Creating the Regulatory Framework to Grow the Region's Resource Development

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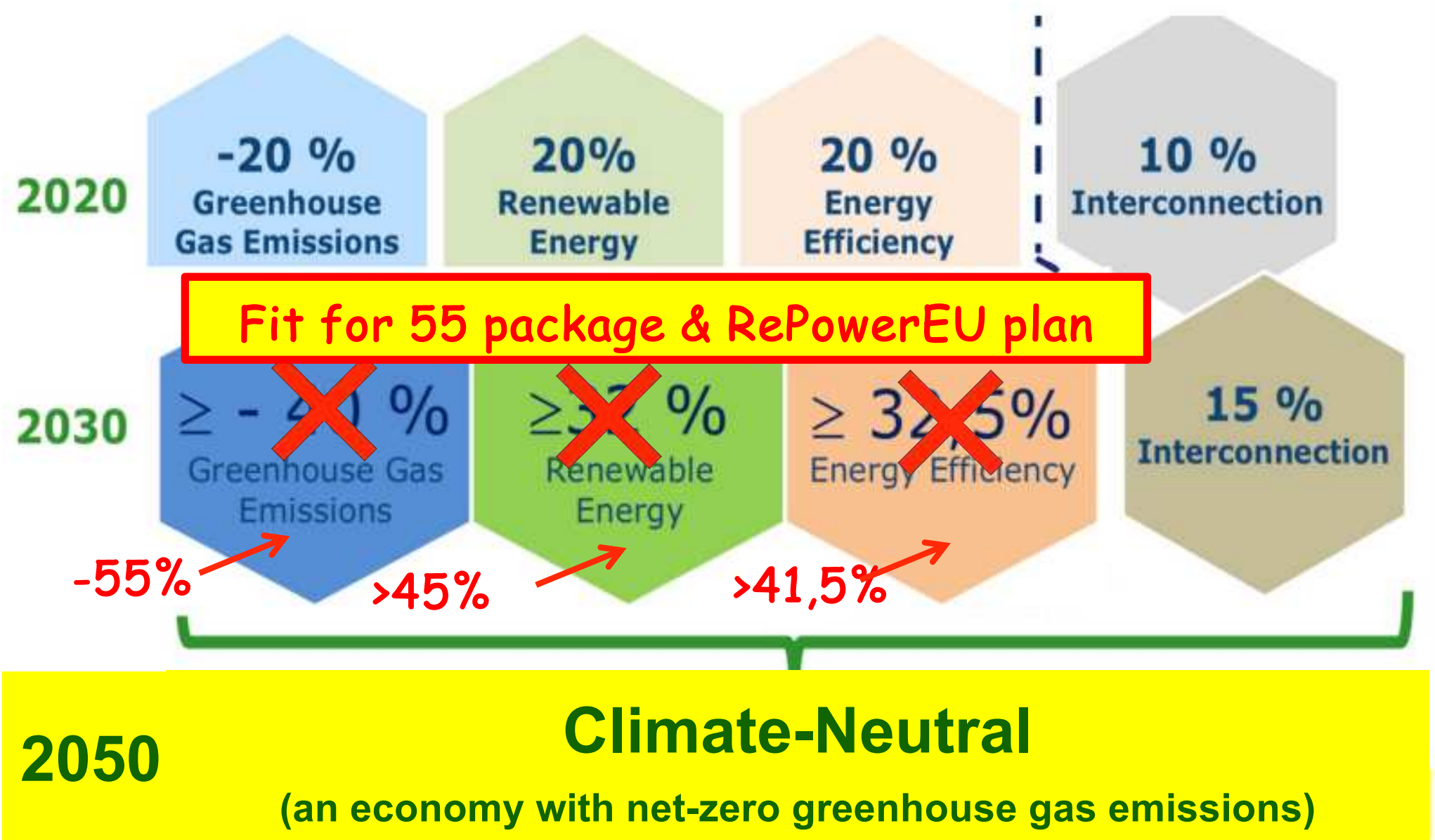
EU energy strategy

Energy transition towards 2050

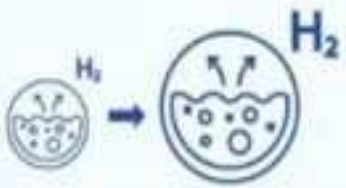
Energy transition

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

EU medium and long term targets



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

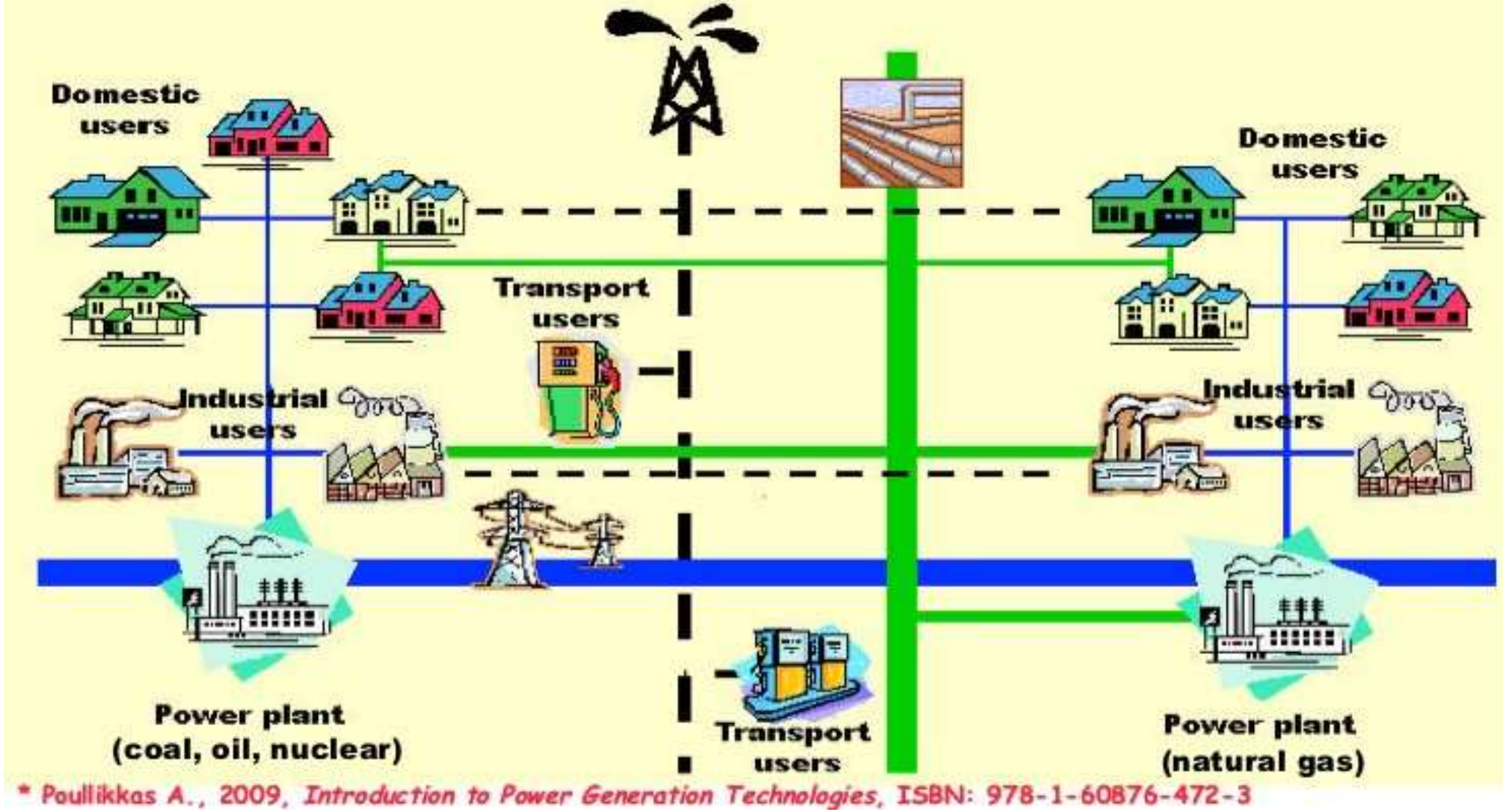
* *A hydrogen strategy for a climate-neutral Europe*, EU, 2020

The role of H_2 in Energy Transition

long-term scenarios from carbon economy to hydrogen economy

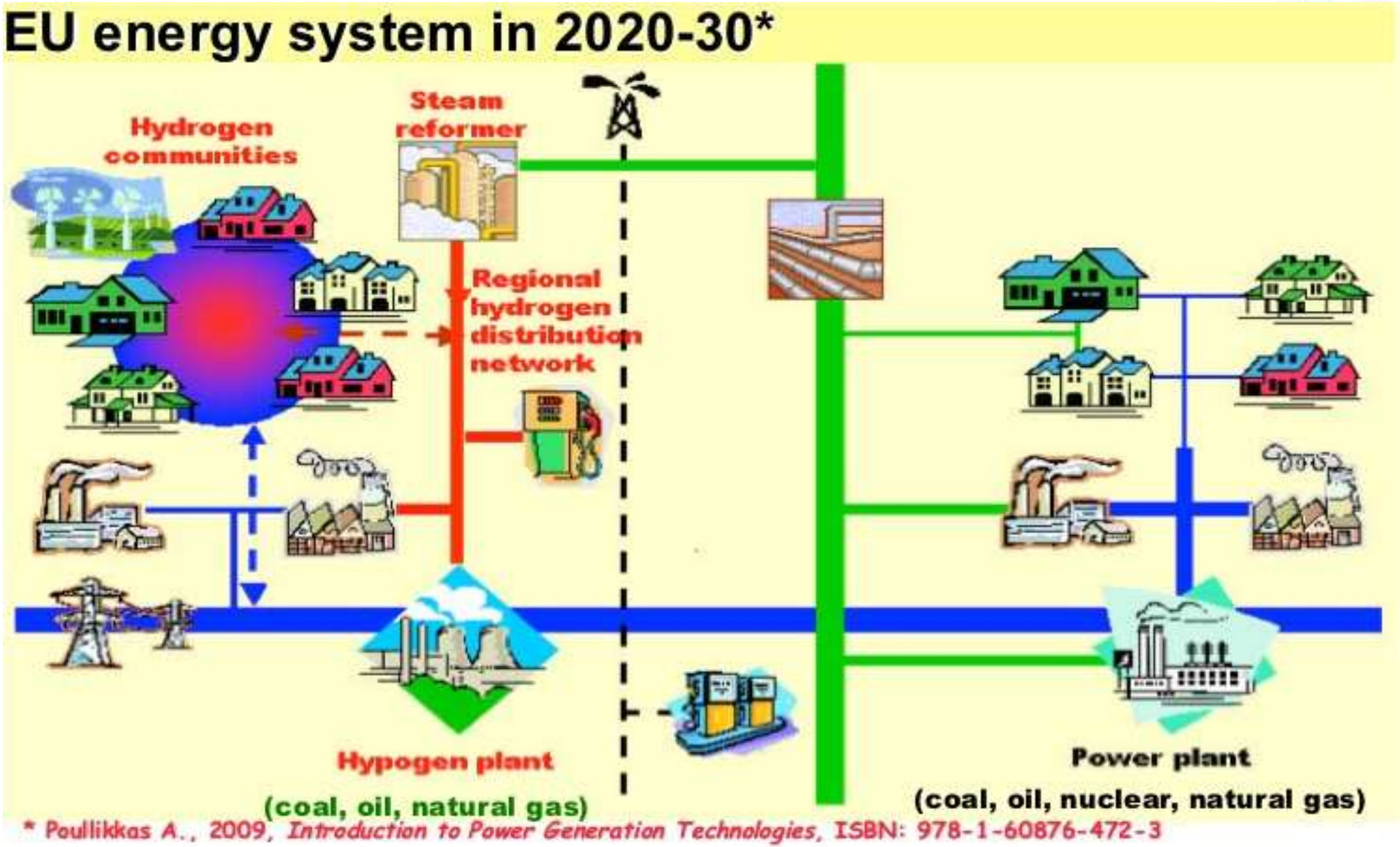
Energy system in 2010

EU energy system in 2010*

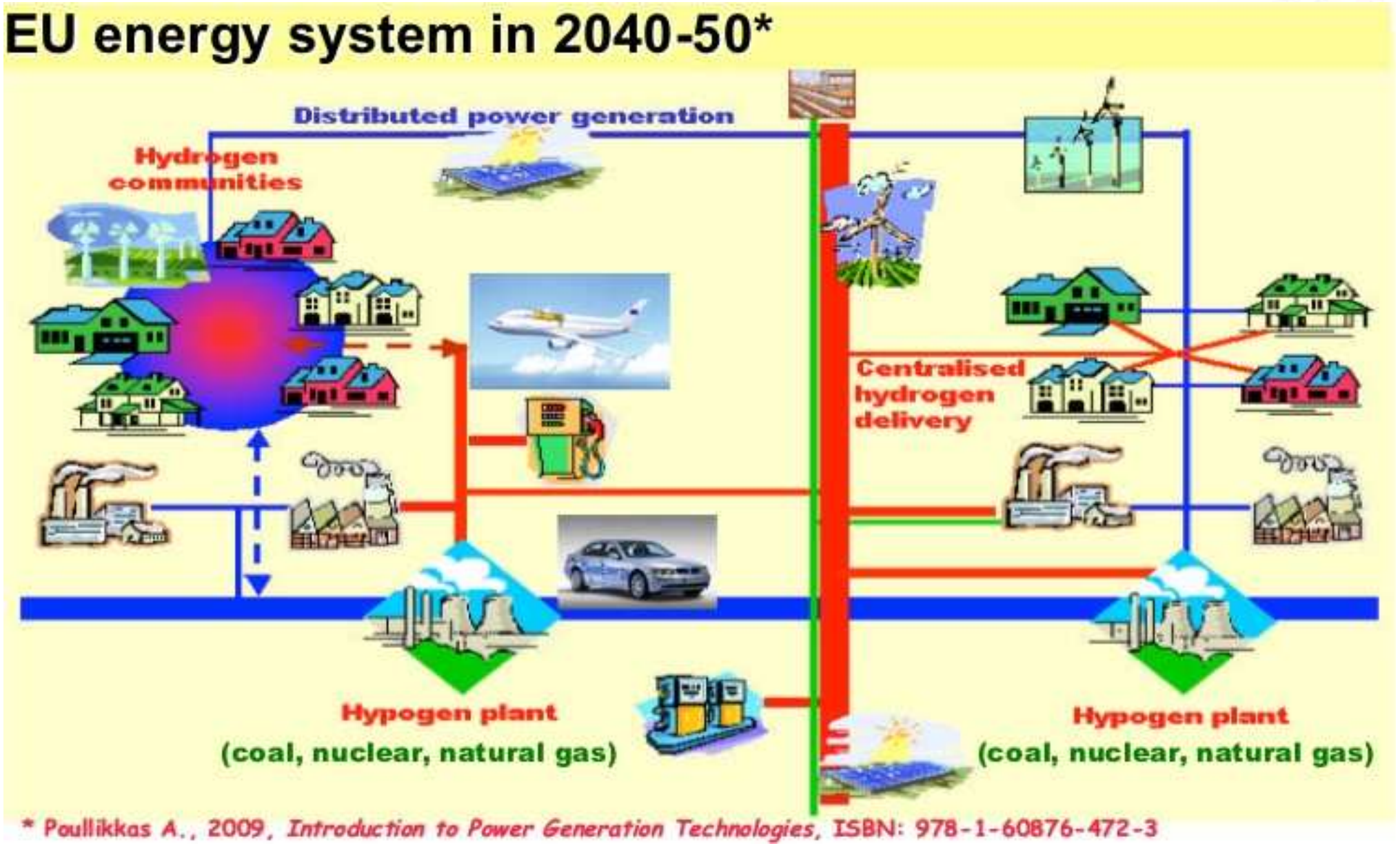


* Poullikkas A., 2009, *Introduction to Power Generation Technologies*, ISBN: 978-1-60876-472-3

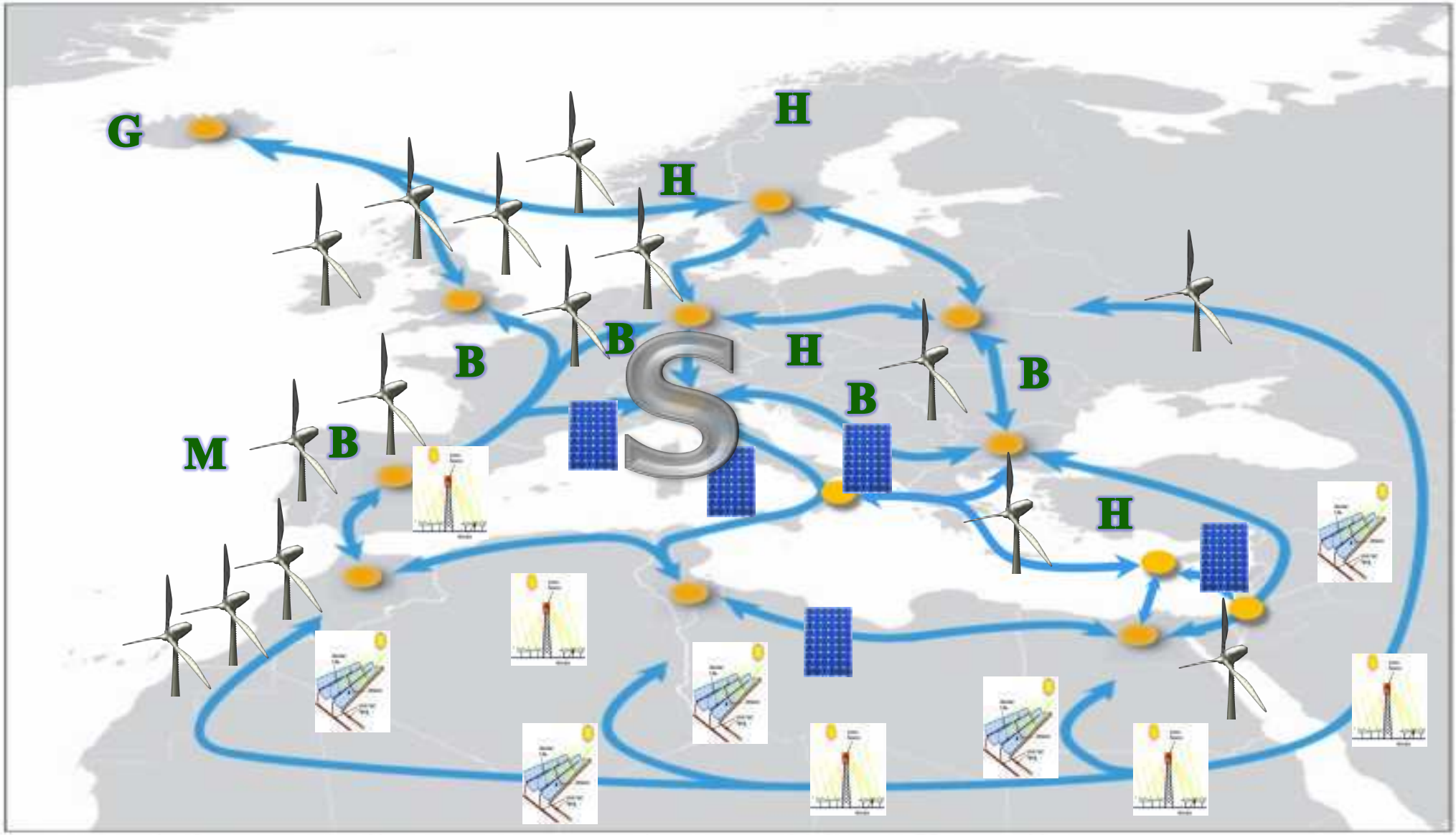
Future energy systems (optimistic scenario)



Future energy systems (optimistic scenario)

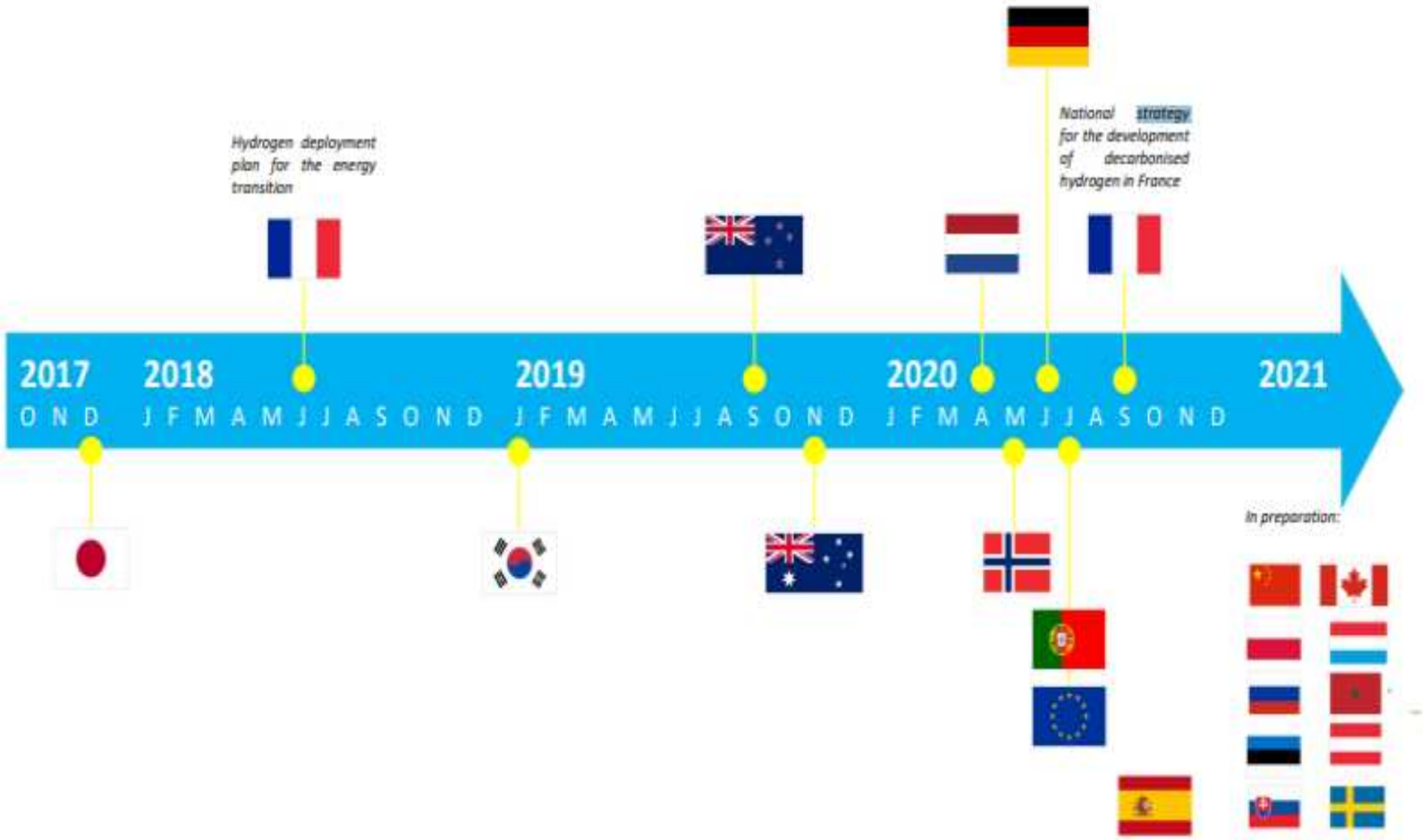


The Super Smart Grid after 2050*
(may allow for 100% RES)



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

National Hydrogen Strategies*



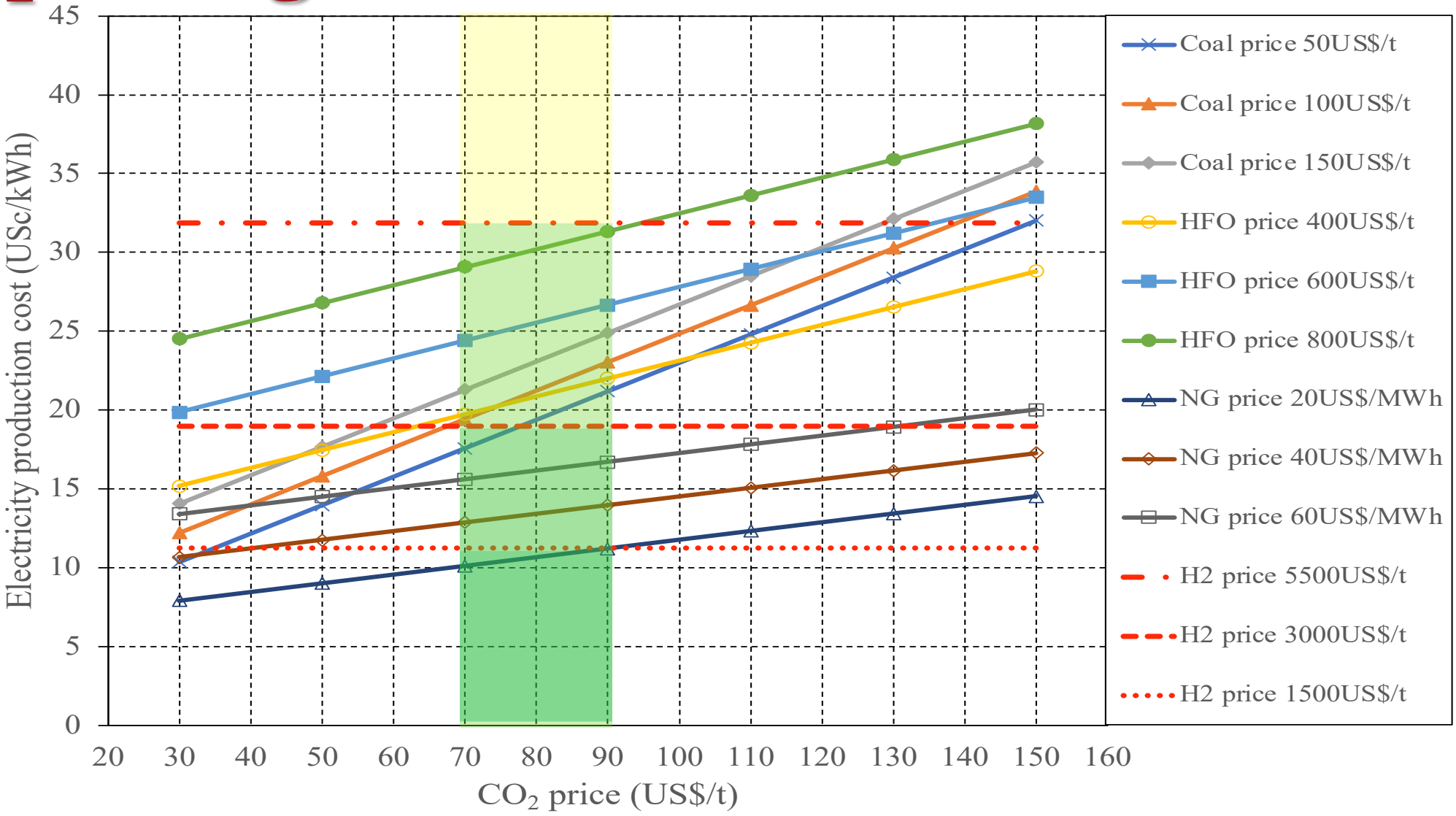
** Possible regulation of hydrogen networks, ACER 2021*

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

Carbon price *vs* green hydrogen power generation*



* Venizelos V., Poullikkas A., 2023, "The effect of carbon price towards green hydrogen power generation", *in preparation*

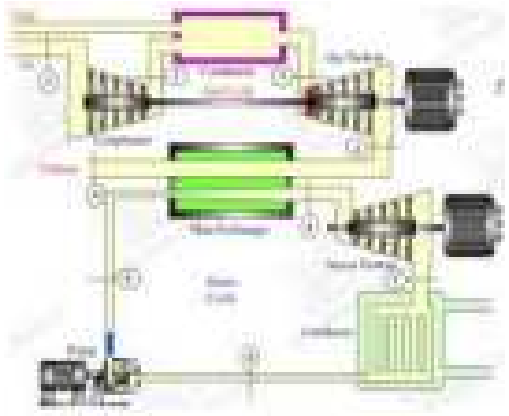
Cyprus current electricity and NG systems

Systems characteristics

Existing power generation system

- **Steam turbine units (HFO)**
  - Dhekelia power station 6x60MWe
  - Vasilikos power station 3x130MWe

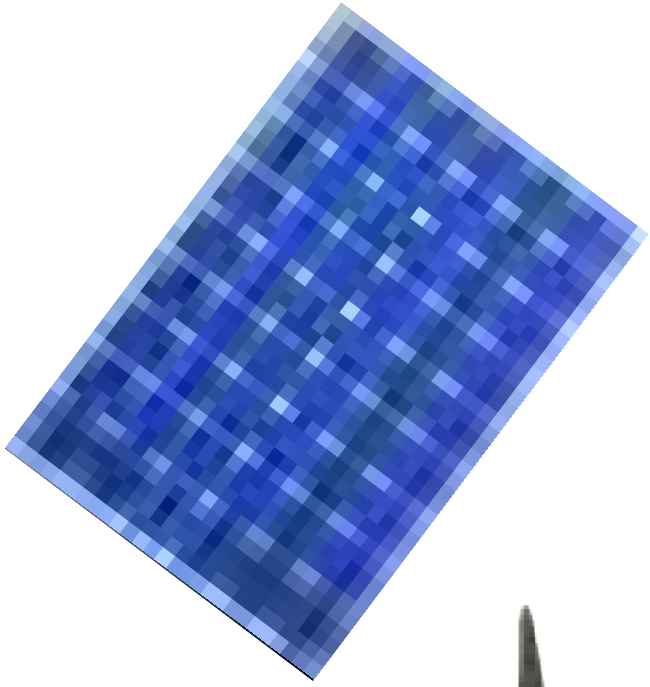
- **Internal combustion engines (HFO)**
  - Dhekelia power station 6x17.5MWe
  - W2E1 (Kofinou) station 3x1.5MWe



- **Combined cycles (Diesel)**
  - Vasilikos power station 2x220MWe
- **Gas turbine units (Diesel)**
  - Moni power station 4x37,5MWe
  - Vasilikos power station 1x38MWe

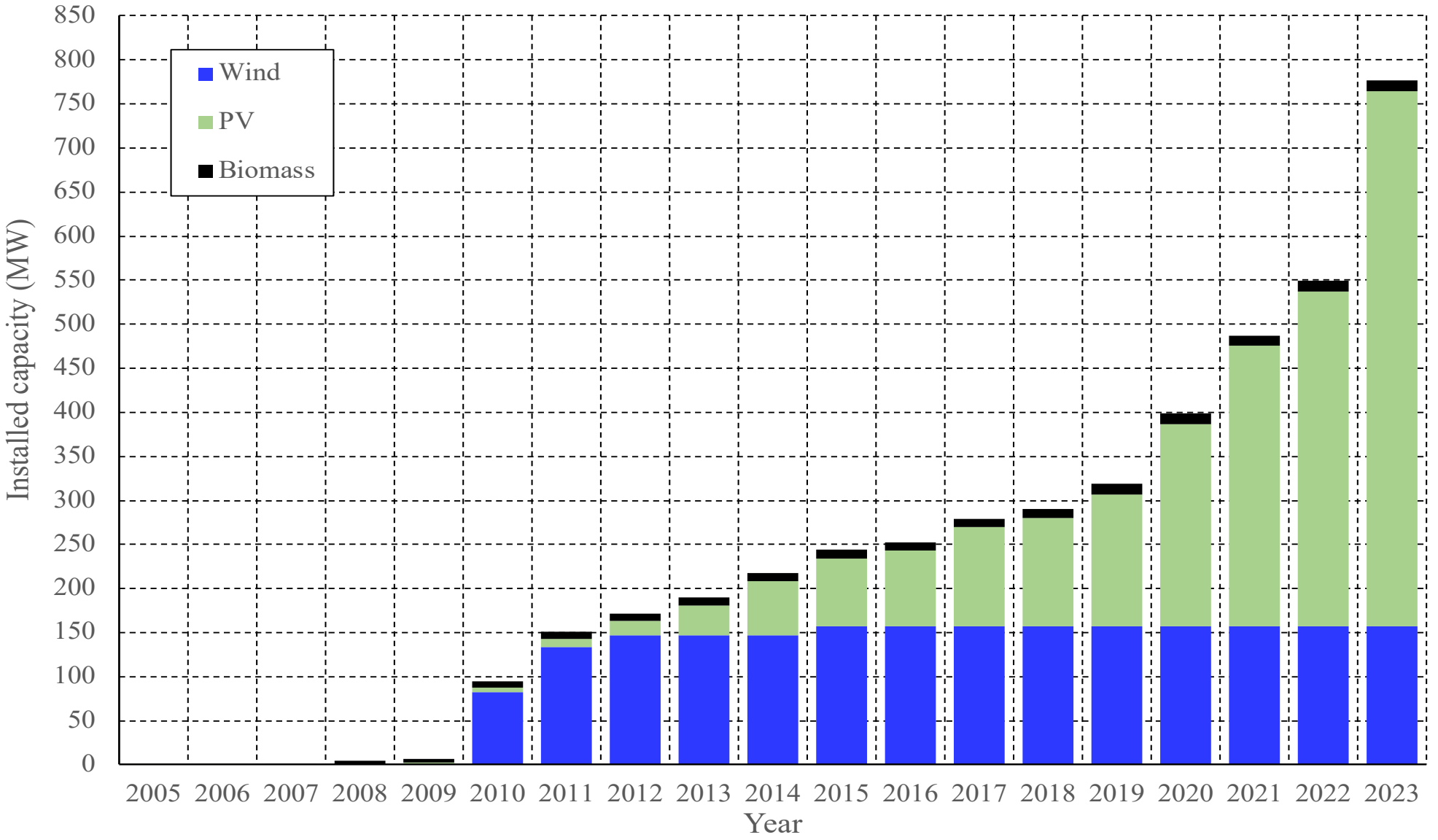
Existing power generation system (cont.)

- **Renewables**
  - **PVs: 606MWe**
  - **Wind: 157MWe**
  - **Biomass: 13MWe**



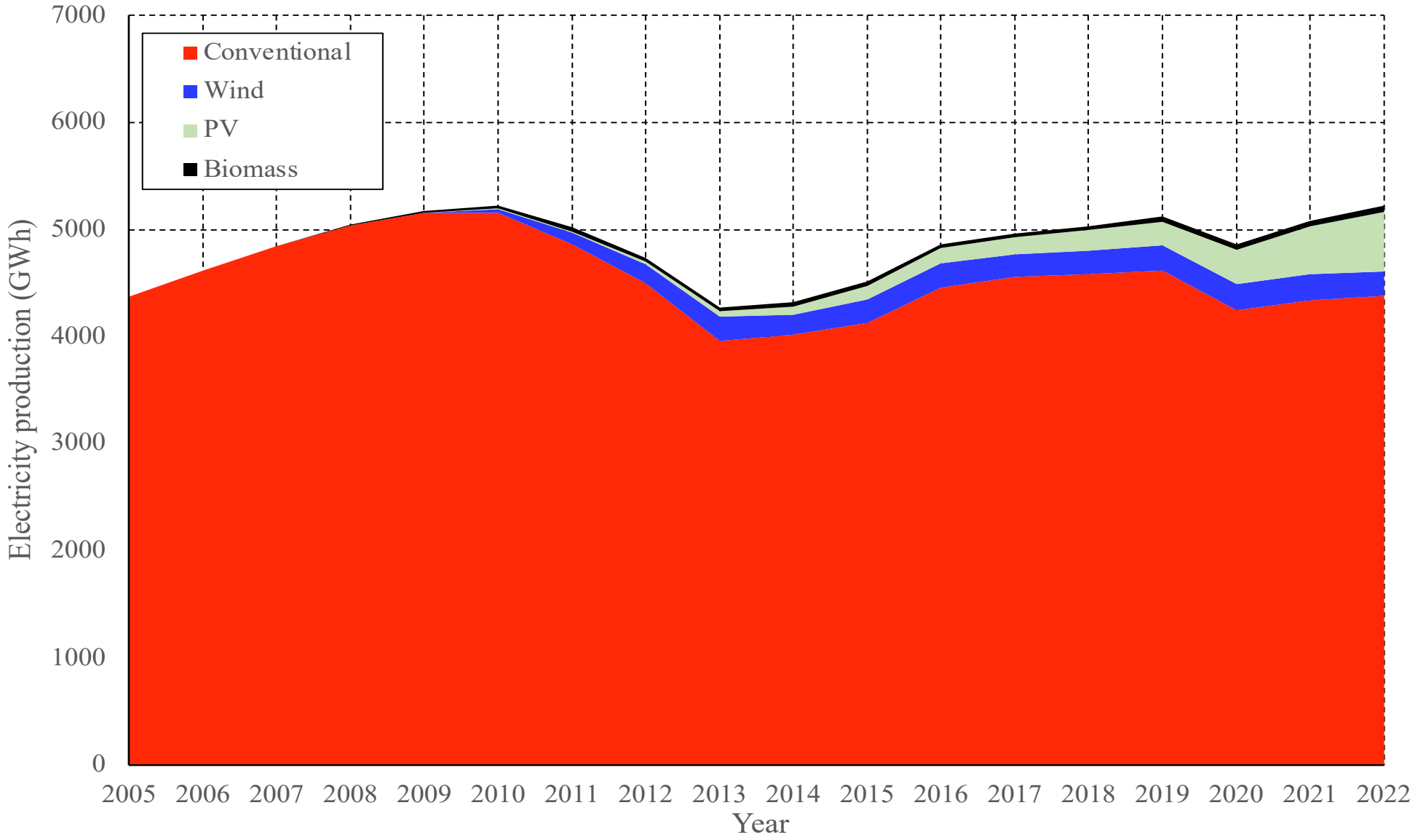
- **Total installed capacity:**
  - **Conventional: 1488MWe**
  - **Renewables: 776MWe**

RES-E installed capacity*



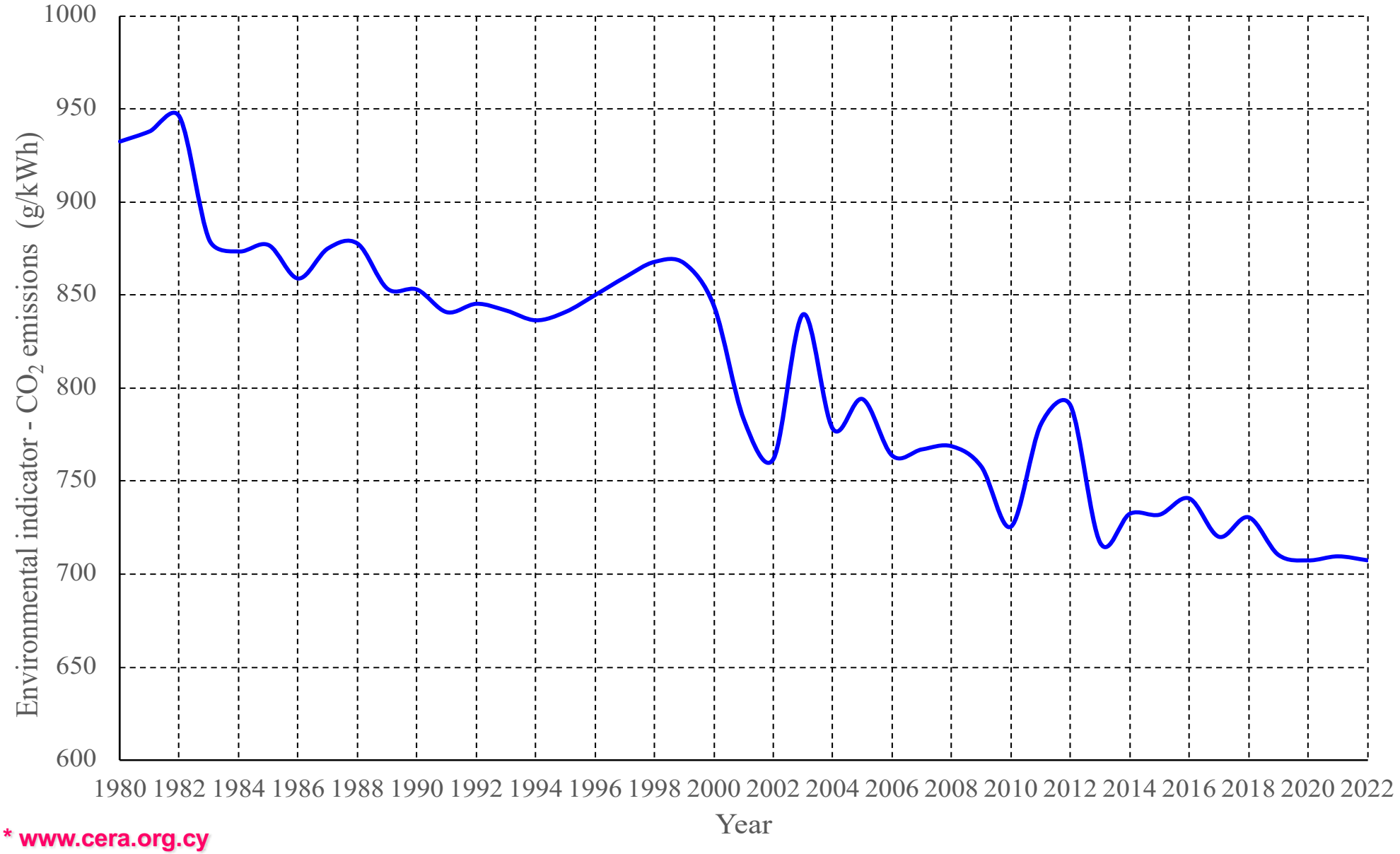
* www.cera.org.cy

Total electricity production per year*



* www.cera.org.cy

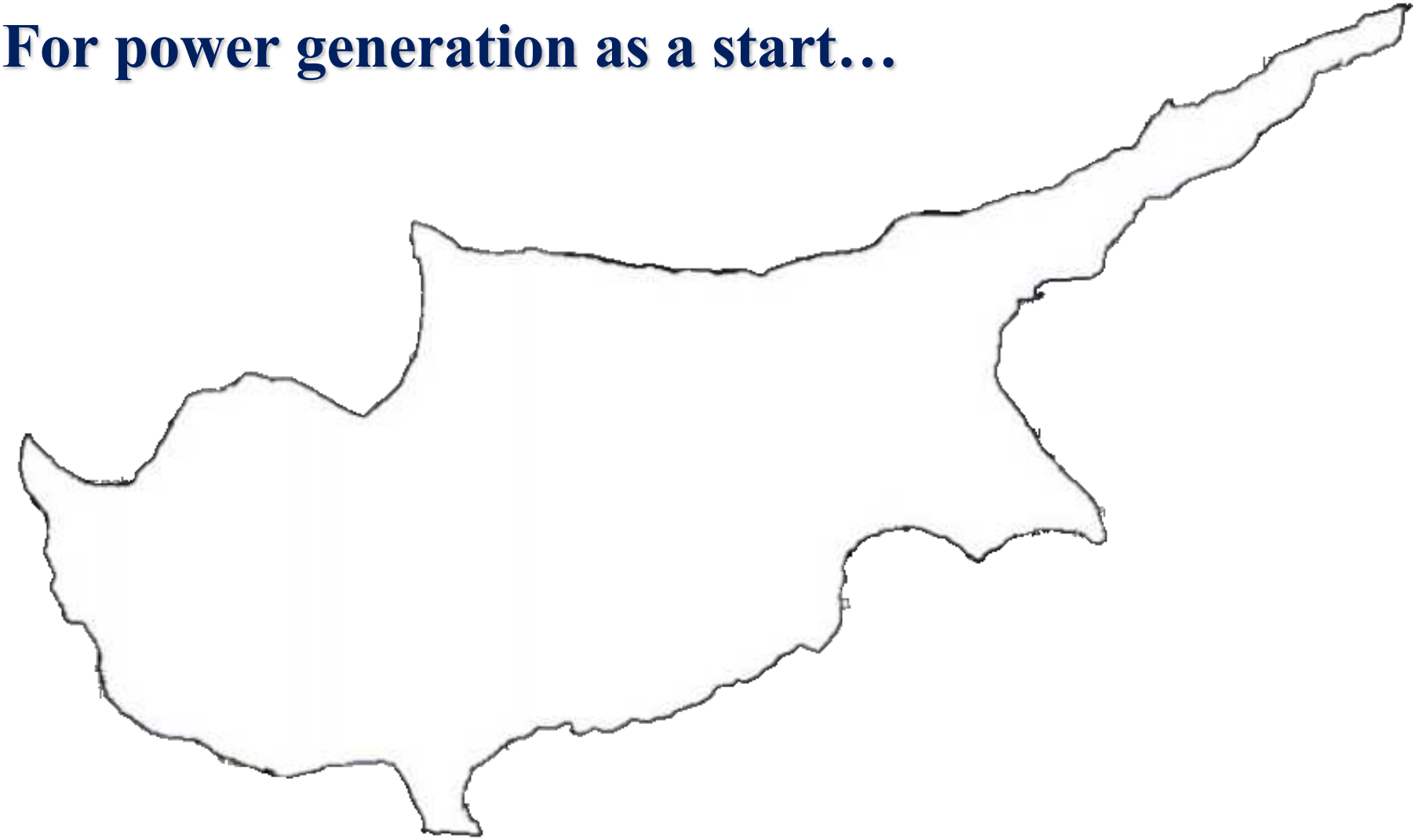
CO_2 environmental indicator*



* www.cera.org.cy

Existing natural gas system

- **Under development !**
- **For power generation as a start…**



Challenges of energy transition in island systems

Solutions for isolated systems

Characteristics of isolated electricity systems*

- **High fuel costs**
  - ~ use of oil derivatives
  - ~ high CO_2 emissions (additional cost)
- **Economies of scale cannot be adequately exploited**
  - ~ generation units cannot exceed a certain size since the loss of a unit would mean the loss of a high percentage of the entire system
- **Need to maintain high reserve capacity to ensure power system reliability**

The smaller the electrical system size, the more the expenses will be

* Poullikkas A., 2015, *Sustainable Energy Policy for Cyprus*, ISBN: 978-9963-7355-6-3

The solution*

- **Increase system flexibility**
  - ~ integrate RES into electricity market
  - ~ use natural gas, storage and RES for power generation
  - ~ promote e-mobility (V2G technology - bidirectional flow of electricity between the electric car and the grid)
- **Establish electricity interconnections**
  - ~ with EU internal electricity market (the island of Cyprus is the only non-interconnected Member State)
- **Production of hydrogen** (energy carrier)
  - ~ from RES and natural gas

* Poullikkas A., 2016, *Fundamentals of Energy Regulation*, ISBN: 978-9963-7355-8-7

CERA Energy Transition Regulatory Decisions

- **Regulatory Decision 01/2017 (ΚΔΠ 34/2017): A detailed schedule for the implementation of EU electricity market target model**
- **Regulatory Decision 02/2018 (ΚΔΠ 259/2018): The mass installation of an Advanced Metering Infrastructure including smartmeters to all electricity consumers**
- **Regulatory Decision 02/2019 (ΚΔΠ 204/2019): The establishment of basic principles of a regulatory framework for the operation of electricity storage systems in the wholesale electricity market**
- **Regulatory Decision 03/2019 (ΚΔΠ 224/2019): The redesign of the power grid to become smart and bi-directional in order to allow integration of large quantities of renewable energy sources in combination with energy storage systems**

CERA Energy Transition Regulatory Decisions (in preparation)

- **Regulatory framework:** Energy communities and Renewable energy communities
- **Regulatory framework:** Electrical interconnections
- **Regulatory framework:** Hydrogen market
- **Regulatory framework:** Price comparison tools
- …

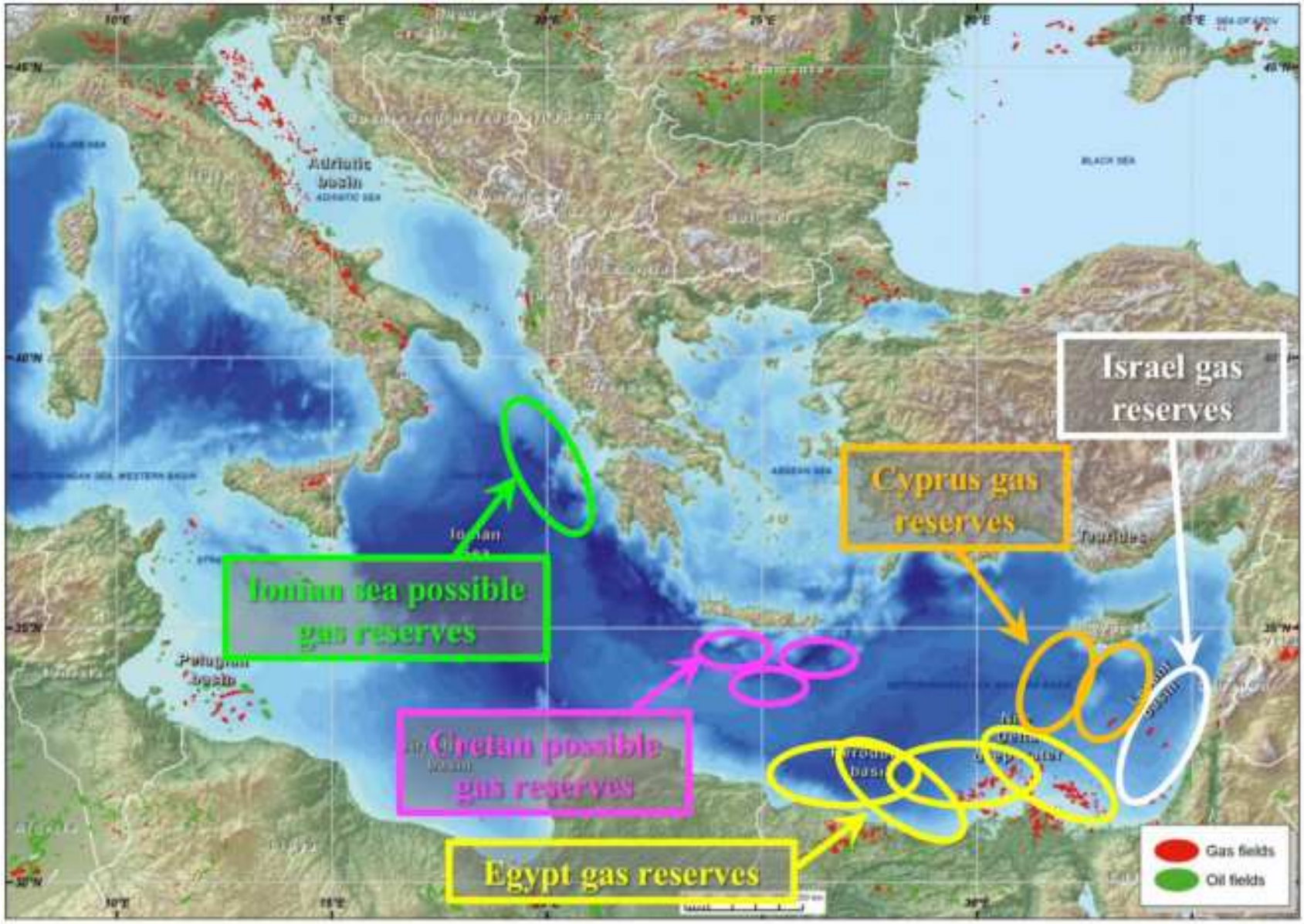
Long-term energy strategy for Cyprus

Regional cooperation towards hydrogen economy

Regional primary energy sources

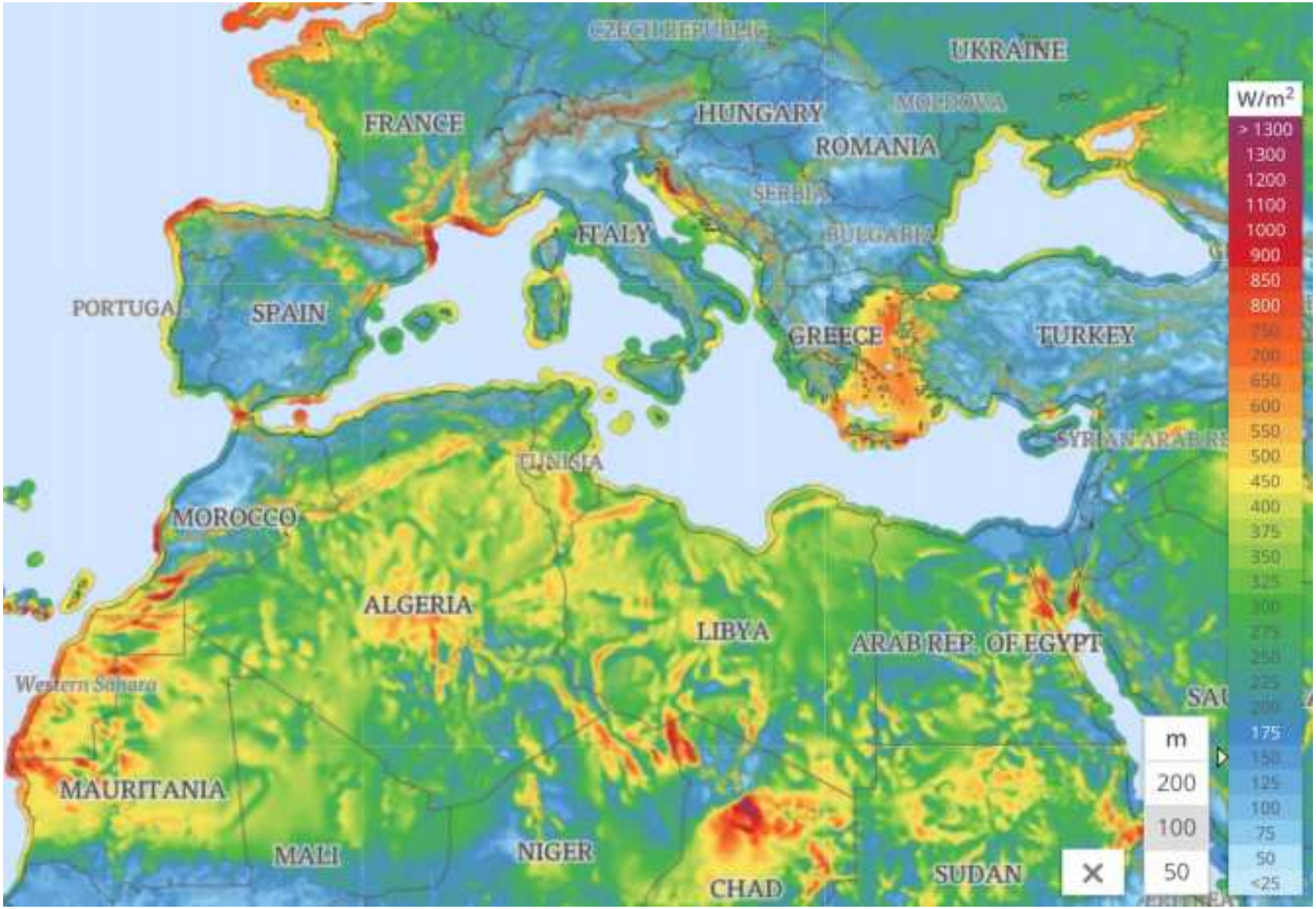
Indigenous energy sources

Gas reserves in SE Mediterranean region*



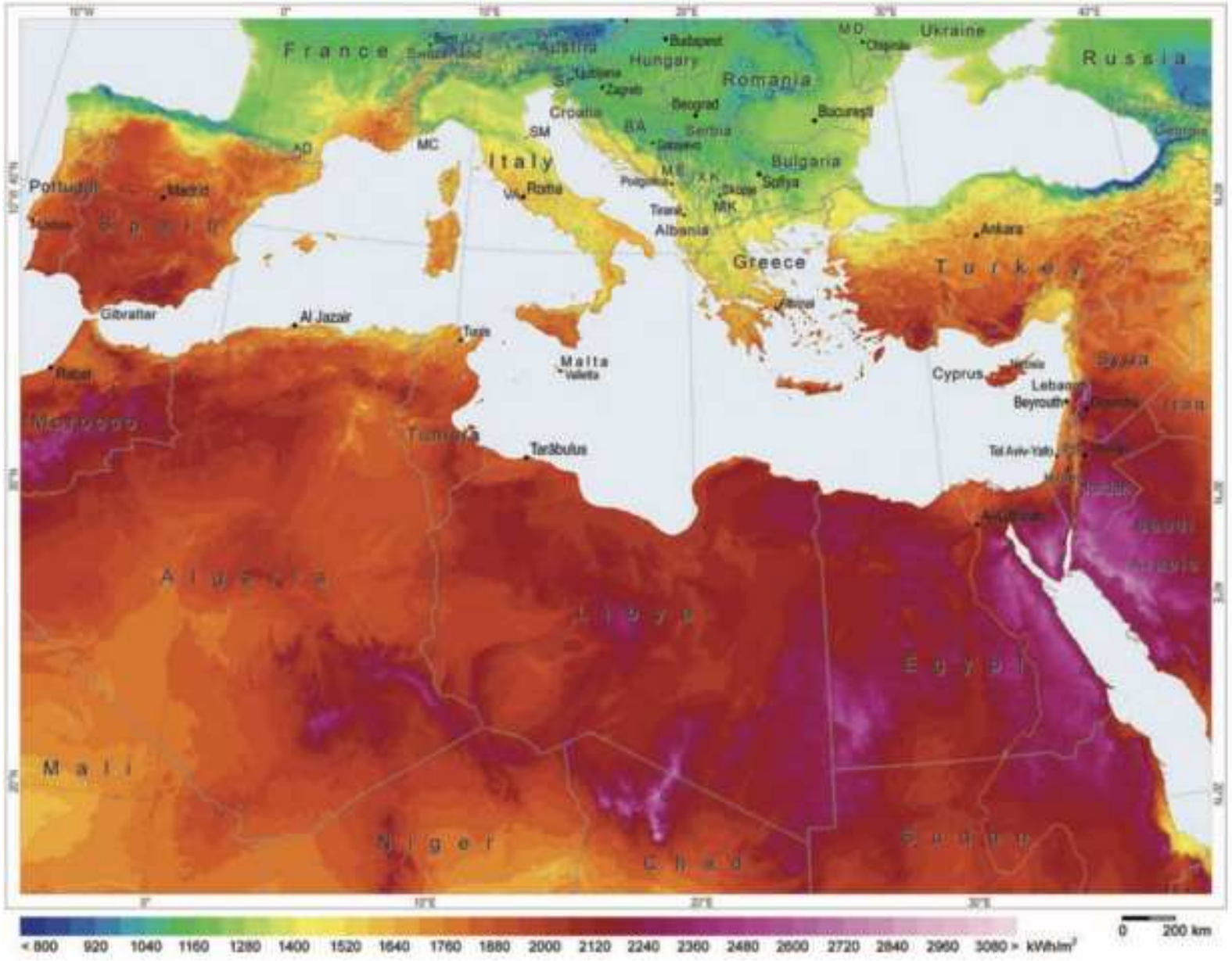
* A. Belopolsky, *et al.*, 2012, "New and emerging plays in the Eastern Mediterranean", *Petroleum Geoscience*

Wind potential in SE Mediterranean region*



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

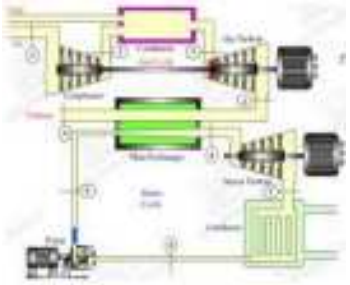
Solar potential in SE Mediterranean region*



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

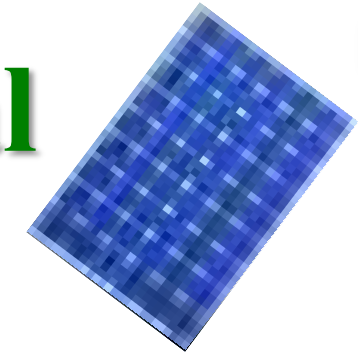
Main indigenous energy sources in SE Mediterranean region

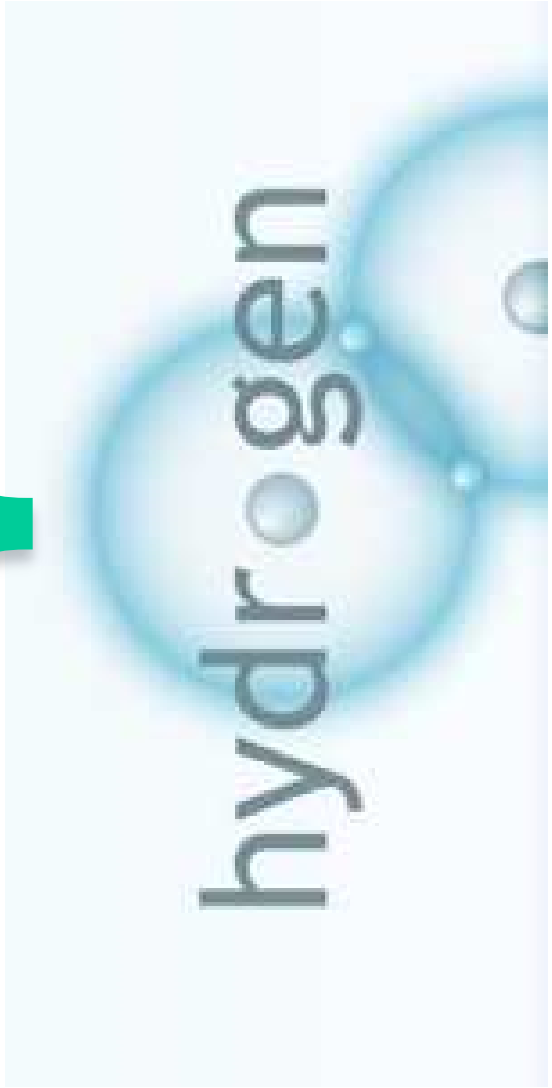
- Natural gas



- Wind potential

- Solar potential





Target-setting for Cyprus' transition to hydrogen economy*

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

Energy transition by 2050*

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

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

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**

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