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The Regulator Views towards Hydrogen Economy

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- **Medium to long term challenges** – the role of interconnections and hydrogen

EU energy strategy

towards 2050

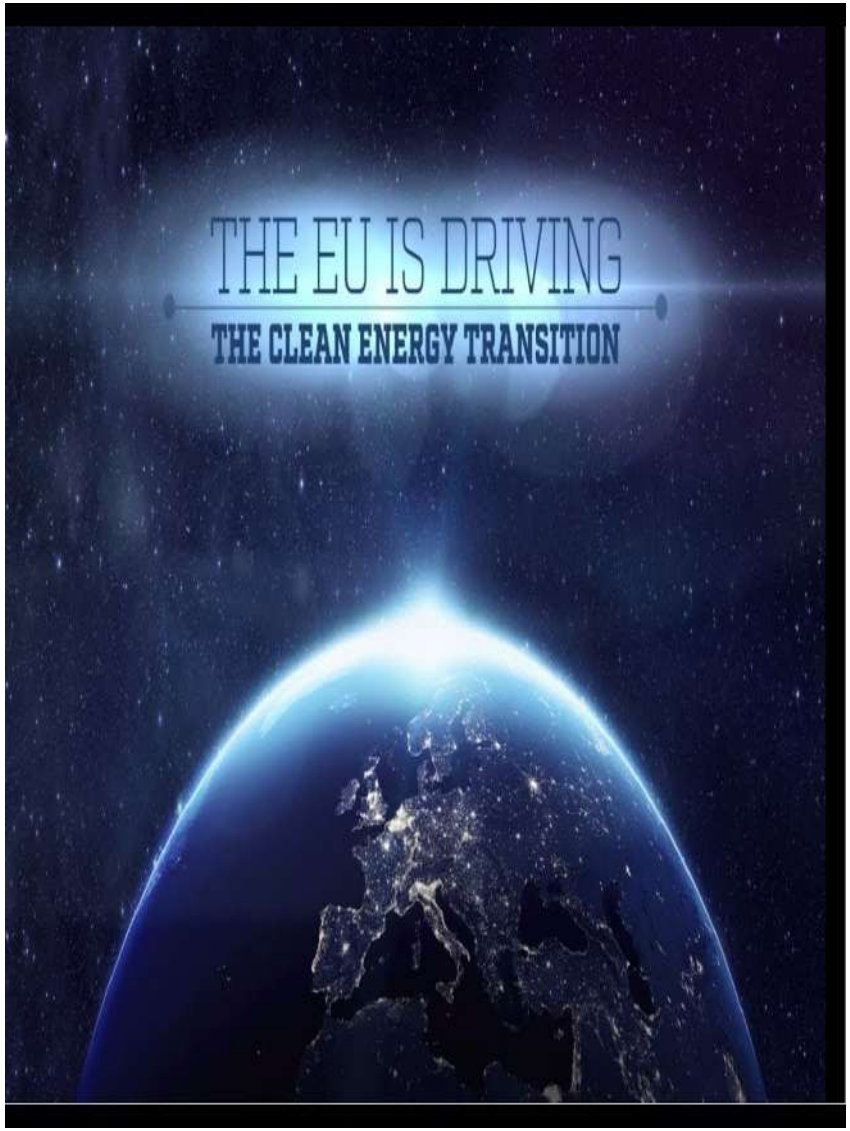
Energy transition

- **greenhouse gas reduction**
  - **EU: climate neutral by 2050**
- **sustainable production and consumption**
- **competition in electricity and natural gas markets**
- **security of supply**

Energy transition*

Need to:

- Reduce cost of security of supply
- Achieve market integration
- Increase socio-economic welfare benefits



* Poullikkas A., 2013, *Renewable Energy: Economics, Emerging Technologies and Global Practices*, ISBN: 978-1-62618-231-8

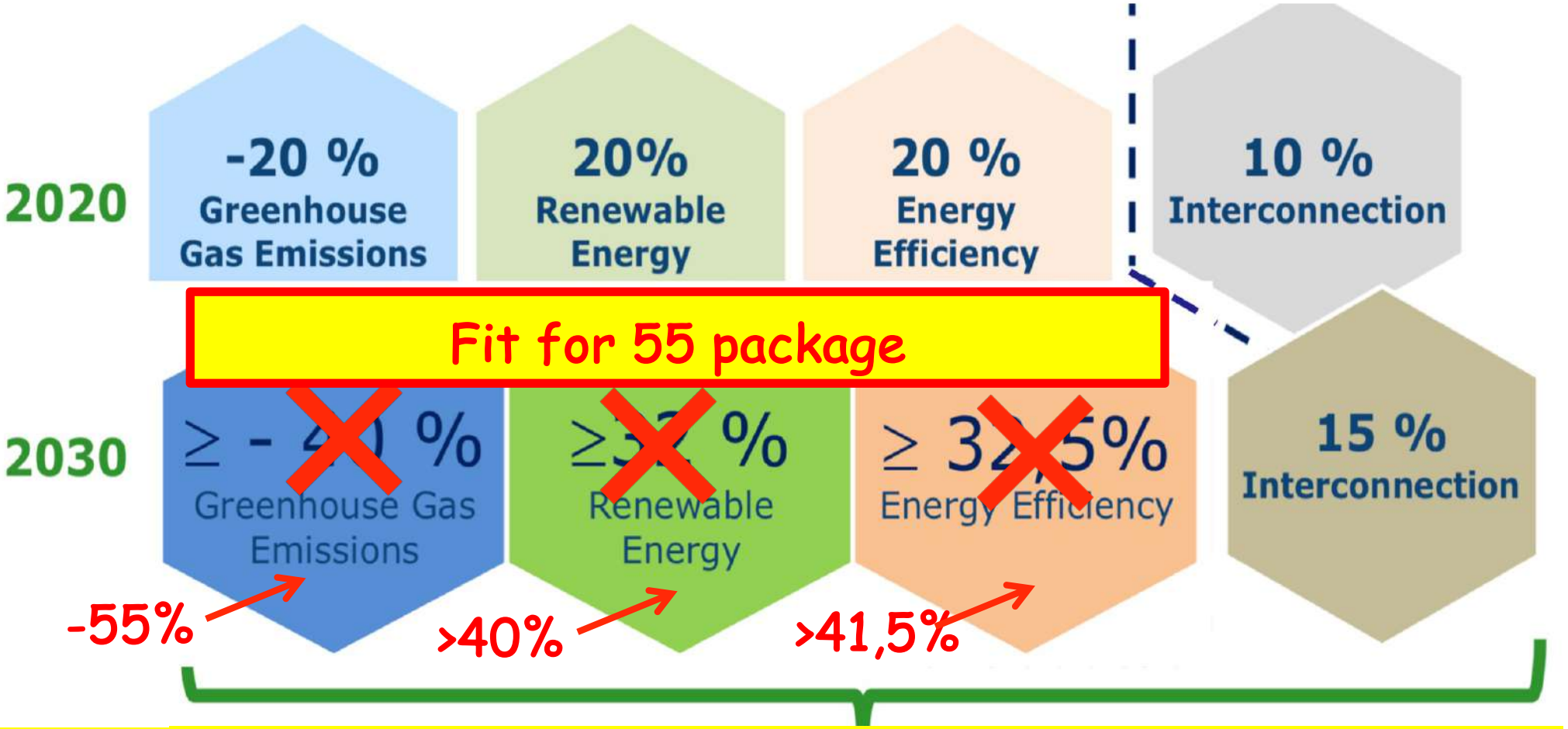
The EU Green Deal and Fit-for-55

…to reach our targets in a:

- **socially fair**
- **cost-efficient**
- **competitive**

way…

EU medium and long term targets



Fit-for-55 strategy

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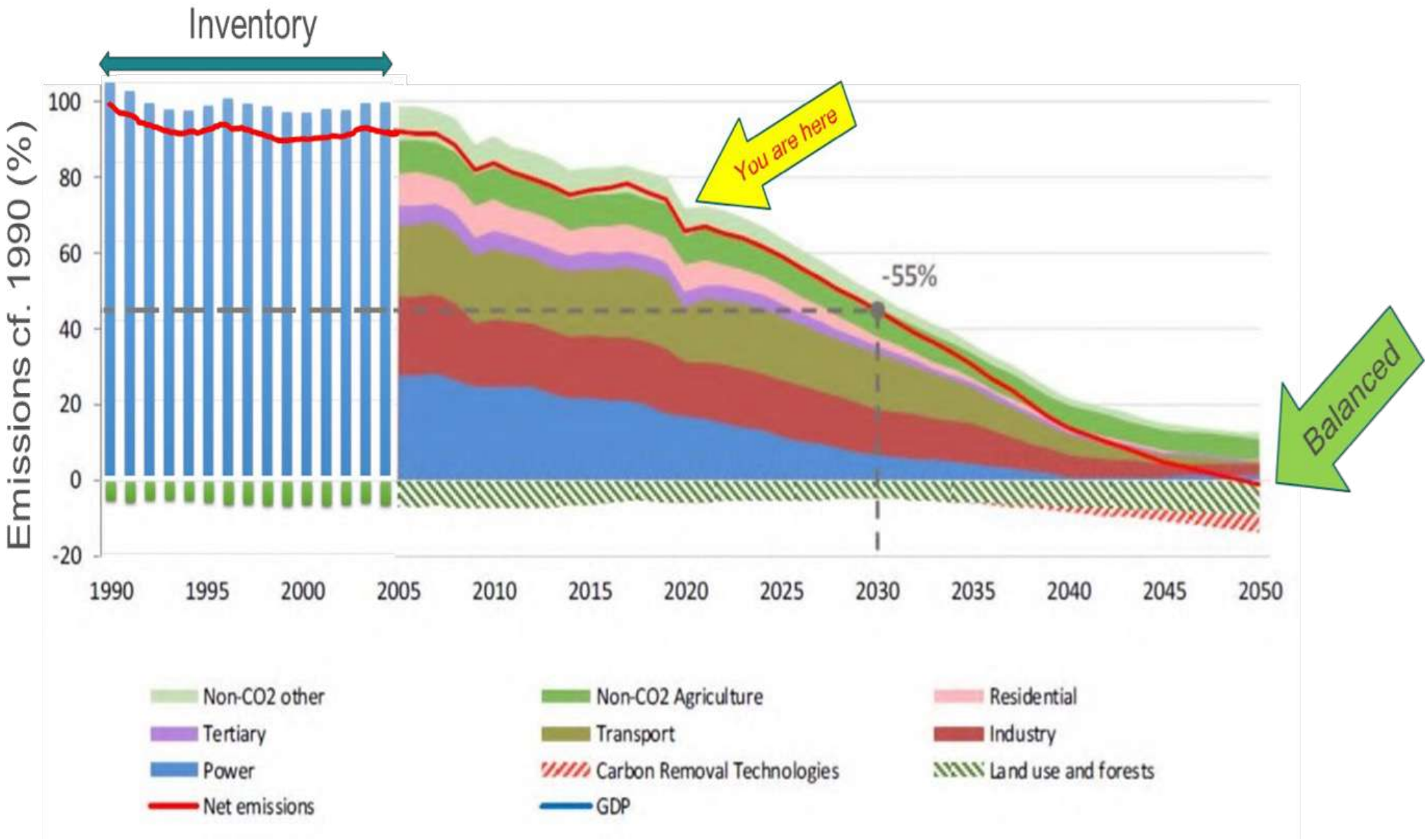
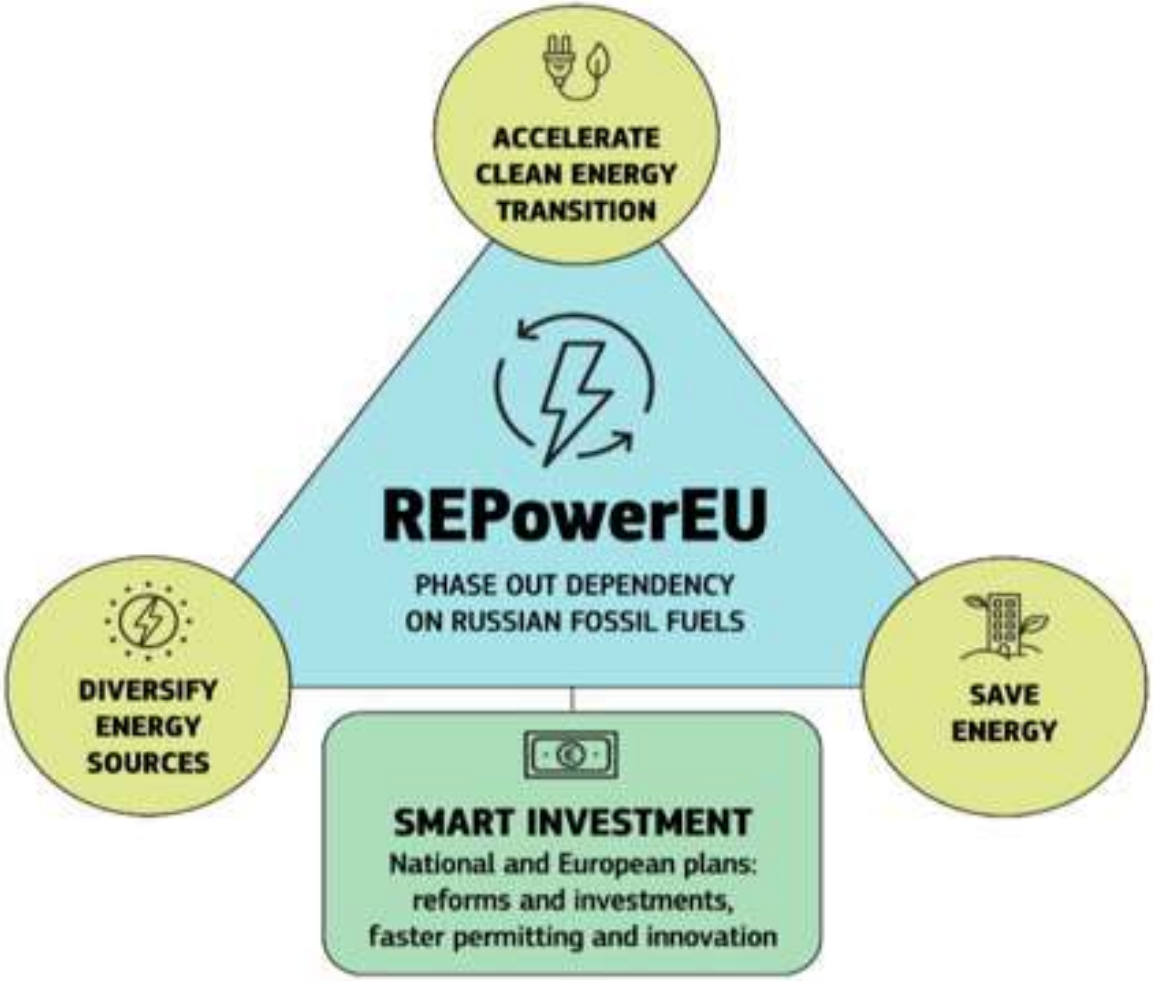


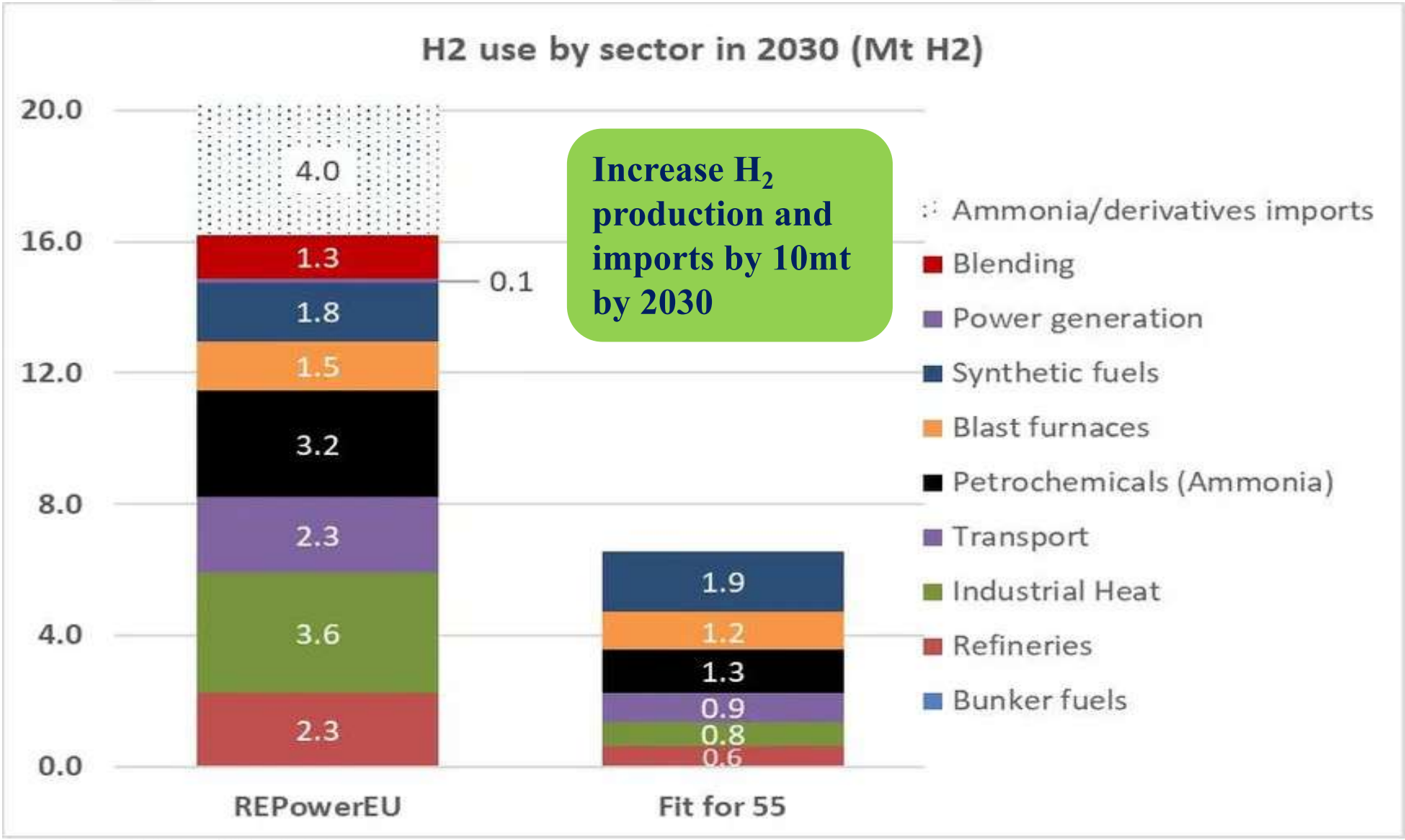
RePowerEU plan*

Phase out dependency on Russian fossil fuels



* *RePowerEU Plan*, EU, 2022

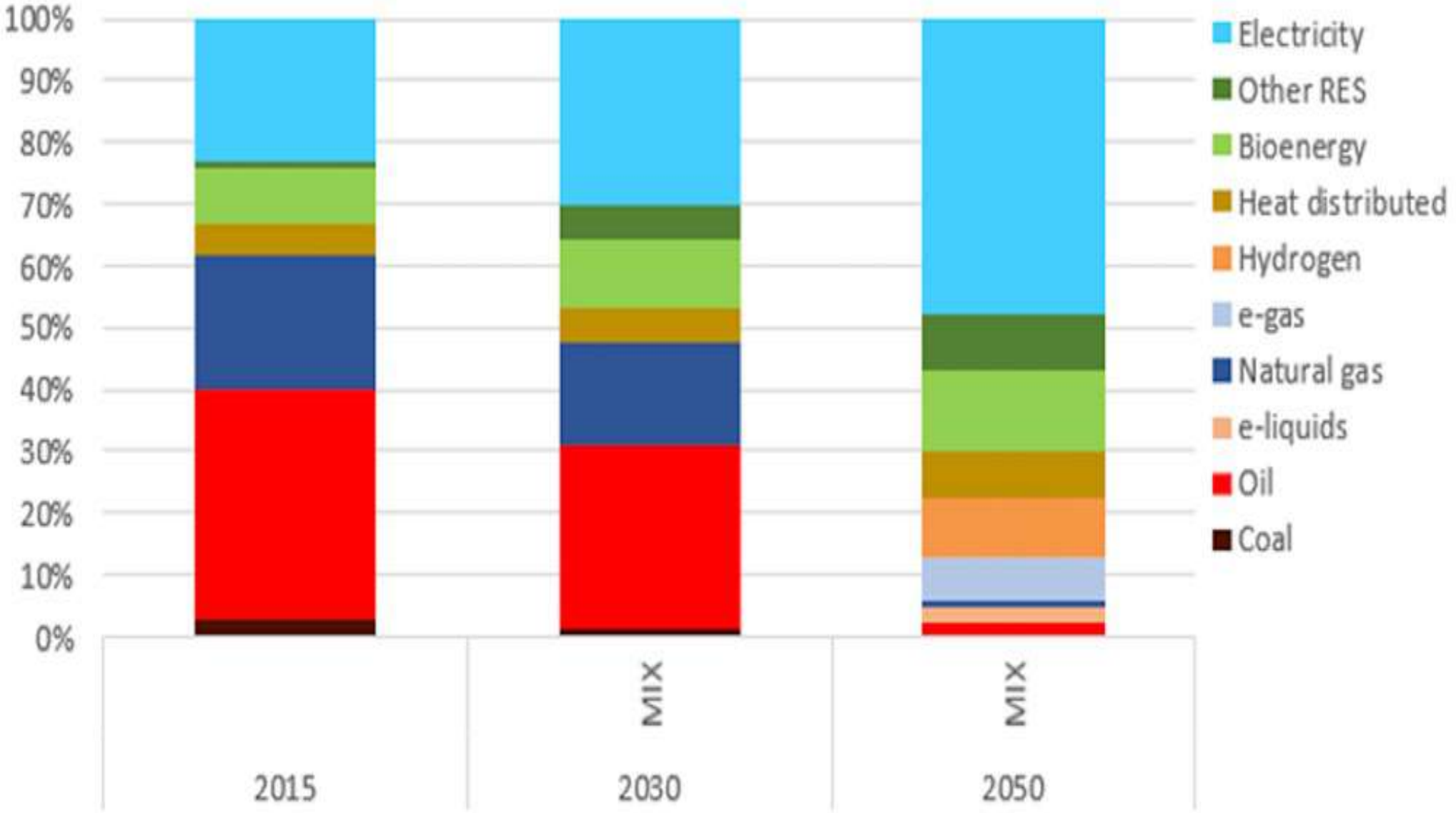
H_2 accelerator*



Increase H_2 production and imports by 10mt by 2030

* *RePowerEU Plan*, EU, 2022

Projected EU fuel mix*



* EU 2030 Climate Target Plan (Basic scenario MIX for Fit-for-55)

Long term scenarios in Europe

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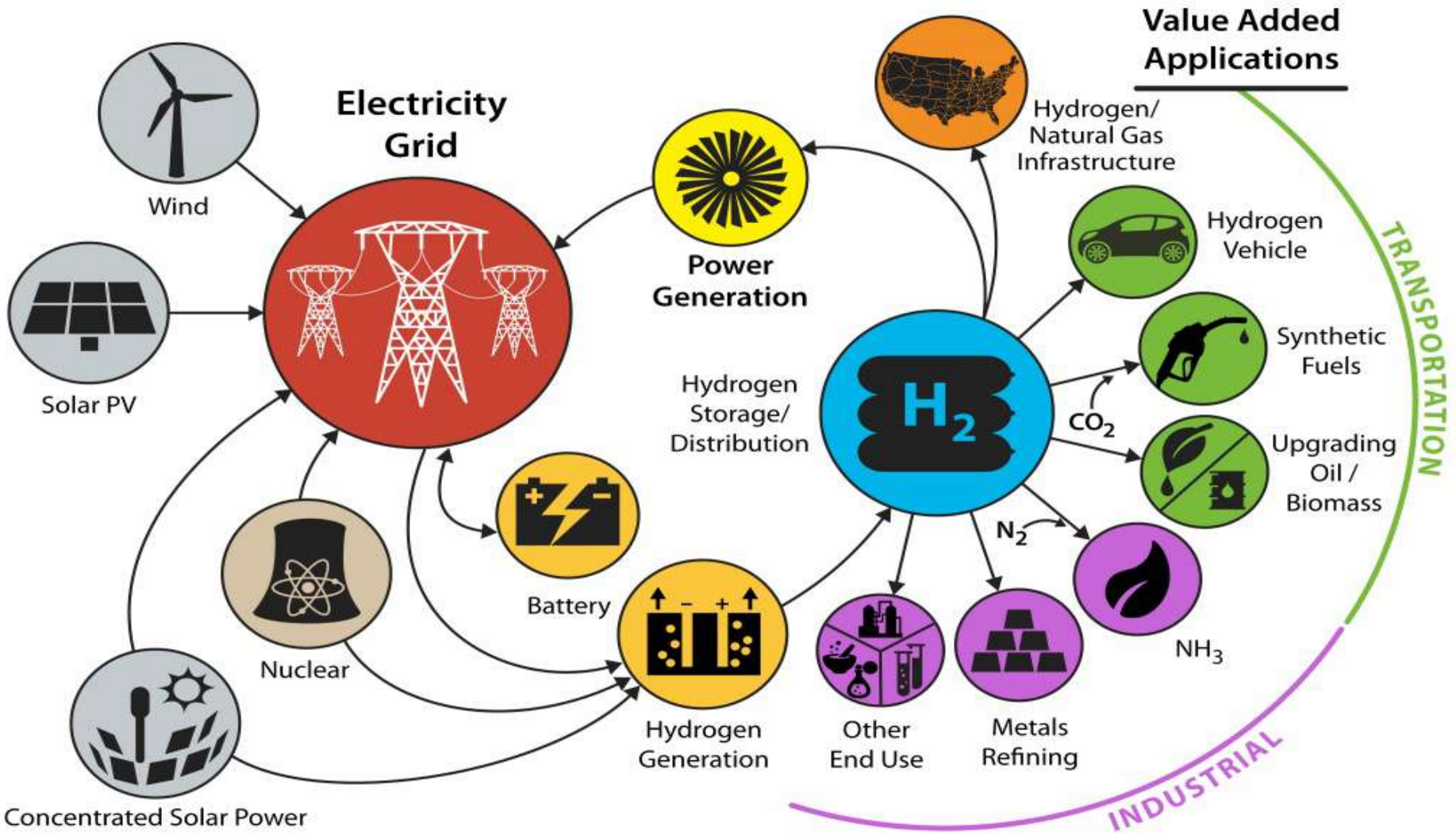
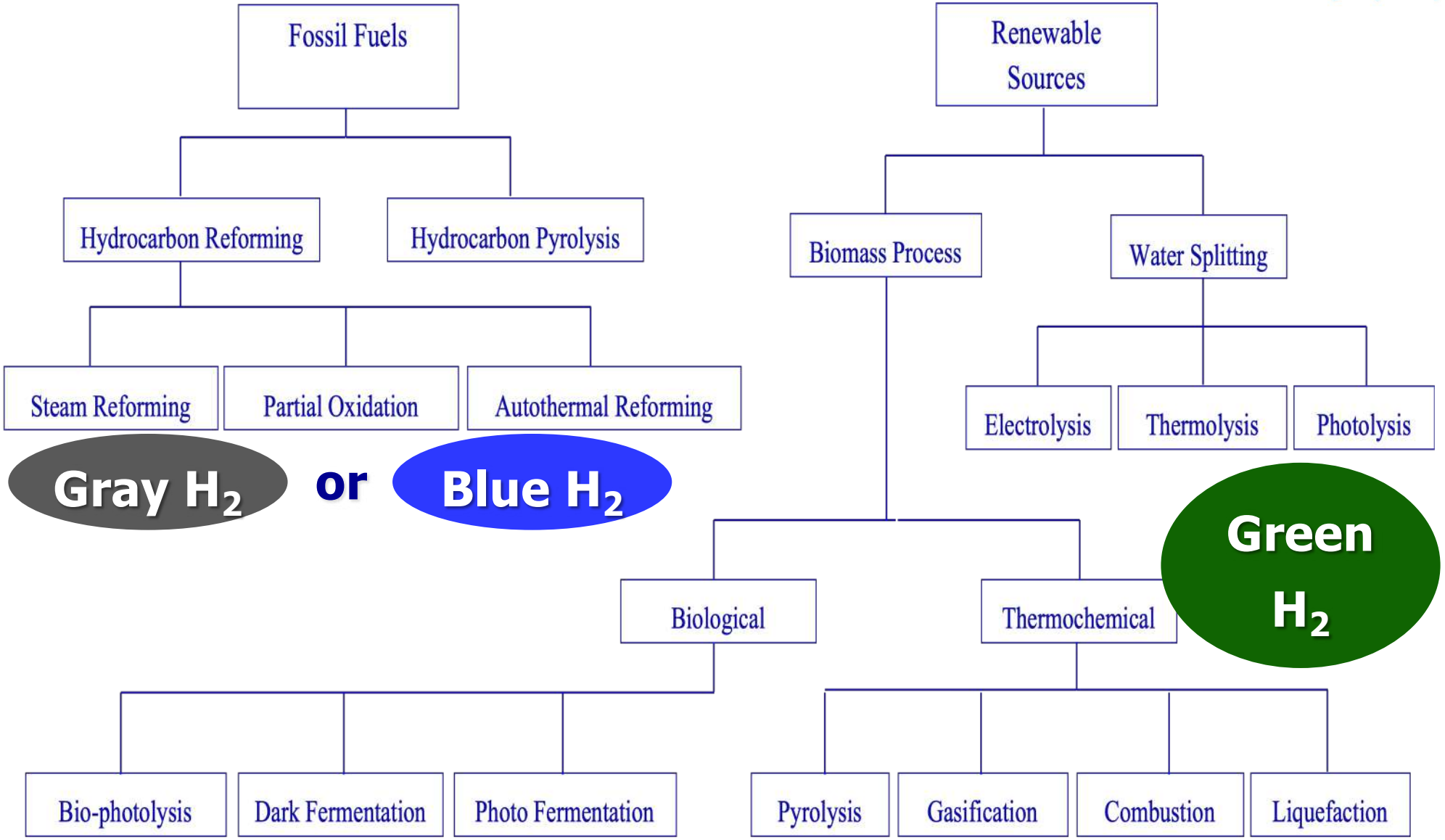
Moving from Carbon economy to Hydrogen economy



The role of H_2 in energy transition

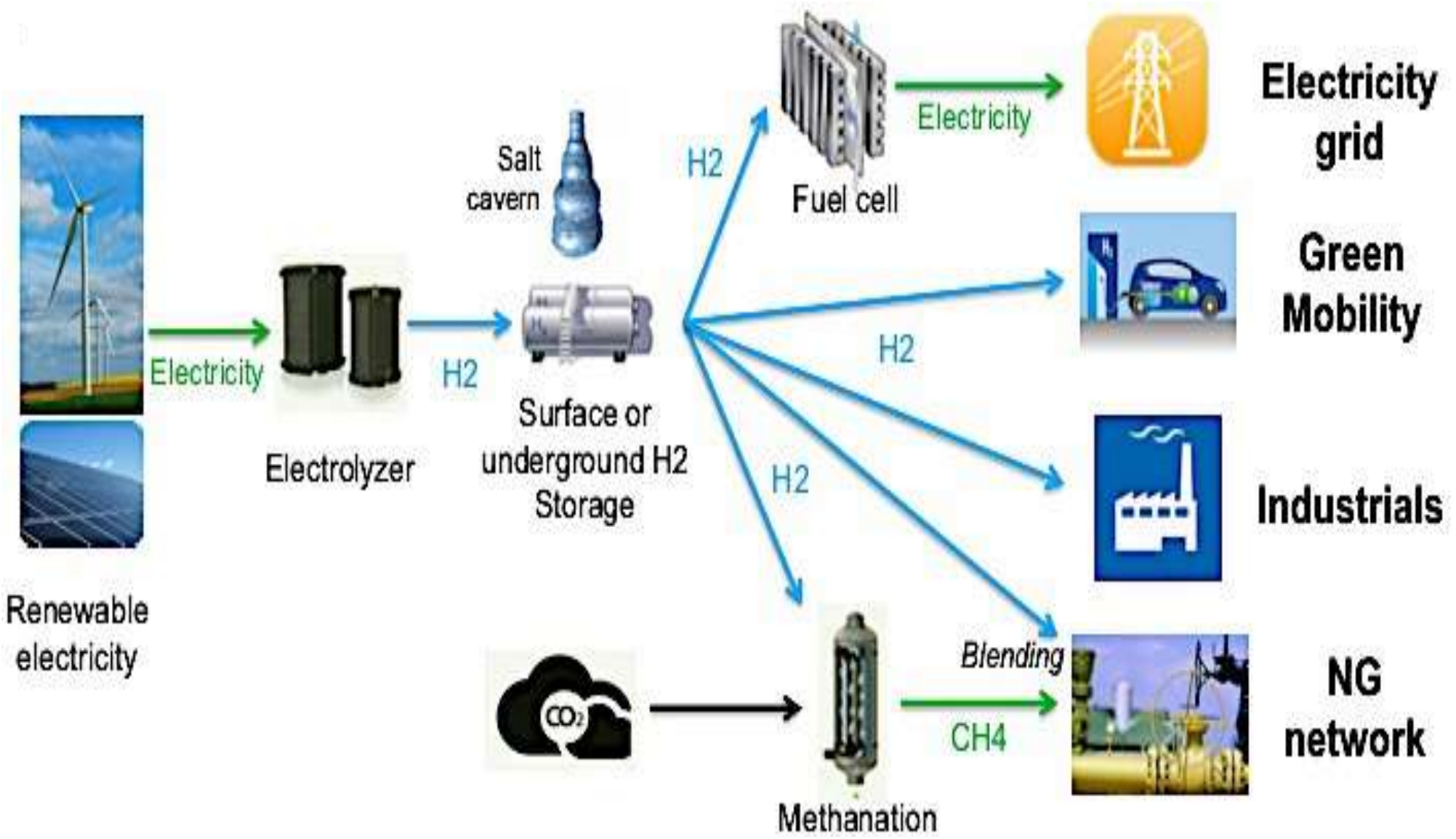
long-term scenarios

H_2 production methods*

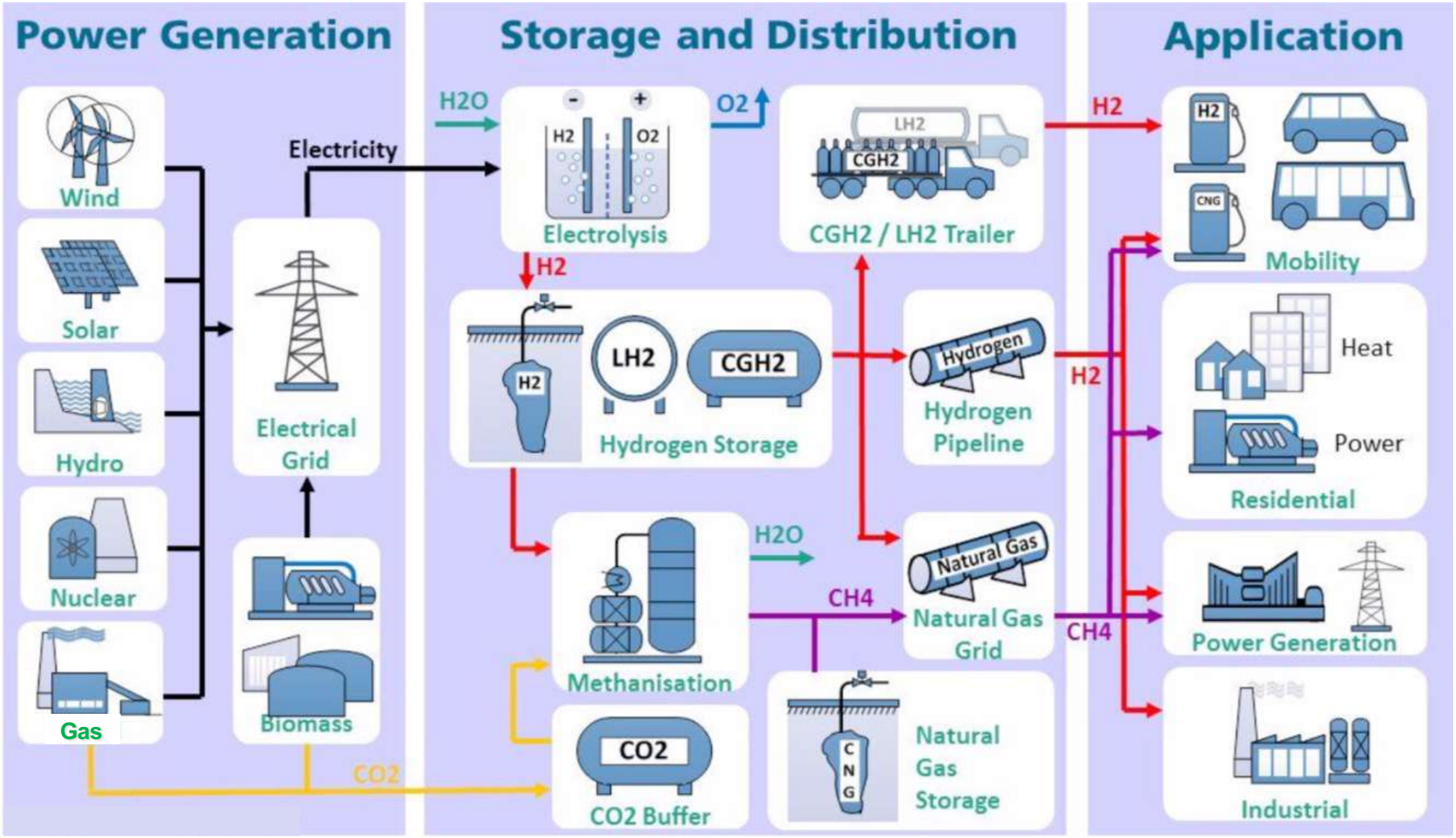


* Nicolaidis P., Poullikkas A., 2017, "A comparative overview of hydrogen production processes" *Renewable and Sustainable Energy Reviews*

Hydrogen : an efficient vector in a decarbonized energy mix



Potential role of hydrogen in the energy transition



Source: EU, 2019

Storage and flexible technologies are the missing links

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Energy storage

Flexible technologies

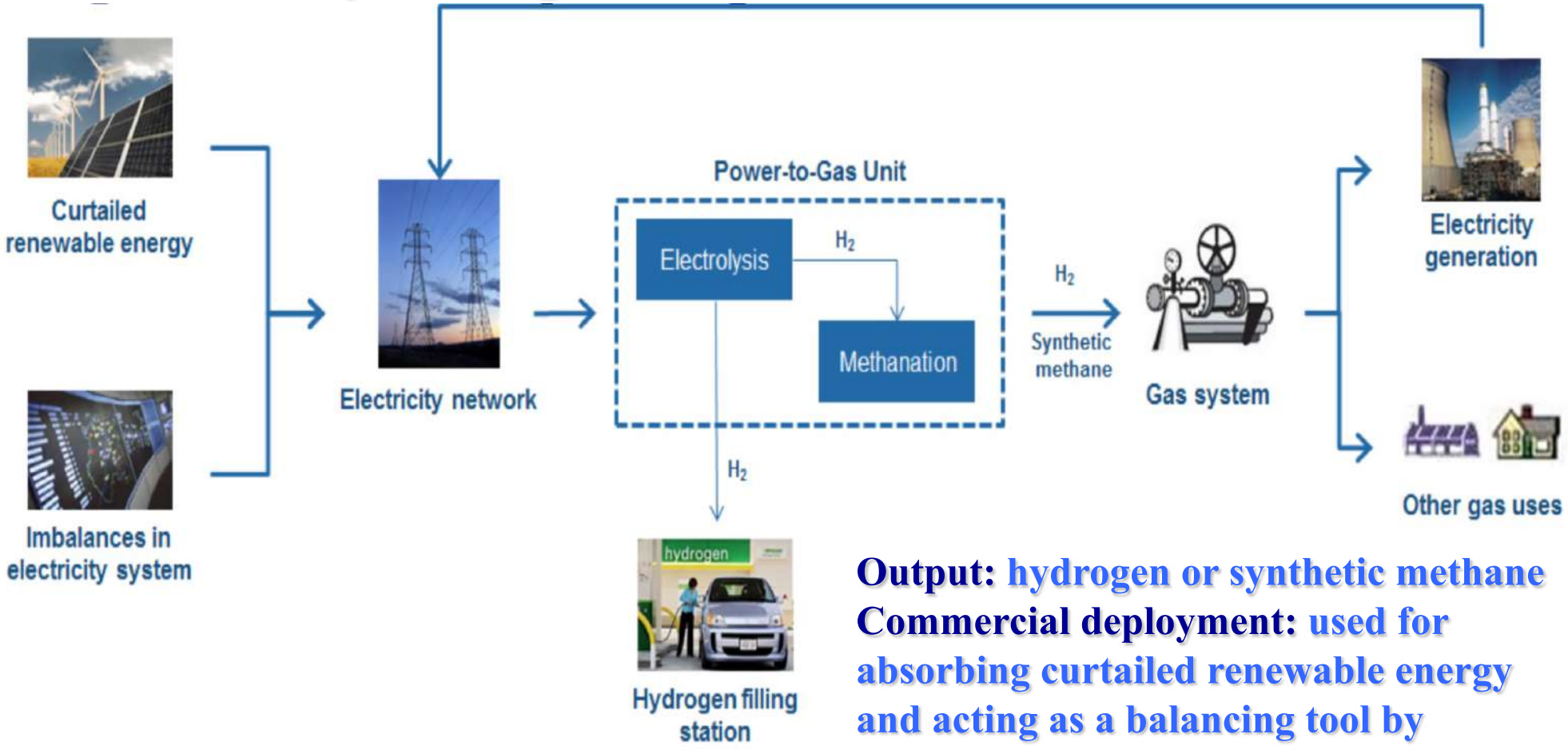
Hydrogen technologies

CERA

Storage, Flexible Technologies and Hydrogen Regulatory Frameworks

Power-to-Gas (P2G)*

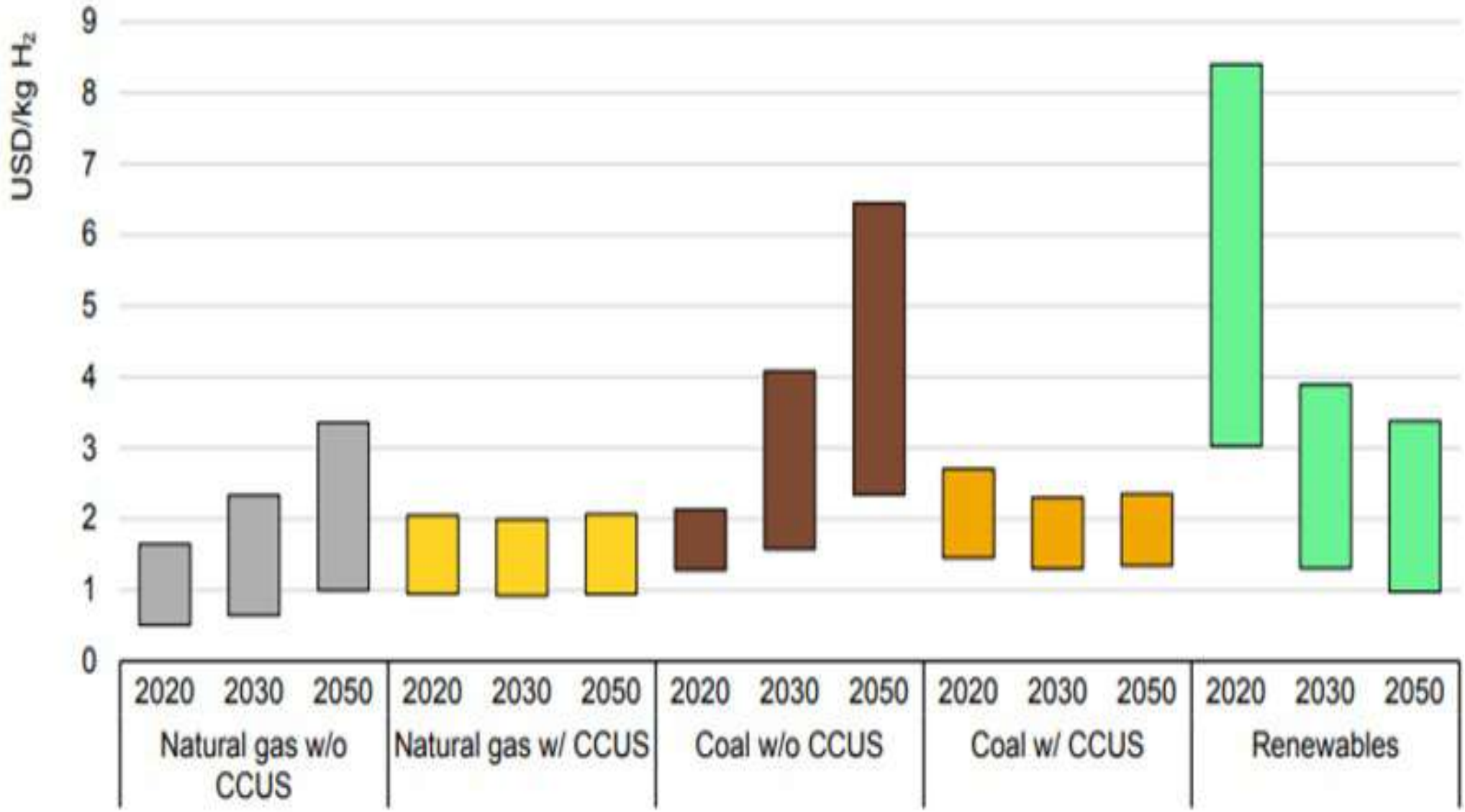
- **energy storage technology linking the electricity and gas infrastructure**



Output: hydrogen or synthetic methane
Commercial deployment: used for absorbing curtailed renewable energy and acting as a balancing tool by electricity TSOs

* Poullikkas A., 2009, *Introduction to Power Generation Technologies*, ISBN: 978-1-60876-472-3

H_2 production cost*



* *The Future of Hydrogen*, International Energy Agency, 2019

Saudi Arabia $5bn Helios H2 project

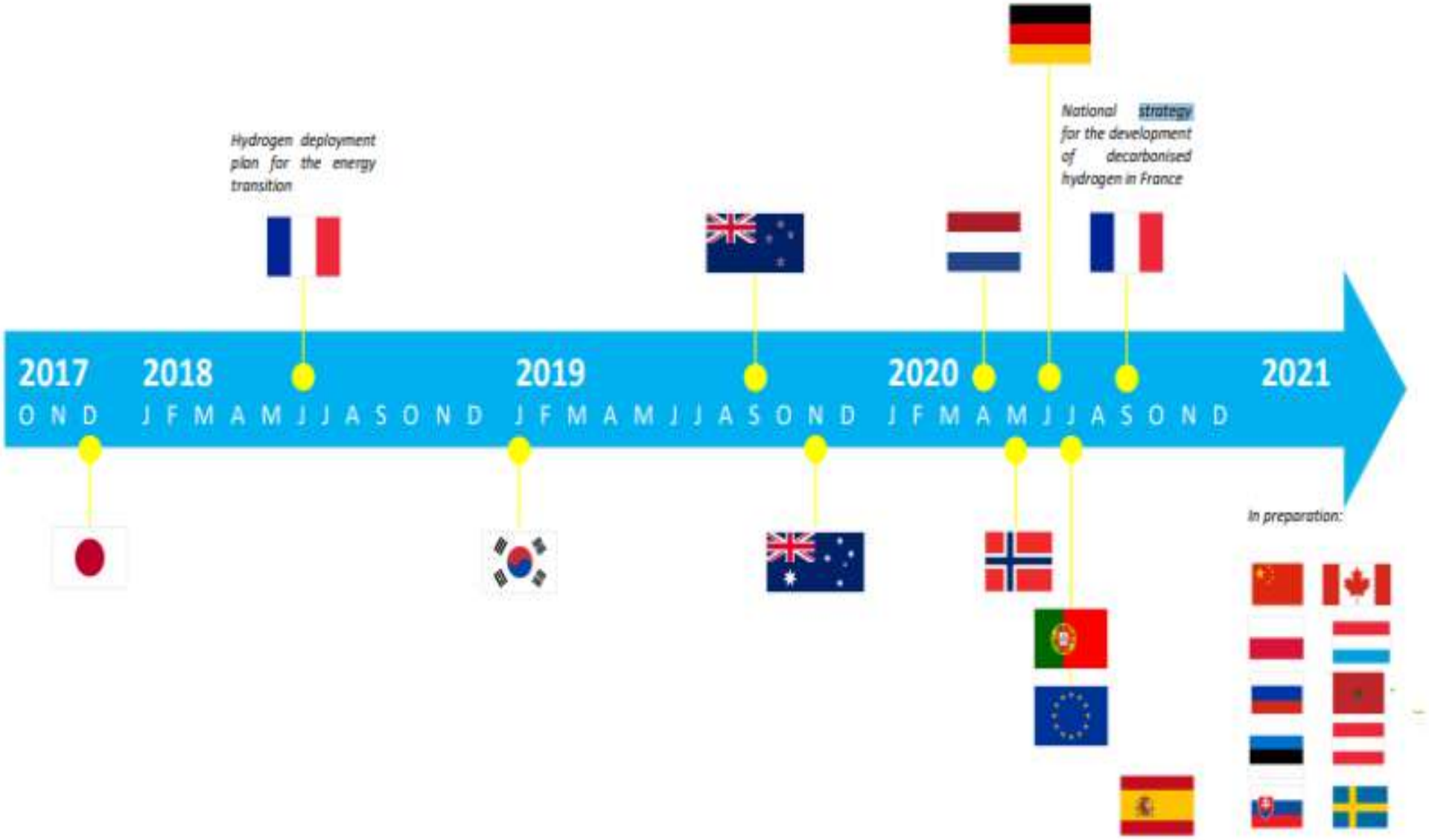
- Desert area = Belgium
- 4GW of Wind and PVs

- Production of 650t/day of H_2
- Reduce of H_2 production from 5US$/kg to 1.5US$/kg
- Long-term: Saudi Arabia to become H_2 exporter

National hydrogen strategies

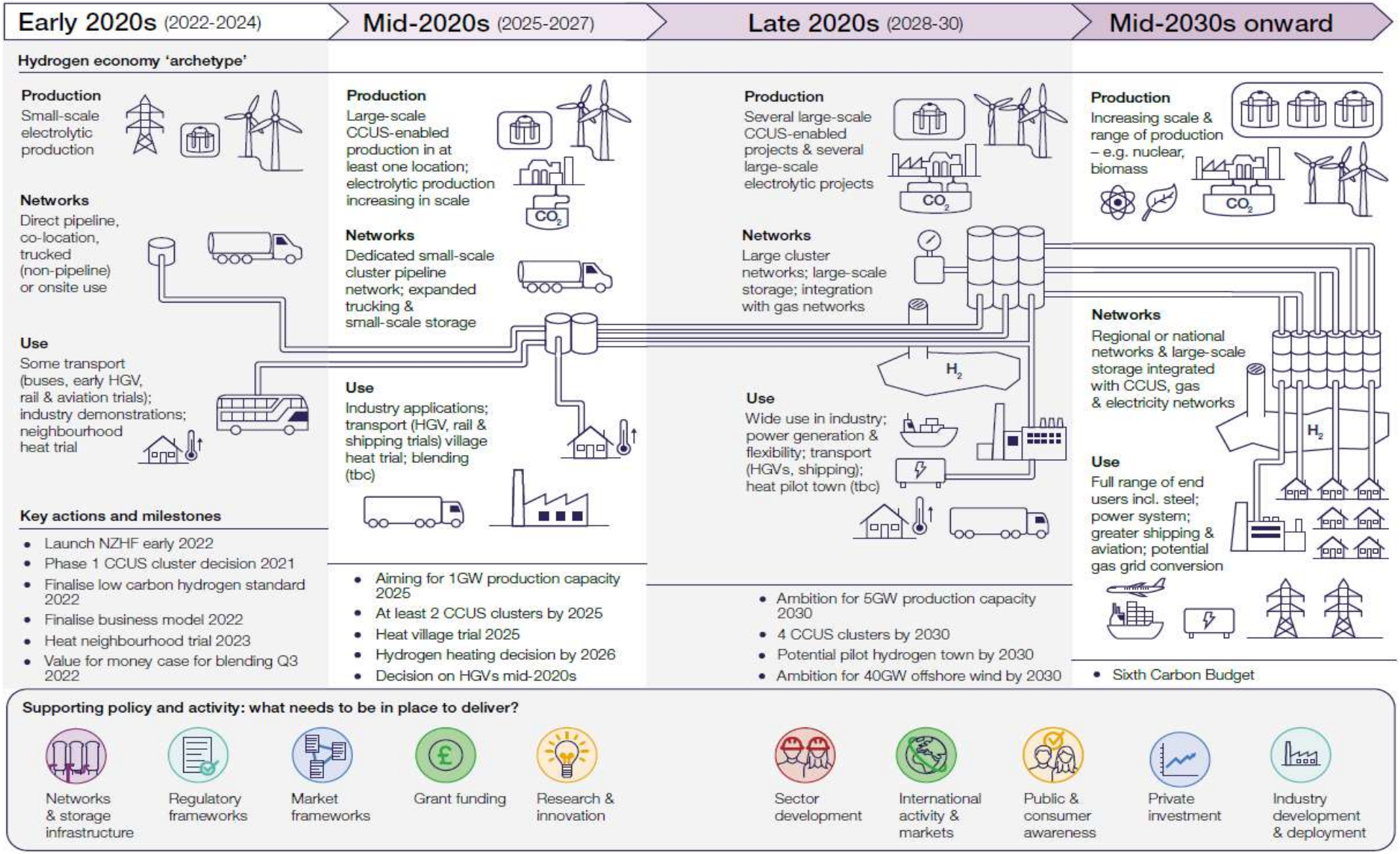
towards 2030-2050

National Hydrogen Strategies*

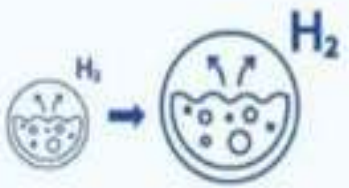


* Possible regulation of hydrogen networks, ACER 2021

UK H_2 roadmap



EU H_2 strategy*



Today - 2024	2025-2030	2030
• Installation of Electrolysers: at least 6GW for green H_2 production • Production of green H_2: up to 1mt	• H_2 to become part of the integrated energy system • Production of green H_2: more than 10mt	• Large scale integration of green H_2

* *A hydrogen strategy for a climate-neutral Europe*, EU, 2020

ACER key regulatory requirements for energy transition (Dec 2021)

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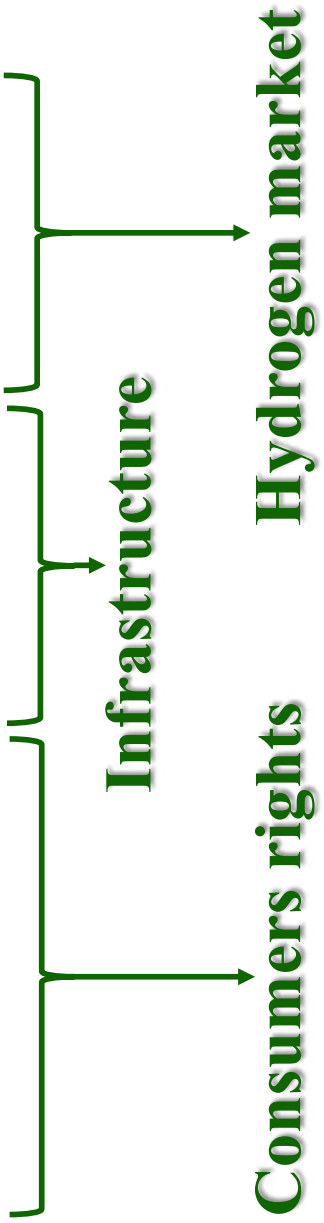
1. Adopt a gradual and flexible regulatory approach to facilitate the emergence of competitive hydrogen markets, by defining core market and regulatory principles, guaranteeing a level playing field, ownership unbundling, third party access, transparency and regulatory oversight
2. Monitor hydrogen markets periodically to identify their development and whether more regulation is needed
3. Apply cost reflectivity and beneficiary-pays principles to hydrogen networks, avoiding cross-subsidies between energy carriers
4. Ensure an integrated, liquid and interoperable EU internal gas market, also by foreseeing a more flexible approach to the application of relevant network codes with respect to specific cross-border charges
5. Adopt a more integrated approach to infrastructure development, both in relation to different levels of the supply chain (vertical), and to the various energy carriers (horizontal), consistent with the revised TEN-E Regulation
6. Guarantee consumer rights regardless of energy carrier
7. Embed robust consumer protection, future innovation, technology developments and new market trends in the decarbonisation policies, recognising the specificities of gas markets
8. Ensure cost efficiency and affordability to safeguard inclusiveness and a just transition, including by promoting and facilitating energy efficiency measures and information
9. Provide consumers with clear and reliable information and support, as well as ensure effective enforcement of their rights and consumer-centric digitalisation rules to enhance their empowerment and trust in the energy transition



Medium to long term challenges

The role of interconnections and hydrogen

Regional primary energy sources

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Indigenous energy sources

Gas reserves in SE Mediterranean region*

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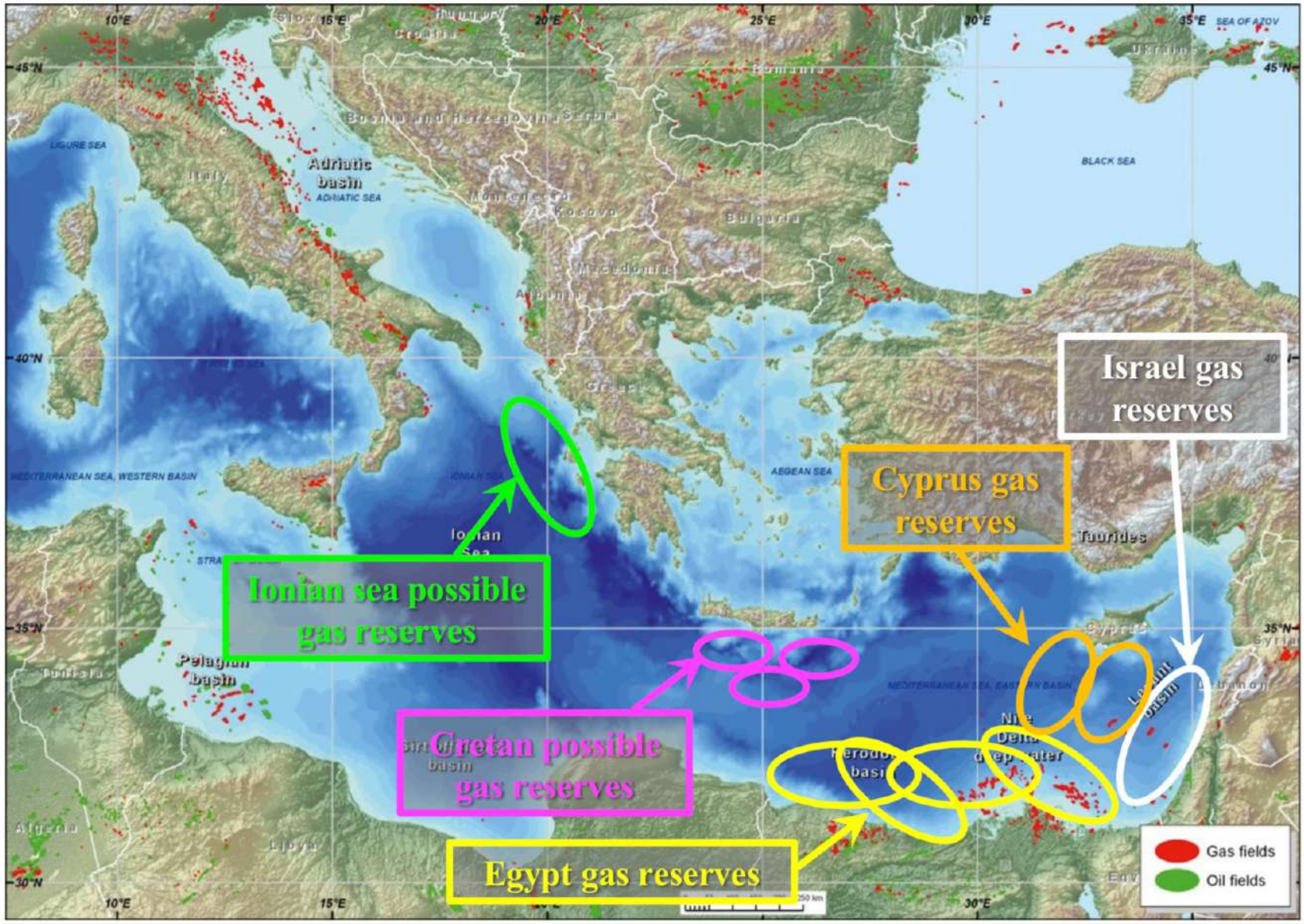
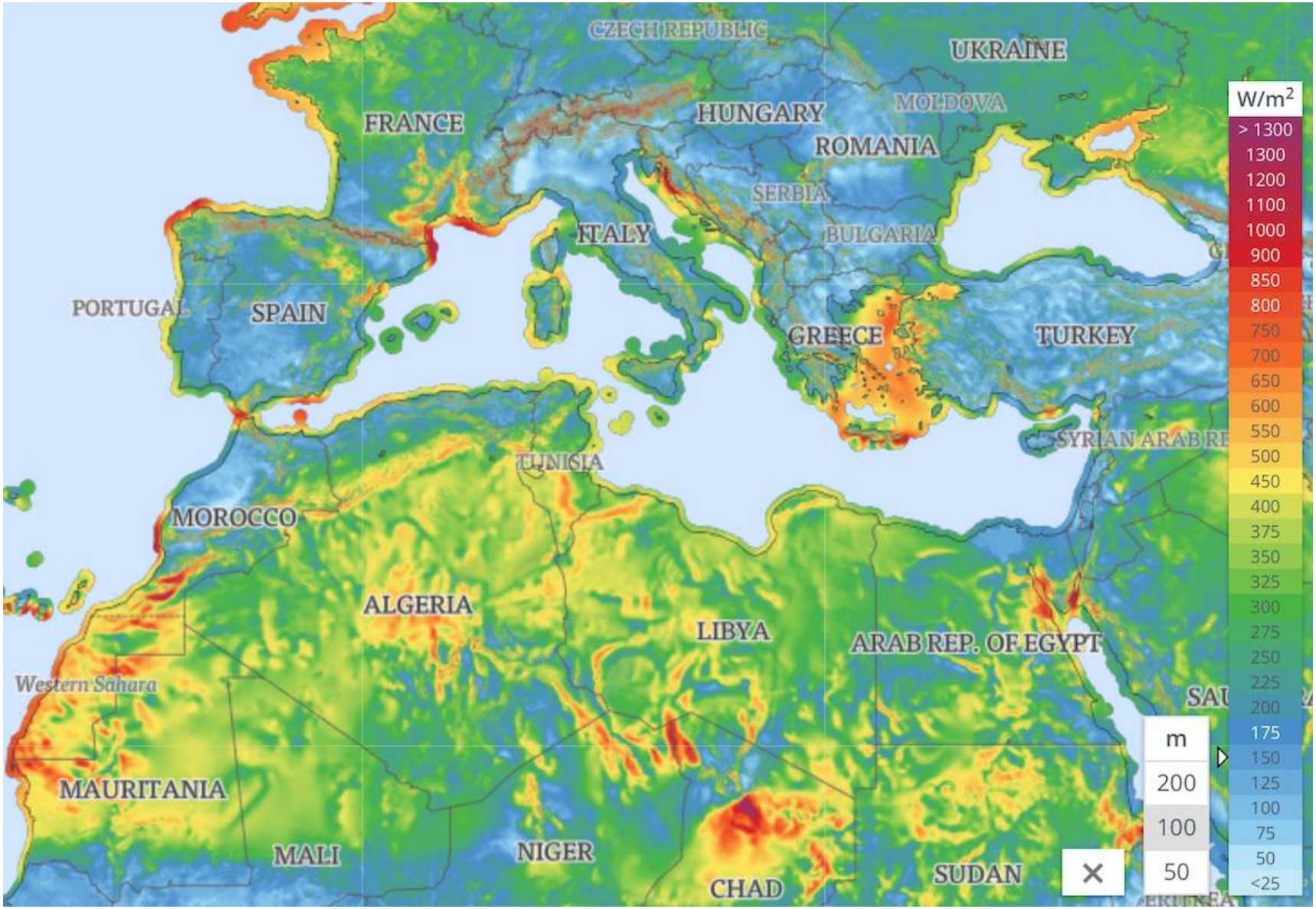


* A. Belopolsky, *et al.*, 2012, "New and emerging plays in the Eastern Mediterranean", *Petroleum Geoscience*

Wind potential in SE Mediterranean region*



* The Global Wind Atlas (https://globalwindatlas)

Solar potential in SE Mediterranean region*

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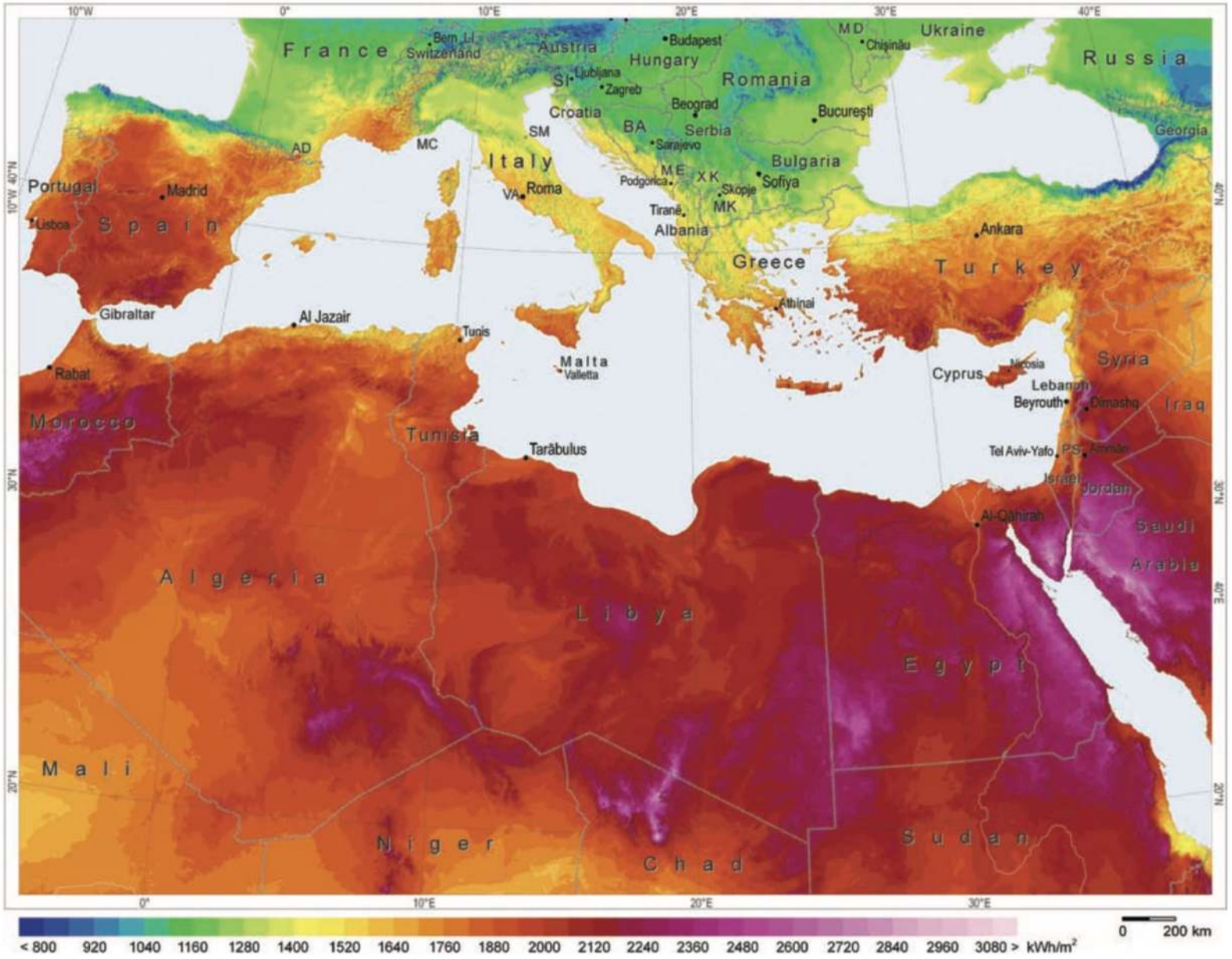

* Easac & Pihl, Erik. (2011). Concentrating Solar Power: Its potential contribution to a sustainable energy future

Main indigenous energy sources in SE Mediterranean region

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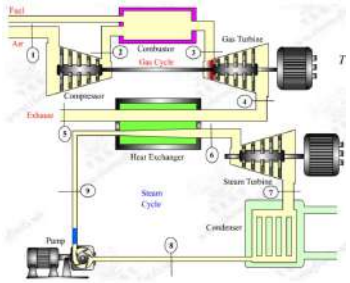
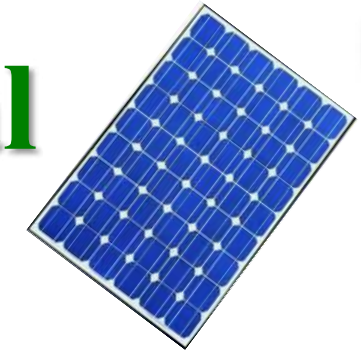
- Natural gas



- Wind potential

- Solar potential



Target-setting for Cyprus' transition to hydrogen economy*

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Target	Year		
	2030	2040	2050
Greenhouse gases	-30%	-75%	-100%
Renewable energy sources	30%	75%	100%
Electrical interconnections	50%	65%	80%

Cyprus could set a long-term goal of reducing greenhouse gas emissions by 100% by 2050 !

* Poullikkas A., 2020, *Long-term Sustainable Energy Strategy: Cyprus' Energy Transition to Hydrogen Economy*, ISBN: 978-9925-7710-0-4

Introduction of H2 in Cyprus's by 2030*

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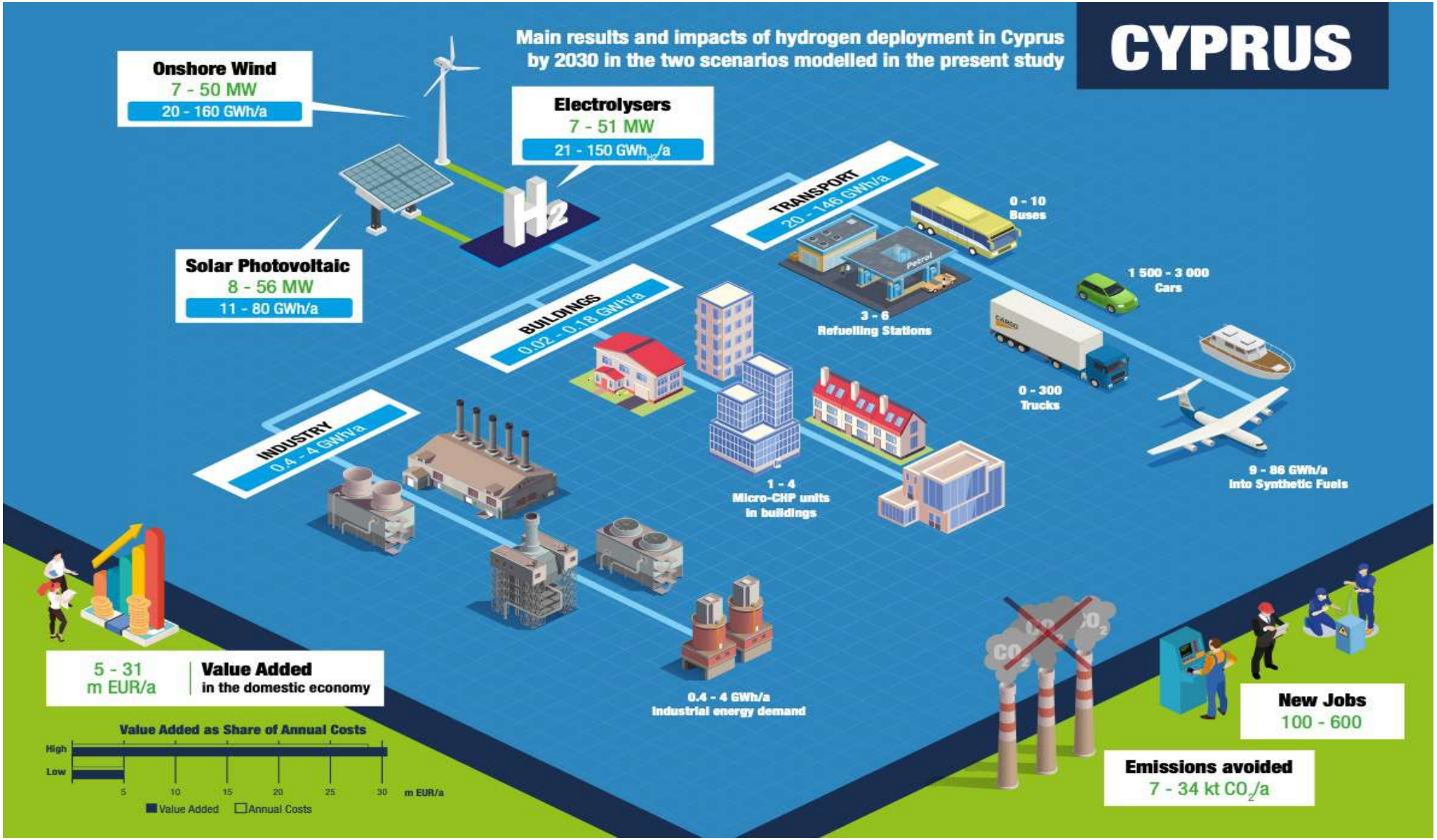

* FCH, EU, 2020

Cyprus H2 strategy?

- Recognition of hydrogen as a key component of the energy mix for 2030 and up to 2050
- Creation of a long-term national energy strategy considering hydrogen
- Creation of a legislative framework - allow the introduction of participants in H_2 market
- Harmonization of national regulatory framework with the relevant European Directives
- Targeted measures to kick-start the hydrogen value chain: production; transport and storage; use in final consumption

Energy transition by 2050

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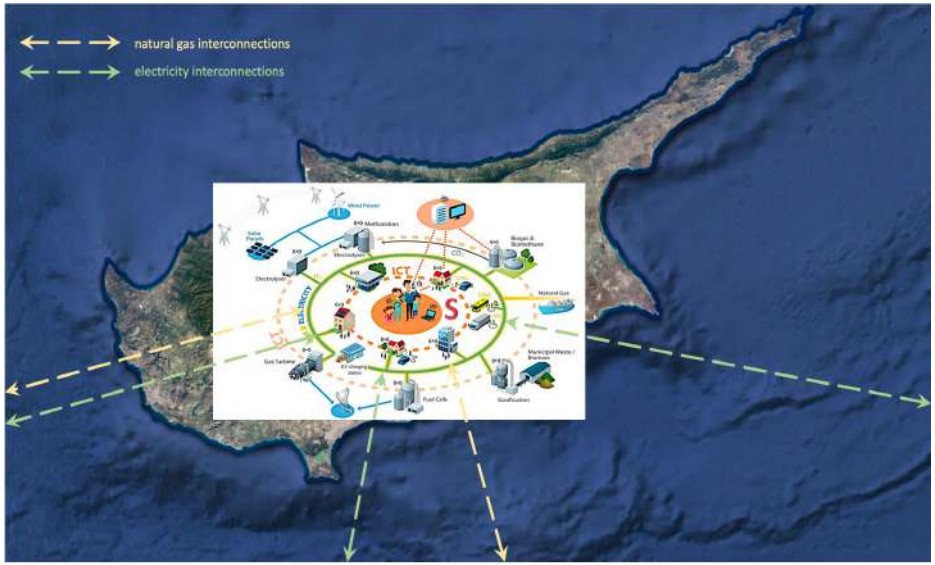
Cyprus' energy system:

- smart and digitised
- flexible
- decentralised
- electrically interconnected
- interconnected gas and/or hydrogen pipelines



Integration:

- hydrogen in all energy sectors
- renewable energy sources
- storage energy systems
- electric mobility

Transition of Cyprus from the current carbon economy to hydrogen economy by the year 2050

Development of regional energy strategy ?

- **Horizon up to 2060**
- **Development of strategic plan for SE Med region:**
  - ~ **Electrical interconnections**
  - ~ **Pipeline interconnections (or virtual pipelines)**
  - ~ **Integration of sustainable technologies and storage**
  - ~ **Use of hydrogen after 2030**
  - ~ **Hydrogen production**
    - From natural gas
    - From renewables
- **Energy exporters to EU**

Additional Slides

Towards hydrogen economy

from carbon economy to hydrogen economy

Energy system in 2010

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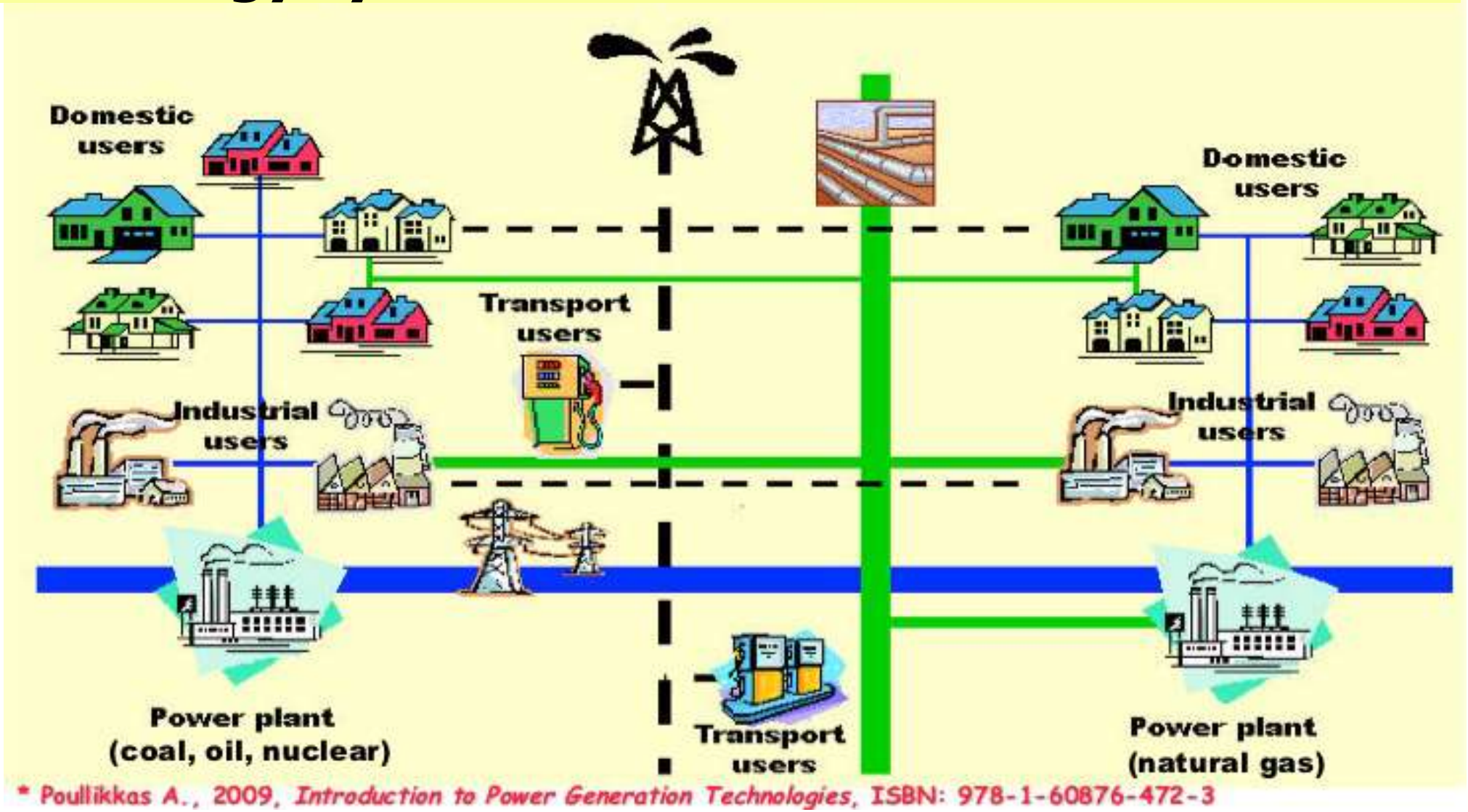
EU energy system in 2010*



* Poullikkas A., 2009, *Introduction to Power Generation Technologies*, ISBN: 978-1-60876-472-3

Future energy systems (optimistic scenario)

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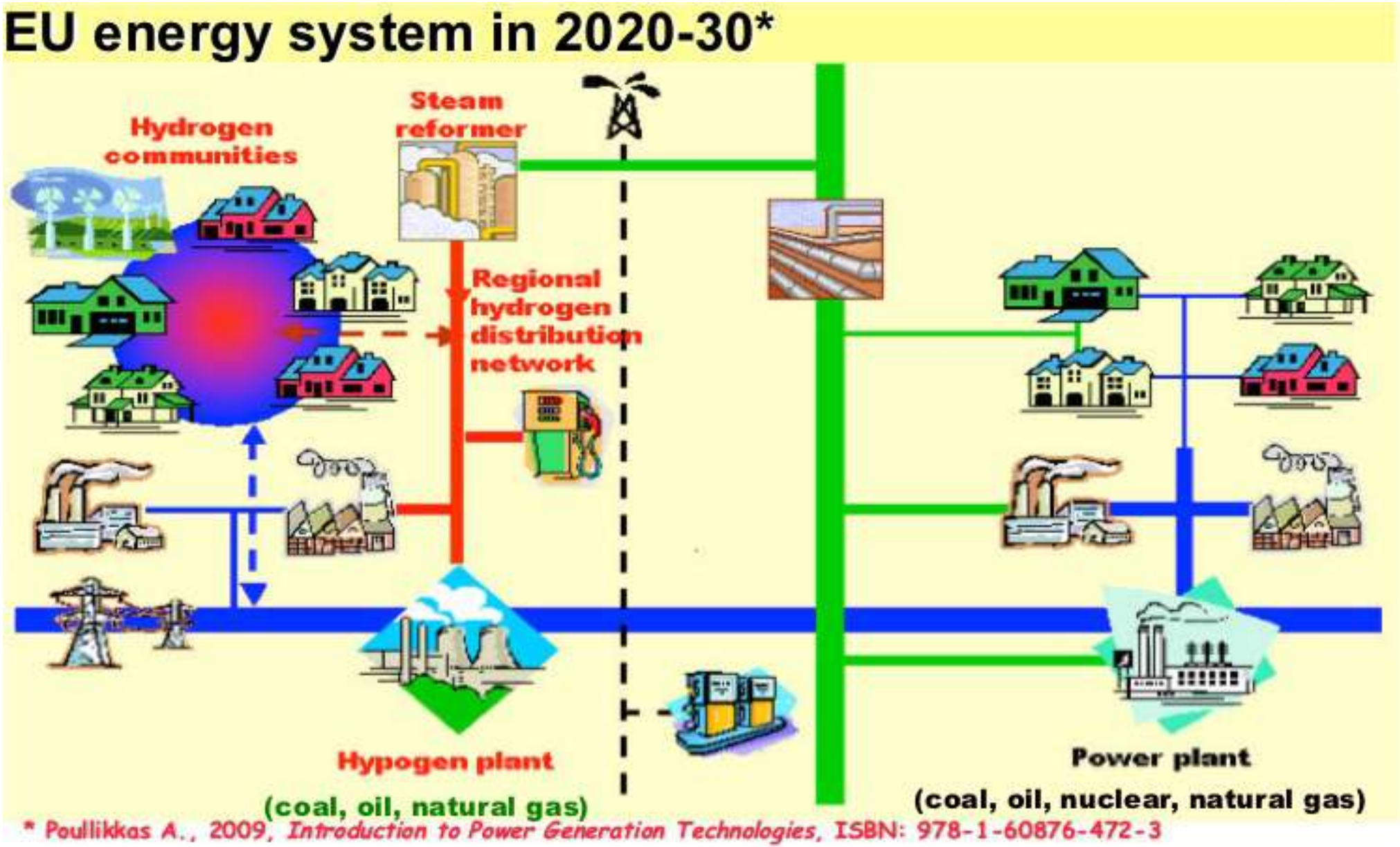

Future energy systems (optimistic scenario)

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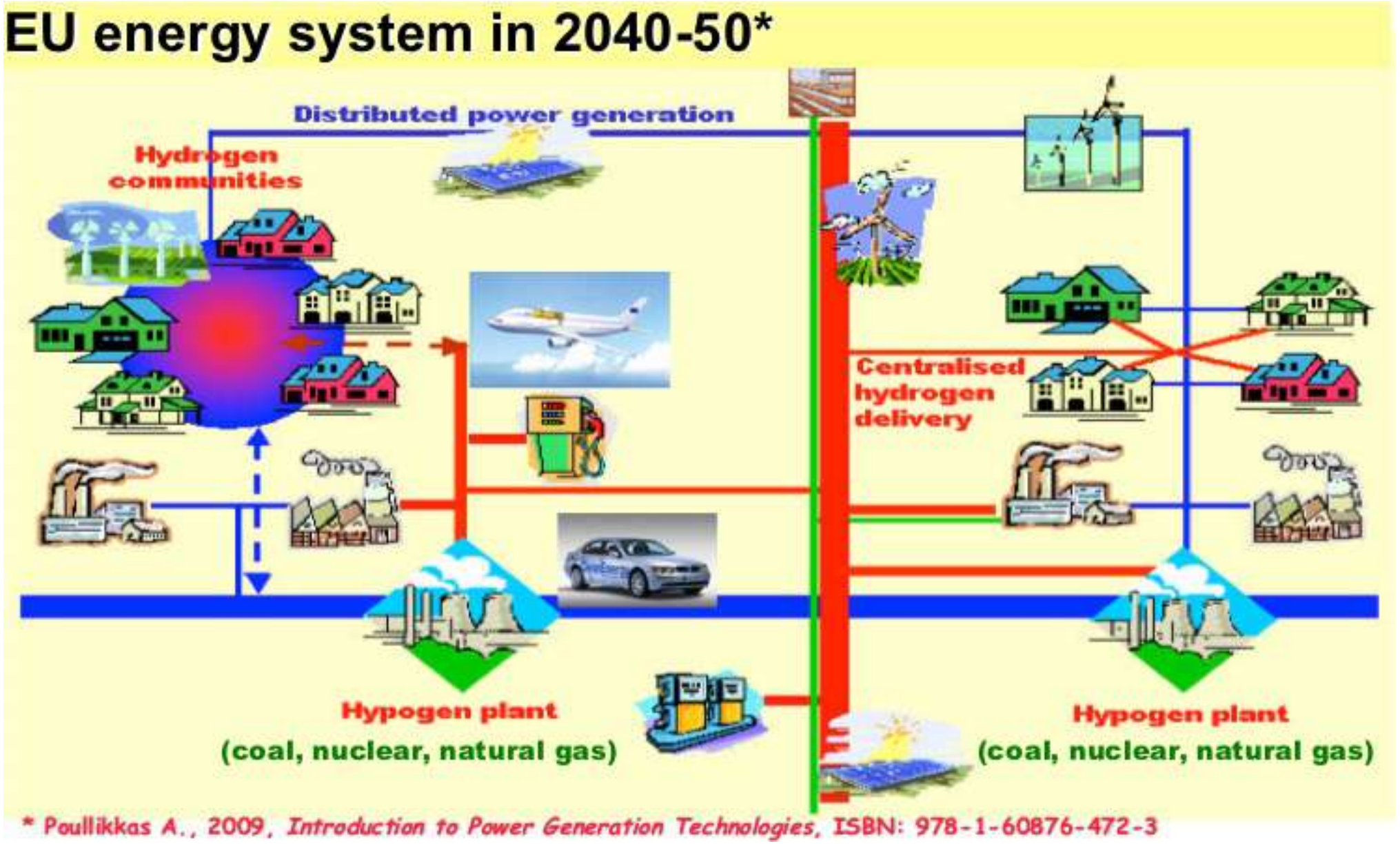
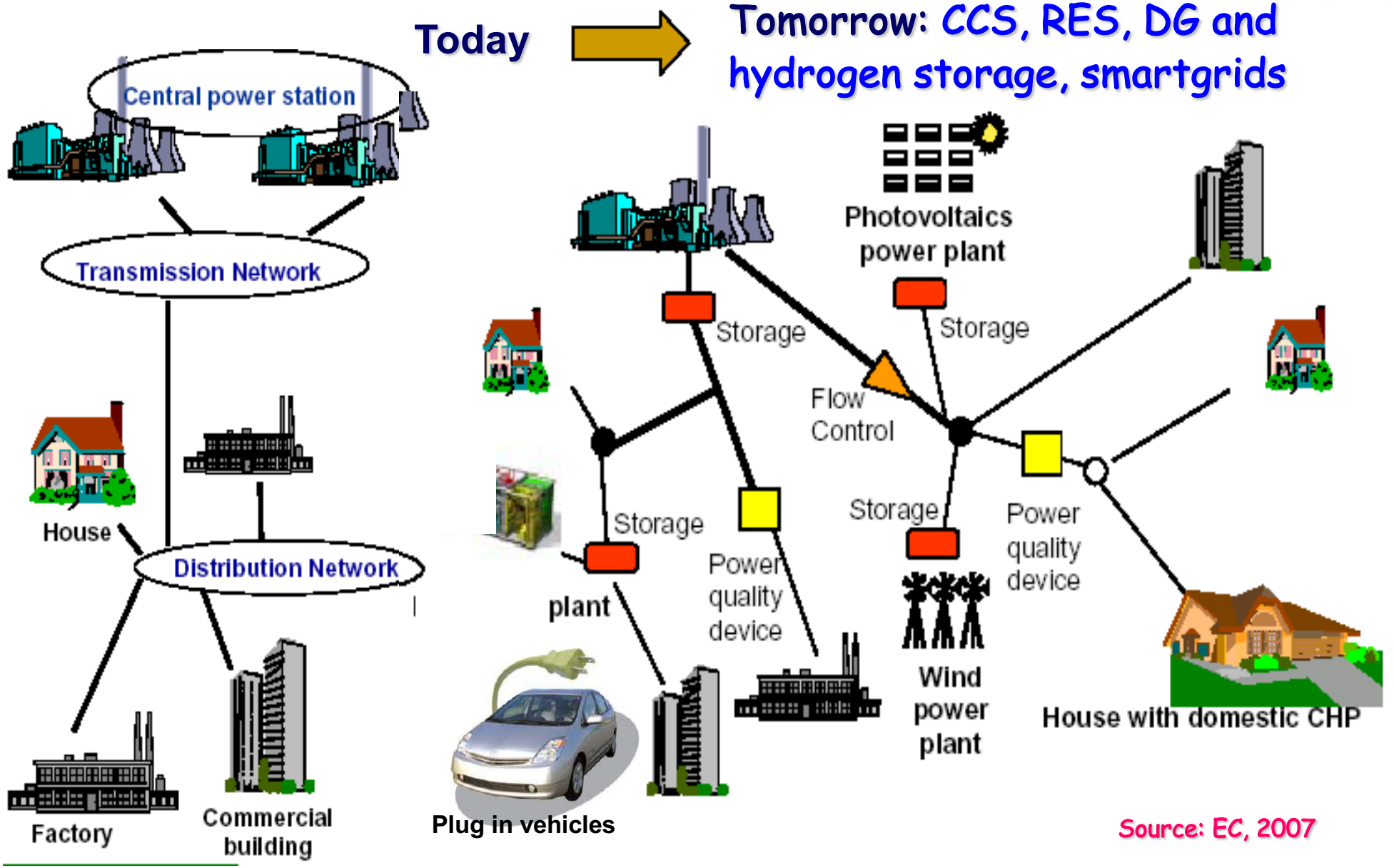


Future power systems



The Super Smart Grid after 2050*
(may allow for 100% RES)

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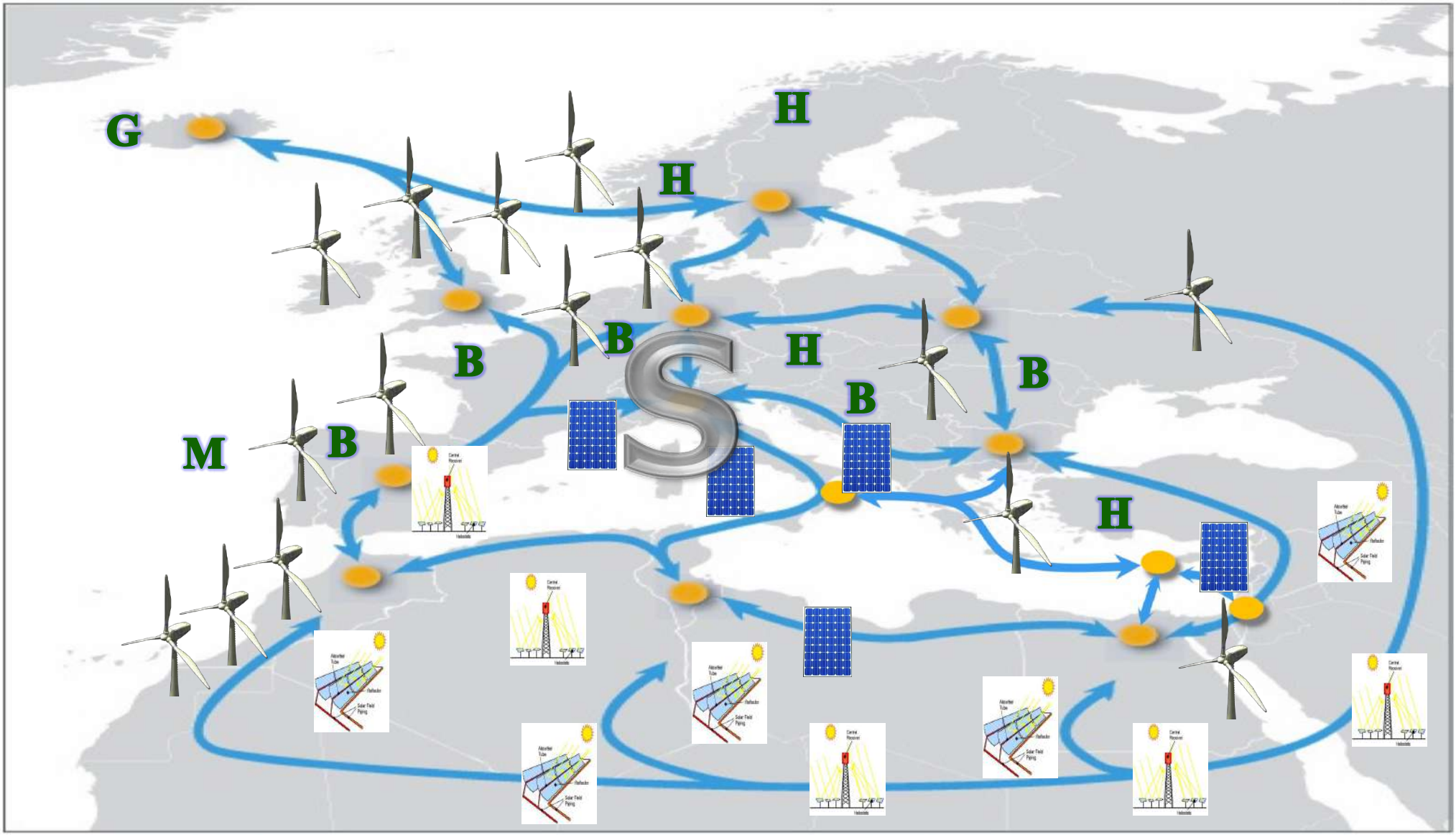
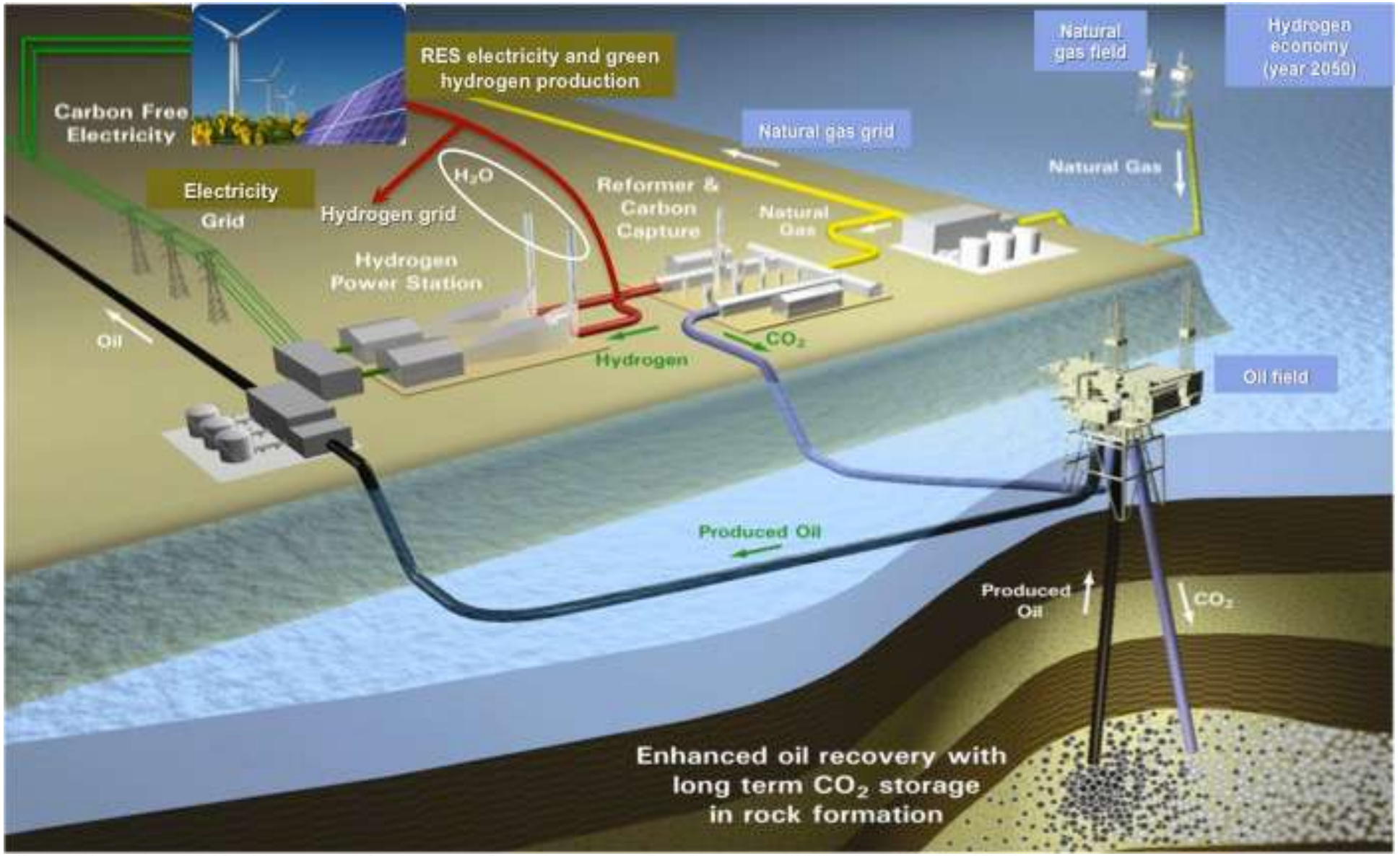


* Poullikkas A., 2013, *Sustainable Energy Development for Cyprus*, ISBN: 978-9963-7355-3-2

Towards hydrogen economy in 2050*



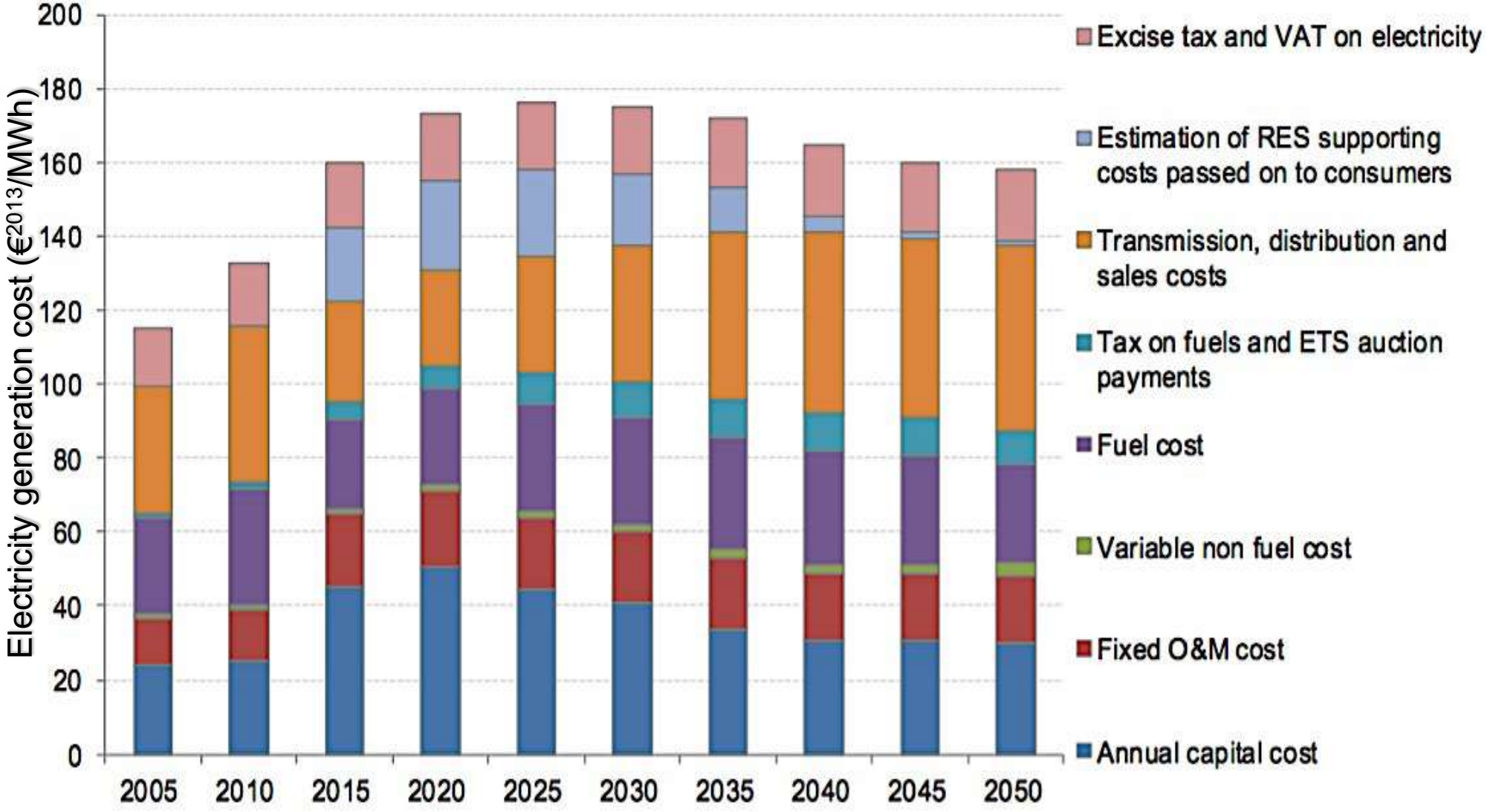
* Poullikkas A., 2013, *Sustainable Energy Development for Cyprus*, ISBN: 978-9963-7355-3-2

Additional Slides

The energy transition cost

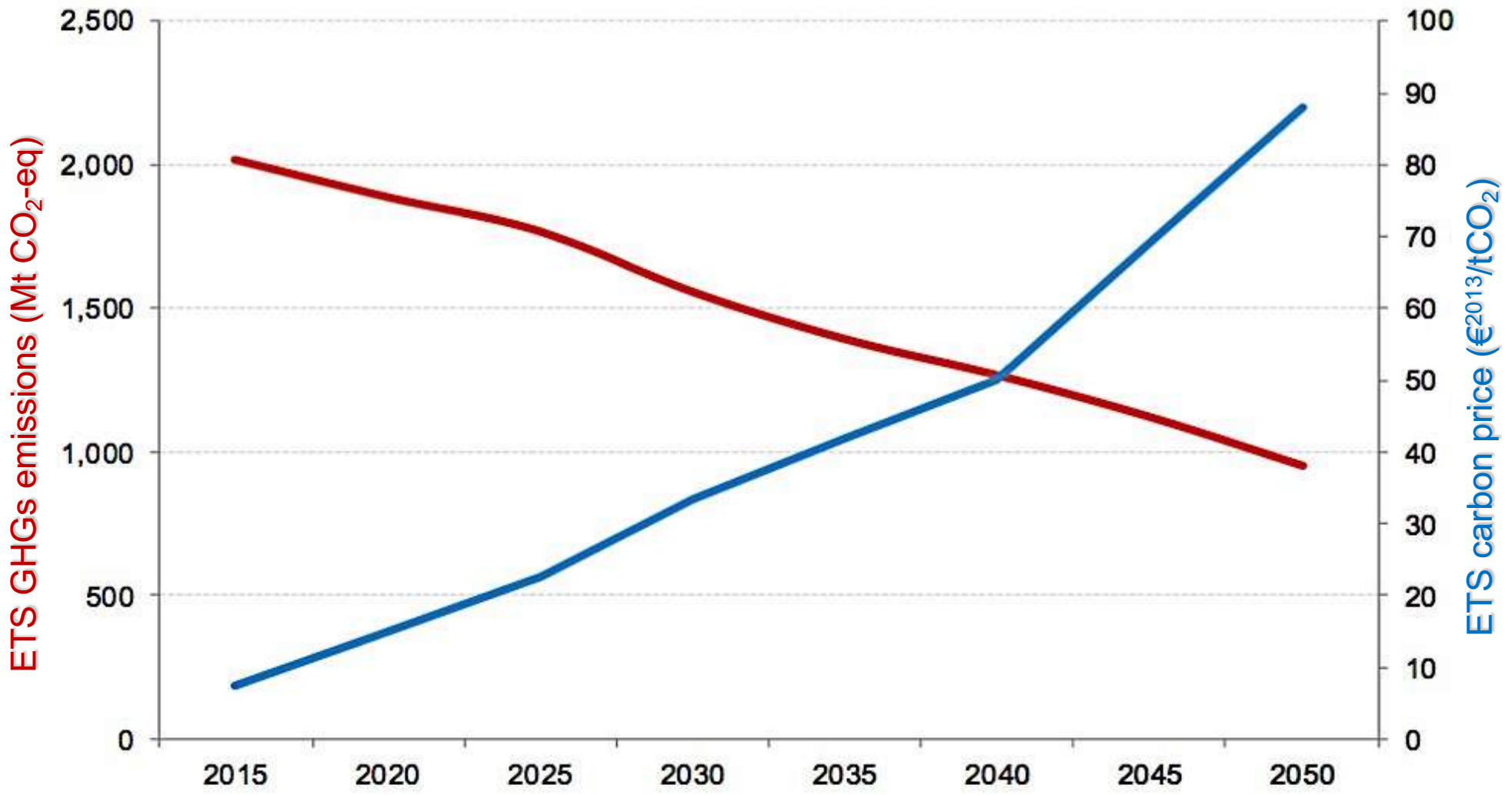
Towards 2050

EU reference scenario 2016



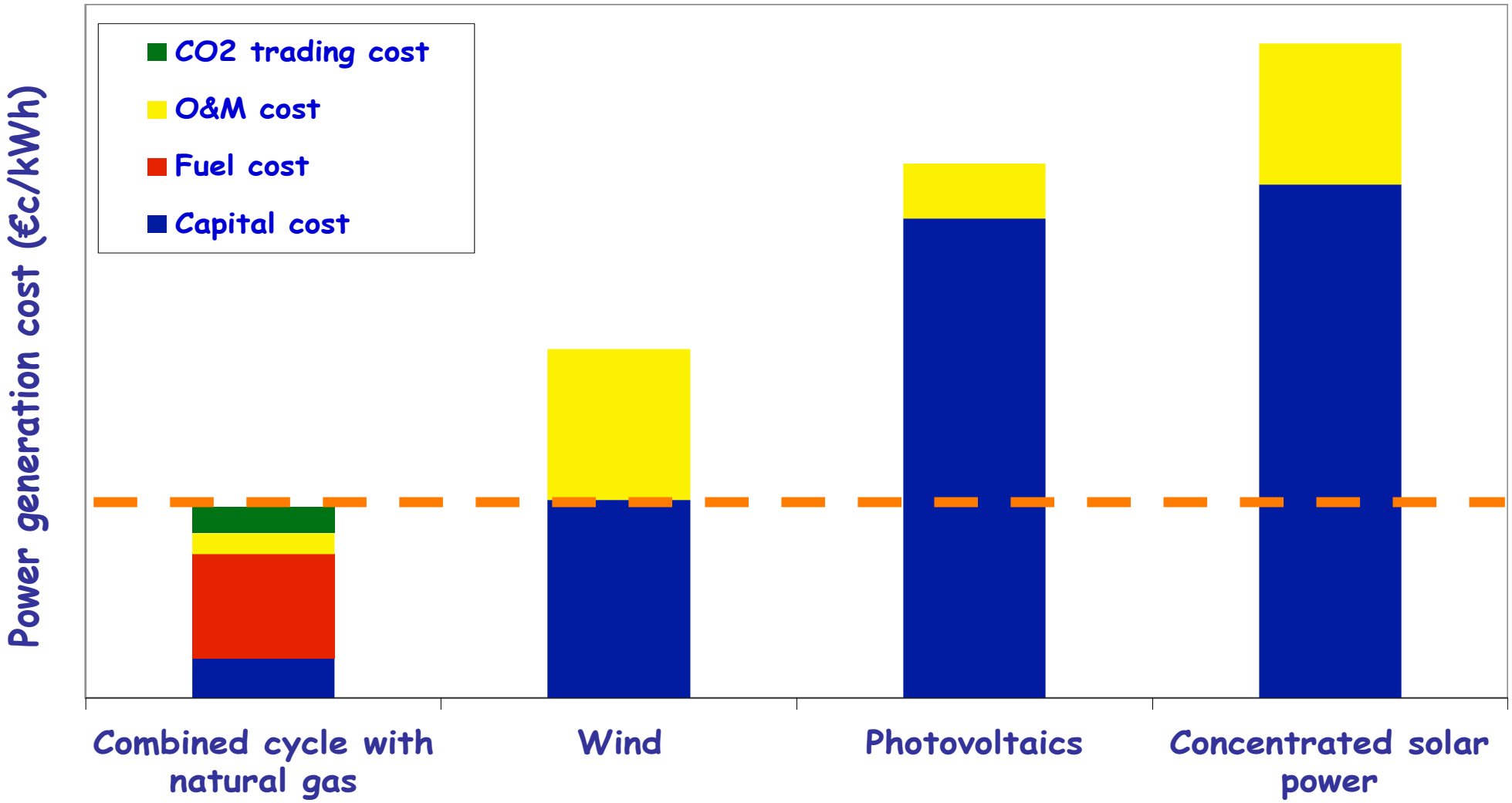
Source: PRIMES

EU reference scenario 2016



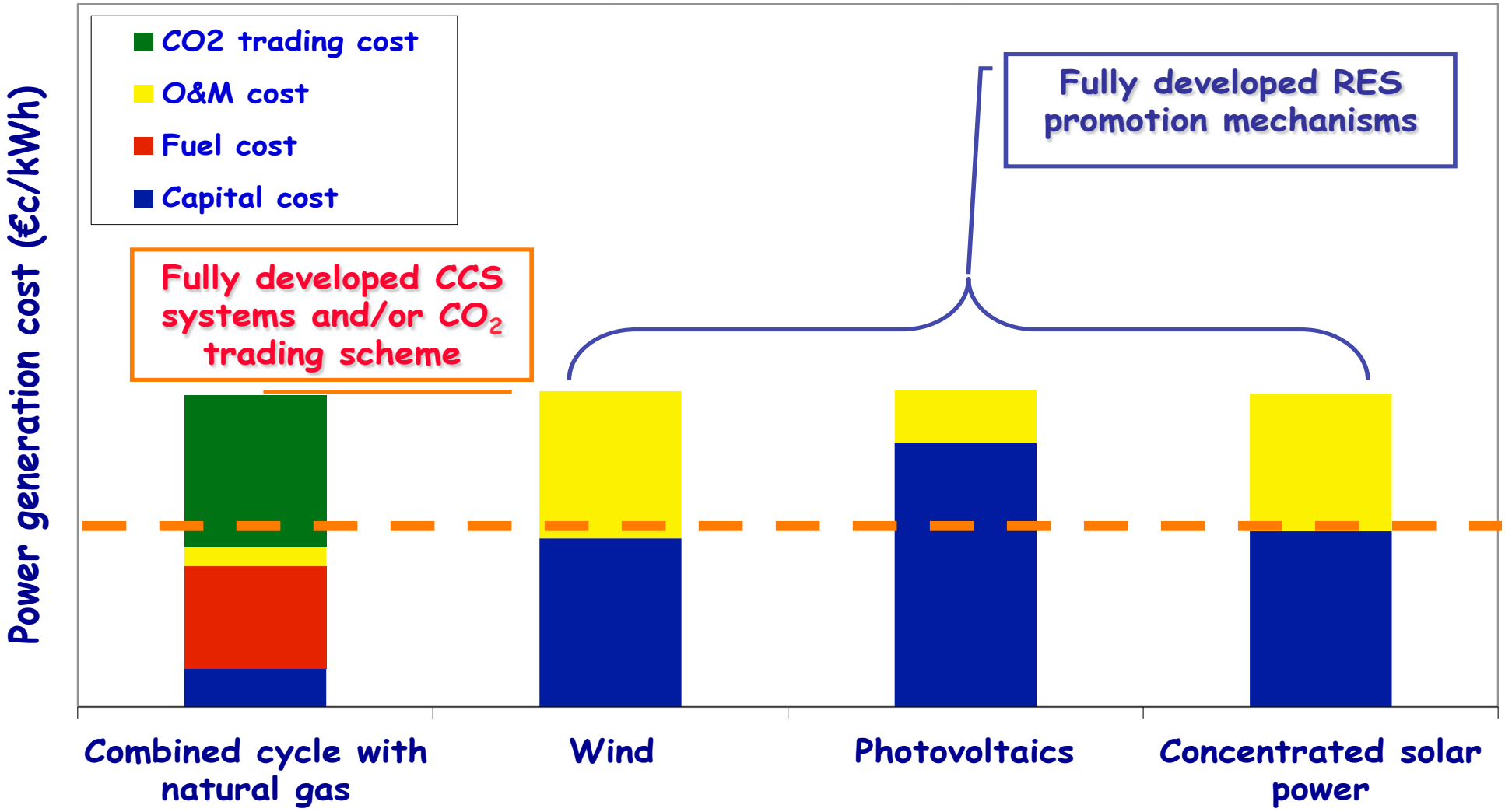
Source: PRIMES, GAINS

Power generation cost (year 2010)*



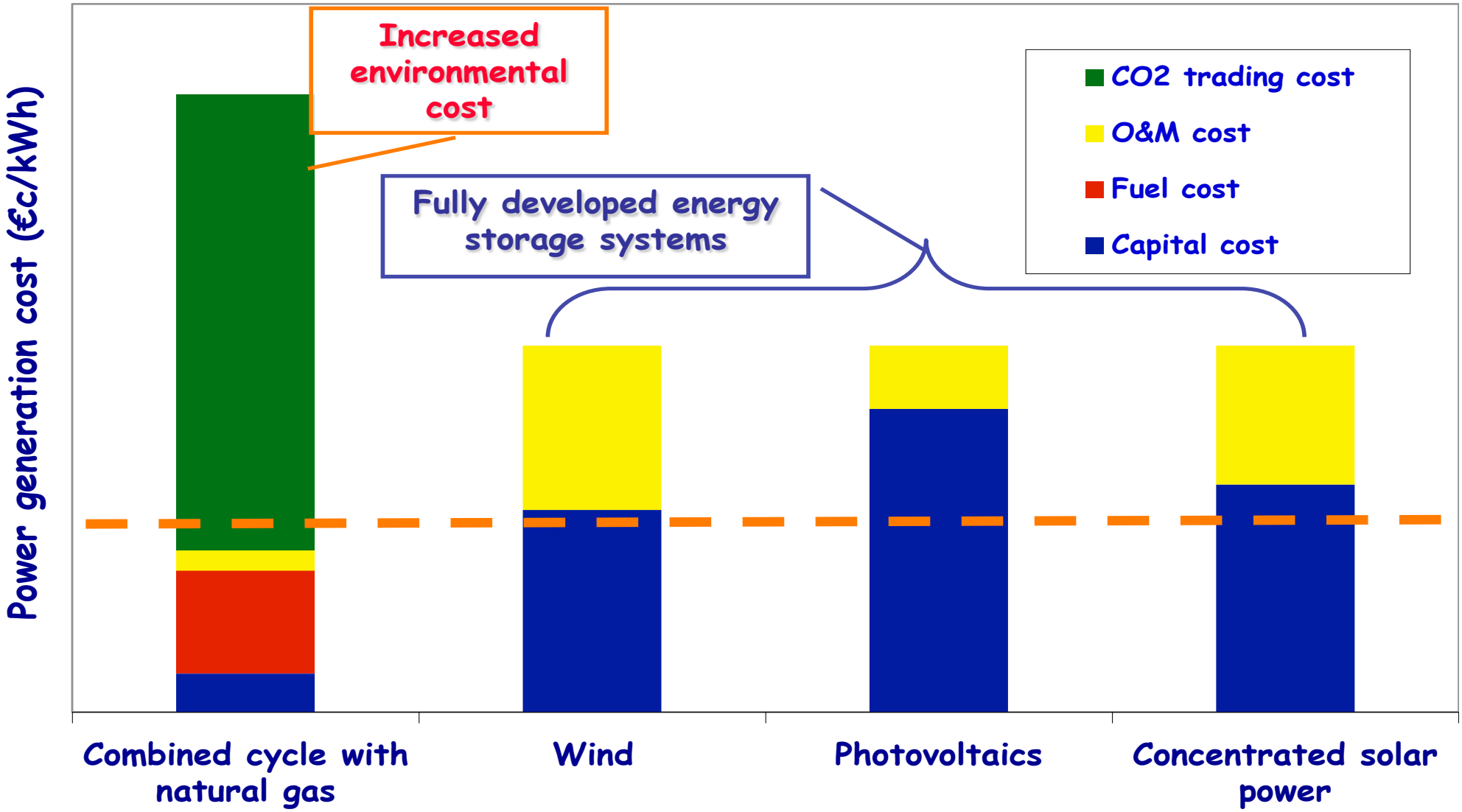
*** Poullikkas A., 2010, "The cost of integration of renewable energy sources", *Accountancy***

Power generation cost (year 2020-30)*



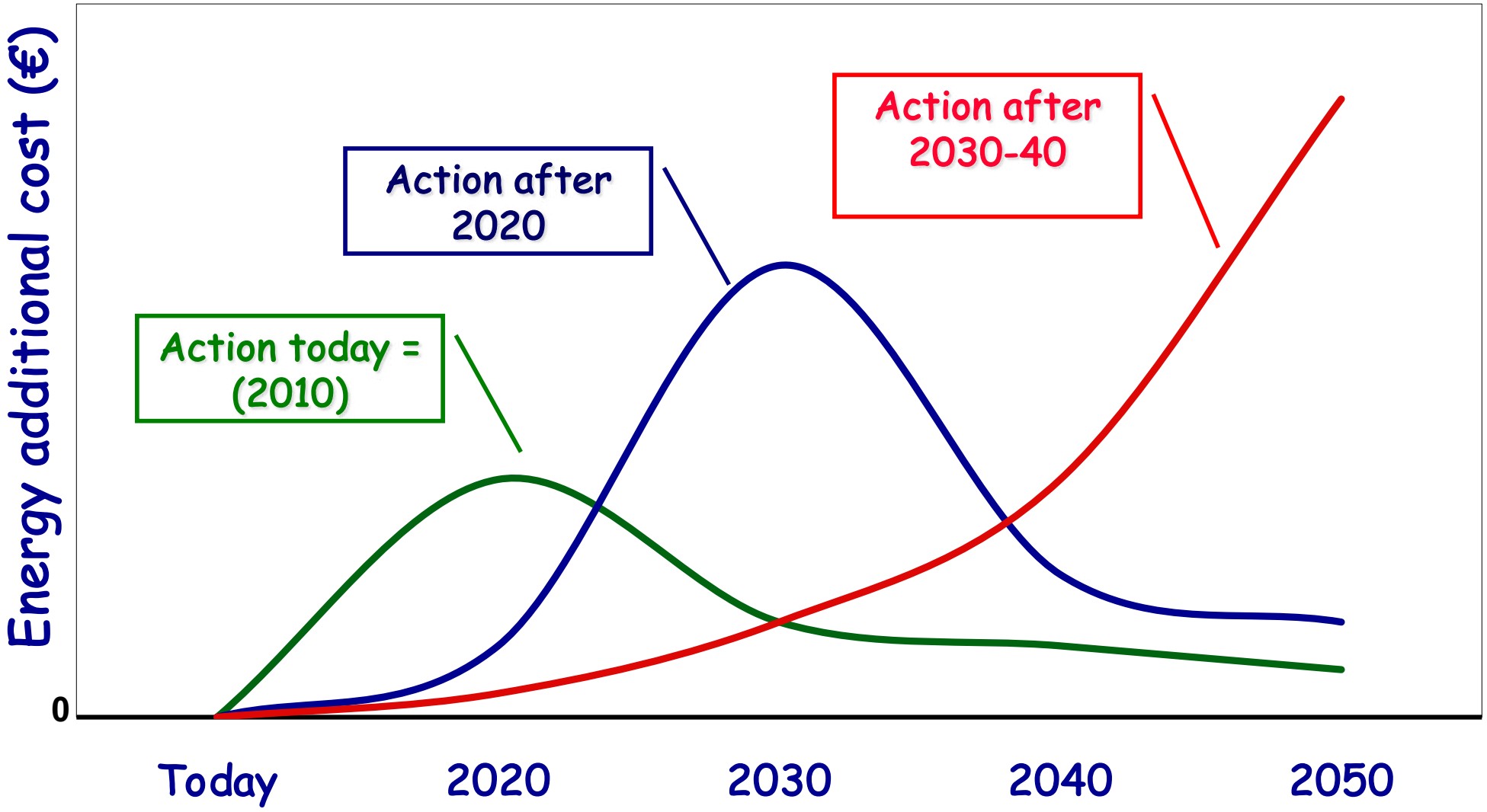
* Poullikkas A., 2010, "The cost of integration of renewable energy sources", *Accountancy*

Power generation cost (year 2040-50)*



* Poullikkas A., 2010, "The cost of integration of renewable energy sources", *Accountancy*

Future energy cost* (for EU only)



* Poullikkas A., 2010, "The cost of integration of renewable energy sources", *Accountancy*