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REGULATORY AUTHORITY FOR ENERGY, WASTE & WATER

Electricity Market Design in Europe – Challenges for the Hellenic electricity market

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EU's Electricity Market Design in Europe

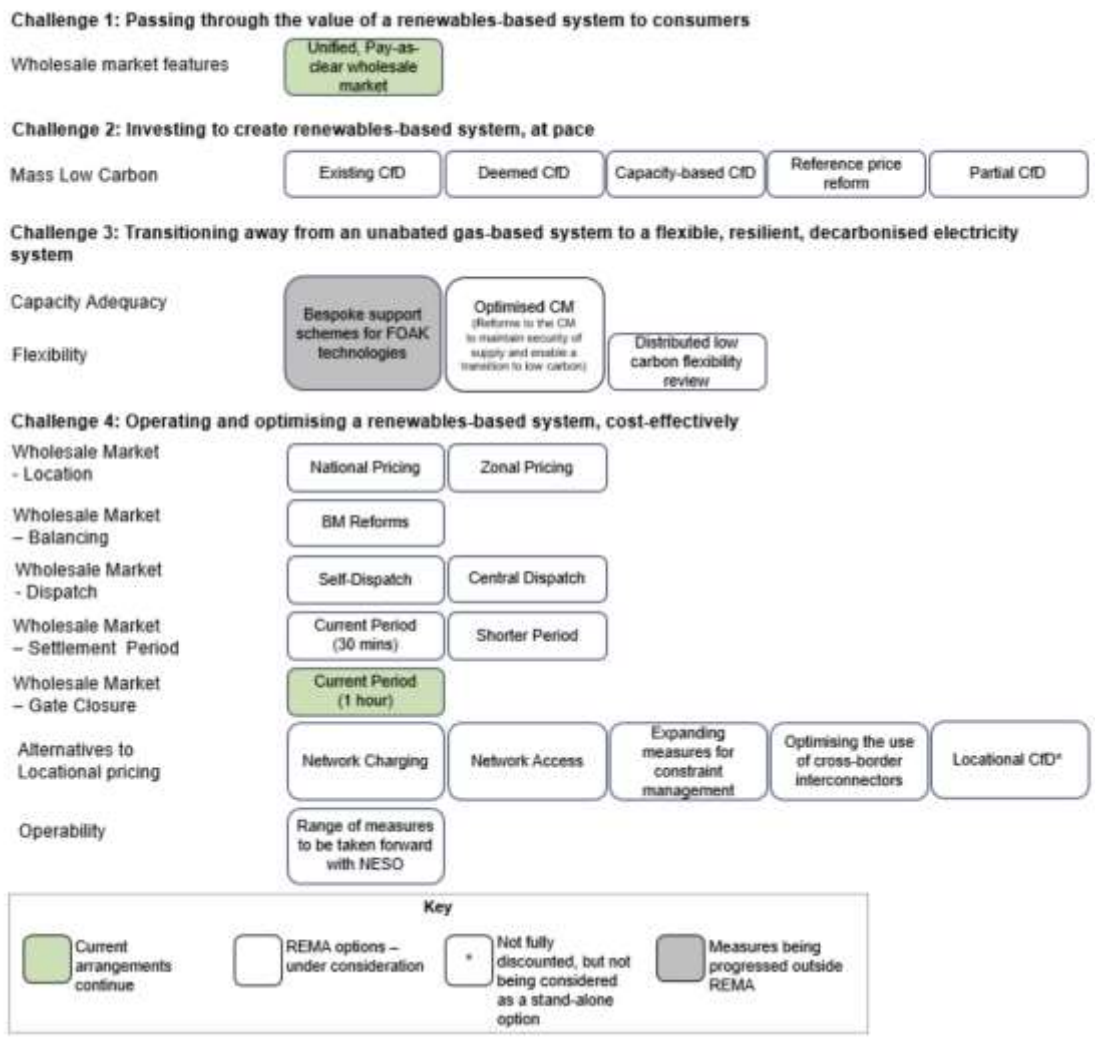
In December 2023, the Council and the Parliament reached a **provisional agreement** to reform the **EU's electricity market design (EMD).** In November 2023, they also reached **provisional agreement on REMIT**, adopted in March 2024 by Council.

Main elements:

- Improved EU's protection against market manipulation through better monitoring and transparency **(REMIT)**
- **Availability of fixed price**, **fixed term** and dynamic **contracts**. **Clearer information**
- **Support vulnerable consumers**
- Access to **affordable energy during an electricity price crisis**
  - Council the power to declare a crisis, based on Commission proposal
- More stable prices through **Power Purchase Agreements (PPAs)**
- PPAs and **two-way Contracts for Difference (CfDs)** to support RES/nuclear penetration
- **Capacity mechanisms** to become a more structural element of the electricity market

UK's Electricity Market Design

Figure 4: REMA Options Space



Sources: Review of Electricity Market Arrangements: Options Assessment (REMA), March 2024, https://assets.publishing.service.gov.uk/media/65eb48f362ff48ff7487b30a/rema-options-assessment.pdf

M. Keay and D. Robinson, 2017, The Decarbonised Electricity System of the Future: The 'Two Market' Approach, Oxford Institute for Energy Studies, https://www.oxfordenergy.org/wpcms/wp-content/uploads/2017/06/The-Decarbonised-Electricity-Sysytem-of-the-Future-The-Two-Market-Approach-OIES-Energy-Insight.pdf

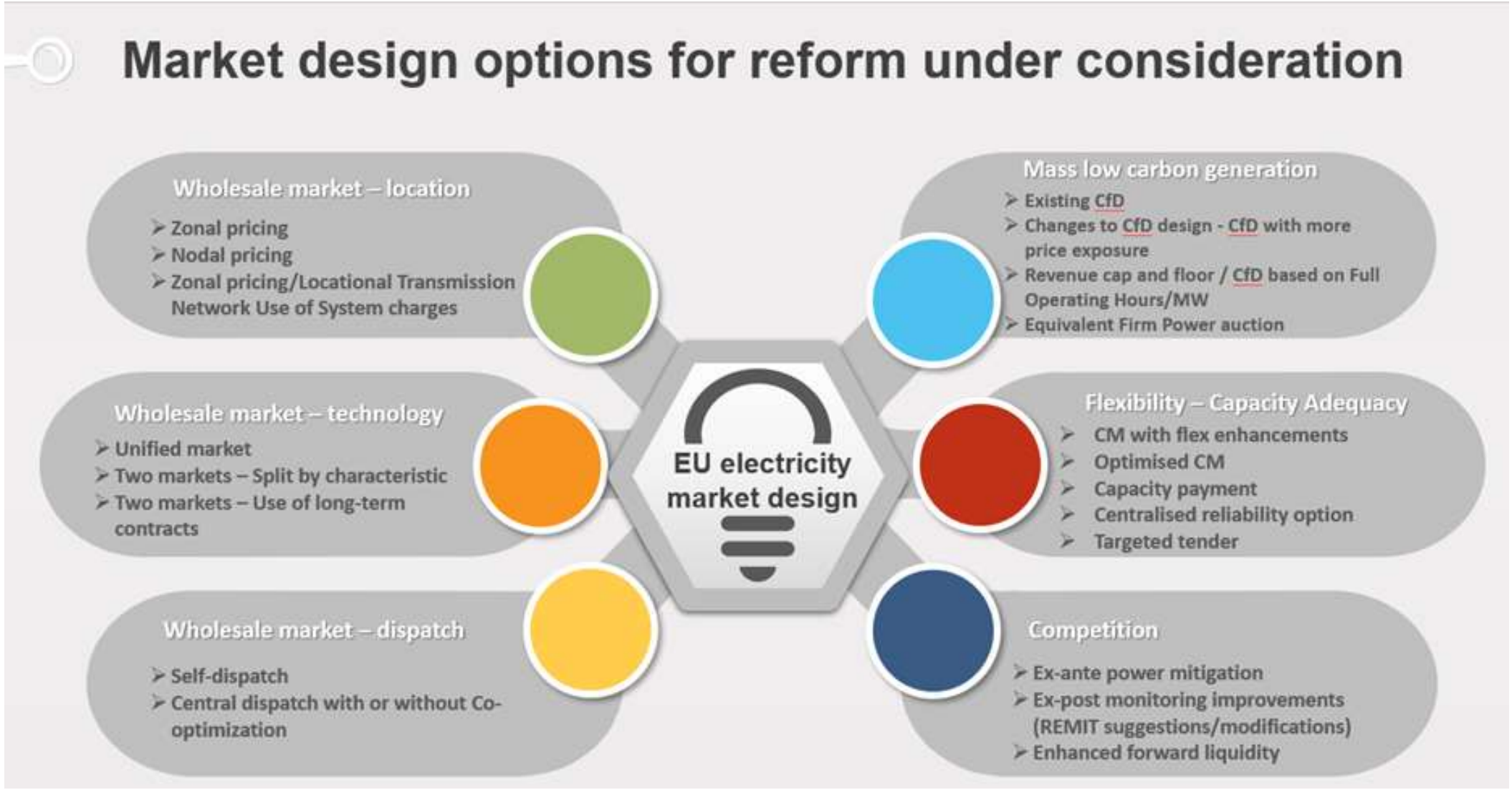
EU's Electricity Market Design in Europe
RAAEY proposals

RAAEY, besides agreement on ACER proposed measures to supporting consumers/retail market**,** **provided positions** **on Market Design** during the preparation of the ACER's Assessment Report of the EU Wholesale Electricity Market Design (April 2022) **for Electricity markets**

1. **Ex-ante dynamic revenue clawback mechanism** on excess profits from the wholesale markets **(during Crisis)**
2. **Ex-ante power market mitigation rules** that permanently eliminate price spikes (increase transparency and spikes)
3. **CfDs ("Contracts for Differences")**, possibly combined with aggregator (single buyer) model, **supplementary of the RES PPAs.**
4. **Increasing the flexibility of the power system** can not be achieved through only preserving the wholesale price signal, but Flexibility can also be implemented through CfDs ("Contracts for Differences") and **well-designed Capacity Renumeration Mechanisms and policies that enhance demand-side, flexibility resources and energy efficiency**

Active participation of RAAEY in the EU's Electricity Market Design

RAE Request of Proposals for consultancy support on: "EU Electricity Market Design assessment and review"



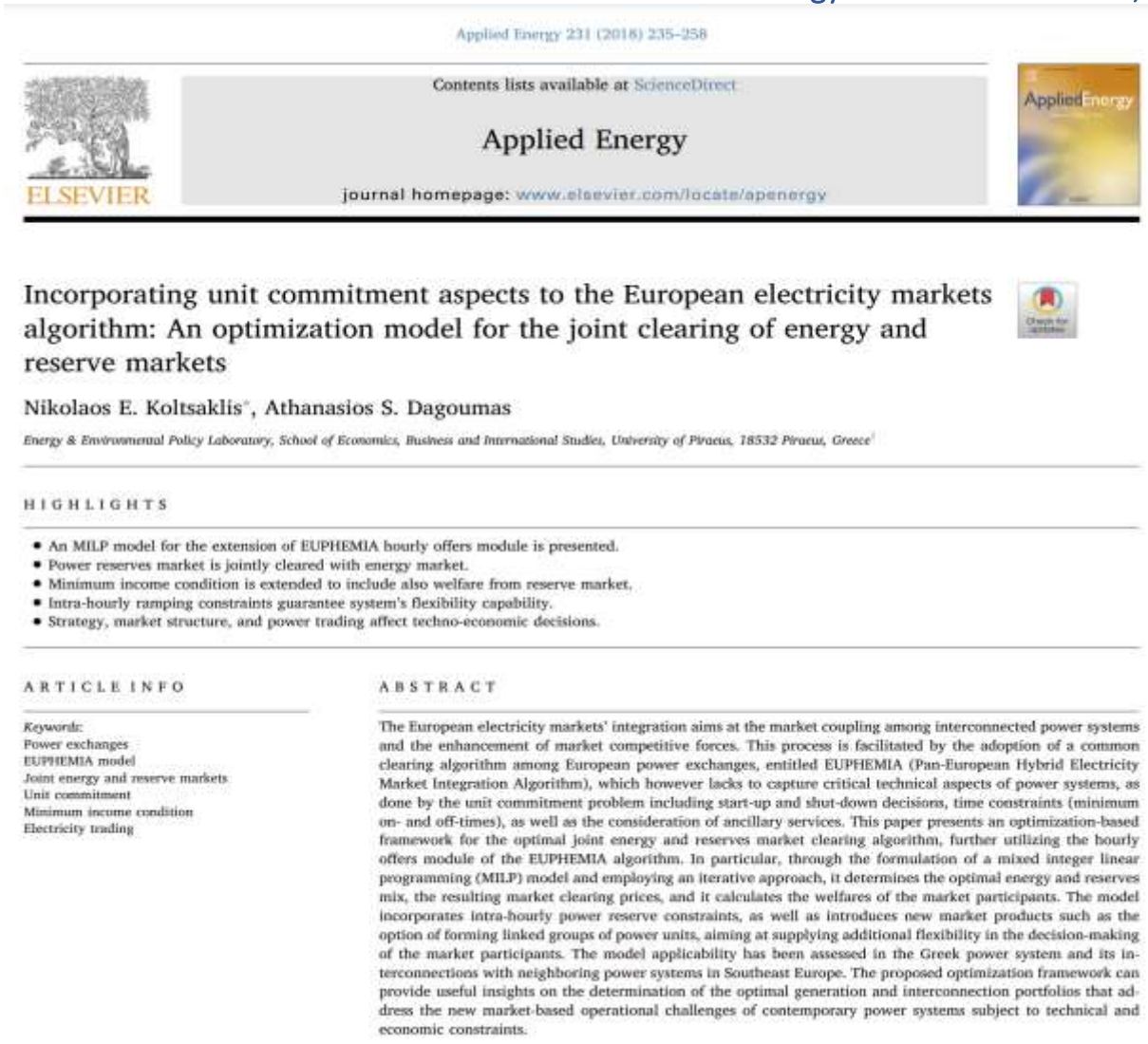
EU's Electricity Market Design
Market design options assessment

Besides the enhanced Protection to Consumers (during crisis and in normal periods)

- **Wholesale Market Location**
  - Zonal pricing expected to be retained (nodal not expected to be adopted, besides advantages)
- **Wholesale Market Technology (split)**
  - Opt-out in EMD (EU) and in REMA (UK)
  - Marginal pricing retained
- **Wholesale Market Dispatch**
  - ACER examines co-optimization of balancing capacity market with day-ahead energy market (amending the EUPHEMIA algorithm)
- **Mass Low Carbon Generation**
  - PPAs and CfD
- **Flexibility- Capacity Adequacy**
  - Capacity mechanism to become element of market design (CM with flex enhancement, optimized CM …)
- **Competition**
  - REMIT update
  - Ex-ante power mitigation not adopted

EU's Electricity Market Design
Co-optimization of energy and reserves markets

Koltsaklis N.E., Dagoumas A.S., 2018, Incorporating unit commitment aspects to the European electricity markets algorithm: An optimization model for the joint clearing of energy and reserve markets, Applied Energy 231, 235-258



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Incorporating unit commitment aspects to the European electricity markets algorithm: An optimization model for the joint clearing of energy and reserve markets

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HIGHLIGHTS

- An MILP model for the extension of EUPHEMIA hourly offers module is presented.
- Power reserves market is jointly cleared with energy market.
- Minimum income condition is extended to include also welfare from reserve market.
- Intra-hourly ramping constraints guarantee system's flexibility capability.
- Strategy, market structure, and power trading affect techno-economic decisions.

ARTICLE INFO

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Power exchanges
EUPHEMIA model
Joint energy and reserve markets
Unit commitment
Minimum income condition
Electricity trading

ABSTRACT

The European electricity markets' integration aims at the market coupling among interconnected power systems and the enhancement of market competitive forces. This process is facilitated by the adoption of a common clearing algorithm among European power exchanges, entitled EUPHEMIA (Pan-European Hybrid Electricity Market Integration Algorithm), which however lacks to capture critical technical aspects of power systems, as done by the unit commitment problem including start-up and shut-down decisions, time constraints (minimum on- and off-times), as well as the consideration of ancillary services. This paper presents an optimization-based framework for the optimal joint energy and reserves market clearing algorithm, further utilizing the hourly offers module of the EUPHEMIA algorithm. In particular, through the formulation of a mixed integer linear programming (MILP) model and employing an iterative approach, it determines the optimal energy and reserves mix, the resulting market clearing prices, and it calculates the welfares of the market participants. The model incorporates intra-hourly power reserve constraints, as well as introduces new market products such as the option of forming linked groups of power units, aiming at supplying additional flexibility in the decision-making of the market participants. The model applicability has been assessed in the Greek power system and its interconnections with neighboring power systems in Southeast Europe. The proposed optimization framework can provide useful insights on the determination of the optimal generation and interconnection portfolios that address the new market-based operational challenges of contemporary power systems subject to technical and economic constraints.

Source: https://www.sciencedirect.com/science/article/pii/S0306261918314090#f0005

Objective function:

$$\textit{Min Cost}^{day} = \overbrace{\sum_{ht}\sum_{t}\sum_{f^{ht}}\sum_{dt} e^{prd}_{ht,t,f^{ht},dt}\cdot C^{prd}_{ht,t,f^{ht},dt}}^{\textit{Hydrothermal units' supply cost}} - \overbrace{\sum_{dm}\sum_{t}\sum_{f^{dm}}\sum_{dt} e^{dem}_{dm,t,f^{dm},dt}\cdot C^{dem}_{dm,t,f^{dm},dt}}^{\textit{Priced load revenues}} +$$

$$\sum_{in}\sum_{t}\sum_{f^{in}}\sum_{dt}\Big[\overbrace{(e^{imp}_{in,t,f^{in},dt}\cdot C^{imp}_{in,t,f^{in},dt})}^{\textit{Electricity imports cost}} - \overbrace{(e^{exp}_{in,t,f^{in},dt}\cdot C^{exp}_{in,t,f^{in},dt})}^{\textit{Electricity exports revenues}}\Big]$$

$$\sum_{ht}\sum_{t}\sum_{dt}\Big[\overbrace{\overbrace{(r^{2+}_{ht,t,dt}\cdot C^{2+}_{ht,t,dt})}^{\textit{Secondary-up reserve provision cost}} + \overbrace{(r^{2-}_{ht,t,dt}\cdot C^{2-}_{ht,t,dt})}^{\textit{Secondary-down reserve provision cost}}}^{\textit{Total reserve provision cost (secondary and tertiary)}} + \overbrace{(r^{3sp+}_{ht,t,dt}\cdot C^{3s+}_{ht,t,dt})}^{\textit{Tertiary-up spinning reserve provision cost}} + \overbrace{(r^{3sp-}_{ht,t,dt}\cdot C^{3s-}_{ht,t,dt})}^{\textit{Tertiary-down spinning reserve provision cost}} + \overbrace{(r^{3ns}_{ht,t,dt}\cdot C^{3ns}_{ht,t,dt})}^{\textit{Tertiary-up non-spinning reserve provision cost}}\Big]$$

The main contributions and the prominent features of our work include:

(i) incorporation of the interaction of power capacity reserves with an energy-only market,

(ii) incorporation of the linked hourly orders, facilitating the creation of a correlated portfolio consisting of a series of units,

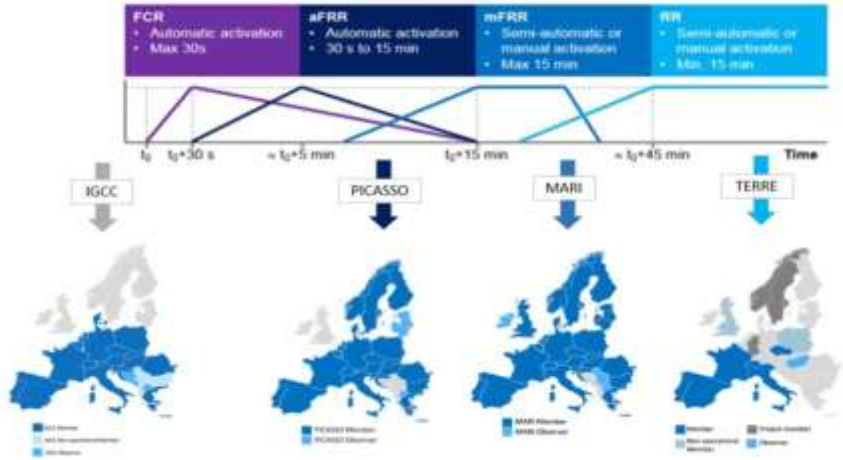
(iii) consideration of power reserve constraints satisfaction at an intra-hourly level,

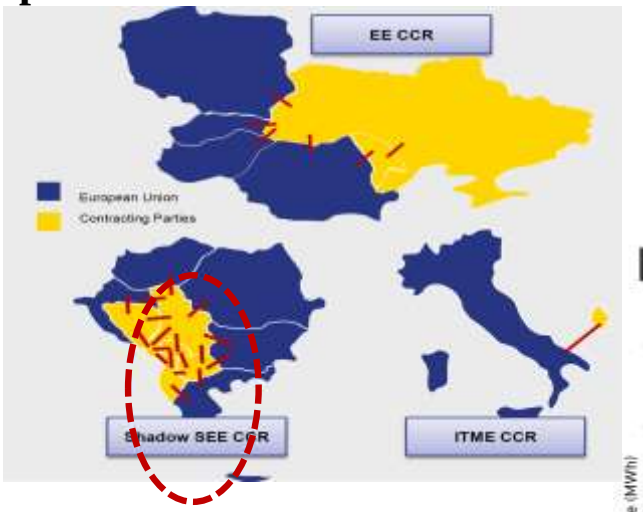
(iv) quantification of the impacts of key operational aspects of thermal units on the currently utilized economic-based market clearing algorithm, and

(v) provision of price signals on potential investors for the optimal determination of investments in the power sector.

Important challenges for the Hellenic wholesale market

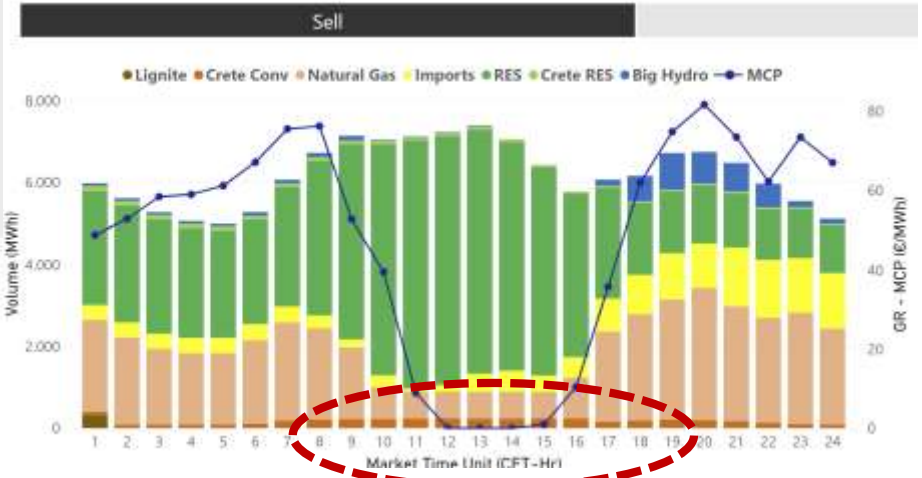
- **Completion of remaining tasks of Market Reform Plan (vast majority of MRP tasks completed – as noted in NCEP assessment by EU)**
  - **Balancing markets' platforms (IPTO to join MARI-PICASSO)**
  - **TSO-DSO coordination (facilitated by the completion of dispatch centers by DSO)**
  - **RES PPAs platform (to be completed by Henex)**
  - **Market coupling with Western Balkans (adoption of common CCR rules and enhanced role of Selene)**





- **Big bang 15-minute MTU implementation**
- **Potential implementation of CM and**
- **Potential adoption of co-optimization**

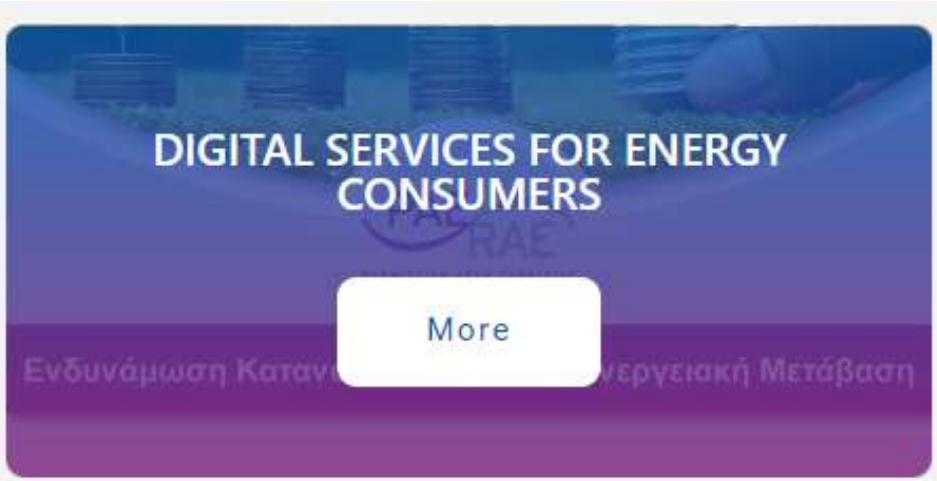
- **Curtailment and renumeration of RES generation**
  - **zero prices eliminate energy cost for retailers and consumers,**
  - **however, they create uncertainty in RES projects**
  - **(that could be offset through long-term contracts – CfD and PPAs)**



Transforming Regulator nature (R2C), creating Consumer's Place

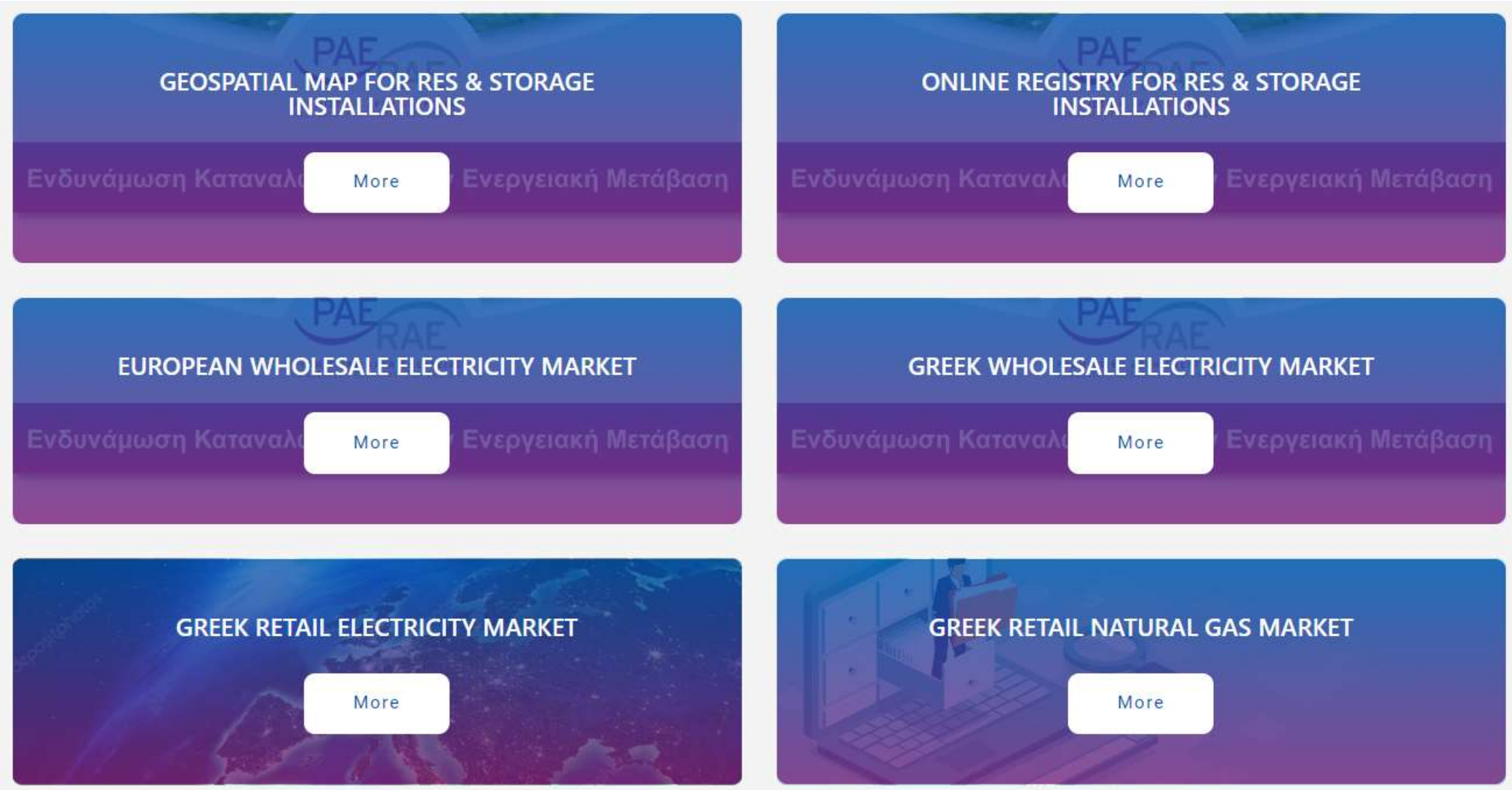
to Protect Consumers and Enhance Transparency

Digital services for Energy Consumers and Markets



Digital services for Energy Consumers

Digital services for Energy Markets

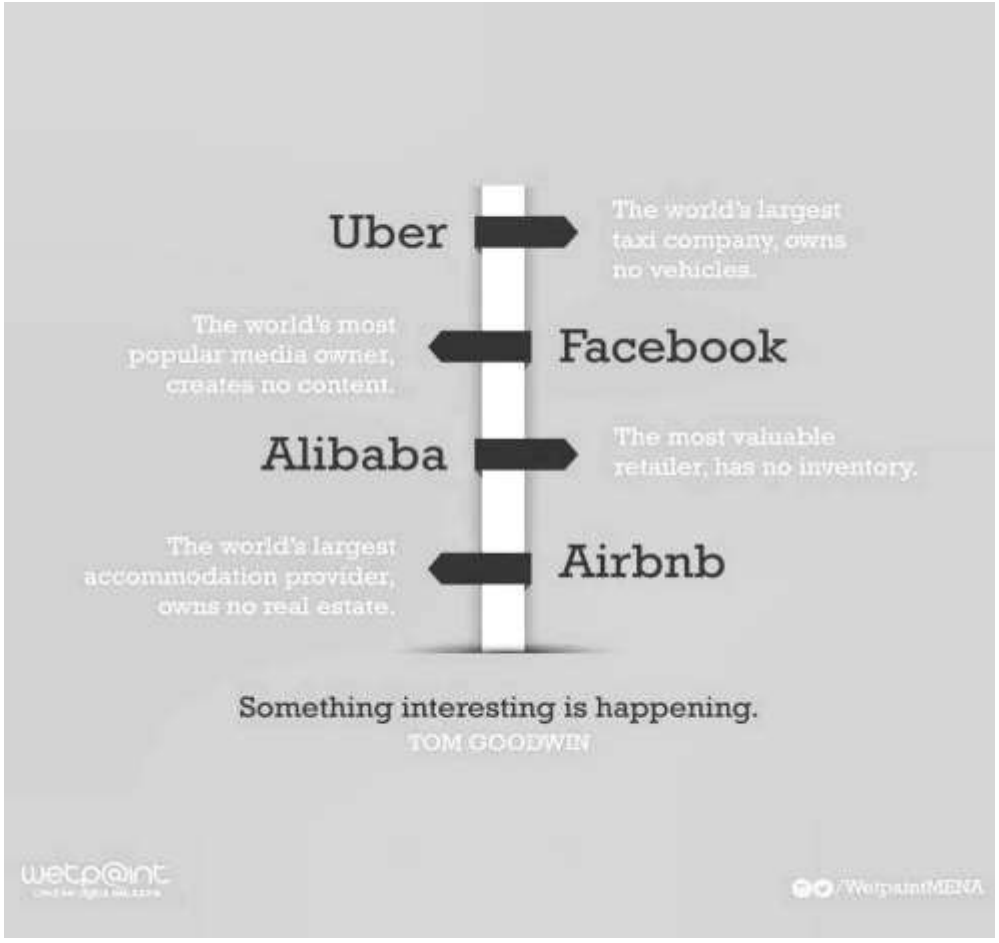


We Create a Consumers‘ Place

We transform Regulator‘s nature from B2B (R2B) to R2C

in a similar way that innovative companies

Engage Assets’ owners to create Market Place



We Engage Citizens to create Consumers Place

Through a number of innovative tools:

MyRAE
Energy Ombudsman
Energy-Whistleblowing

Energy Cost and Charging Cost comparison tools

Tools enhancing Transparency and Understanding
Retail Billing database

Energy Cost calculator and Building Energy Savings tools

Summary

European Electricity Market Design

- Improved **REMIT**
- **Better protection of consumers**
- **PPAs** and **two-way Contracts for Difference (CfDs)** to support RES penetration
- **Capacity mechanisms** to become element of the electricity market
- Assessed options (retaining of marginal pricing and zonal pricing, no adoption of technology market split and ex-ante power mitigation, potential adoption of co-optimization)

EU's EMD

- Completion of few **remaining tasks of Market Reform Plan** (MARI/PICASSO, TSO-DSO coordination, RES PPA platform, Market coupling with Western Balkans,)
- **Big bang 15-minute MTU implementation**
- **Potential implementation of CM** and adoption of co-optimization
- **Curtailment and renumeration of RES generation**

Challenges for Greek wholesale electricity market

- **Digitalizing procedures for Energy Consumers and Markets**
  - **Transforming nature of Regulator (from R2B to R2C)**
  - **Creating Consumers' Place to Protect Consumers and Enhance Transparency**

Creation of a Consumers' Place to Protect Consumers

Thank you for your attention!

ΡΑΑΕΥ
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