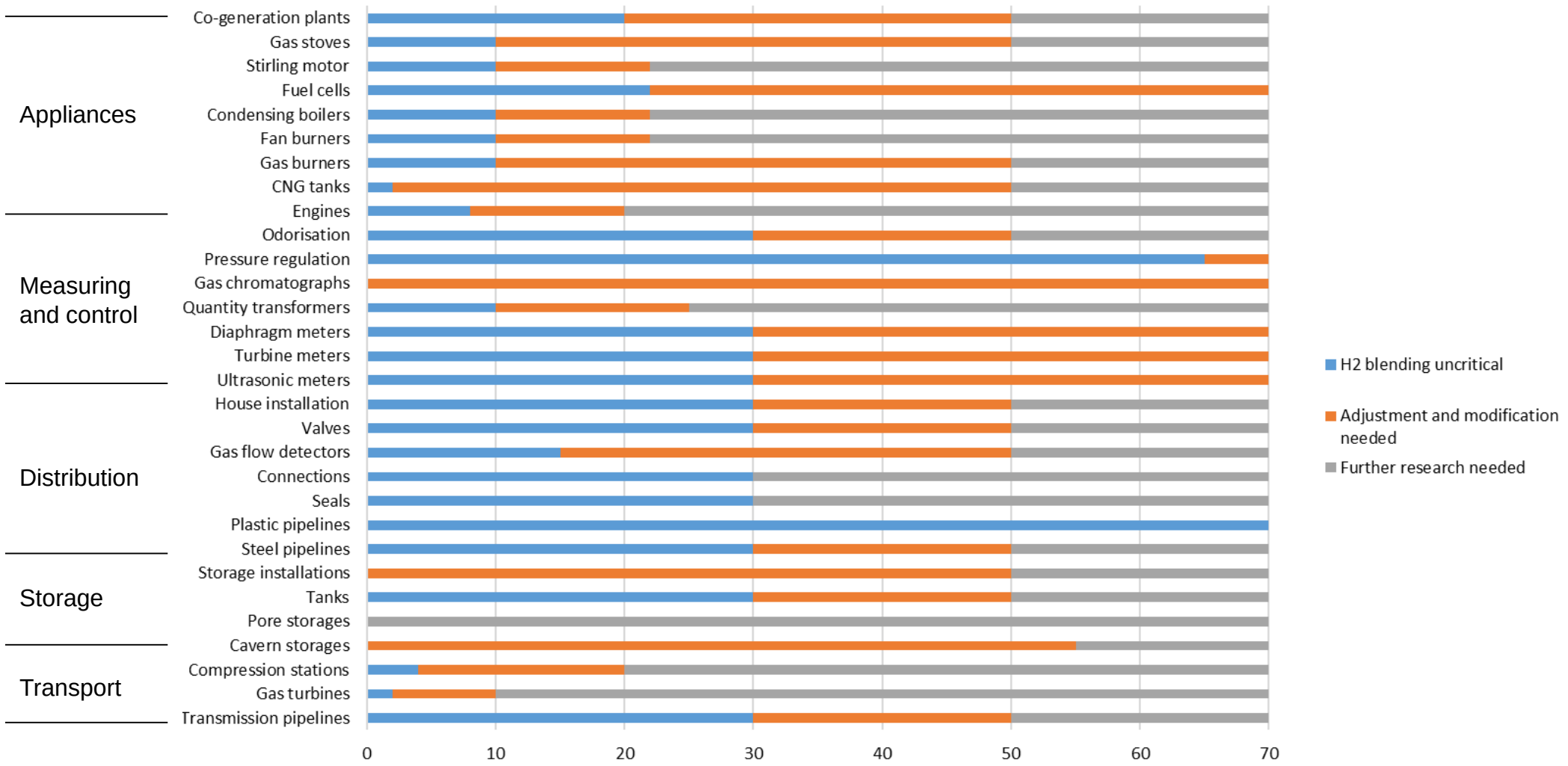
- Alternative clean fuel for land, air and sea transport, riding on gas grid
- On-board back-up for trains

- Refine crude oil
- Syn-gas as feedstock for chemical plants

- Hydrogen carrier for long distance transportation
- Fertilisers and other usage

Challenges & Opportunities

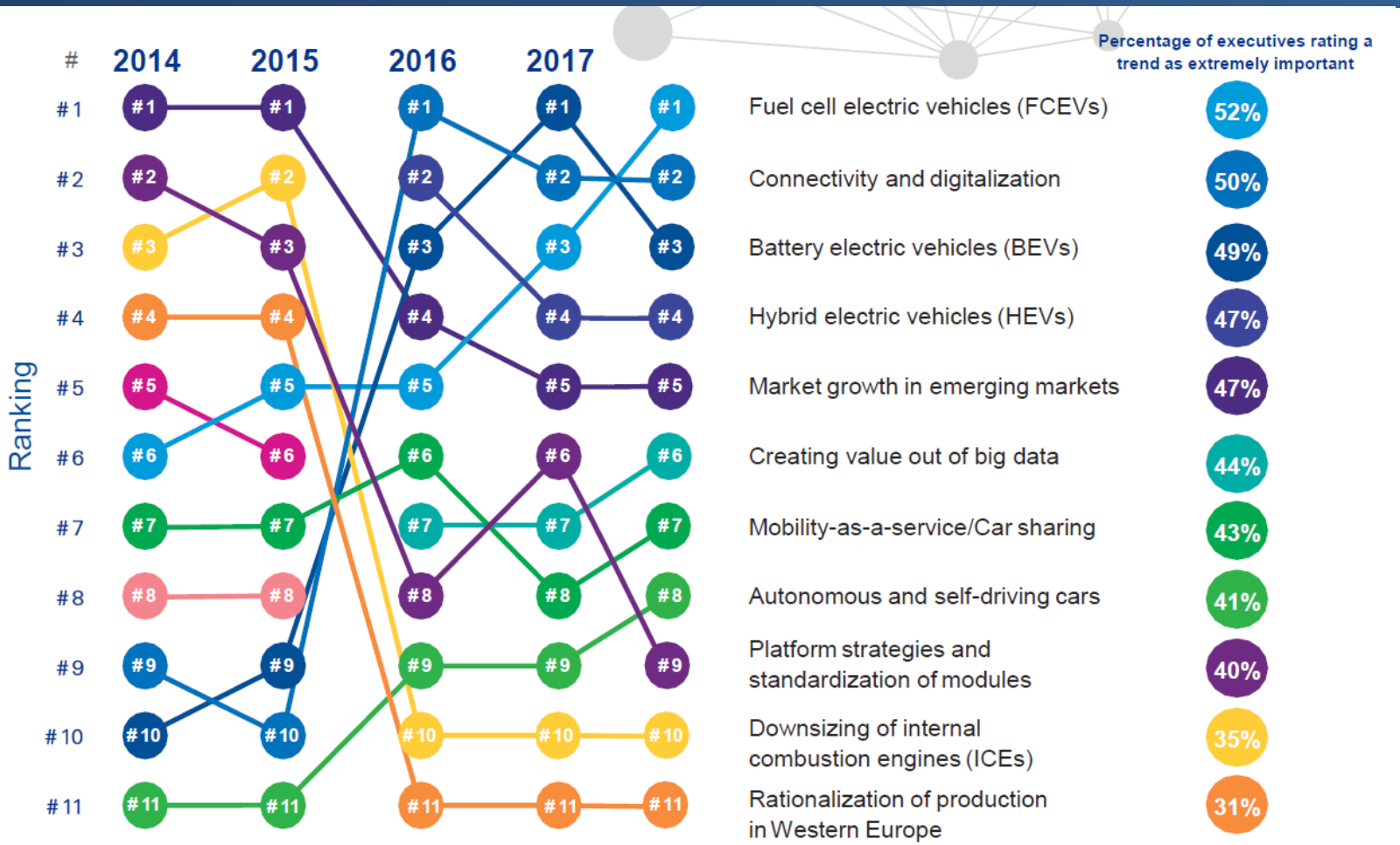
Use of Hydrogen in Current Gas Network and Usage



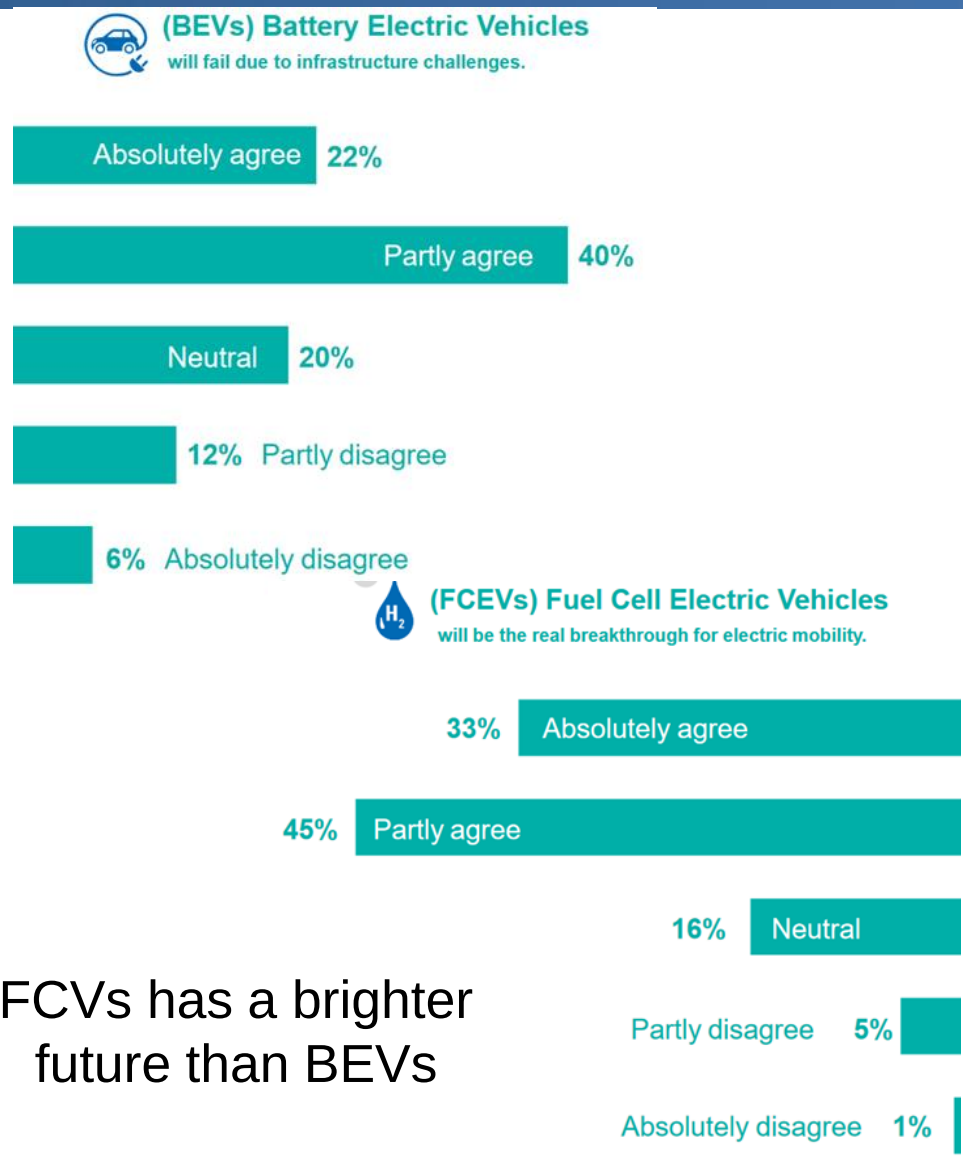
5 to 15 % vol. of hydrogen blending is viable without significant increase in risk associated with gas blend utilisation, overall public safety, or the durability and integrity of the existing gas network

Source: IEA Technology Roadmap, Hydrogen and fuel cell, 2015; Blending hydrogen into natural gas pipeline networks: A review of key issues, 2013

Challenges & Opportunities
Transportations



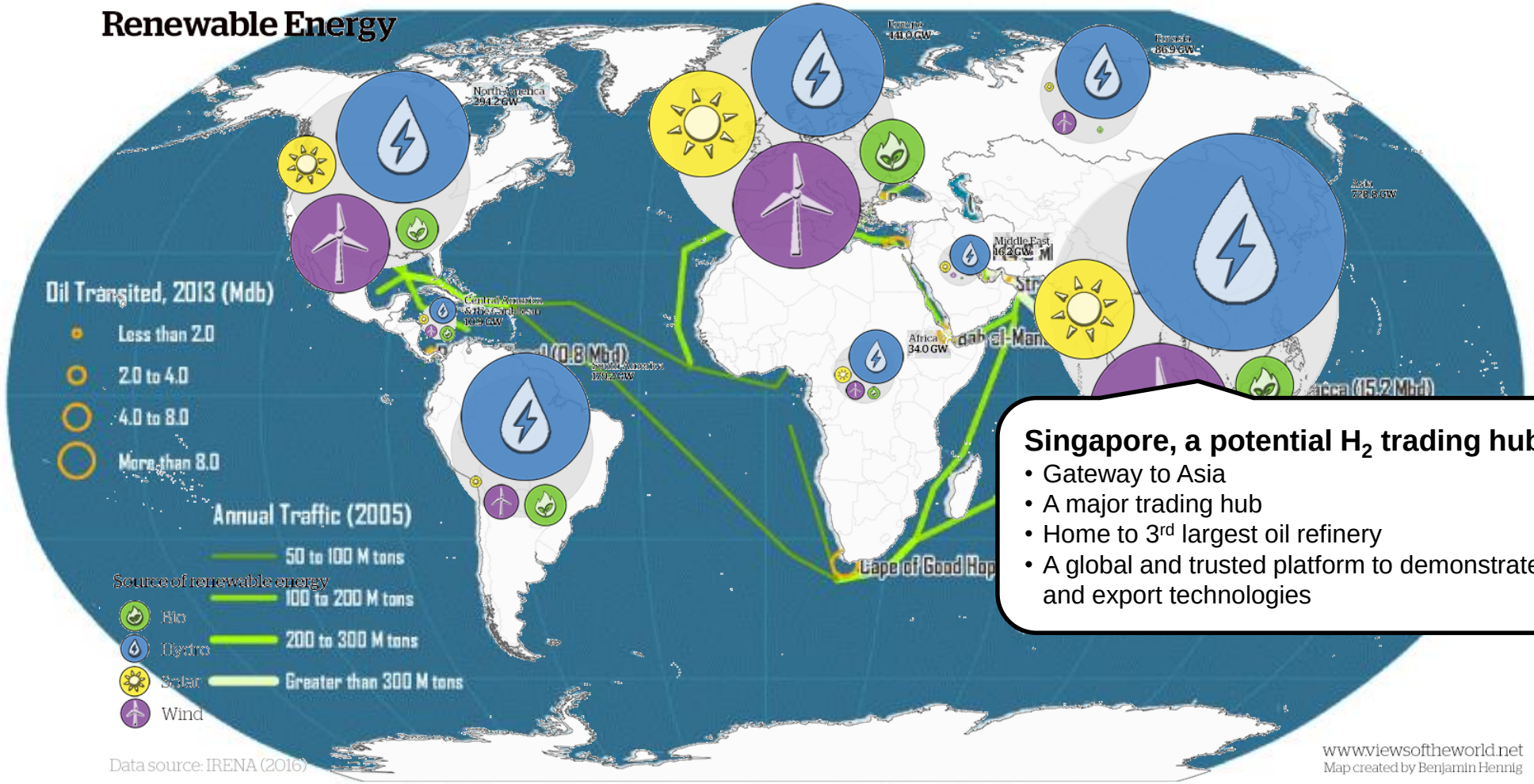
FCVs will lead the trend till 2025



FCVs has a brighter future than BEVs

Source: Global Automotive Executive Survey, KPMG, 2017

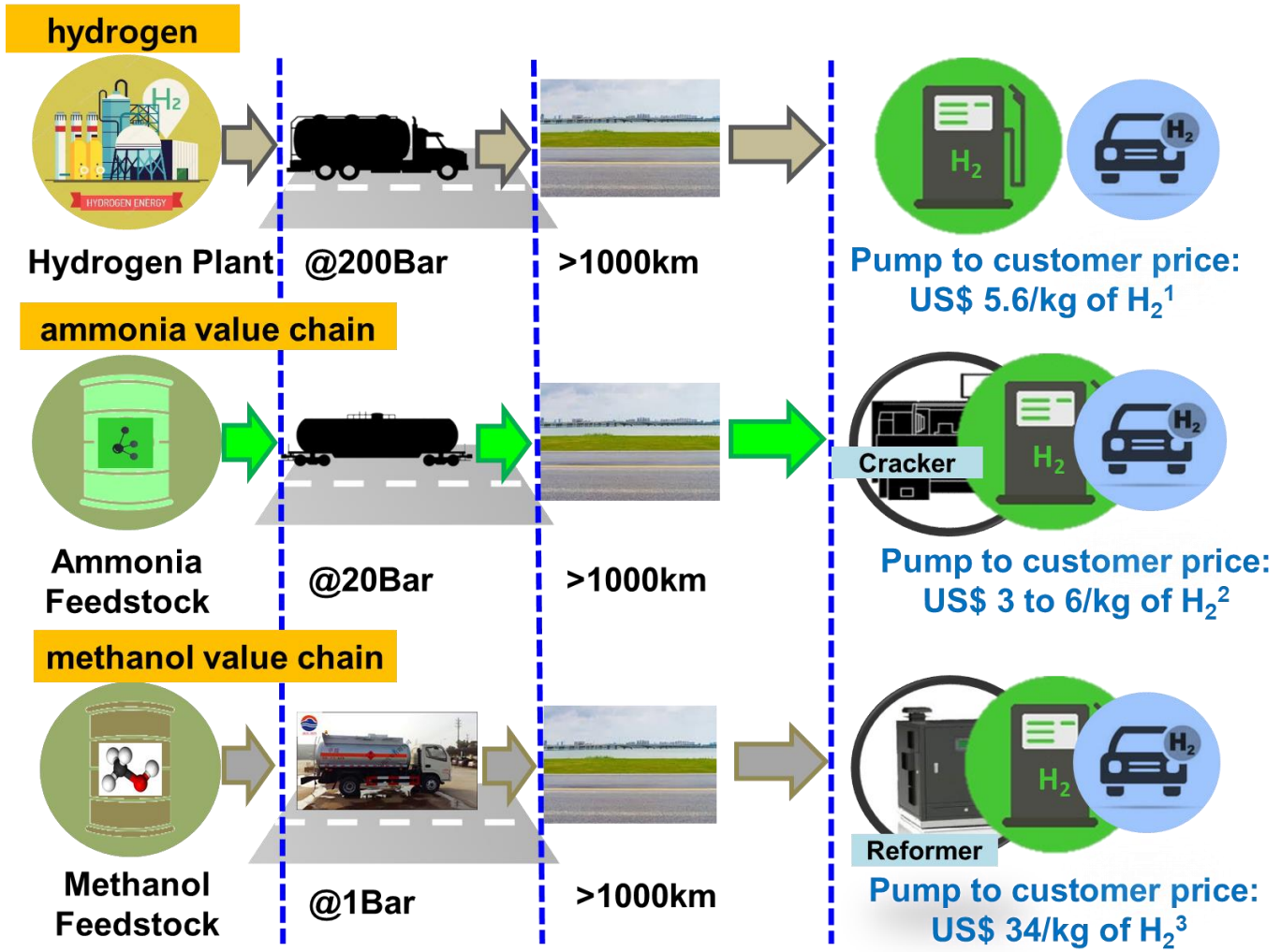
Challenges & Opportunities
Hydrogen Sources and Transportation



Singapore, a potential H_2 trading hub –
- Gateway to Asia
- A major trading hub
- Home to 3rd largest oil refinery
- A global and trusted platform to demonstrate and export technologies

Hydrogen can be the next black gold

Challenges & Opportunities
Hydrogen Sources and Transportation



Hydrogen can be transported in different medium
Price will determine the preferred route

1. Price obtained from interviews conducted with supplier
2. Based on 400 m^3/h @ atm, 12 h/day, 365 operation
3. Price obtained from supplier

Challenges & Opportunities
Others

High temperature electrolyser
- Highly efficient, durable and cost effective solution to be developed and reach commercial stage

Low temperature electrolyser
- Durability and cost effectiveness need to be further improved

Safety
- Establish safety guidelines and approach for hydrogen applications

Mindset
- Further education on hydrogen required
- Demonstration project can be a possible tool

Questions & Answers

Let’s work towards a carbon free future