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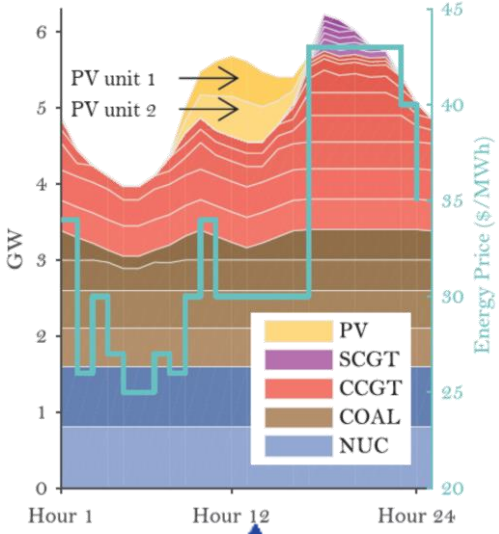
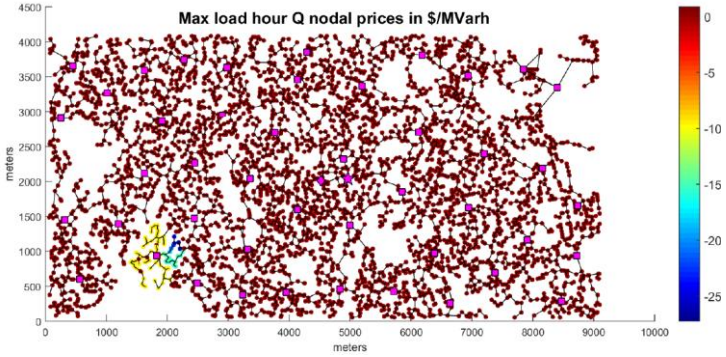
Aim, tools and contributors

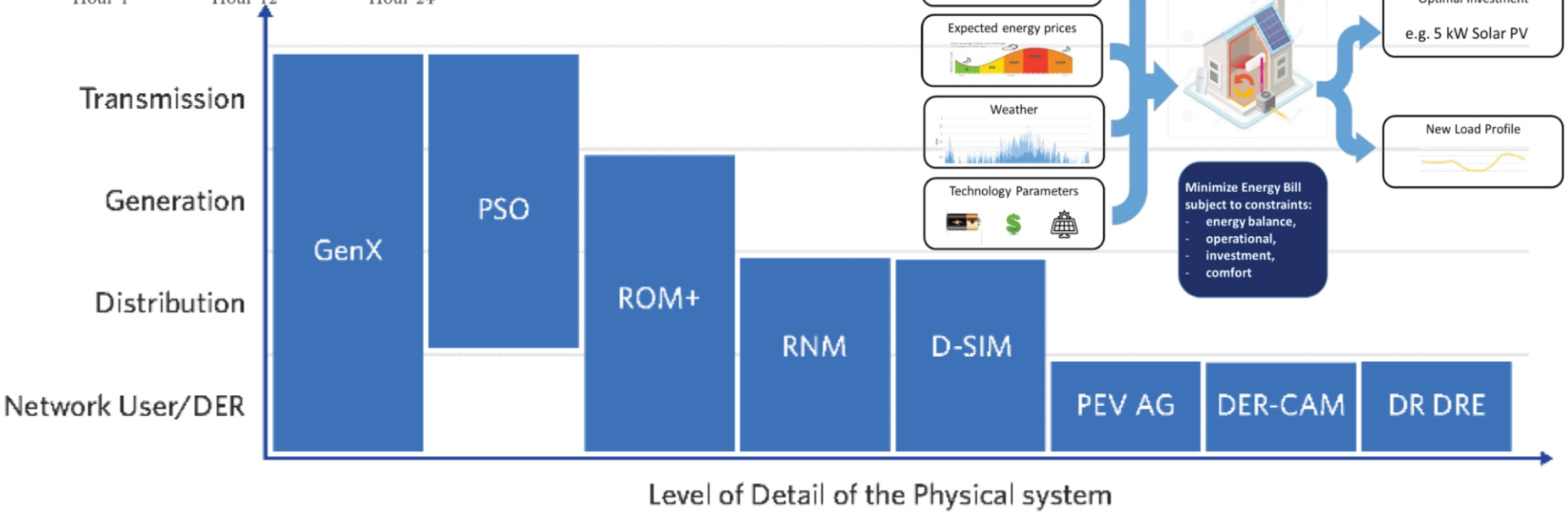
The future of the provision of electricity services

- Examine new options for the provision of electricity services from **DERs** and **ICTs**
- Focus on the **USA & Europe** over the **next decade** & beyond
- **Policy and regulatory recommendations** to facilitate an **efficient utilization of ALL resources**, whether **centralized or decentralized**

The modeling tools







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Booz | Allen | Hamilton

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Paul & Matthew Mashikian

Scope & key recommendations

Part 1: Understanding distributed energy resources (DERs) and the new ways of providing electricity services

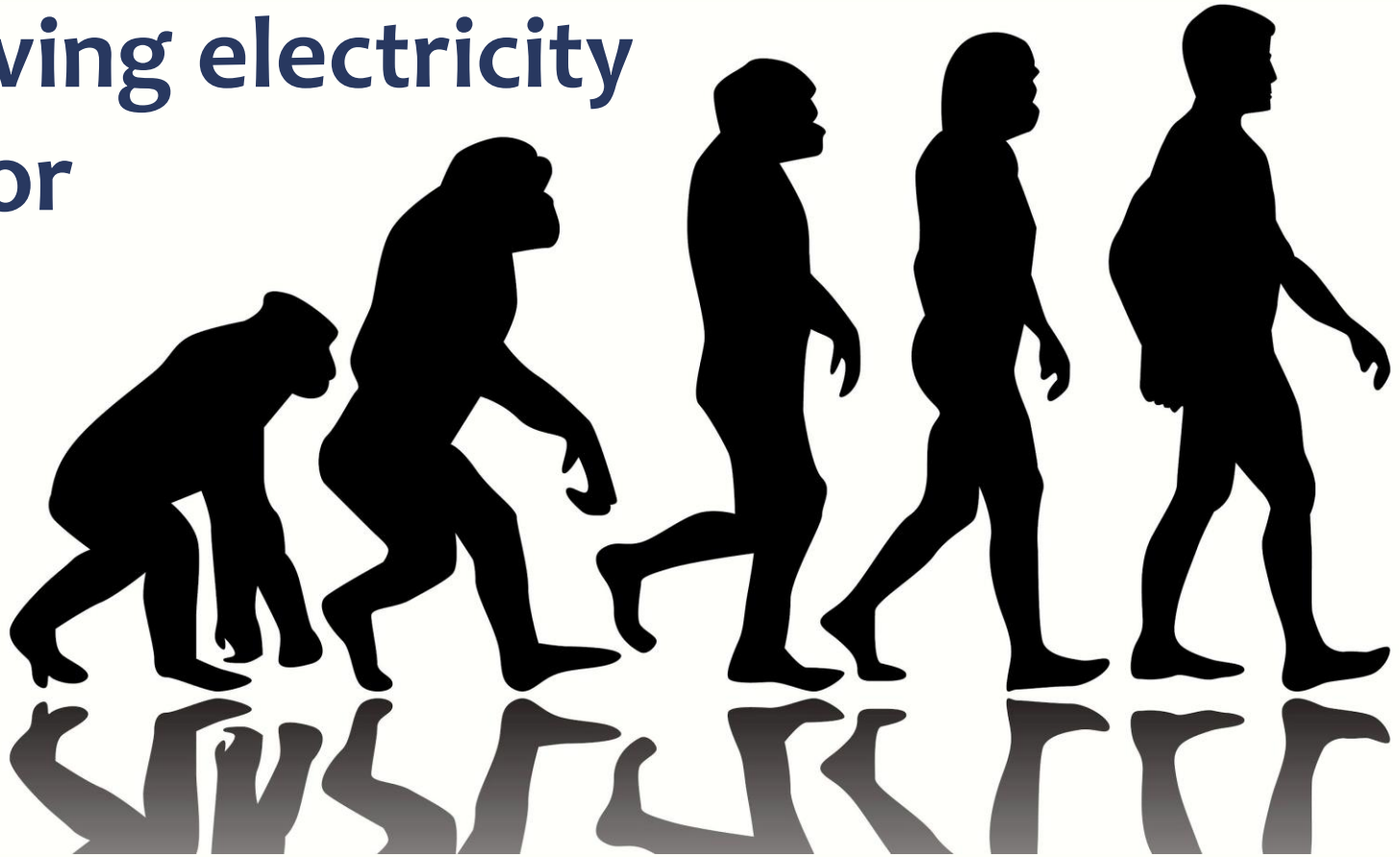
"L'avenir, tu n'as point à le prévoir mais à le permettre"
Citadelle, Antoine de Saint-Exupéry, 1948

"The future, you do not have to foresee it, but to enable it"

Is the future distributed?

The future is integrated

A framework for an evolving electricity sector



Part 2: A framework for an efficient and evolving power system

4. A Comprehensive and Efficient **System of Prices and Regulated Charges** for Electricity Services

5. The Future of the **Regulated Network Utility Business Model**

6. Restructuring Revisited: Electricity **Industry Structure** in a More Distributed Future

7. The **Re-Evolution** of Short- and Long-Term Electricity **Market Design**

KEY RECOMMENDATIONS

1. Cost-reflective prices and charges

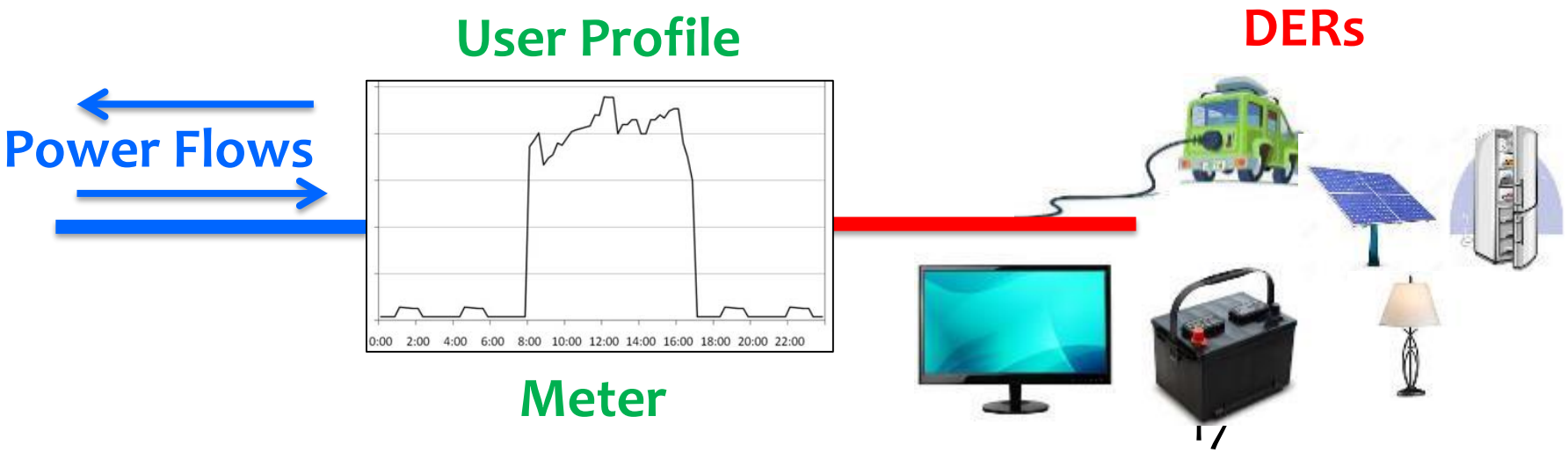
Part 2: Understanding distributed energy resources (DERs) and the new ways of providing electricity services

CREATE A COMPREHENSIVE & EFFICIENT SYSTEM OF PRICES & CHARGES

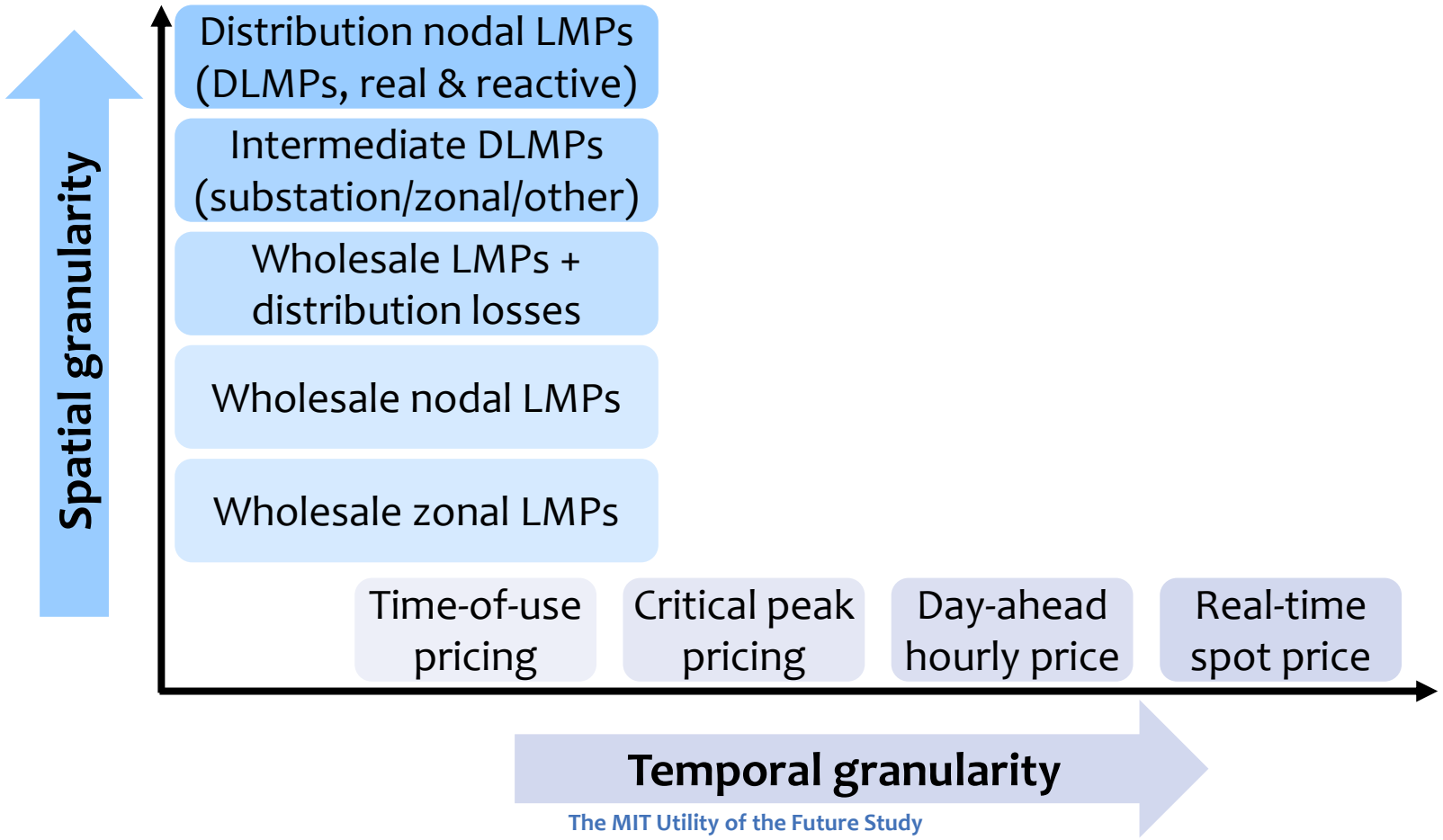
The only way to put all resources (**centralized & distributed**) on a **level playing field** and achieve **efficient operation and planning**

Prices and charges

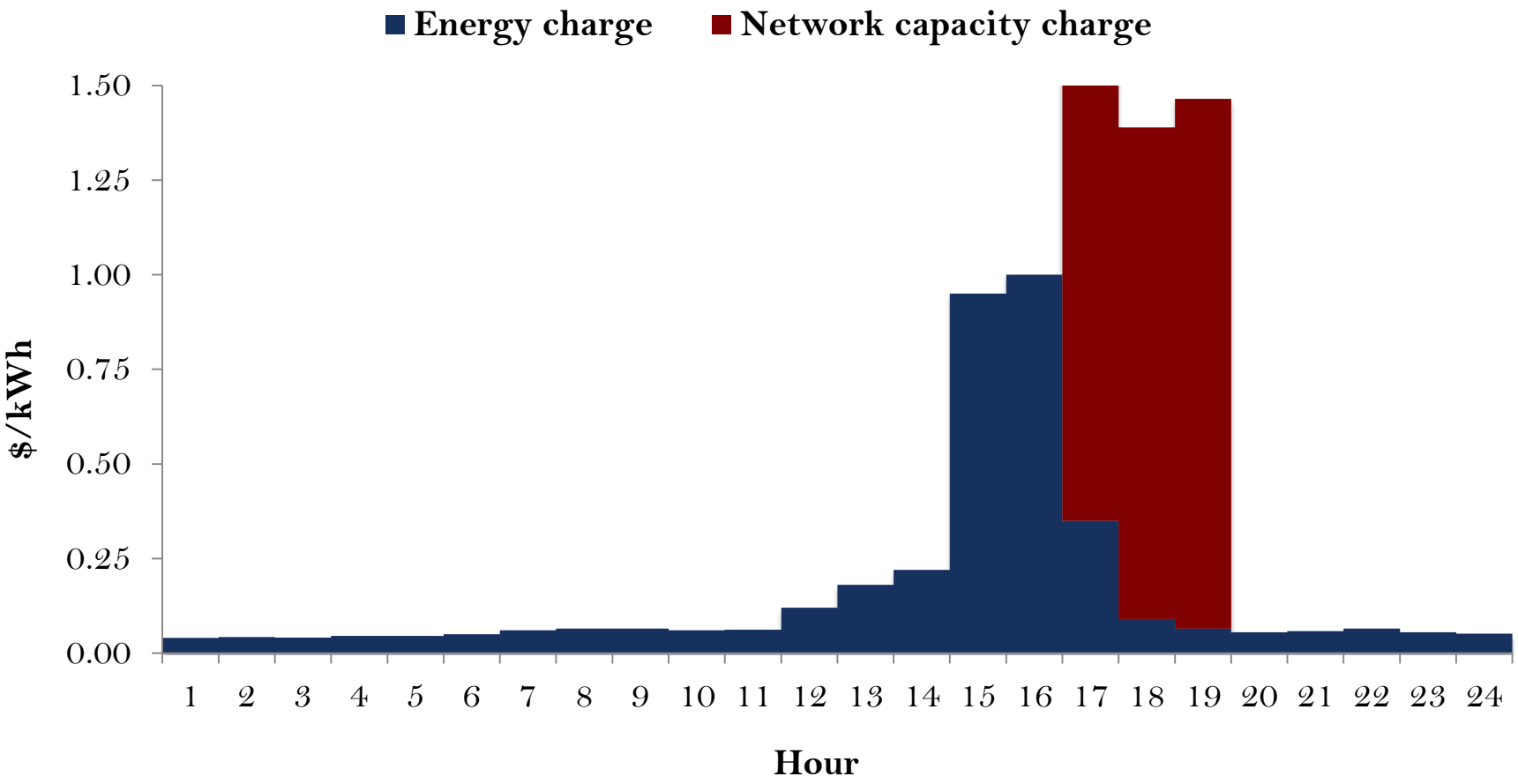
- Based on the individual injection & withdrawal profiles
  - Symmetrical
  - Avoiding going behind the meter



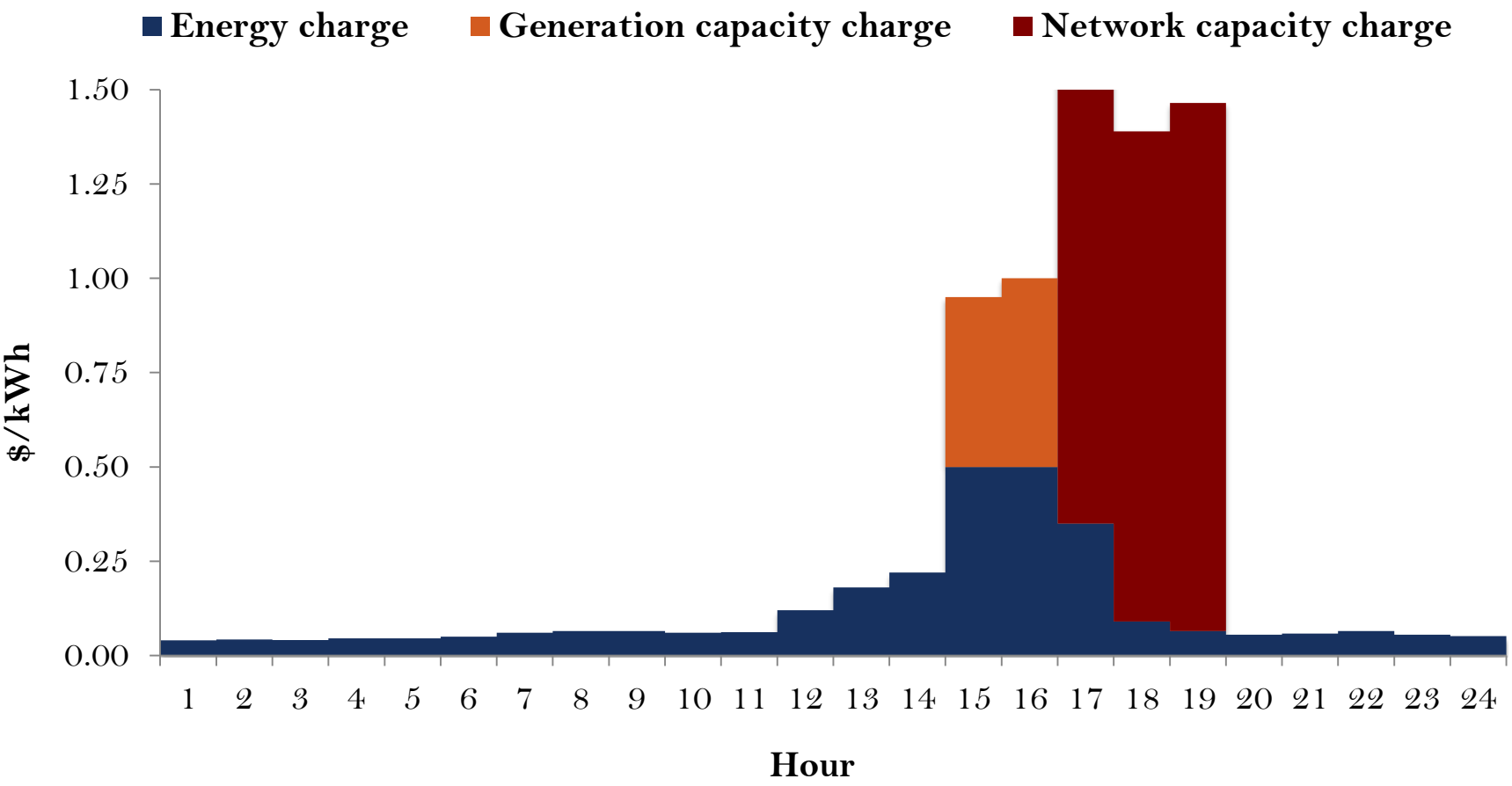
Optimize the granularity of price signals with respect to both time and location



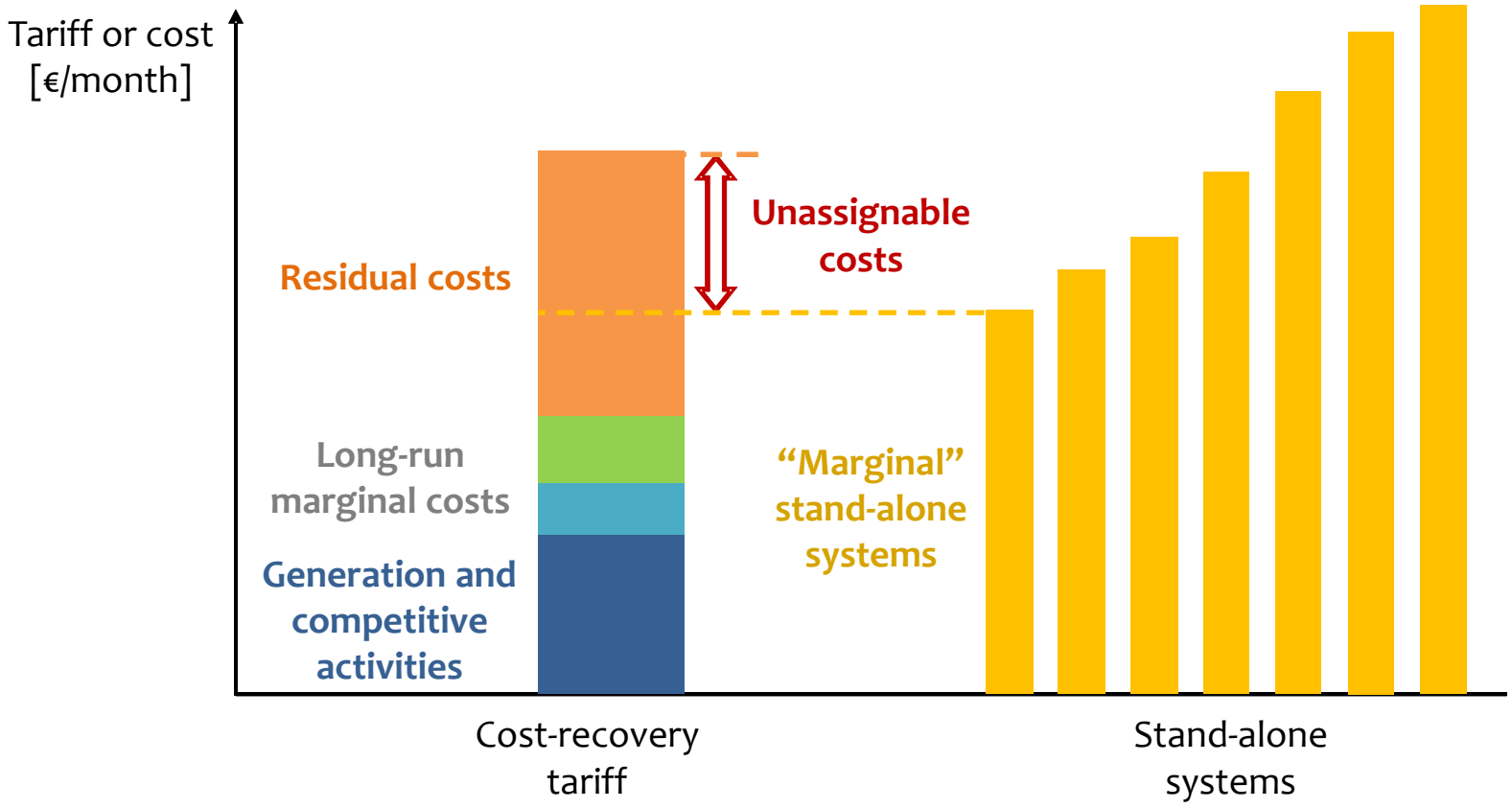
Forward-looking peak-coincident network capacity charges



… and scarcity-coincident generation capacity charges



Allocate residual network and policy costs without distorting efficient incentives



Address distributional concerns without sacrificing efficient incentives

Efficient pricing would unwind cross-subsidies and result in greater variability in charges

- Lump-sum bill credits or surcharges can restore desired cross-subsidies if desired
- Lump-sum pre-payments or hedging arrangements can address monthly bill variability
- Means-tested low-income assistance can replace implicit subsidy due to volumetric charges

2. Improved network regulation

Part 2: Understanding distributed energy resources (DERs) and the new ways of providing electricity services

ENHANCE DISTRIBUTION REGULATION

To **enable** the development of more **efficient** & **innovative** distribution utility **business models**

State of the art regulatory tools to reduce information asymmetry & manage uncertainty

Incentive-compatible menu of contracts

- to induce accurate utility forecasts and minimize strategy behavior

Engineering-based reference network models

- to equip regulators for forward-looking benchmarks and analyze uncertainty scenarios

Automatic adjustment mechanisms

- to account for forecast errors

See Jenkins & Pérez-Arriaga (2017), "Improved Regulatory Approaches for the Remuneration of Electricity Distribution Utilities with High Penetrations of Distributed Energy Resources," *The Energy Journal* 38(3): 63-91

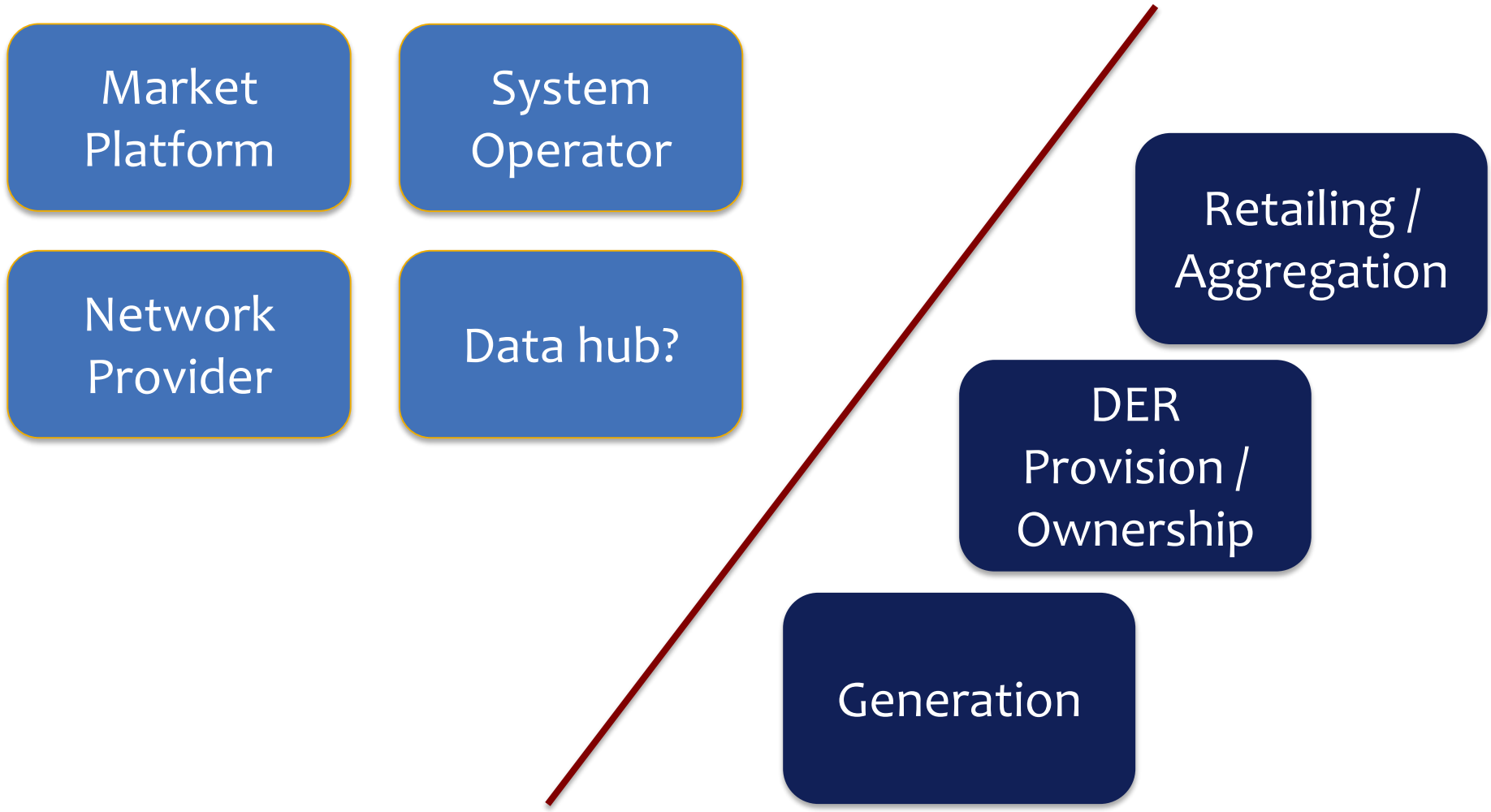
3. Revisit industry structure

Part 2: Understanding distributed energy resources (DERs) and the new ways of providing electricity services

RETHINK INDUSTRY STRUCTURE TO MINIMIZE CONFLICTS OF INTEREST

Responsibilities and **independence** of network providers, system operators and market platforms through **unbundling** and strict regulatory **oversight**

Carefully assign responsibility to minimize potential conflicts of interest



4. Update electricity markets

Part 2: Understanding distributed energy resources (DERs) and the new ways of providing electricity services

IMPROVE WHOLESALE MARKET DESIGN TO BETTER INTEGRATE DERS

Reward **flexibility** improving bidding formats, time granularity and reserves pricing and **evolve RES support mechanisms** for **a level playing field for all technologies**

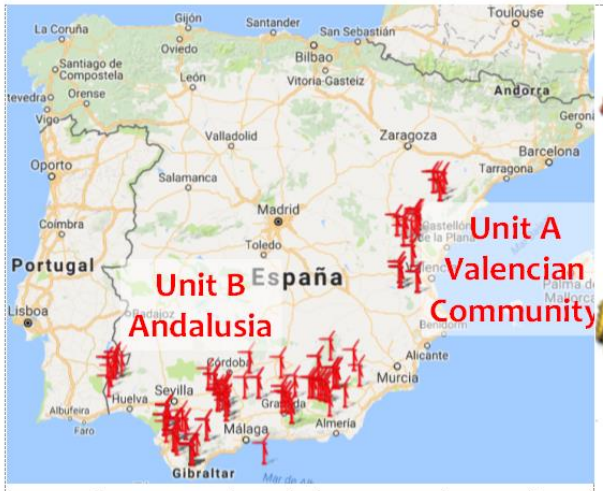
Enable new resources to play in existing and emerging markets

Update wholesale **market rules** (such as bidding formats) to reflect the operational constraints of new resources

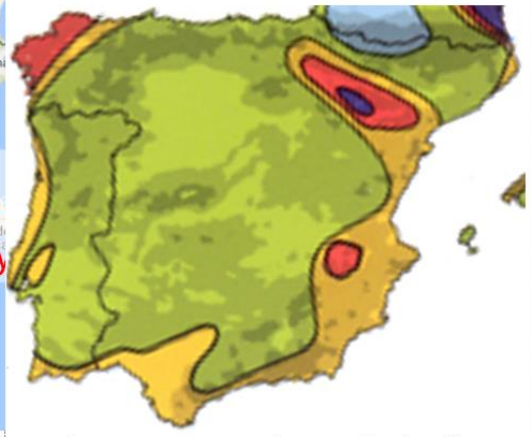
Implement **liquidity**-oriented solutions to mitigate existing **entry barriers**

Minimize the interference of support mechanisms for clean technologies in electricity markets

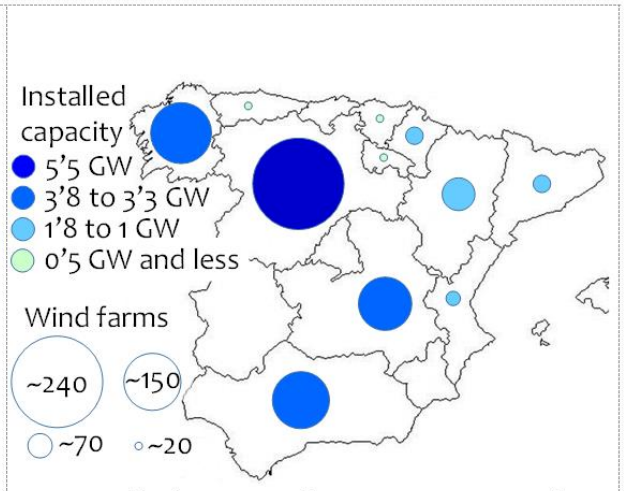
Auctioned **capacity-based subsidies** complemented with ex-post compensations defined for reference benchmark plants



A. Valencia and Andalusia wind maps[10]

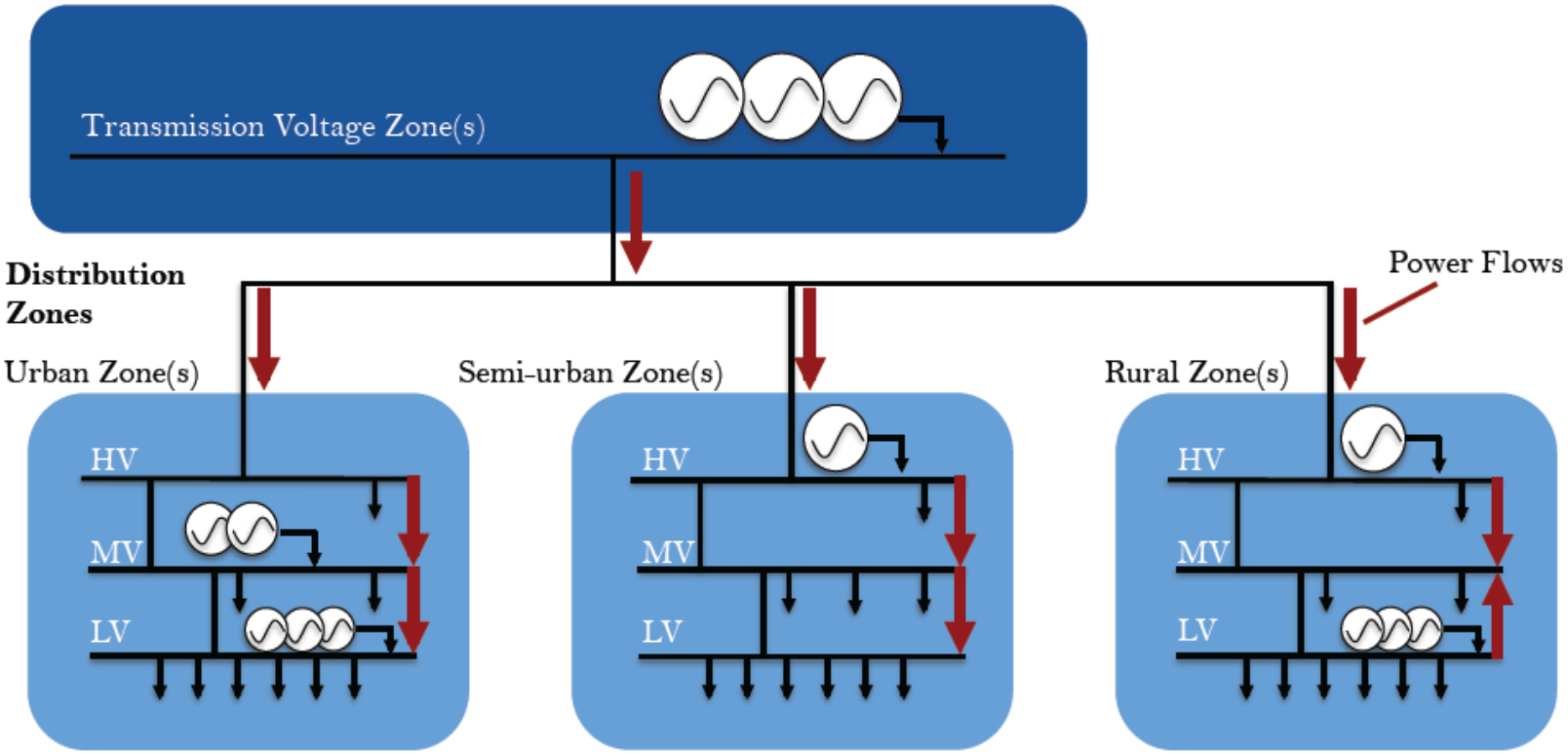


B. Iberian Peninsula wind atlas[11]



C. Installed capacity by regions in 2015[12]

Part 3: Insights on the Economics of DERs and the Competition between Centralized and DERs



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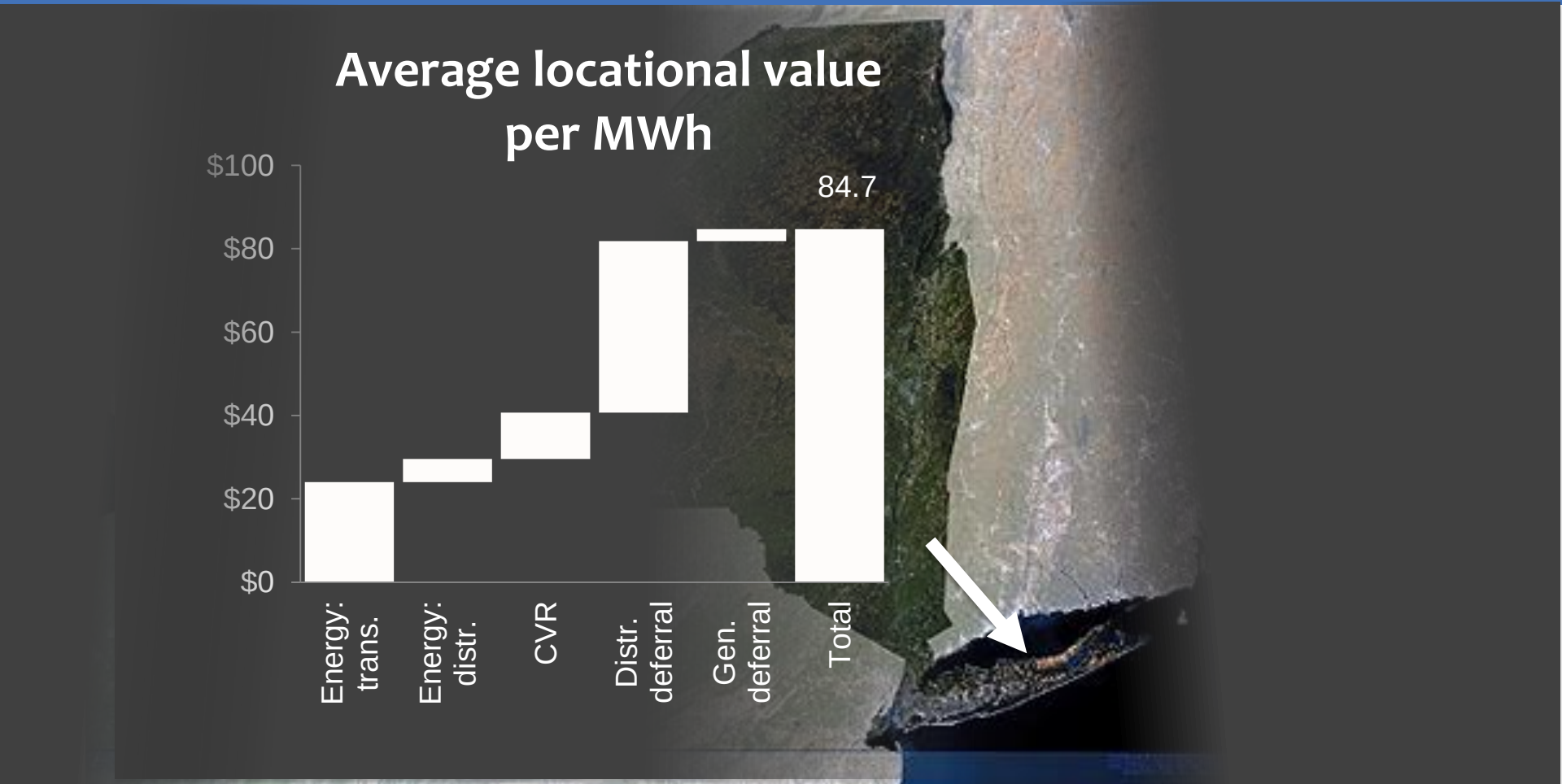

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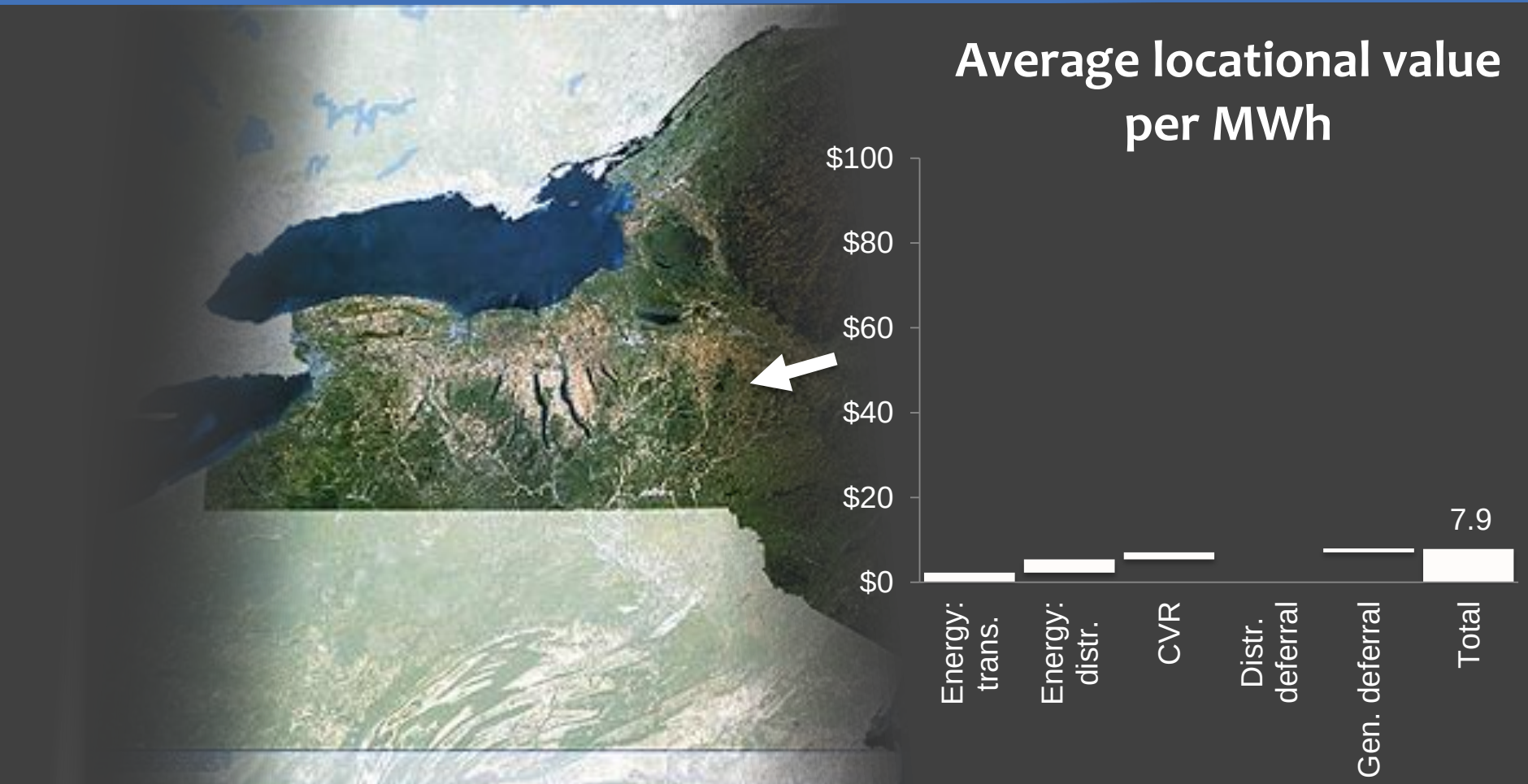

Part 3: Insights on the Economics of DERs and the Competition between Centralized and DERs

CAREFULLY EVALUATE THE ECONOMIC OPPORTUNITIES AND COSTS OF DERS

Better utilization of existing assets hold **great potential for cost savings.**
Economies of scale still matter.
The **distributed** deployment of resources is **not always cost-effective**

Part 4: A Policy and Regulatory Toolkit for the Future Power System

PROACTIVE POLICY & REGULATORY REFORMS

Networks, markets, end-user prices and charges, industry structure, cybersecurity…

Robust to the uncertain changes underway

TO FACILITATE EFFICIENCY IN THE FUTURE

Technology agnostic (centralized or decentralized, renewable or conventional, …)

Part 4: A Policy and Regulatory Toolkit for the Future Power System

IN SUMMARY, WHAT THE STUDY PROPOSES

- can be gradually implemented with existing technology and reasonable regulatory measures
- sets a level playing field for competition of centralized and distributed resources
- enabling an efficient outcome regardless of the future development of technologies or policy objectives

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UTILITY OF THE FUTURE

An MIT Energy Initiative response to an industry in transition

In collaboration with IIT-Comillas

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