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cyprus energy regulatory authority

Energy challenges towards 2050

The case of Cyprus

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EU energy strategy

2020, 2030, 2050

Future energy systems

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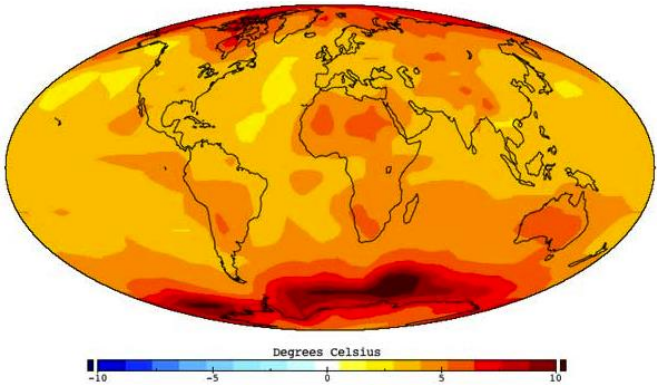
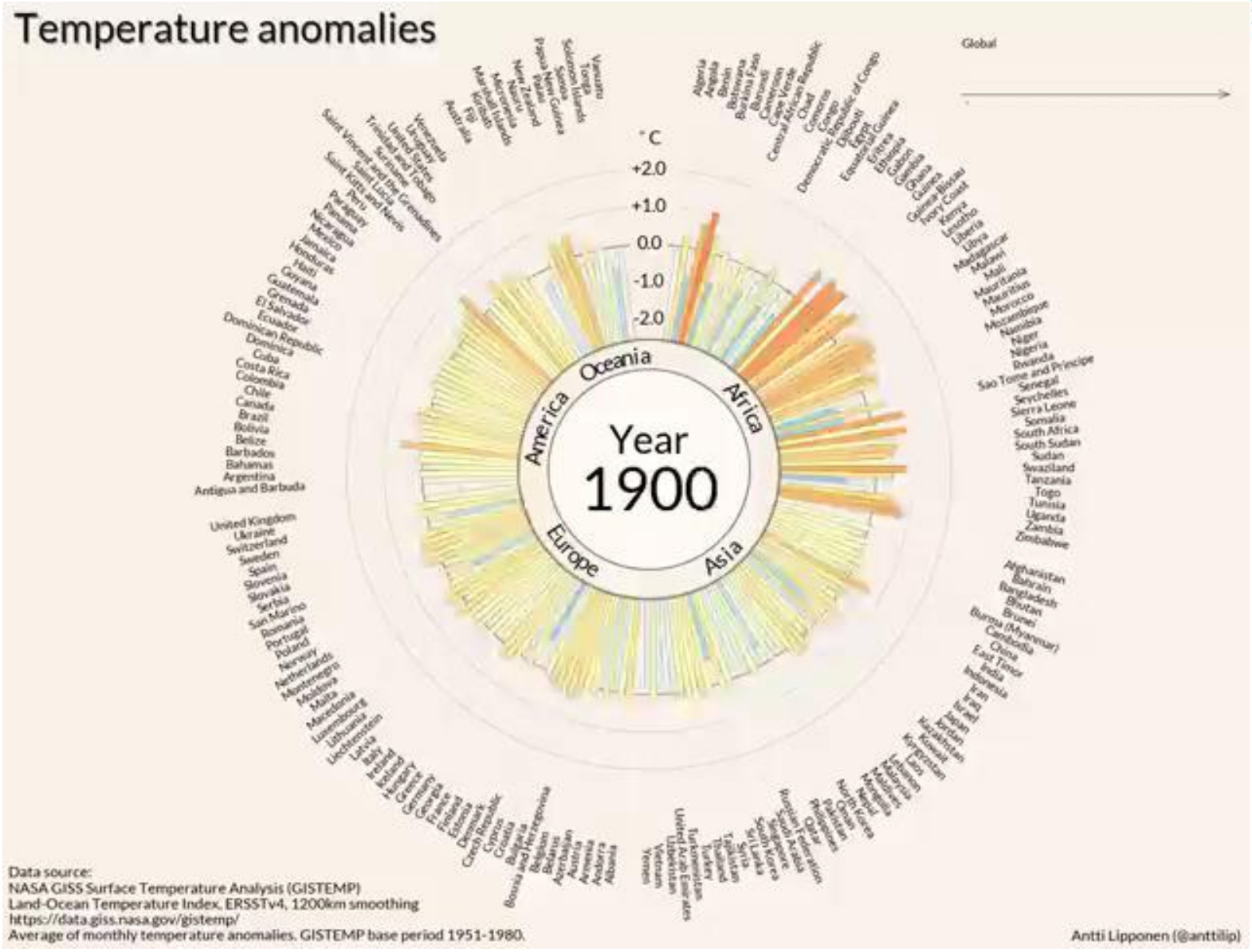
- **Climate change**



- **Third energy revolution**

- **Future energy economics**

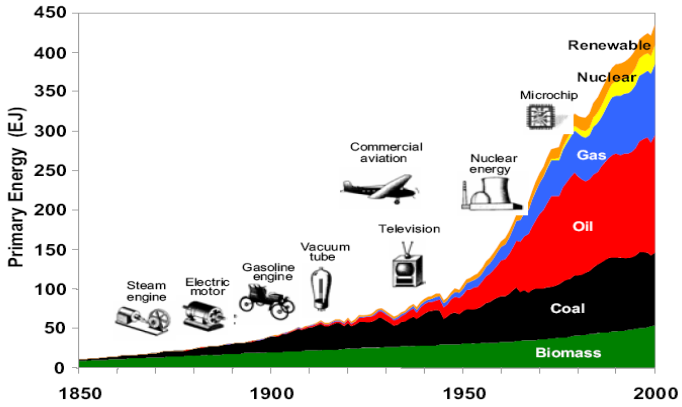
Temperature anomalies *



*** UN Environment, 2017.**

EU energy objectives

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



EU medium and long term targets

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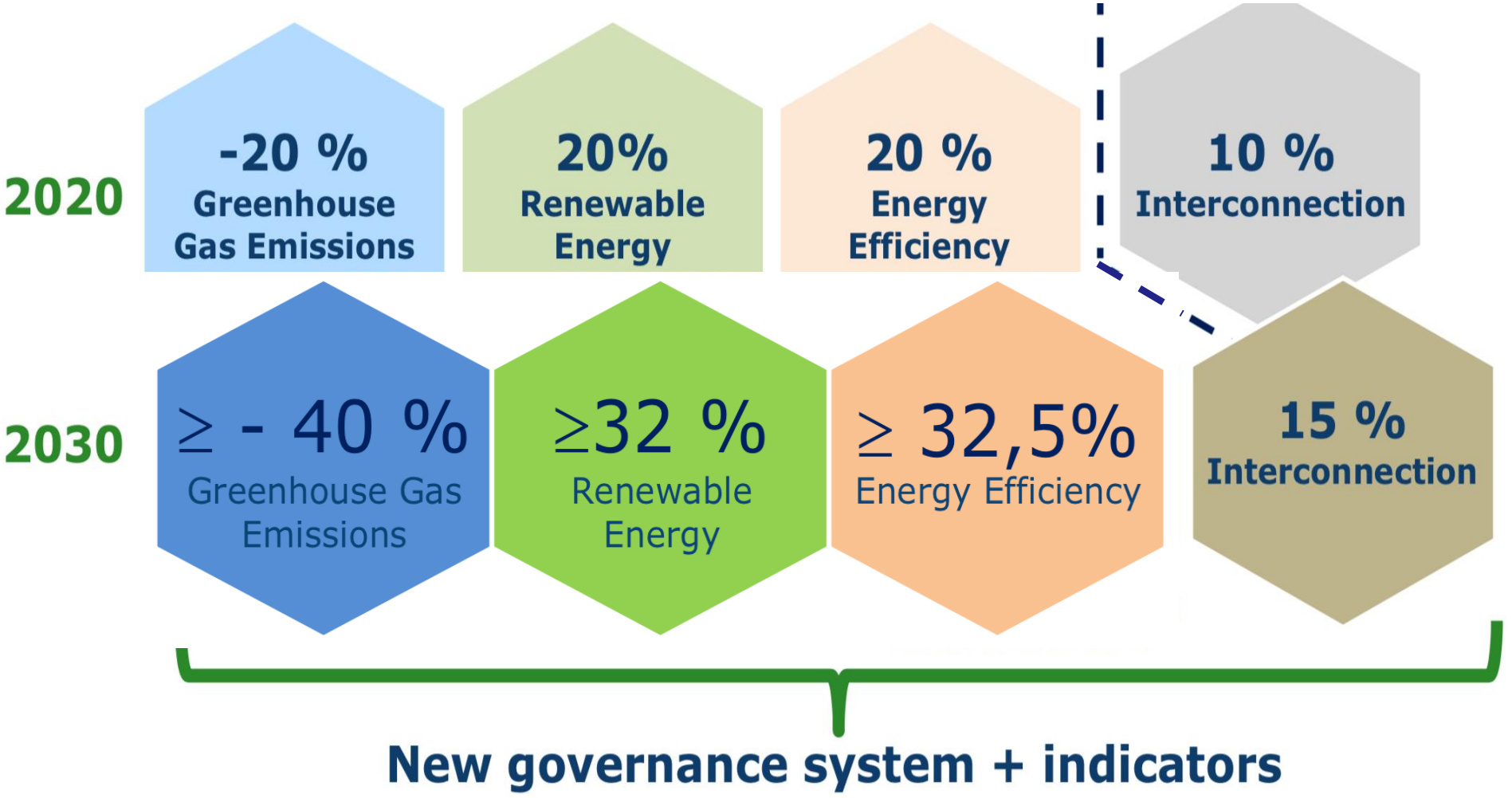

2050 -80% Greenhouse Gas Emissions

EU reduction in greenhouse gas emissions

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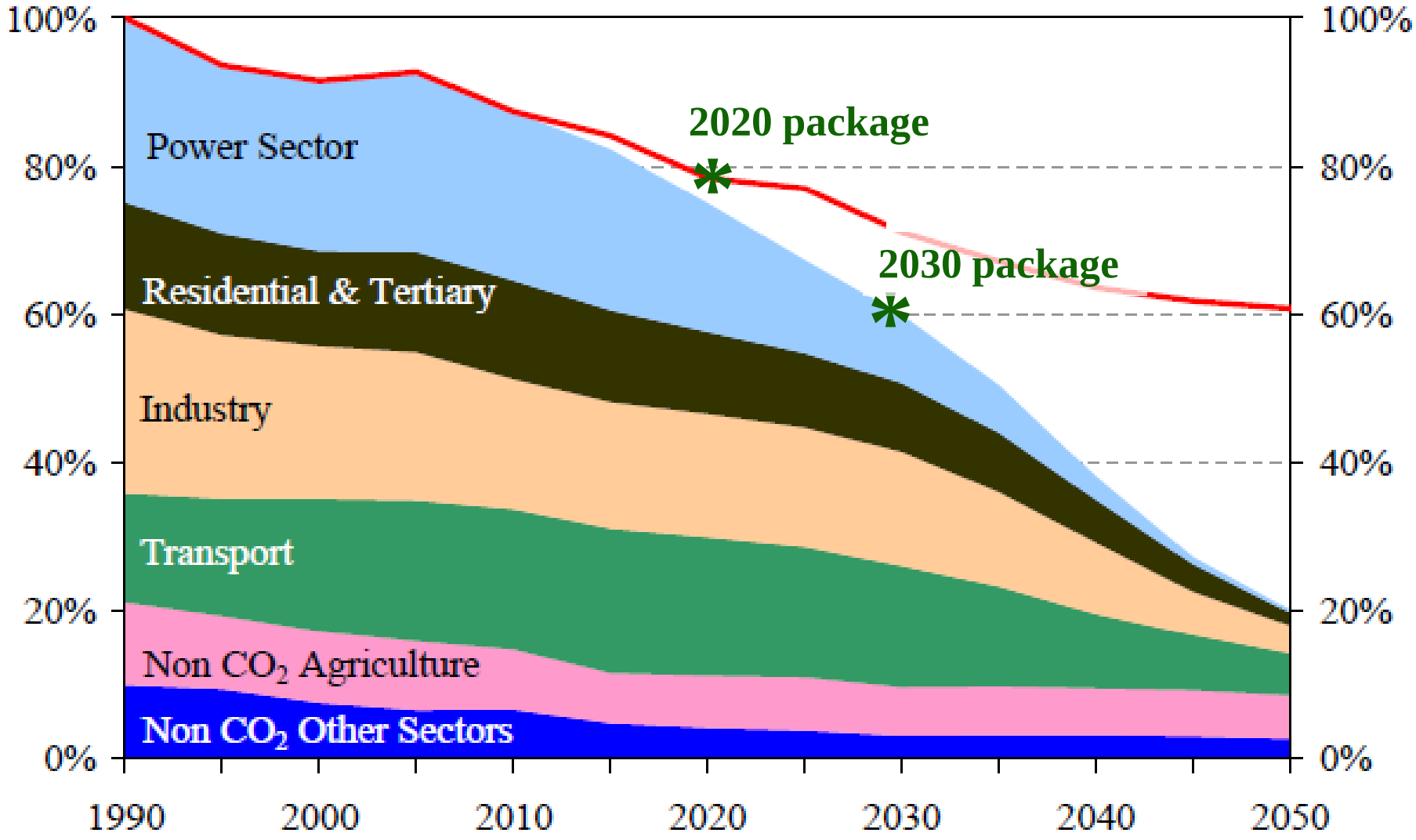

Our 3D energy future

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Decarbonisation:

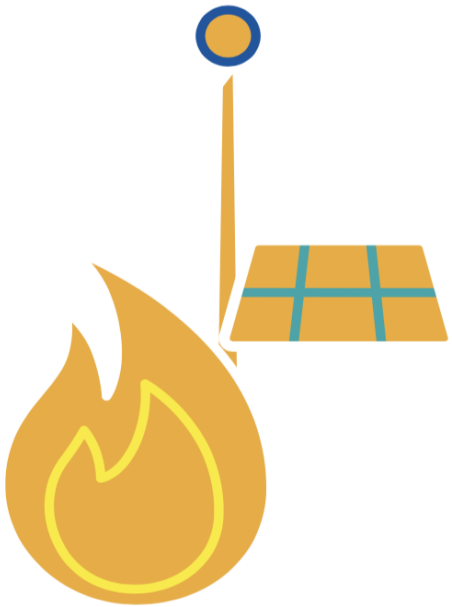
oil/coal-to-gas switch, renewable gas, wind and sun, carbon capture and usage

Decentralisation:

Solar panels, micro-CHPs/fuel cells, storage via power-to-gas and batteries

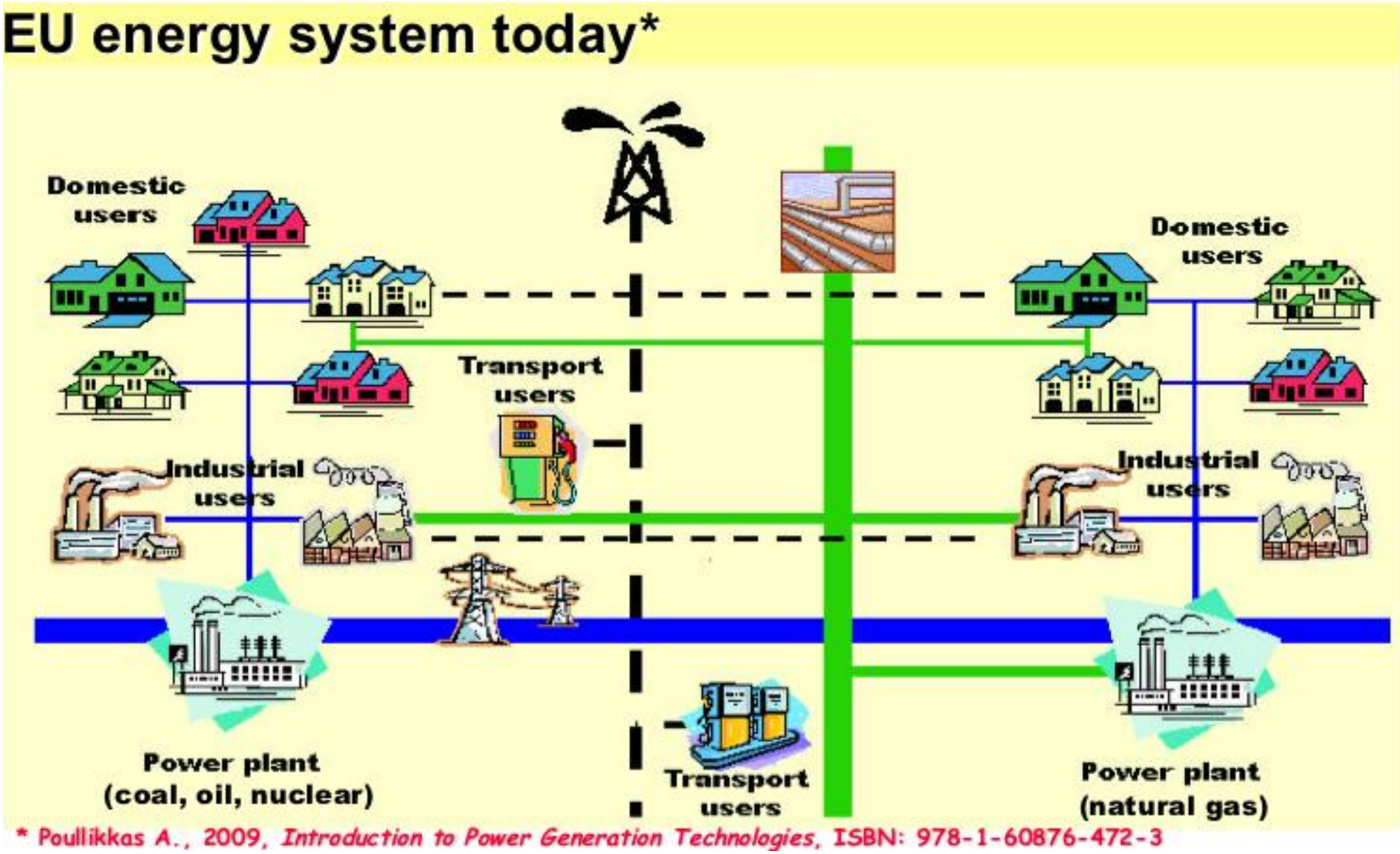
Digitalisation:

ICT for smart households and smart gas/electricity grids



- **Extrapolating developments of the past does not forecast the future**
- **Gas, wind and sun – providing Europe with clean heat, electricity and transport**

Current energy system



Future energy systems (optimistic scenario)

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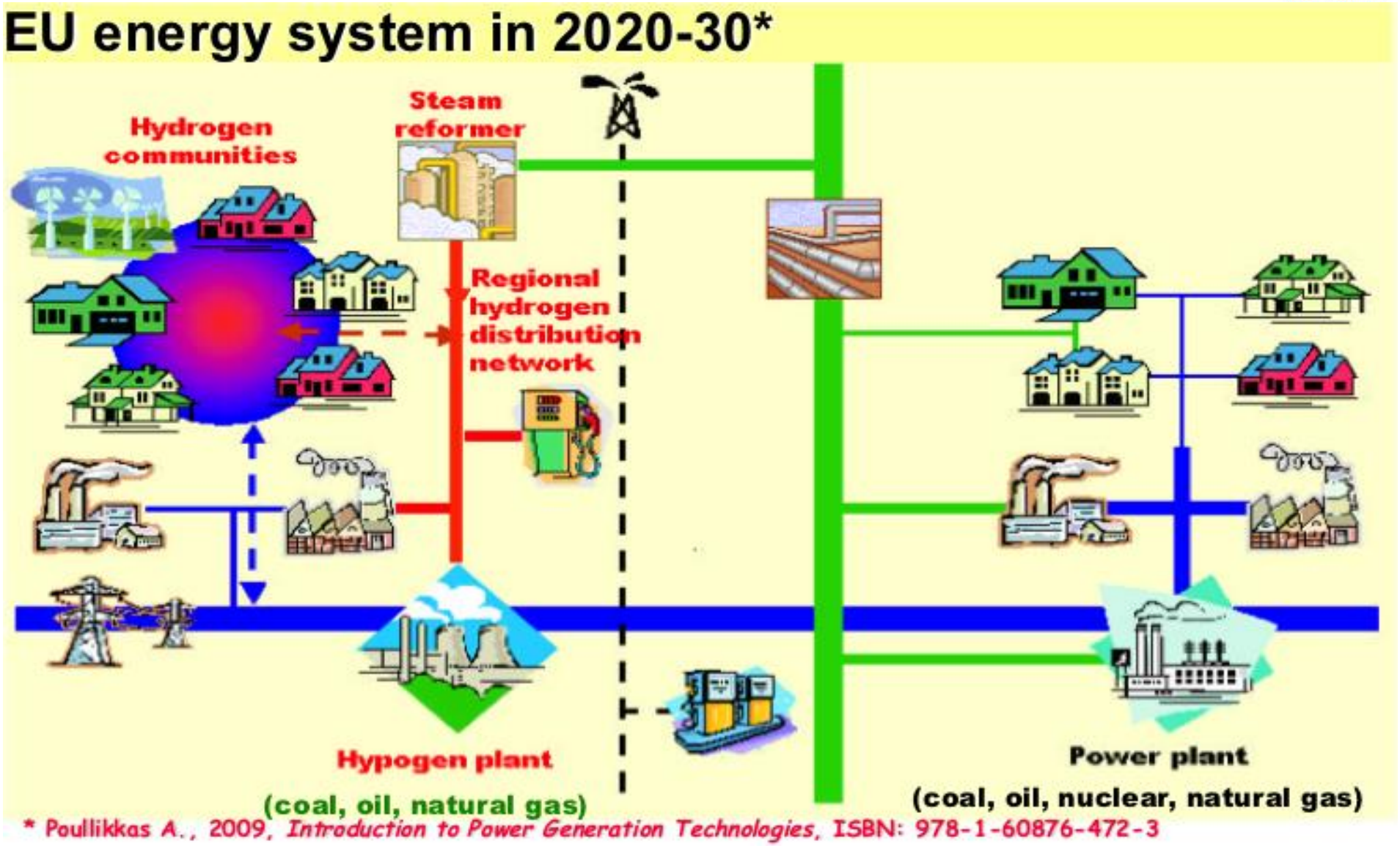

Future energy systems (optimistic scenario)

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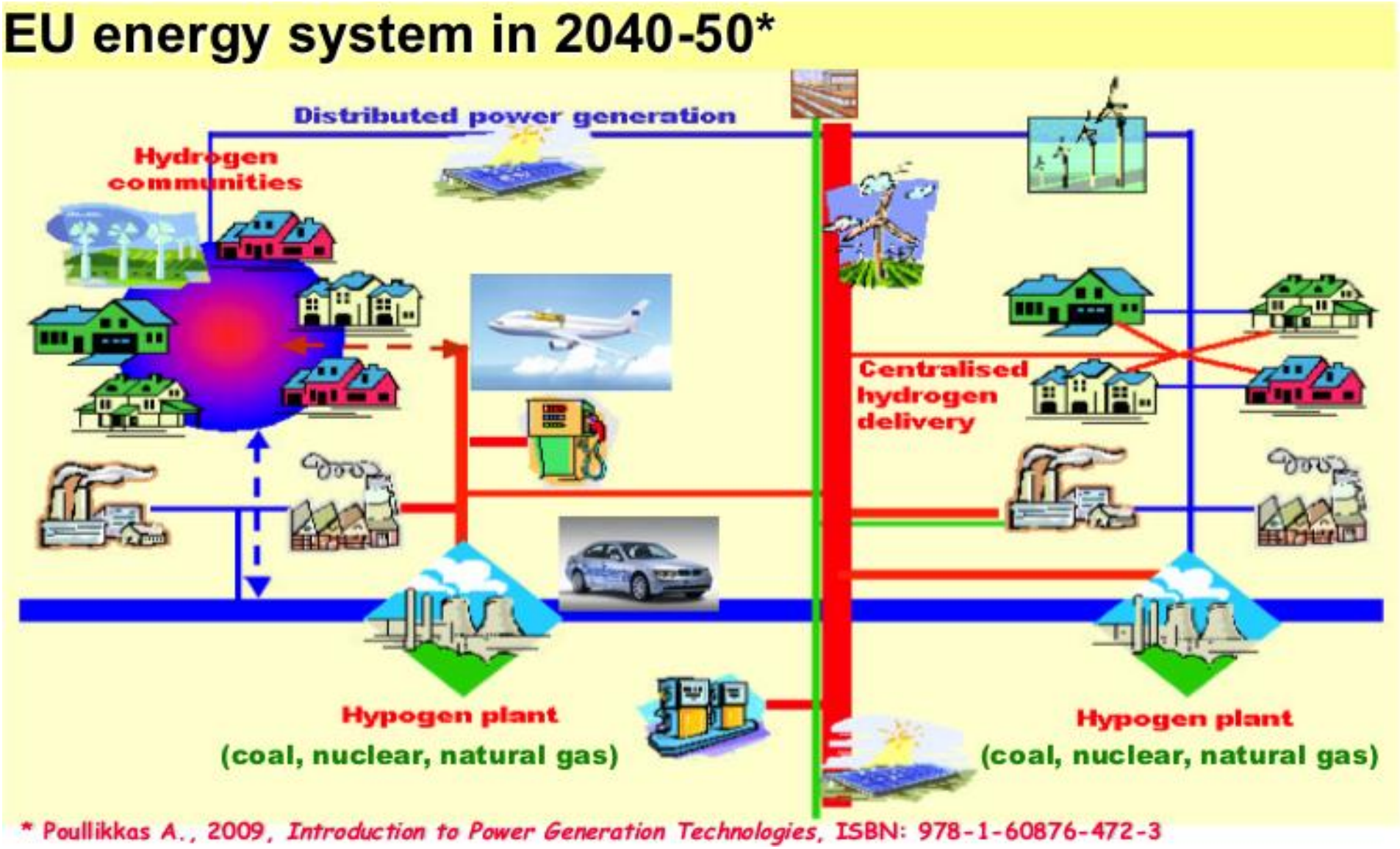
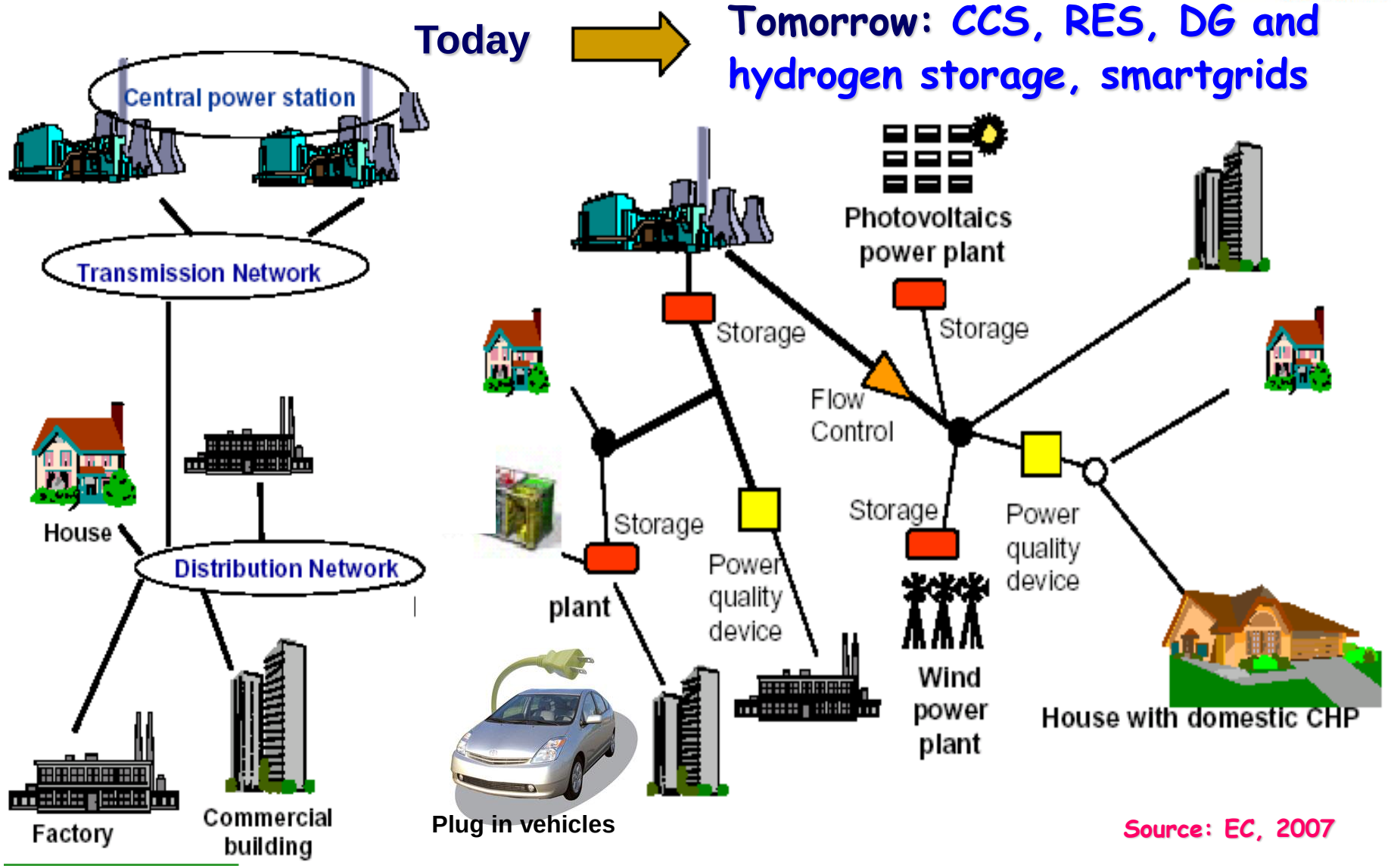
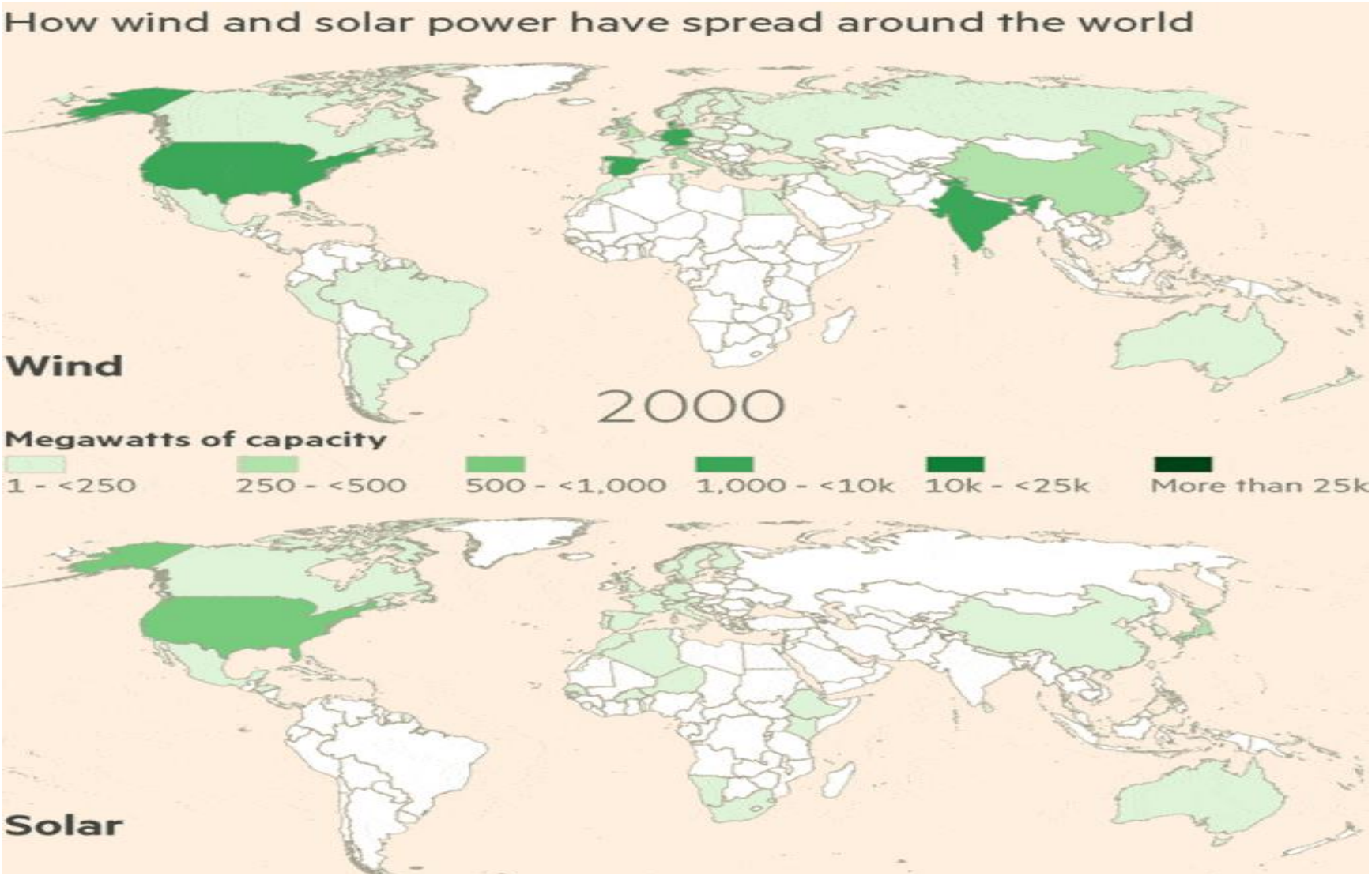


Future power systems



Development of wind and solar power *



*** International Renewables Energy Agency**

End goal – the smart future

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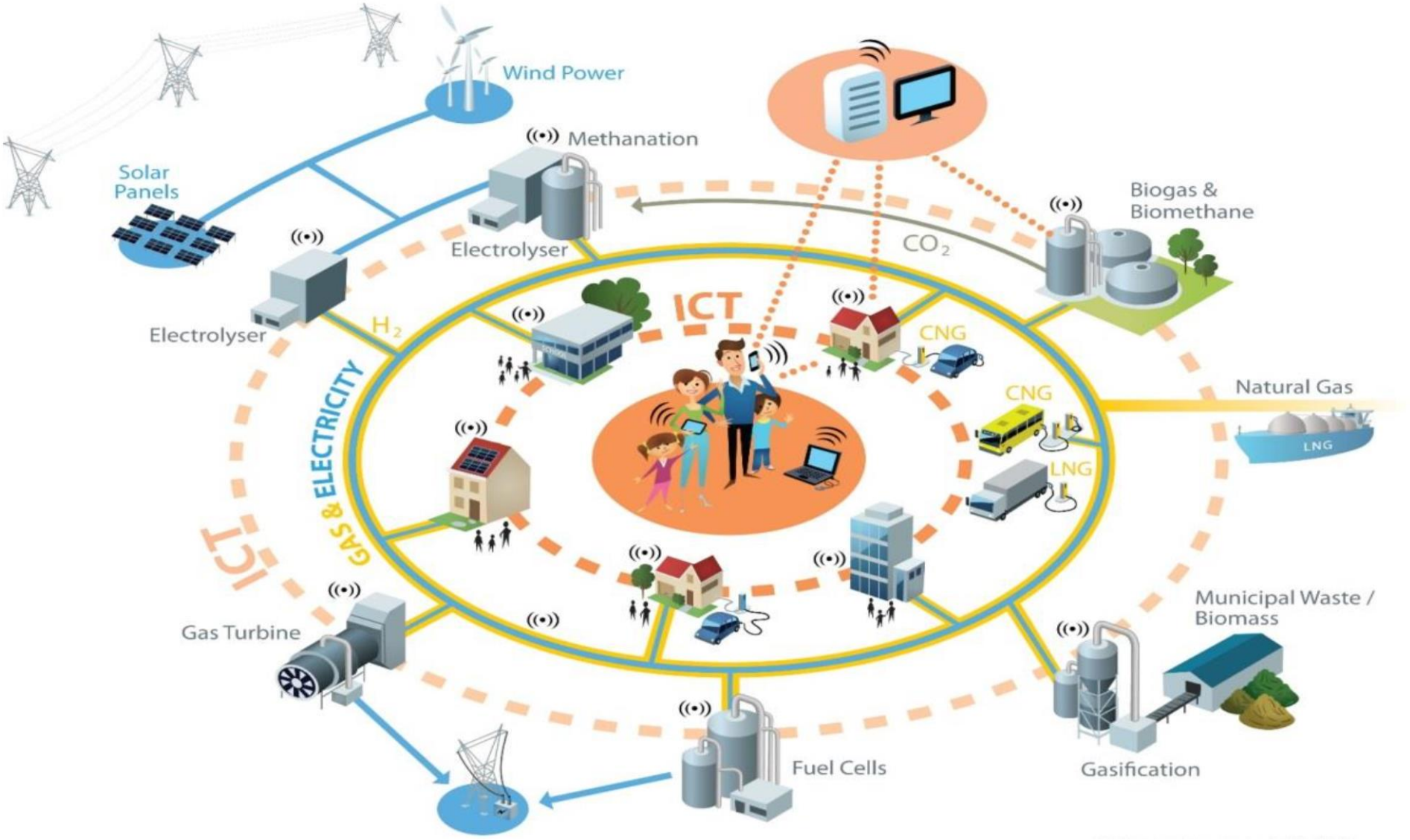

The Super Smart Grid after 2050*
(may allow for 100% RES)

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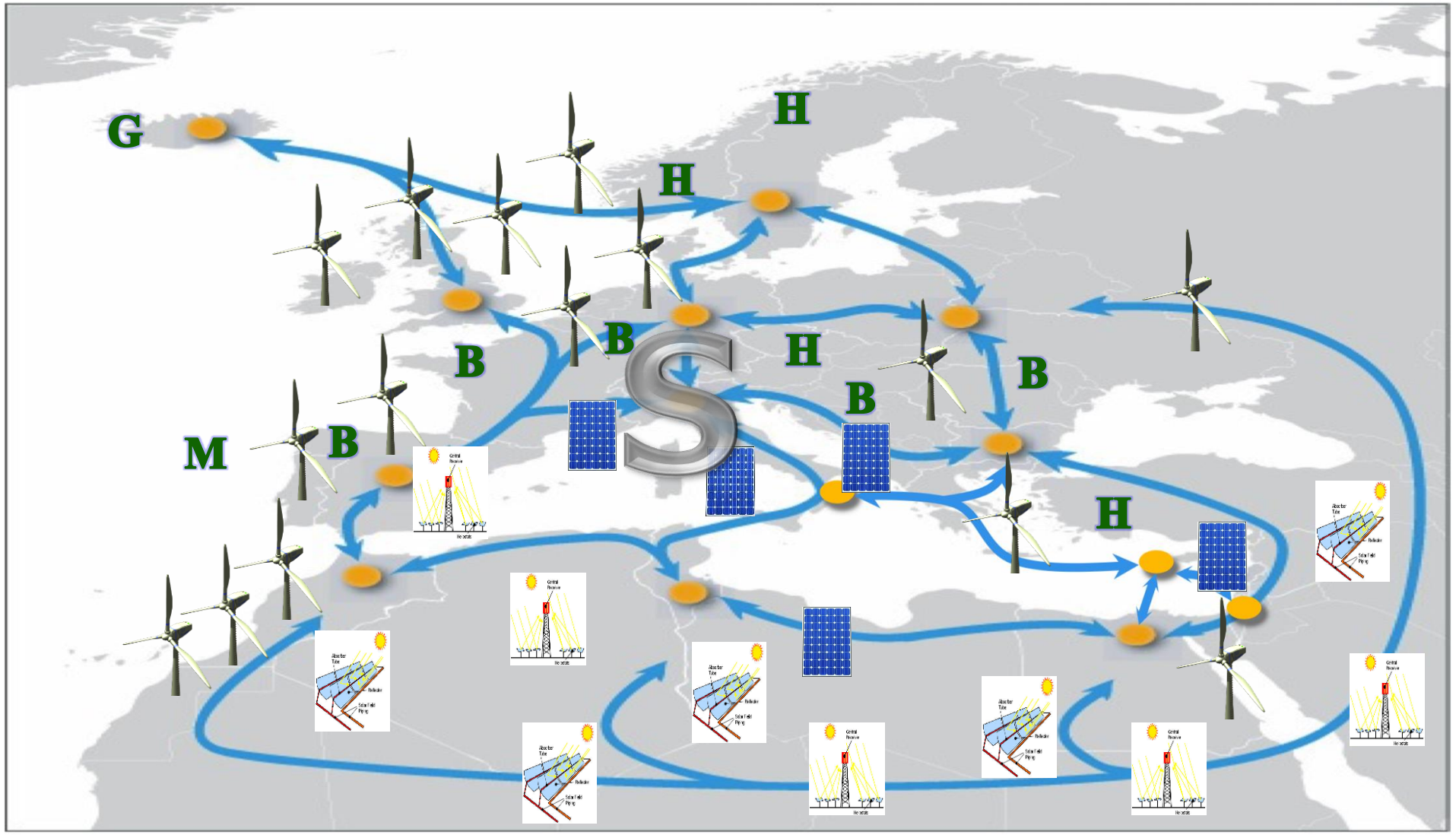
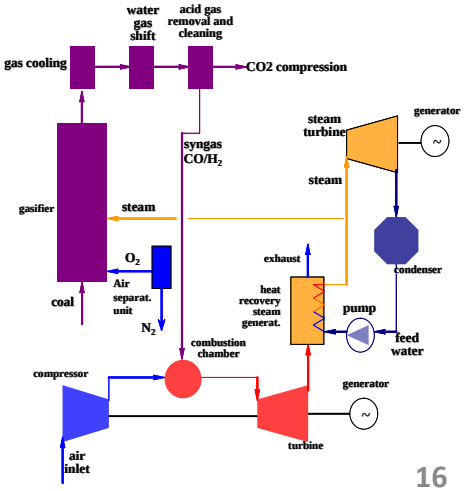


* Poullikkas A., 2013, *Sustainable Energy Development for Cyprus*, ISBN: 978-9963-7355-3-2

Long term EU energy strategy (2050)

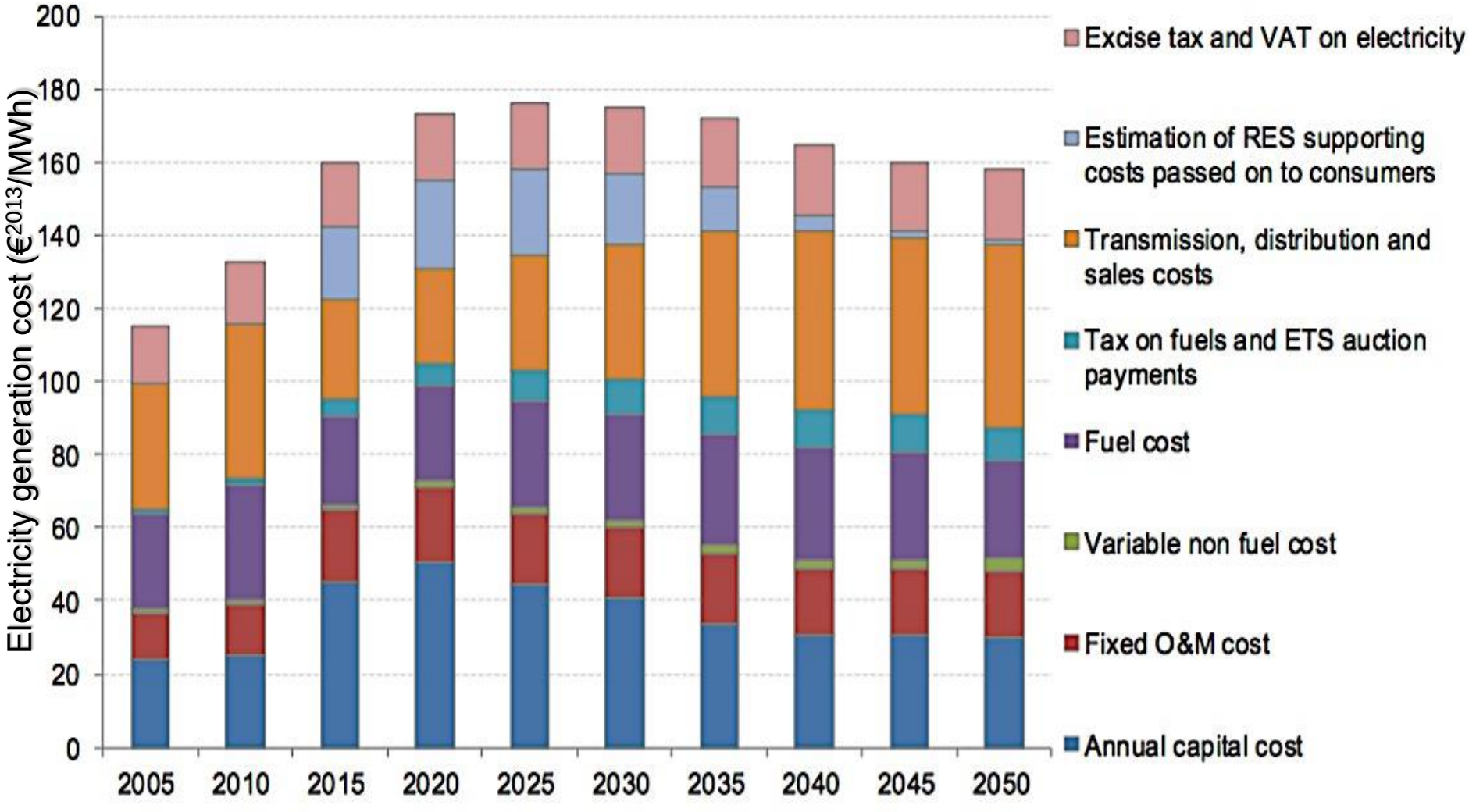
- **A vision of carbon free EU**
- **Main ingredients of future sustainable energy systems:**
  - **Large scale integration of renewable energy sources**
  - **Distributed generation**
  - **Carbon capture and storage**
  - **Smartgrids**
  - **Electric vehicles**
  - **Storage devices**
  - **Hydrogen**



Need to develop advanced simulation tools, new sustainable technologies and infrastructure !!

Energy cost

EU reference scenario 2016



Source: PRIMES

EU reference scenario 2016

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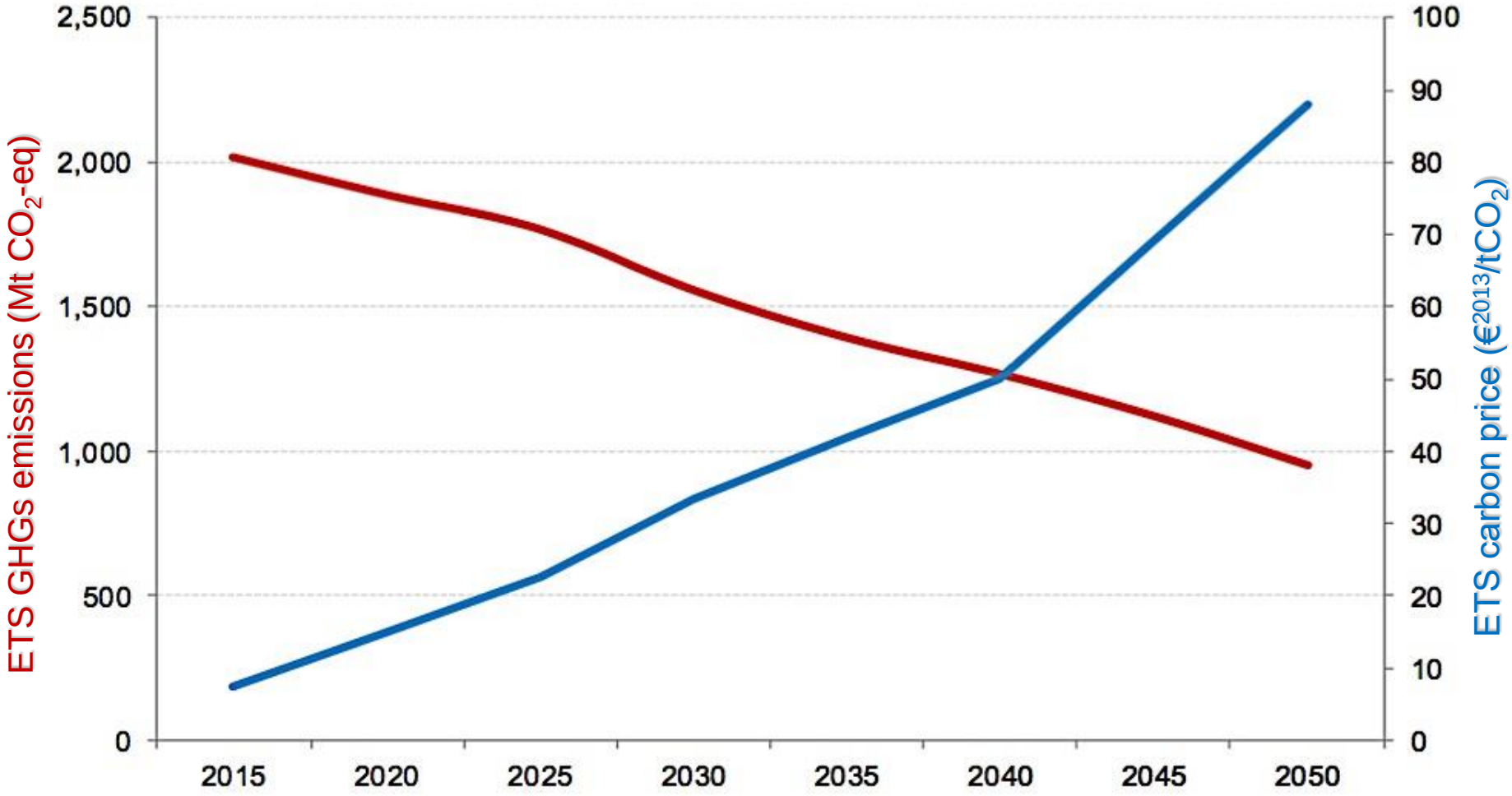
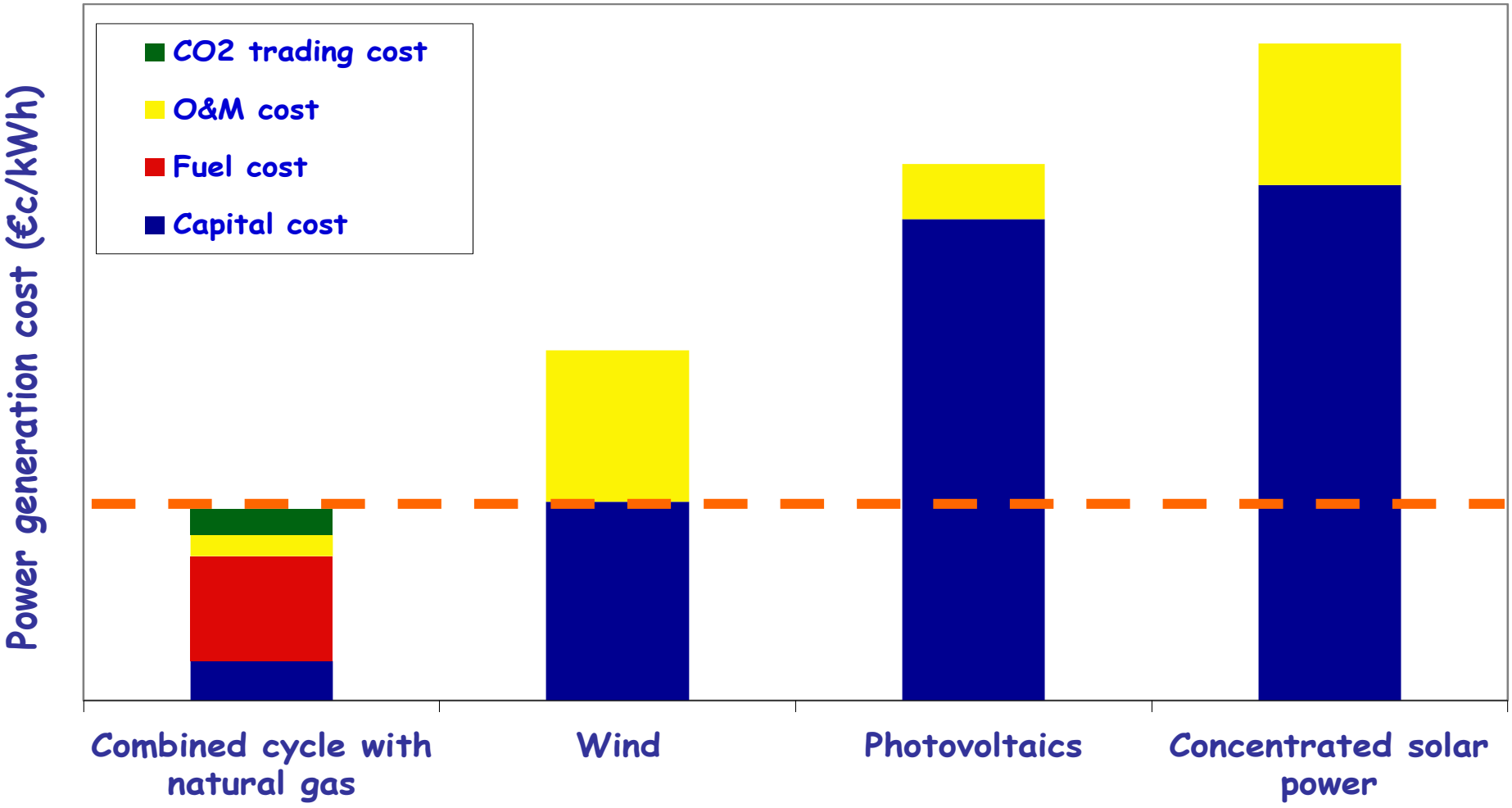


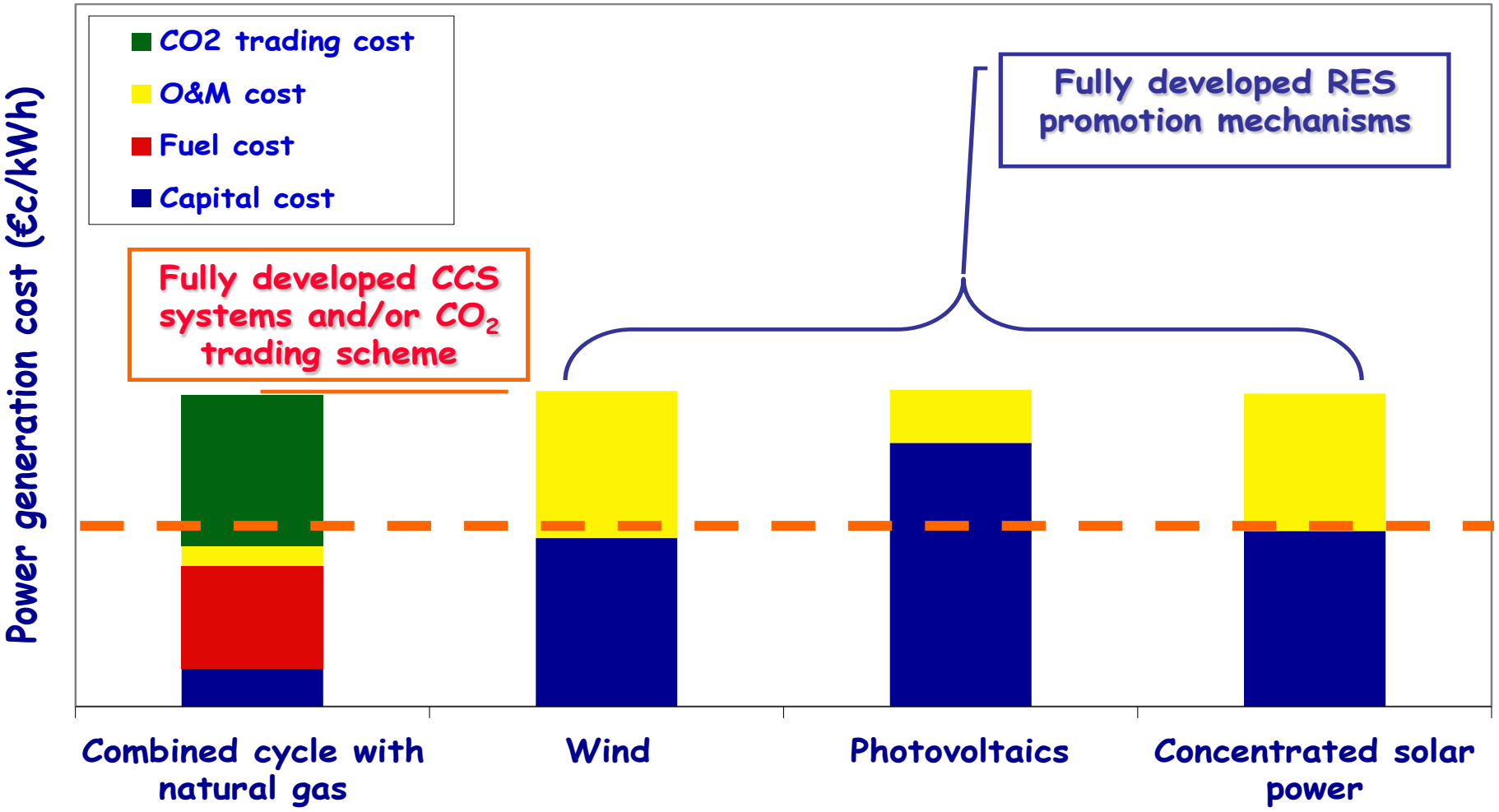
Source: PRIMES, GAINS

Power generation cost (year 2010)*



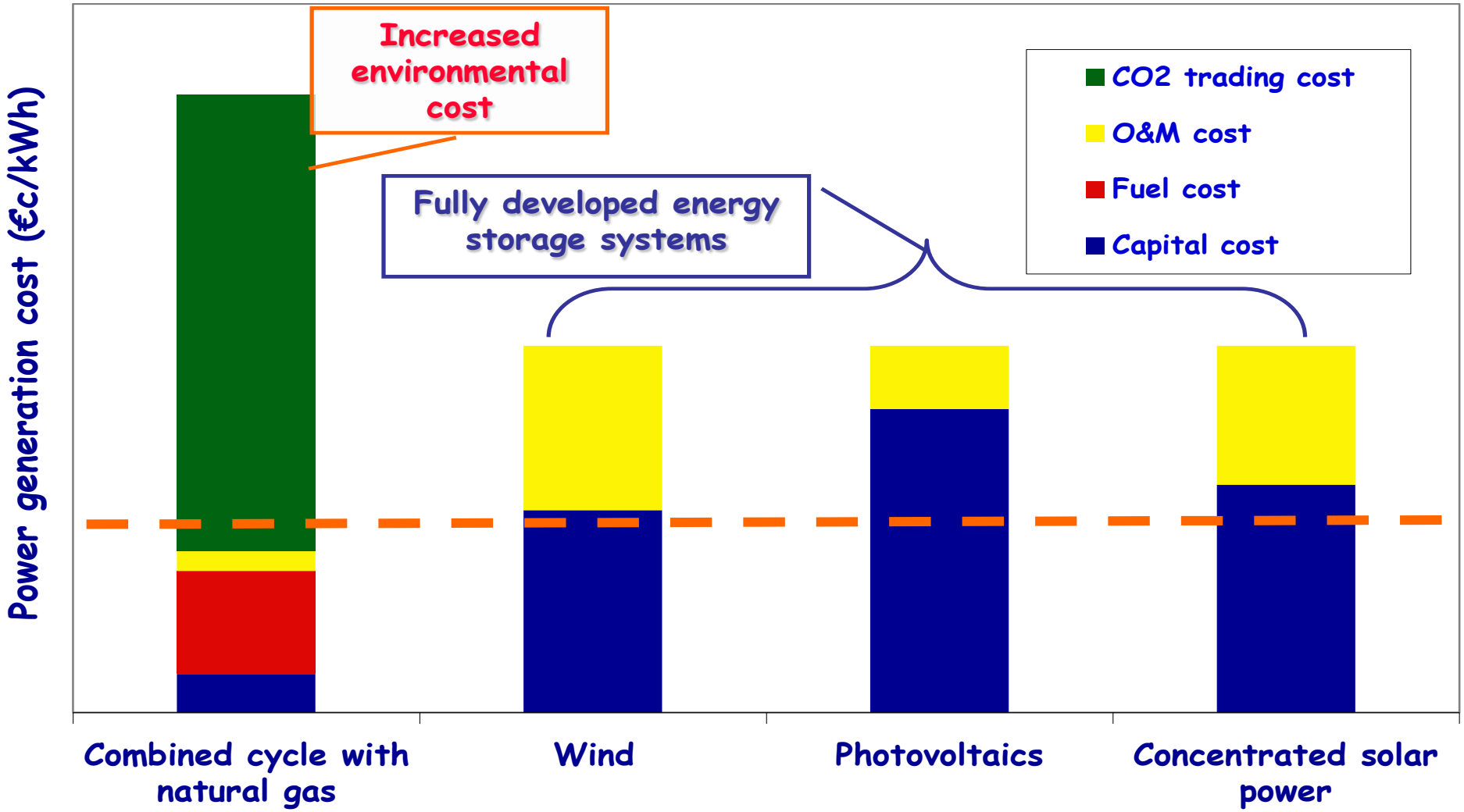
* Poullikkas A., 2010, "The cost of integration of renewable energy sources", *Accountancy*

Power generation cost (year 2020-30)*



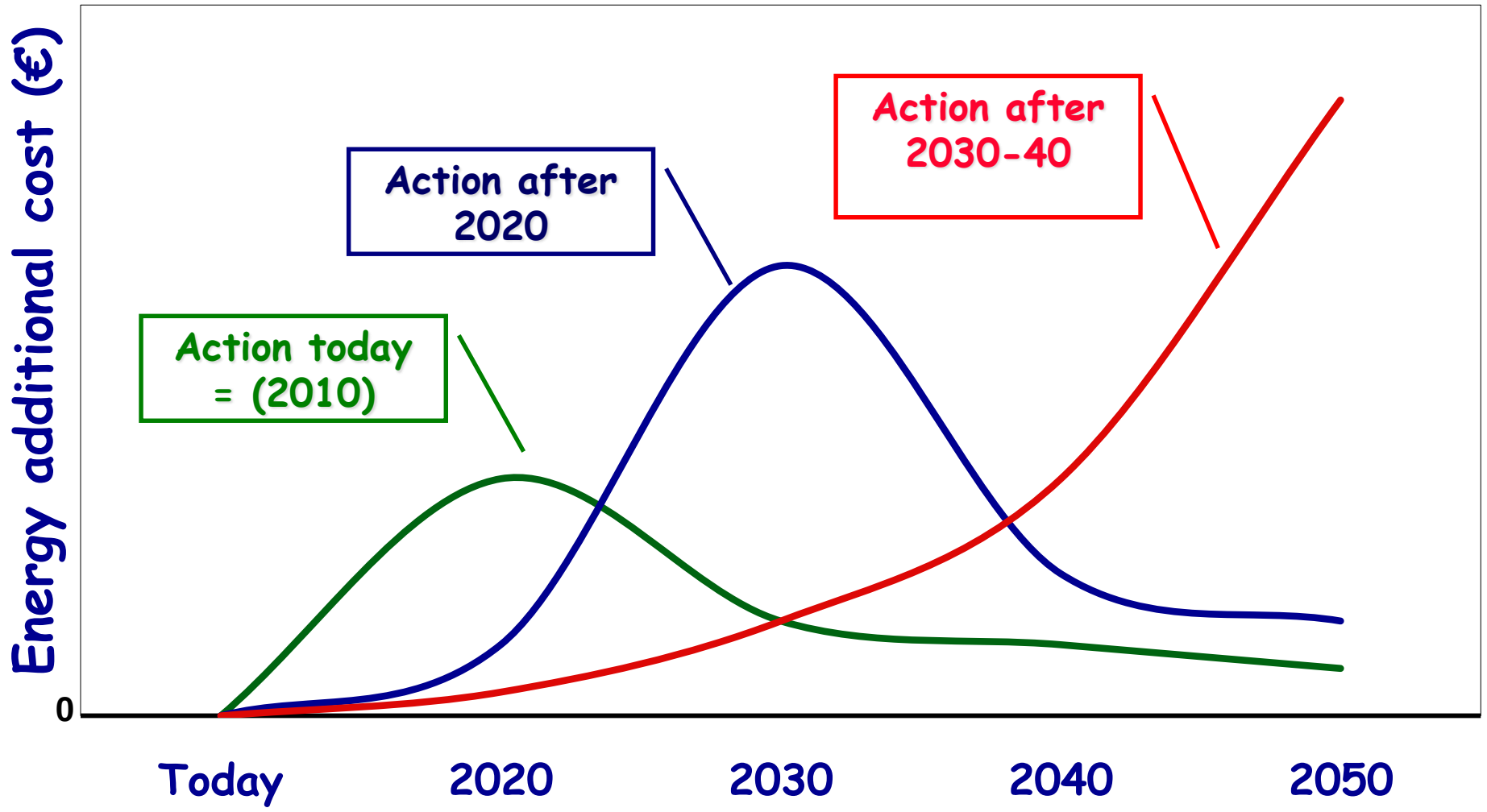
* Poullikkas A., 2010, "The cost of integration of renewable energy sources", *Accountancy*

Power generation cost (year 2040-50)*



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

Future energy cost* (for EU only)



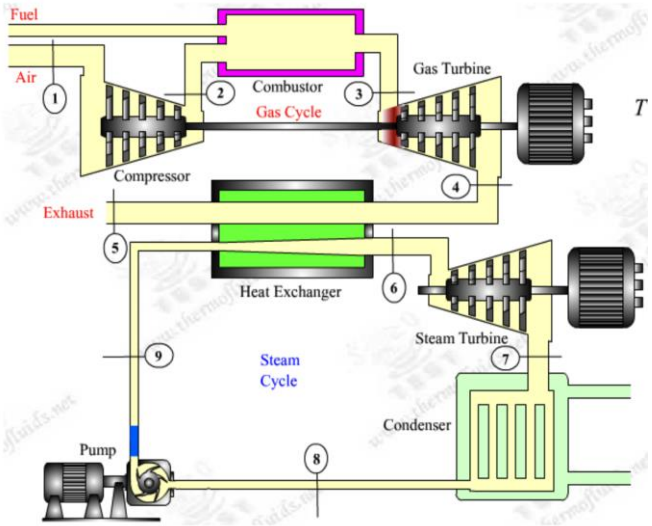
* Poullikkas A., 2010, "The cost of integration of renewable energy sources", *Accountancy*

Cyprus electricity and NG system

Statistics

Existing power generation system

- **Steam turbine units (HFO)**
  - Dhekelia power station 6x60MWe
  - Vasilikos power station 3x130MWe
- **Combined cycles (Diesel)**
  - Vasilikos power station 2x220MWe
- **Gas turbine units (Diesel)**
  - Moni power station 4x37,5MWe
  - Vasilikos power station 1x38MWe
- **Renewables**
  - PVs 121MWe
  - Wind 157MWe
  - Biomass 13MWe



Distribution of RES-E

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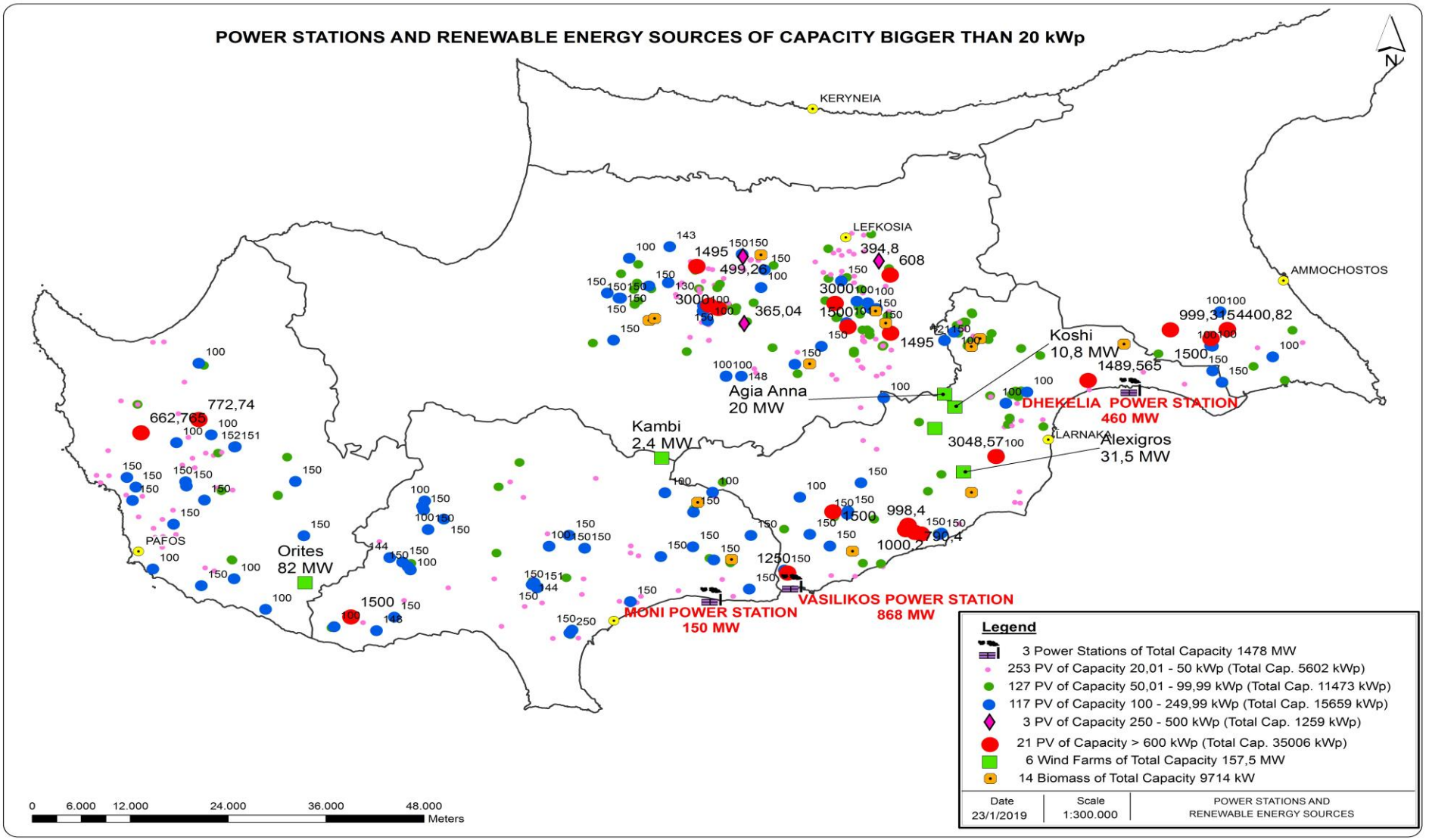
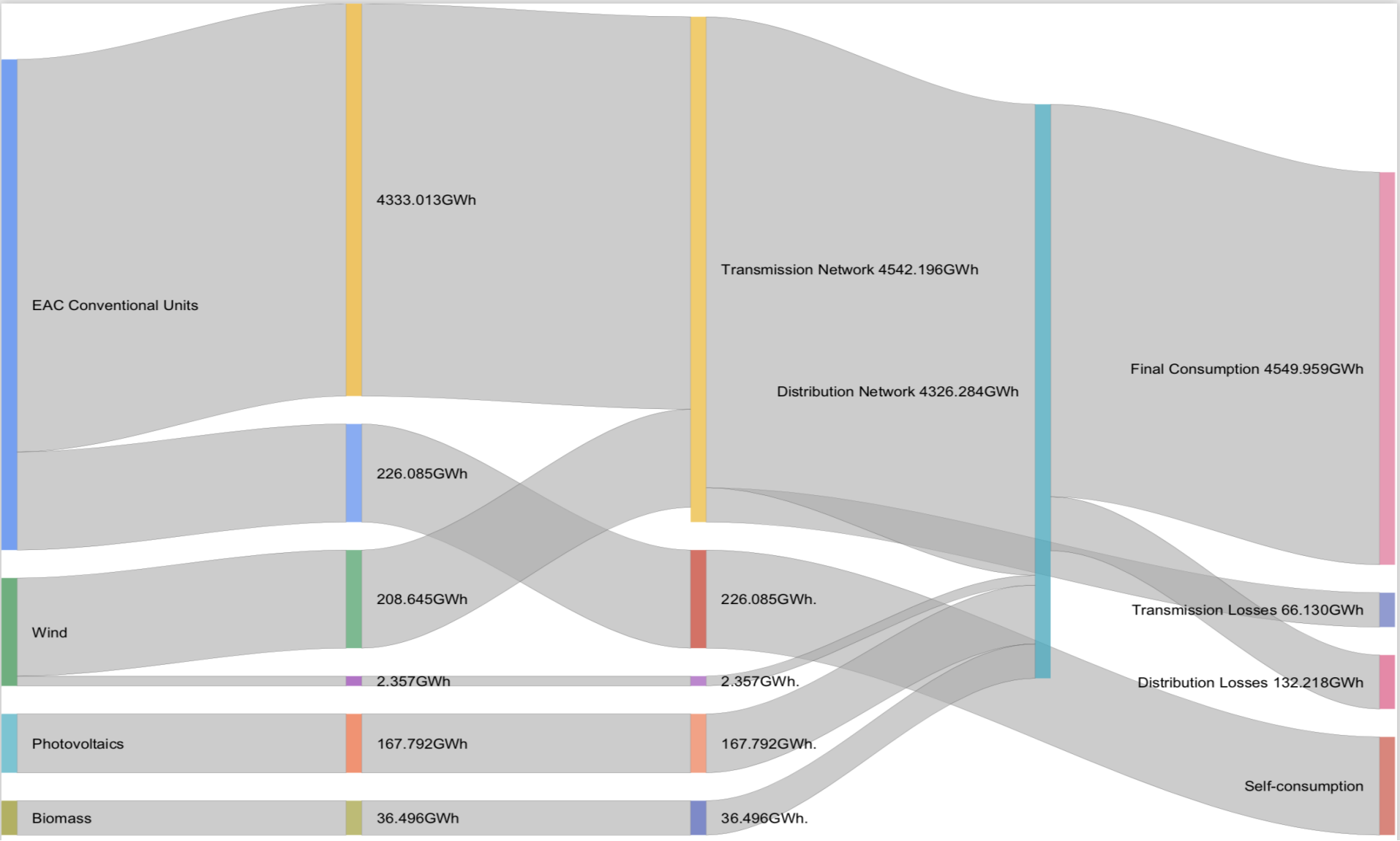


Sankey diagram for electricity (2017)*



RES-E targets

- **Current RES-E penetration: ~9%**

  - PVs 121MWe
  - Wind 157MWe
  - Biomass 13MWe

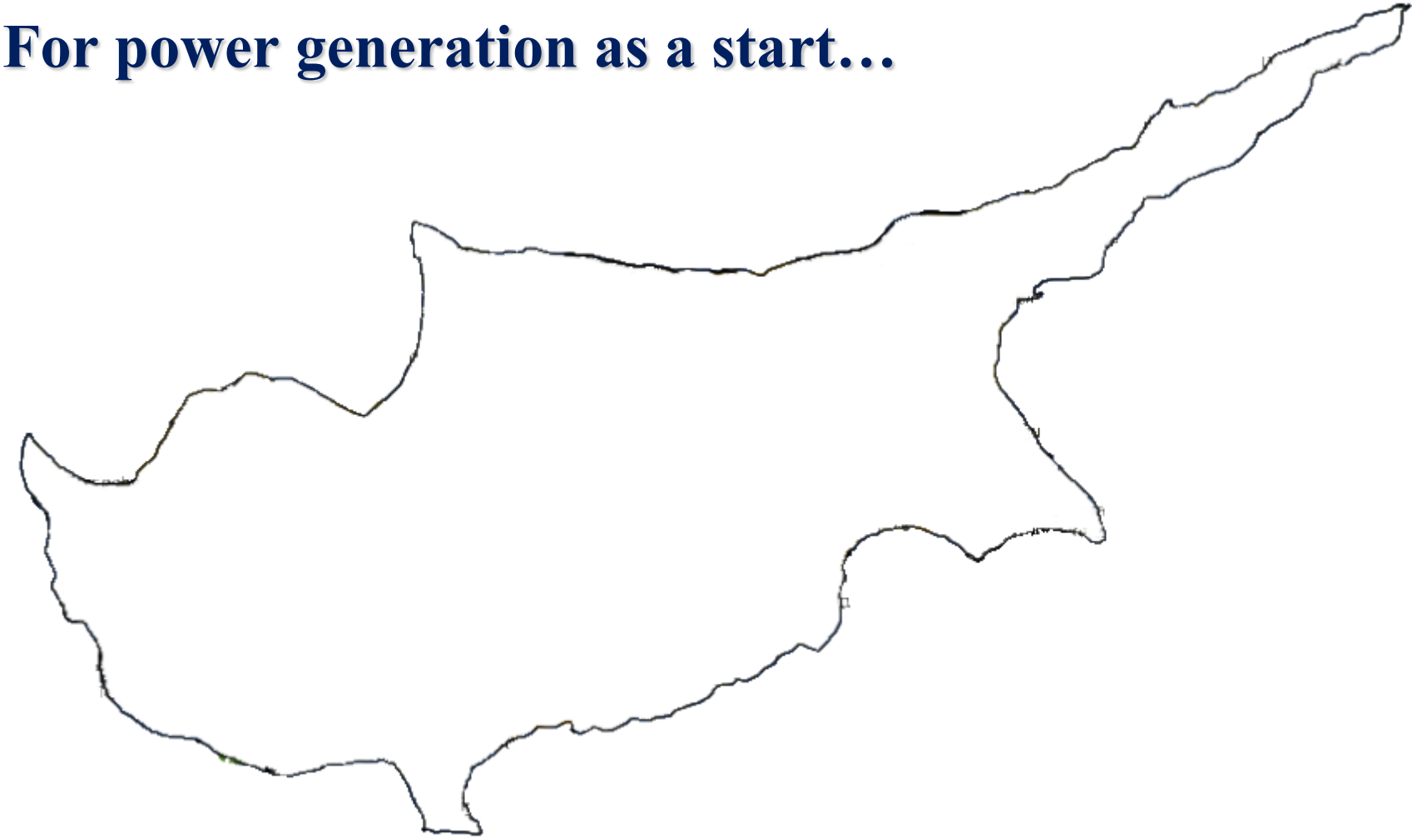
- **RES-E target for 2020: 16%**

  - PVs 288MWe
  - CSP 50MWe or PVs 72MWe
  - Wind 175MWe
  - Biomass 15MWe

- **RES-E target for 2030: not yet**

Existing natural gas system

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



Ρύθμιση ενεργειακού τομέα

Βασικές αρχές ρύθμισης

Βασικές αρχές ρύθμισης

- **Ανεξαρτησία της Ρυθμιστικής Αρχής Ενέργειας**
- **Διαφάνεια στις αποφάσεις της Ρυθμιστικής Αρχής Ενέργειας**
- **Προστασία των επενδυτών και των καταναλωτών ενέργειας από τη Ρυθμιστική Αρχή Ενέργειας**

Επίτευξη βασικών αρχών ρύθμισης

- **Σωστό νομοθετικό πλαίσιο**
- **Αυτονομία στη διαχείριση των οικονομικών πόρων της Ρυθμιστικής Αρχής Ενέργειας**
- **Ικανό και επιστημονικά καταρτισμένο ανθρώπινο δυναμικό**

Η ΡΑΕΚ λογοδοτεί στον Οργανισμό Ρυθμιστών της ΕΕ

Η ΡΑΕΚ (Ευρωπαϊκή και Εθνική νομοθεσία)

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- **Ανεξάρτητη Αρχή, νομικά διακριτή και λειτουργικά ανεξάρτητη από κάθε άλλη δημόσια ή ιδιωτική οντότητα**
- **Λαμβάνει αυτόνομες αποφάσεις**
- **Καταρτίζει ξεχωριστές δημοσιονομικές προβλέψεις, αυτονομία ως προς την εκτέλεση του προϋπολογισμού και για την εκτέλεση των καθηκόντων της**
- **Διορίζει μέλη του προσωπικού του γραφείου της ΡΑΕΚ, για την εκτέλεση των καθηκόντων της**

Κύριες εξουσίες ΡΑΕΚ

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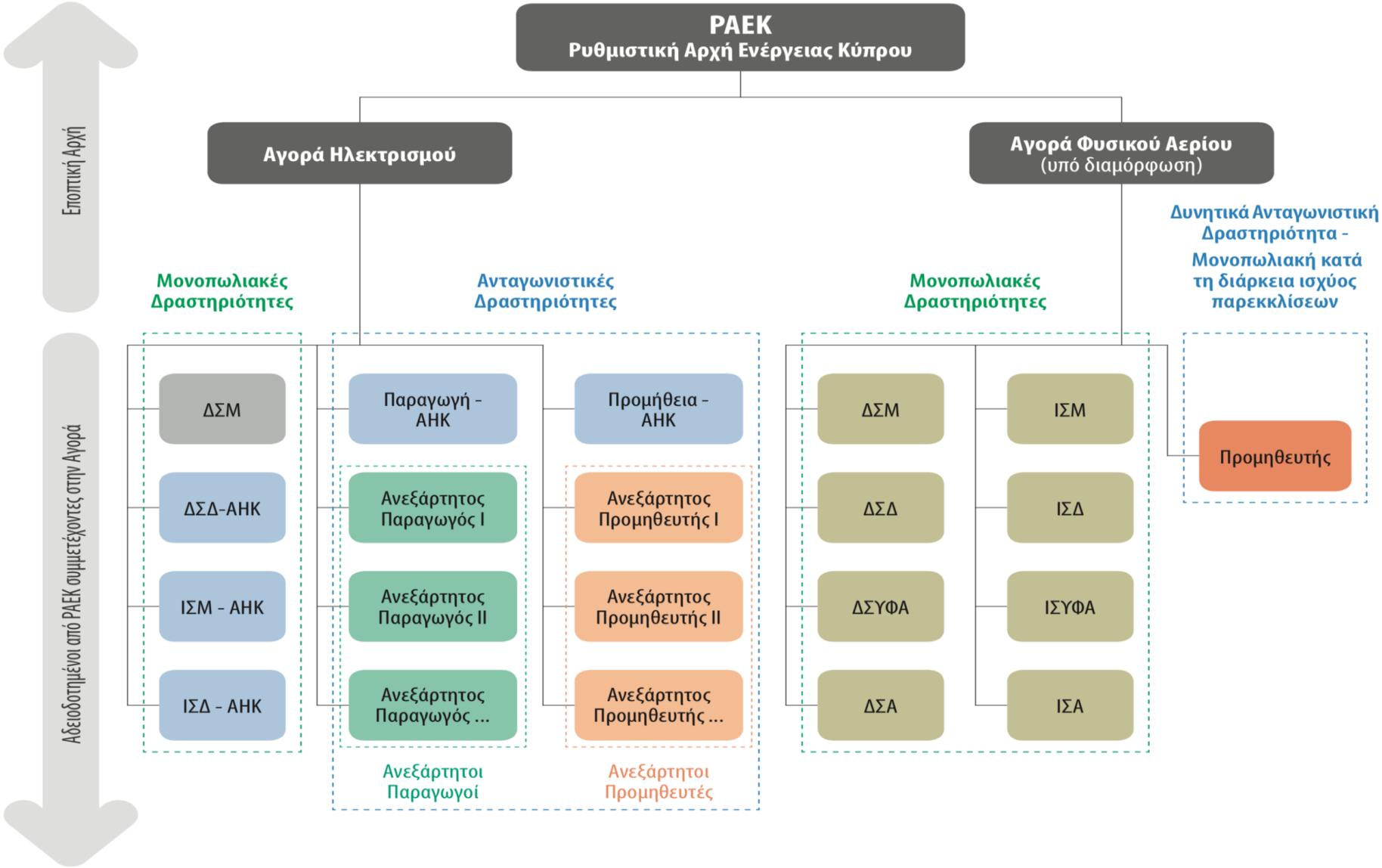
- **Επιβλέπει και ρυθμίζει την αγορά ηλεκτρισμού και φυσικού αερίου**
- **Διασφαλίζει τον ουσιαστικό και υγιή ανταγωνισμό**
- **Προστατεύει τα συμφέροντα των καταναλωτών**
- **Εξασφαλίζει την ασφάλεια, την ποιότητα, την επάρκεια και την αξιοπιστία στην παροχή ενέργειας**
- **Ενθαρρύνει τη χρήση των ΑΠΕ**

Κύριες εξουσίες ΡΑΕΚ (συνέχεια)

- **Αδειοδοτεί και επιβλέπει όλους τους συμμετέχοντες στις αγορές ηλεκτρισμού και φυσικού αερίου:**
  - **Ανταγωνιστικές δραστηριότητες: παραγωγούς ηλεκτρικής ενέργειας, προμηθευτές ηλεκτρικής ενέργειας, προμηθευτές φυσικού αερίου, κλπ**
  - **Μονοπωλιακές δραστηριότητες: ιδιοκτήτη συστήματος μεταφοράς, διαχειριστή συστήματος μεταφοράς, ιδιοκτήτη συστήματος διανομής, διαχειριστή συστήματος διανομής, λειτουργό αγοράς, κλπ**
- **Πιστοποιεί τον διαχειριστή συστήματος μεταφοράς**

Εποπτεία - αδειοδότηση



Challenges in electricity markets

RES integration

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

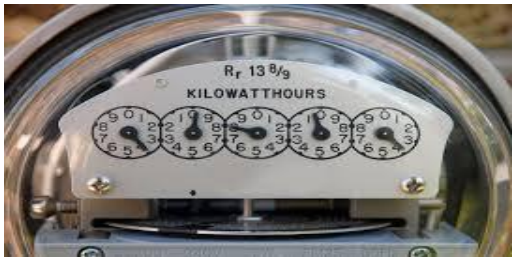
Electricity market functions

- **Generation** (competition)

- **Transmission** (monopoly)

- **Distribution** (monopoly)

- **Supply** (competition)



Competition *vs* monopoly

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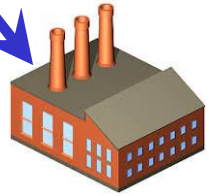
Transmission grid



Distribution grid



Electricity markets current issues

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- **Electricity markets open to competition**
  - **Increase in technologies efficiency**
  - **Reduce energy generation costs**
- **Protection of the environment**
  - **Reduce primary emissions**
  - **Reduce greenhouse gas emissions**
  - **Develop alternative technologies**

EU electricity market target model

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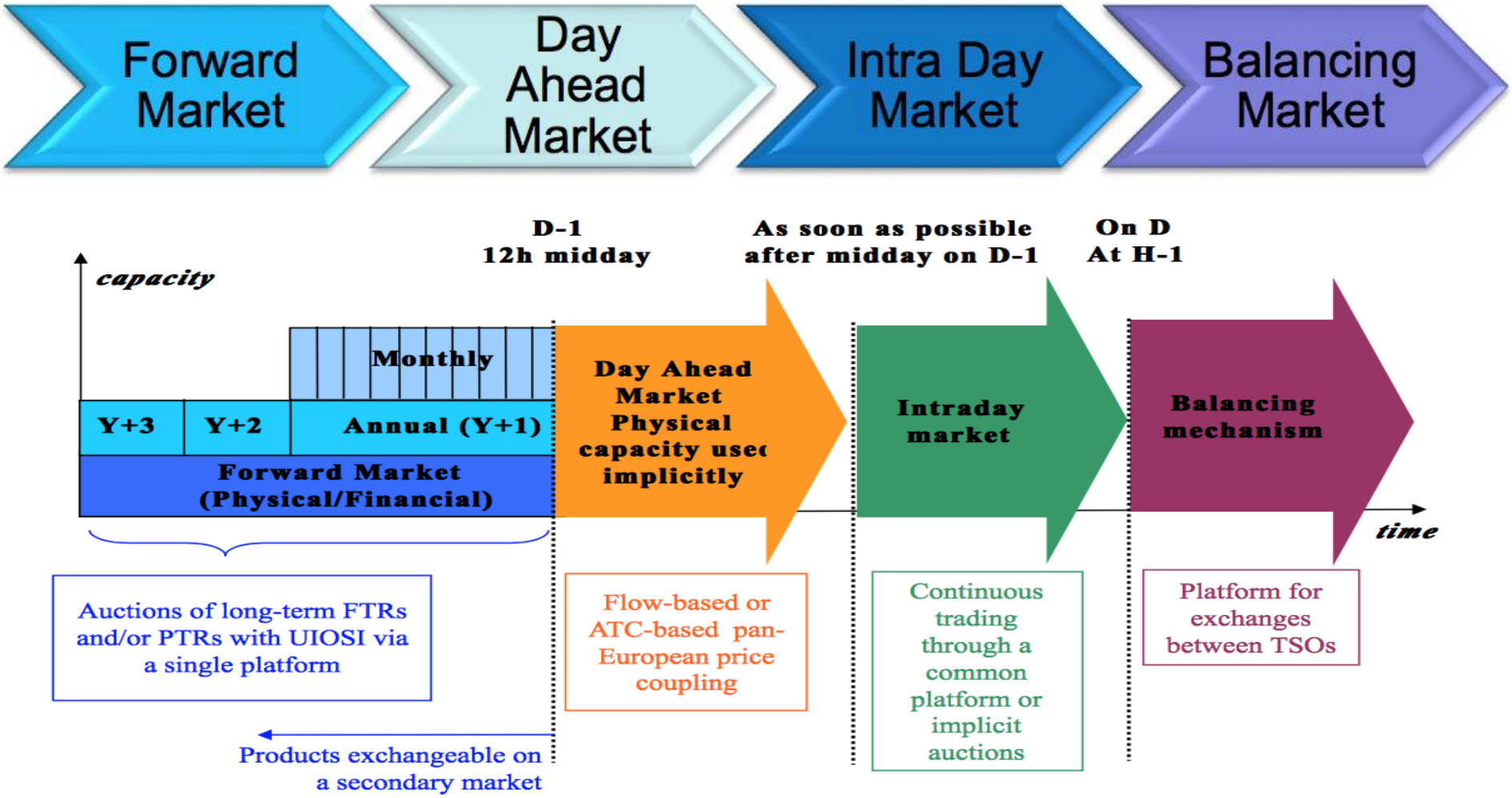


Integration of RES: LCOE *vs* Reliability

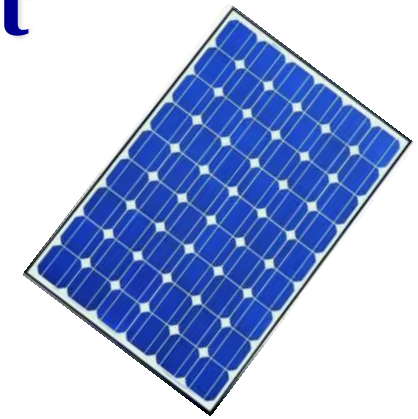
Power system reliability*

- **adequacy, PS ability to satisfy customers needs both in power and electrical energy**
- **security, PS ability to remain in operation after sudden disturbances**

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

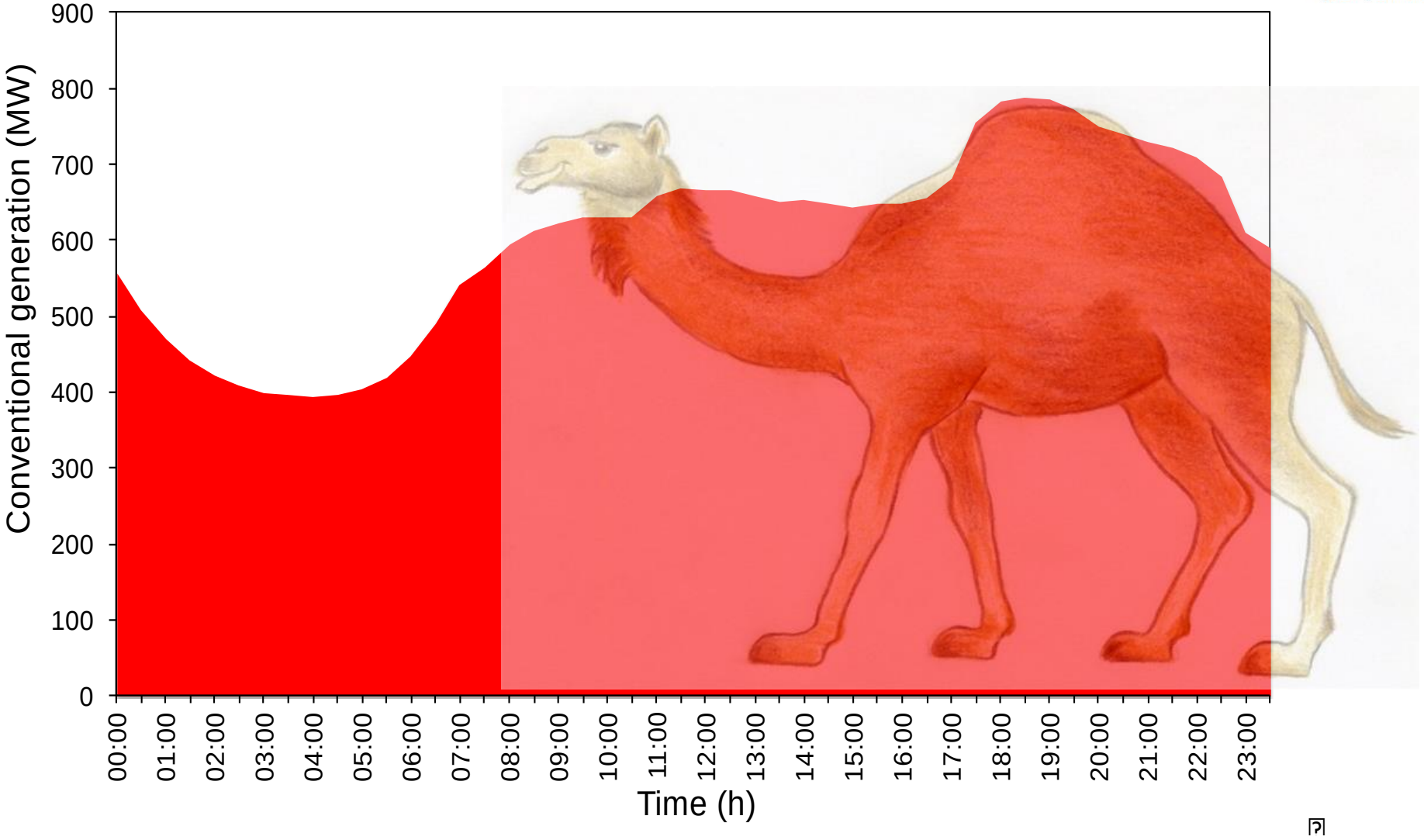
Intermittent energy source*

- 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



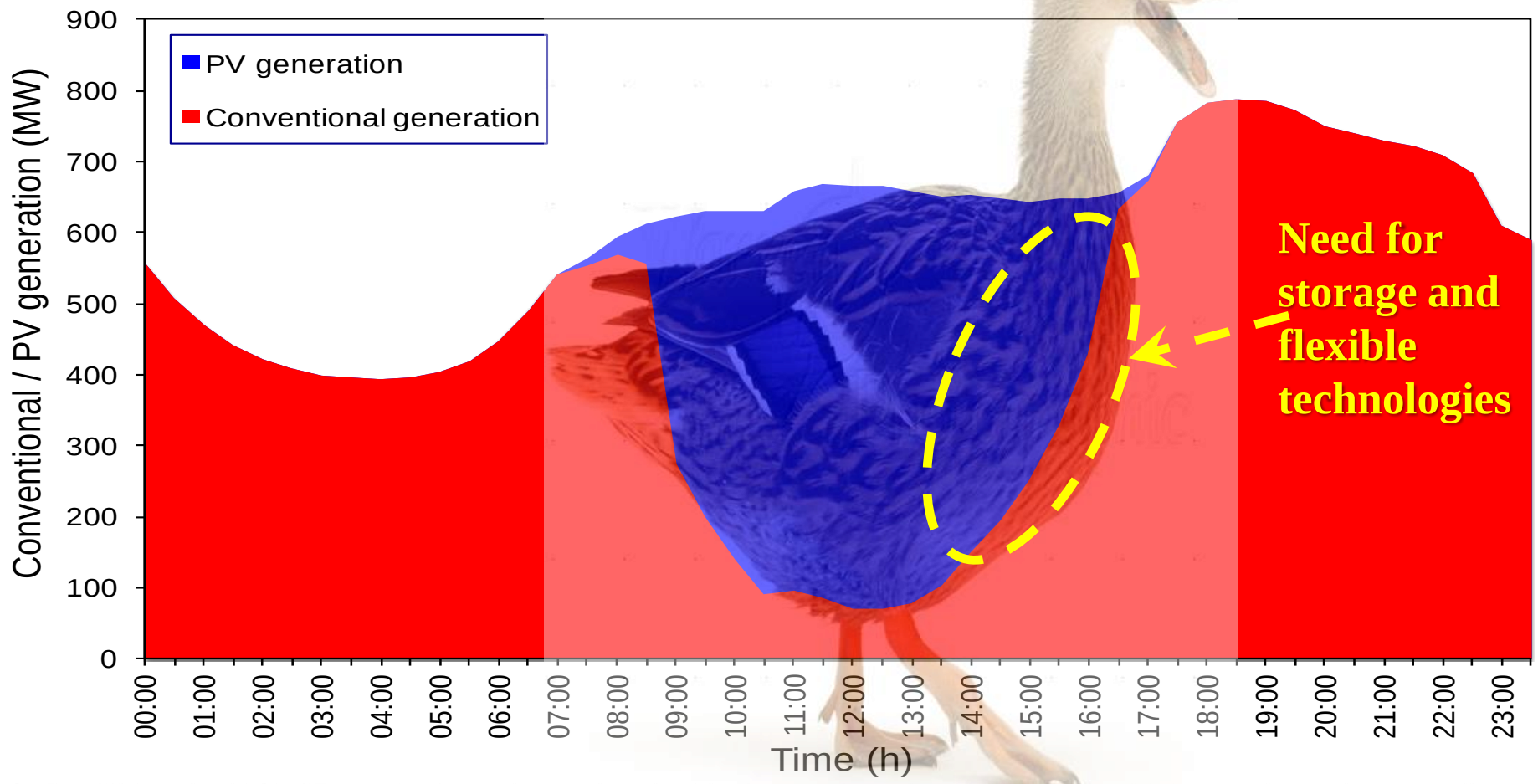
* Poullikkas A., 2013, *Renewable Energy: Economics, Emerging Technologies and Global Practices*, ISBN: 978-1-62618-231-8

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*

Gas is a pillar of renewable energy (power production in UK*)

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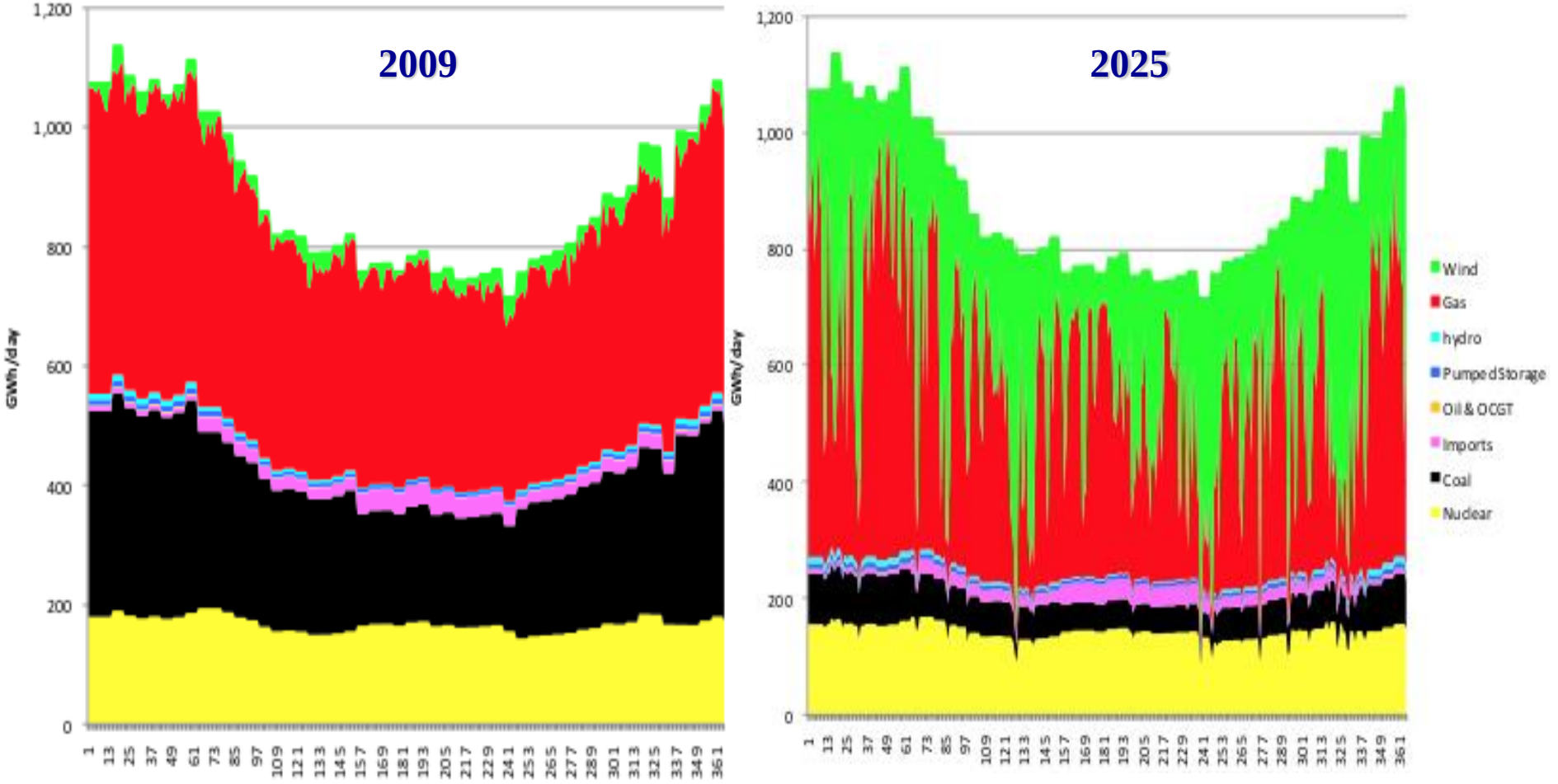
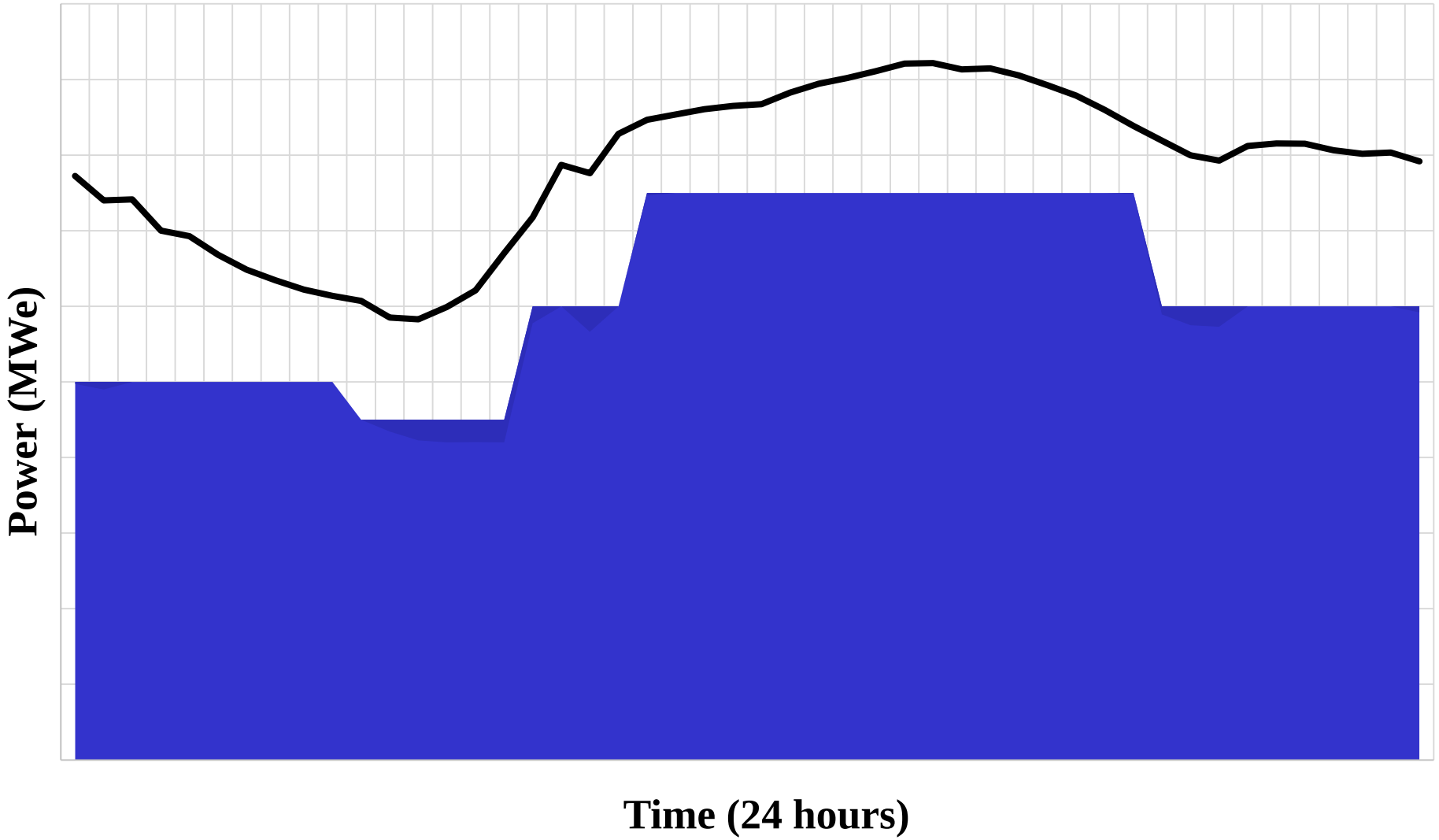


* H.V. Rogers, 2011, *The Impact of Import Dependence and Wind Generation on UK Gas Demand and Security of Supply to 2025*, The Oxford Institute For Energy Studies

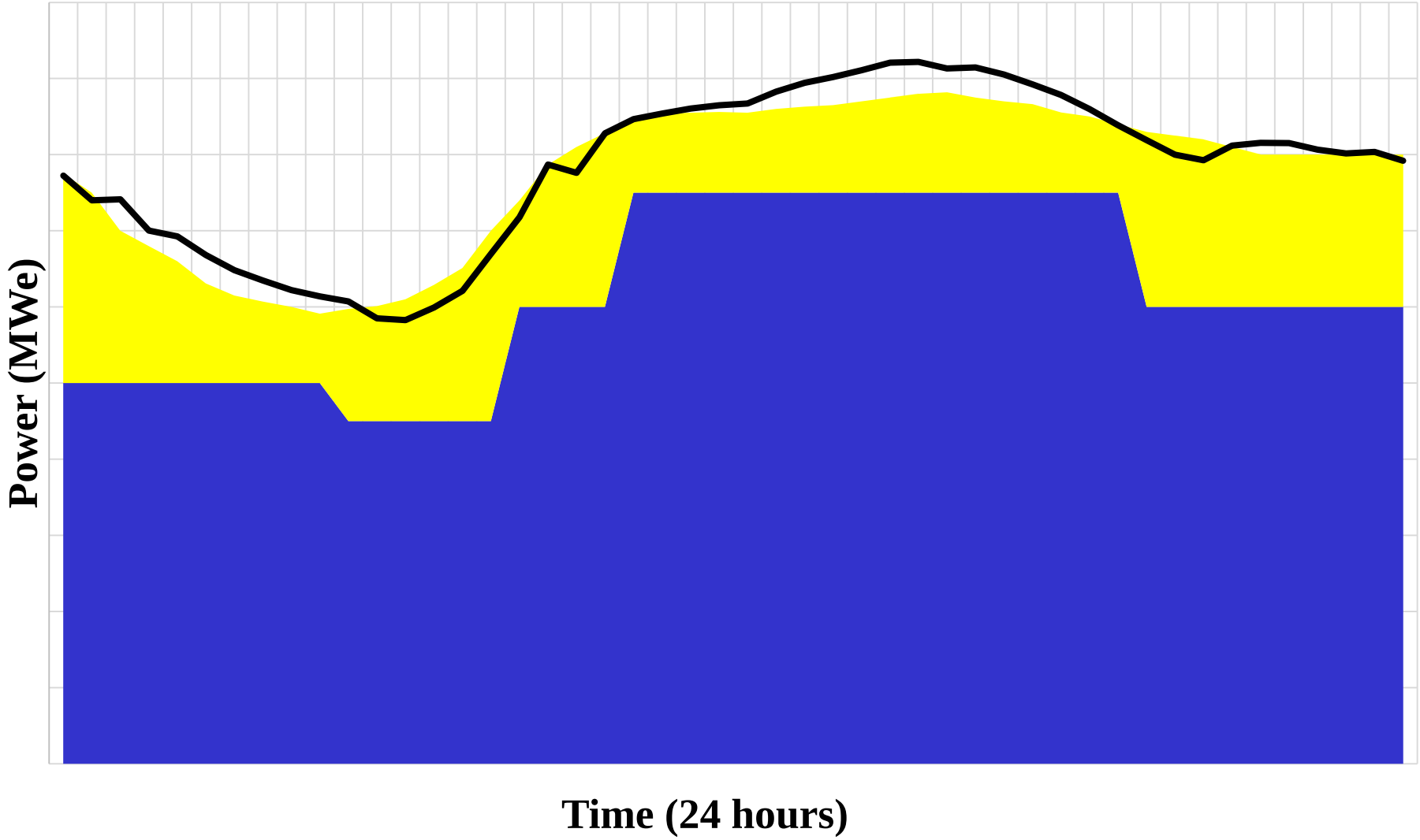
Electricity market operation

- **Forward market**



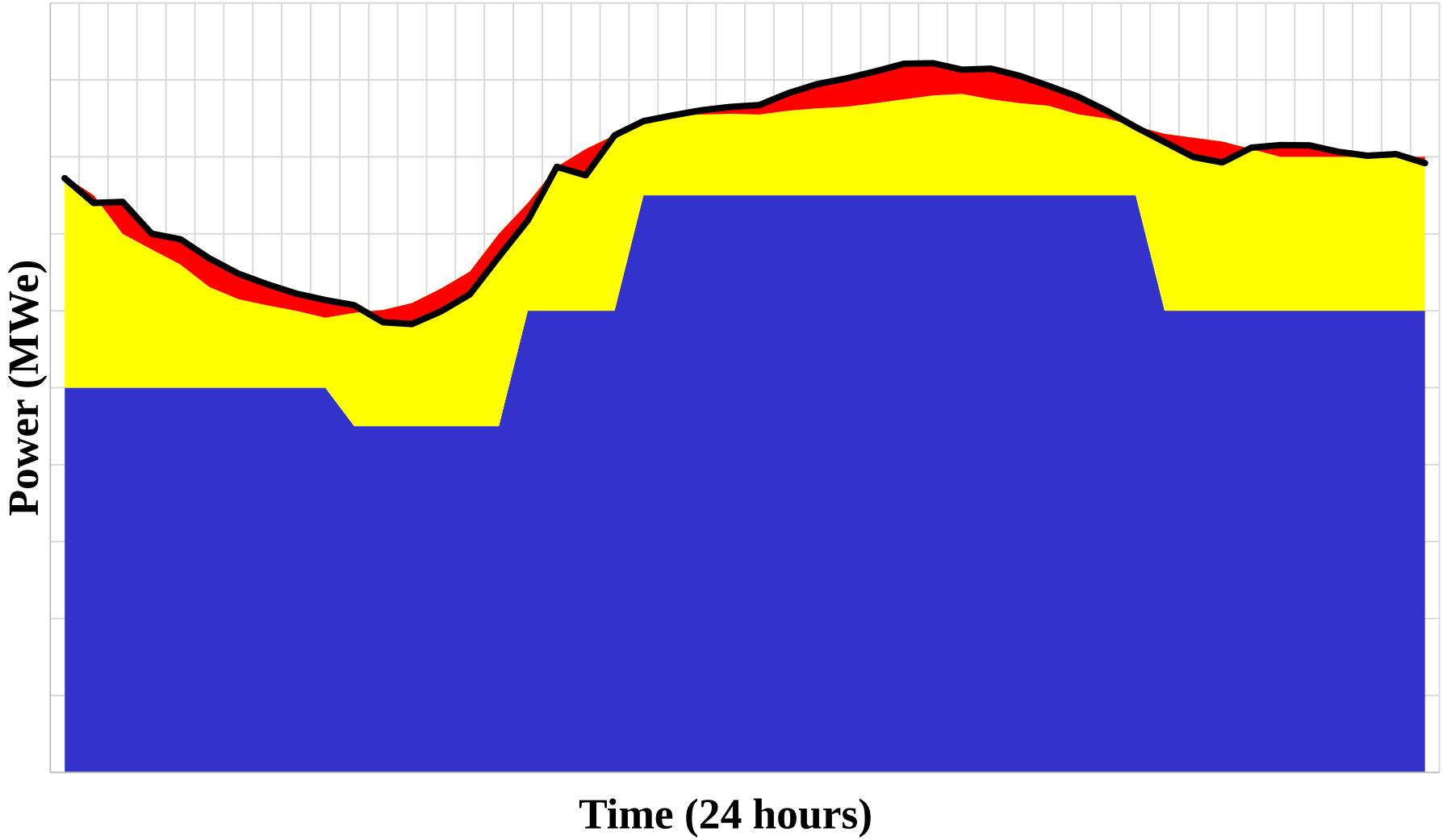
Electricity market operation

- **Forward market + Day ahead market**



Electricity market operation

- **Forward market + Day ahead market + Balancing market**



Basics of electricity tariffs

- Generation cost including reserves to meet peak demand and forced outages at reference fuel prices (e.g. at 300€/MT)
- Transmission and distribution cost
- Metering cost
- Supply cost
- Rate of return
- Fuel cost adjustment at real fuel (e.g., Aug 2017 318€/MT or Aug 2018 460€/MT)

Tariff regulation

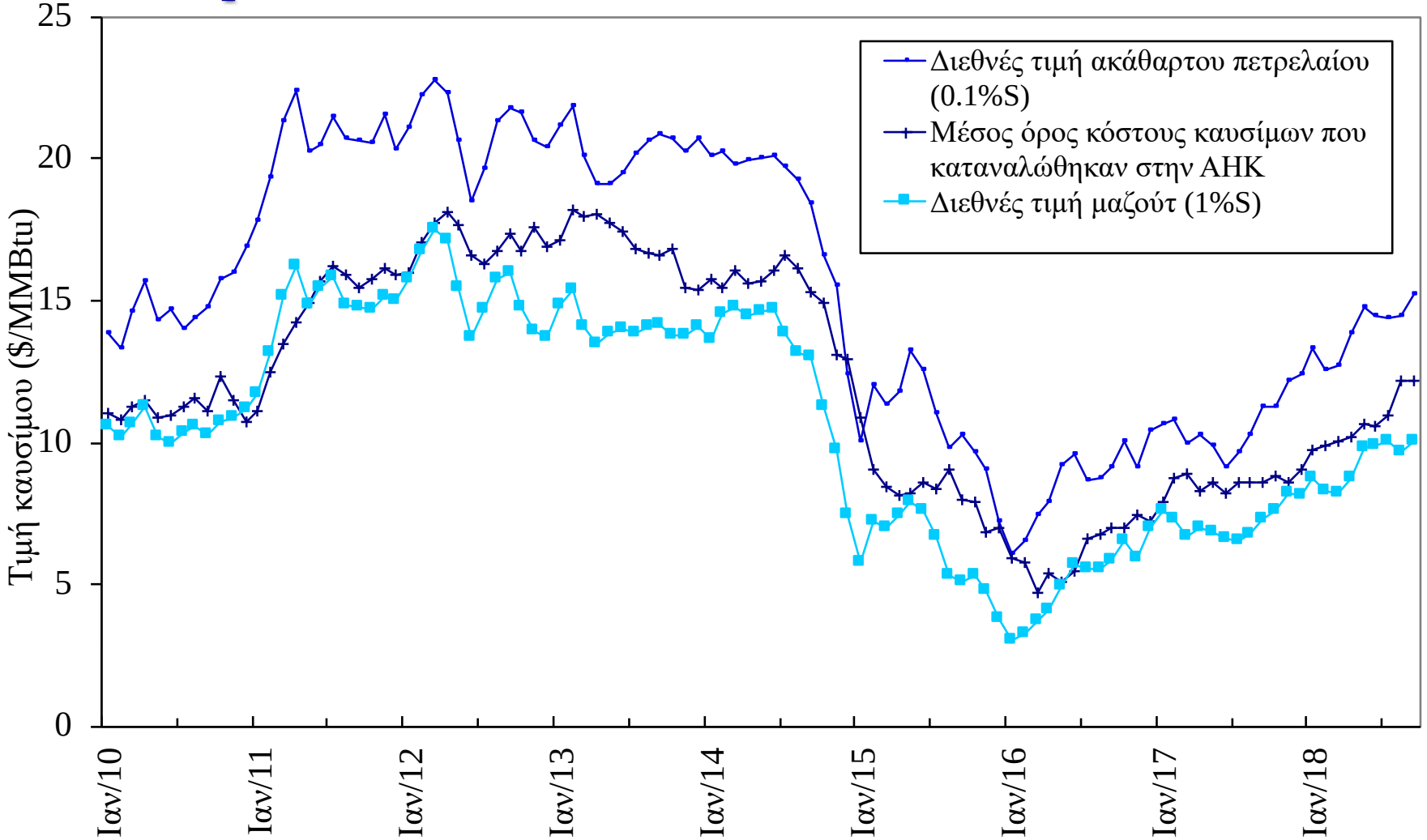
- **Incentive regulation *vs* cost plus regulation**
- **New regulated tariffs since Sep 2017**
  - **Public consultation**
  - **Allowable income for the next 5 years**
  - **WACC set at 4.6% (significantly decreased)**
  - **Efficiency factor set at -1.5%**
  - **Overall ~ 6% reduction on basic tariffs**
  - **Transparency in electricity bills**

Parameters affecting electricity price

- **Capital expenditure – control by allowable income**
- **Operating cost – control by allowable income**
- **Other taxes – Government policy**
  - **Green tax**
  - **Public service obligations**
  - **VAT**
- **Fuel mix – available generation technologies; fuel used**
- **Fuel price – international market**

Historic fuel prices

- **Brent oil price 2017: 50US$/bbl**
- **Brent oil price 2018: 80US$/bbl**



Historic tariffs for Cyprus* (2012-Aug 2017)

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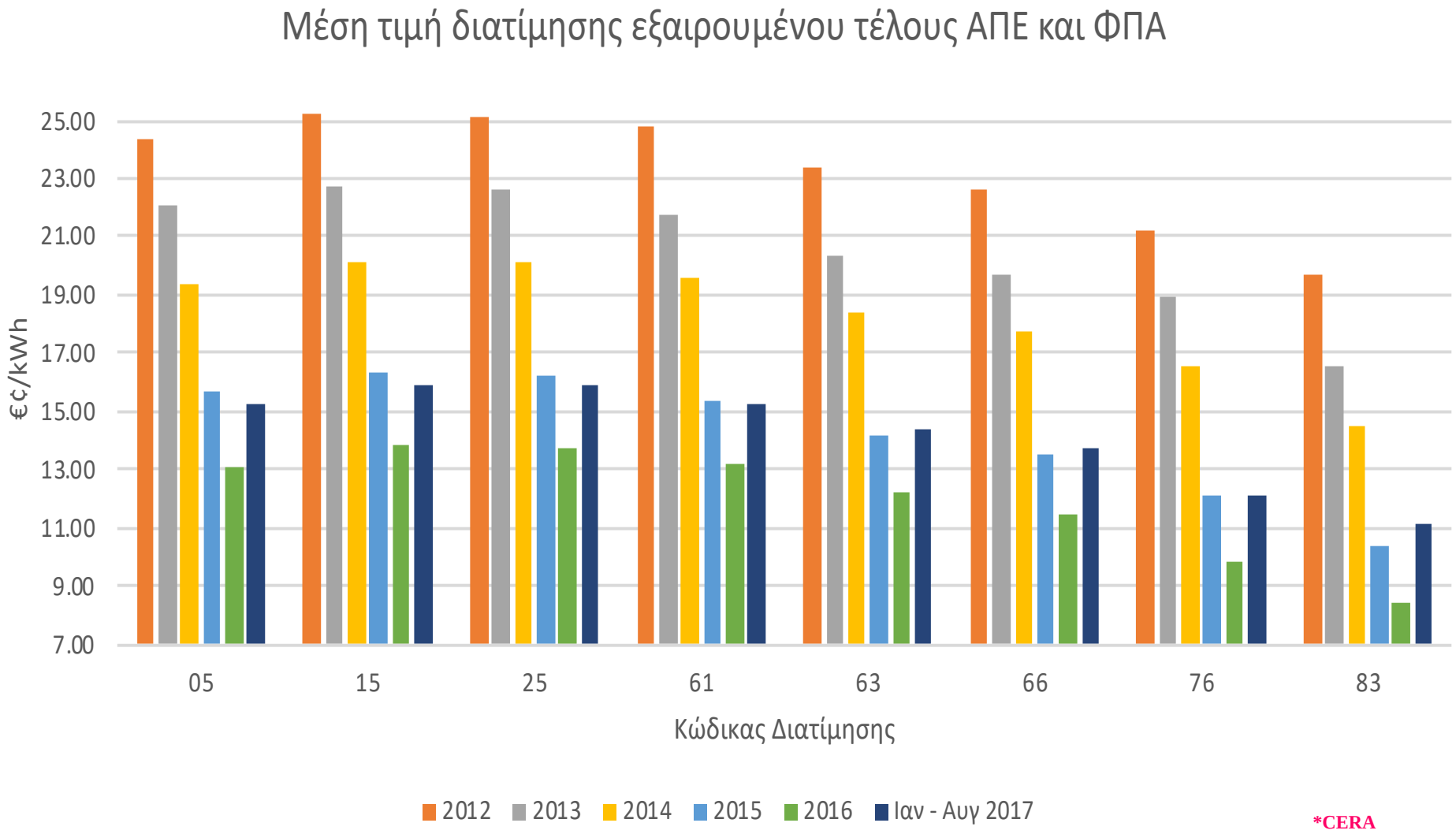

*CERA

Electricity bill

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ΕΝΔΕΙΞΕΙΣ ΜΕΤΡΗΤΗ (kWh)

Διατίμηση	Τελευταία	Προηγούμενη	ΣΜ	Κατανάλωση
01	99780	97910		1870

Σύνολο κατανάλωσης 1.870 kWh
Αντίστοιχη περσινή κατανάλωση 1.499 kWh

Εξόφληση μέσω μισθολογίου ΑΗΚ
Πληρωμή με μηνιαίες δόσεις. Ποσό δόσης €225

Βασική τιμή καυσίμων: €300/MT {Μετρικό Τόνο}
Τρέχουσα τιμή καυσίμων: €439,15/MT
Αναπροσαρμογή τιμής καυσίμων: €0,034321/kWh

ΑΝΑΛΥΣΗ ΓΙΑ ΤΗΝ ΠΕΡΙΟΔΟ 11/12/2018 - 11/02/2019	Αξία (€)
Χρεώσεις Διατίμησης 01	
Παραγωγή Ηλεκτρικής Ενέργ. {1.870 kWh x €0,0923}	
Χρήση Δικτύου {1.870 kWh x €0,0321}	
Επικουρικές Υπηρεσίες {1.870 kWh x €0,0067}	
Μέτρηση Κατανάλωσης	
Προμήθεια Ηλεκτρικής Ενέργειας	
Σύνολο με Βασική Τιμή Καυσίμων	
Αναπροσαρμογή Καυσίμων {1.870kWh x €0,034321}	
Υποχρεώσεις Δημόσιας Ωφελείας {1.870kWh x €0,00083}	
Σύνολο πριν το ΦΠΑ {19%}	
Ταμείο ΑΠΕ & ΕΞΕ {1.870kWh x €0,01}	
Σύνολο χρεώσεων περιόδου εκτός ΦΠΑ	
ΦΠΑ {19%}	
Σύνολο χρεώσεων περιόδου	
Υπόλοιπο από μεταφορά	
Πληρωμές	
Υπόλοιπο προς μεταφορά	
Πληρωτέο μέχρι 06/03/2019	

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Challenges in natural gas markets

Towards sustainable energy systems

Pathways to low emissions

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Why gas is perfectly suited to play a pivotal role in the energy mix of the future

1. Gas is **clean**

gas produces less than half as much CO_2 per KWh than electricity

2. Gas is **scalable**

Gas is sufficiently abundant to continue to meet a large share of European and global energy demand

3. Gas is **flexible**

Gas can quickly meet short term fluctuations in power demand where other power sources can not

3. Gas **technology** is improving

Gas technological improvements are driving energy efficiency gains

EU gas market target model

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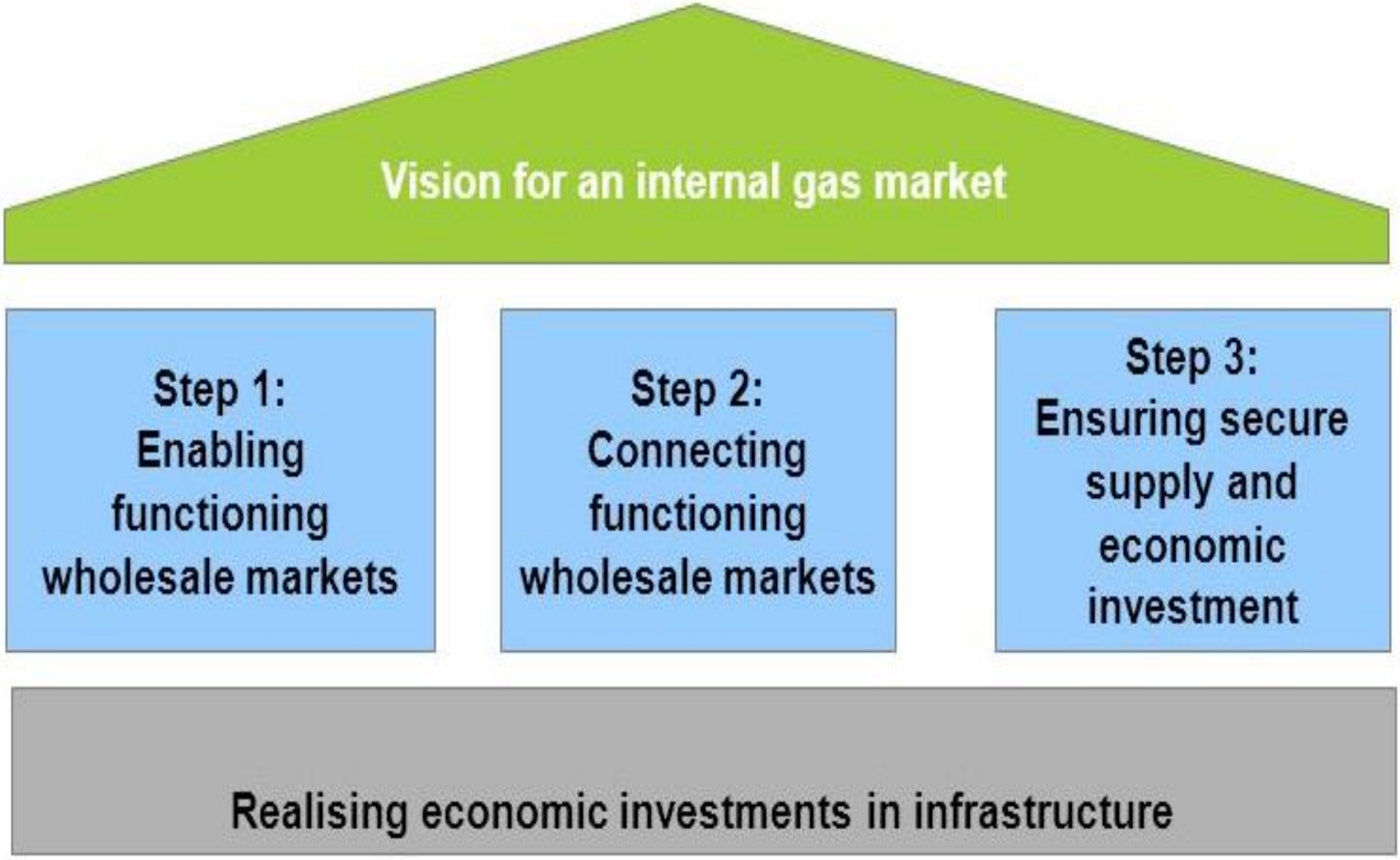
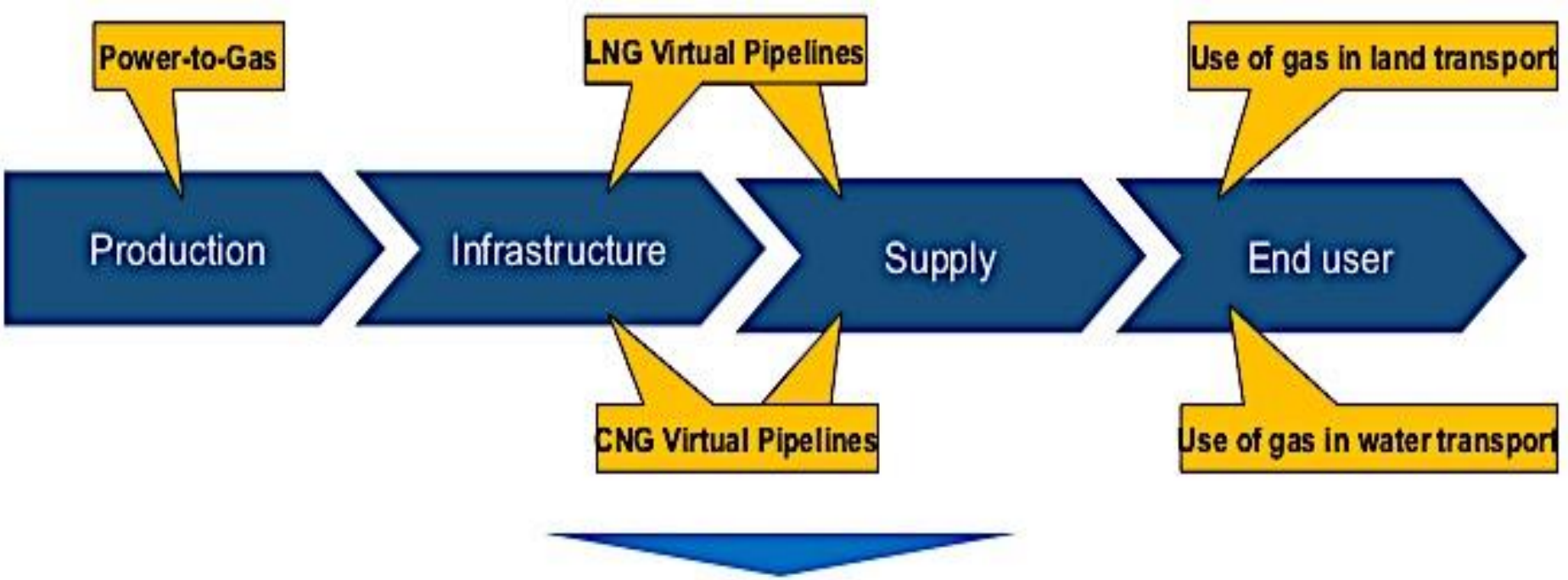


EU gas market target model

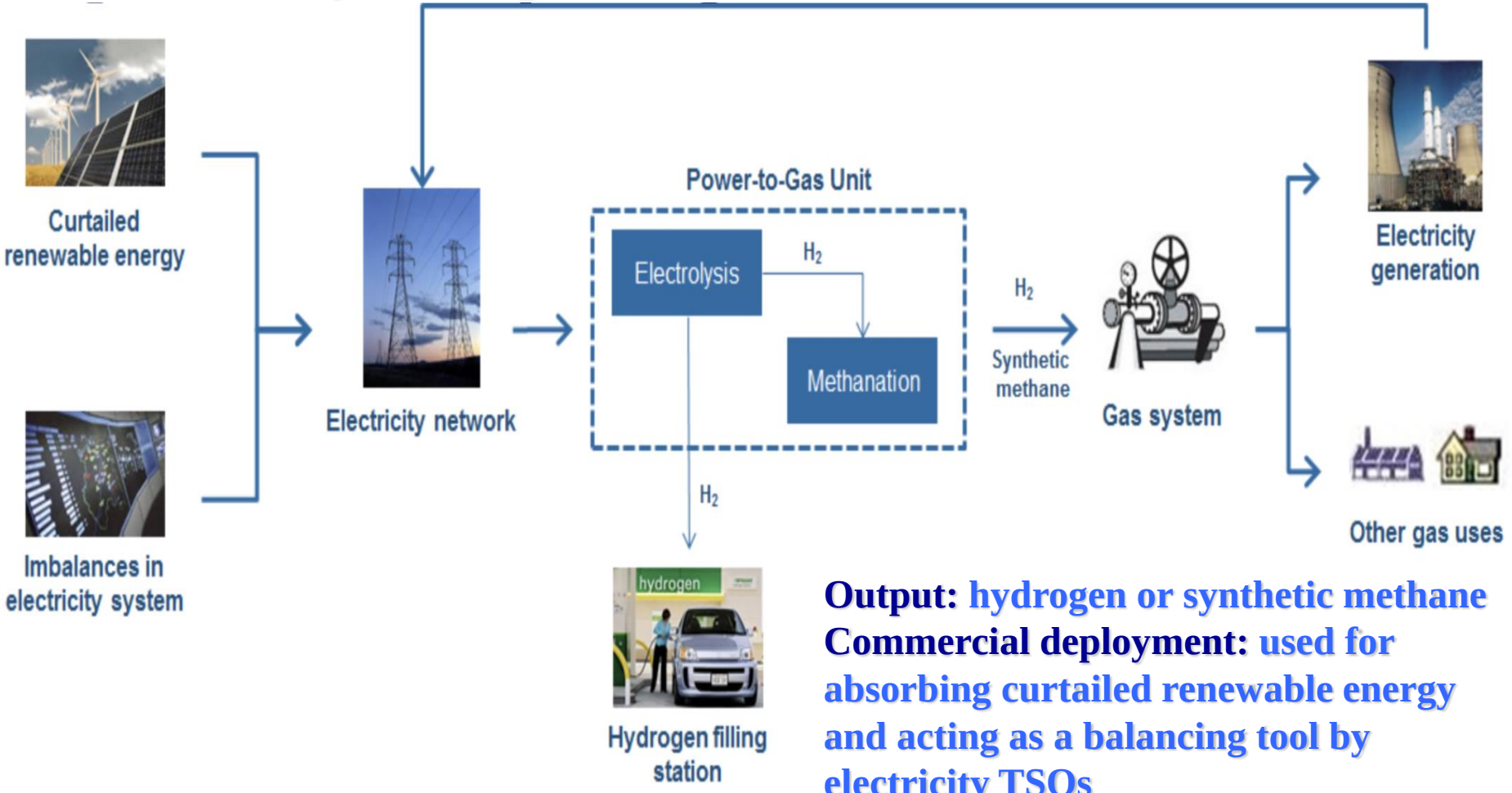
- **The new uses for gas have different roles across the gas supply chain**



Virtual pipelines are closely related to the development of the use of gas in the transport sector, particularly in the case of LNG

Power-to-Gas (P2G)

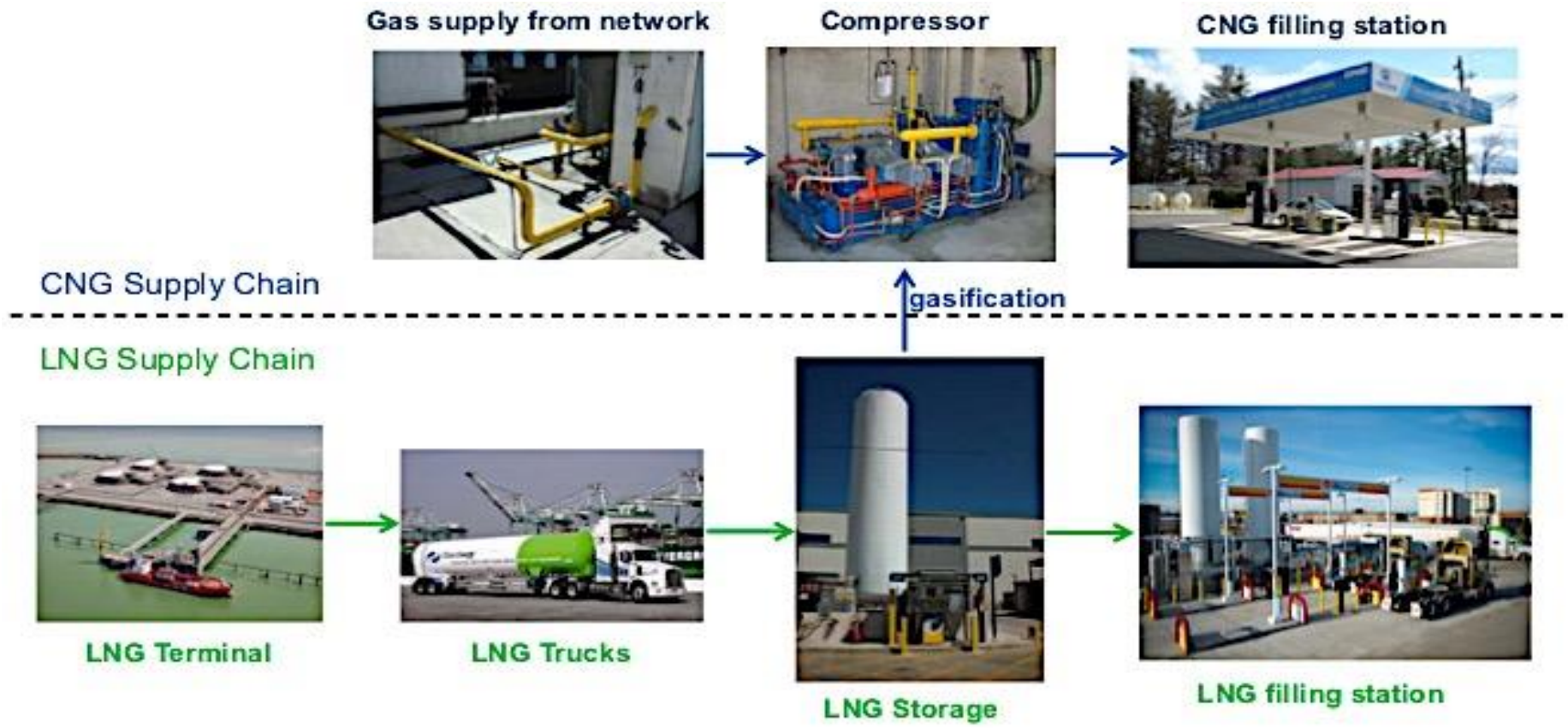
- **energy storage technology linking the electricity and gas infrastructure**



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

Virtual pipelines

- LNG stations are supplied through trucks
- CNG stations are supplied either from the network or with LNG (L- CNG)



Virtual pipeline: the supply chain transporting natural gas to final consumers in the form of CNG or LNG, using road and sea means of transportation, such as trucks, vessels and rail

LNG bunkering

- **Supply chain is the same for applications in deep-sea trading and inland waterways**

Satellite LNG storage (e.g. port)

LNG Truck

LNG Terminal

LNG barge

Deep sea vessels / inland waterways

LNG bunkering options: Ship-to-Ship (STS), Truck-to-Ship (TTS), Terminal-to-Ship (TPS)

The role of NG

- **NG is clean**
- **NG is flexible**
- **NG is scalable**
- **NG technology is improving**

NG will play an important role for the development of the future sustainable energy systems