Workshop on photovoltaics, grid integration and funding of the next wave of PV expansion in Cyprus

How the grid is and how it will be transformed in the next 5 years ……?

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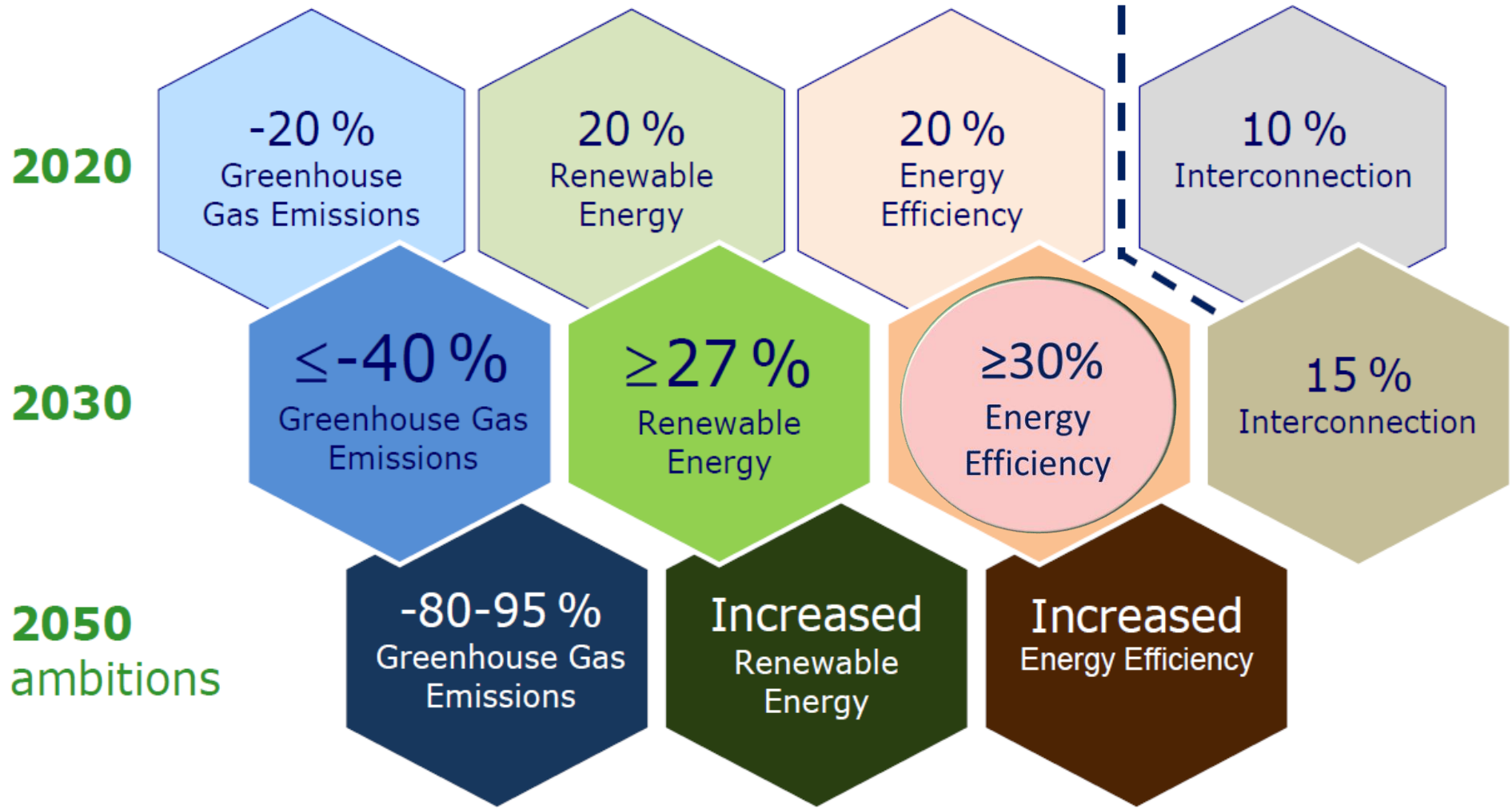
Strategy of Europe for 2020 to 2030 +



27% renewable energy in 2030: up to 45% renewable electricity

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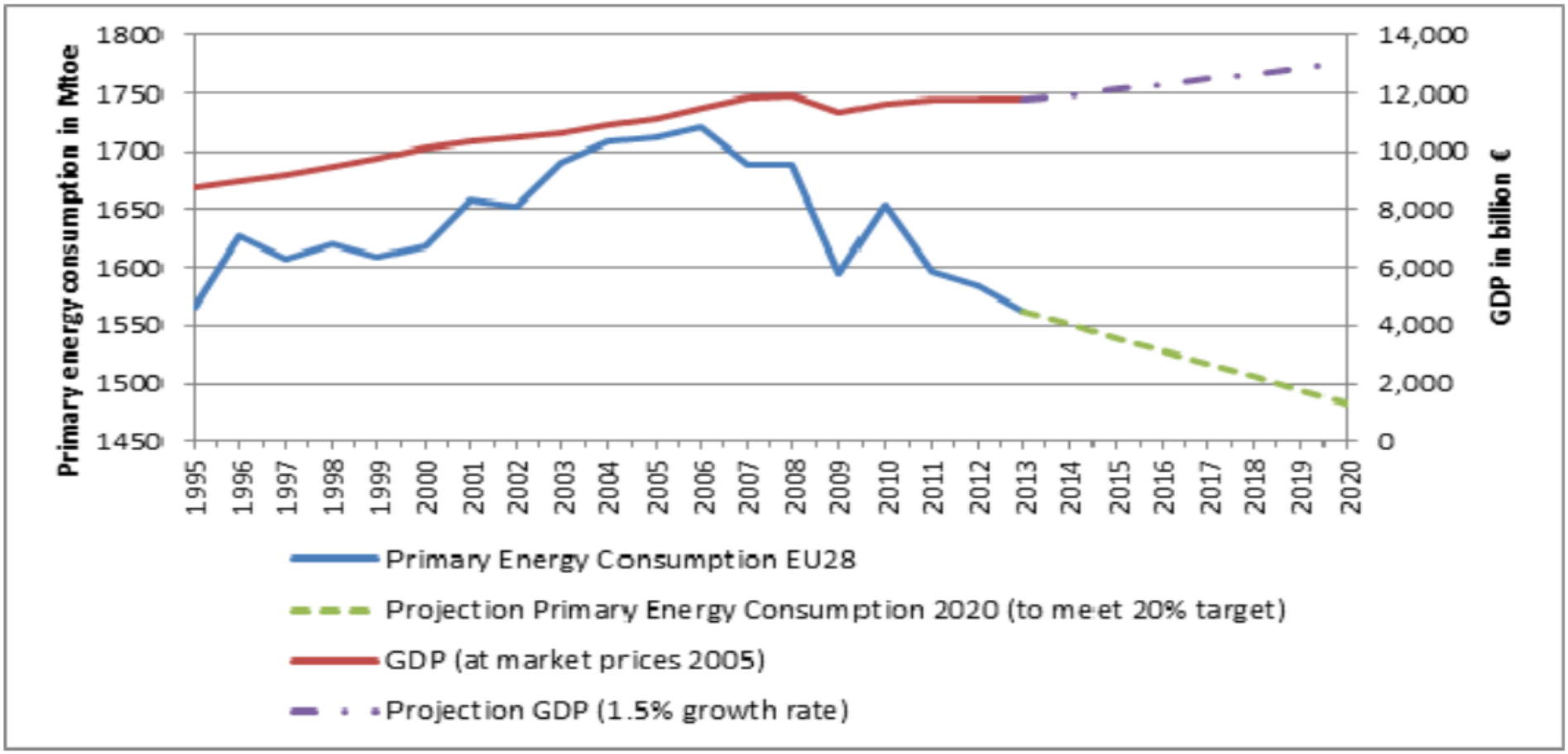
The challenge of efficiency…



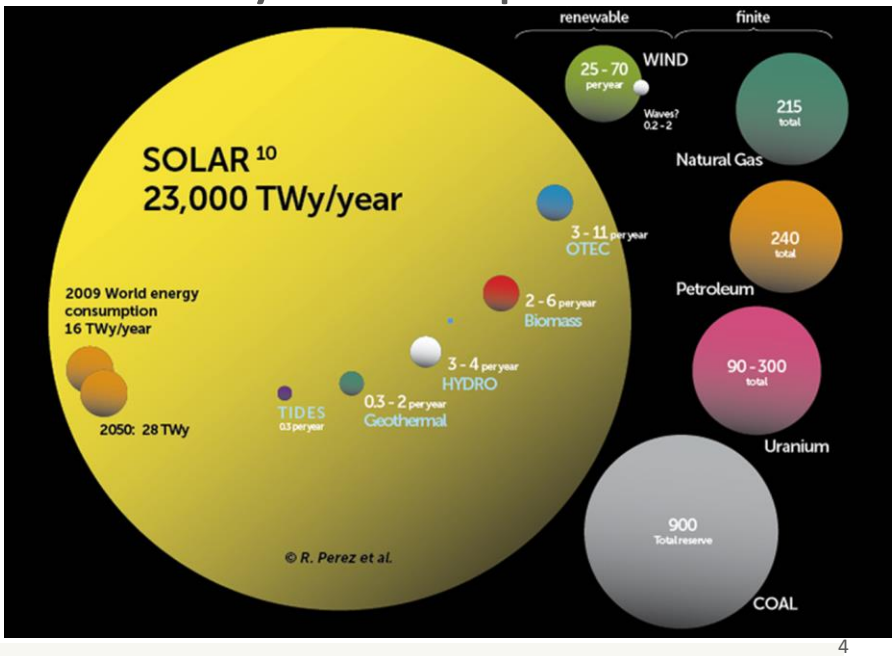
Source: Commission services based on EUROSTAT data

How the grid is and how it will be transformed in the next 5 years ……?

Energy in transition: Grid responds

- We are moving on a road that is characterised by fundamental changes in the energy mix;
- How do we transform the strategy of our countries for achieving the objectives set out collectively at European level?

- **How do we harvest the inexhaustive source of energy that is coming to us from the sun for economic and social prosperity?**



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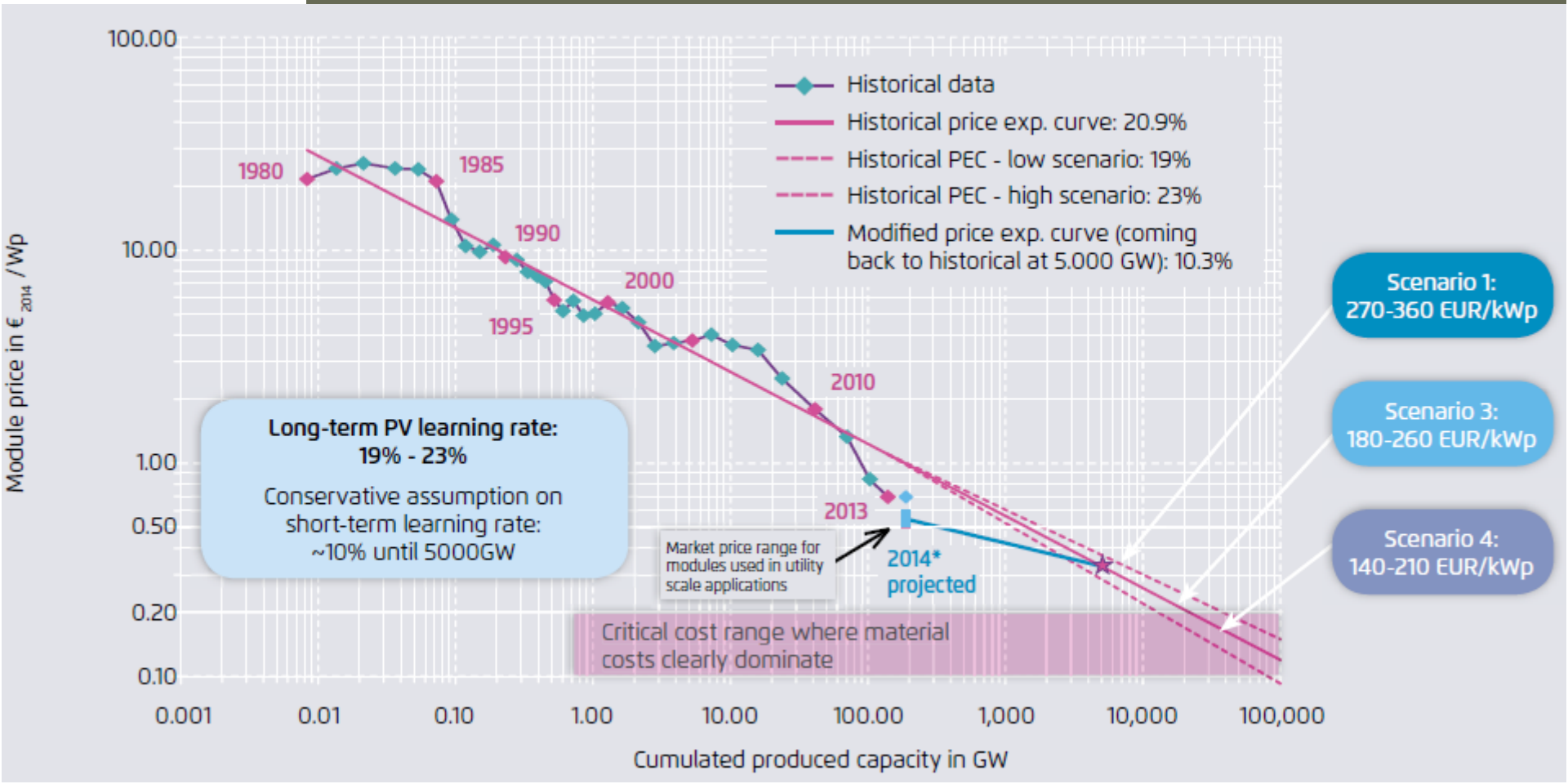
Long-term utility-scale PV system price scenarios



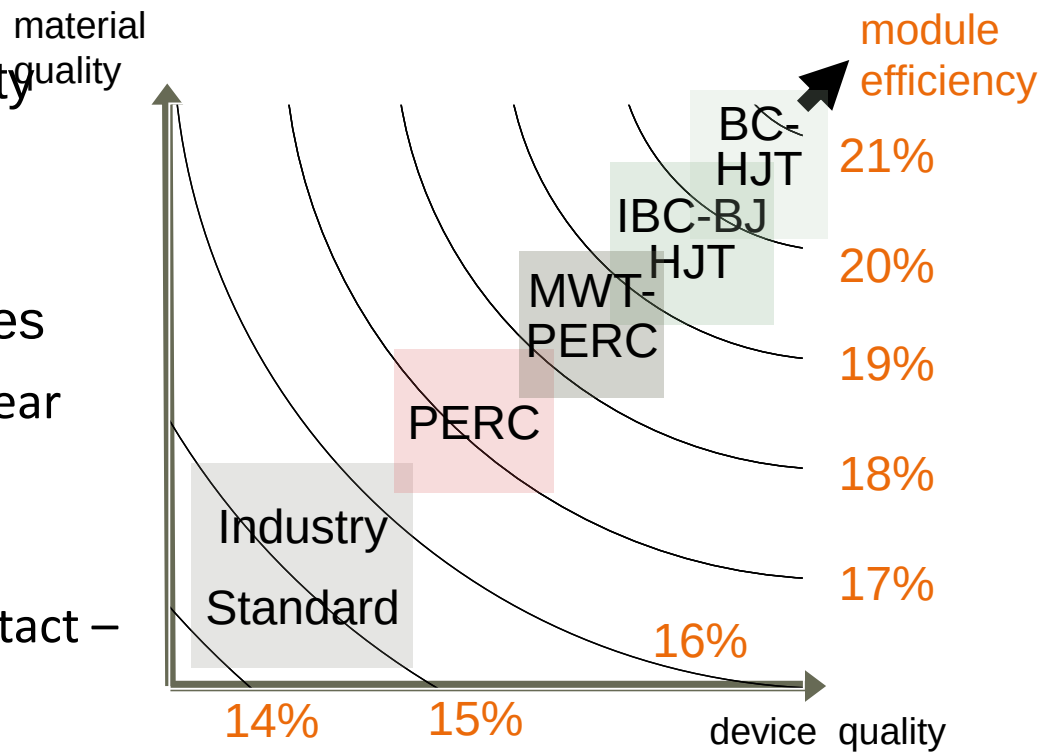
Source: Fraunhofer ISE (2015): Current and Future Cost of Photovoltaics.
Study on behalf of Agora Energiewende

How the grid is and how it will be transformed in the next 5 years ……?

Crystalline Silicon Technology Portfolio
c-Si - PV is not a Commodity, but a High-Tech Product!

material quality

- diffusion length
- base conductivity device quality
- passivation of surfaces
- low series resistance
- light confinement cell structures
- PERC: Passivated Emitter and Rear Cell
- MWT: Metal Wrap Through
- IBC-BJ: Interdigitated Back Contact – Back Junction
- HJT: Hetero Junction Technology



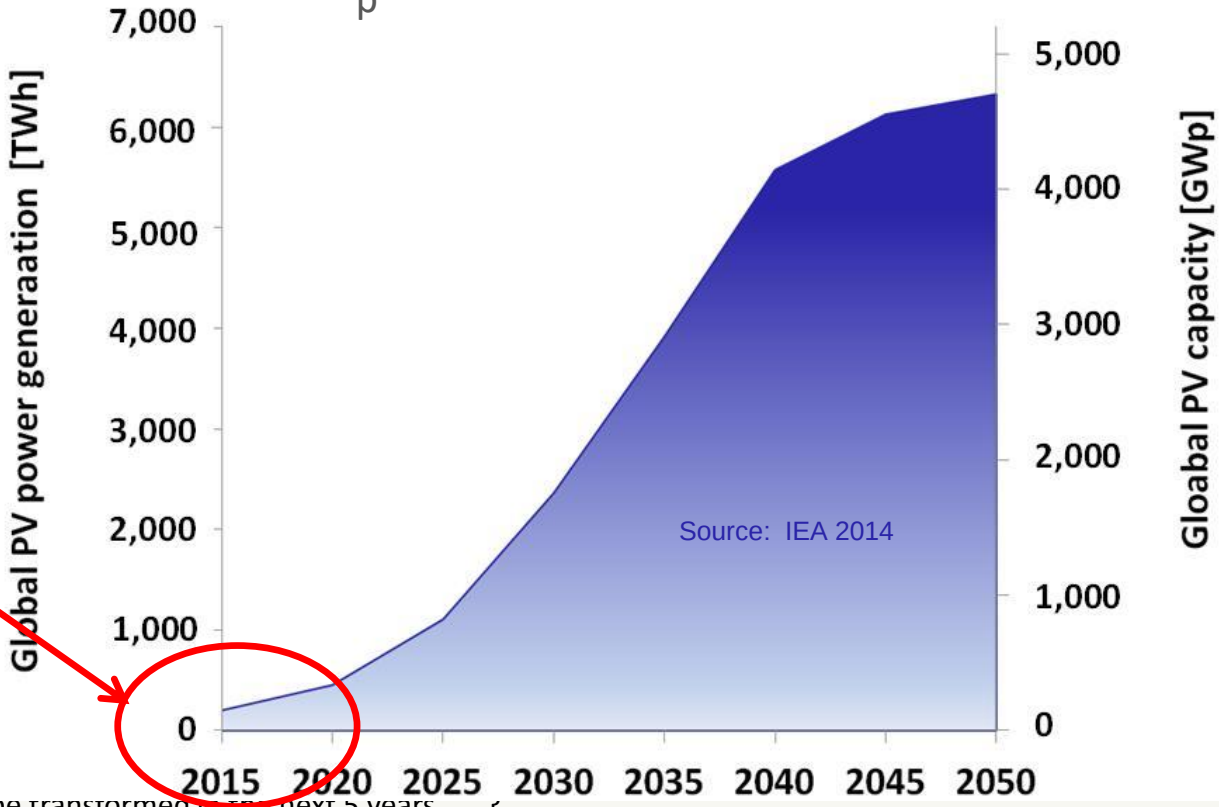
Adapted from Preu et al., EU-PVSEC 2009

How the grid is and how it will be transformed in the next 5 years ……?

PV Market Growth: PV heading into the Terawatt Range!

- Rapid introduction of PV globally is fueled by availability of cost-competitive, distributed energy
- In 2050 between 4.000 and 30.000 GW_p PV will be installed!
- By 2015, less than 300 GW_p have been installed!

We are just at the beginning of the global growth curve!



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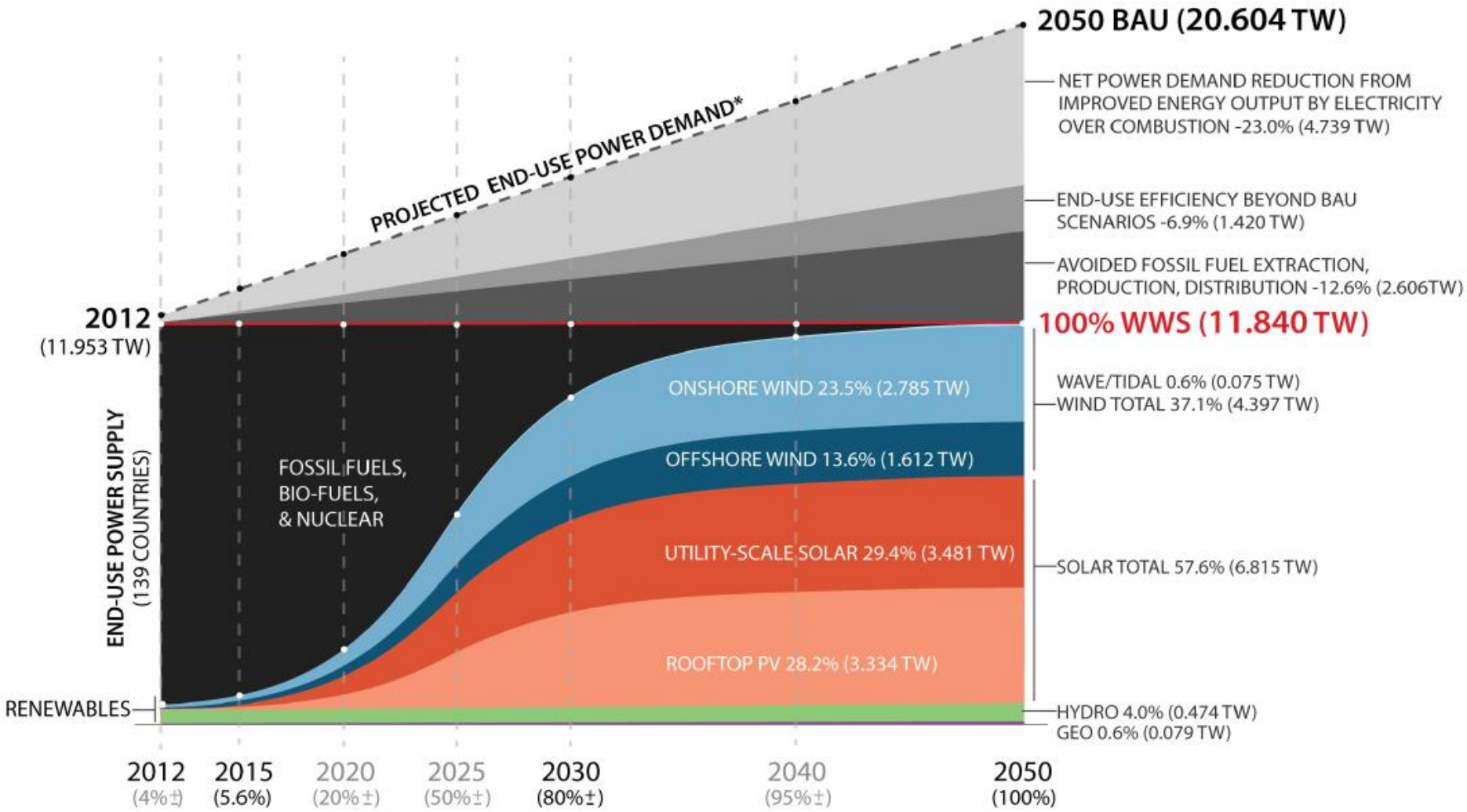
Technical University of Denmark DTU



Atmosphere/Energy Program, Dept. of Civil and Env. Engineering, Stanford University

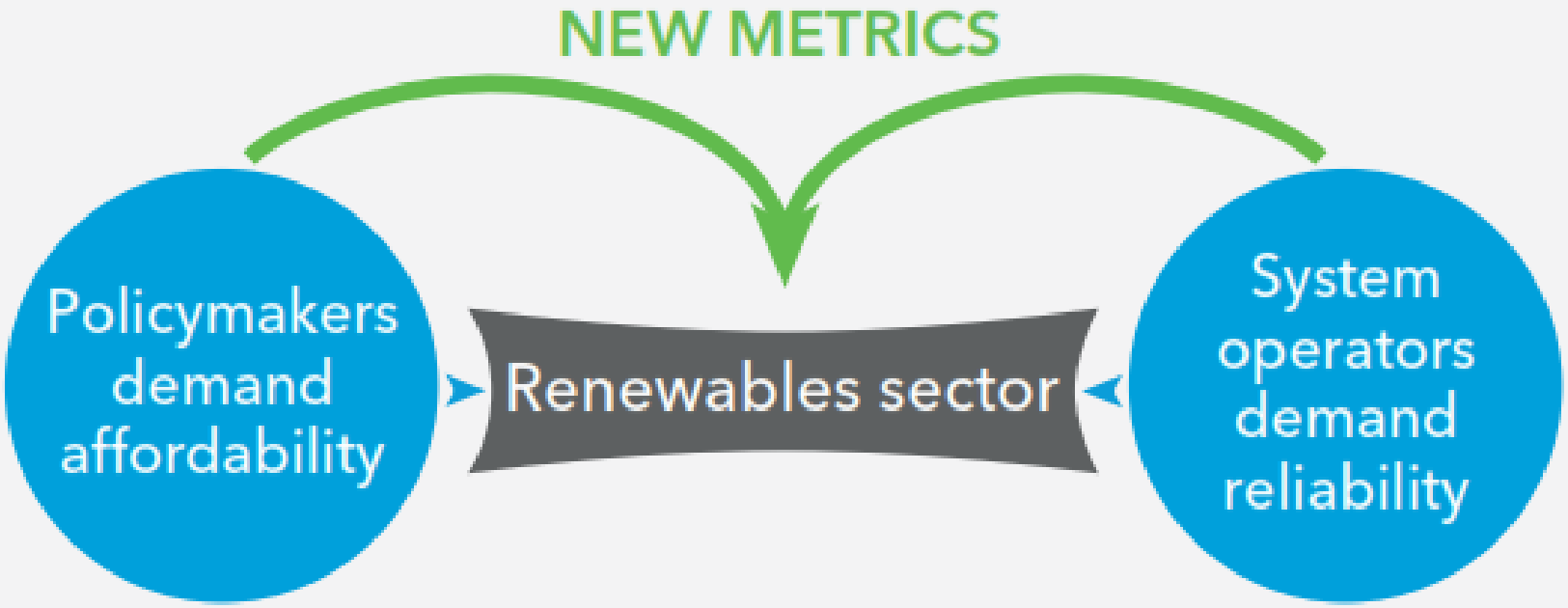
Institute of Transportation Studies, U.C. Berkeley
Technical University of Berlin

How the grid is and how it will be transformed in the next 5 years ……?

Business is not as usual: A new norm is born

- Through the dynamics of RES we are re-shaping the electrical industry,
- We need to go beyond integration – RES is not as conceived, a tolerable integration into status quo arrangements but a much smarter need,
- Through the adoption of these new technologies, a new norm is born that requires:

Convergence between policymakers for better prices and demand reliability from System Operators



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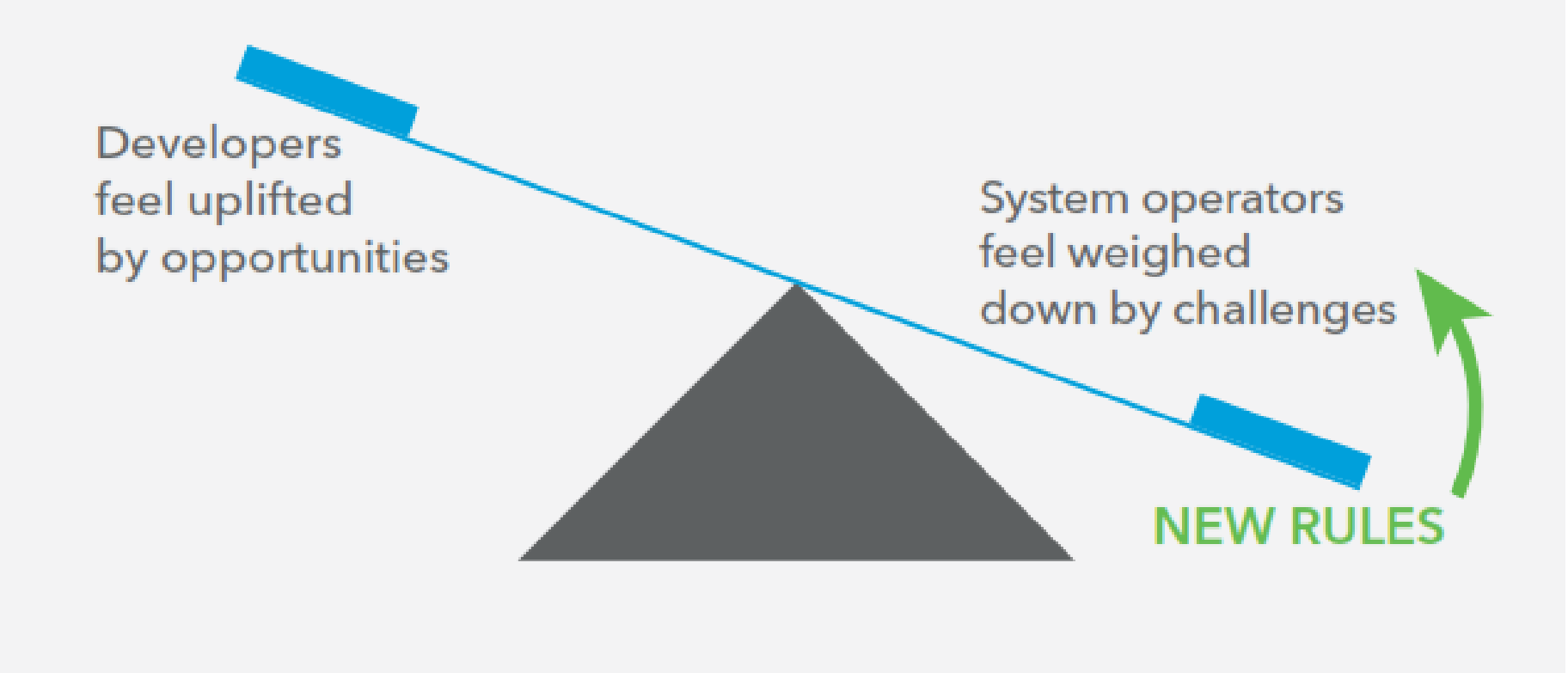
Rebalancing between opportunities of developers and grid challenges of System Operators



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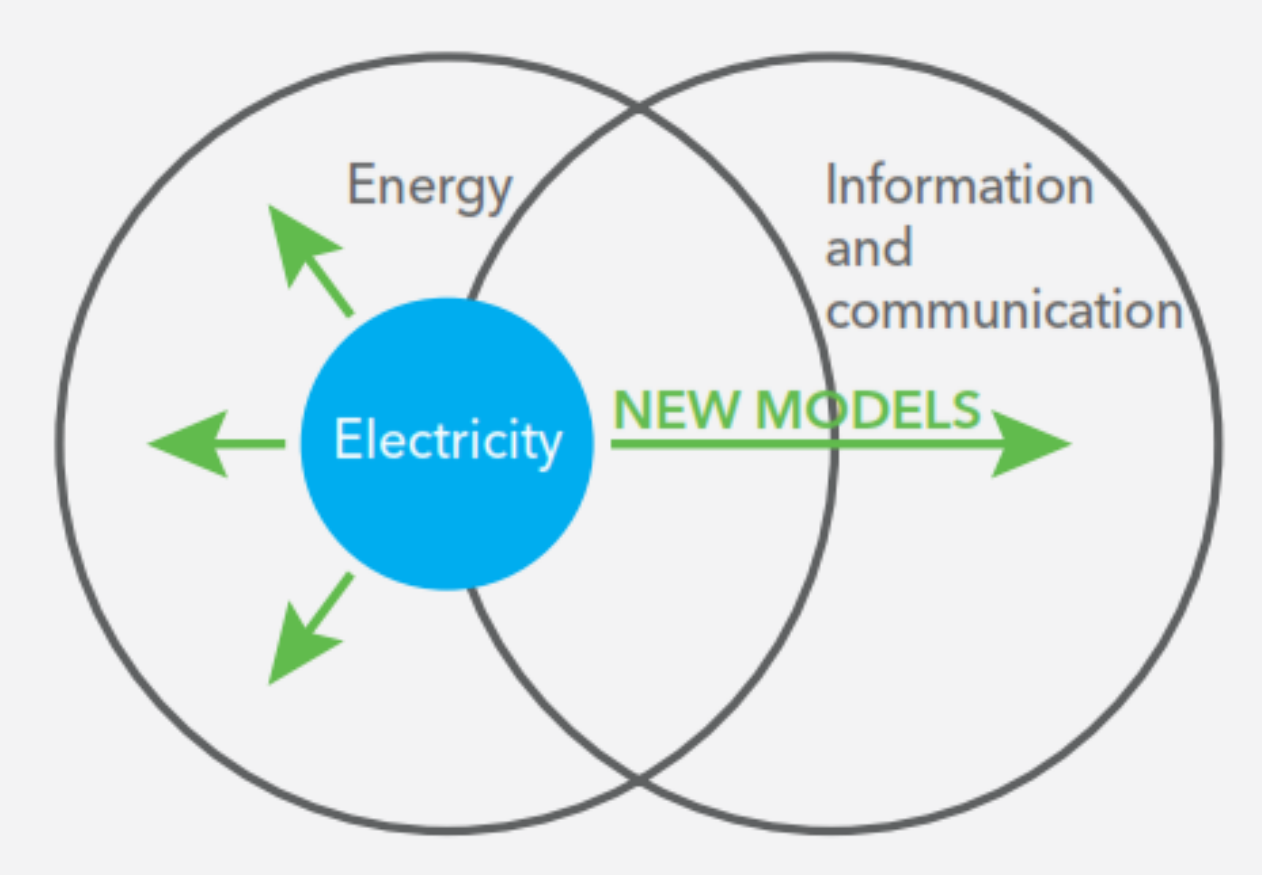
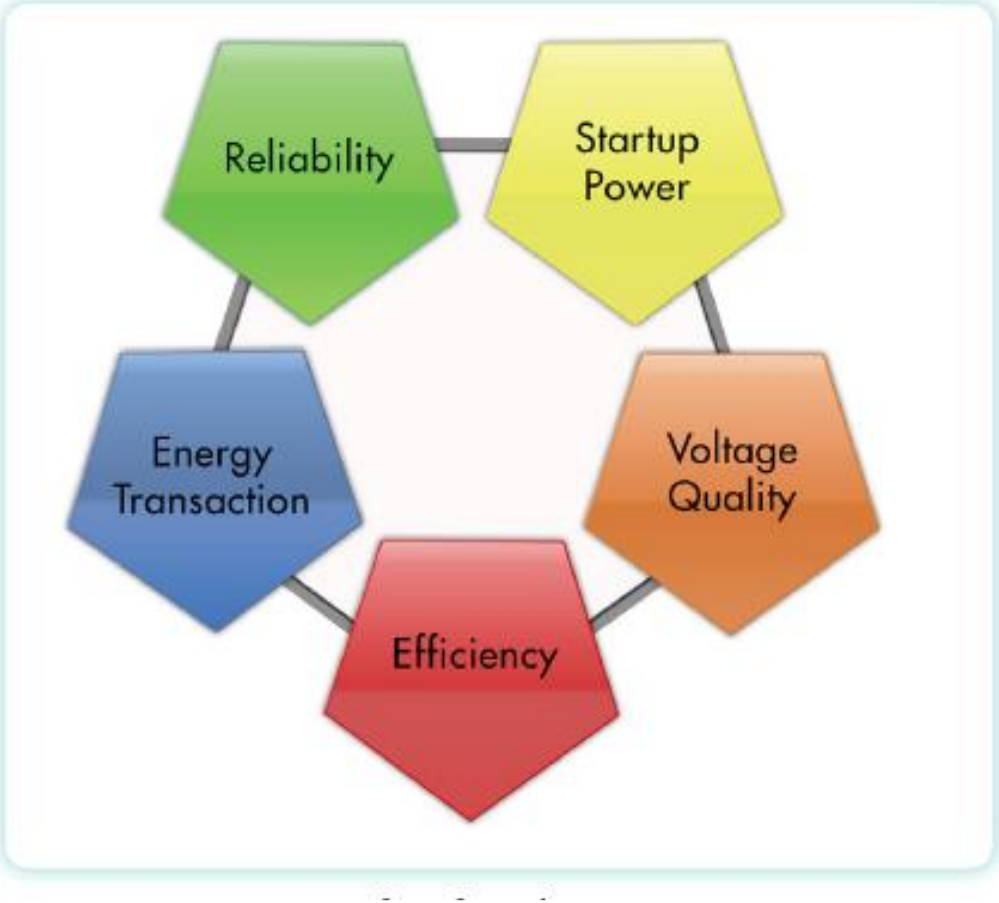
New market models for expanding the electricity business into the internet of energy



How the grid is and how it will be transformed in the next 5 years ……?

Value of Grid Service: Five Primary Benefits

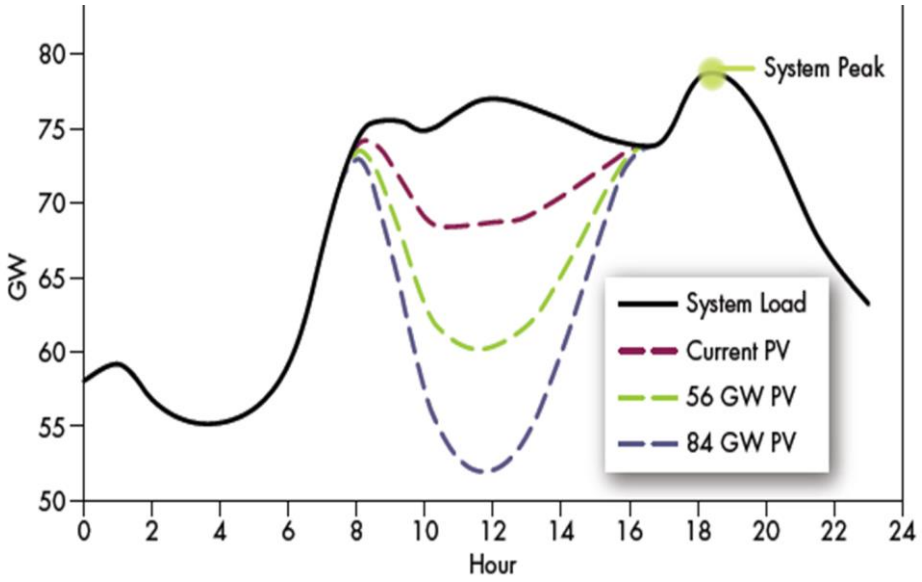
The full value of a grid connection is not fully understood. Grid-provided energy (kWh) offers clearly recognized value, but grid connectivity serves roles that are important beyond providing energy. Grid capacity provides needed power for overload capacity, may absorb energy during over-generation, and supports stable voltage and frequency.



Grid is becoming bi-directional

- Today's power system has served society well, with average annual system reliability of 99.7% + in Cyprus, in terms of electricity availability.

The classic vision of electric power grids with one-way flow is changing. Consumers, energy suppliers, and developers increasingly are adopting DER to supplement or supplant grid-provided electricity. This is particularly notable with respect to distributed PV power generation.



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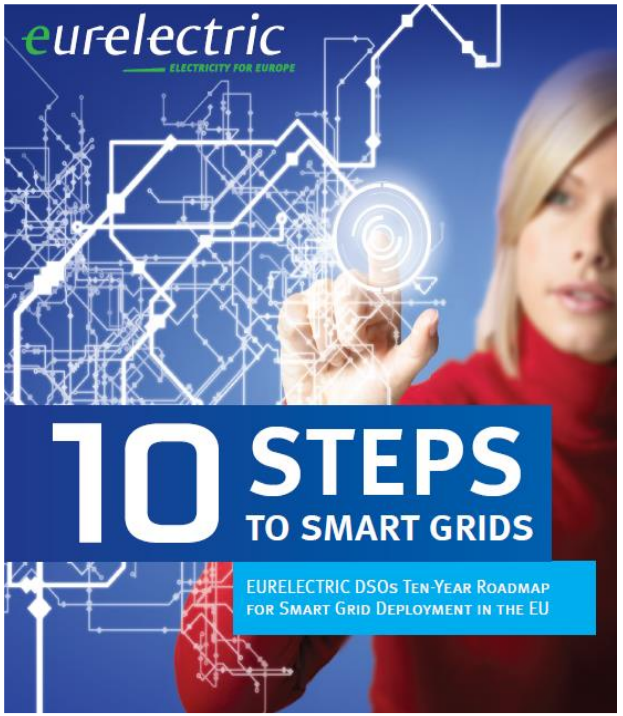
Decarbonisation & RES

Distribution networks need to become ‘smart’ to cope with the power decarbonisation challenge & required RES penetration



A smart approach is needed to manage the shift from centralized to dispersed energy

How the grid is and how it will be transformed in the next 5 years ……?

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The decarbonisation pathway is changing the role of the electricity network !

- More dispersed generation will increasingly be connected to distribution networks
- Most of the demand side flexibility will be developed on distribution networks
- Quality expectations remain high
- Pressure on costs remains high
- Many innovative solutions to be integrated within distribution networks

The days we are living the DSOs are active players in designing the EU electricity system

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The Electrical Industry sees challenges in infrastructure and smart grid development

Investments need to be delivered

Appropriate regulatory incentives need to be in place for Operators to invest in Smart Grids

'Smart' market models must be developed

Clear roles and responsibilities for Operators, market players and third parties

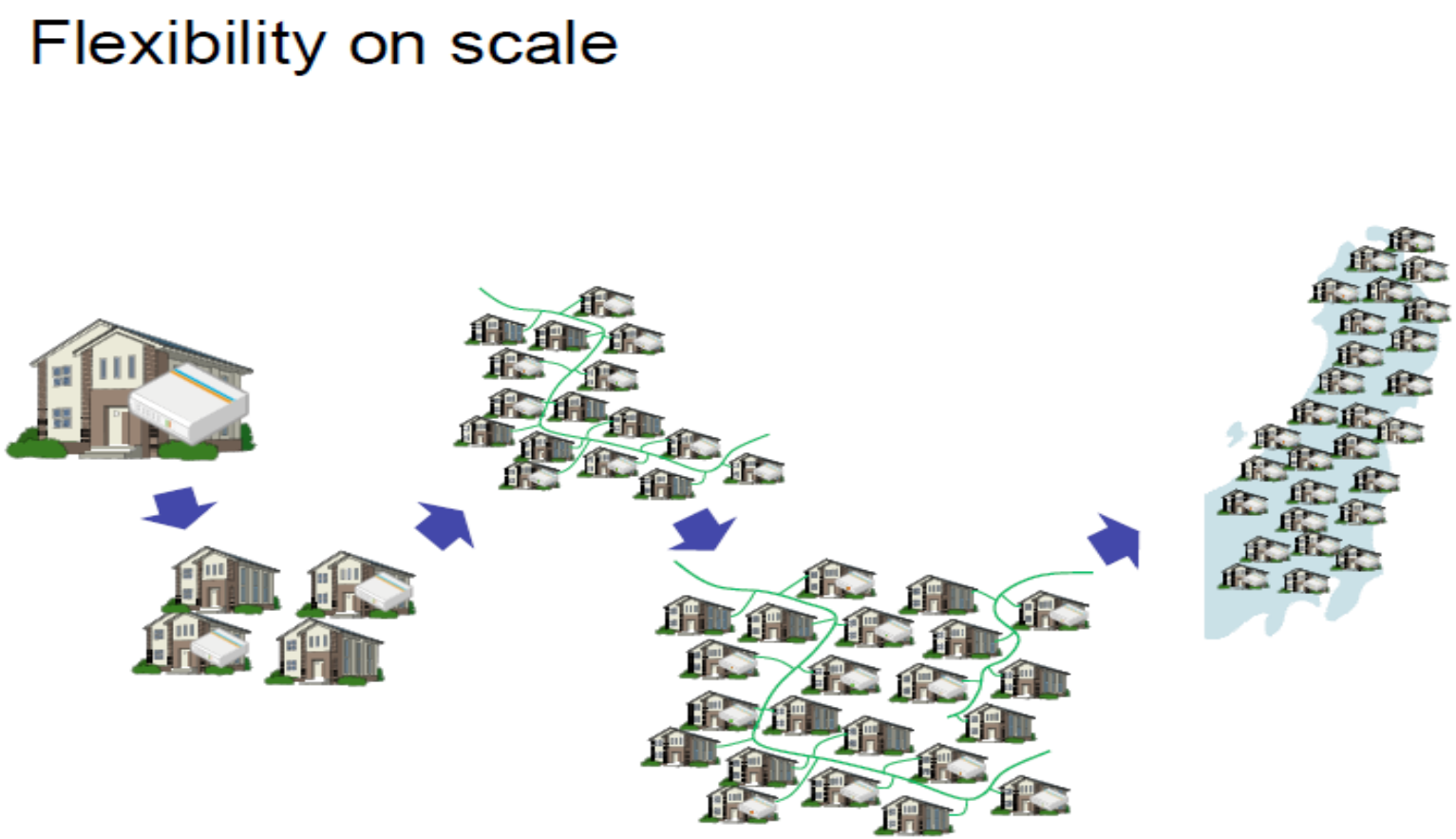
Electrify the demand side: bring customers on board

Privacy and data confidentiality. The customers are not going to be regulated and are not to be restricted by business models

Large scale deployment must be a priority

At all voltage levels

Scaling up of smart grid connectivity is flexible …

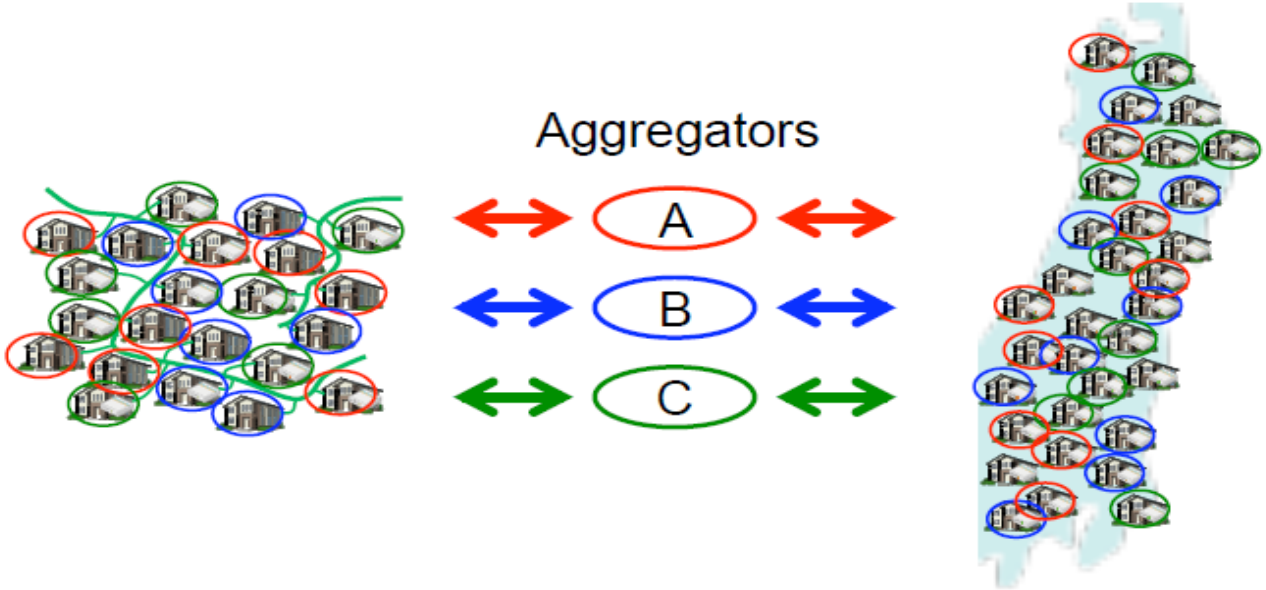


How the grid is and how it will be transformed in the next 5 years ……?

Aggregation is flexible …

Consumers can choose

- Aggregators / autonomous (independent)
- No monopoly

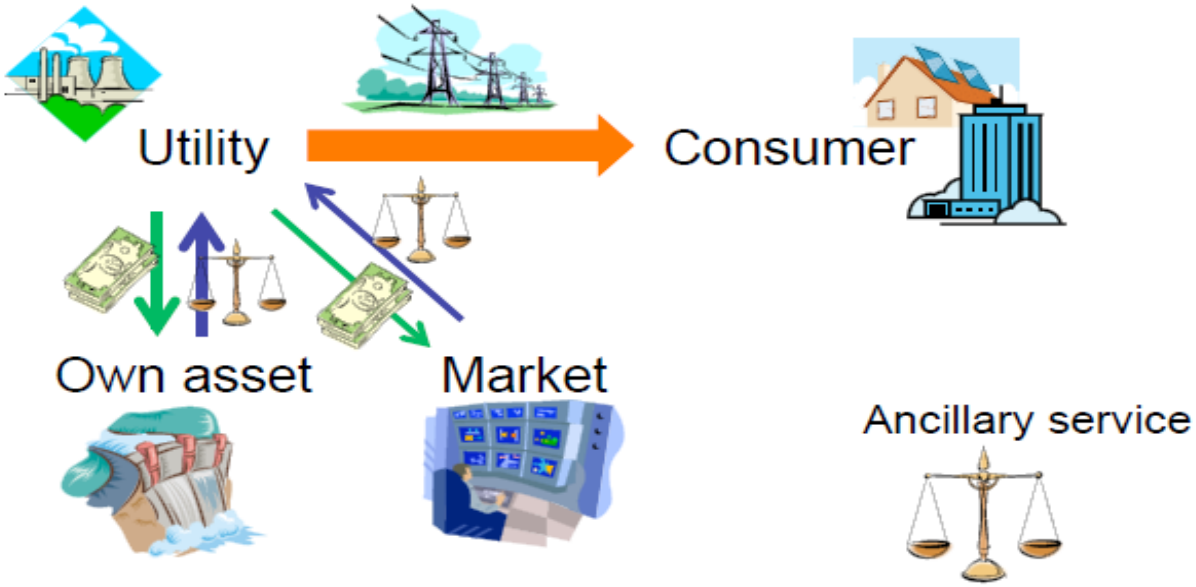


How the grid is and how it will be transformed in the next 5 years ……?

Market functioning is flexible …

Contribution of DER on power system operation

- Now: power system operation is done by utility only

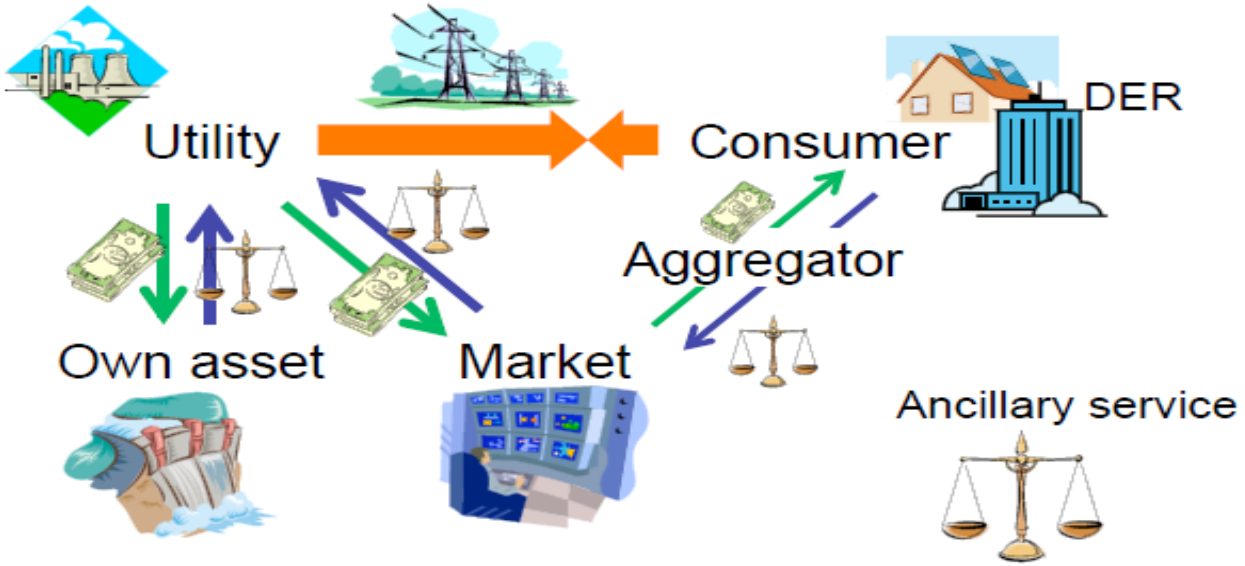


How the grid is and how it will be transformed in the next 5 years ……?

Market functioning through aggregators

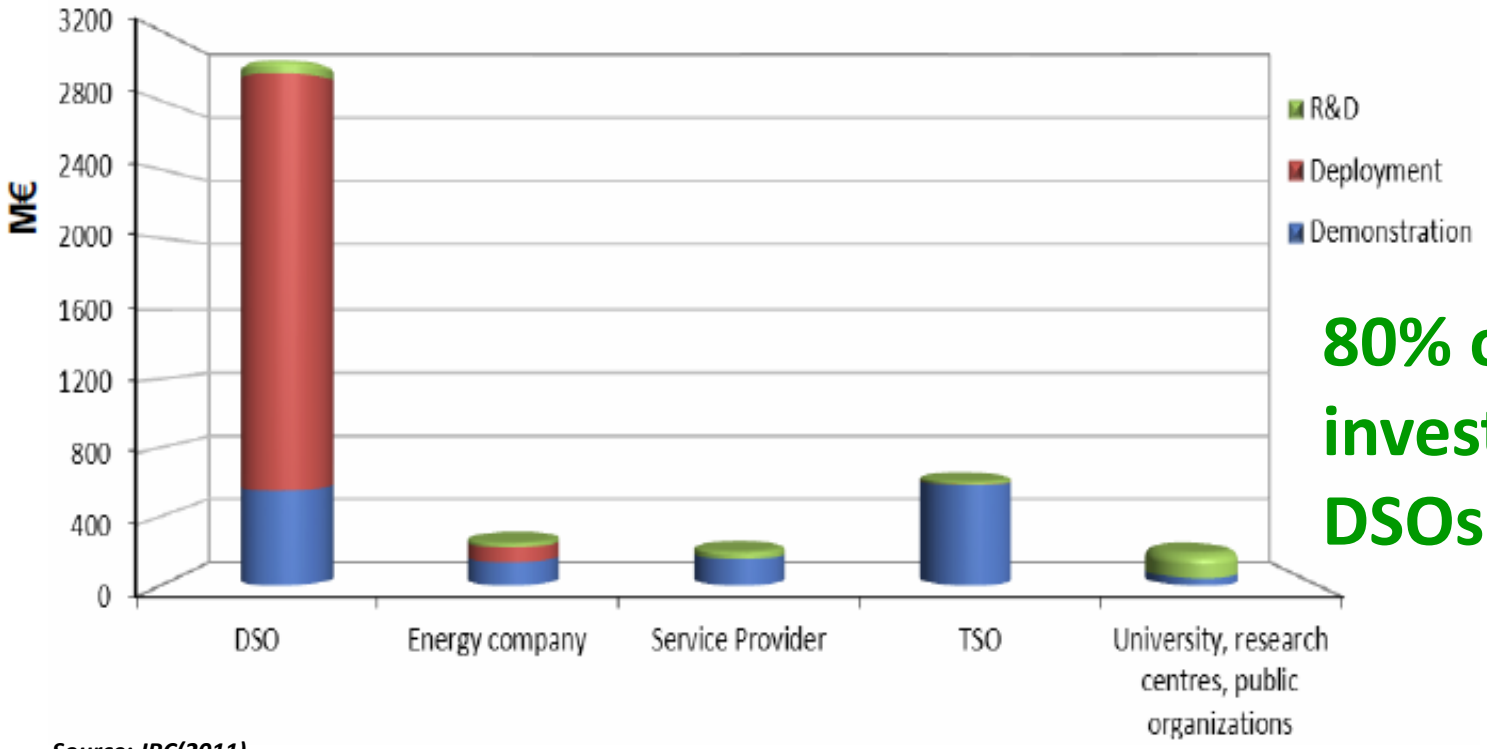
Contribution of DER on power system operation

- Now: power system operation is done by utility only
- Future: consumers join through markets



How the grid is and how it will be transformed in the next 5 years ……?

Investments for SG might benefit several parties, but mostly are done by DSOs



80% of investments by DSOs

Source: JRC(2011)

A smart infrastructure investment is the one which achieves the goal at the lowest cost (cost-efficient system approach!)

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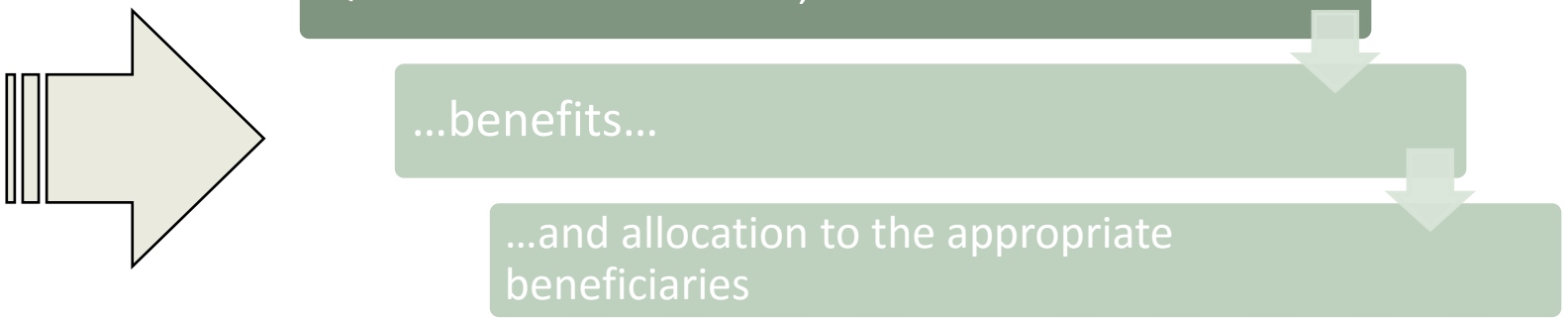
A cost-benefit analysis of past and on-going projects is a must to evaluate their impact

Market forces must see real financial returns in achieving energy policy goals to incentivise the continued significant investments



Necessary to mitigate business risks and encourage investors!

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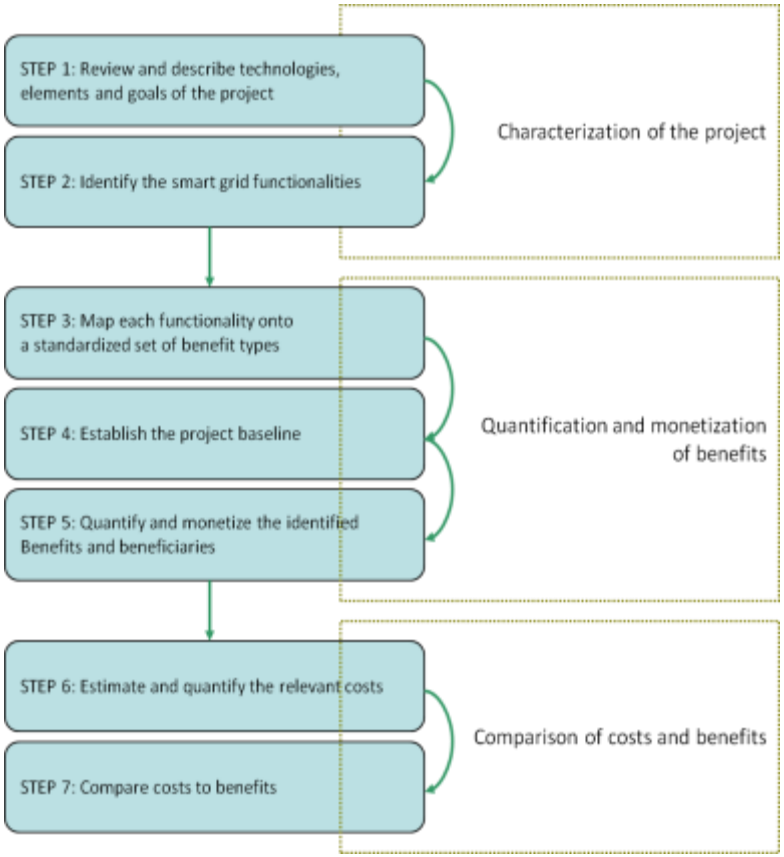
EURELECTRIC and JRC have delivered a methodology – "The Smartness Barometer"

A methodology that can support distribution companies in evaluating and comparing different types of 'smart' innovative investments, communicating their results and developing investment strategies which incorporate smart investment options

A methodology with a 7-step approach



1. Help to show **which technological solutions work**

2. Universal **meaningful comparisons between different type of projects** installed in different network systems

3. Show the **value of investment, compare costs to benefits** and pinpoint who will benefit

How the grid is and how it will be transformed in the next 5 years ……?

Why this methodology and CBA of smart grid projects is so important?

… the communication of benefits is most universal and most practical when in monetary terms – an investor can see the return of his investment .

… it offers a unique value when one is looking to obtain project funding, indicating not only the benefits, but who benefits.

... it strengthens a business case, particularly as presented to the regulator whose primary concern is the benefits to society at large rather than the grid company.

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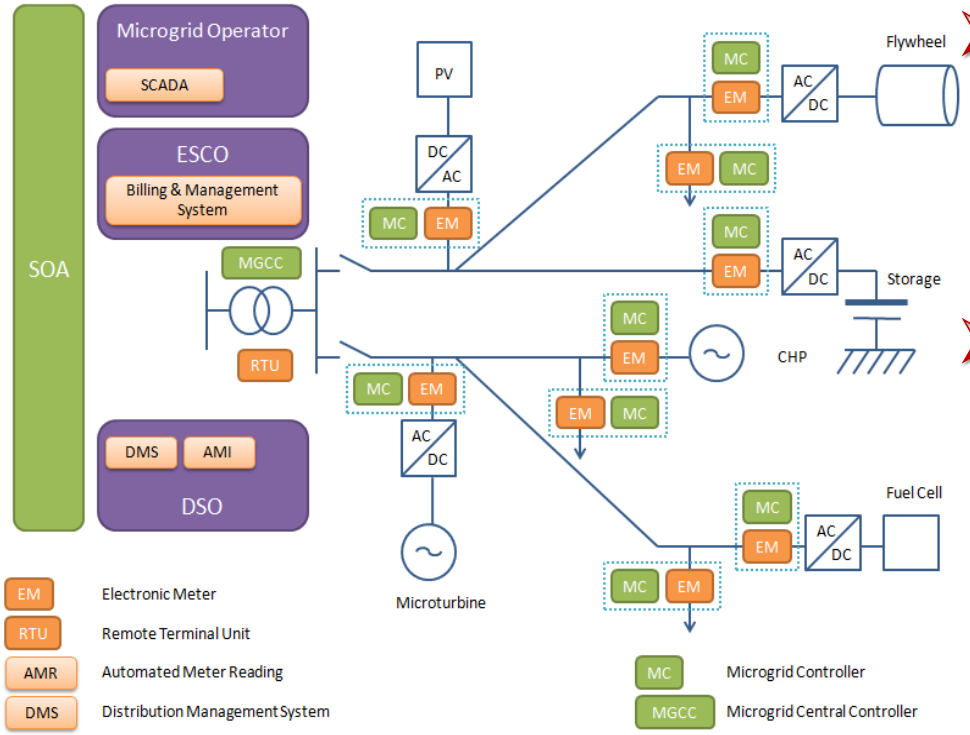
There is a need for smart regulation with incentives …



- **Distributed control architecture will prevail seamlessly linking all active elements of the integrated grid**
- **Embedded systems with microgrid capabilities or "web of cell" connectivity will offer quality inclusion of energy efficient buildings**

- **Policy and Regulatory shortcomings need to be addressed for smart investments to prevail and maximize benefits to all active stakeholders !!!**

Who will manage the network for optimal efficiencies?

It is natural that the Operators will have a leading role in managing the multi services networks that are emerging and the business model should be adopted accordingly for optimal efficiencies. The current views of the Electrical Industry are:

- Moving beyond traditional role of "building and connecting" towards "connecting and managing"
- Becoming facilitators for producers, service providers and customers to meet in an open efficient market
- Gaining better control over activities in the network using more ICT, sensors, demand side management etc.

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Smart Grids & market competition

The interface between the tasks of smart grid and market with the related commercial players is changing:

- DSOs are gaining importance as **independent information hubs.**
- Large scale introduction of DER and EV will link further the functions of DSOs and their core responsibilities with the competitive side of the market.
- **Synergies with telecom providers** are emerging and these need to be properly exploited for the benefit of the end customers.
- Distributed control, efficient microgrid operation and VPP effectiveness will eventually dictate **local balancing as a DSO function.**

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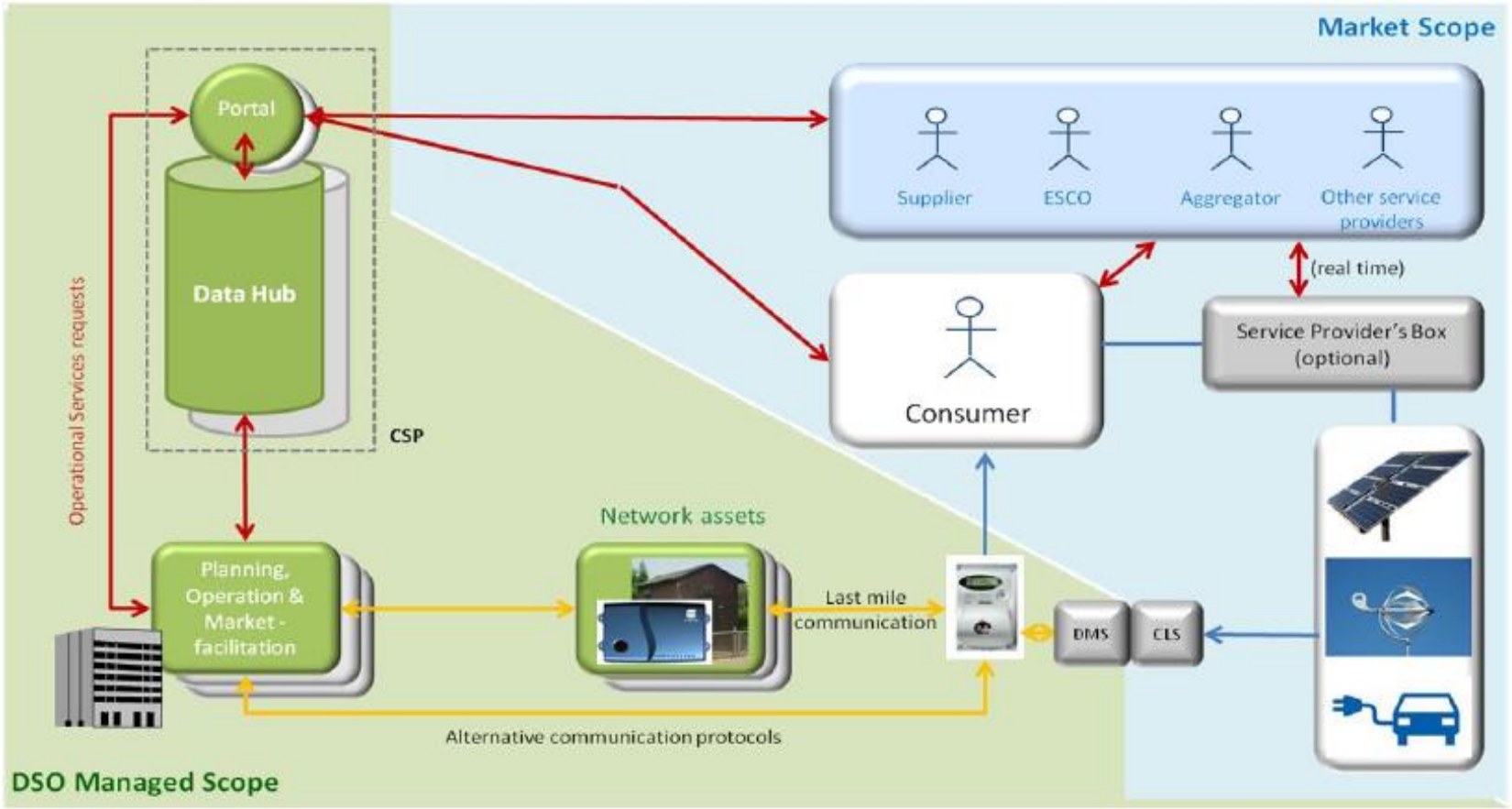
Smart Grid Task Force EG3: Options of handling Smart Grids Data

Case I: DSO as market Facilitator



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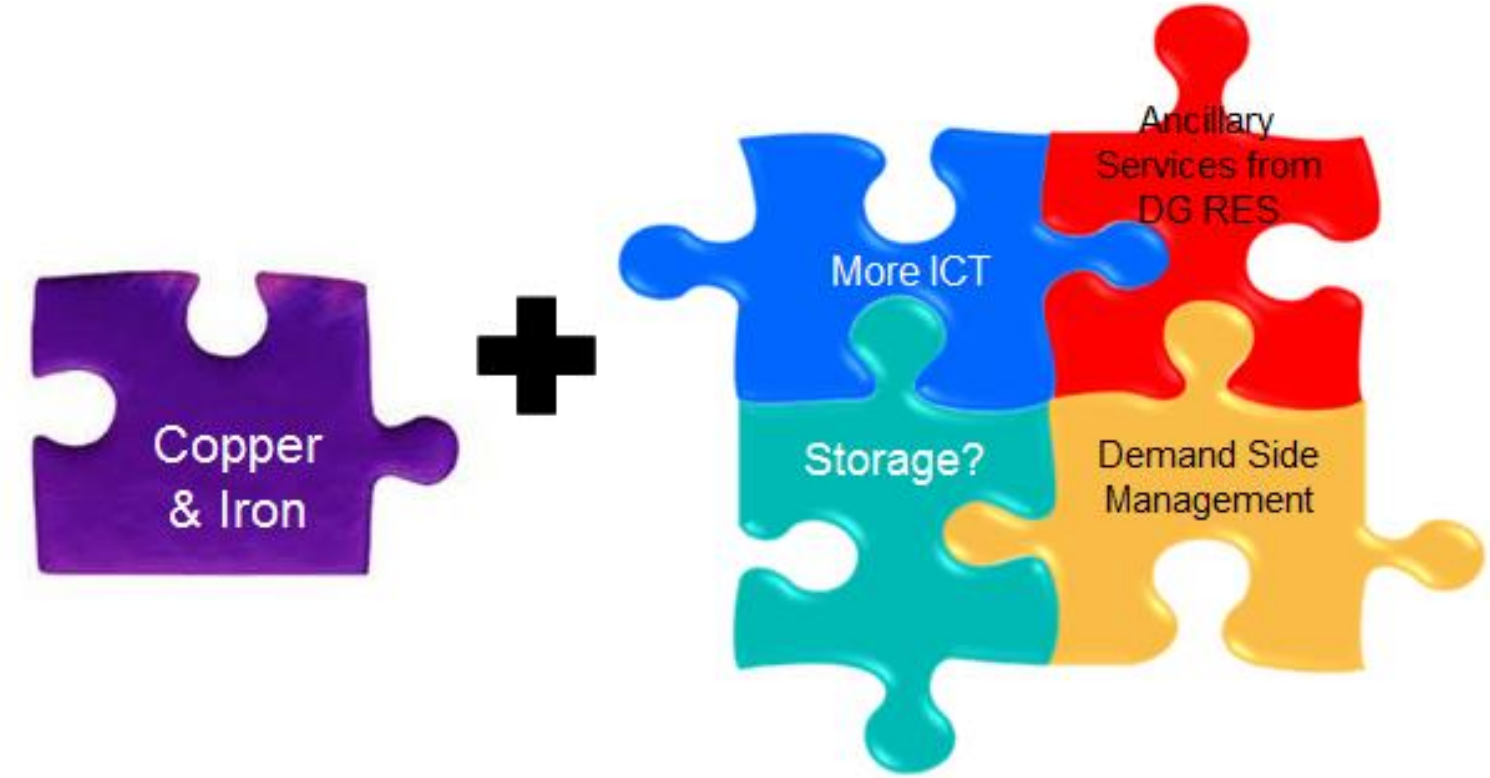
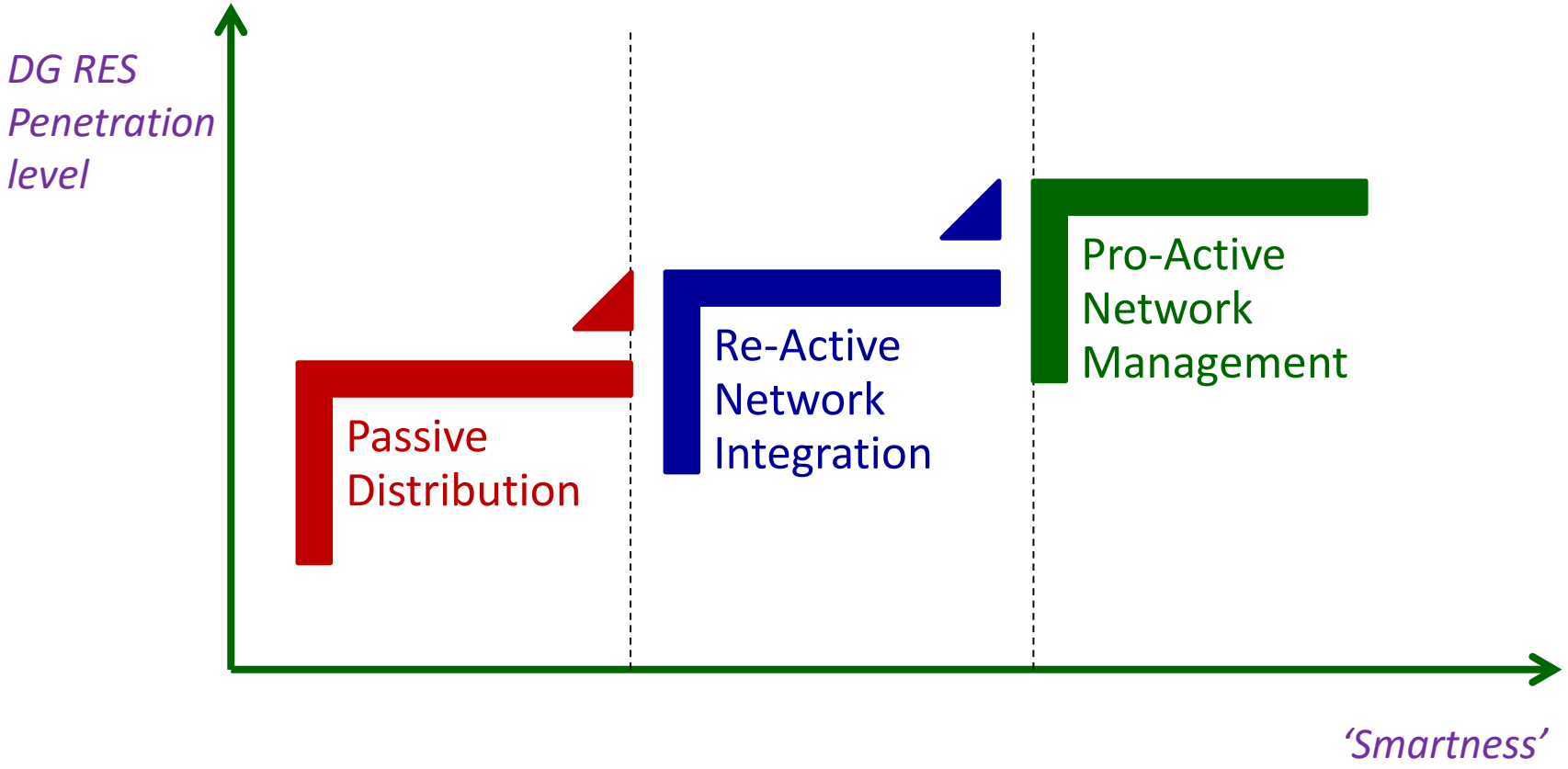
Operators will need flexibility to manage local network constraints…to integrate DG RES & comply with their responsibilities



Beyond a certain level, reinforcement is necessary but the existing capacity could be used more efficiently, investment deferred & the peak load required on the network reduced!

Not a 'Revolution' but an 'Evolution' of Roles, Responsibilities & Interactions



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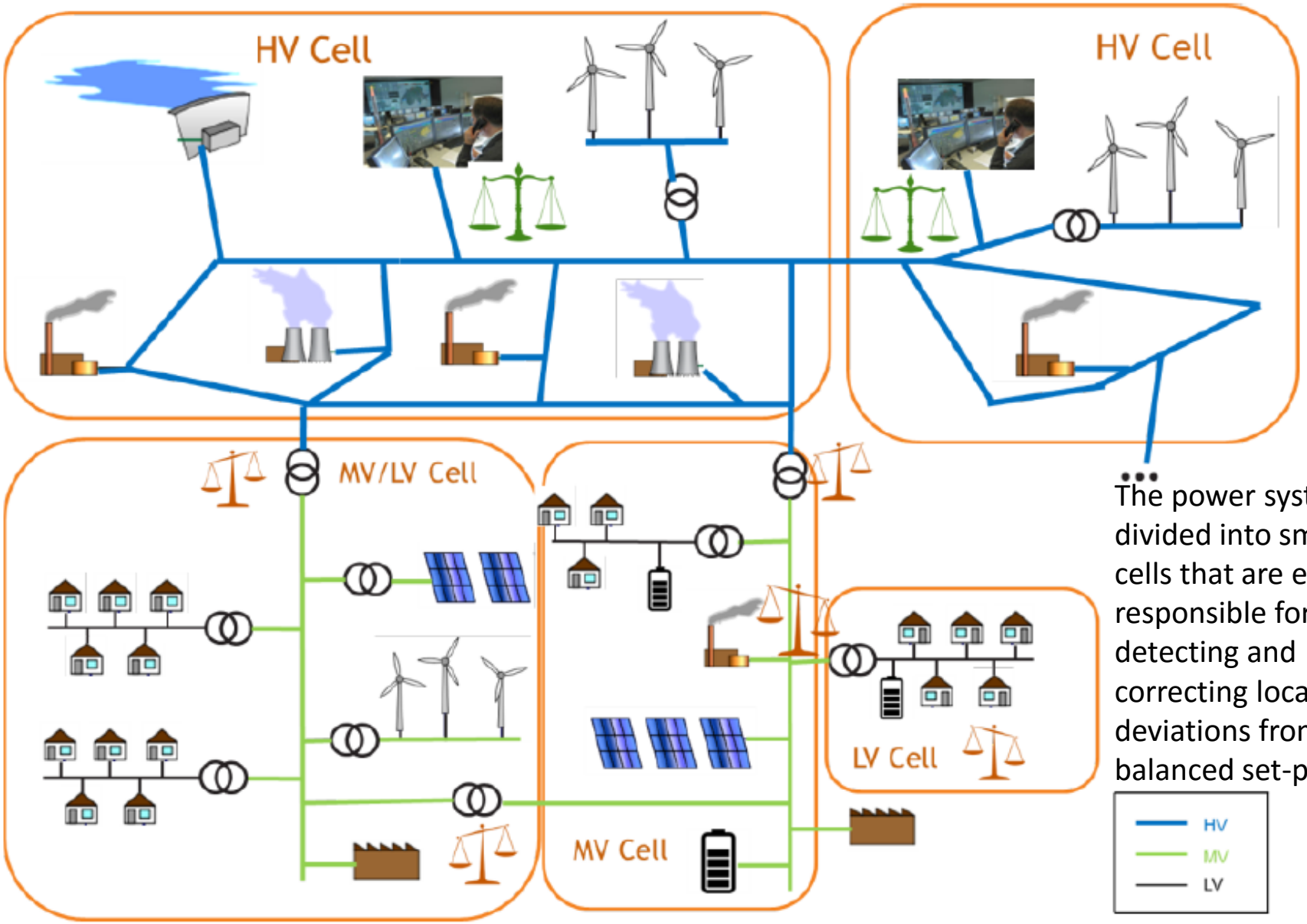
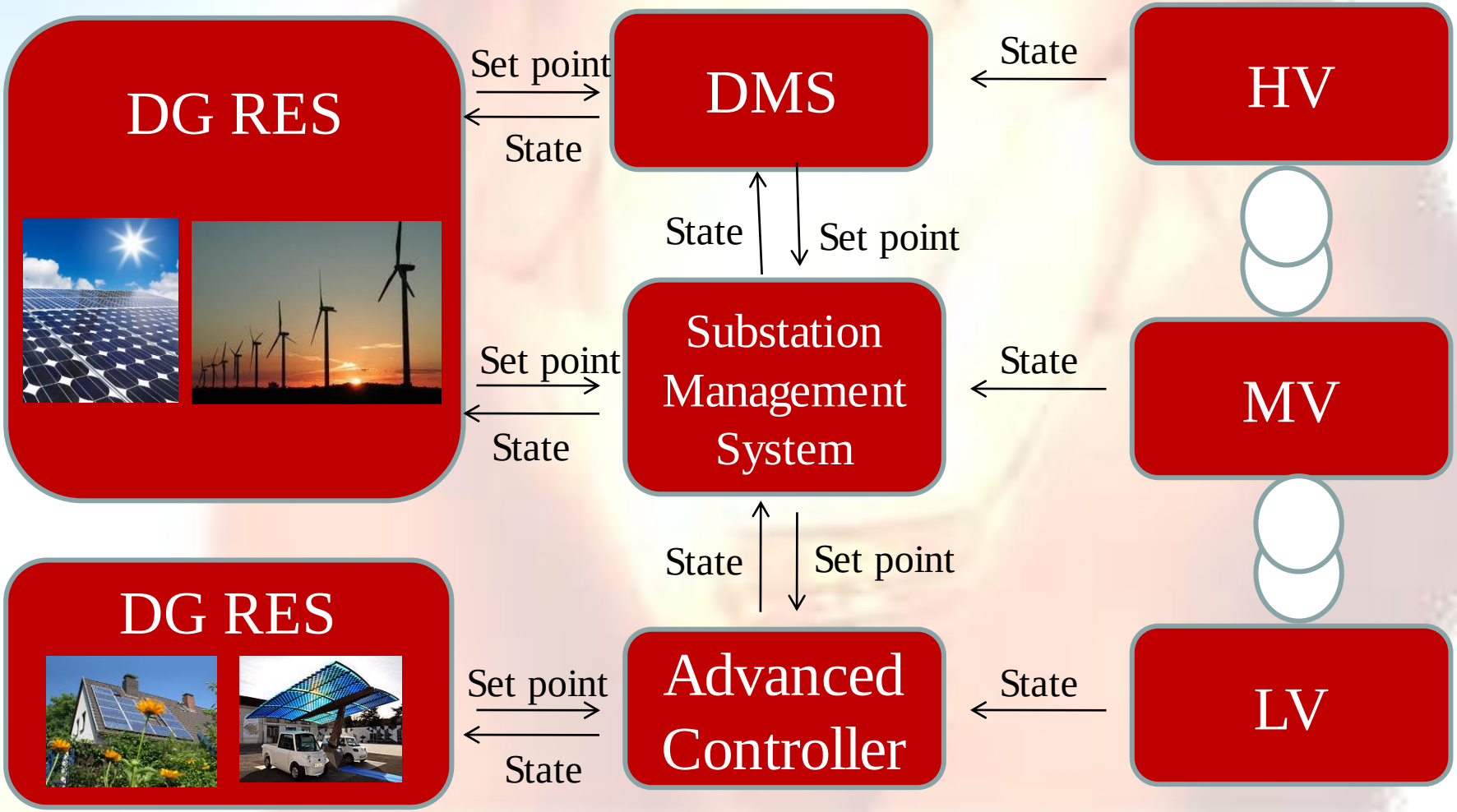
Schematic example of evolution of "Web-of-Cells" architecture

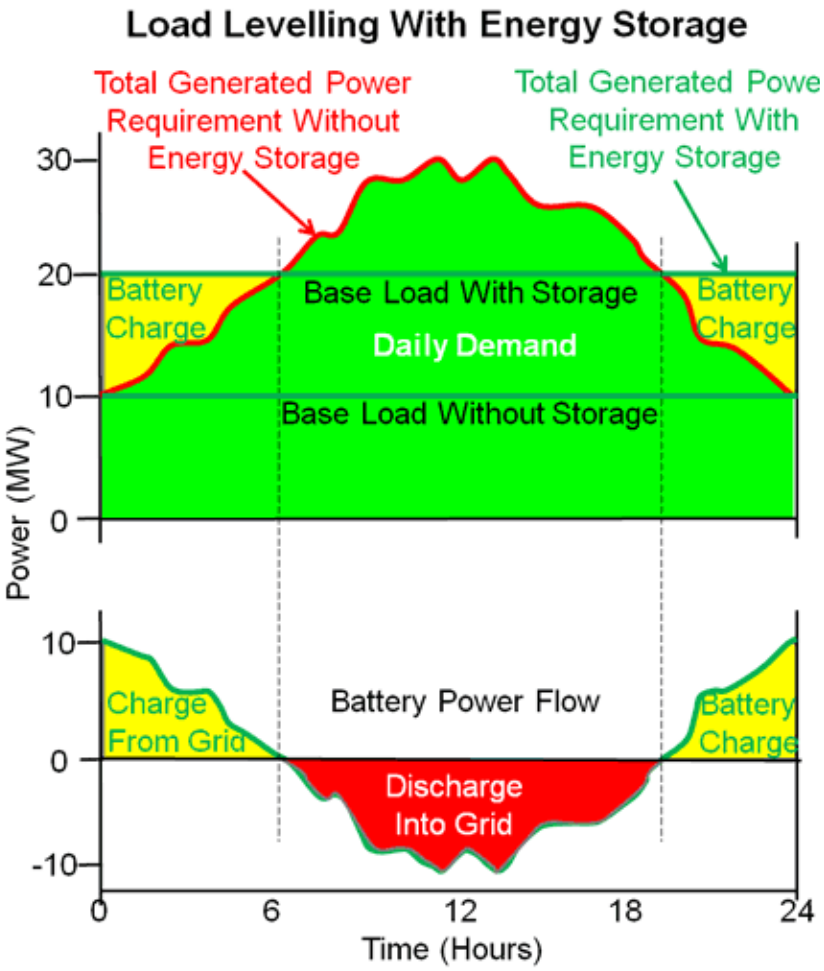


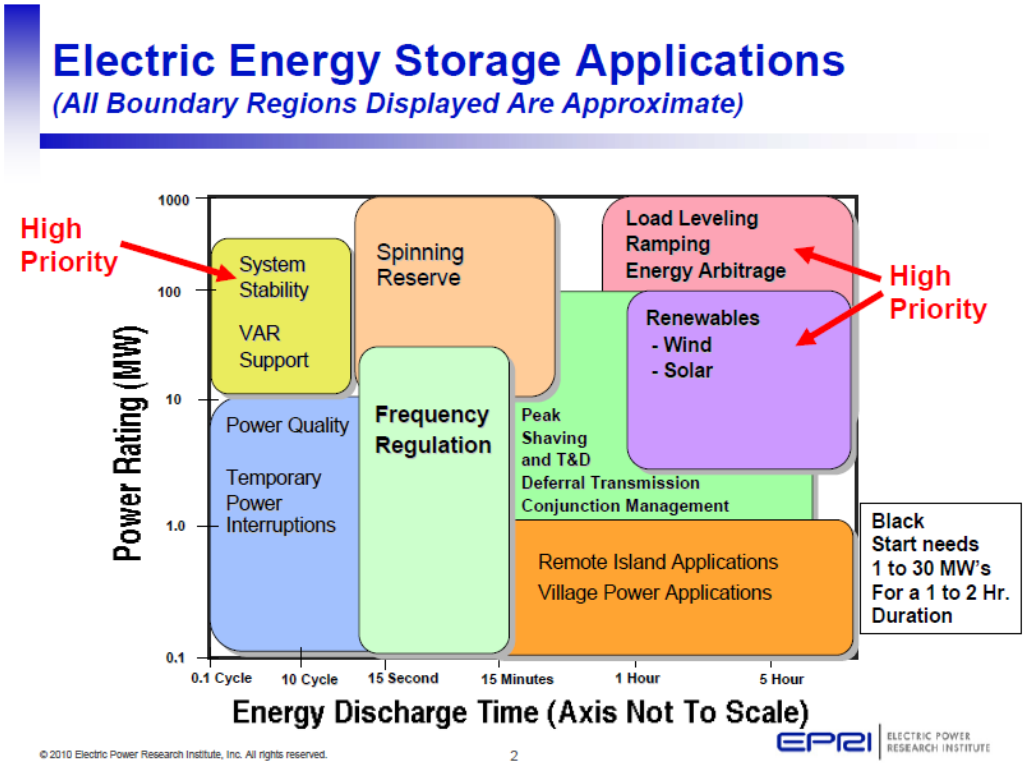
The power system is divided into smaller cells that are each responsible for locally detecting and correcting local deviations from the balanced set-point.

Hierarchical Multiagent enabling advanced distributed control



The bi-directional nature of storage offers a wealth of flexibility …





Complex to regulate due to its multi-use capability – But offers much needed flexibility !

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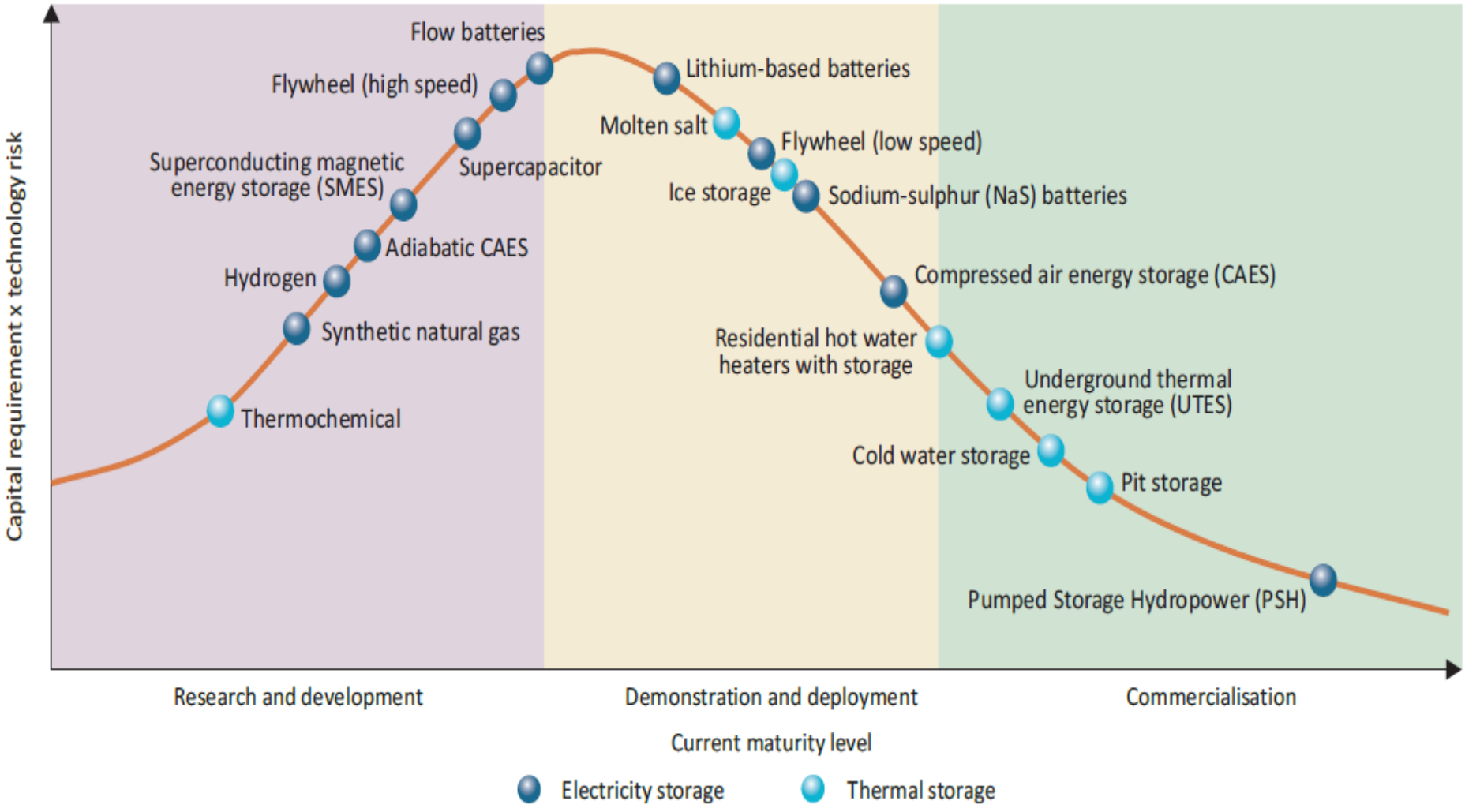
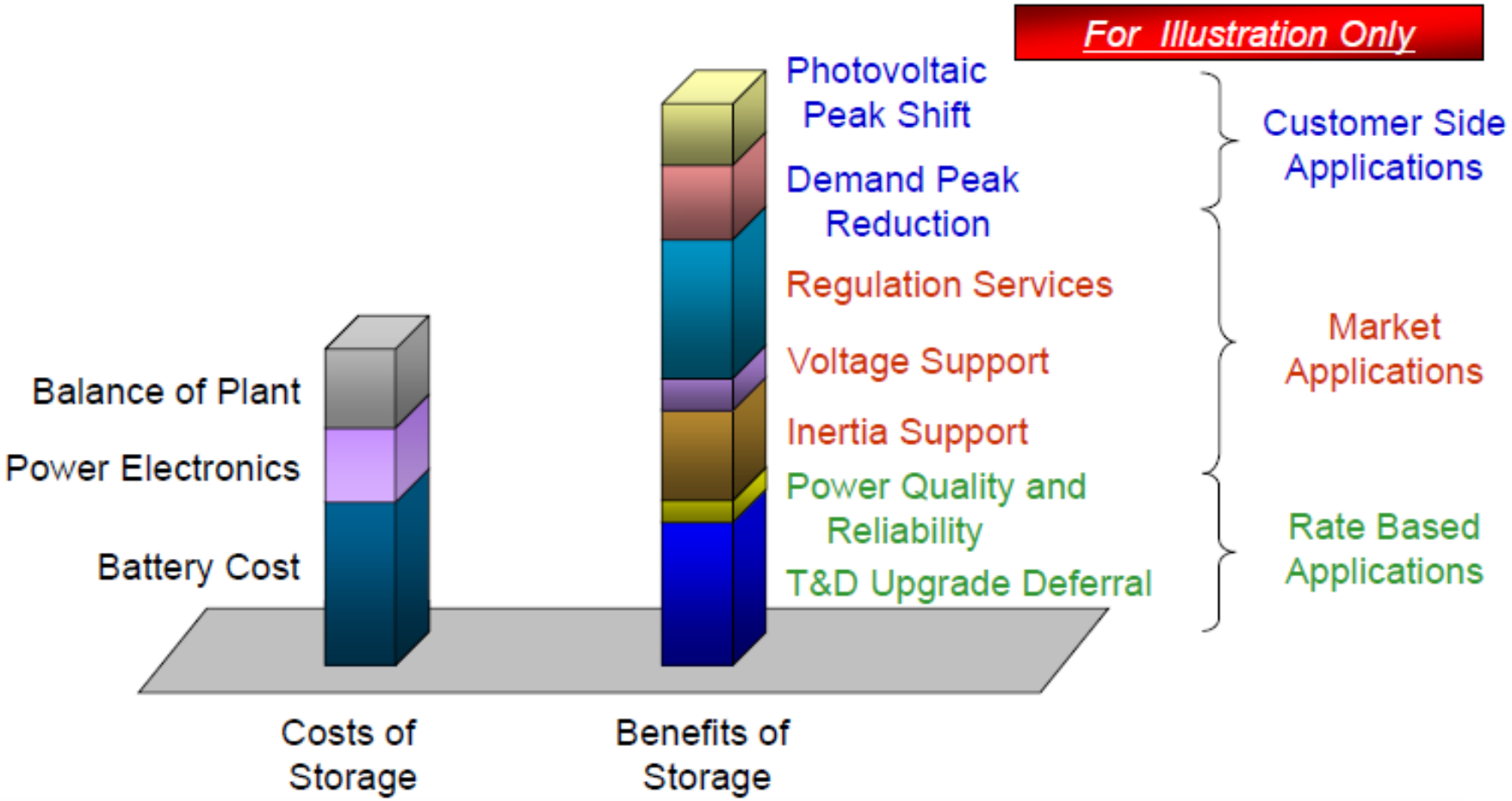
Maturity of energy storage technologies



Source: Decourt, B. and R. Debarre (2013), "Electricity storage", *Factbook*, Schlumberger Business Consulting Energy Institute, Paris, France and Paksoy, H. (2013), "Thermal Energy Storage Today" presented at the IEA Energy Storage Technology Roadmap Stakeholder Engagement Workshop, Paris, France, 14 February.

Analyzing the Value of Storage



Using storage for multiple applications can be effective, but is highly site-dependent

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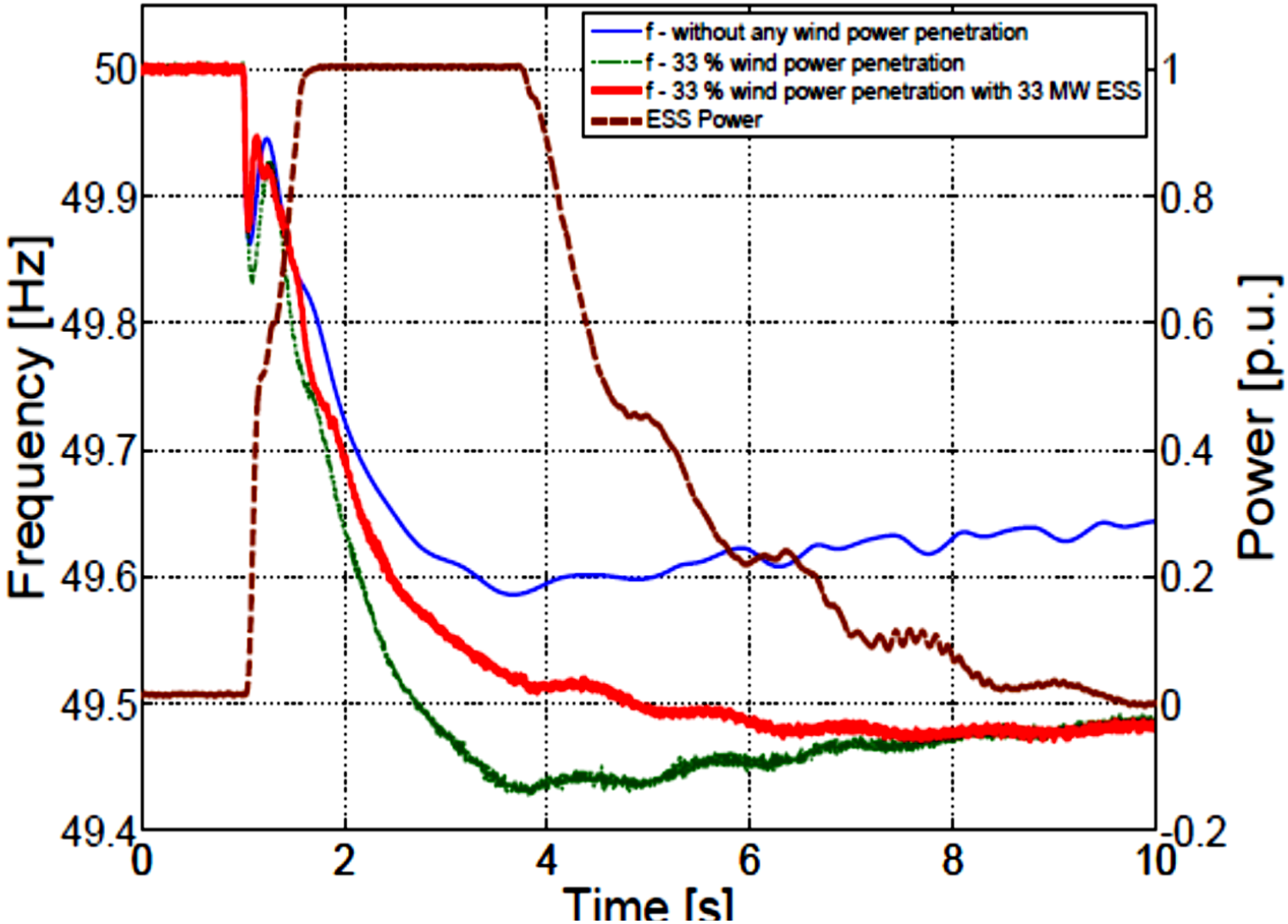
Storage system can give maximum power within 2 sec



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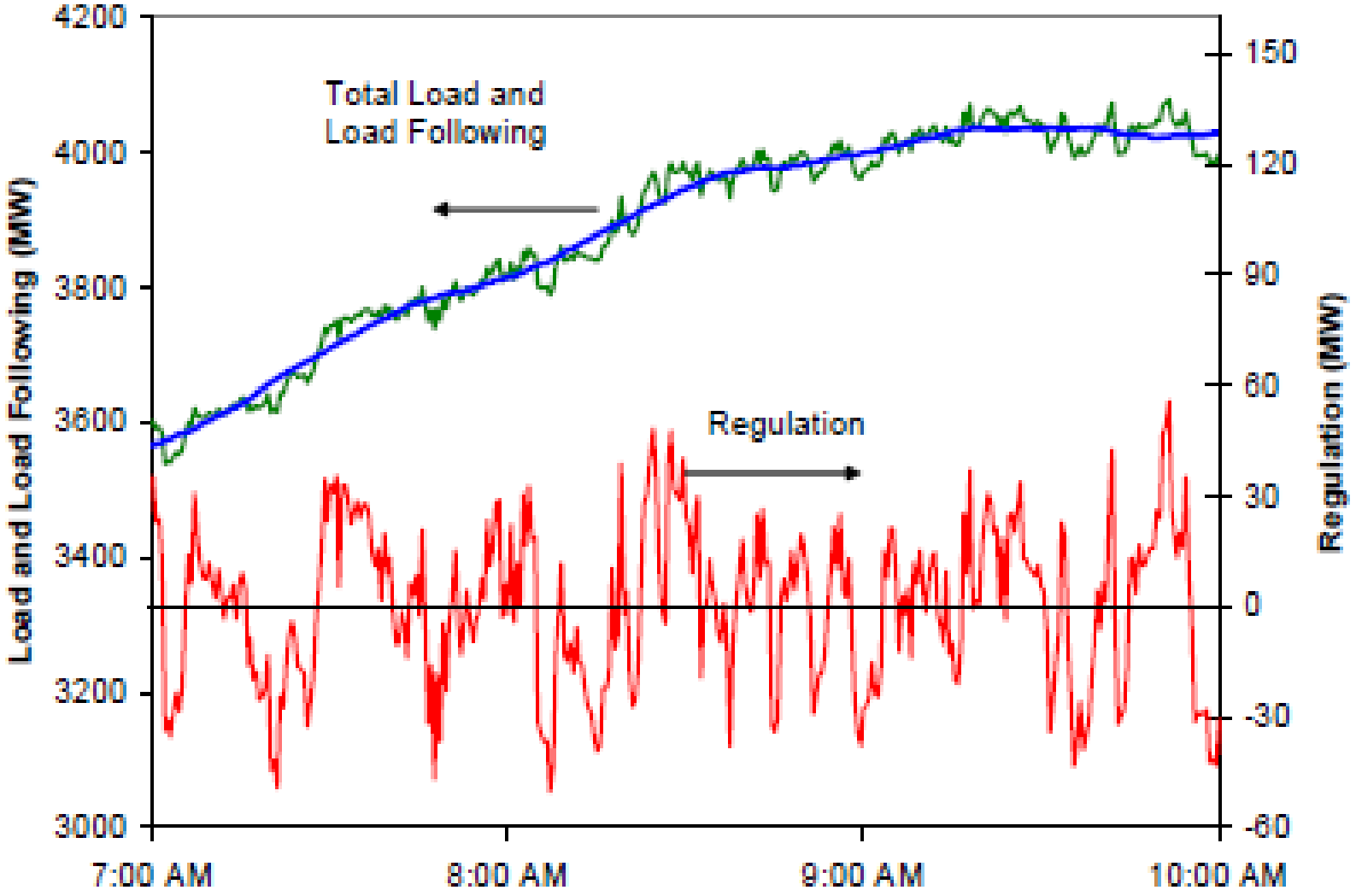
Very responsive to System needs – best for frequency control



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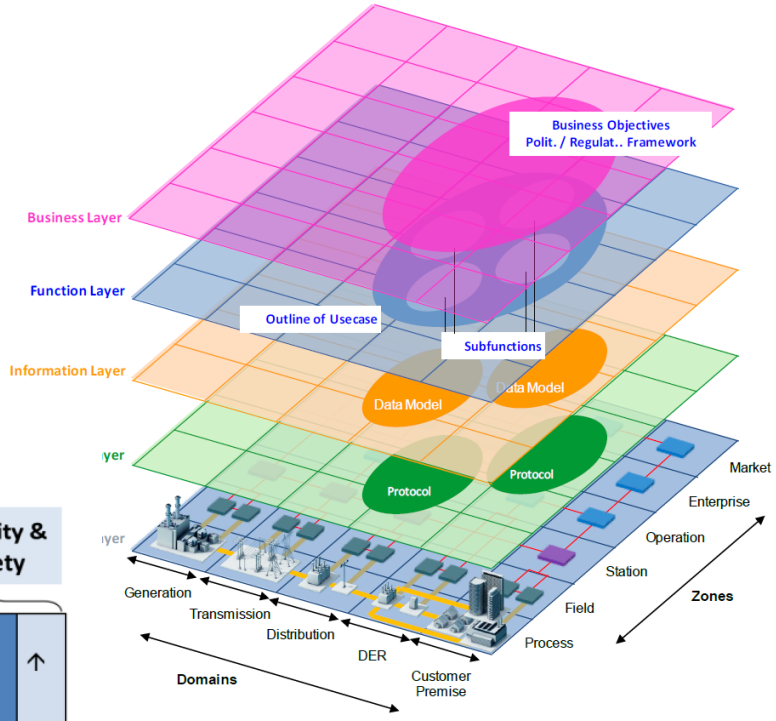
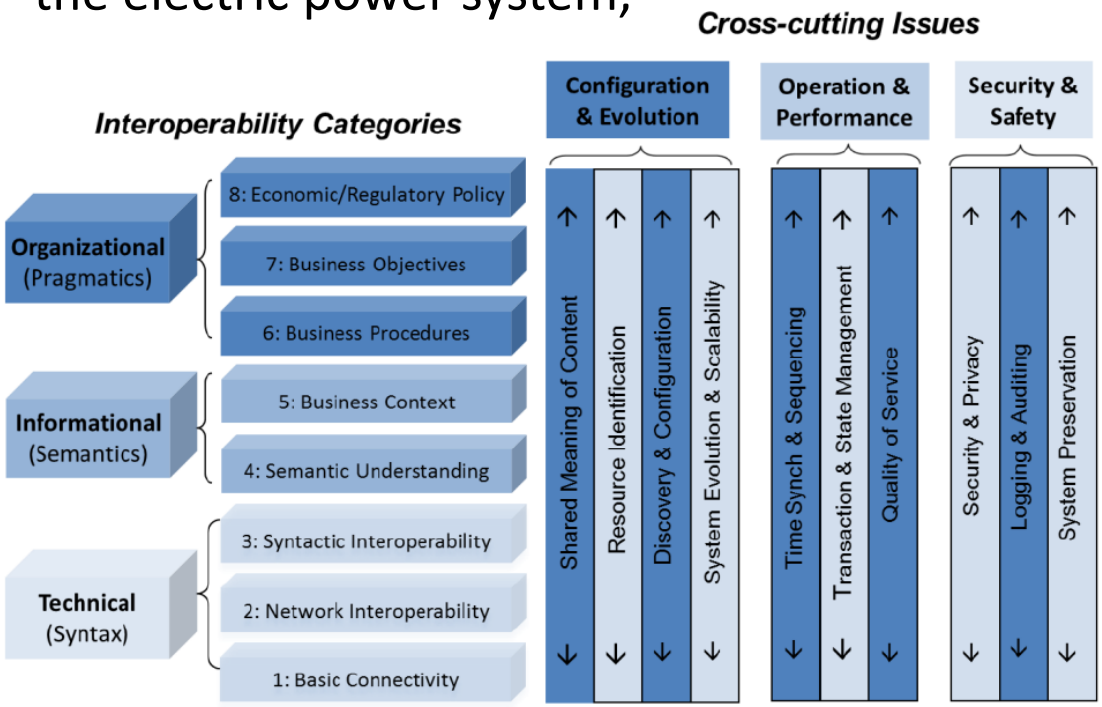
Reference architecture for E-mobility (SGAM- CEN, CENELEC,ETSI)

Interoperability enables intelligent devices and systems to connect and work securely and effectively with little or no inconvenience to the user. When the scale of information and communications technology (ICT) connectivity is as big as the electric power system,





the multipliers are large and the benefits of improving interoperability are manifold!

Ref: GridWise

Basic realities

- EVs provide an important part of the solution towards more sustainable transport. They are cleaner, quieter and **three times more energy efficient** than their conventional counterparts.
- 90% of EV charging is estimated to take place at household and workplace locations
- **Analysis shows that even if all the cars on the road today were electric in EU the current electricity system could cope with the resulting increase in electricity demand:** i.e. a corresponding **802 TWh or 24.3%** increase in the total demand

Why smart charging is essential?

- **Smart charging** can enable EVs to act as flexible loads and decentralised storage resource that can benefit the power system as a whole and minimise or **eventually avoid grid reinforcements**
- **Customers will be able to save on their energy bill by agreeing to shift their consumption to off-peak hours with cheaper electricity tariffs**.
- In doing so, and adding further savings from fuel switching, **car owners can benefit from a reduction of 23% in an electric car's total cost of ownership (TCO)** as compared to a conventional fuel car.

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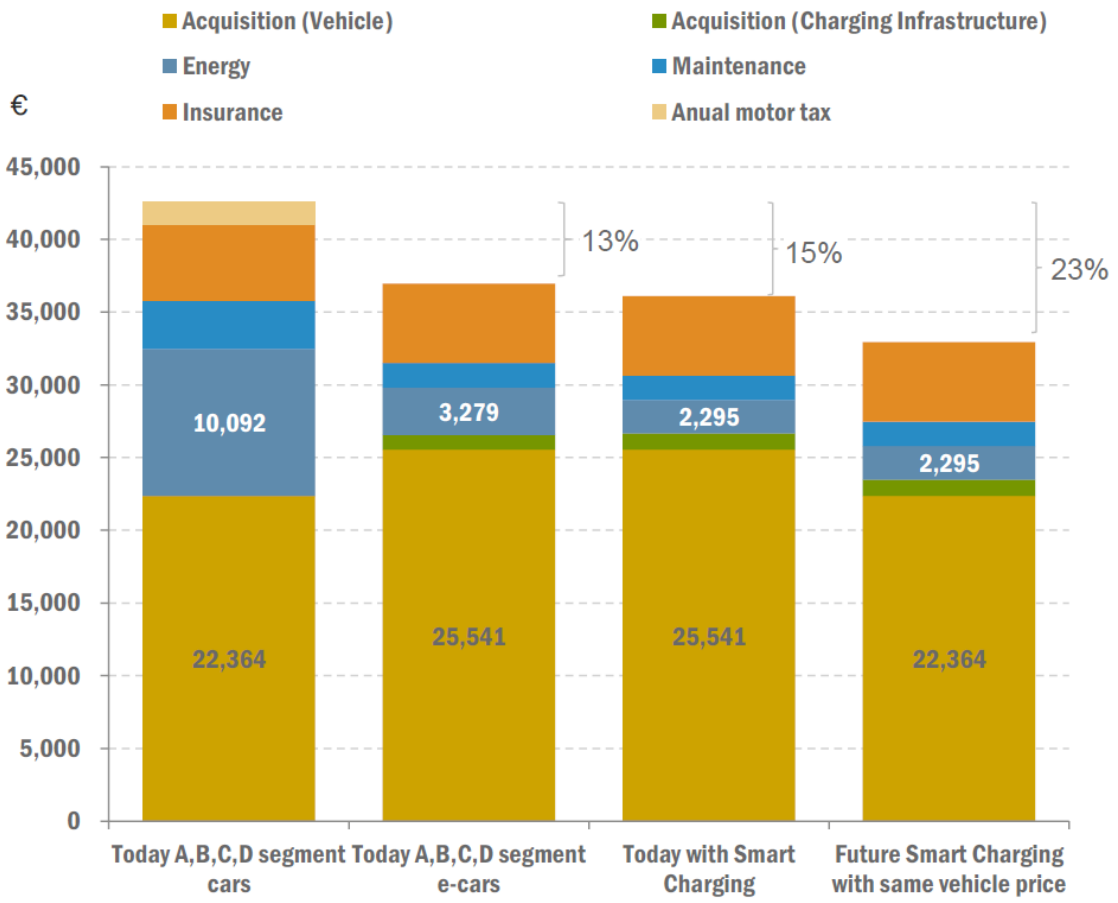
Total cost of ownership is lower

Over a ten-year lifetime of a car, customers can benefit from a cost reduction of up to 23% when the conventional fuel car is replaced by a comparable electric car and when smart charging is used.

EURELECTRIC: Smart charging - Steering the charge, driving the change

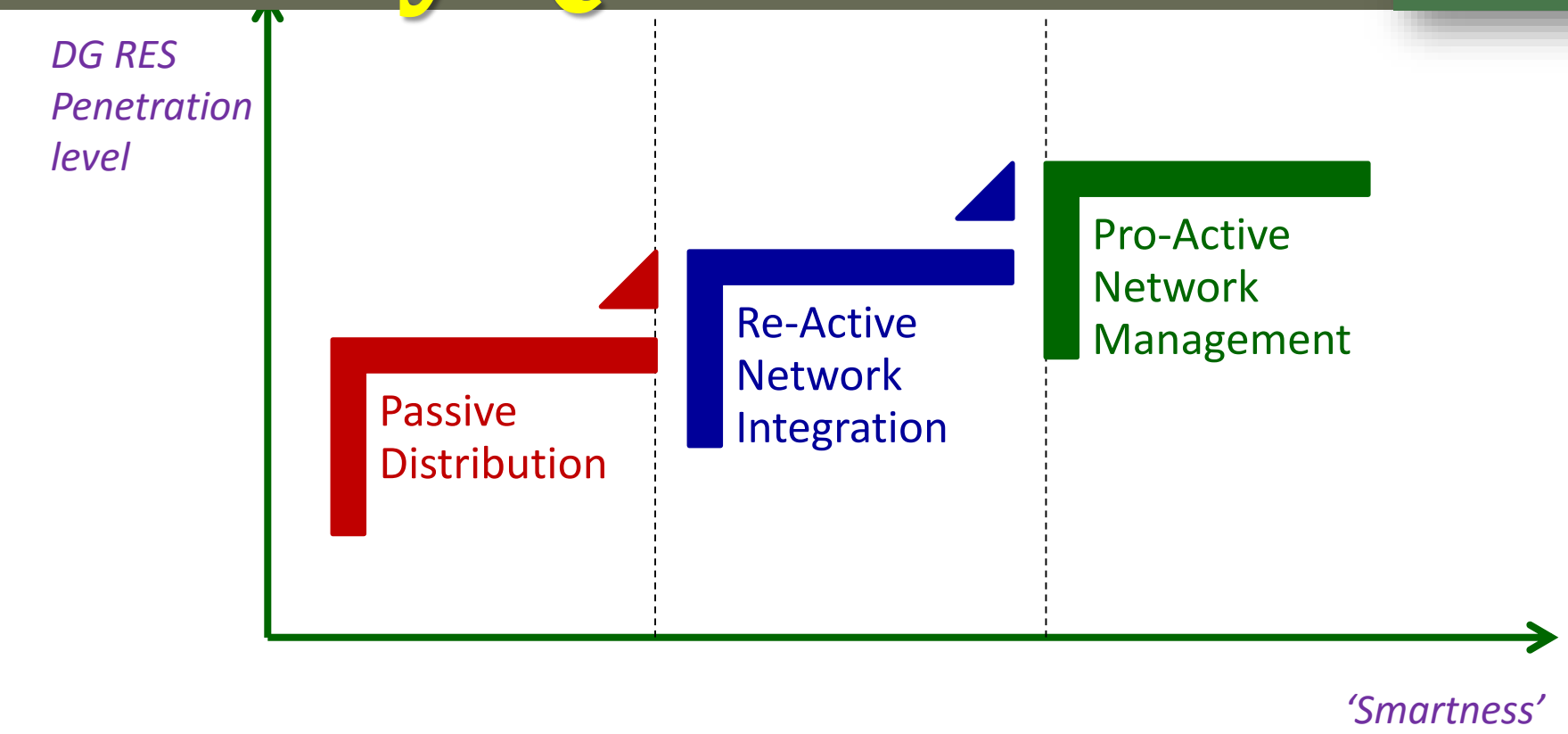


Just to remember .....

"The train to a global clean-energy future has already left the station. We can choose to get on board — to lead — or we can choose to be left behind, to stand stubbornly still. If we stubbornly deny the science and change around us, we will fall victim to our own paralysis."

Gina McCarthy, EPA Chief

Thank you !!
Any Questions



How the grid is and how it will be transformed in the next 5 years ……?