



Ρυθμιστικές προκλήσεις κατά την ενεργειακή μετάβαση

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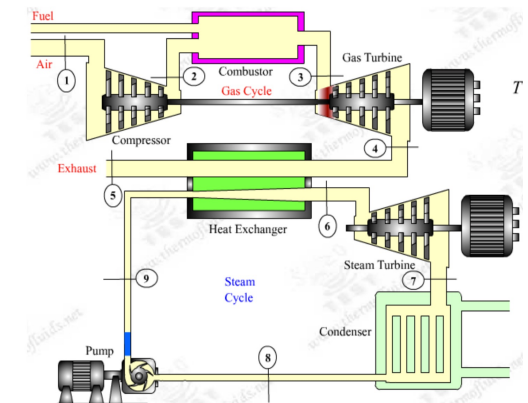
- **Cyprus current electricity and NG systems**
– system characteristics
- **Challenges in electricity markets** – large scale
integration of RES, storage, interconnections and hydrogen
- **Energy transition for island systems** – solutions
for isolated systems
- **Energy transition regulatory challenges** –
towards sustainable energy

Cyprus current electricity and NG systems

System characteristics

Existing power generation system

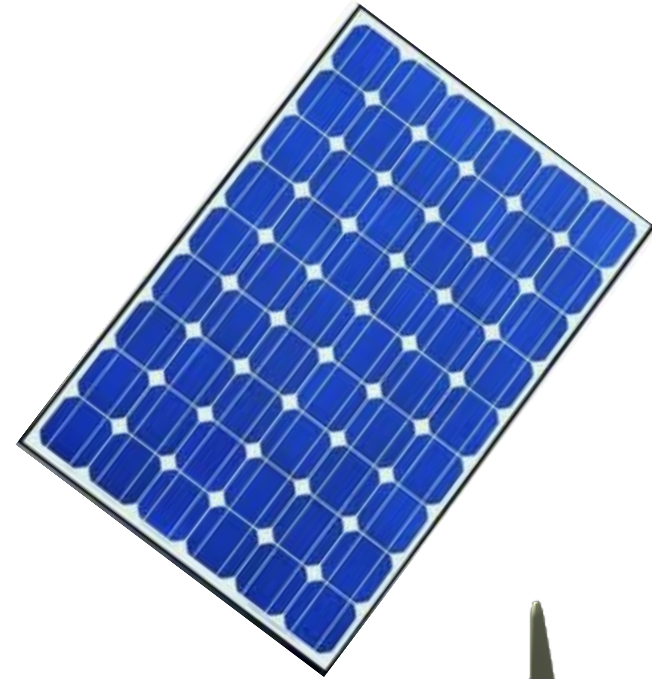
- **Steam turbine units (HFO)**
 - Dhekelia power station 6x60MWe
 - Vasilikos power station 3x130MWe
- **Internal combustion engines (HFO)**
 - Dhekelia power station 6x17.5MWe
- **Combined cycles (Diesel)**
 - Vasilikos power station 2x220MWe
- **Gas turbine units (Diesel)**
 - Moni power station 4x37,5MWe
 - Vasilikos power station 1x38MWe



Existing power generation system (cont.)

- **Renewables**

- **PVs: 433MWe**
- **Wind: 157MWe**
- **Biomass: 13MWe**

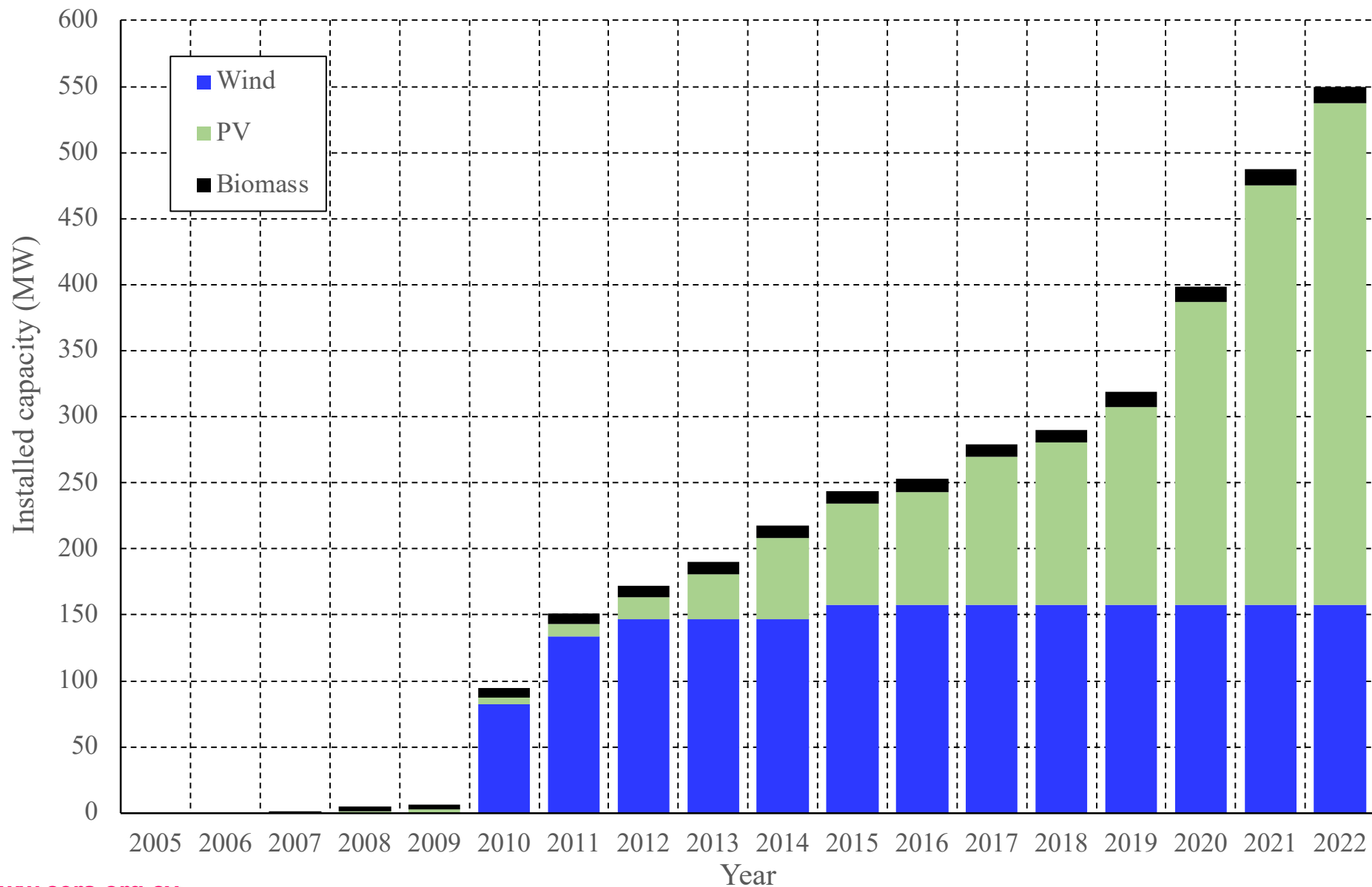


- **Total installed capacity:**

- **Conventional: 1483MWe**
- **Renewables: 603MWe**

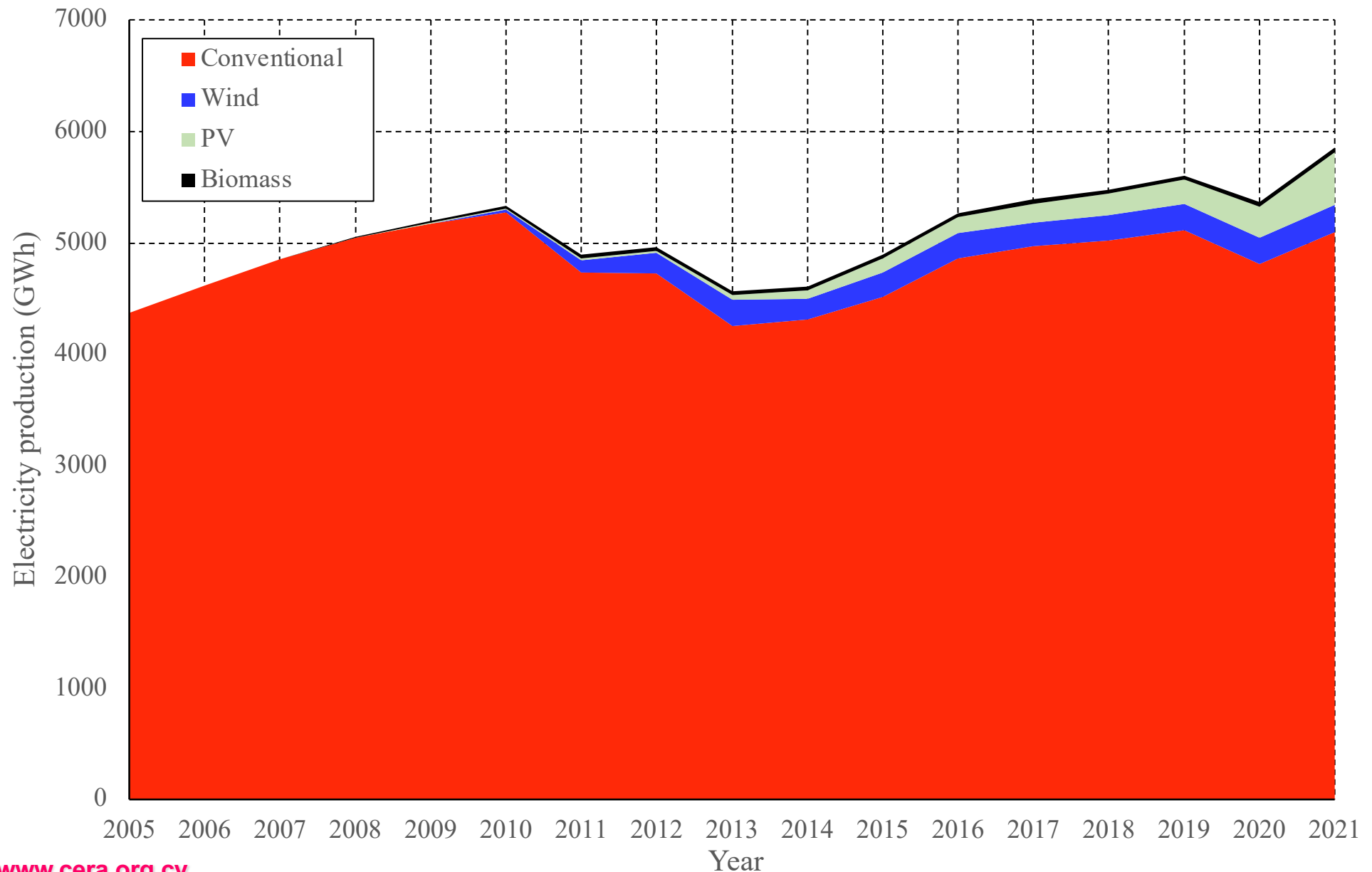


RES installed capacity*



* www.cera.org.cy

Total electricity production*



* www.cera.org.cy

Existing natural gas system

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



Challenges in electricity markets

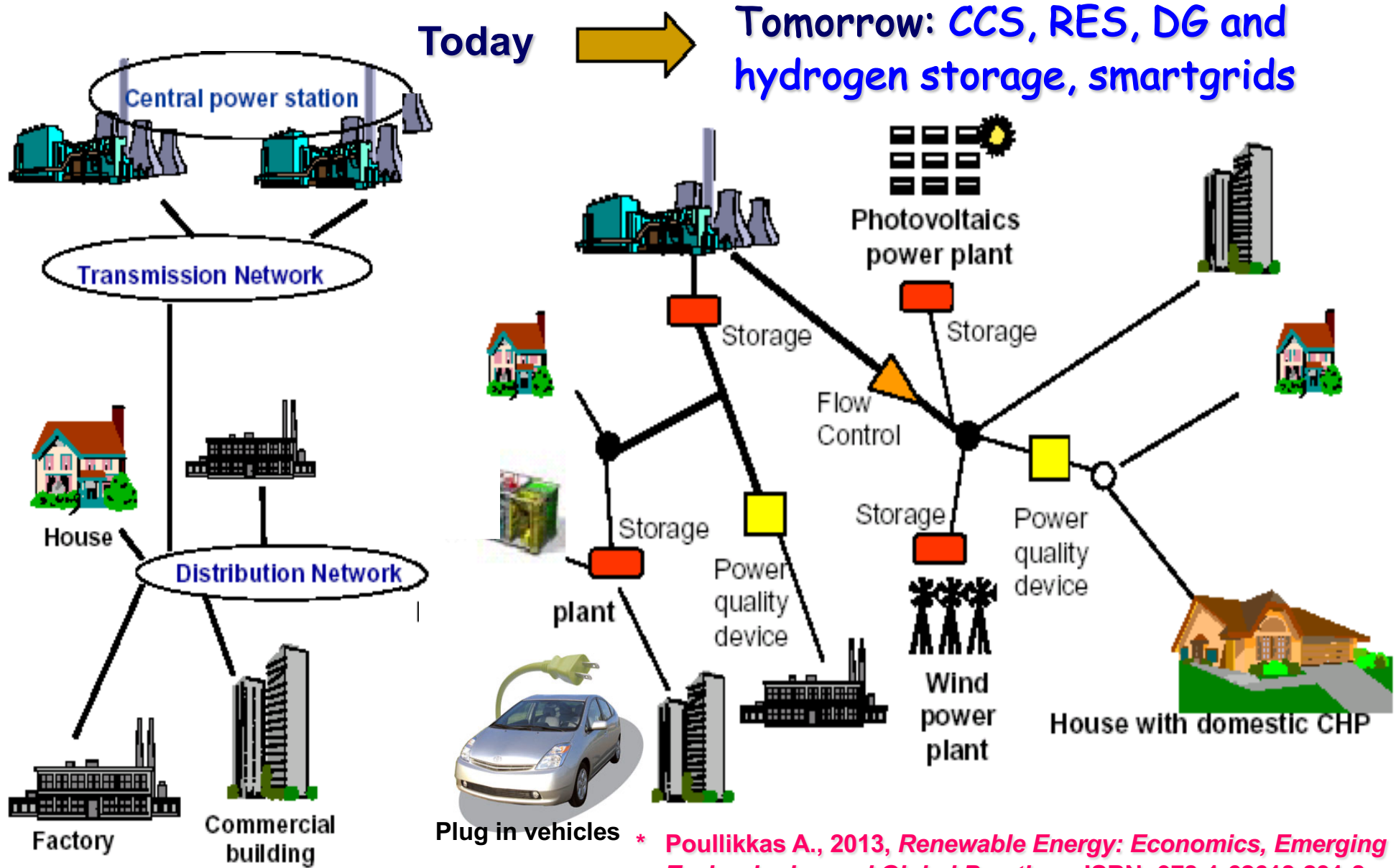
**Large scale integration of RES,
storage, interconnections and
hydrogen**

Energy transition

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

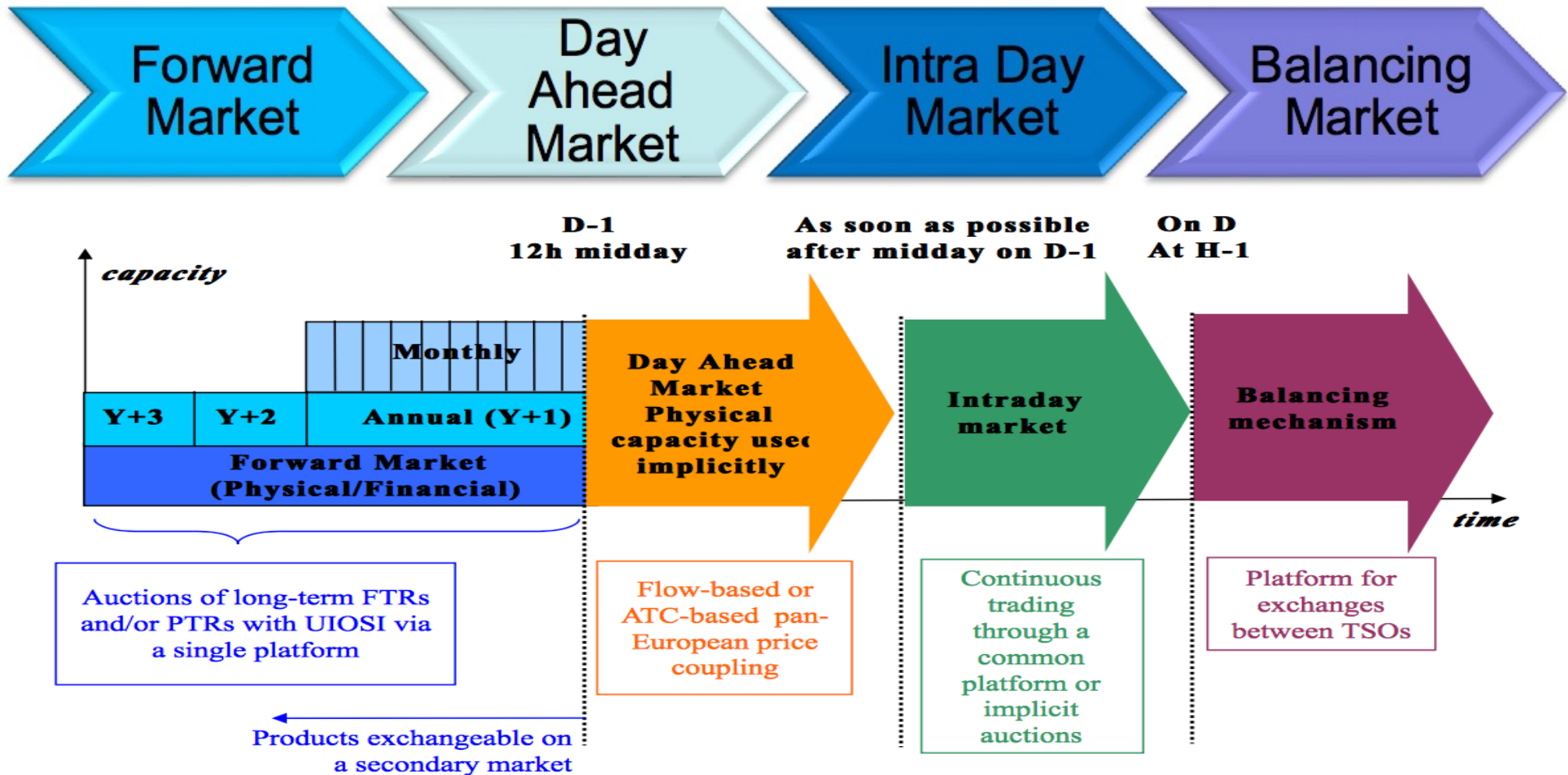


Future power systems*



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

EU electricity market target model

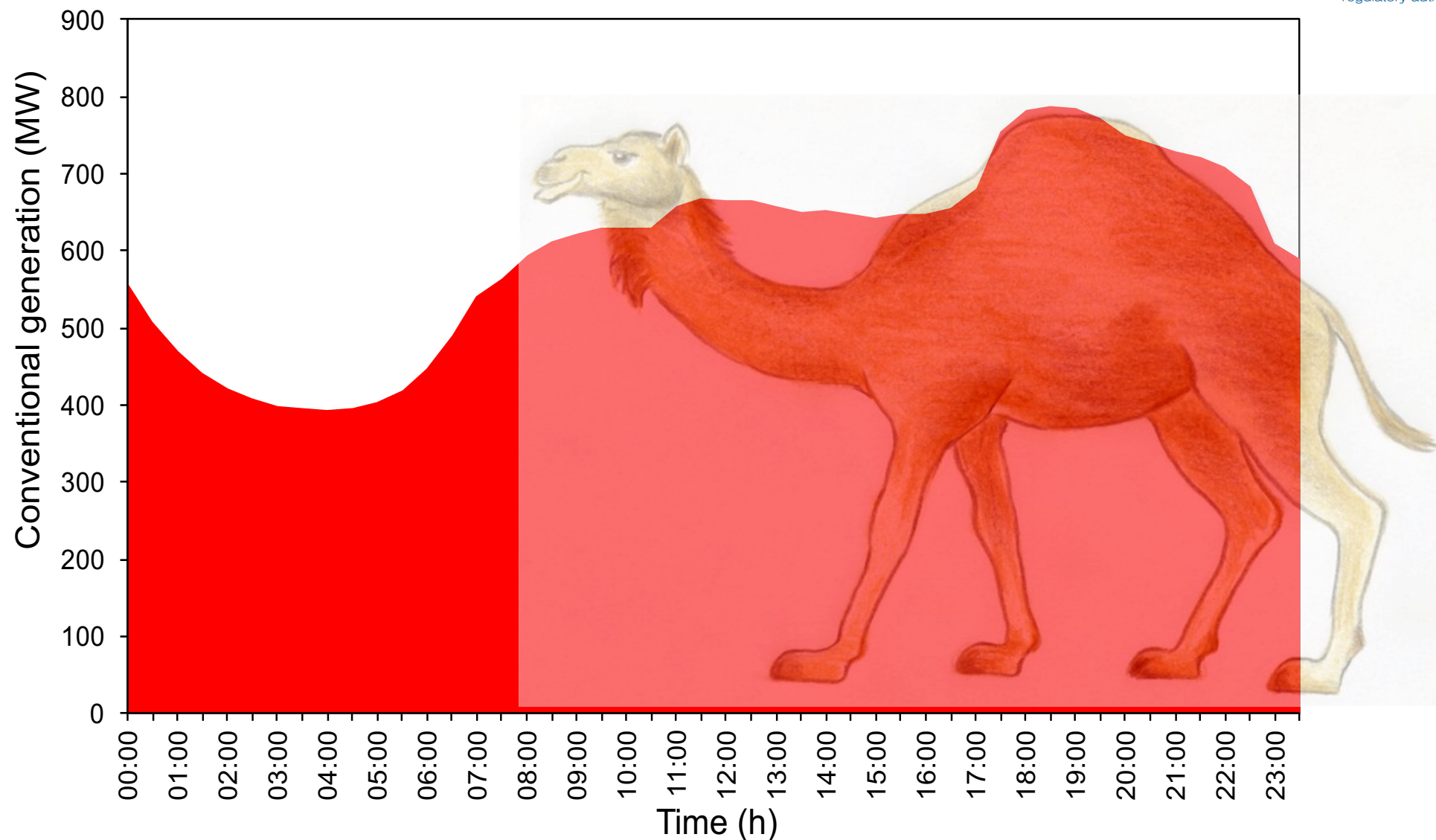


Integration of RES*: LCOE vs Reliability

* 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*

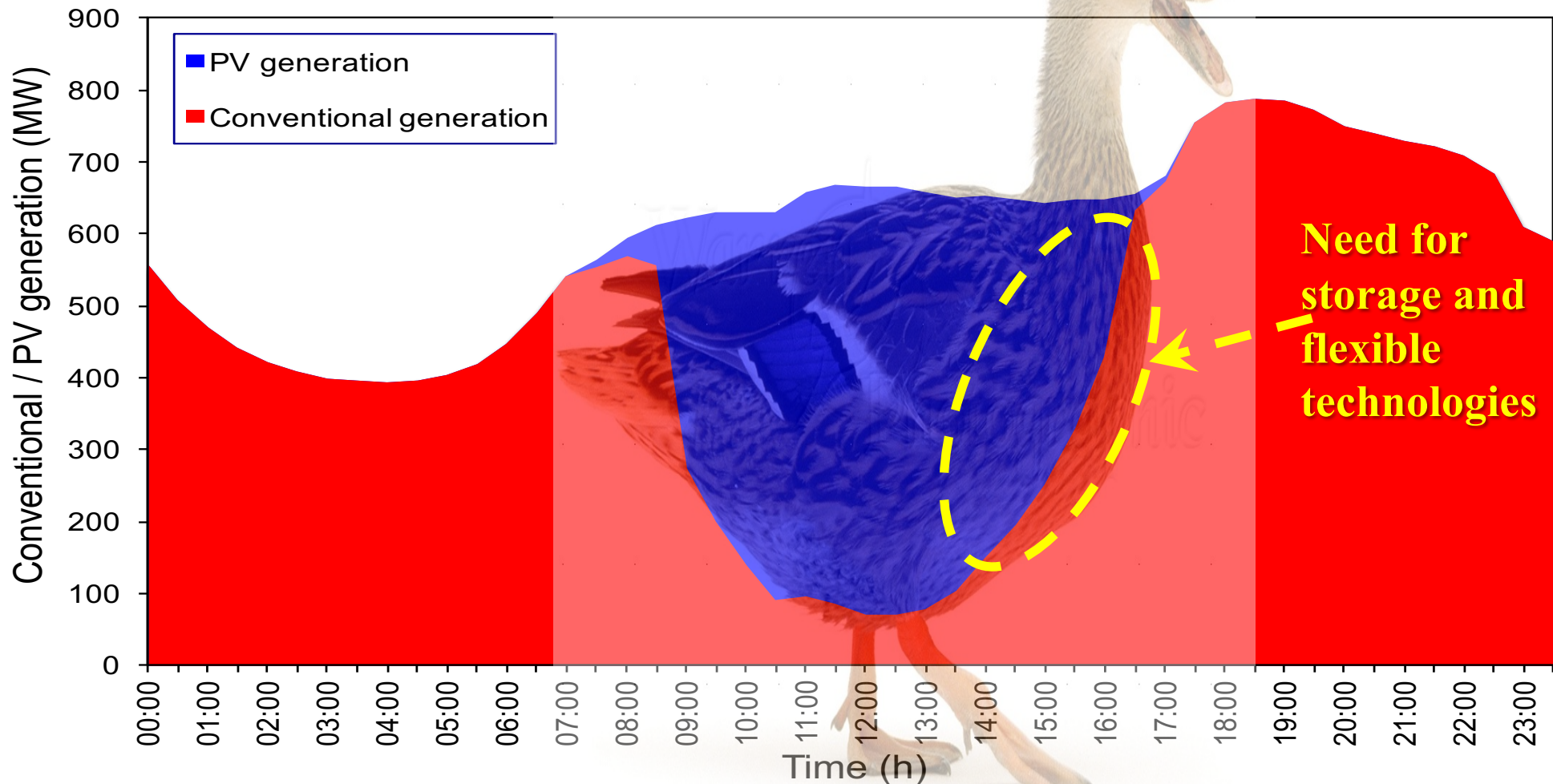
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ΟΕΒ,, Λευκωσία, 7 Απριλίου 2023

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*

Simulated effect of 500MW PV generation on load curve (the 'duck curve')*



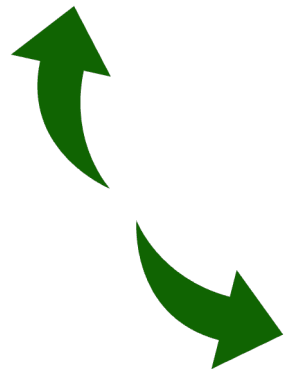
* Poullikkas A., 2016, "From the 'camel curve' to the 'duck curve' on electric systems with increasing solar power", *Accountancy*

Storage and flexible technologies are the missing links



Energy storage

Flexible technologies



Hydrogen technologies



CERA
Storage, Flexible
Technologies and Hydrogen
Regulatory Frameworks

Energy transition for island systems

Solutions for isolated systems

Characteristics of isolated electricity systems*

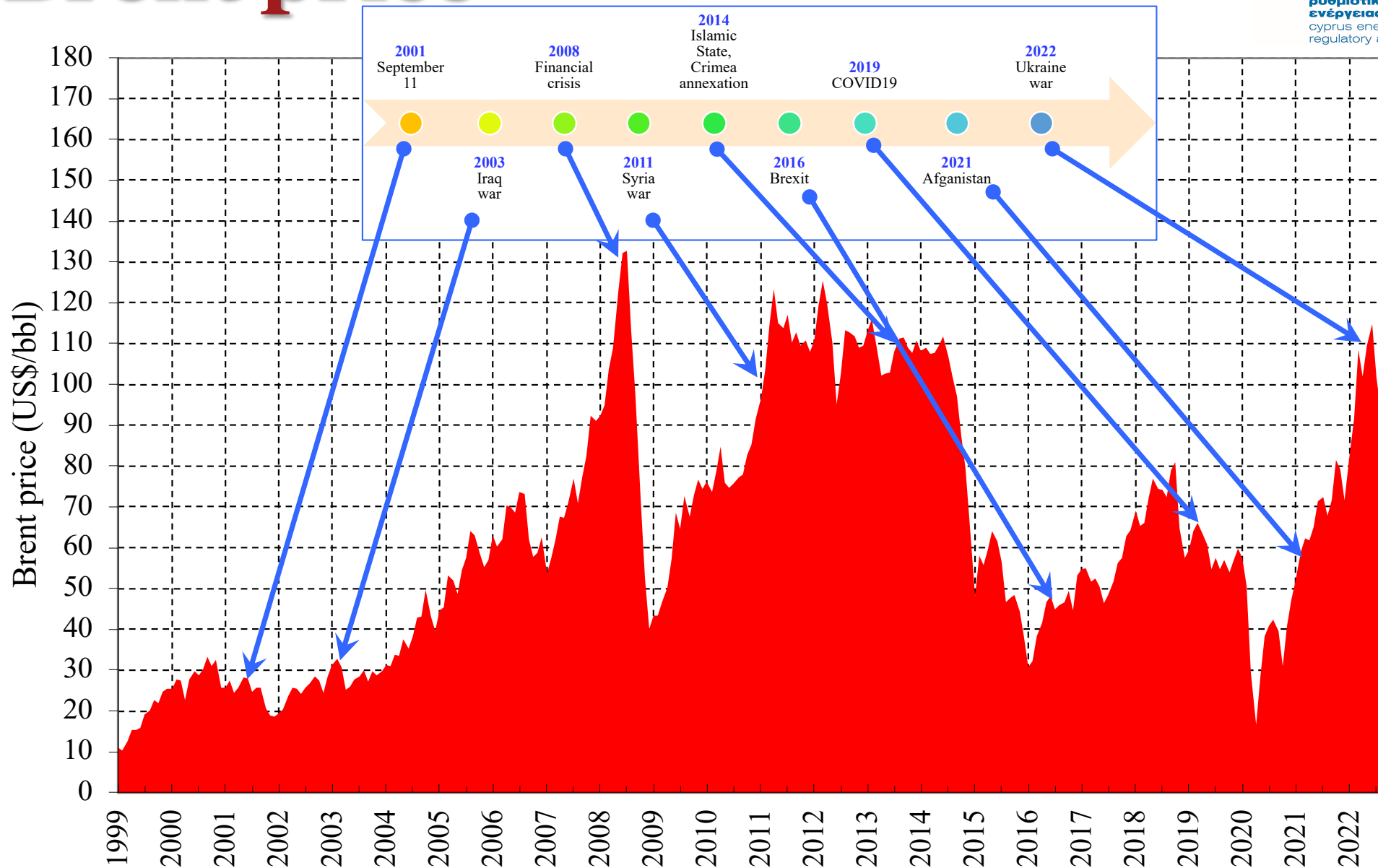


- **High fuel costs**
 - ~ use of oil derivatives
 - ~ high CO₂ emissions (additional cost)
- **Economies of scale cannot be adequately exploited**
 - ~ generation units cannot exceed a certain size since the loss of a unit would mean the loss of a high percentage of the entire system
- **Need to maintain high reserve capacity to ensure power system reliability**

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

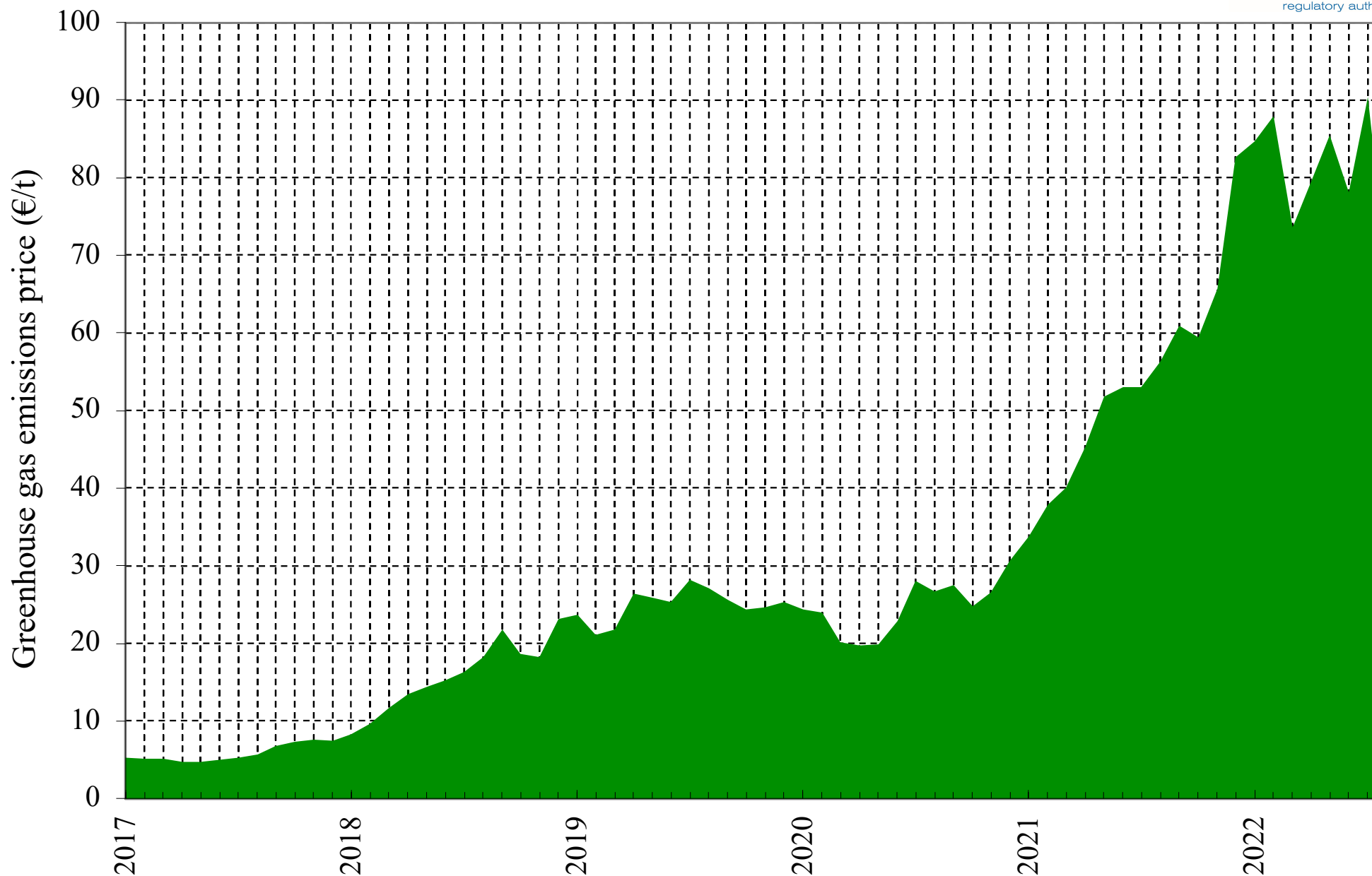
* Poulikkas A., 2015, *Sustainable Energy Policy for Cyprus*, ISBN: 978-9963-7355-6-3

Brent price*

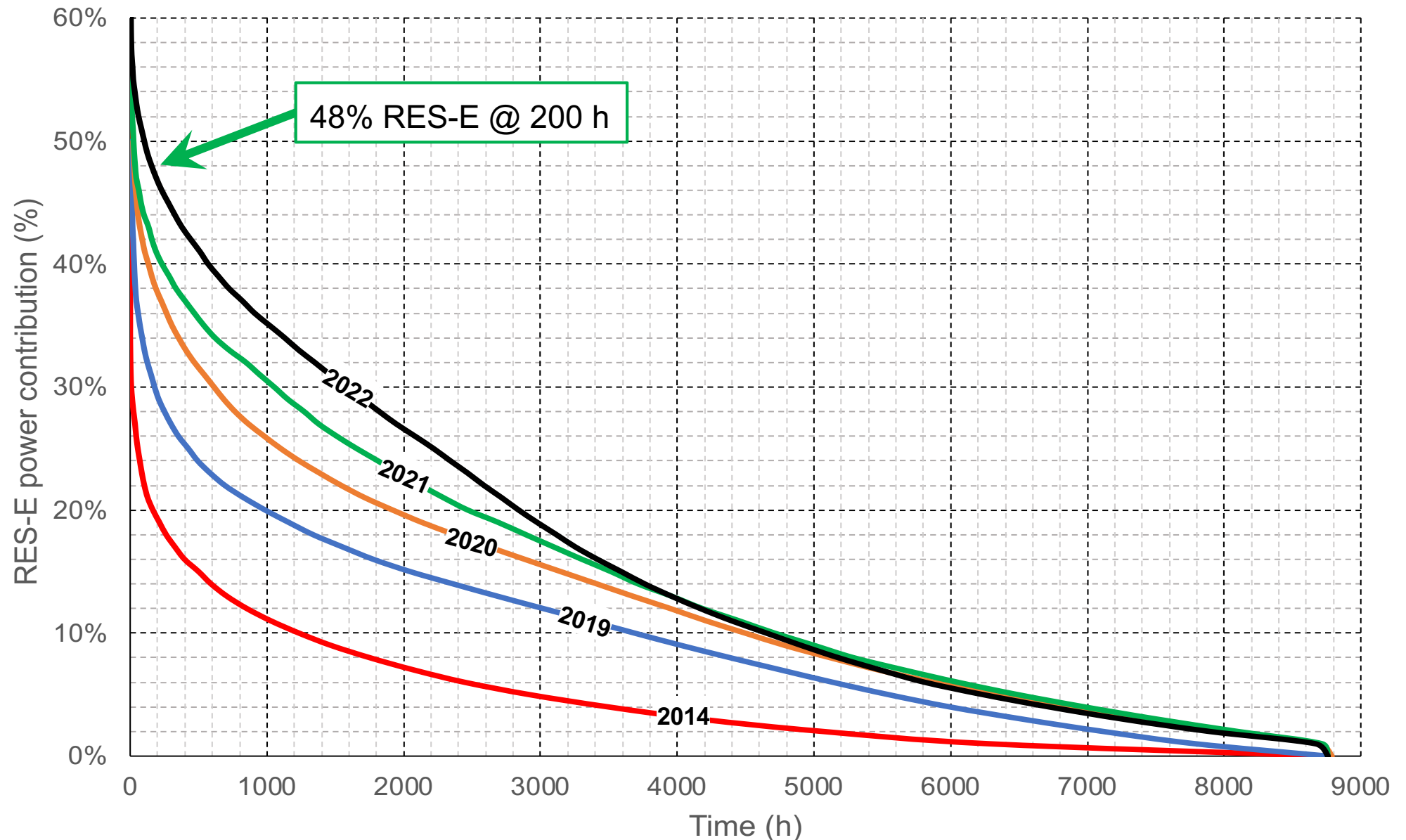


* Poullikkas A., 2018, "An adaptive longterm electricity price risk modelling using Monte Carlo simulation", *Journal of Power Technologies*

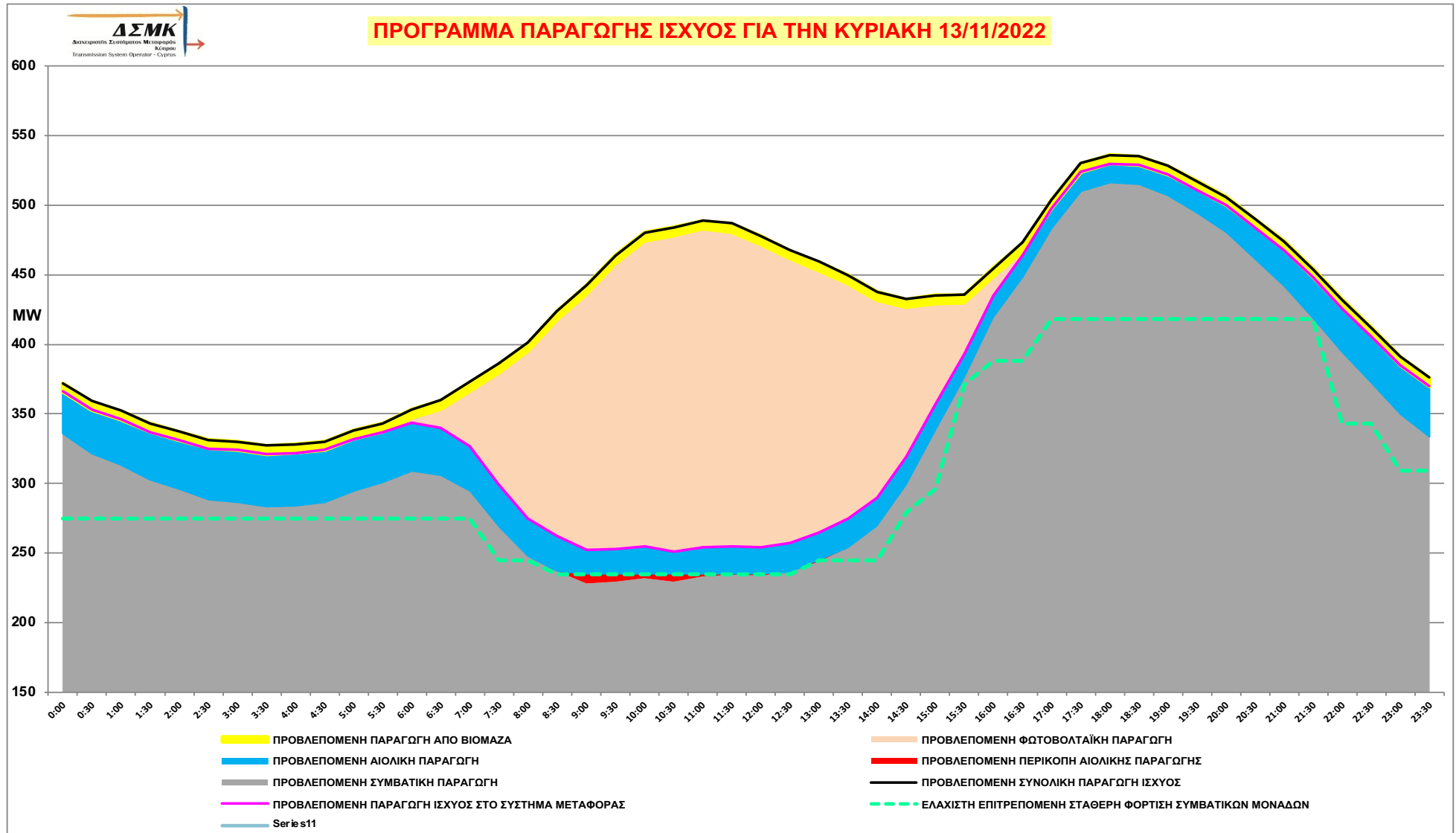
Greenhouse gas emissions price



RES-E Load Duration Curve



Real effect of 380MW PV generation on load curve*



* TSOC

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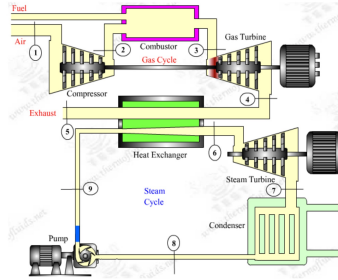
The solution*

- **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

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

Main indigenous energy sources in SE Mediterranean region

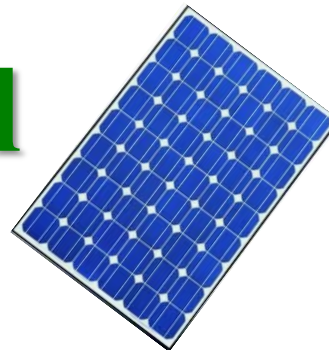
- Natural gas



- Wind potential



- Solar potential



Energy transition by 2050*

Cyprus' energy system:

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



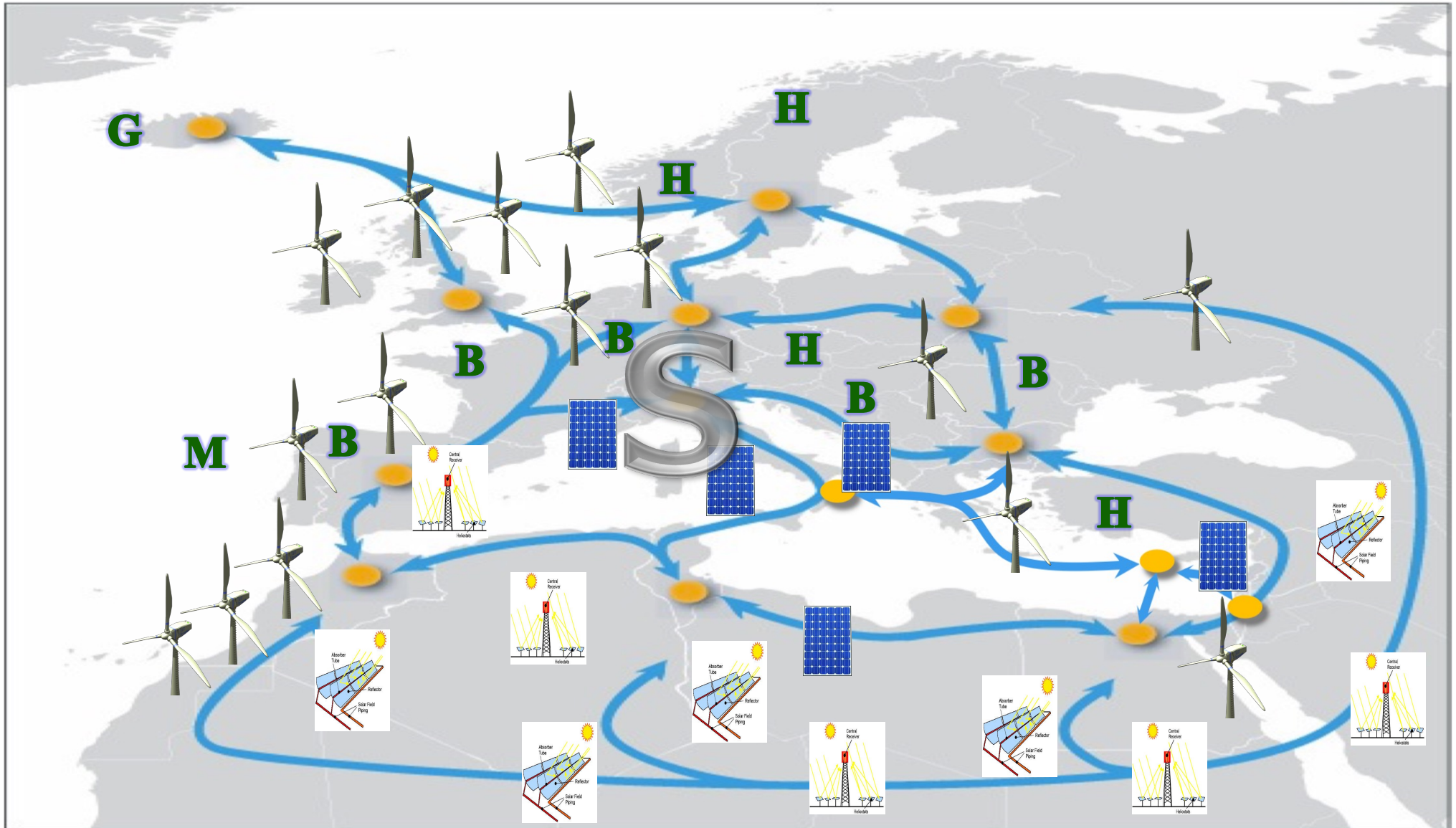
Integration:

- 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

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

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Energy transition

regulatory challenges

Towards sustainable energy

CEEA Energy Transition Regulatory Decisions

- **Regulatory Decision 01/2017 (ΚΑΠ 34/2017):** A detailed schedule for the implementation of EU electricity market target model
- **Regulatory Decision 02/2018 (ΚΑΠ 259/2018):** The mass installation of an Advanced Metering Infrastructure including smartmeters to all electricity consumers
- **Regulatory Decision 02/2019 (ΚΑΠ 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 (ΚΑΠ 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

CEERA 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**

IN PROGRESS