



# Μεταβαίνοντας προς τη νέα ενεργειακή εποχή – Προκλήσεις στην αγορά ηλεκτρισμού

**Δρ. Ανδρέας Πουλλικκός**

*Ph.D, D.Tech, FIET*

**Πρόεδρος Ρυθμιστικής Αρχής Ενέργειας Κύπρου**

**Πρόεδρος Συμβουλίου Ενεργειακής Στρατηγικής**

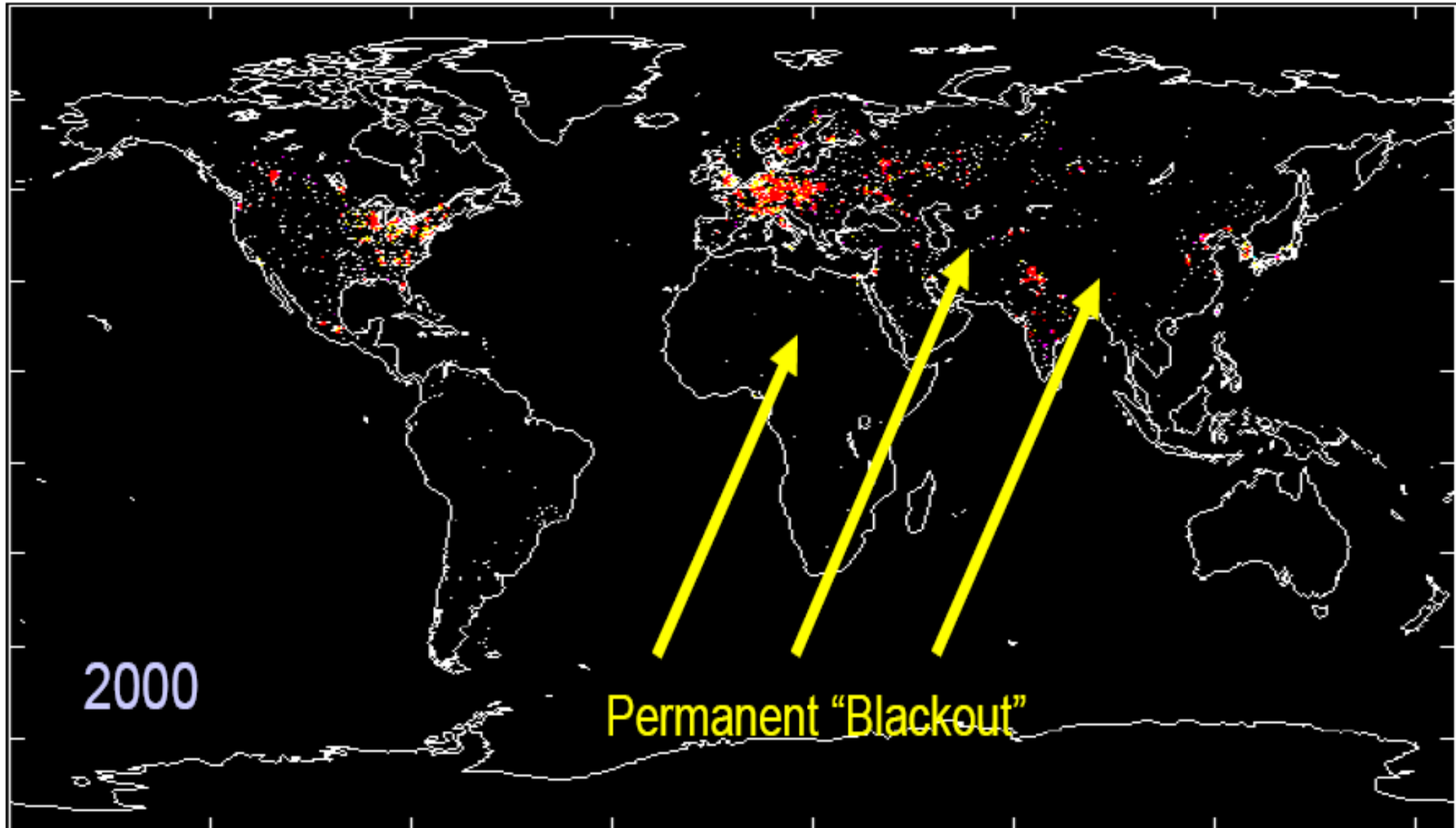
**[apoulikkas@cera.org.cy](mailto:apoulikkas@cera.org.cy)**

# Περιεχόμενα

- **Ευρωπαϊκή Ενεργειακή Στρατηγική**
  - Μακροπρόθεσμη στρατηγική (2050)
  - Ενεργειακή Ένωση (2030)
- **Προκλήσεις στην αγορά ηλεκτρισμού**
- **Ενεργειακό κόστος**

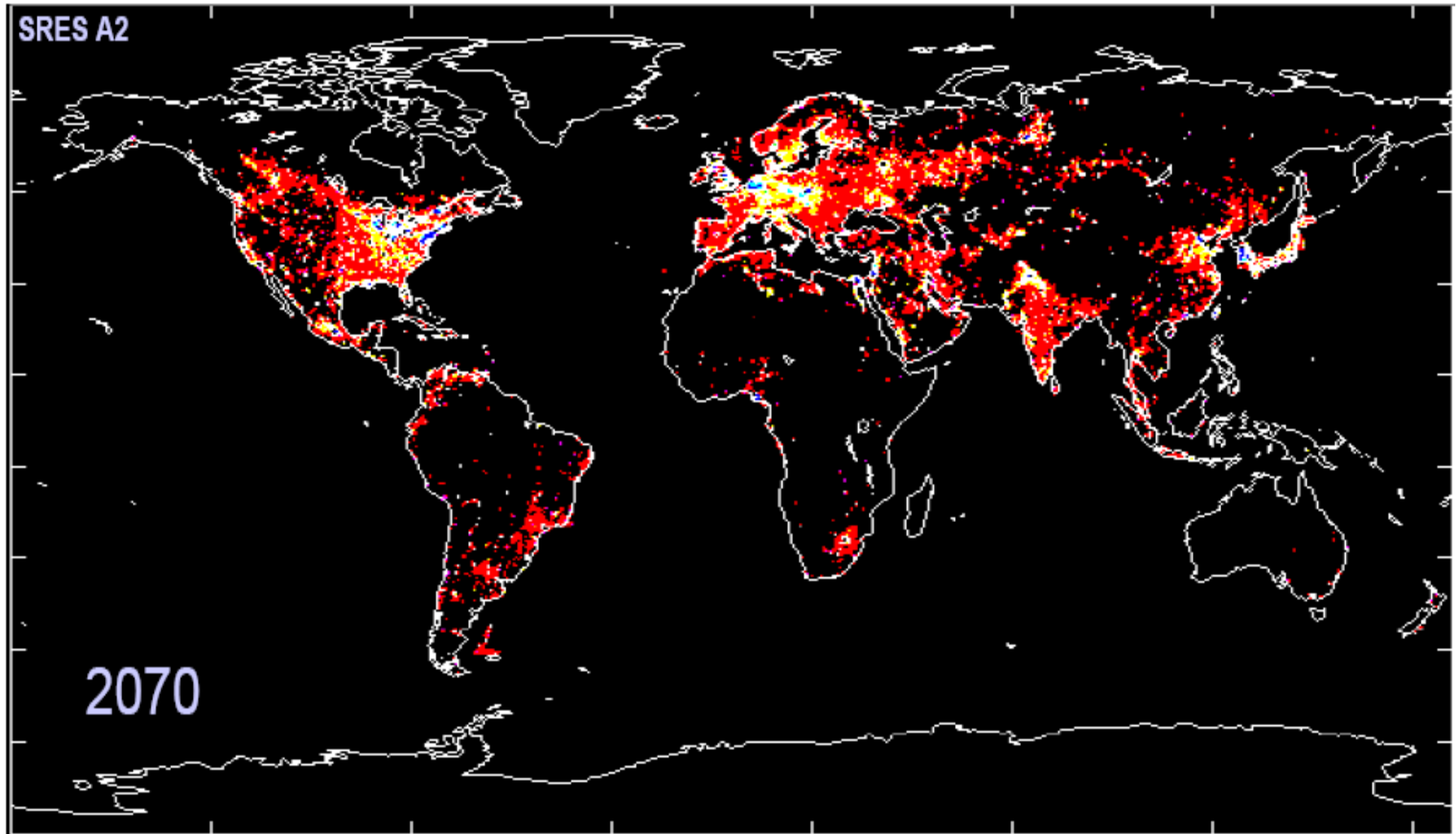
# Ευρωπαϊκή Ενεργειακή Στρατηγική Μακροπρόθεσμη στρατηγική

# Night lights in 2000



Source: e2050, 2006.

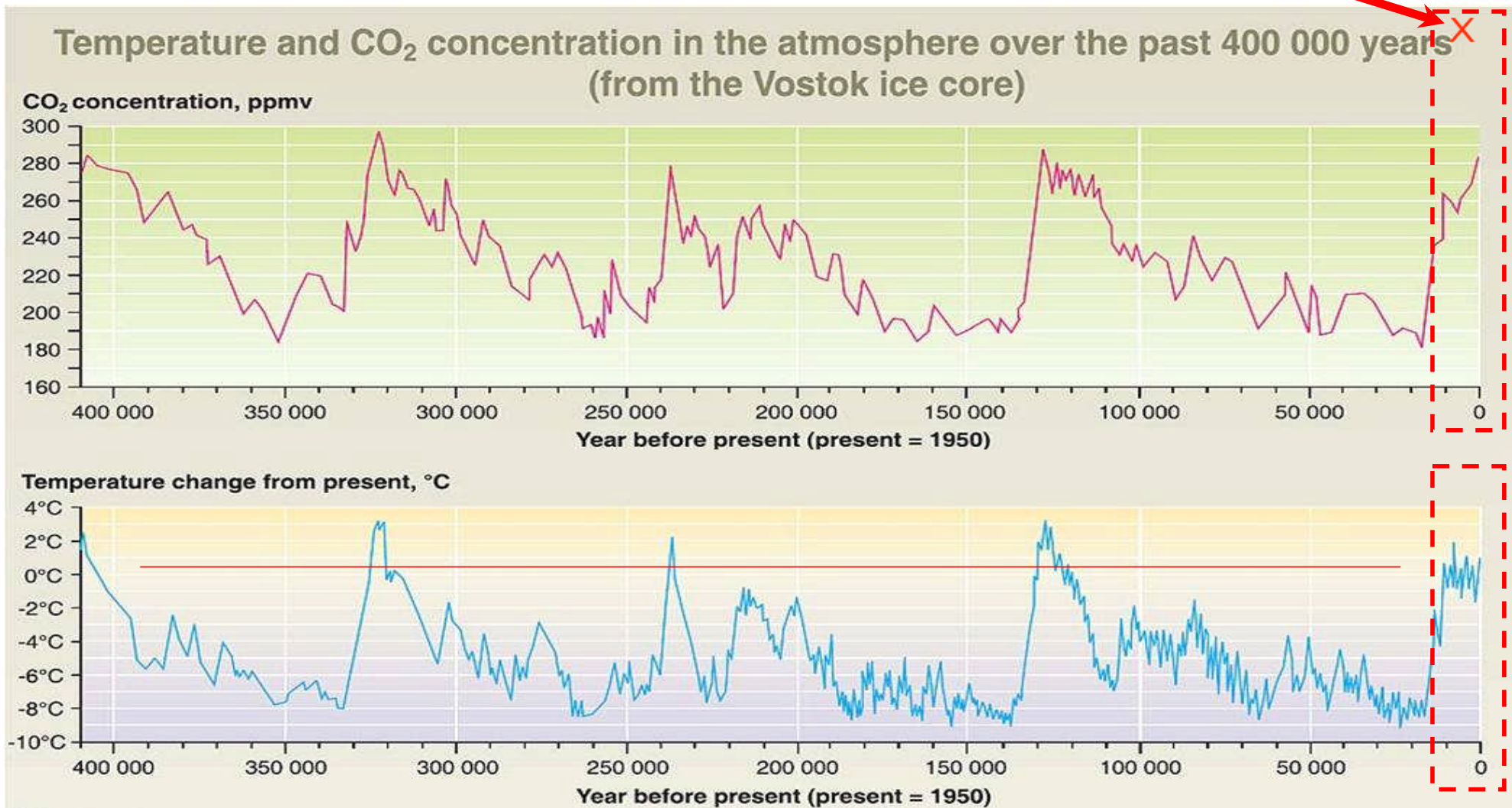
# Night lights in 2070



Source: e2050, 2006.

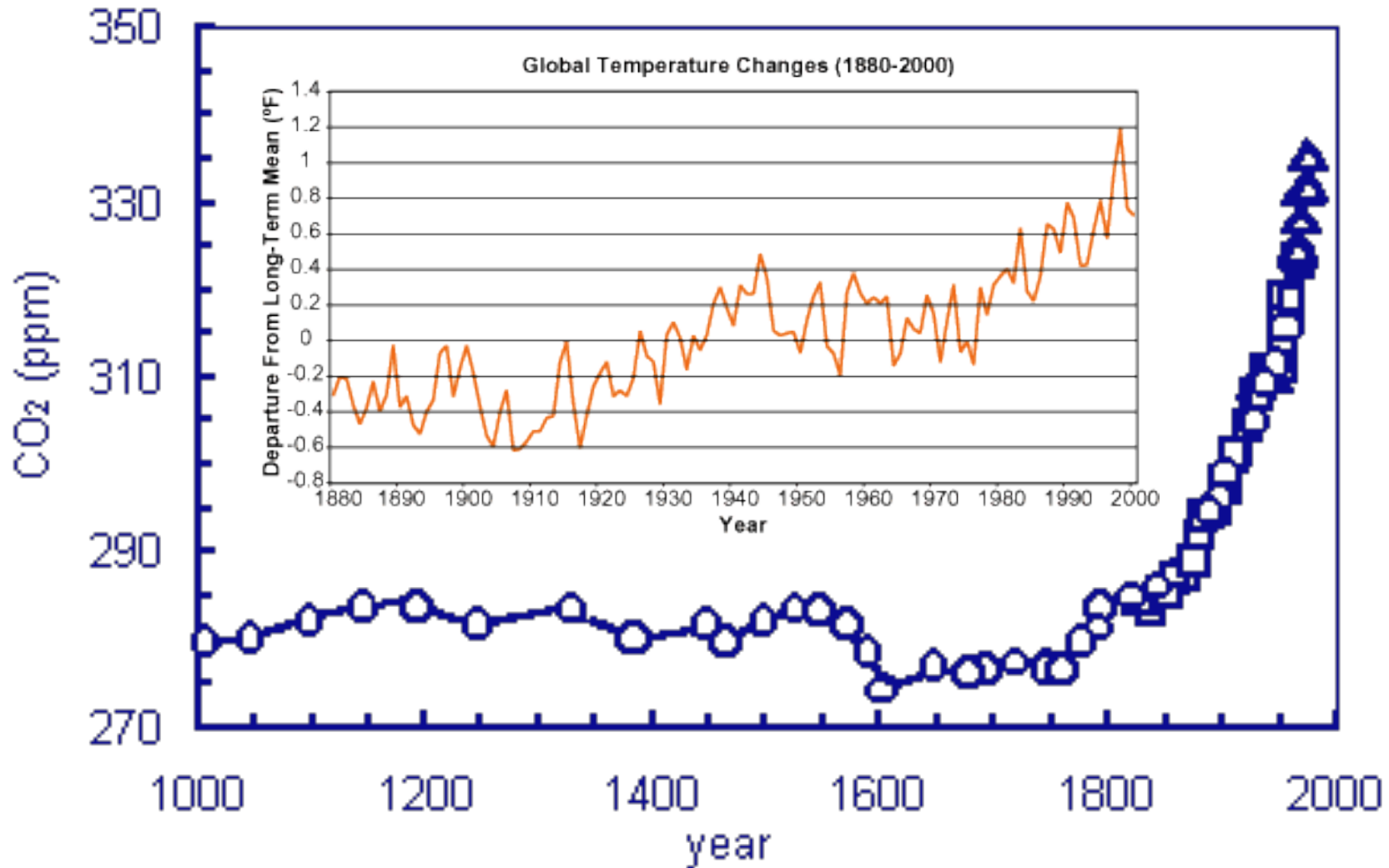
# Global warming

today !



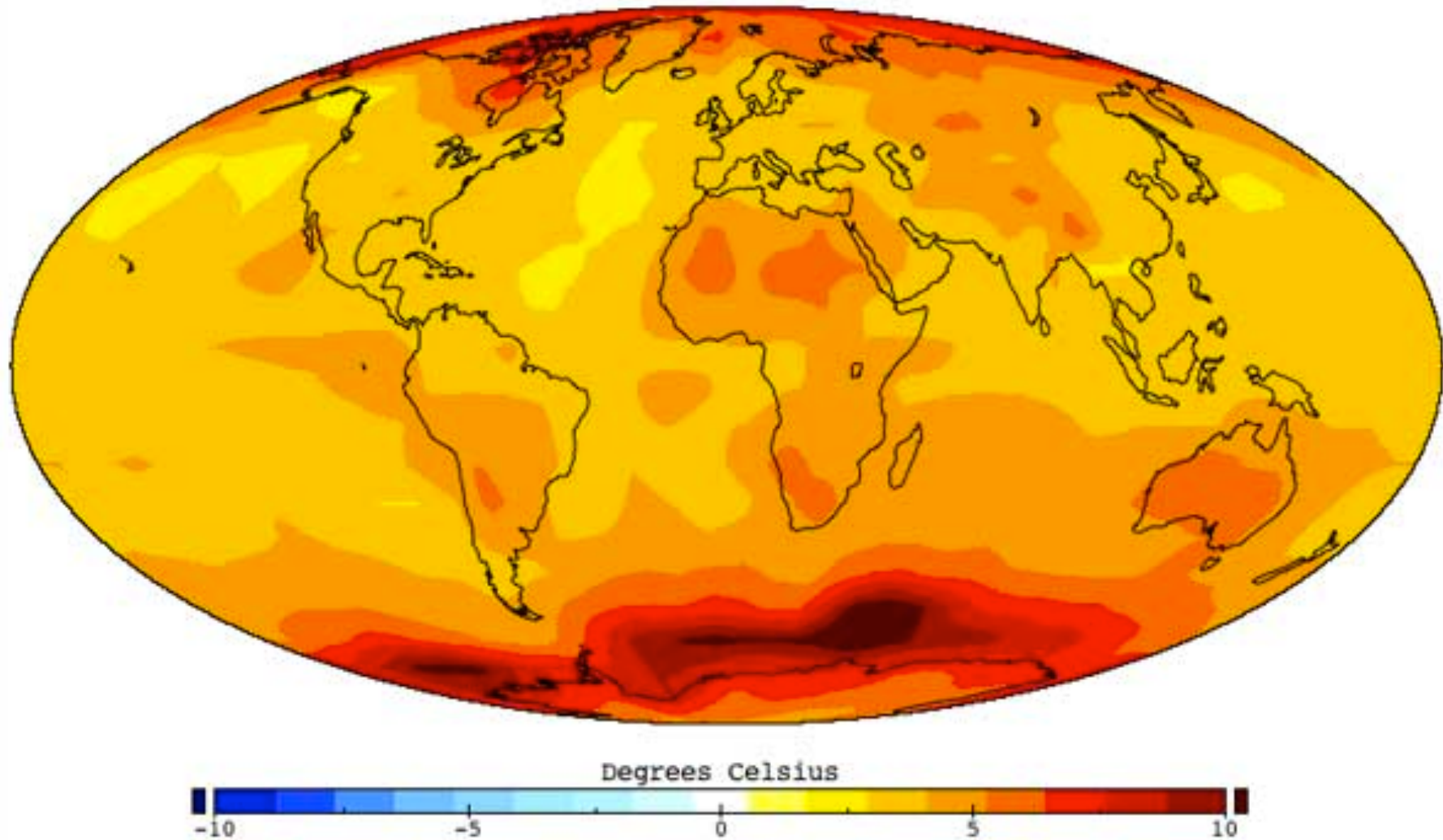
Source: J.R. Petit *et al*, Nature, 1999.

# Global warming



Source: U.S. National Climatic Data Center, 2001.

# Increase of Earth global temperature 1960-2060

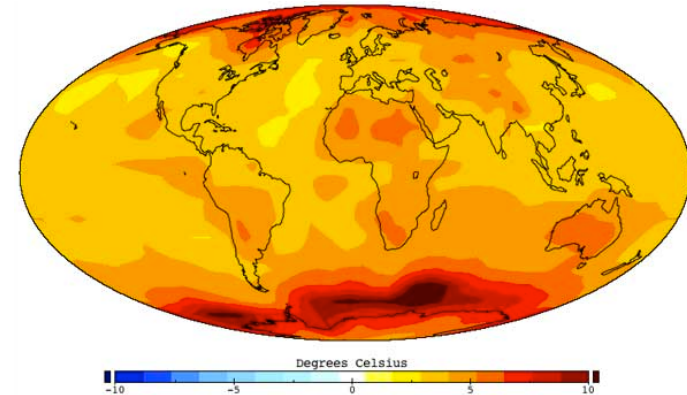


**Source: NASA, 2010.**



# Future energy systems

- **Climate change**

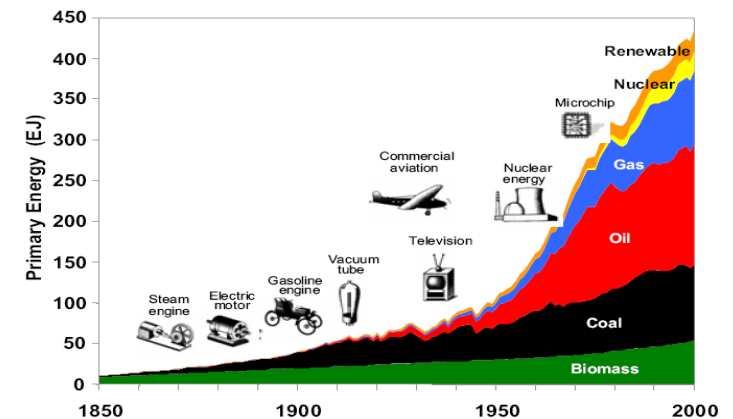


- **Third industrial revolution**

- **Future energy economics**

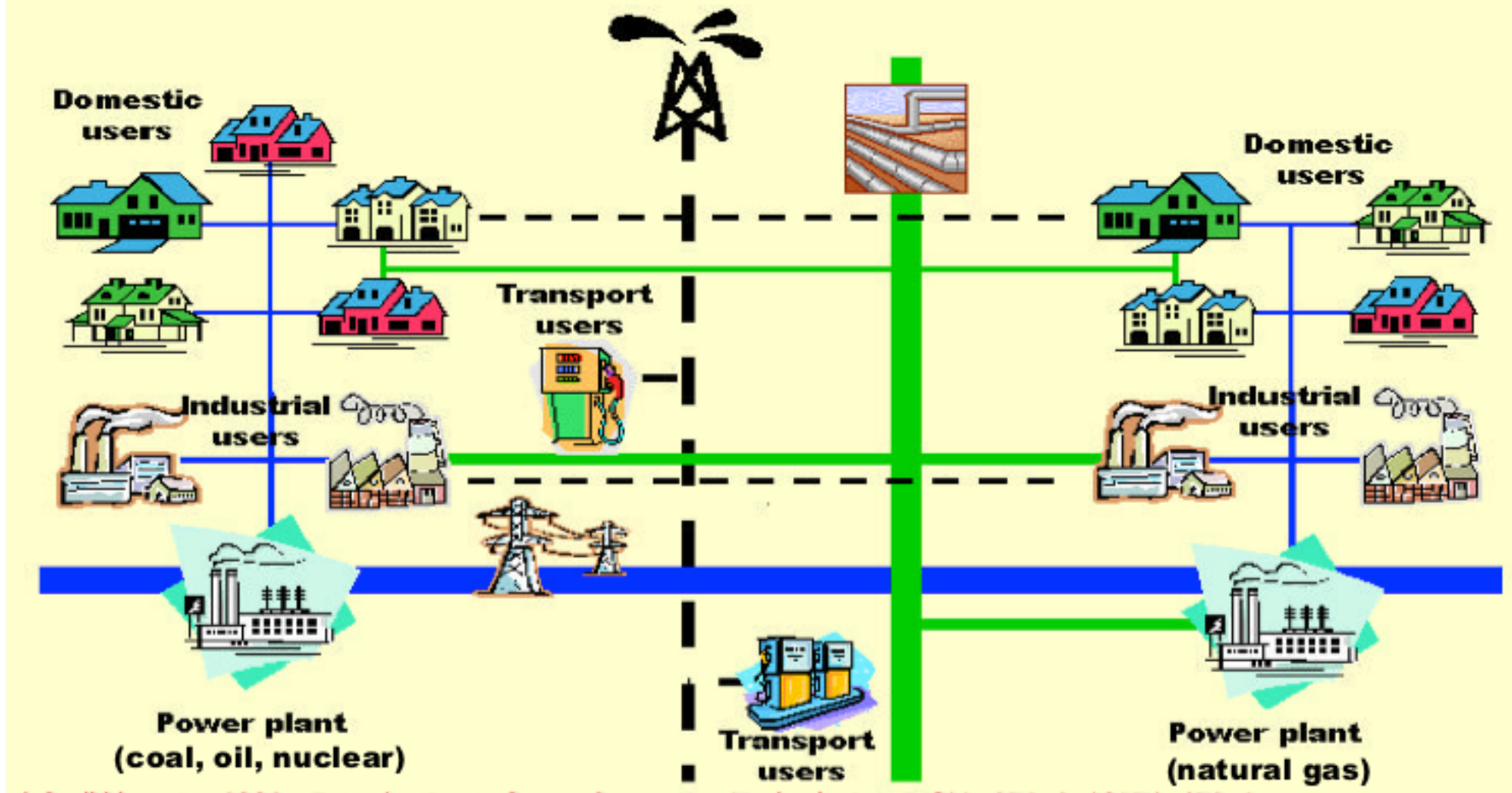
# EU energy objectives

- **greenhouse gas reduction**
- **sustainable production and consumption**
- **competition in electricity and natural gas markets**
- **security of supply**



# Current energy system

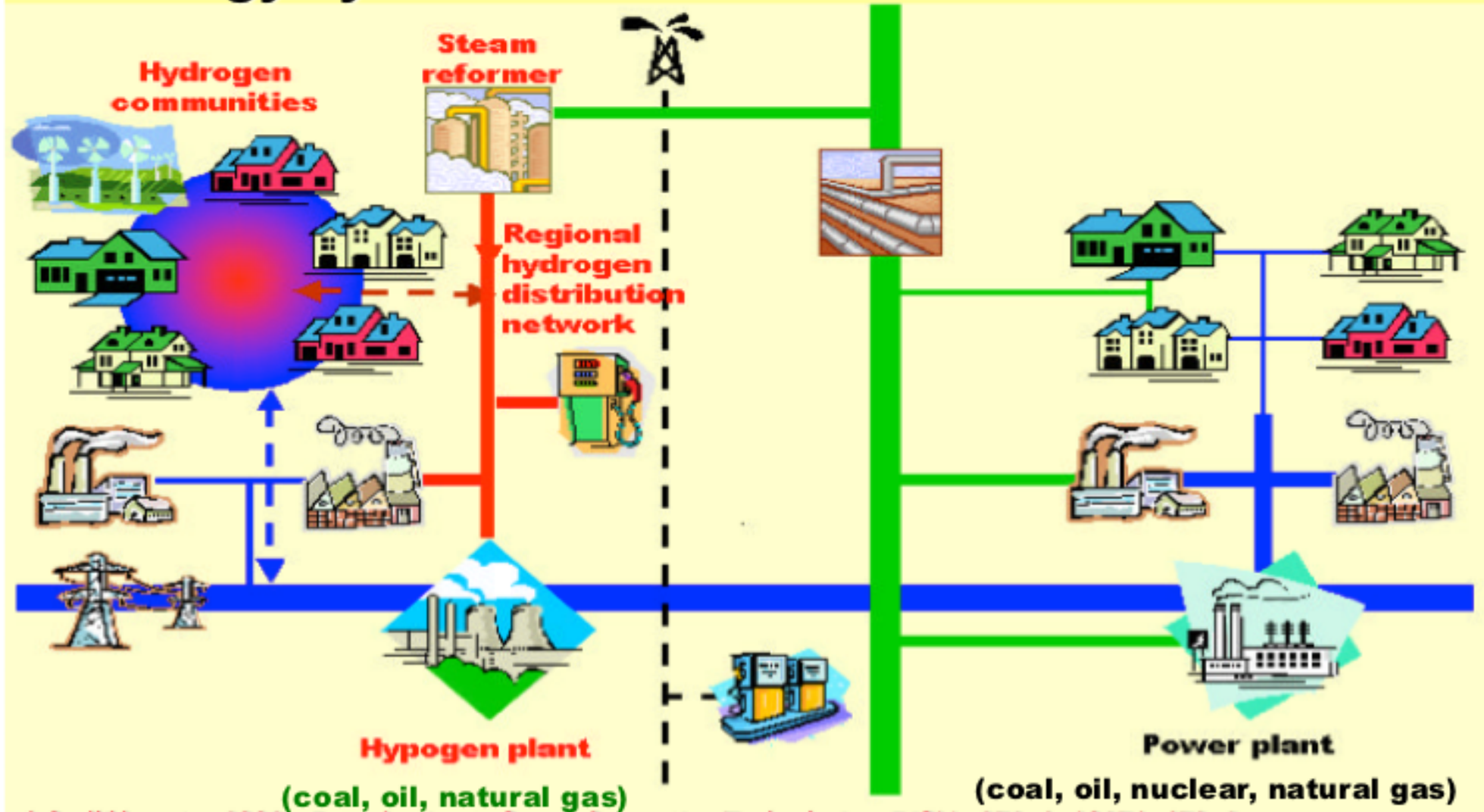
## EU energy system today\*



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

# Future energy systems (optimistic scenario)

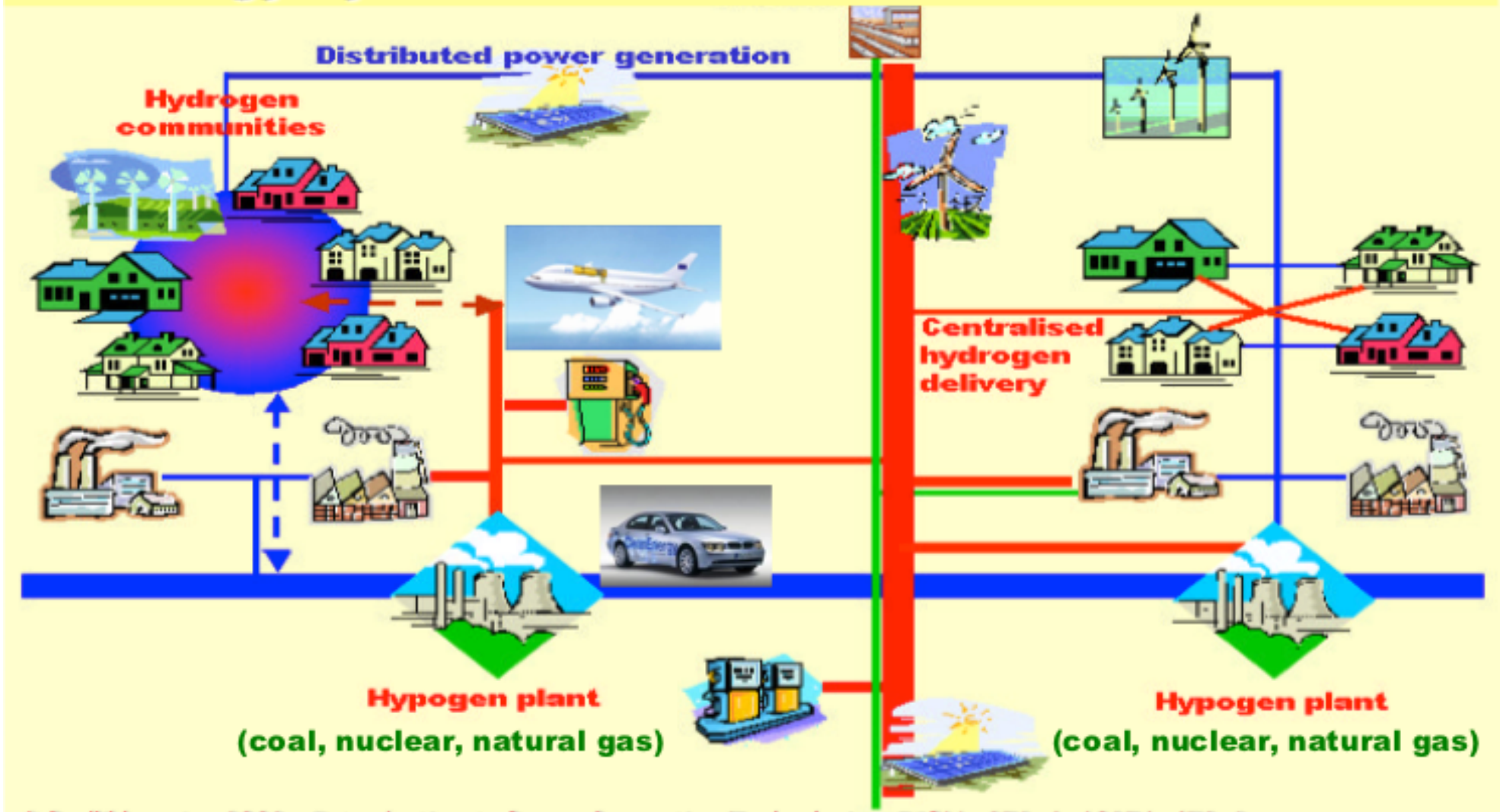
## EU energy system in 2020-30\*



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

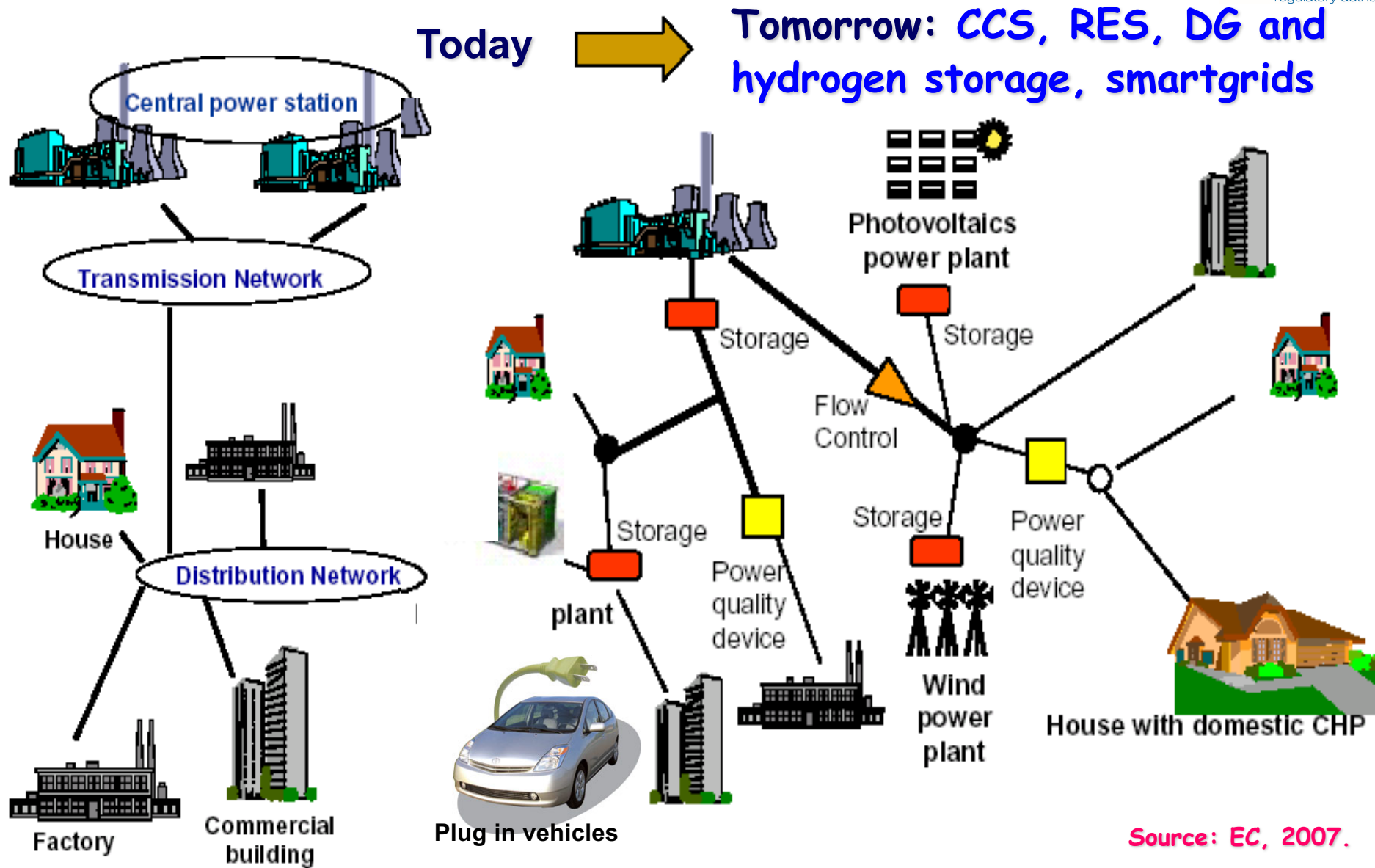
# Future energy systems (optimistic scenario)

## EU energy system in 2040-50\*



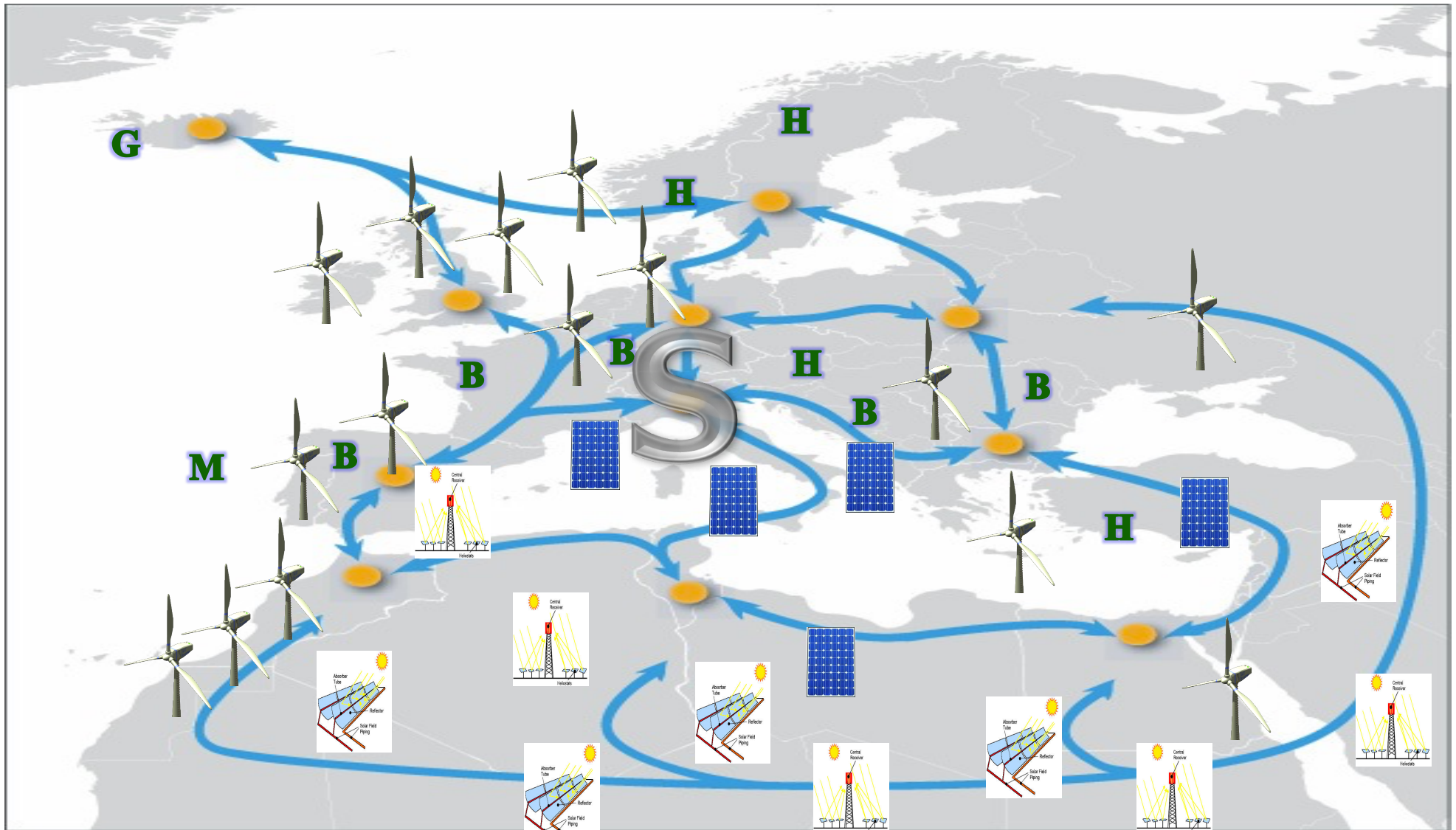
\* Poullikkas A., 2009, *Introduction to Power Generation Technologies*, ISBN: 978-1-60876-472-3

# Future power systems



Source: EC, 2007.

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

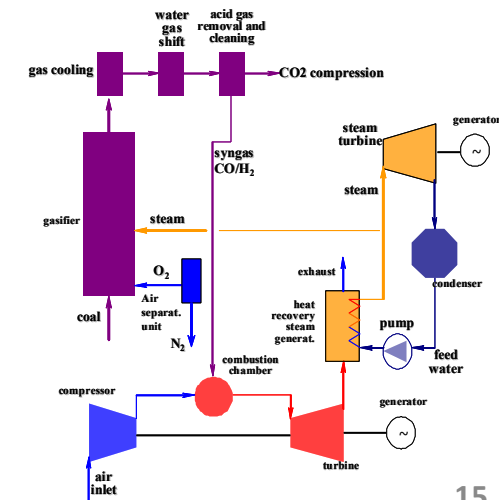


\* Poulikkas A., 2013, *Sustainable Energy Development for Cyprus*, ISBN: 978-9963-7355-3-2

# Long term EU energy strategy (2050)

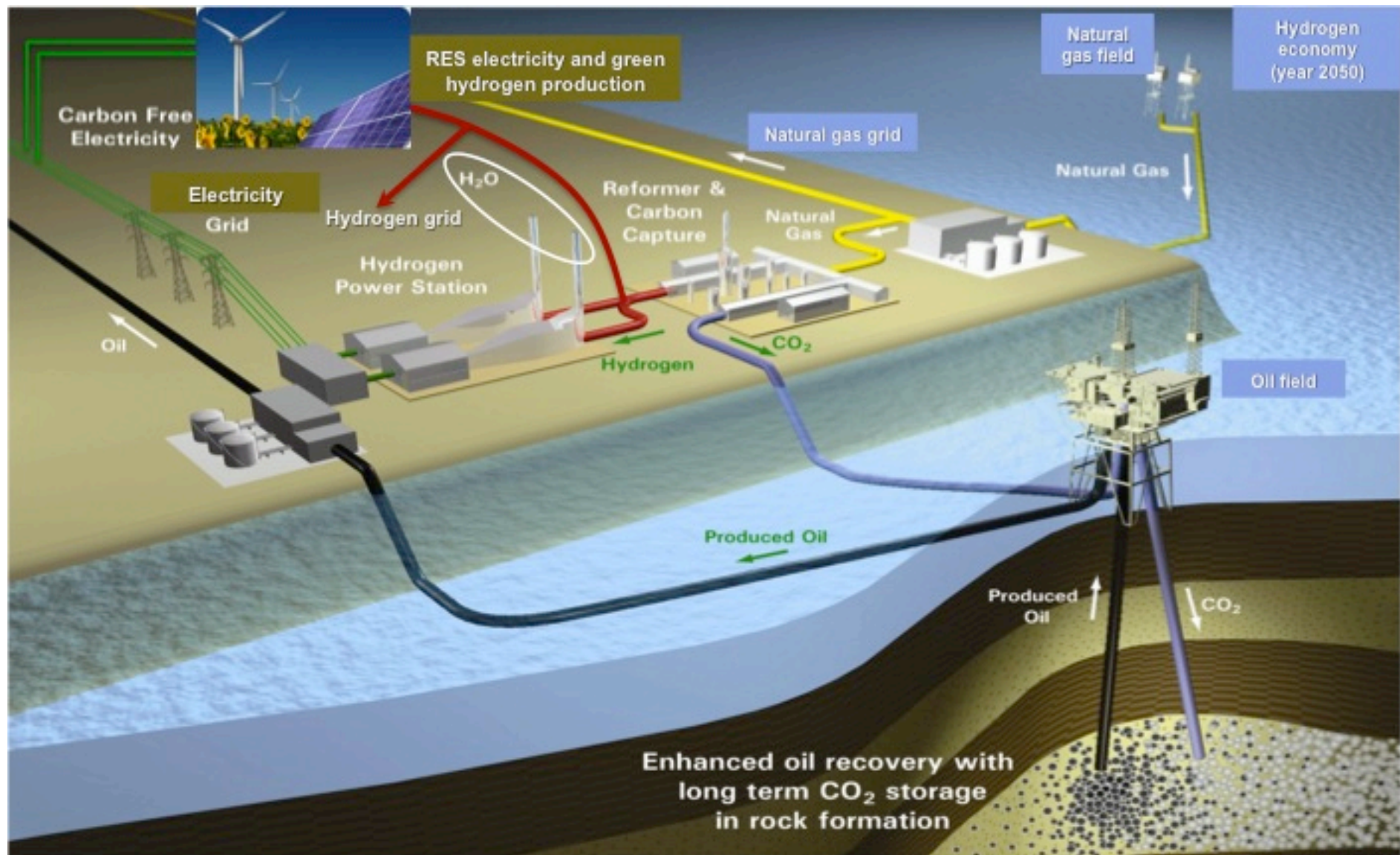
- A vision of carbon free EU
- Main ingredients of future sustainable energy systems:
  - Large scale integration of renewable energy sources
  - Distributed generation
  - Carbon capture and storage
  - Smartgrids
  - Electric vehicles
  - Storage devices
  - Hydrogen

Development of new sustainable technologies and infrastructure





# Towards hydrogen economy in 2050\*



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

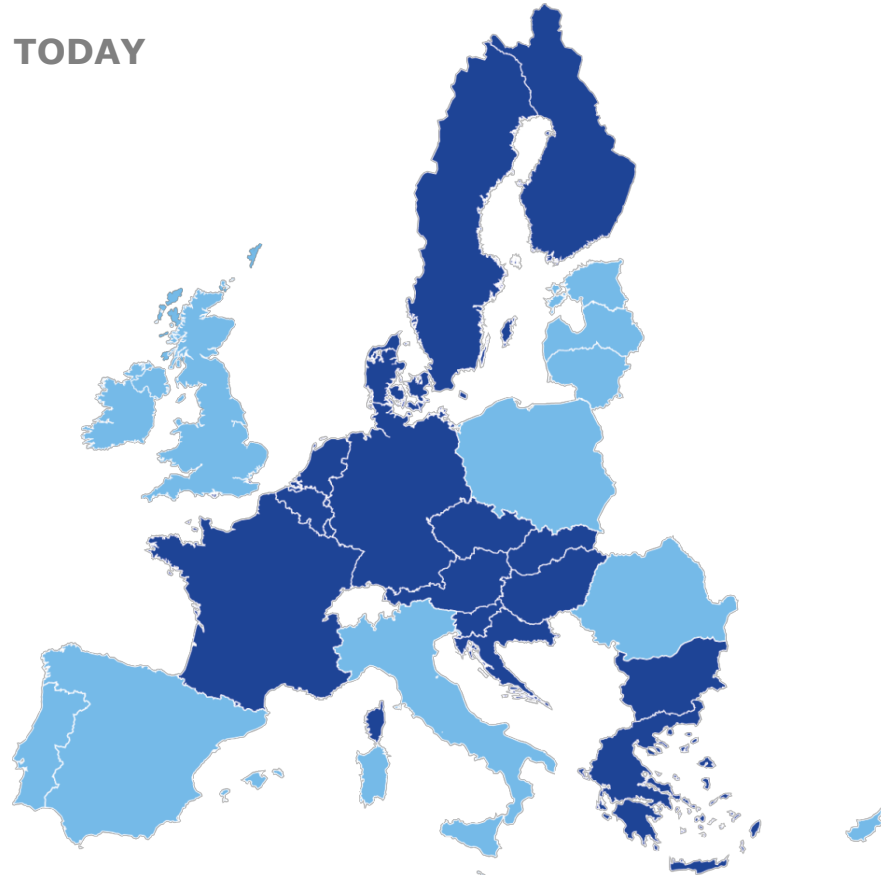
# Ευρωπαϊκή Ενεργειακή Στρατηγική Ενεργειακή Ένωση

# Energy Union

- a binding EU target of at least 40% less greenhouse gas emissions by 2030, compared to 1990
- a binding target of at least 27% of renewable energy use at EU level
- an energy efficiency increase of at least 27%
- the completion of the internal energy market by reaching an electricity interconnection target of 15%
- increase energy security (natural gas South Corridor)

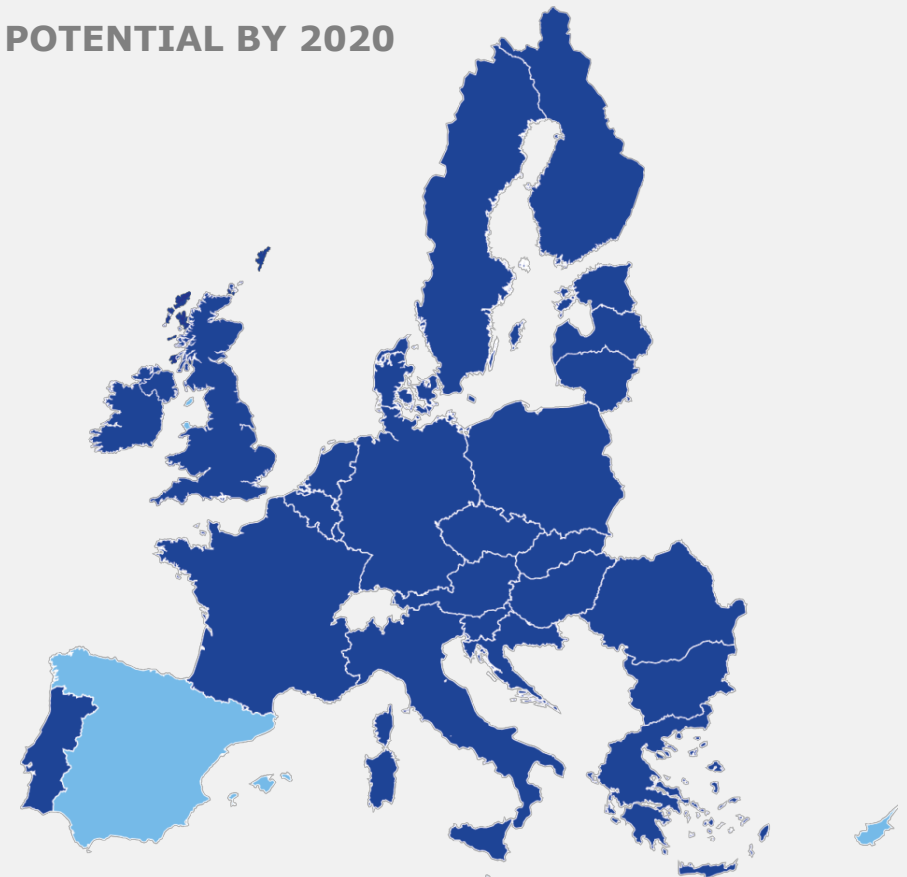
# Connecting electricity markets

TODAY



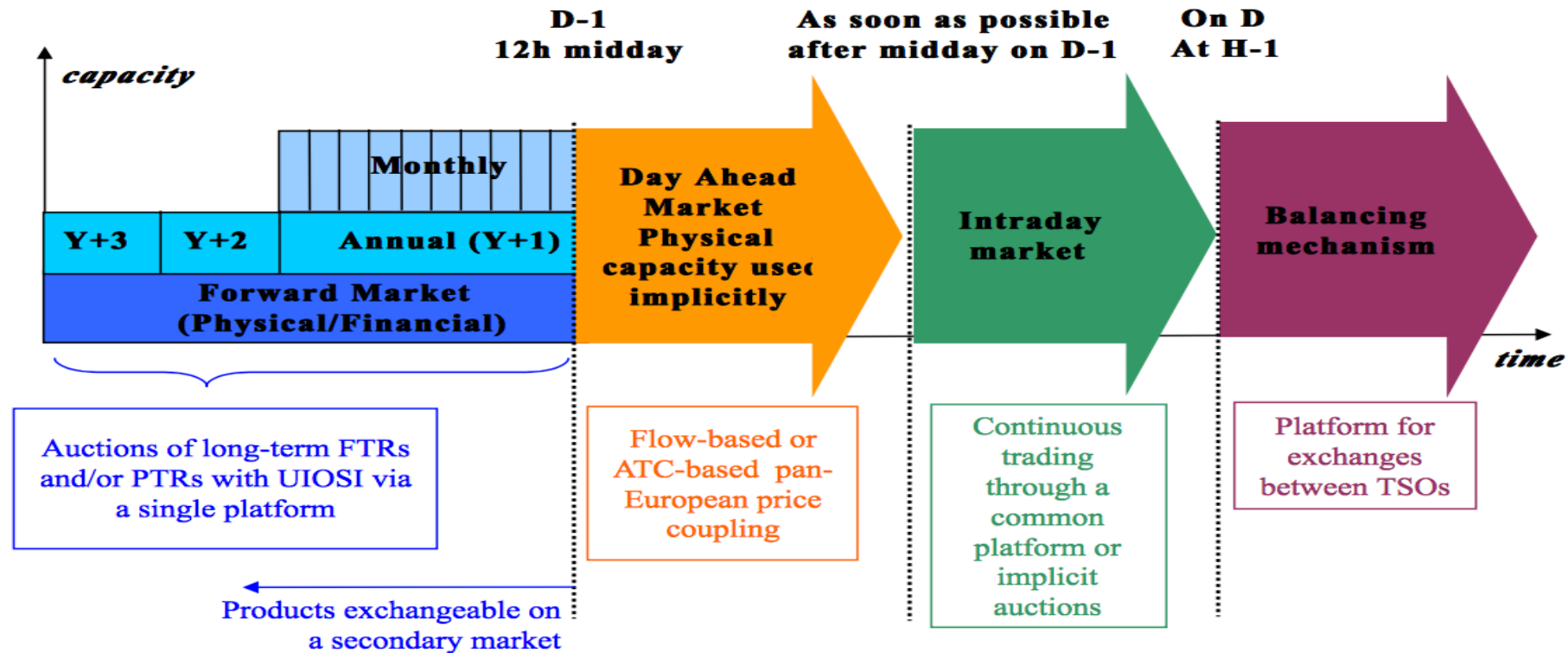
- Countries meeting the 10% **interconnection** target
- Countries not meeting the 10% **interconnection** target

POTENTIAL BY 2020



**Efforts need to be stepped up for those below the 10% target by 2020, mainly Spain and Cyprus, and in view of achieving the 15% target by 2030.**

# EU electricity market target model



# Key aims of recent Winter Package

- **To establish a common power market design across EU and to ensure the adequacy power systems**
- **To promote the better integration of electricity produced from RES into the market**
- **To advance energy efficiency, energy cleanliness and energy performance**
- **To implement rules on the governance of the Energy Union**

# Προκλήσεις στην αγορά ηλεκτρισμού

# What is a power system?

- **Largest and most complex manmade system**
- **Electrical power is somewhat like the air we breath**
  - **We think about it only when it is missing**
- **PS should be operated with the goal of achieving:**
  - **Highest reliability standards**
  - **Lowest operation cost**
  - **Minimum environmental impacts**



# Electricity market complexities\*

- **Energy market**
- **Power market (flow of energy)**
- **Ancillary services market**
  - Reserve (spinning, cold, primary, etc.)
  - Voltage regulation
  - Frequency regulation, etc.

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

# Electricity market functions

- **Generation** (competition)



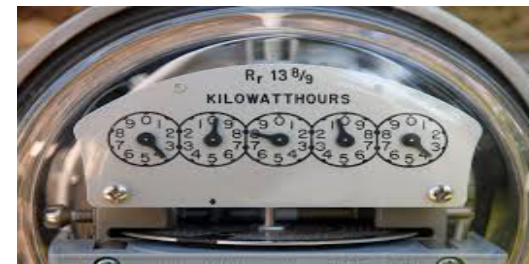
- **Transmission** (monopoly)



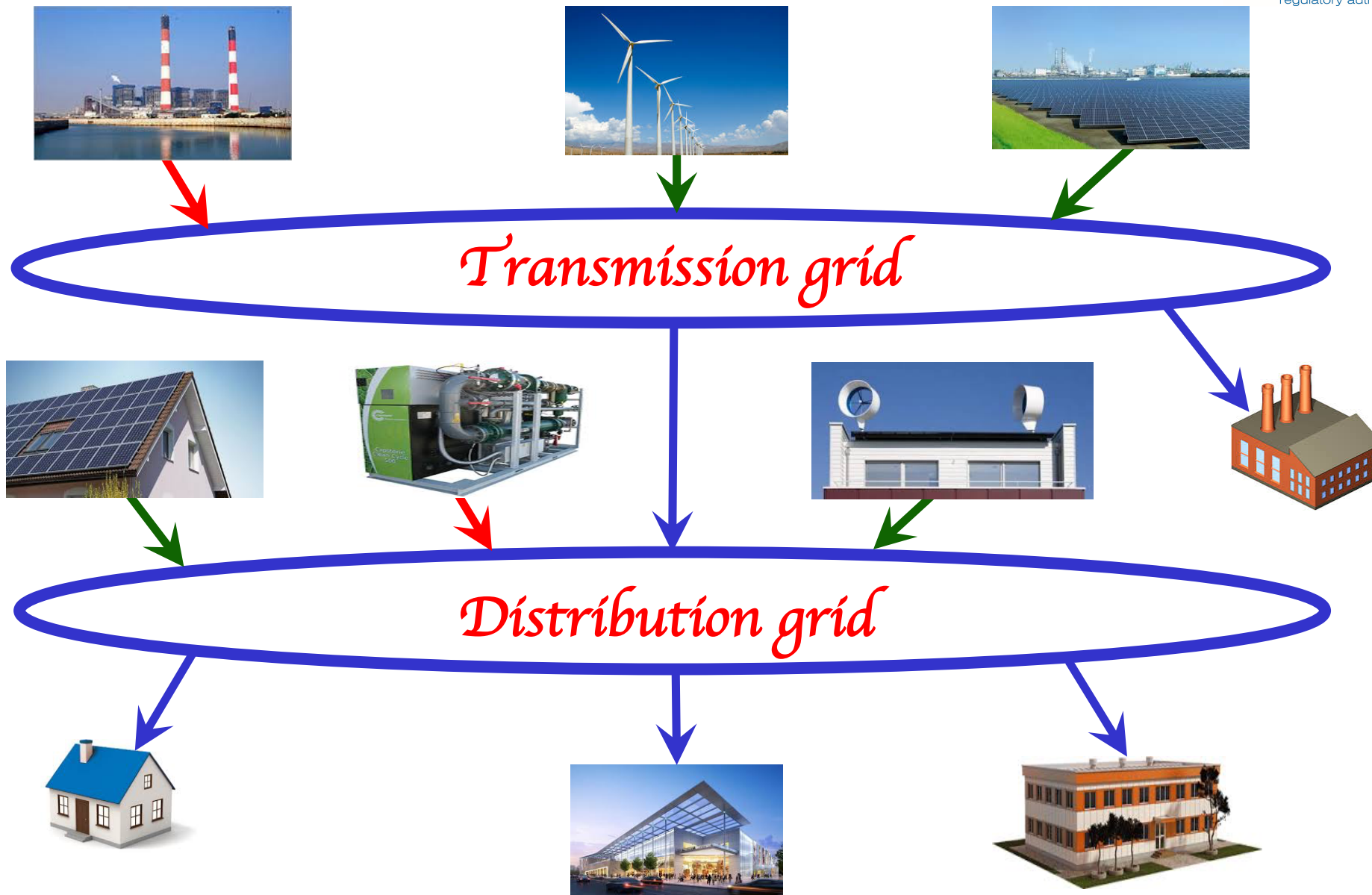
- **Distribution** (monopoly)



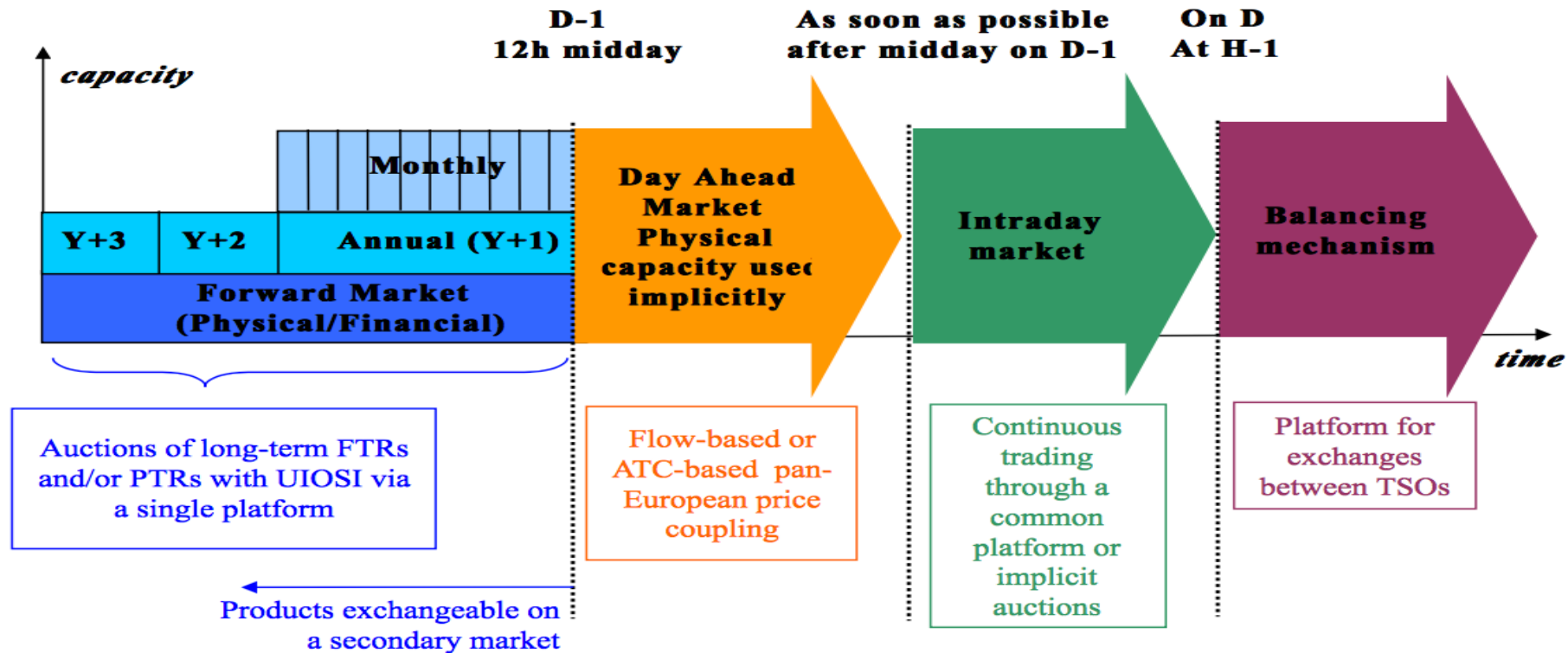
- **Supply** (competition)



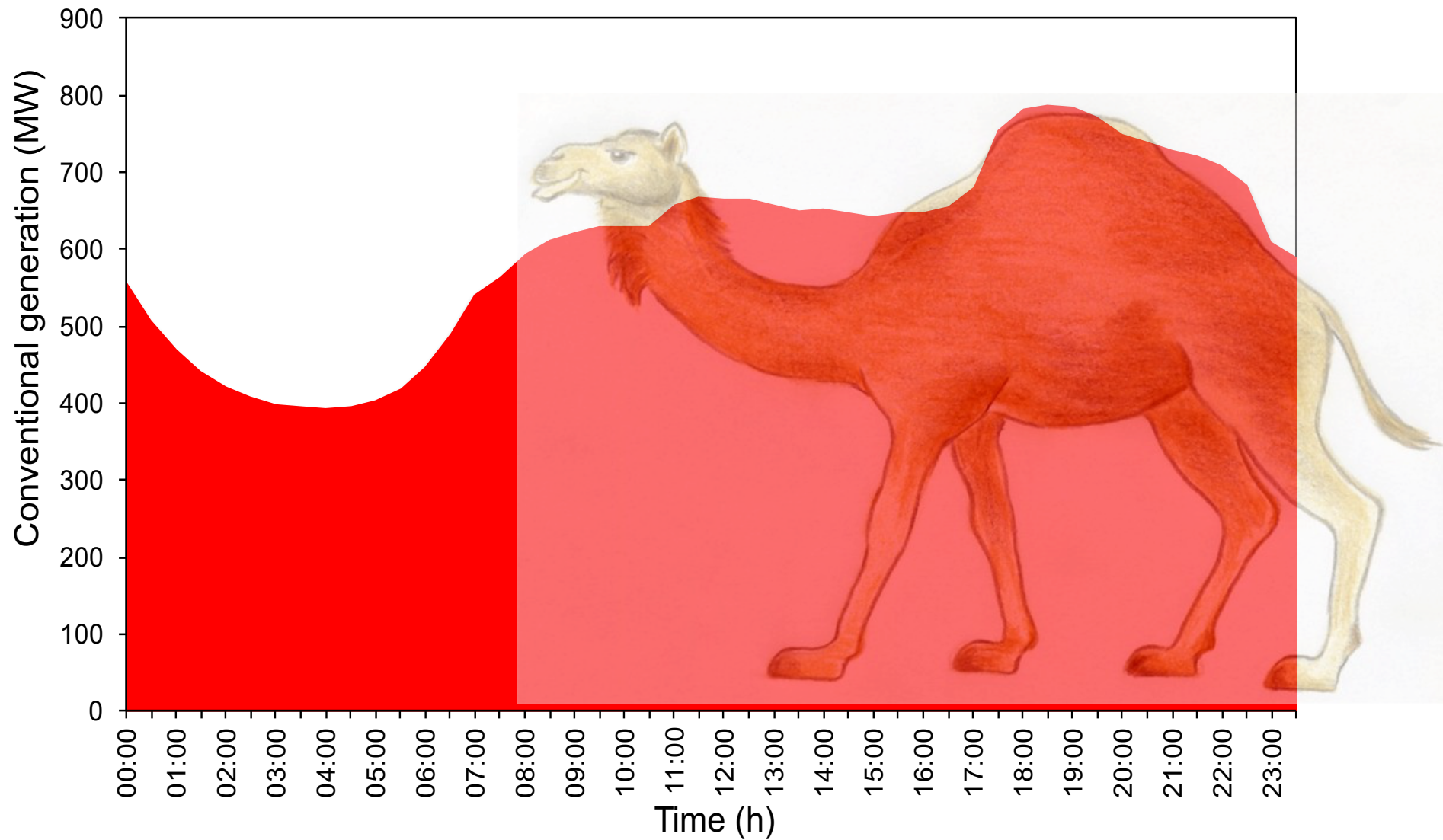
# Competition vs monopoly



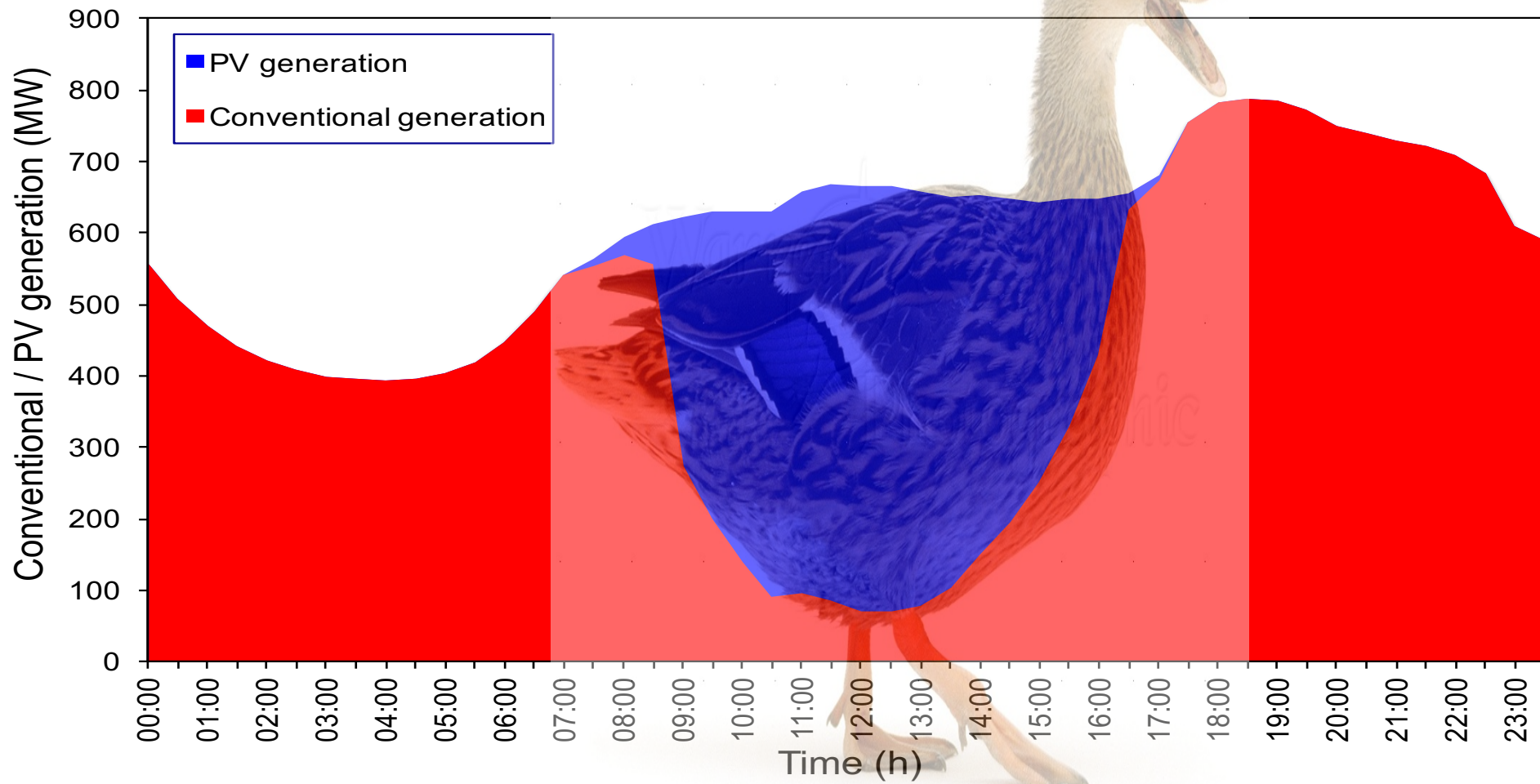
# EU electricity market target model



# Daily load curve (the 'camel curve')

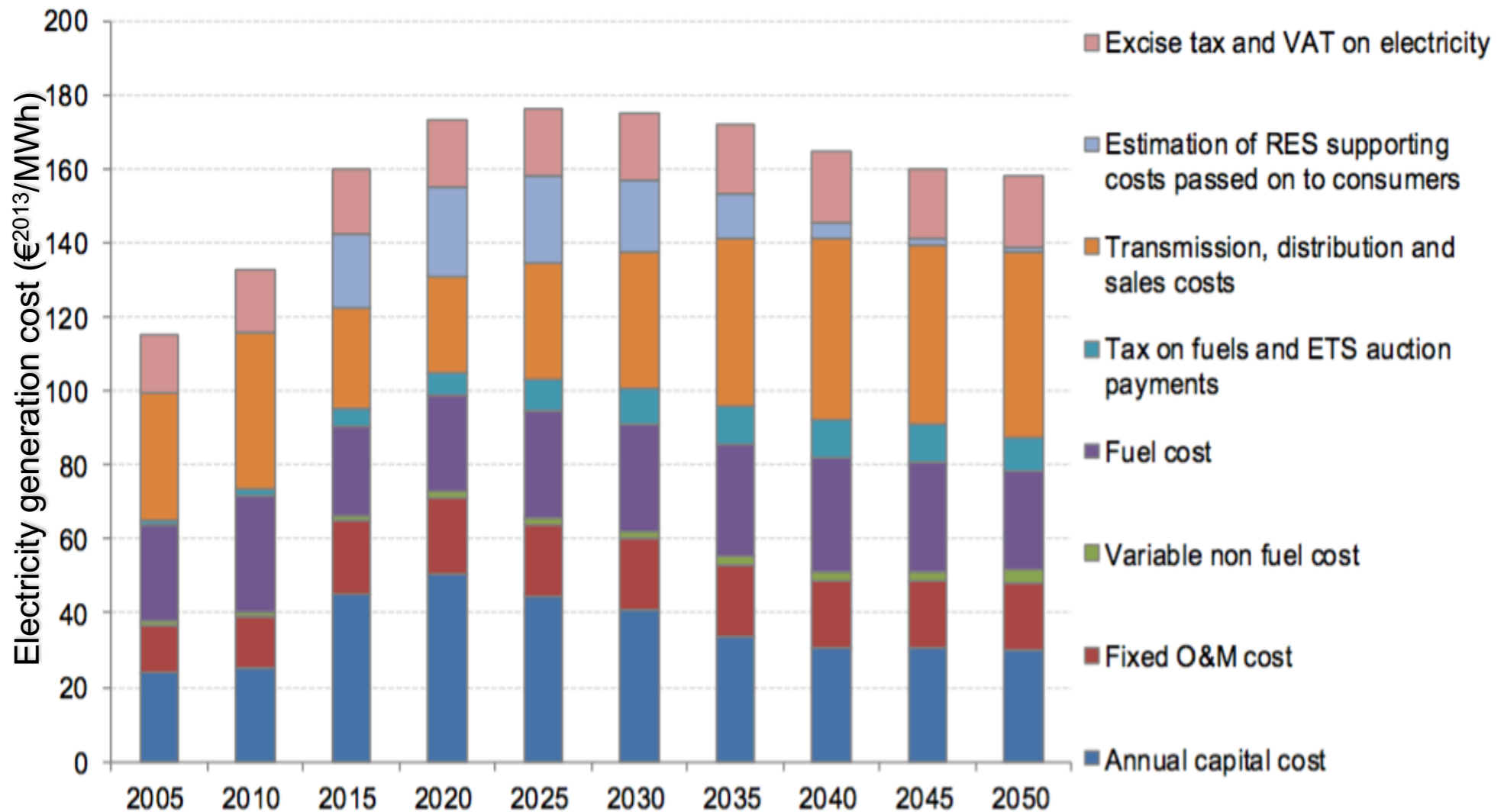


# Effect of PV generation on load curve (the 'duck curve')



# Ενεργειακό Κόστος

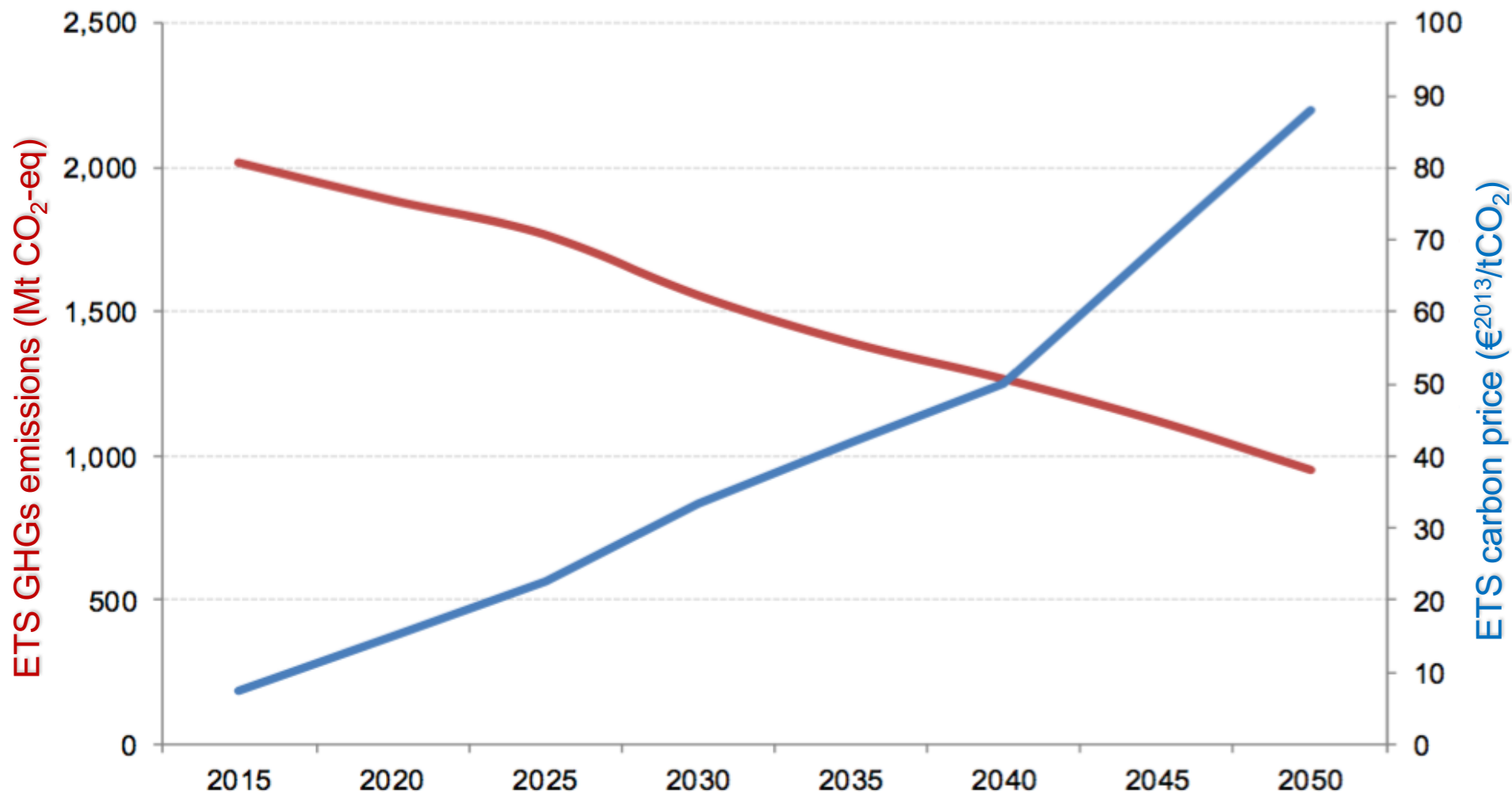
# EU reference scenario 2016



Source: PRIMES

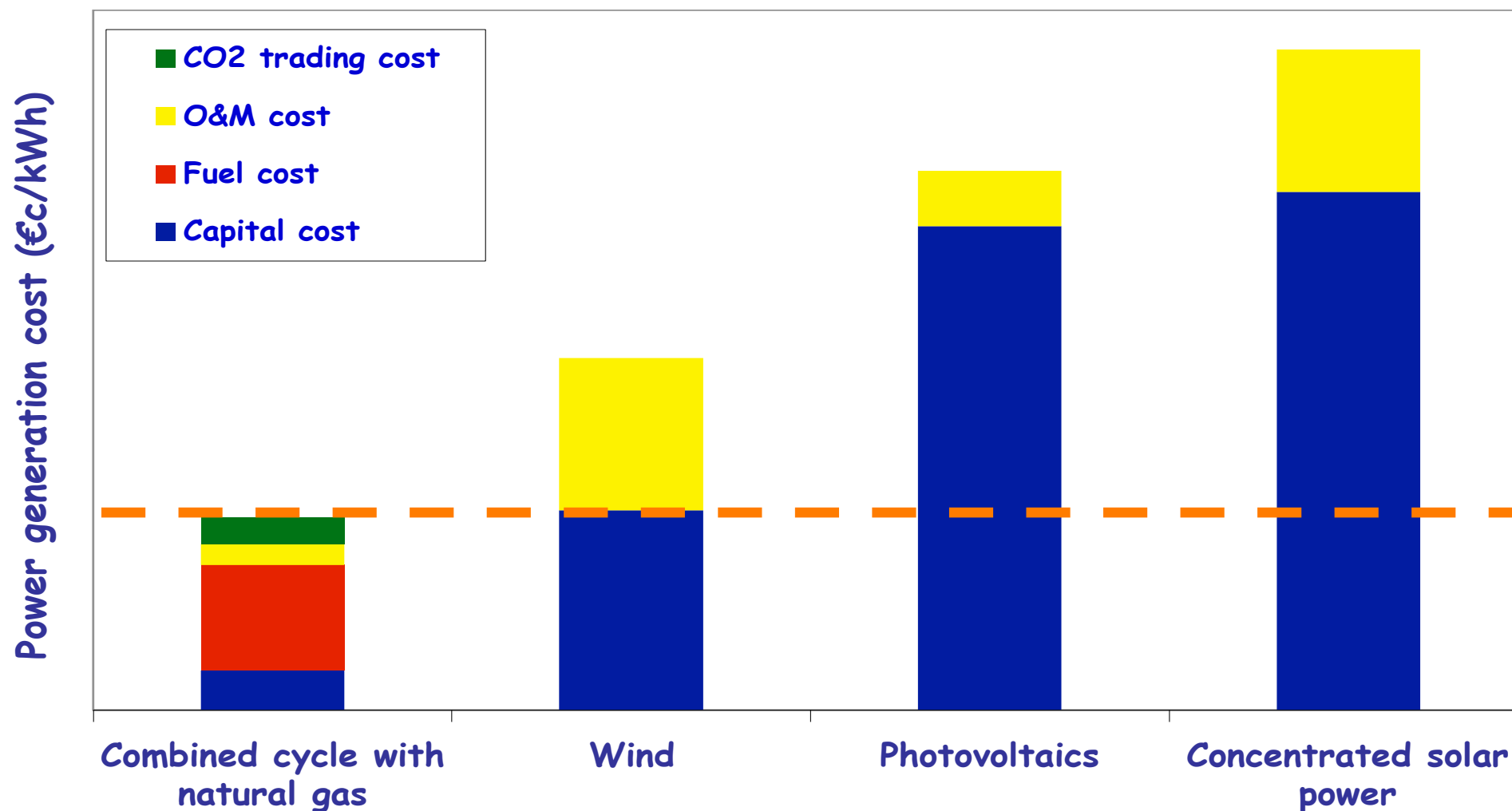


# EU reference scenario 2016



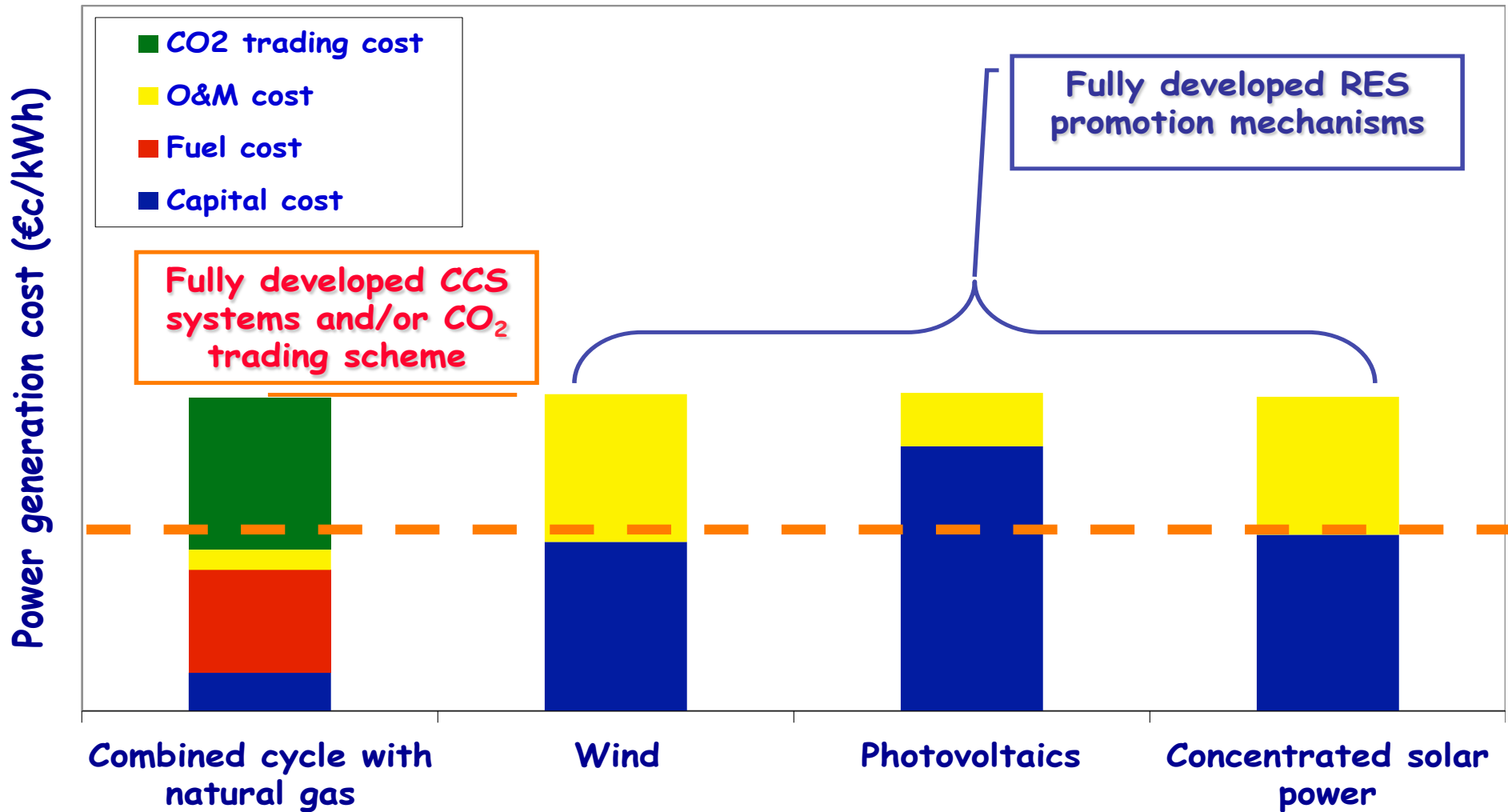
Source: PRIMES, GAINS

# Power generation cost (year 2010)\*



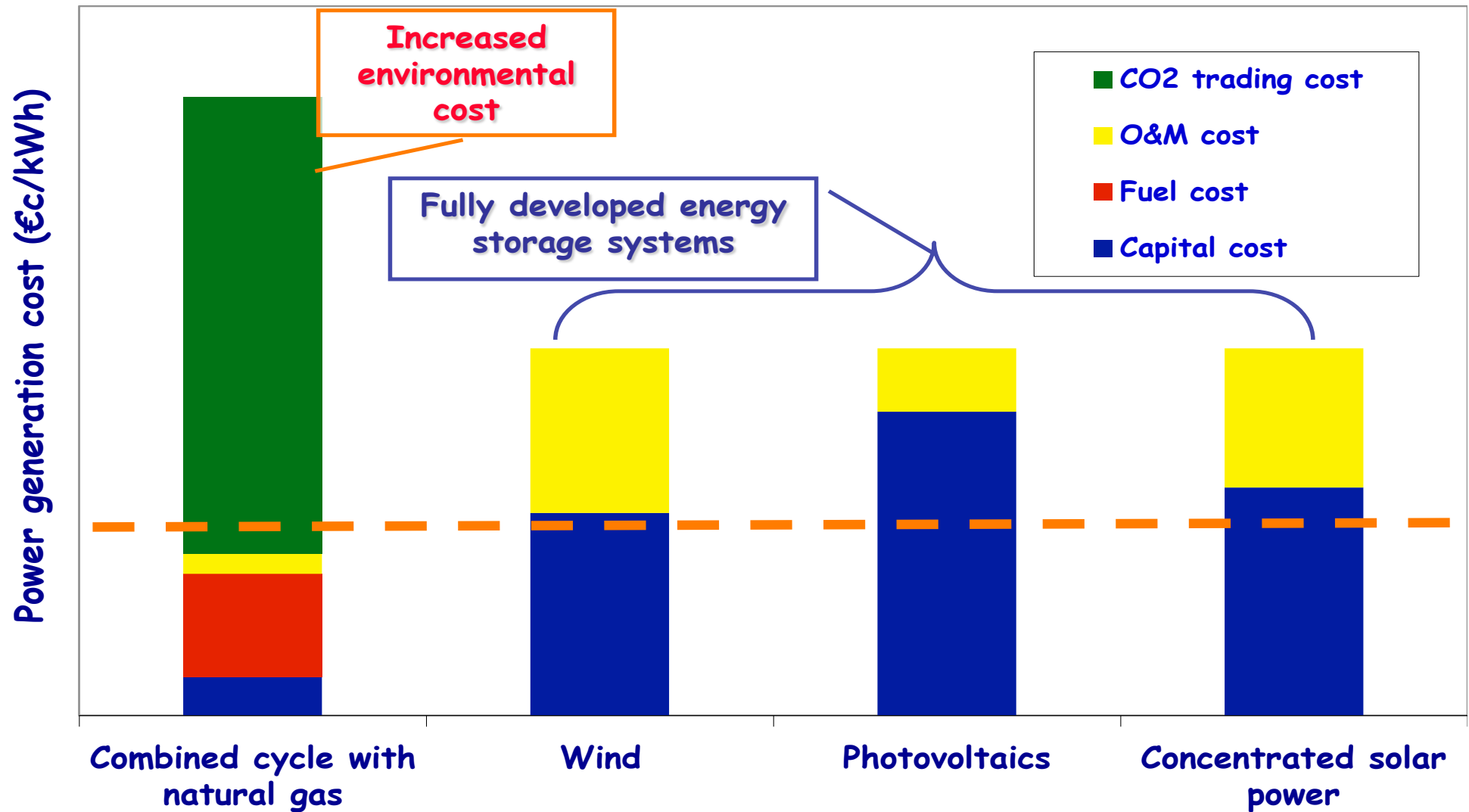
\* Poullikkas A., 2010, "The cost of integration of renewable energy sources", Accountancy

# Power generation cost (year 2020-30)\*



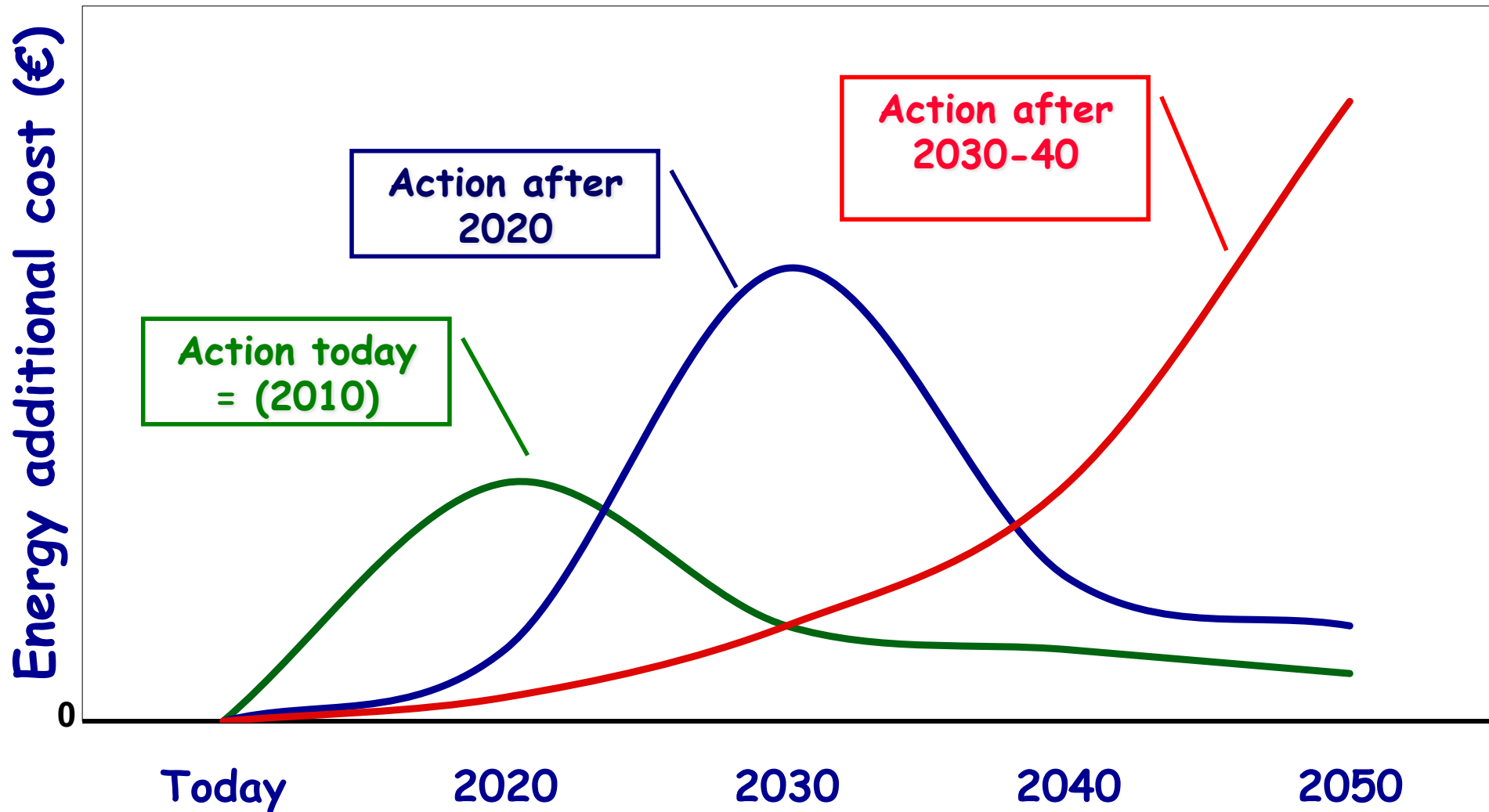
\* Poullikkas A., 2010, "The cost of integration of renewable energy sources", Accountancy

# 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*