Tackling the energy and climate crises: Striving for a greener Europe with energy security

Dr. Andreas Poullikkas

M.Phil, Ph.D, D.Tech, FIET

Chairman, Cyprus Energy Regulatory Authority

apoullikkas@cera.org.cy

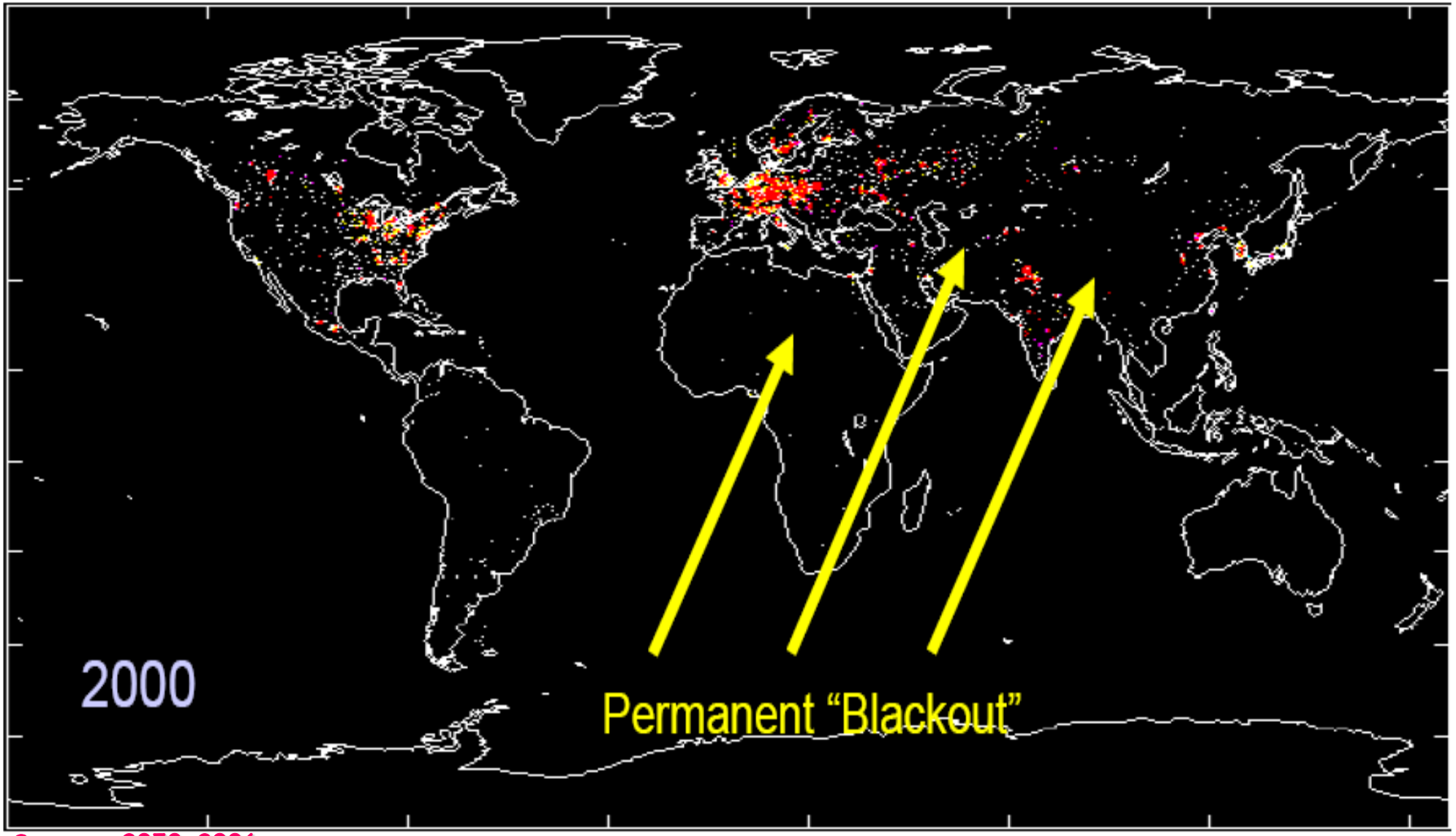
Contents

- **Climate change** – towards sustainability
- **EU energy strategy** – towards 2050
- **RePowerEU plan** – phase out dependency on Russian fossil fuels
- **Short to medium term challenges** – large scale integration of RES
- **Long term scenarios** – from carbon economy to hydrogen economy
- **Development of optimization algorithms** – advance simulation tools

Climate change

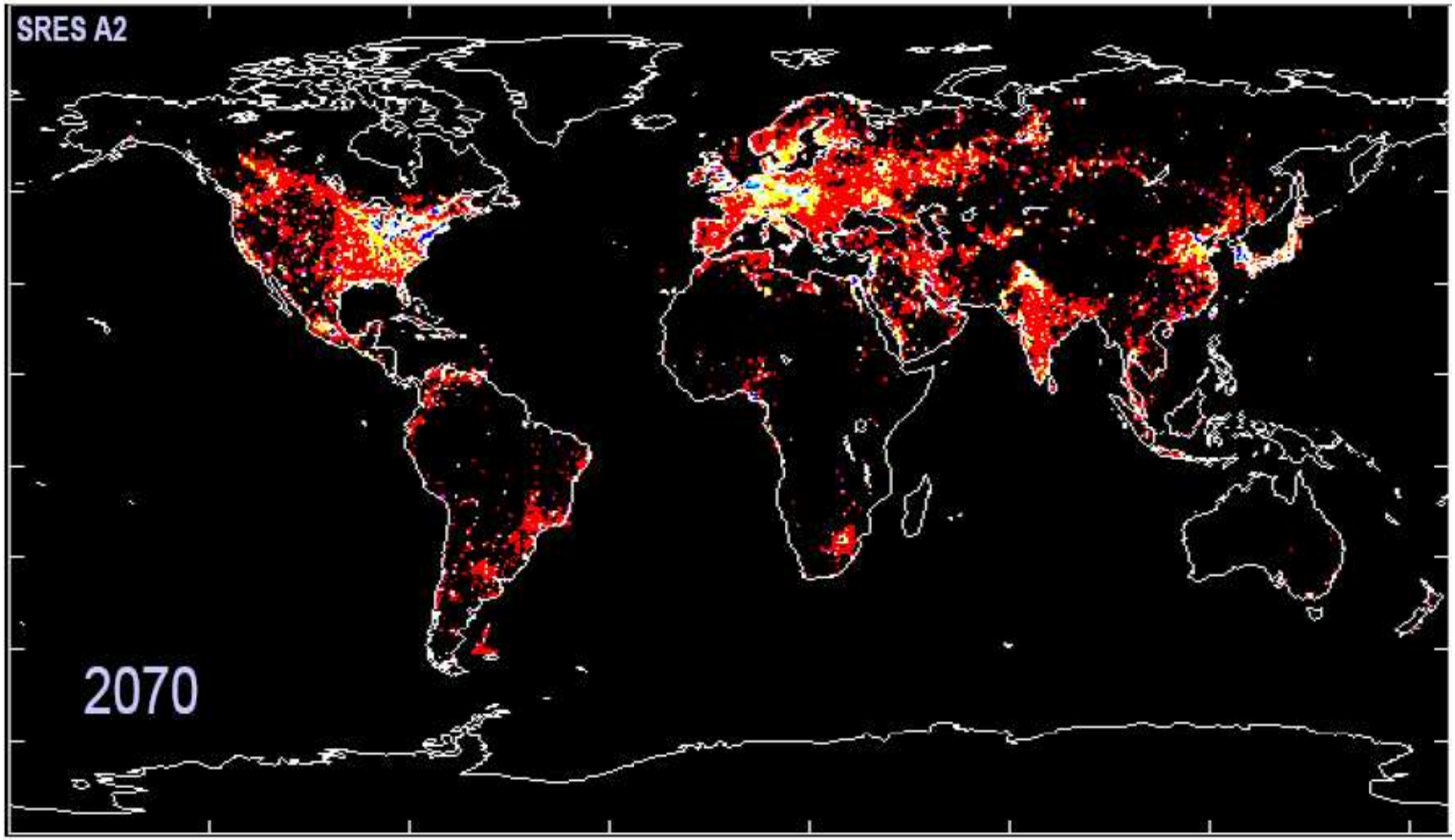
towards sustainability

Night lights in 2000



Source: e2050, 2006.

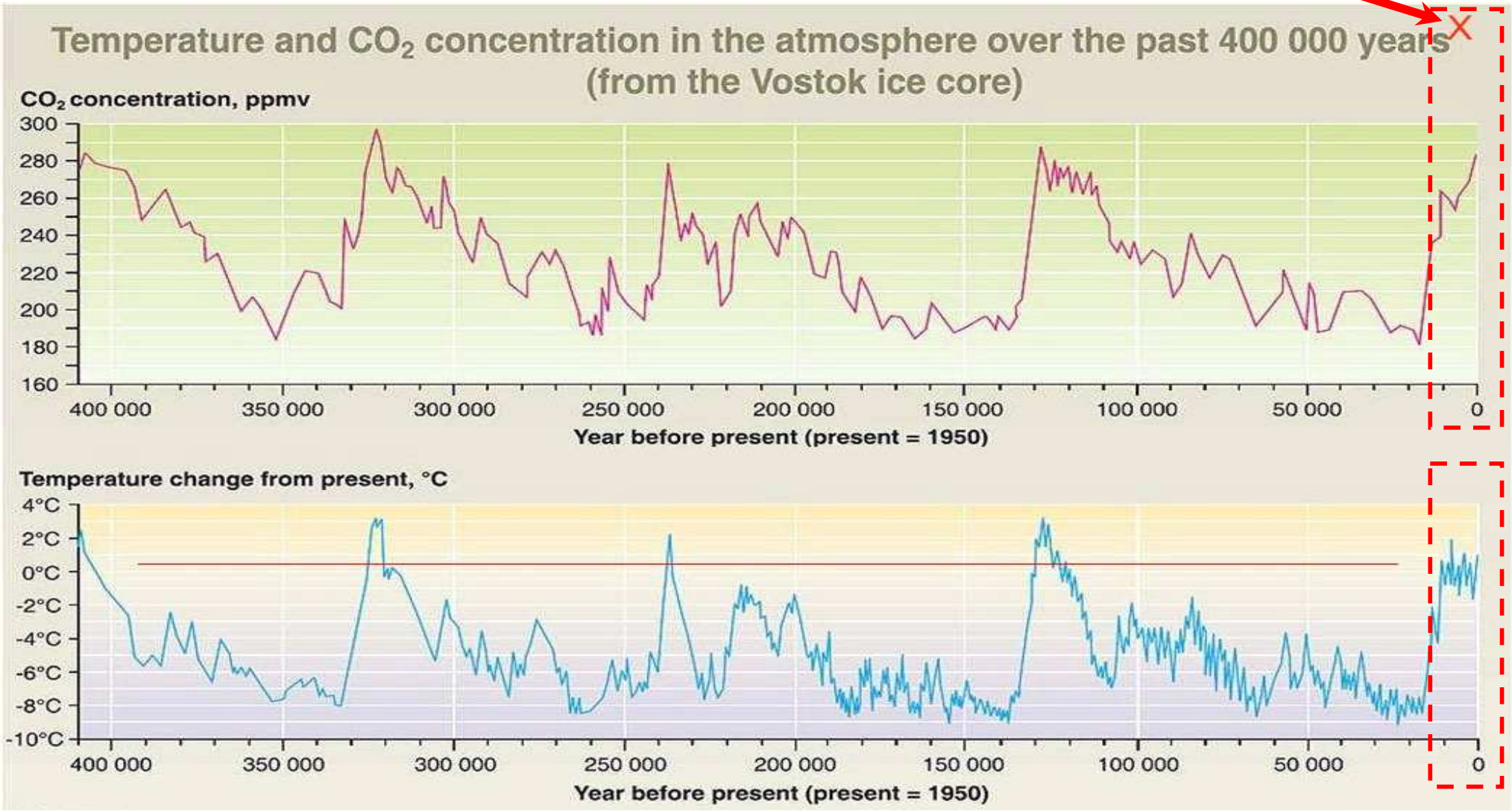
Night lights in 2070



Source: e2050, 2006.

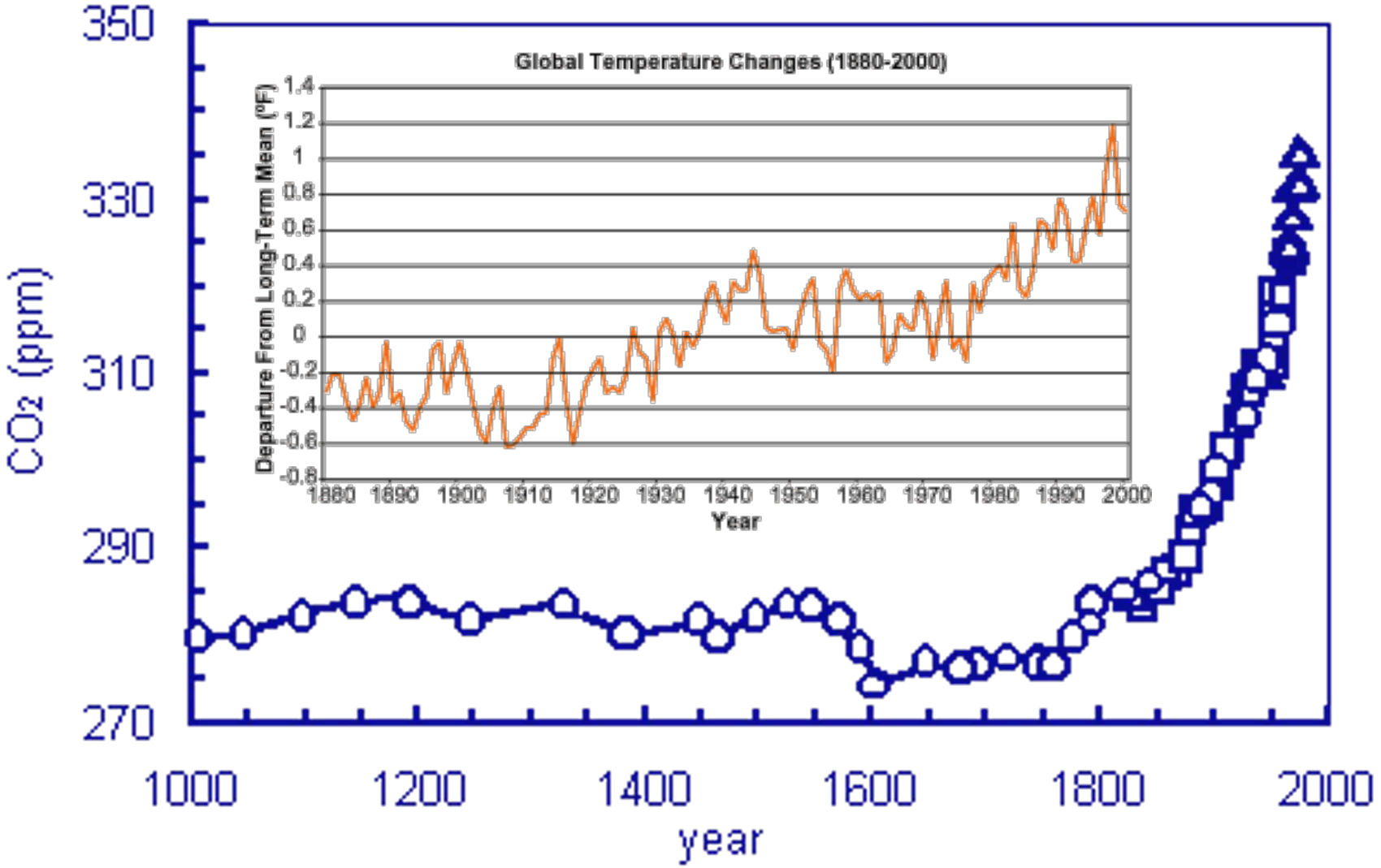
Global warming

today !



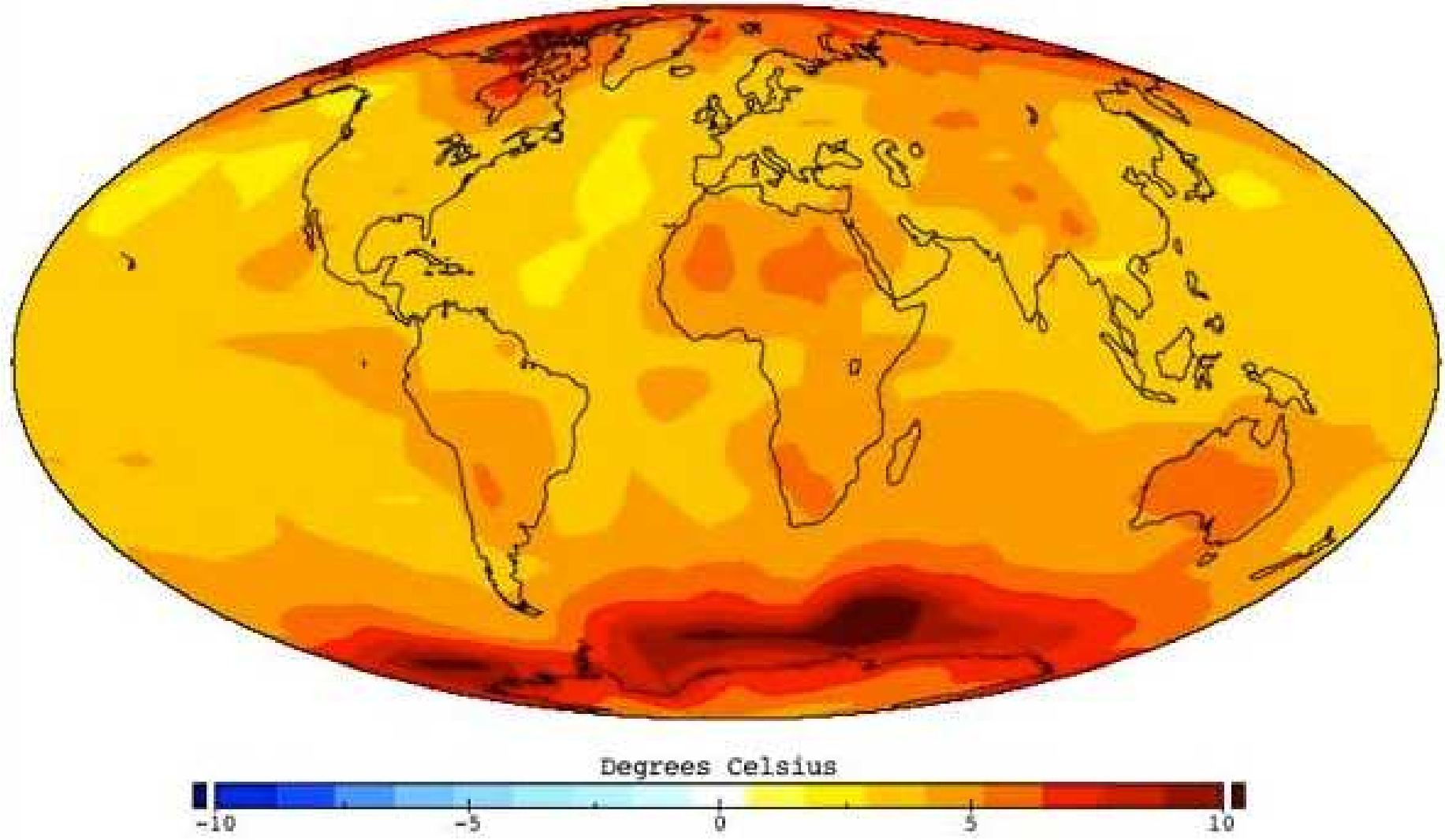
Source: J.R. Petit *et al*, Nature, 1999.

Global warming



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

Increase of Earth global temperature 1960-2060



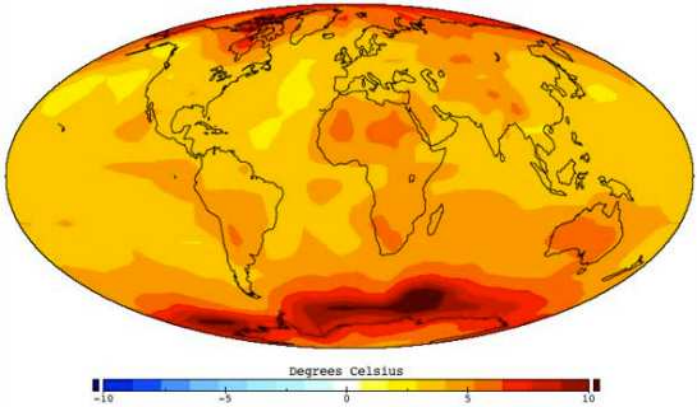
Source: NASA, 2010.

EU energy strategy

towards 2050

Future energy systems

- **Climate change**



- **Third energy revolution**

- **Future energy economics**

Energy transition

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

Sustainable energy

… provision of energy that meets the needs of the present without compromising the ability of future generations to meet their needs …

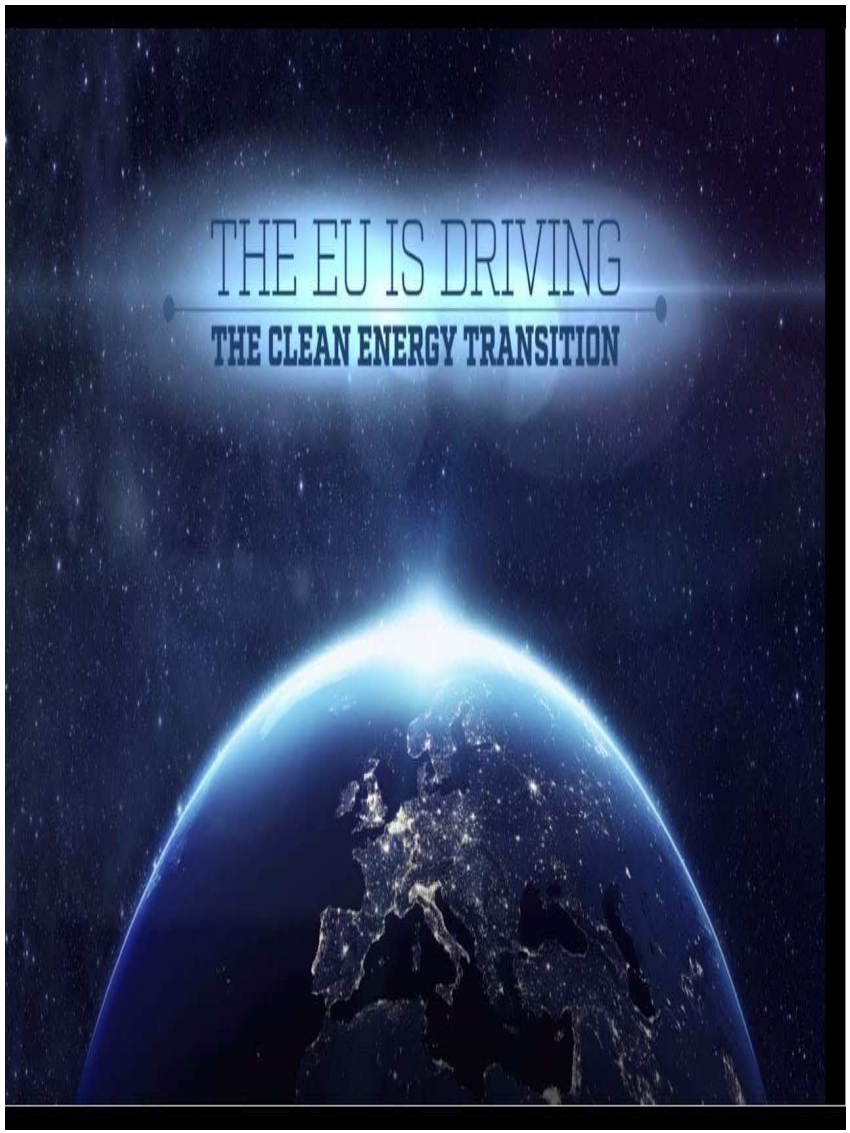
Sustainable technologies

… technologies that promote sustainable energy include renewable energy sources as well as technologies designed to improve energy efficiency …

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

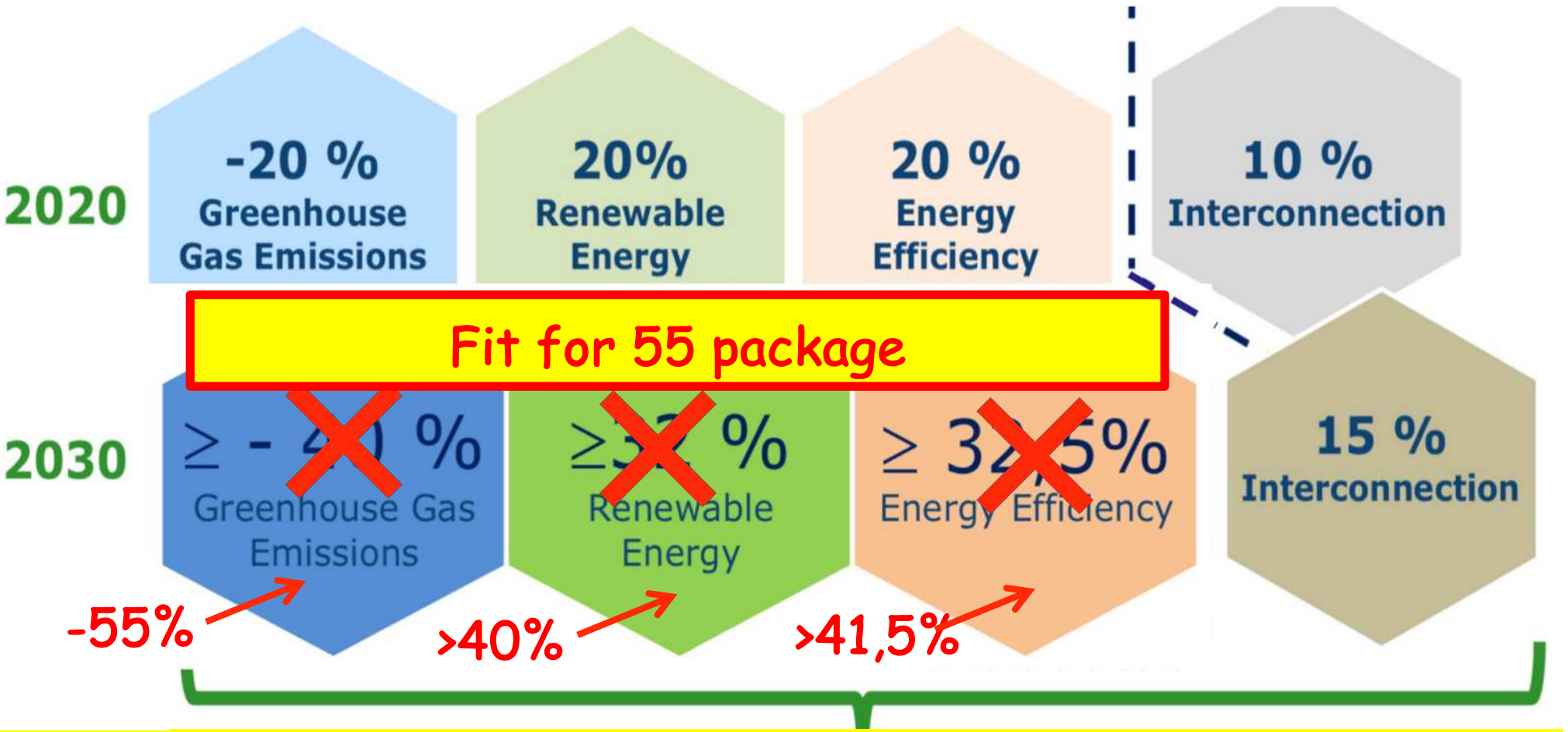
The EU Green Deal and Fit-for-55

…to reach our targets in a:

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

way…

EU medium and long term targets



2050 **Climate-Neutral**

(an economy with net-zero greenhouse gas emissions)

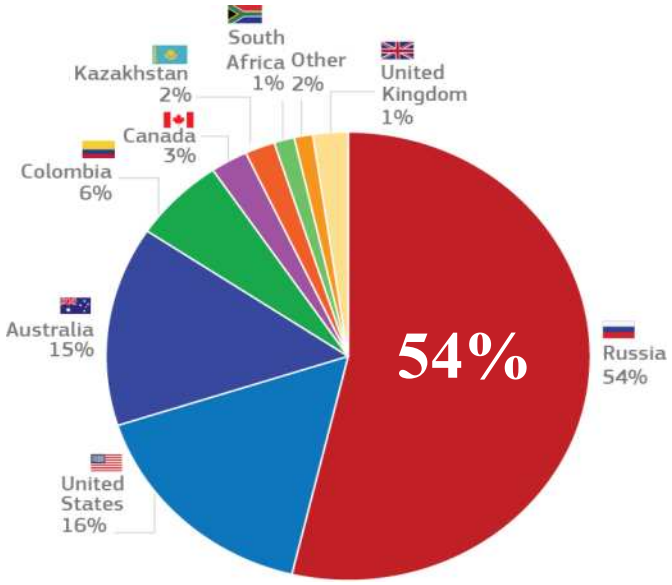
RePowerEU plan

phase out dependency on Russian fossil fuels

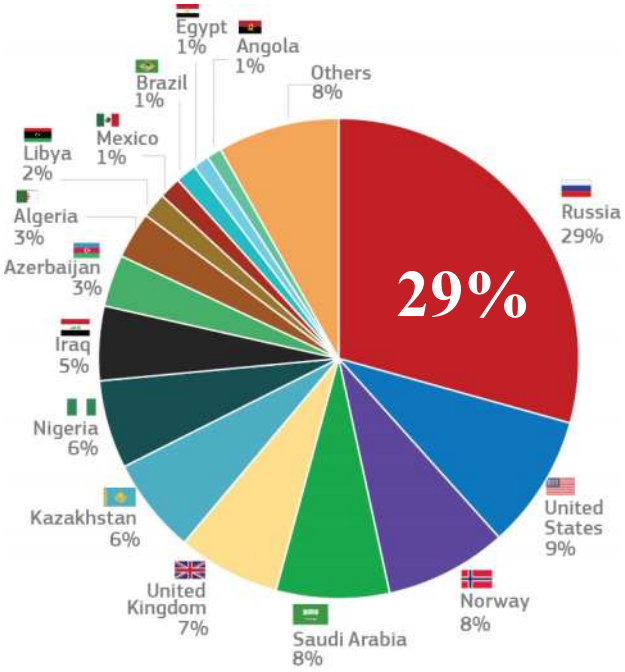
EU energy import dependency on Russia (year 2021)

ρυθμιστική αρχή ενέργειας κύπρου
cyprus energy regulatory authority

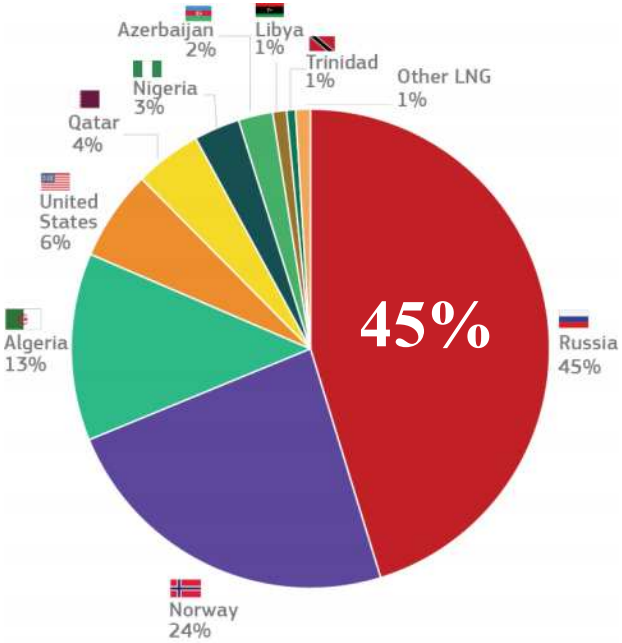
Coal



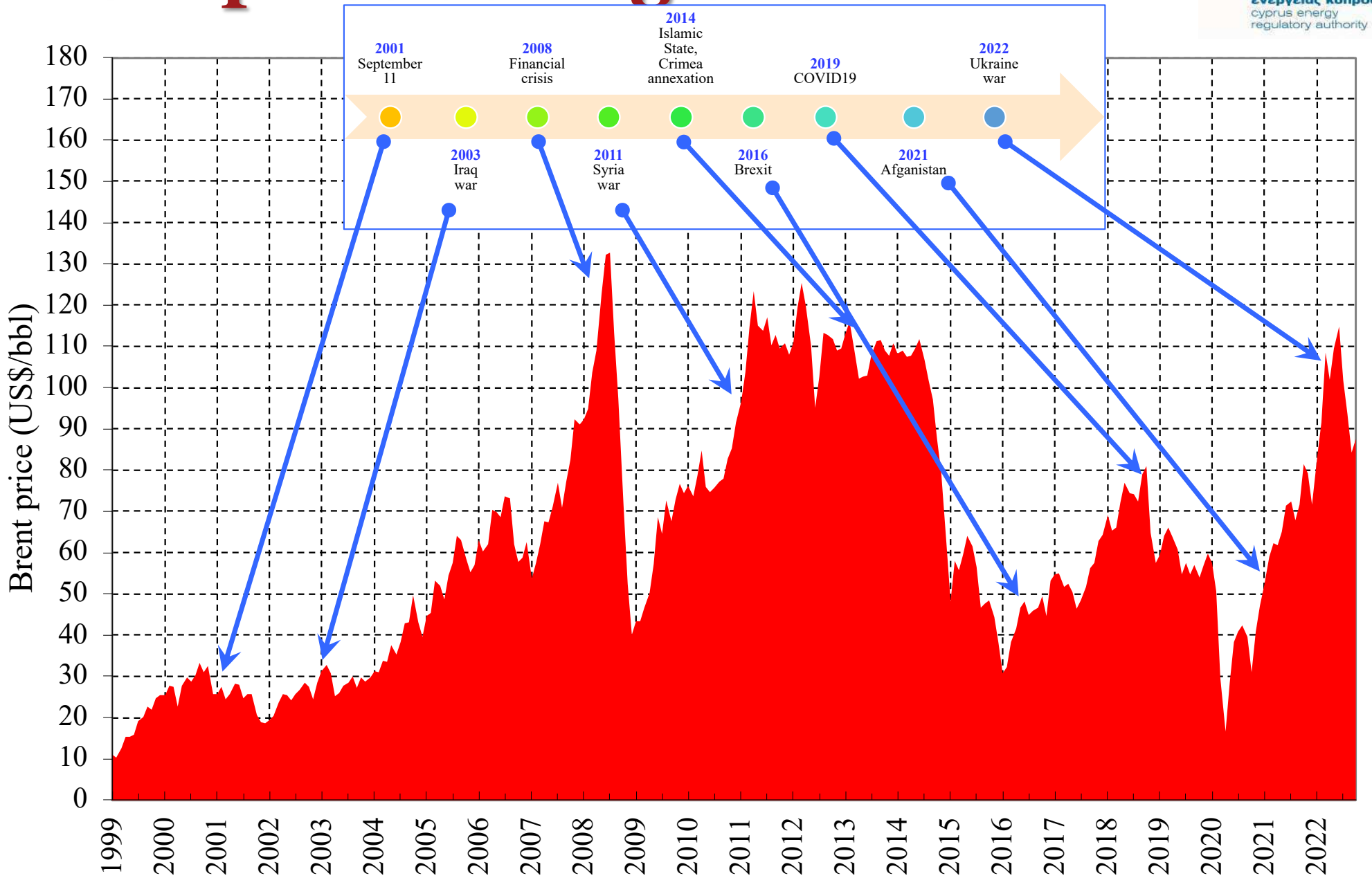
Oil



Natural gas
(pipe and LNG)

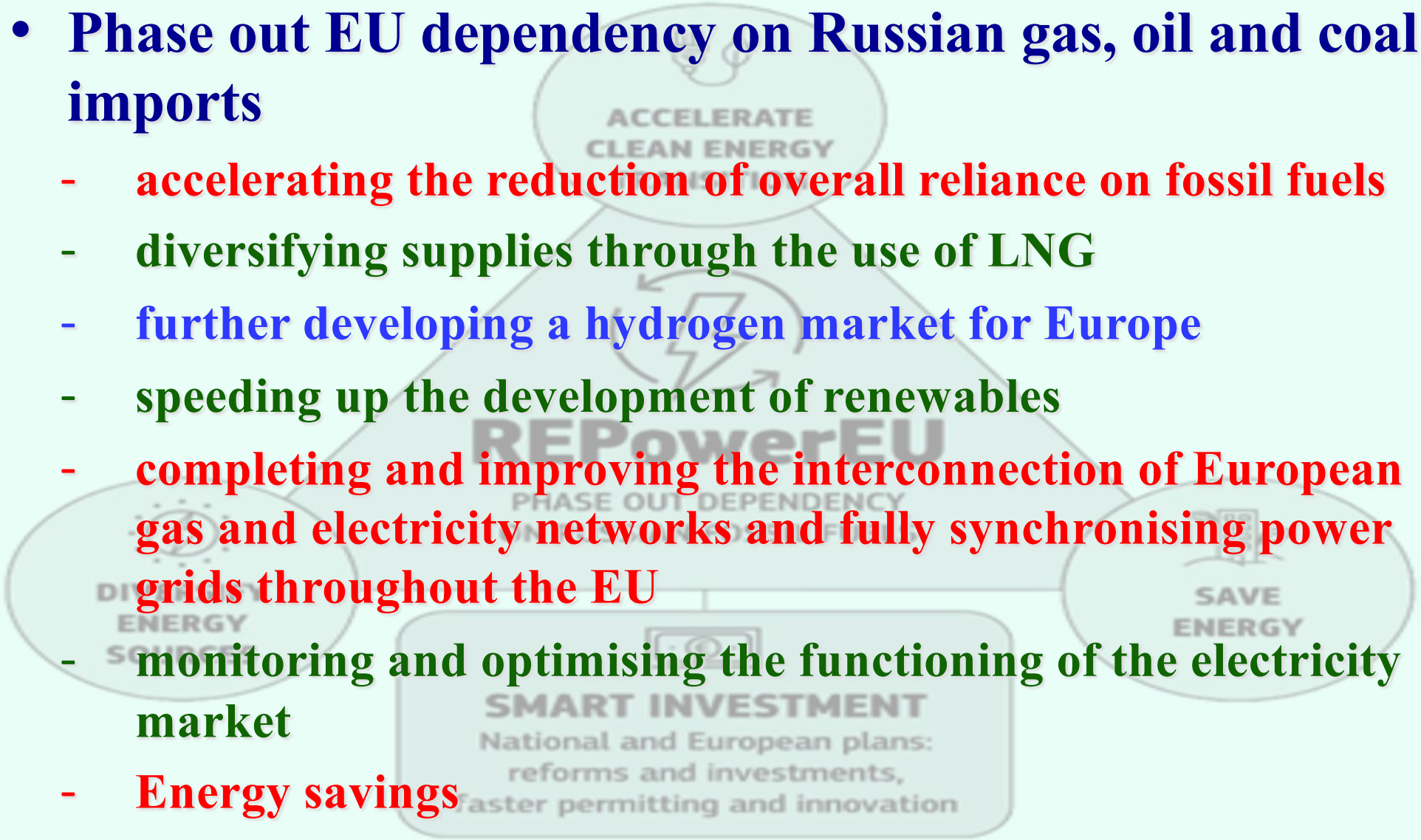


Brent price during crisis



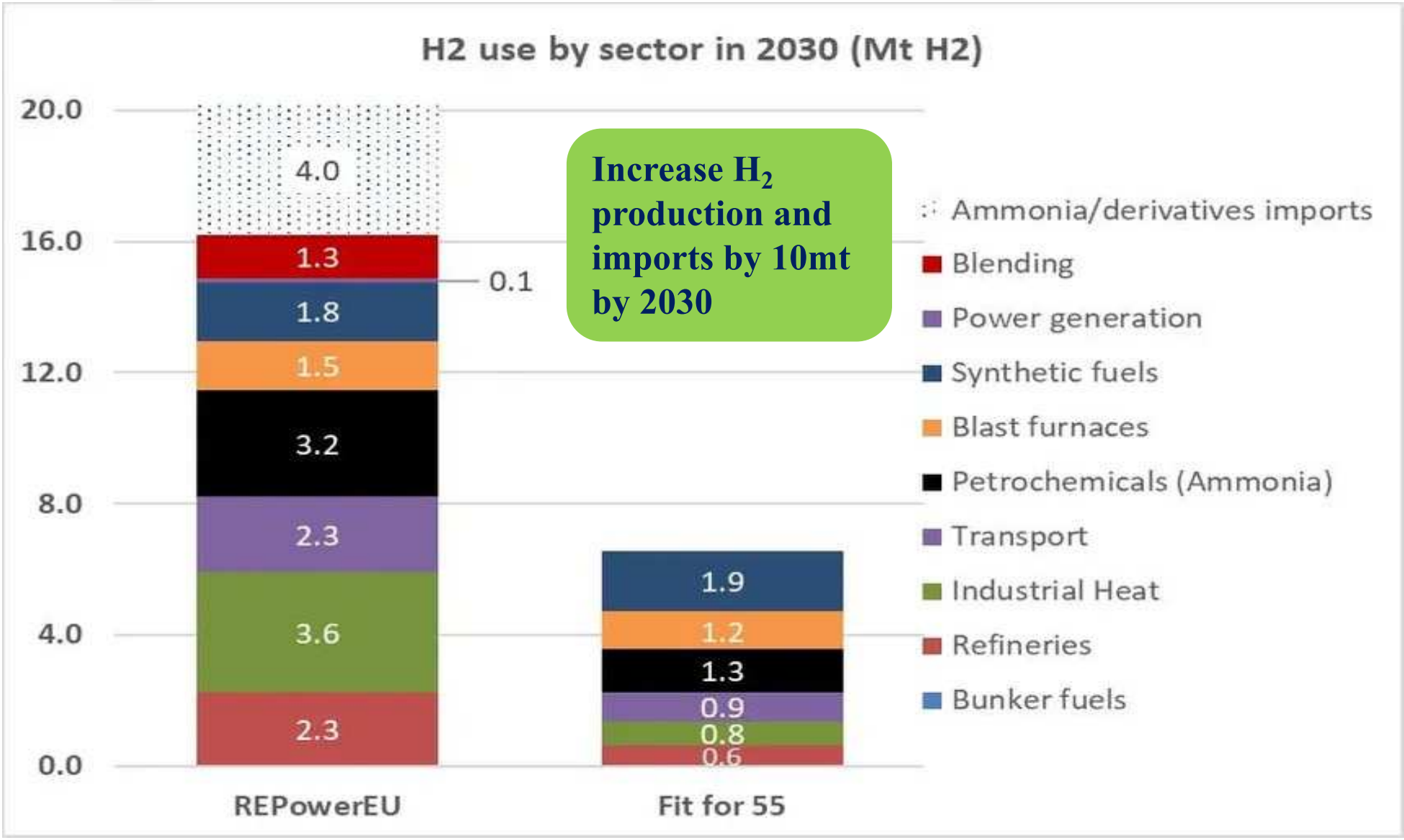
RePowerEU plan*

- **Phase out EU dependency on Russian gas, oil and coal imports**
  - accelerating the reduction of overall reliance on fossil fuels
  - diversifying supplies through the use of LNG
  - further developing a hydrogen market for Europe
  - speeding up the development of renewables
  - completing and improving the interconnection of European gas and electricity networks and fully synchronising power grids throughout the EU
  - monitoring and optimising the functioning of the electricity market
  - Energy savings



* *RePowerEU Plan*, EU, 2022

H_2 accelerator*



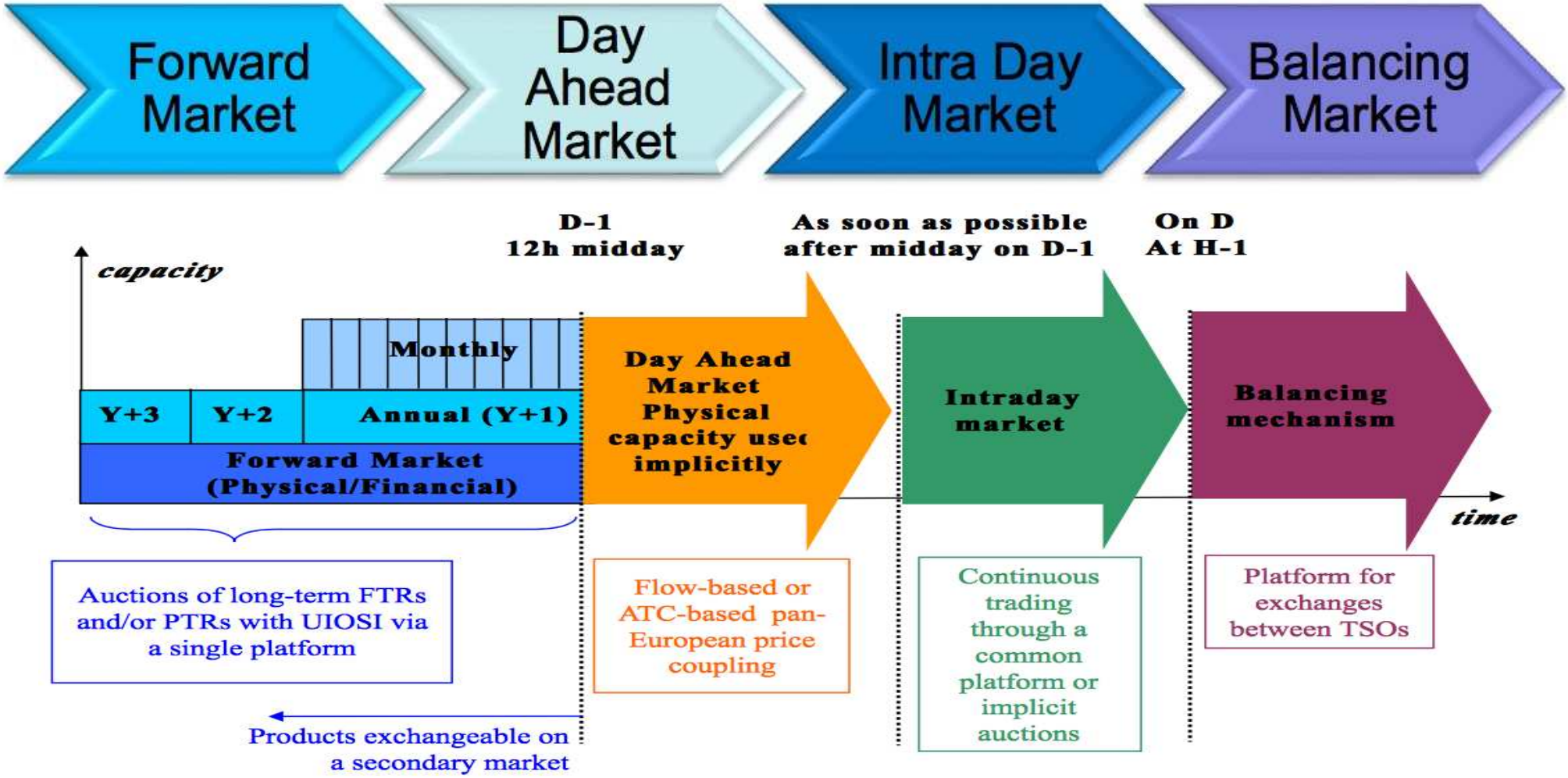
Increase H_2 production and imports by 10mt by 2030

* *RePowerEU Plan, EU, 2022*

Short to medium term challenges

Large scale integration of RES

EU electricity market target model

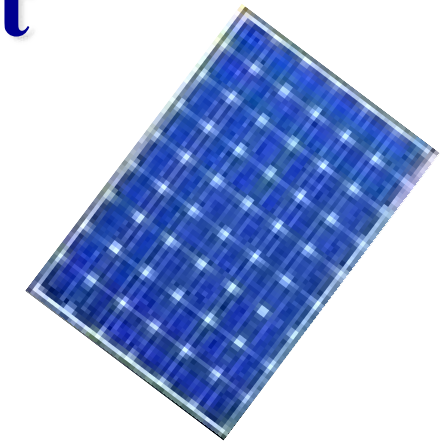


Integration of RES*: LCOE *vs* Reliability

* Nicolaidis P., Poullikkas A., 2022, "Co-optimization of active power curtailment, load shedding and spinning reserve deficits through hybrid approach: Comparison of electrochemical storage technologies", *IET Renewable Power Generation*

Intermittent energy source*

- Any source of energy that is not continuously available

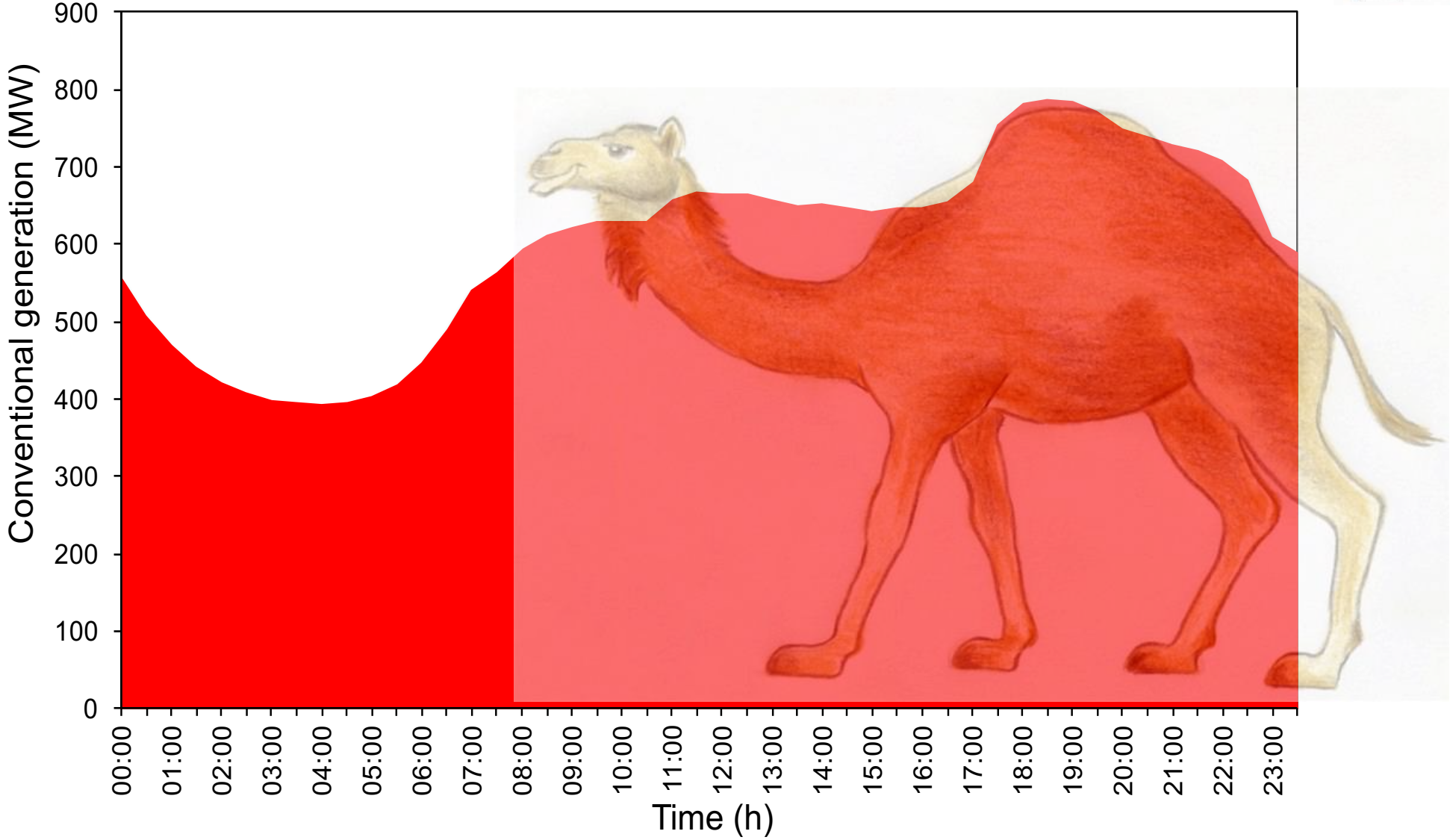


- May be quite predictable
- Cannot be dispatched to meet the demand of a power system

- For dispatching need storage

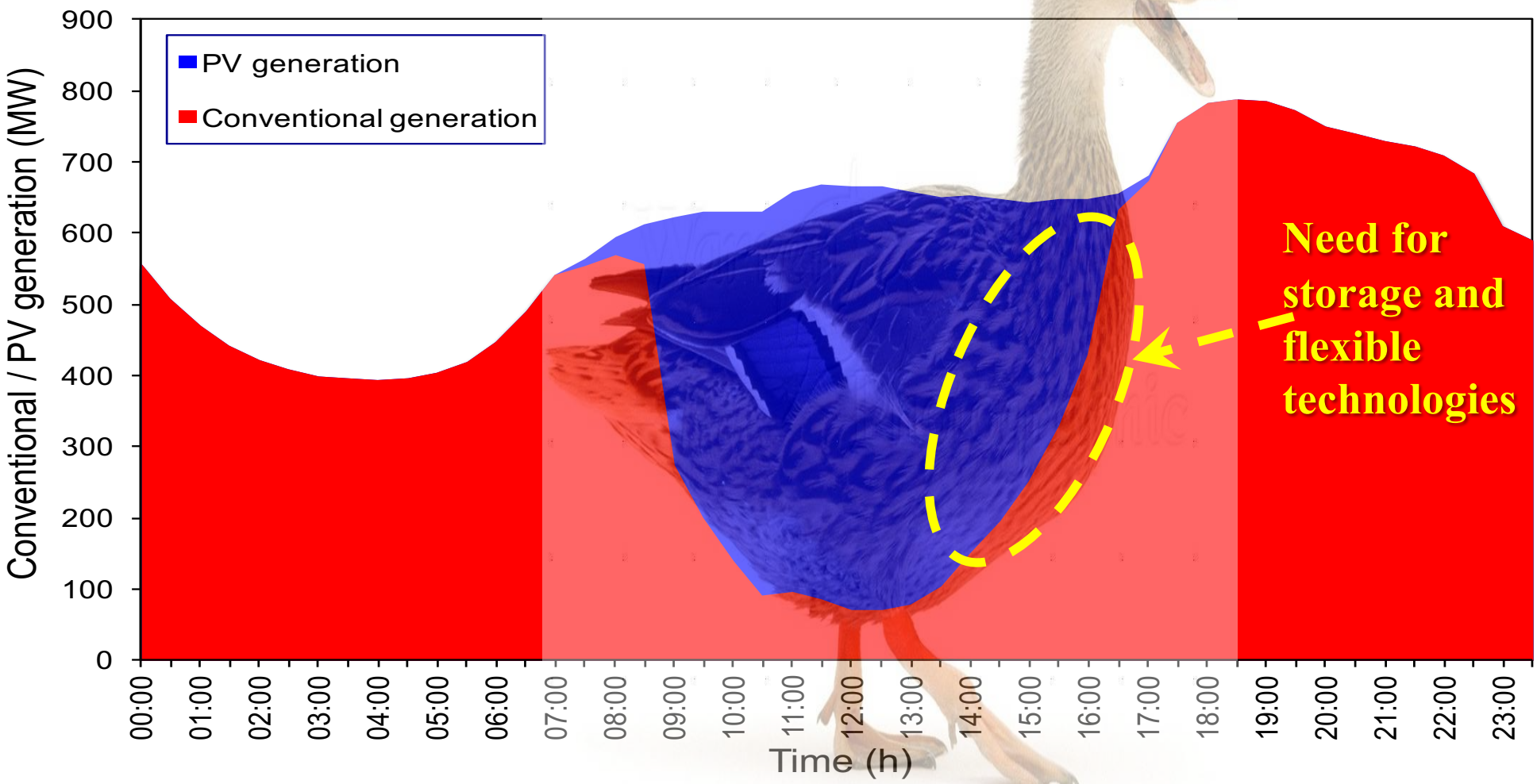
* Poullikkas A., 2013, *Renewable Energy: Economics, Emerging Technologies and Global Practices*, ISBN: 978-1-62618-231-8

Daily load curve (the 'camel curve')*



* **Poullikkas A., 2016, "From the 'camel curve' to the 'duck curve' on electric systems with increasing solar power", *Accountancy***

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



* Poullikkas A., 2016, "From the 'camel curve' to the 'duck curve' on electric systems with increasing solar power", *Accountancy*

Storage and flexible technologies are the missing links

Energy storage

Flexible technologies

Hydrogen technologies

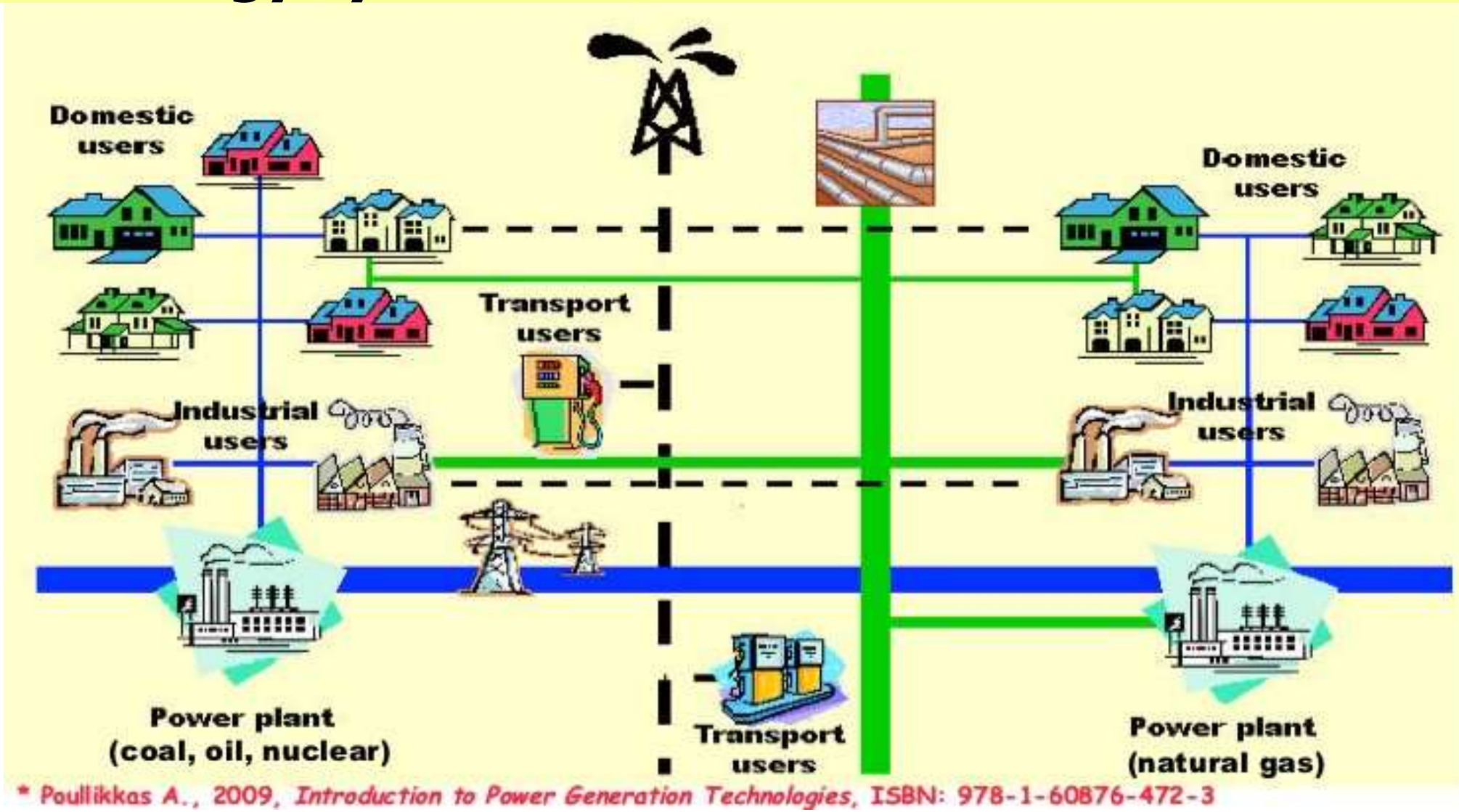
Storage, Flexible Technologies and Hydrogen Regulatory Frameworks

Long term scenarios

from carbon economy to hydrogen economy

Energy system in 2010

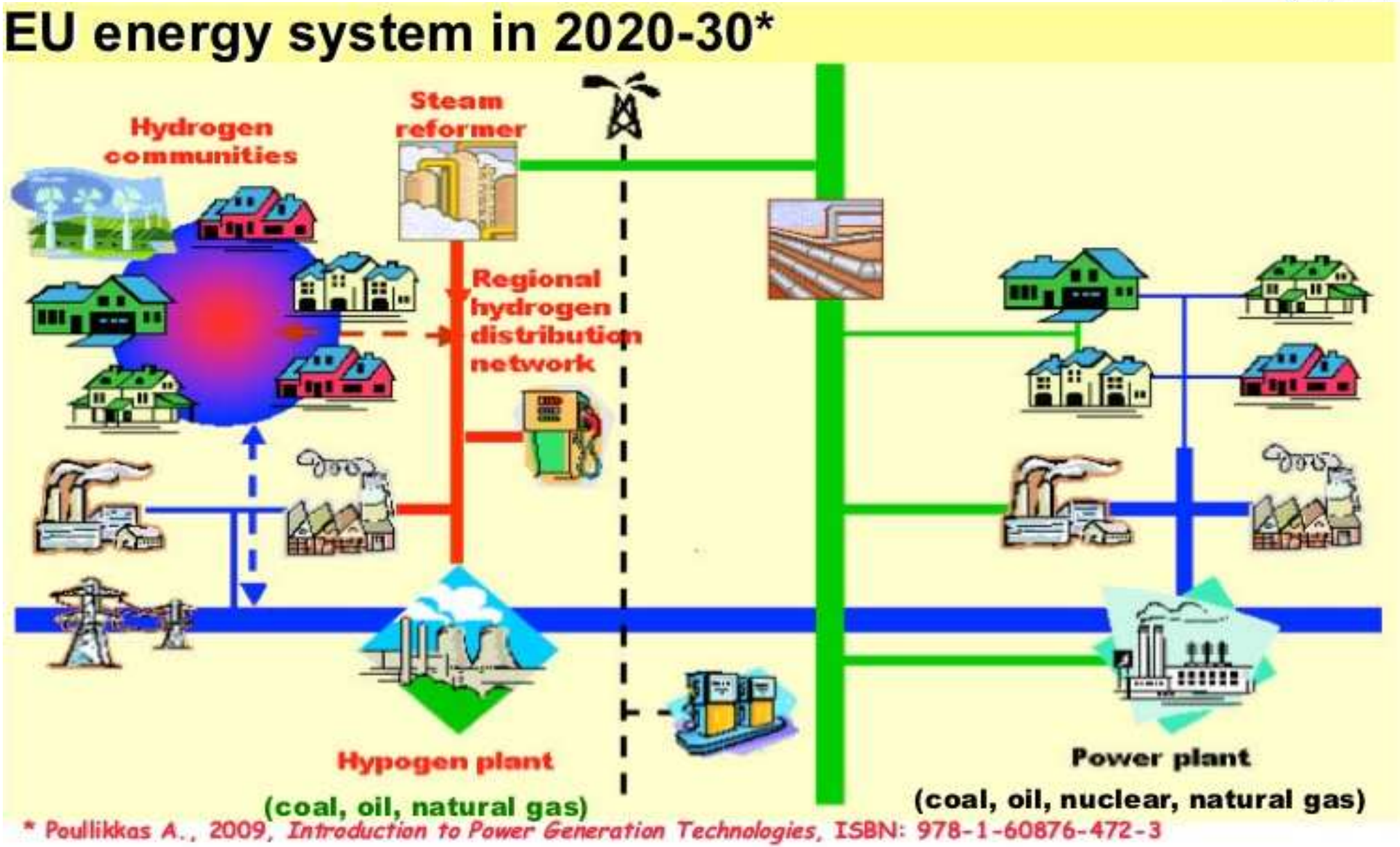
EU energy system in 2010*



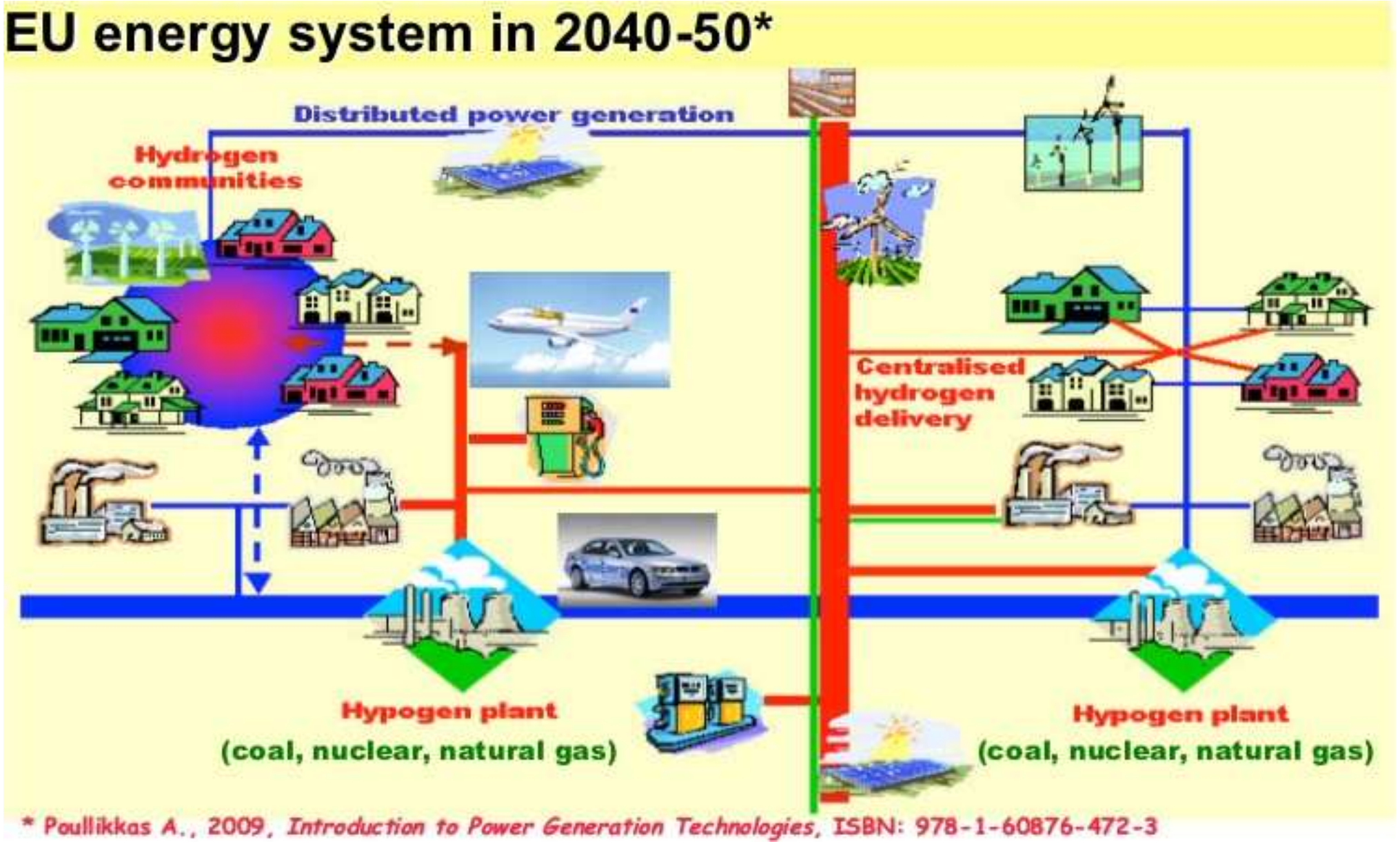
* Poullikkas A., 2009, *Introduction to Power Generation Technologies*, ISBN: 978-1-60876-472-3

Future energy systems (optimistic scenario)

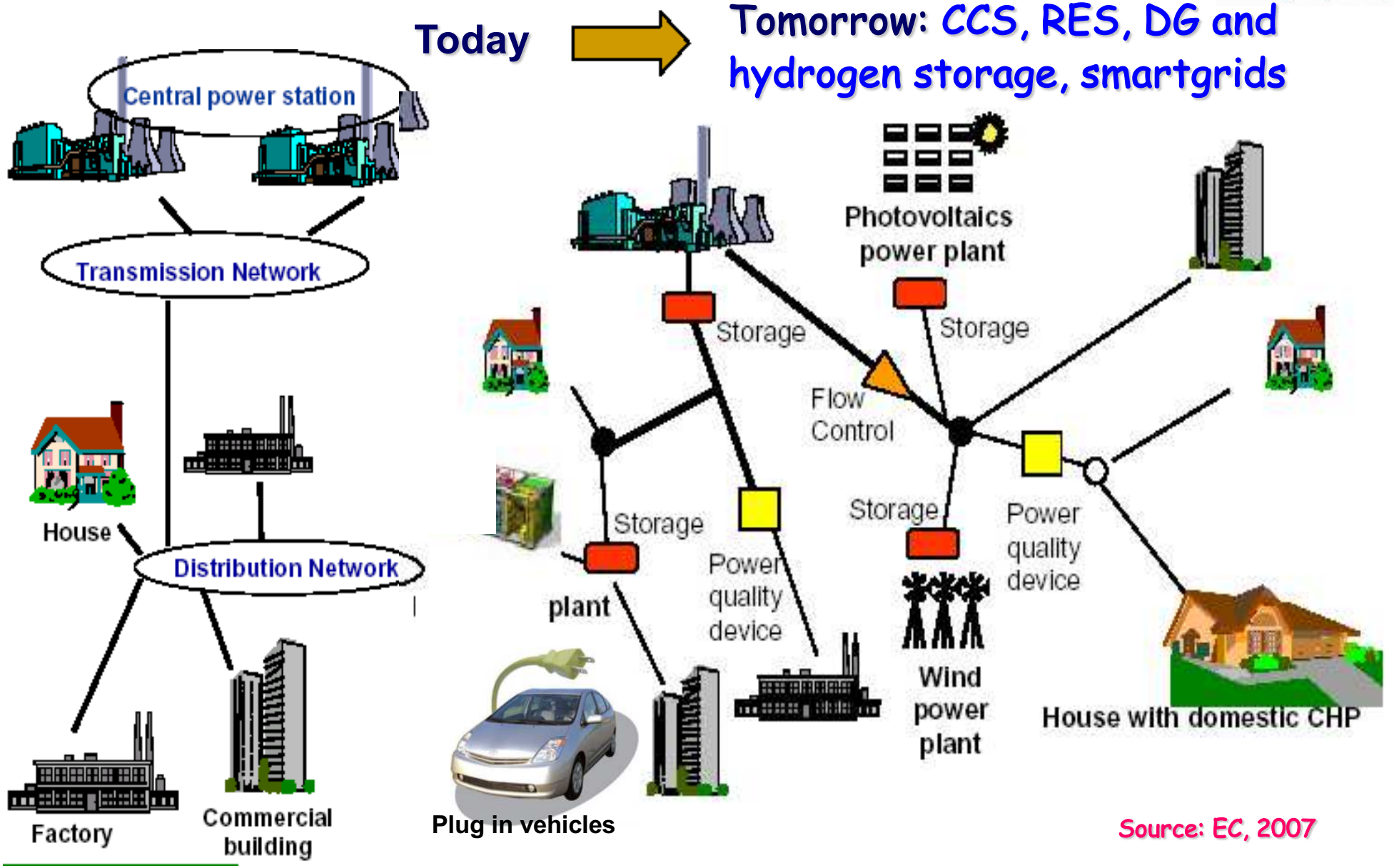
ρυθμιστική αρχή ενέργειας κύπρου
cyprus energy regulatory authority



Future energy systems (optimistic scenario)

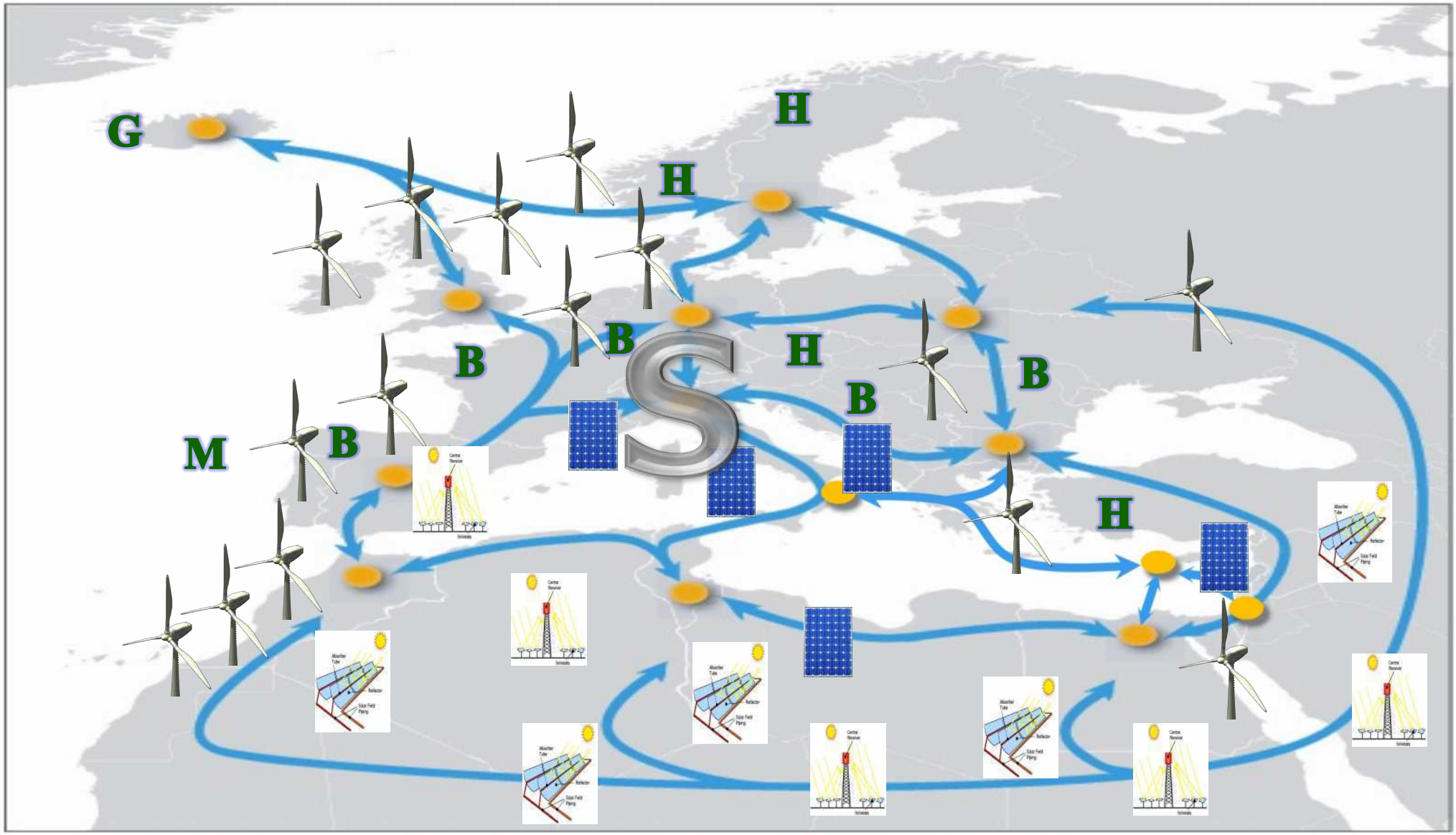


Future power systems



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

ρυθμιστική αρχή ενέργειας κύπρου
cyprus energy regulatory authority

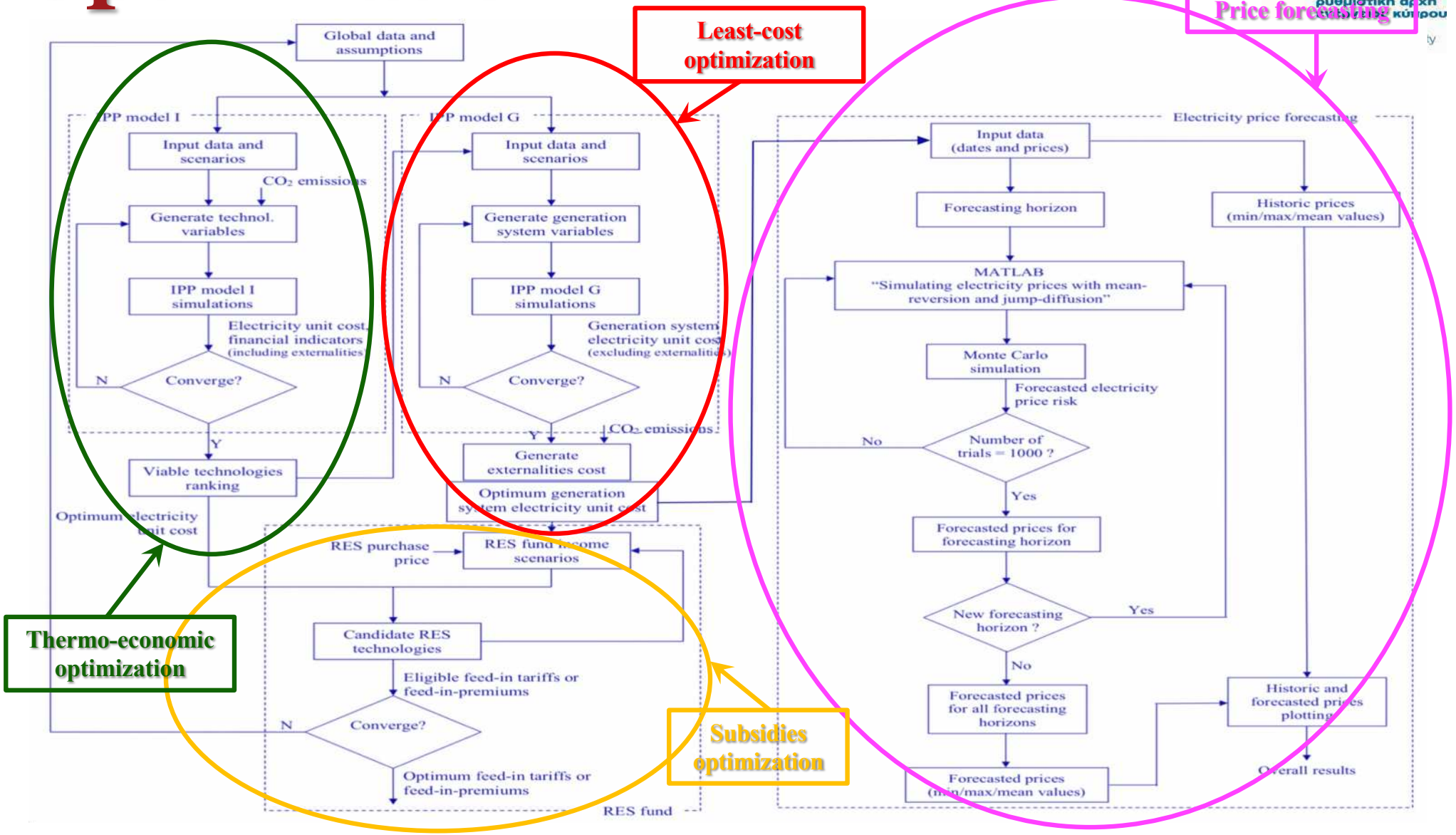


* Poullikkas A., 2013, *Sustainable Energy Development for Cyprus*, ISBN: 978-9963-7355-3-2

Development of optimization algorithms

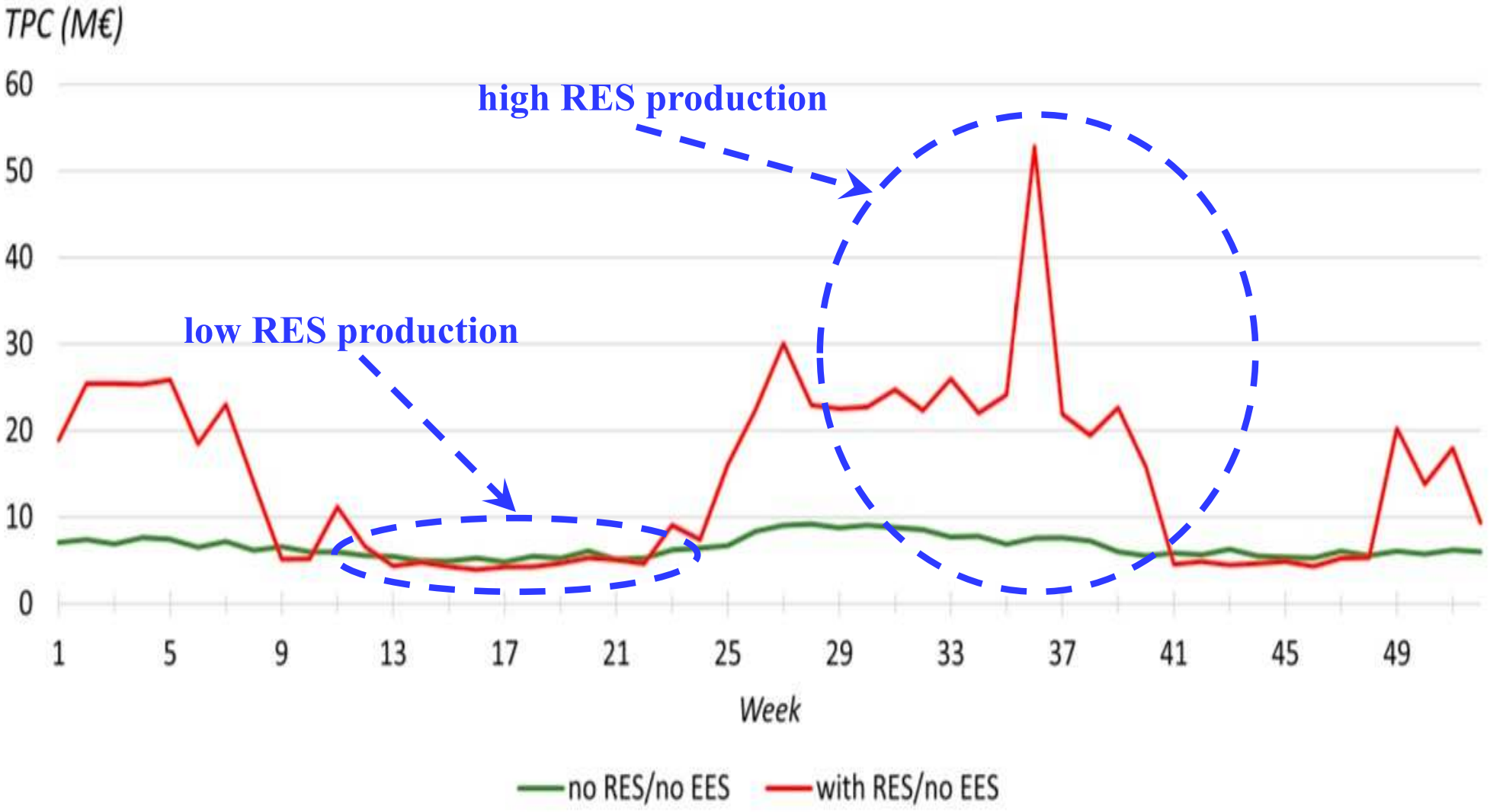
advanced simulation tools for large scale integration of sustainable technologies including storage

Optimization model*



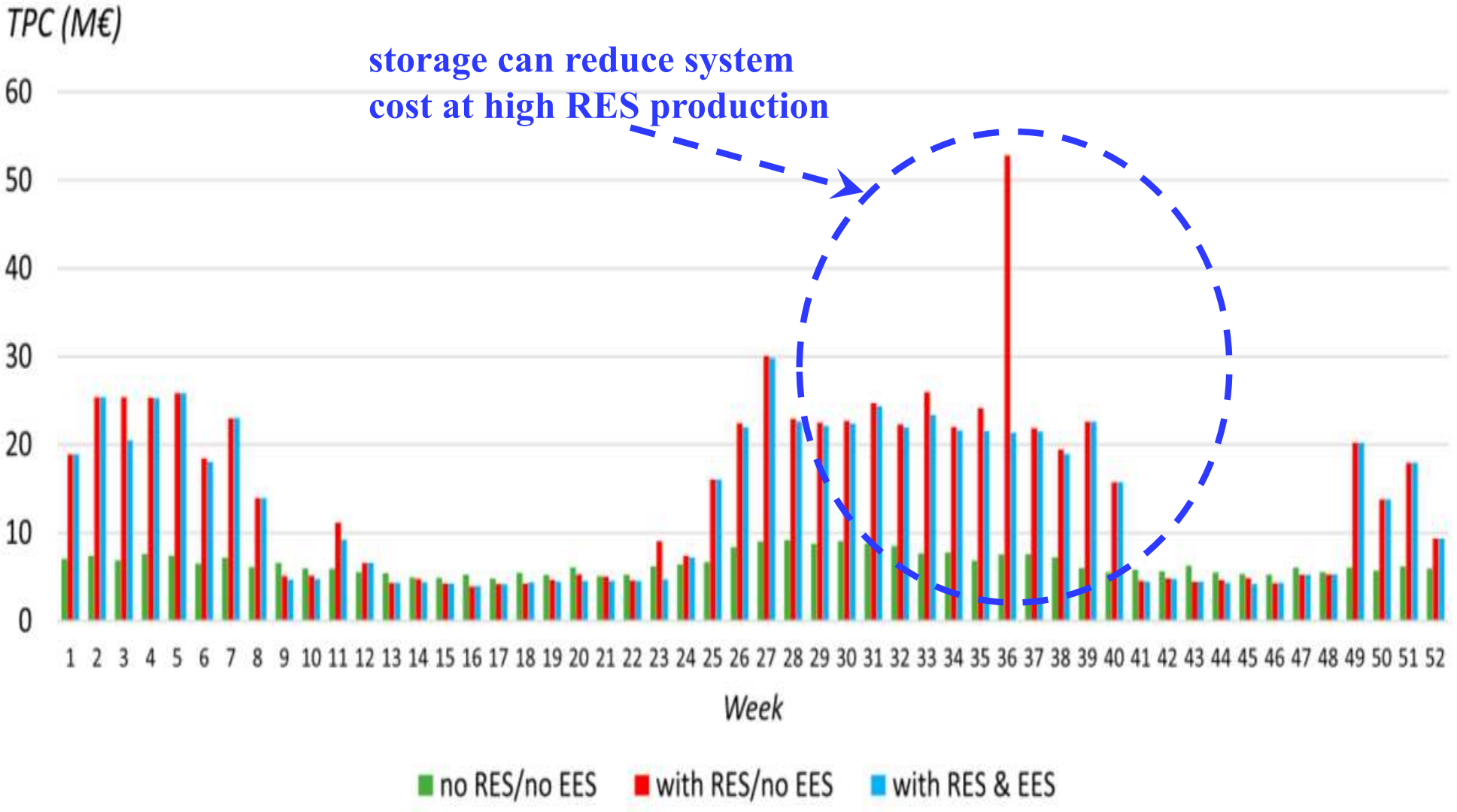
* Poullikkas A., 2018, "An adaptive longterm electricity price risk modelling using Monte Carlo simulation", *Journal of Power Technologies*

Cost of reserves with RES production*



* Nicolaidis P., Chatzis S., Poullikkas A., 2018, "Renewable energy integration through optimal unit commitment and electricity storage in weak power networks", *International Journal of Sustainable Energy*

Integration of storage*



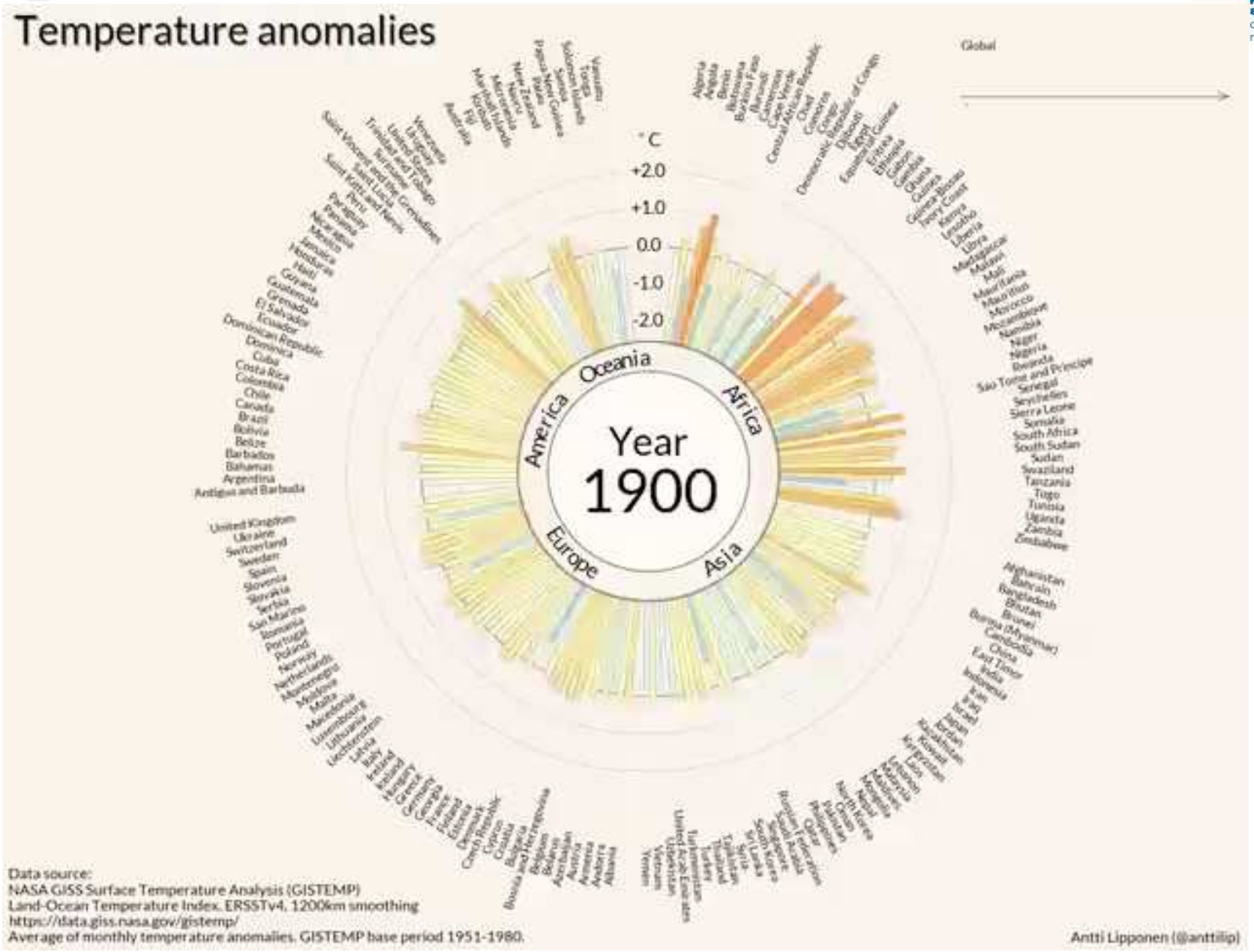
* Nicolaidis P., Chatzis S., Poullikkas A., 2018, "Renewable energy integration through optimal unit commitment and electricity storage in weak power networks", *International Journal of Sustainable Energy*

Additional Slides

The energy transition cost

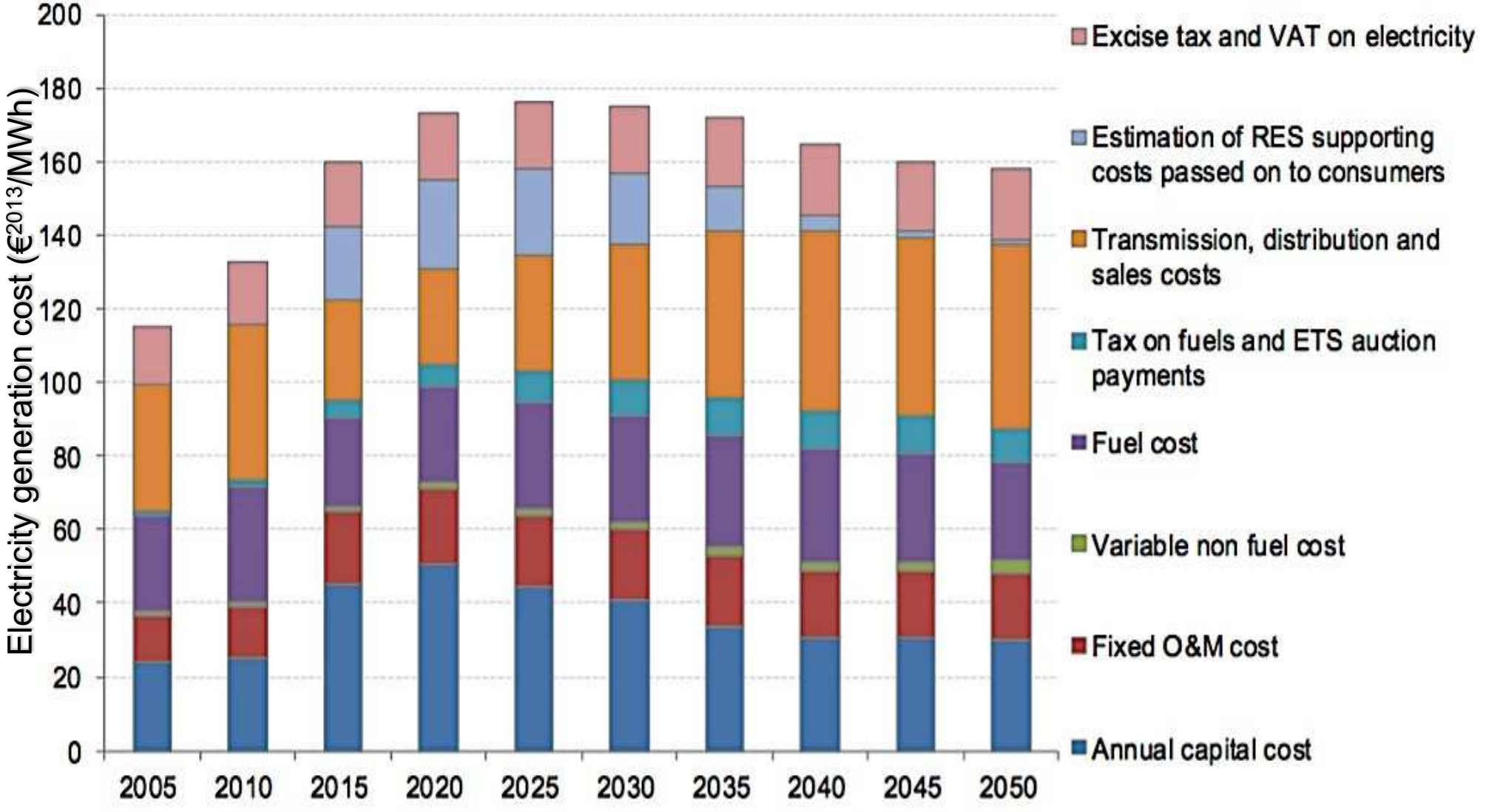
Towards 2050

Temperature anomalies *



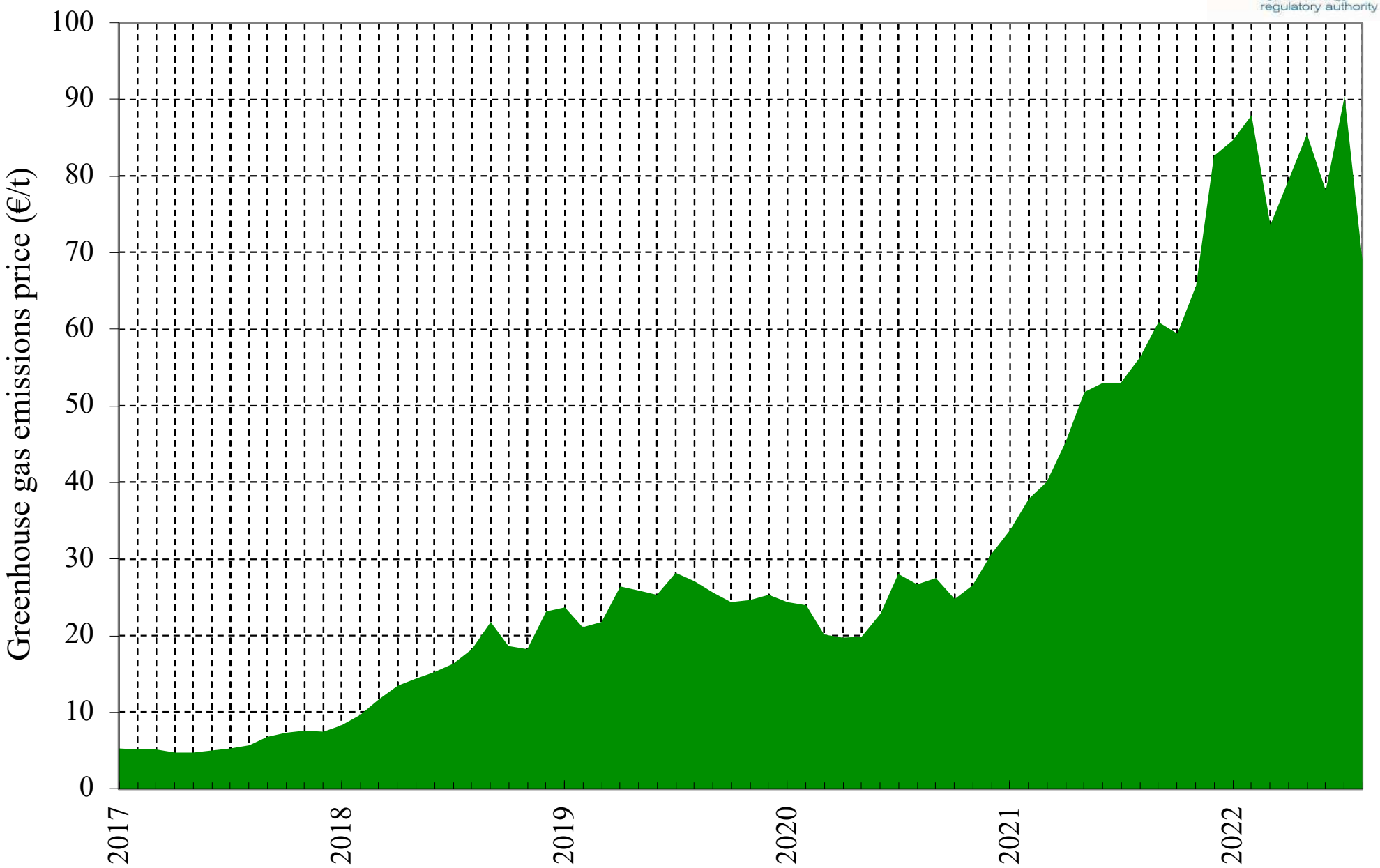
*** UN Environment, 2017.**

EU reference scenario 2016

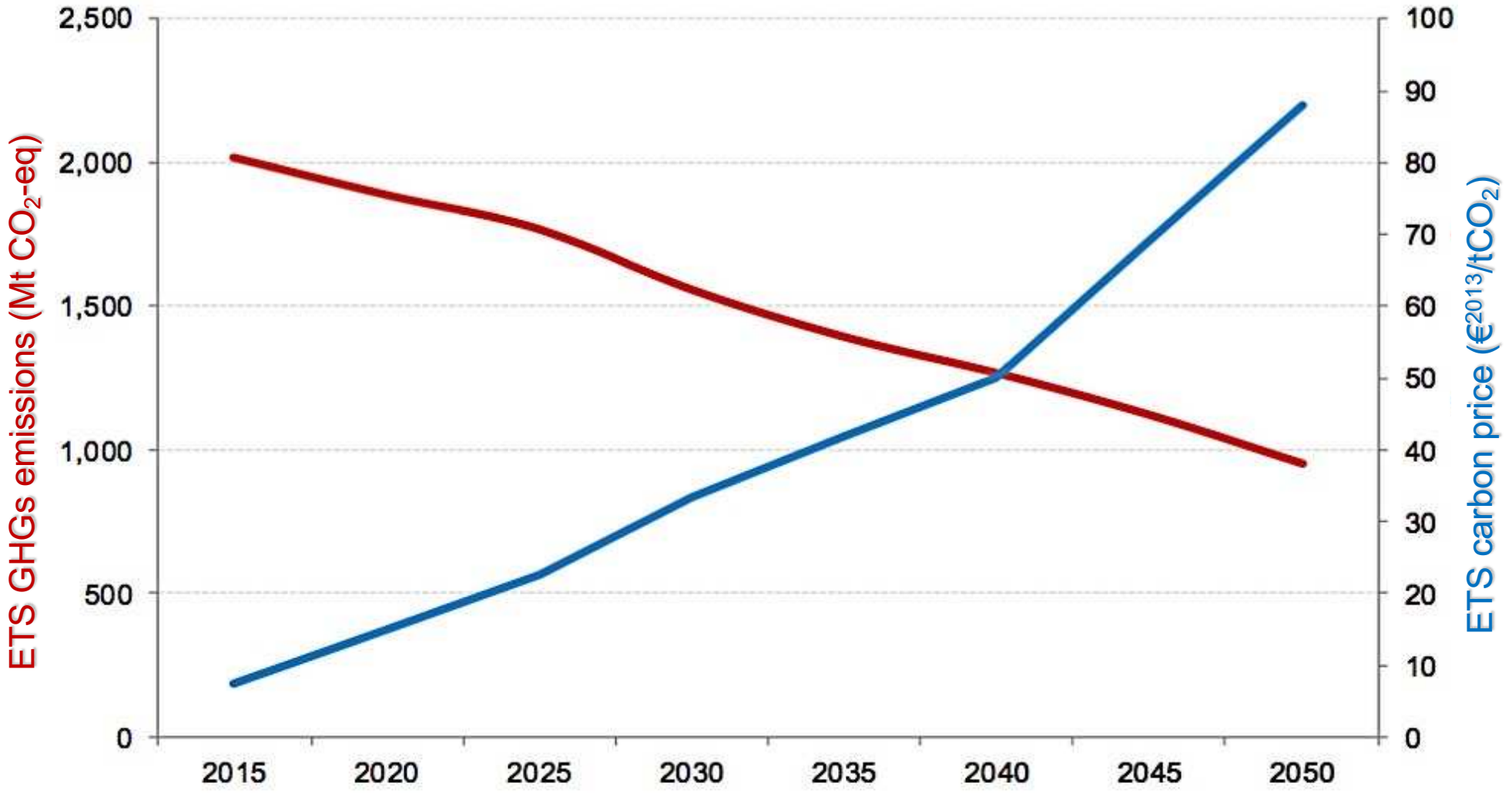


Source: PRIMES

Greenhouse gas emissions price

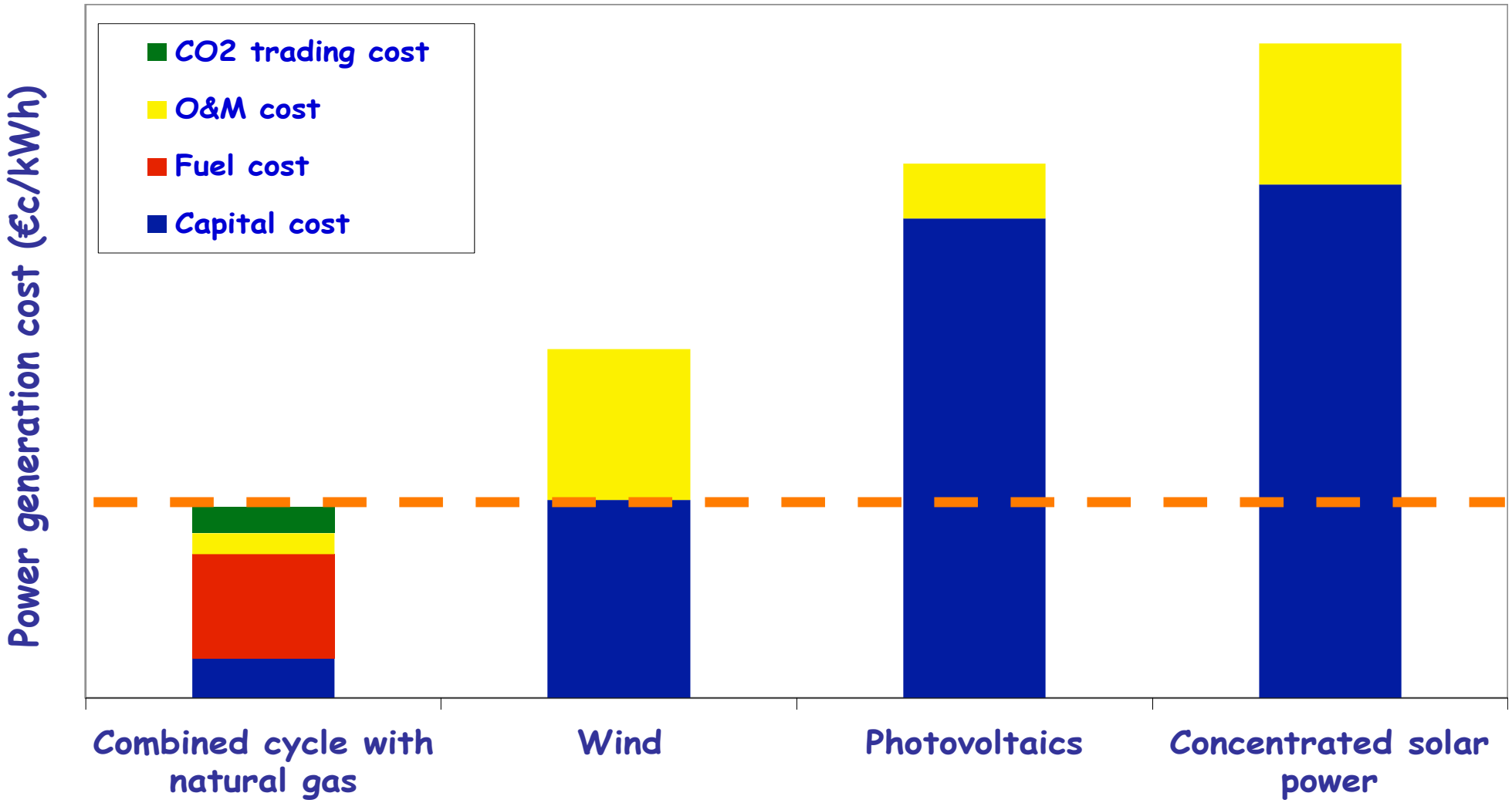


EU reference scenario 2016



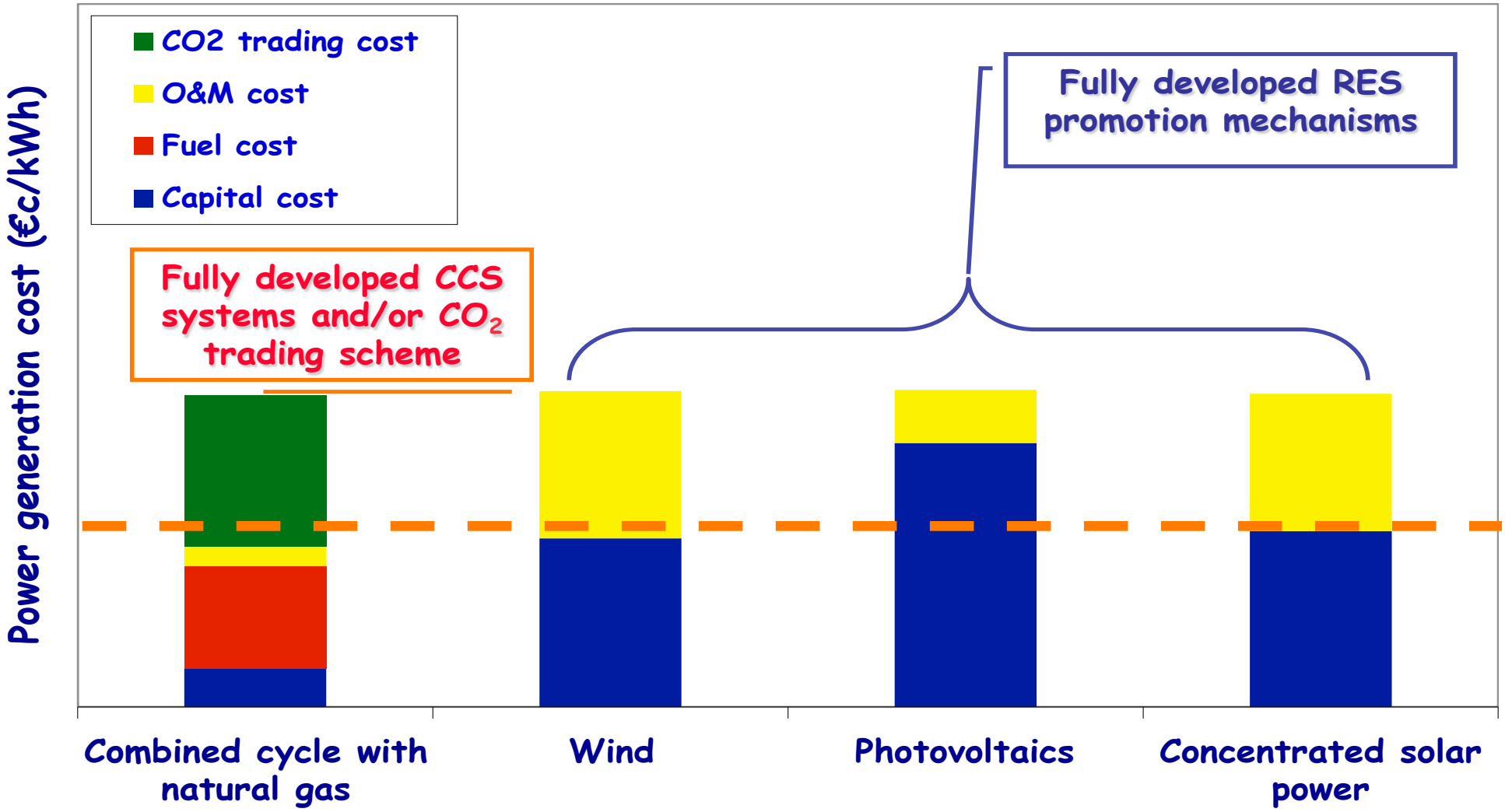
Source: PRIMES, GAINS

Power generation cost (year 2010)*



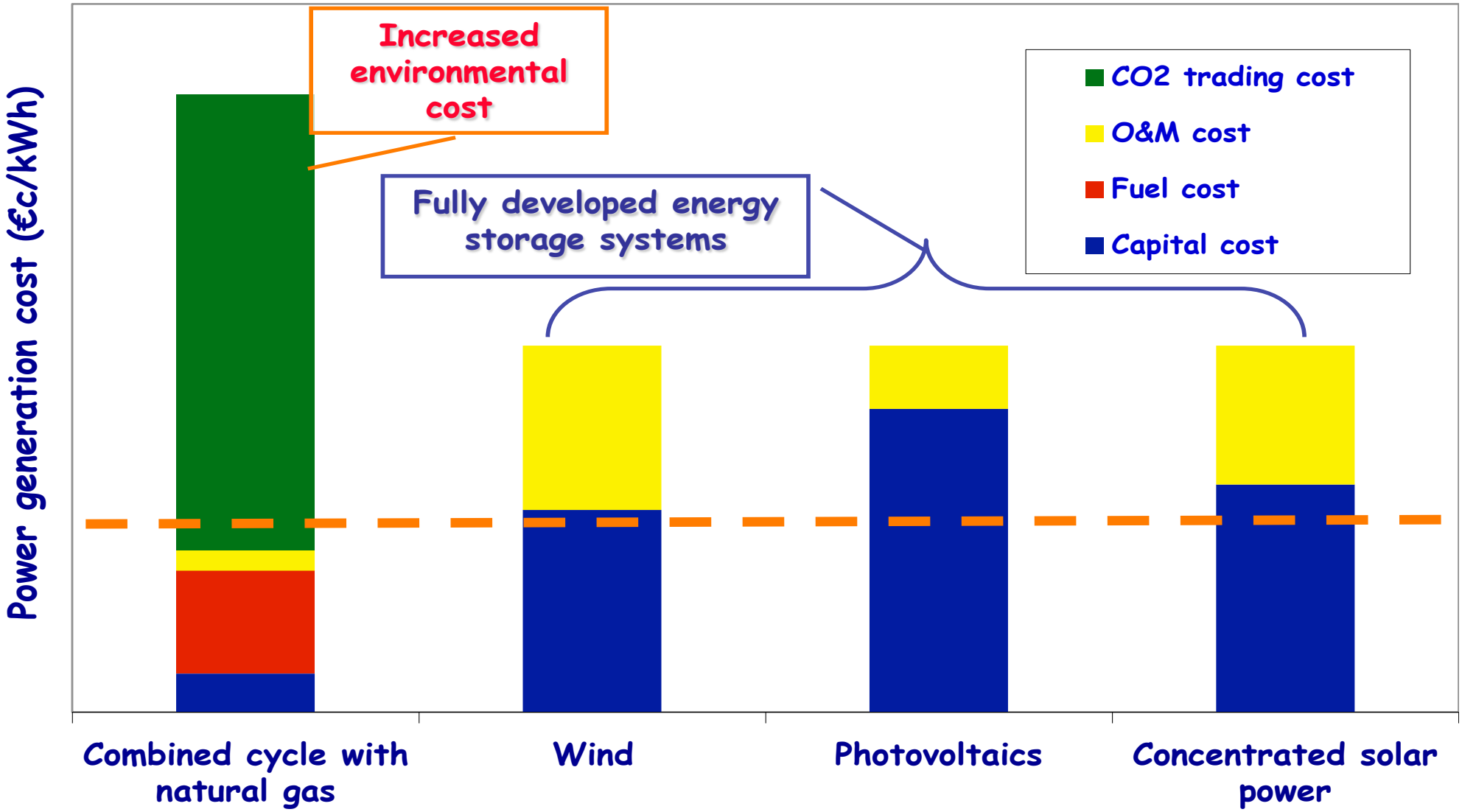
* Poullikkas A., 2010, "The cost of integration of renewable energy sources", *Accountancy*

Power generation cost (year 2020-30)*



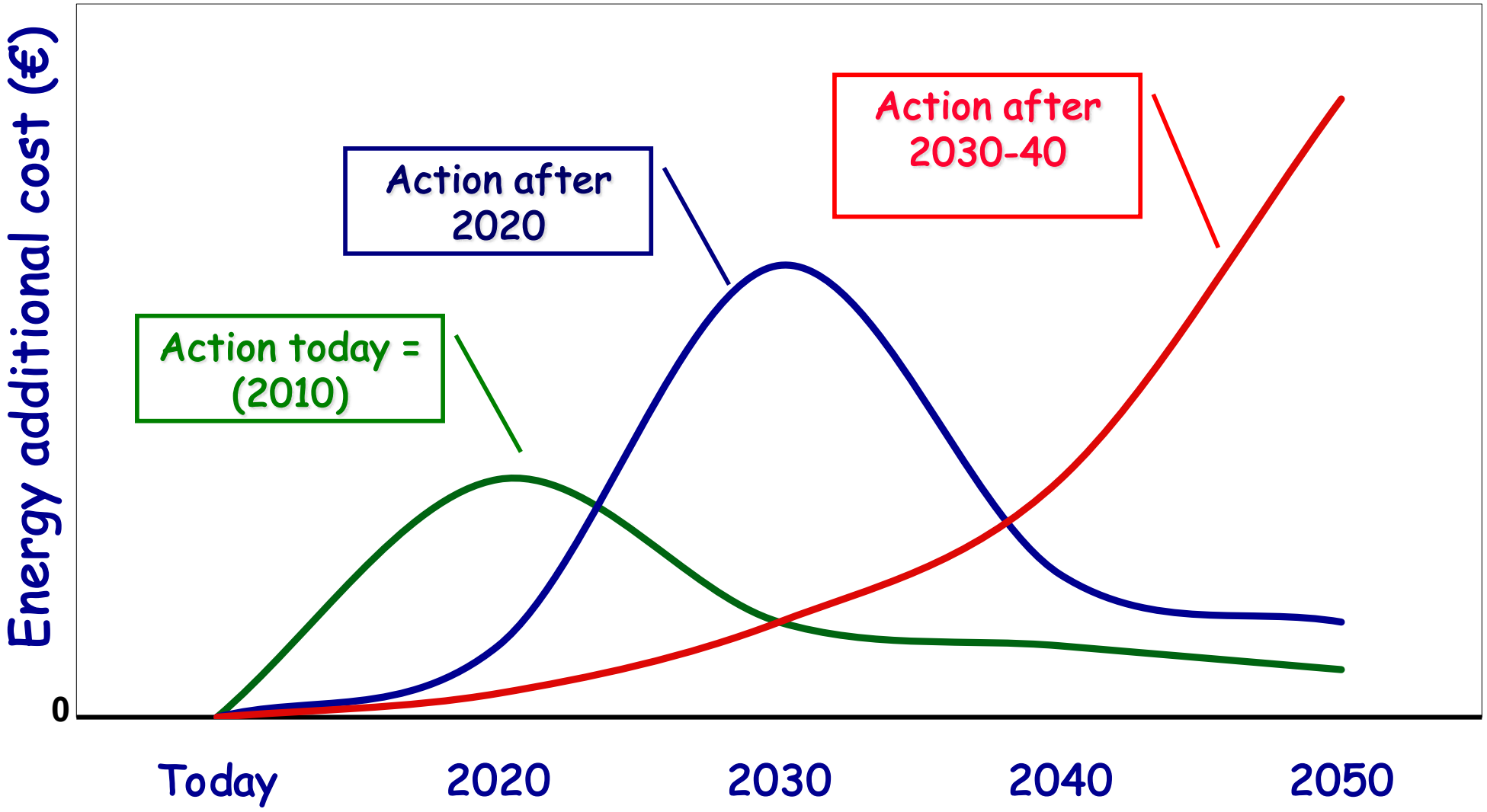
* Poullikkas A., 2010, "The cost of integration of renewable energy sources", *Accountancy*

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*