The H2020 Flexitranstore project: Markets, regulation, technology and emerging business models

ETH Zurich, 20 December 2018

Ben Bowler, EMAX
ben.bowler@emaxgroup.eu

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Introduction – Ben Bowler

- Business development manager - markets and innovation (EMAX – Brussels / **Geneva**)
- Storage, RES integration, smart grids. Future market design, regulation

- Business development manager, Siemens Energy GB&I (offshore wind, transmission, distribution, energy storage)

- Project management - distribution

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Agenda

- European context and the need for flexibility
- Introduction to the Flexitranstore project
- Areas we are exploring: business models, markets and regulation
  - Growing opportunities for storage, virtual marketplaces
  - Challenges with hybridisation
  - Data / algorithm engine value proposition
  - Growing role of short term markets, and opportunities – IDM
  - Regulatory barriers and opportunities

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Context - evolution of regulation

Route to a common power market

Problem: how can it be achieved in 27-28 member states?

- Common **directives**
- Mandatory through national regulations

1st Energy Package (1996/92 EC)

- Independent transmission and distribution network operators
- Independent, licenses generation companies – **unbundling**

2nd Energy Package (2003/54 EC)

- Full liberalised market from 2007 (including residential)
- Market power mitigation; energy regulators enforcing
- Unbundled universal service providers
- **Goal** – common internal energy market

2007 internal electricity market

- Via smaller regional markets
- But – no common market emerged; regions started to diverge

3rd EU energy package (2009/72 EC)

- Extends goals of 2nd package: speed, centralisation.
- Concept of internal energy market
- Extension of consumer rights
- Centralised agencies for regulatory coordination (ACER), planning / standardisation (ENTSO-E)

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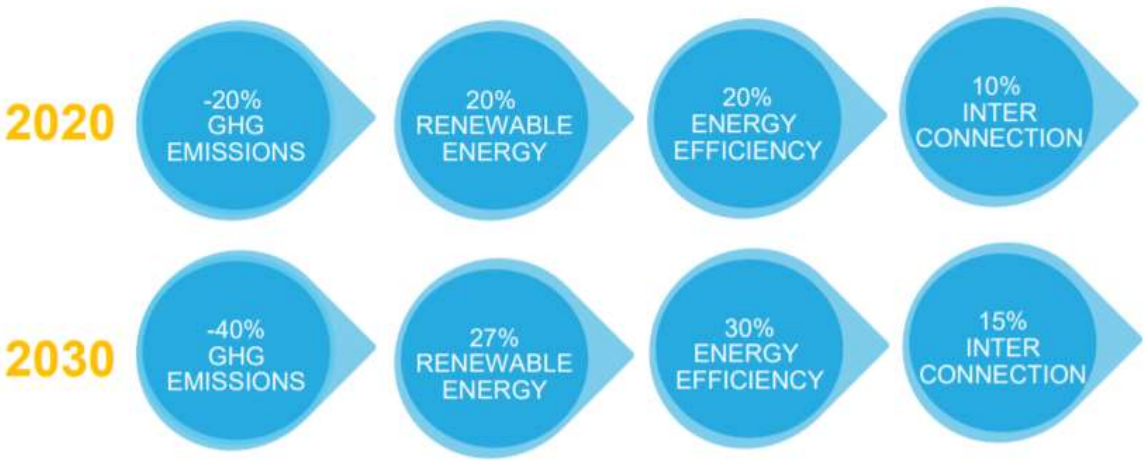
Clean Energy for All Europeans (4th Package)



- 2030 – 27% from renewables; 2050 – electricity completely carbon free
- Boost competitiveness; jobs and growth; global leadership
- Energy efficiency
- Fair deal for consumers
- Cast and recast

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MARKETS FIT FOR PURPOSE

Competitive energy markets are at the heart of a competitive economy

Strengthened short-term markets

- Increase **cross-border trading opportunities** over shorter timeframes (intraday and balancing markets)
- **Reward flexibility** for generation, demand-response and storage
- Allow **prices to show real value** of electricity in terms of time and location (scarcity pricing)

Level-playing field among sources

- Rules on **priority access** and dispatch
- **Curtailment** rules
- **Remuneration** on equal terms on market principles
- Extended **balancing** responsibilities

Competitive retail markets

- **Flexible network** management
- **Regulated prices** phased out
- **Fair market access** for new market players such as new service providers
- Distribution operators as neutral but **active market facilitators**

Regional cooperation

- **Regional Operation Centres (TSOs)**
- Common rules on **crisis prevention**
- European framework for capacity remuneration
- New tasks for **ACER**

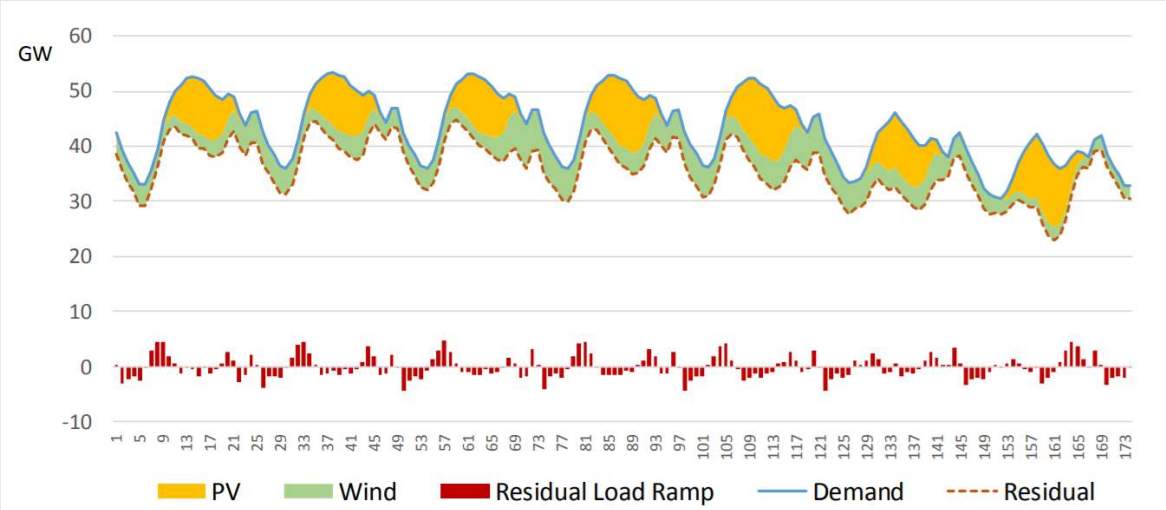
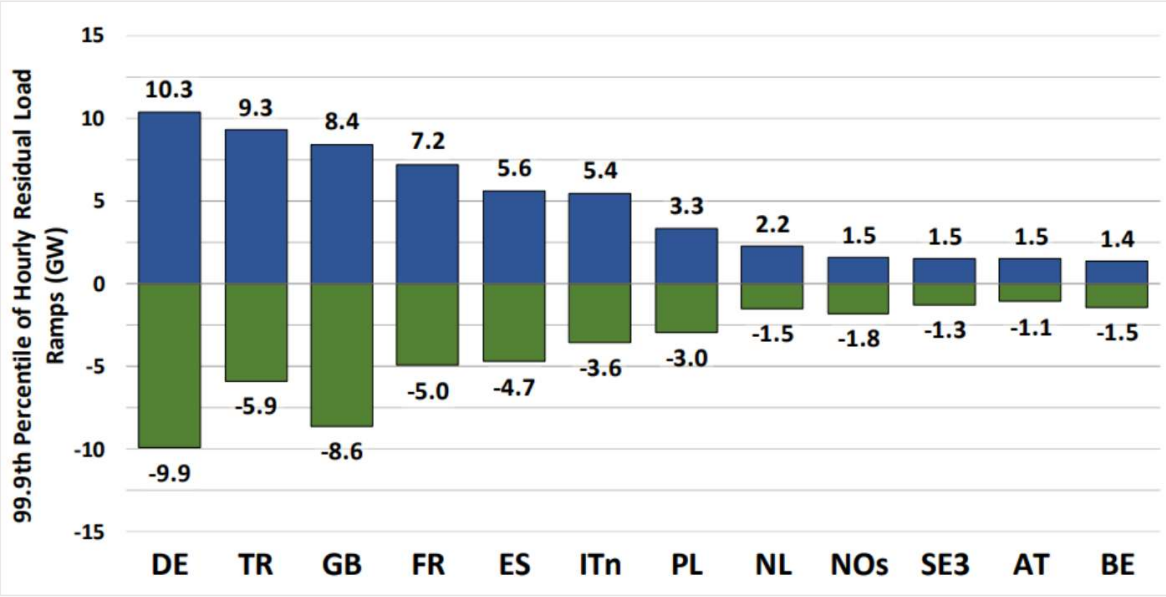


Figure 36: Demand, renewable generation and residual load during one week (hourly resolution)



Flexibility: the need

- **Driver**: decarbonisation
- **Impacts**:
  - Load variability,
  - Load uncertainty,
  - Fixed capital costs but zero or negative variable costs
  - Decoupling of supply and demand
- **Enablers**: distributed generation, digitalisation, storage
- Security of supply at efficient cost levels call for **new levels of flexibility**

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Demonstrating solutions: FLEXITRANSTORE

Project Grant Agreement No. 774407

Budget: 21.7 M Euro

Grant: 17 M Euro

Start: 1 Nov 2017 (M1)

End: 31 Oct 2021 (M48)

LCE-04-2017 call: Demonstration of system integration with smart transmission grid and storage technologies with increasing share of renewables

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 774407

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Flexitranstore - partners

Flexitranstore - Objectives

To **enhance and accelerate** the **integration of renewables** into European energy systems

To increase cross border electricity flows across Europe

At a technical level:
→Develop a **next generation Flexible Energy Grid (FEG)** - the technical basis to support the valorization of flexibility services, **enhancing the existing European Internal Energy Market (IEM)**

At a market level:
→ A **wholesale market infrastructure** and new business models, demonstrating new business perspectives for cross border resource management and energy trading

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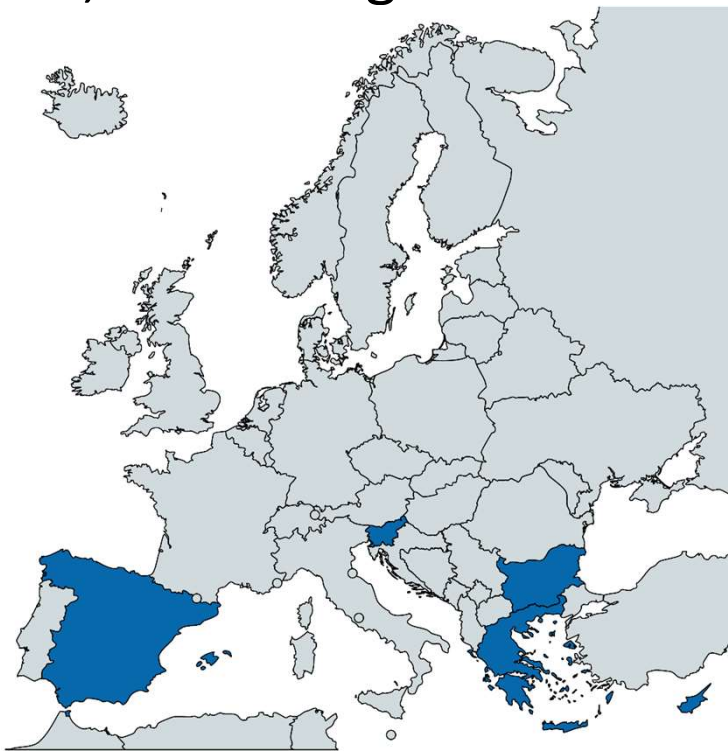
Demonstrators

FLEXITRANSTORE will create 8 demonstrations in 5 countries.

The demonstrators are divided into three layers, according to their application across the energy value chain.



- **Layer 1:** Flexibility at transmission connection points: production and demand.
- **Layer 2:** Increasing cross border capacity and clean energy flows.
- **Layer 3:** Flexibility entering the market.

Demonstrators

1. **Active Substation Controller with storage at TSO/DSO interface** (site: Cyprus)
2. **Active Substation Controller with storage at wind park substation** (site: Greece)
3. **Plant Integrated Battery Energy Storage System in GT generator** (site: TBD)
4. **Dynamic Line Rating** technology (sites: Slovenia, Bulgaria)
5. **Power Flow Control devices** – Power Line Guardian (sites: Bulgaria, Greece)
6. **Wholesale market** demonstration and clearing (sites: Bulgaria, Cyprus)
7. **Active Substation Controller in Hardware In the Loop** (HIL) demonstration (site: Virtual lab in Spain)

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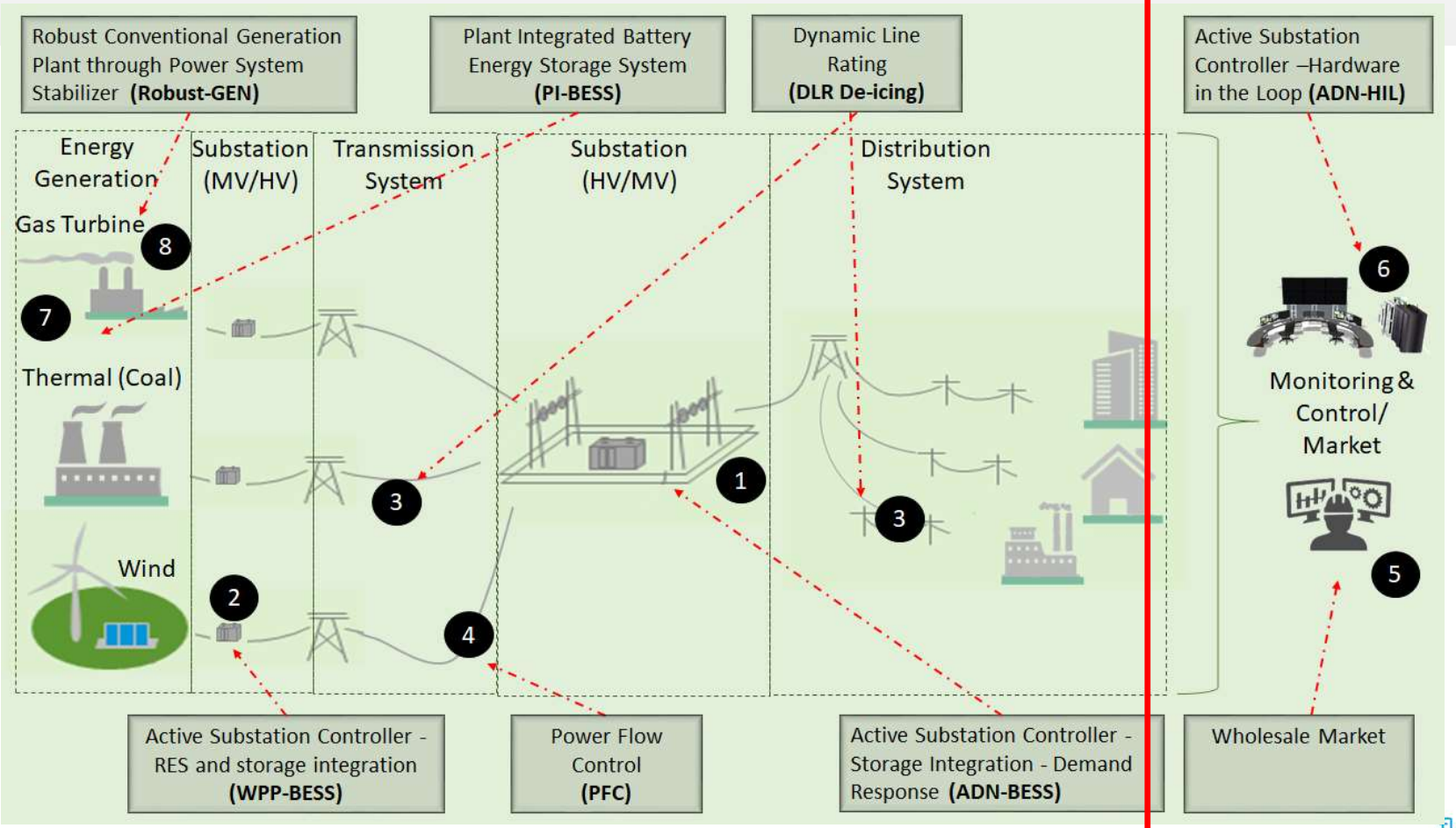
Conceptual Workflow



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Technical framework – ‘flexible energy grid’ (FEG) platform

FEG platform will include:

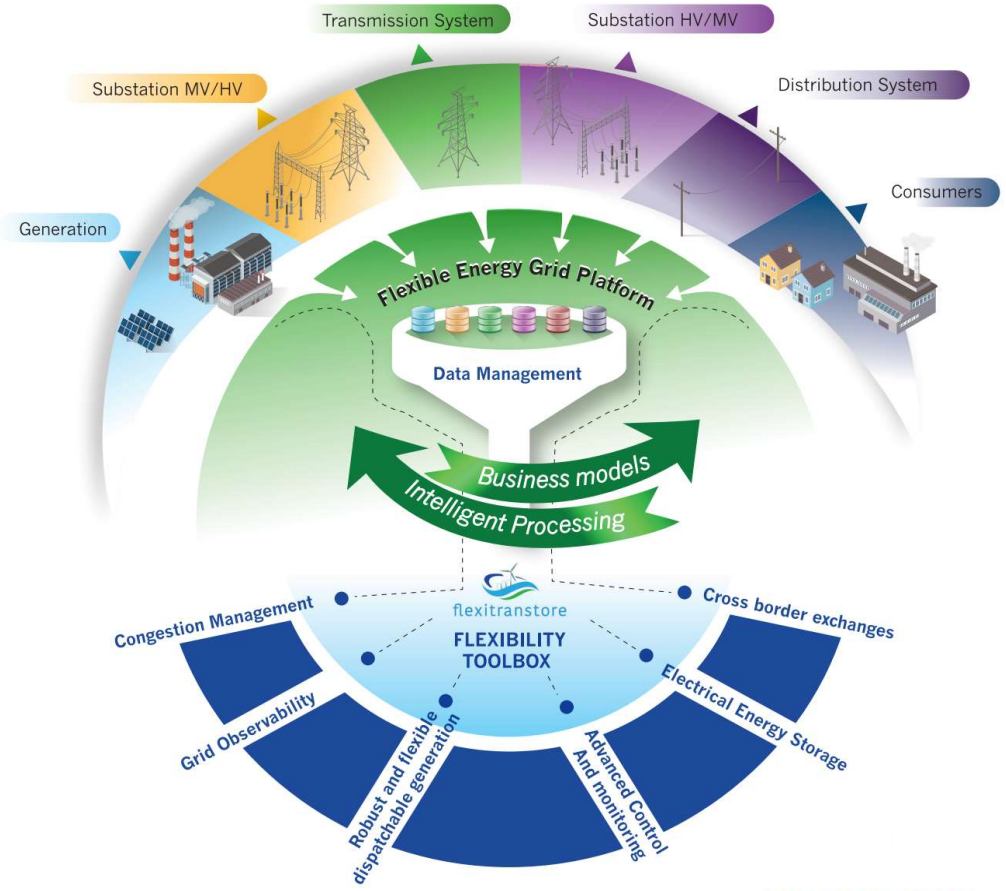
- **applications (toolbox)** → functionalities of the toolbox will be connected to specific power system flexibility resources (demand response, market, grid assets efficiency)
- **business models** to govern the operation of the applications (where applicable)
- **Data management and IT architecture** that accommodates all these functionalities
- **interfaces with external databases** and simulation engines

FEG Platform will:

✓ Adhere to guidelines of the **Data Management Working Group of the BRIDGE Initiative**

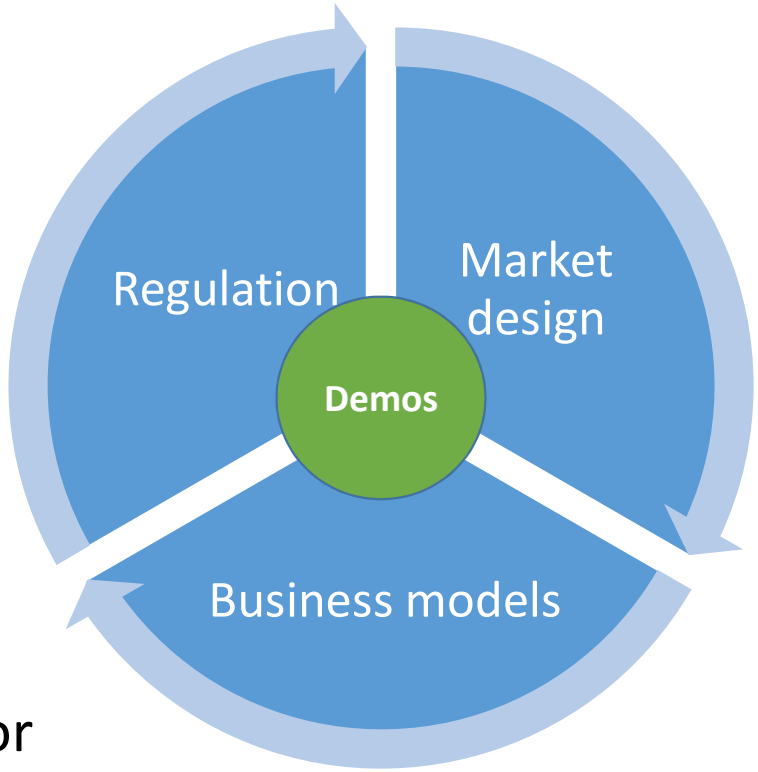
✓ Attempt to address different Market Designs (Forward, Day-ahead, Intra-day, etc.)

✓ Offer a powerful tool mainly for TSOs but also for DSOs and other relevant stakeholders



WP3 - Markets, regulation, business models

- **Regulation** - regulator actions that encourage flexibility
- **Market design** - changes that improve flexibility
- Emerging **business models** - innovation and opportunities
- Demo **routes to market** for flexibility



New **market settings,** recommendations for **regulation,** exploitable business cases representing **real investment opportunities**

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Early focus for exploration

Where are the opportunities for scalability, exploitation and commercialisation of flexibility using DSR, aggregation, storage?

- Very strong commercial success of aggregators, VPP where allowed. Storage starting to play clear role
- Growth of secondary marketplaces, DSO's waking up to opportunities for reinforcement avoidance – role for storage
- Significant barriers to hybridisation – impact on HPP?
- Growth of data, algorithms, growth of virtual / automated trading

CEP will not unlock flexibility without further effort by MS

- How can we forecast and guide?

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Limejump enters BM (GB)

BATTERIES

LJ SMART DEVICES

- Pgm. Logic controller
- High speed data logger
- Sub-controller
- Frequency injector

BUSINESS ASSETS

- Chillers
- CHP Engines
- LFG Generators
- AD Generators

...

THE CLOUD

- Live data processing
- Real-time algos
- DB cloud storage
- Weather forecast
- Trading risk mngt. system
- Billing system

OPS & TRADING CENTRE

- Operations dashboard
- Trading dashboard
- Access to live asset issuing
- Assets dispatch controller

COMMERCIAL PLATFORM

- Product quote tool
- Companies management
- Billing control

CUSTOMER PORTAL

- Access to statement
- Live performance data
- Forecast control
- Real-time market data
- Live support chat

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Tendered flexibility services

- Tendered response to reinforcement avoidance (congestion relief)
  - TERNA, Italy, 35MW
  - Badarup, Germany
  - UKPN Flexibility Tender – “flexibility first” approach to network capacity
- Congestion management as a service
  - WPD Flexible Power
- Virtual marketplace
  - PICLO
  - Others

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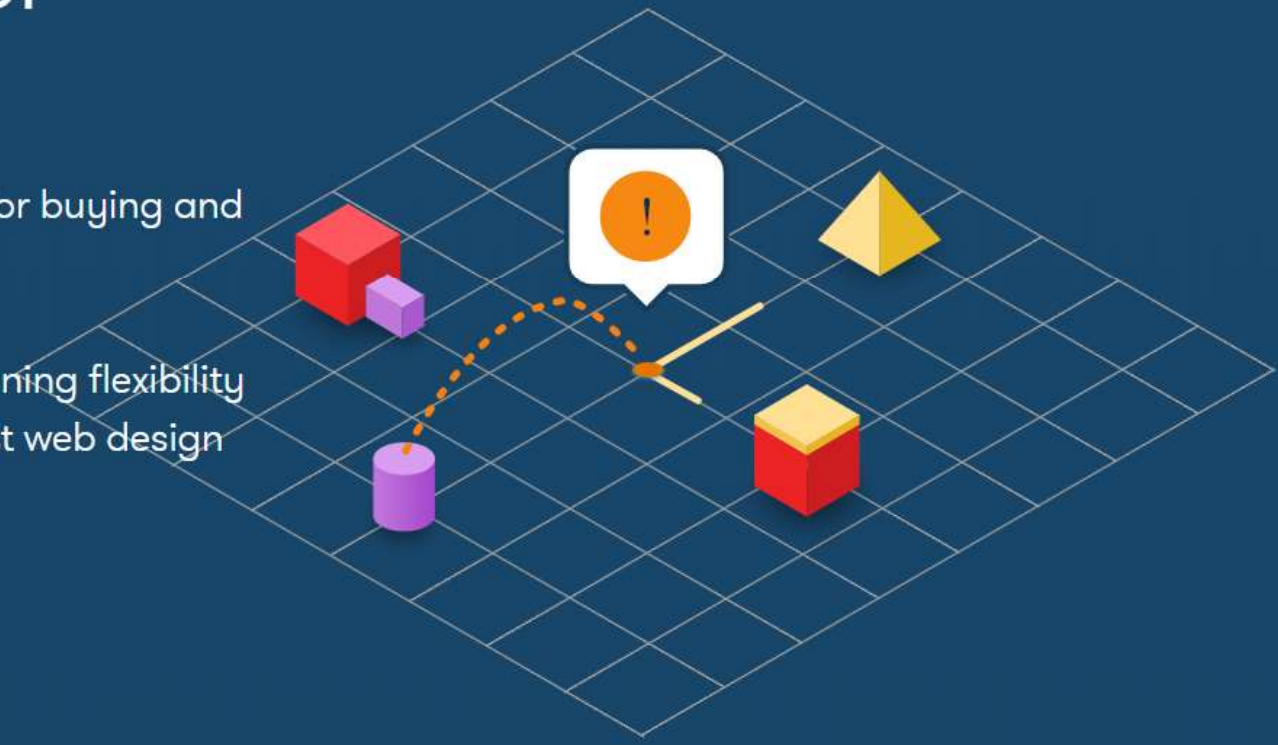
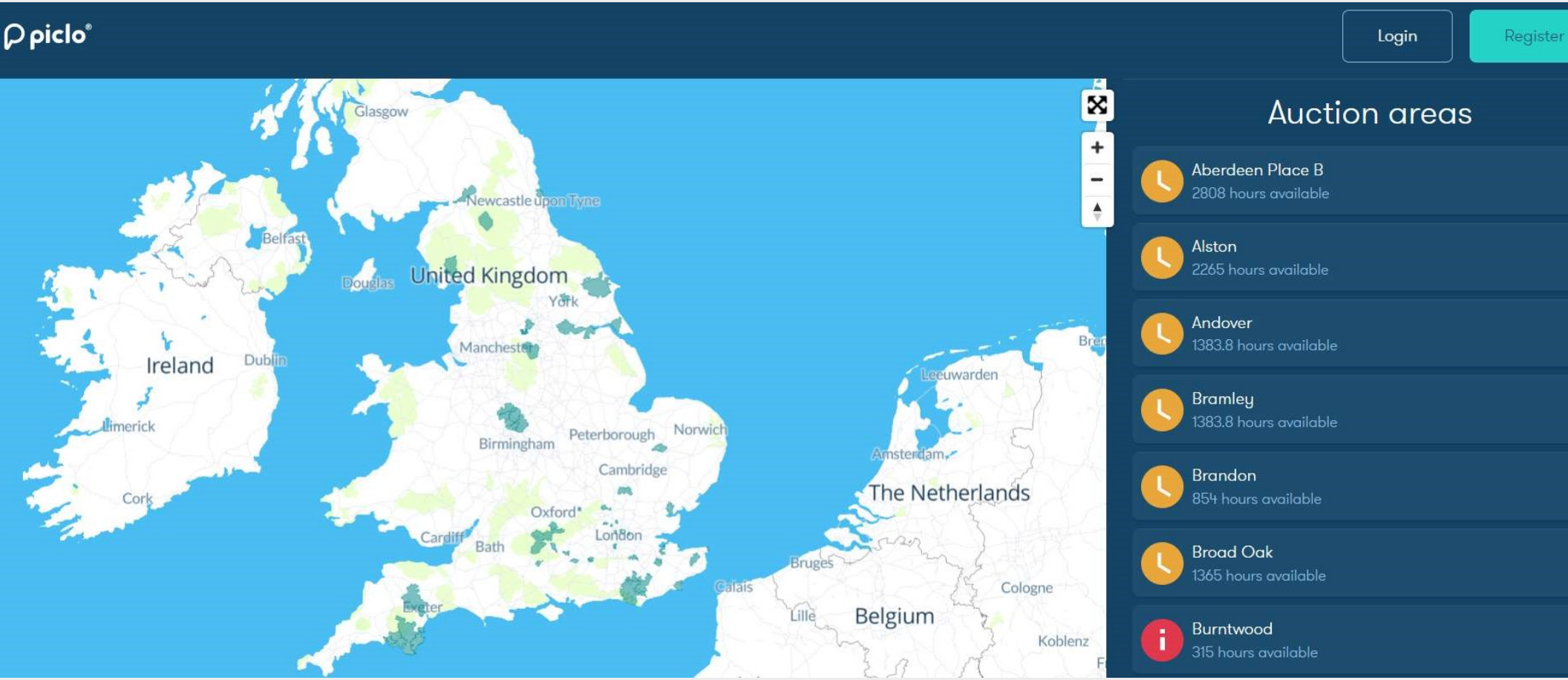
piclo®

The marketplace for flexibility services

Piclo Flex is the independent marketplace for buying and selling smart grid flexibility services.

Our platform takes the proven model of running flexibility auctions and supercharges it with the latest web design and matching algorithms.

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Burntwood
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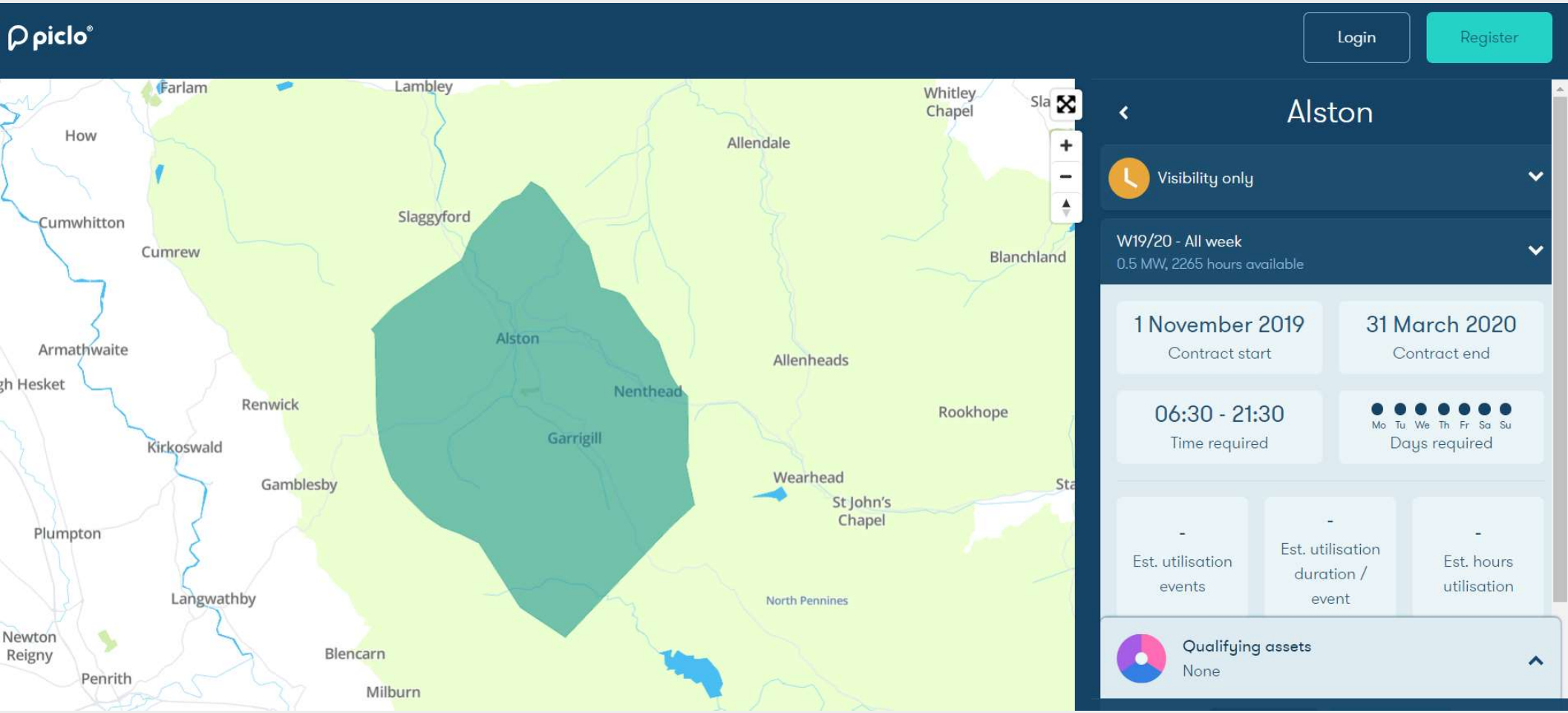
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Kirkoswald
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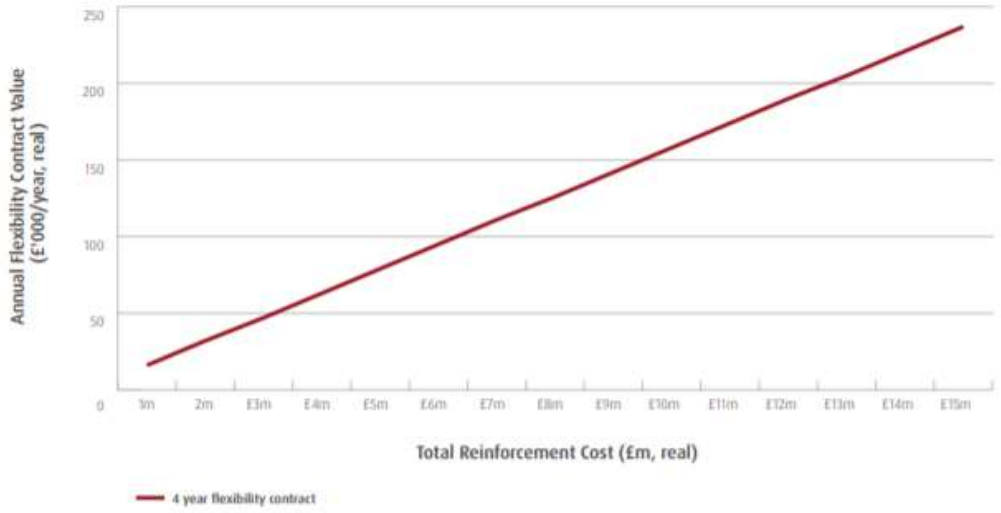
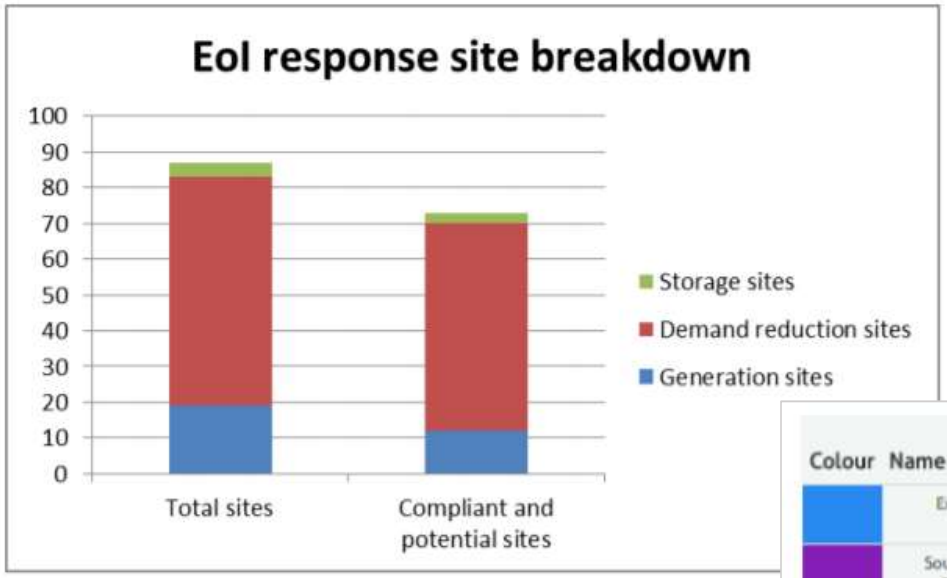
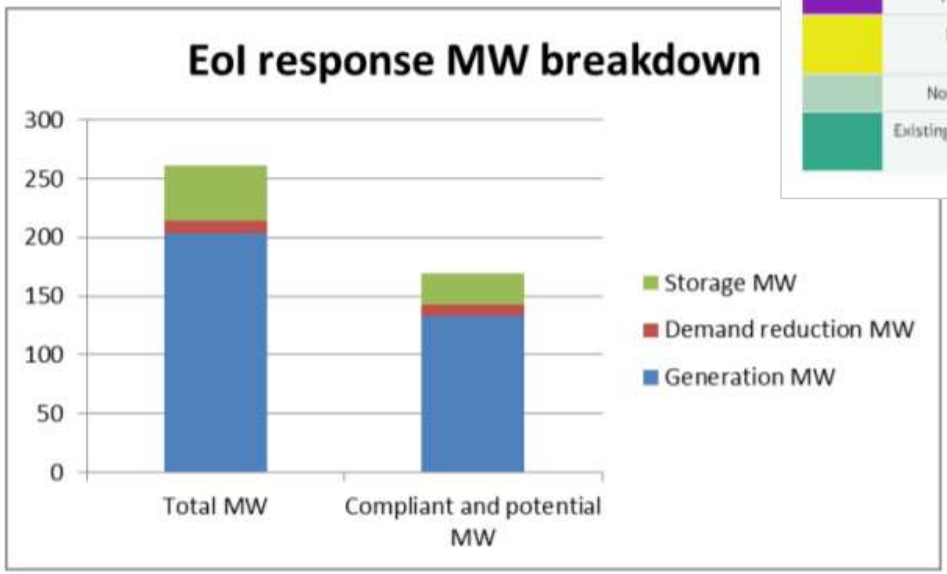
Wearhead
St John's Chapel
Plumpton
Langwathby
North Pennines
Newton Reigny
Blencarn
Penrith
Milburn
Alston
Visibility only
W19/20 - All week
0.5 MW, 2265 hours available
1 November 2019
Contract start
31 March 2020
Contract end
06:30 - 21:30
Time required
Mo Tu We Th Fr Sa Su
Days required
-
Est. utilisation events
-
Est. utilisation duration / event
-
Est. hours utilisation
Qualifying assets
None

Figure 5: Flexibility market potential for EHV and HV reinforcement needs

Figure 7: Flexibility contract values for reinforcement costs







Colour	Name	Services	Arming Fee (£/MW/h)	Availability Fee (£/MW/h)	Utilisation Fee (£/MWh)	Restore Fee (£/MWh)
	Exeter City	Dynamic & Restore	N/A	5	300	600
	South Hams & Plymouth	Dynamic & Restore	N/A	5	300	600
	Rugeley	Secure & Restore	75	N/A	150	600
	Northampton	Restore	N/A	N/A	N/A	600
	Existing Midlands Trial Area	All	N/A	N/A	N/A	N/A

The Voice of the Networks

Energy Networks Association's Flexibility Commitment

As new energy technologies drive change across the energy sector, Britain's households and businesses stand to benefit from a lower cost, lower-carbon energy system.

Britain's energy network operators are committed to creating a smarter, more flexible and more efficient energy system, whilst continuing to provide safe, reliable, affordable energy supply to all of our communities across the country.

Both through the current RIIO price control and the Open Networks Project that will lay the foundations of the UK's smart grid, Britain's six Distribution Network Operators (DNOs) have made strong progress in increasing the use of competitive third party flexibility services that use smart technologies to fulfil requirements for running local electricity networks. They do so where these services provide better value for the public than traditional network infrastructure reinforcements or upgrades, such as such as new pylons, transformers and substations.

This work is key to reducing the costs of new infrastructure investment, running existing infrastructure more efficiently and creating a smarter, more flexible system for us all. DNOs are already testing the market and engaging third party flexibility services in orde they continue to meet obligations to deliver a safe, secure and efficient energy s result, the benefits to customers, the economy and sustainability of encouraging and opening markets are now well recognised.

As part of this work, Britain's six DNOs are now committed to:

- Opening up requirements for building significant new electricity network infrastructure to include smart flexibility service markets as part of day-to-day operations. This covers all new relevant projects of significant value, where local electricity operators face congestion in grid infrastructure that results from increased electricity demand and/or distributed energy projects being connected to the grid.
- Openly test the market to compare relevant reinforcement and market flexibility solutions for all new projects of any significant value.
- Working with Ofgem and other stakeholders to develop the forthcoming RIIO-2 price control framework to ensure that the financial incentives that network companies receive are fully aligned with the greater use of flexibility services and do not favour the building of new infrastructure where these services are more efficient.

Context:
"The role of DSO's in Flexibility in the context of the 4th Energy Package"

CEER, Mar 2018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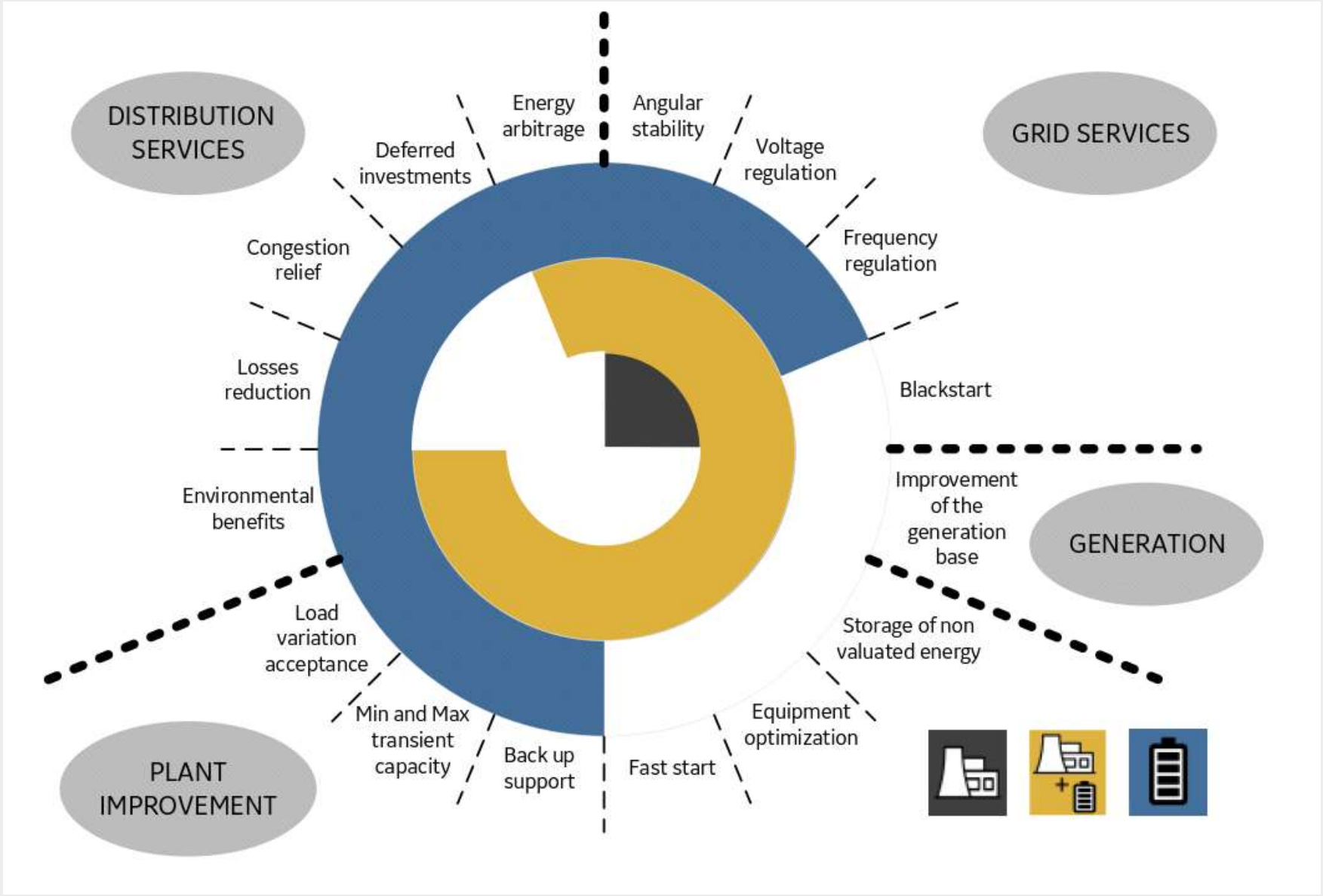
✓ 99.9% availability to Grid

Network Topology


DISTRIBUTION SERVICES
GRID SERVICES
GENERATION
PLANT IMPROVEMENT
Energy arbitrage
Angular stability
Deferred investments
Voltage regulation
Congestion relief
Frequency regulation
Losses reduction
Blackstart
Environmental benefits
Improvement of the generation base
Load variation acceptance
Storage of non valuated energy
Min and Max transient capacity
Equipment optimization
Back up support
Fast start

View of the market – What reduce / make value of an hybrid CCGT in EU

Ireland : ancillary service and related payments not yet fully in place for energy storage application.
Irish TSO do not allow the use of the batteries if the CCGT is not in operation. This represent a limitation in terms of revenues stream considering the CCGTs are not 24h in operation.

UK : For battery, *More favorable market for as iery restrictive grid code*.. Most advanced market. Fast reserve market as opportunity for thermal
National Grid will not procure anymore EFR. All battery projects will be de-rated up to 80% based on storage capacity (MWh) reducing in this way the capacity payment to co-finance energy storage projects. National grid connection requirement may represent a limitation for hybrid application in case the customer wants to operate the batteries when the CCGT is not in operation. For black grid restoration, battery are not yet fully qualified. since NG requires that all house loads will be supplied by an independent source of energy for up to 7 days. This requirement limit the benefit of the batteries.
Services remuneration decreased from 2016 to 2018.

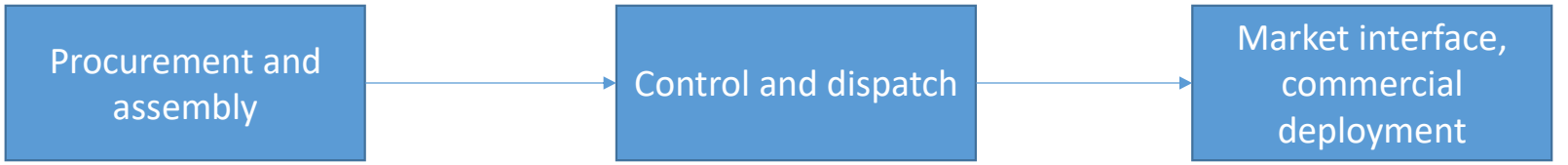
Belgium & Netherlands :Batteries fully qualified by TSO.
Potential Business Case for thermal hybrid (BS +RF) but auction volume very limited.

Germany :Batteries fully qualified by TSO.
Main focus on grid stability but big thermal installed base.

Spain / Italy : battery not yet fully qualified by TSO.
Primary frequency response is mandatory and not remunerated with capacity payment.
Black start availability is not remunerated.
Spain : growing interest due to high renewables & coal phase out.

Turkey : only starting from 2018 energy storage is recognized for frequency regulation application, but there are no payment for black start. Frequency regulation is not mandatory, but it is based on capacity auction similar to Belgium. Without black start payments the business case is still not positive.

Shifting focus: BESS value chain



- Highly commoditised
- Strong competition
- Basic “integrator” role

- Complex
- Strong TSO/DSO track record required
- Dominated by big OEM

- Dynamic
- Market specific
- Volume opportunity
- Knowledge driven

Maturing markets for flexibility

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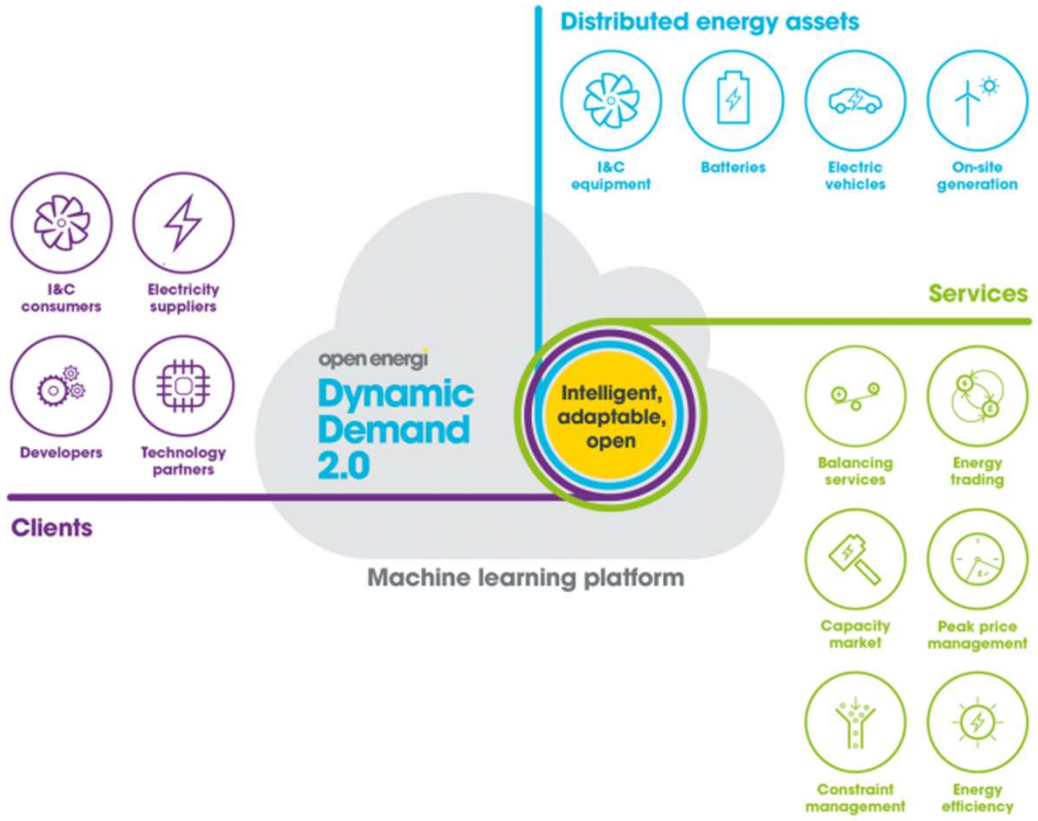
Growing importance of the knowledge engine



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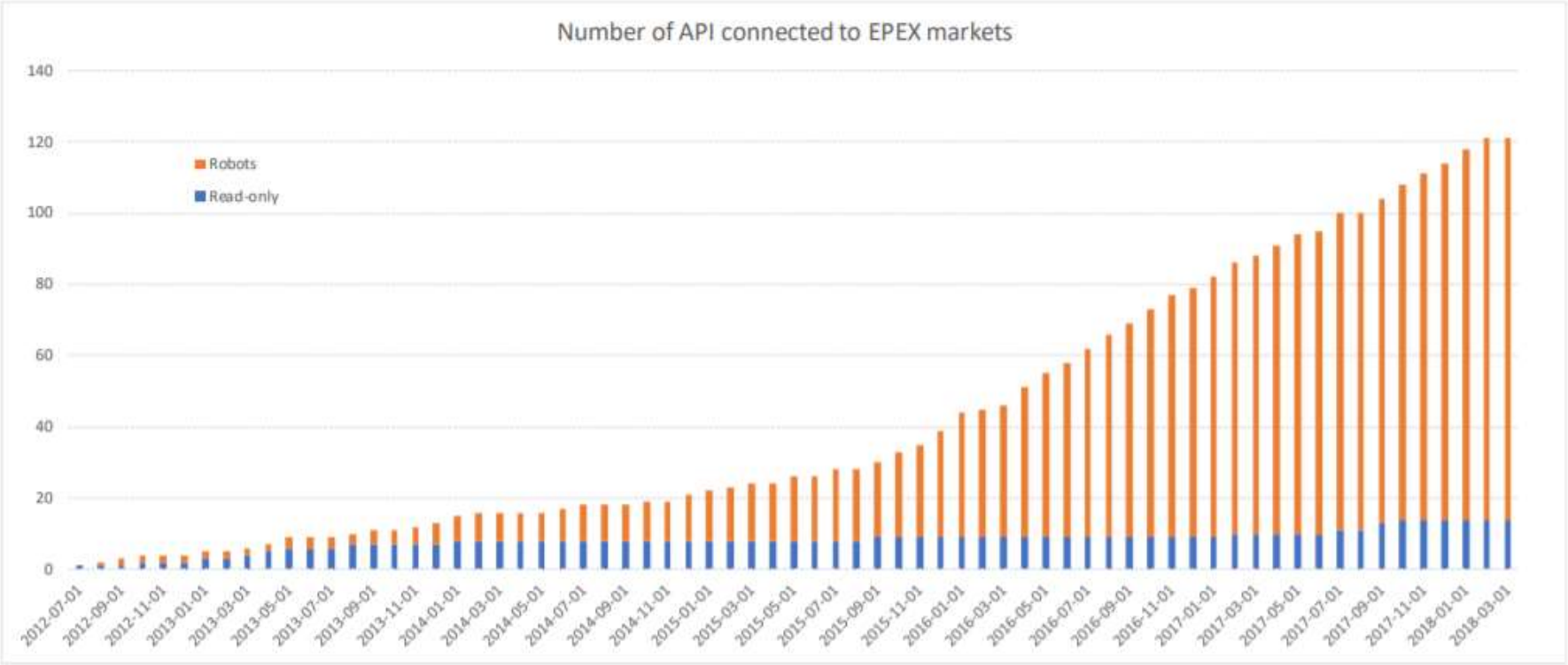
Robots/API developments



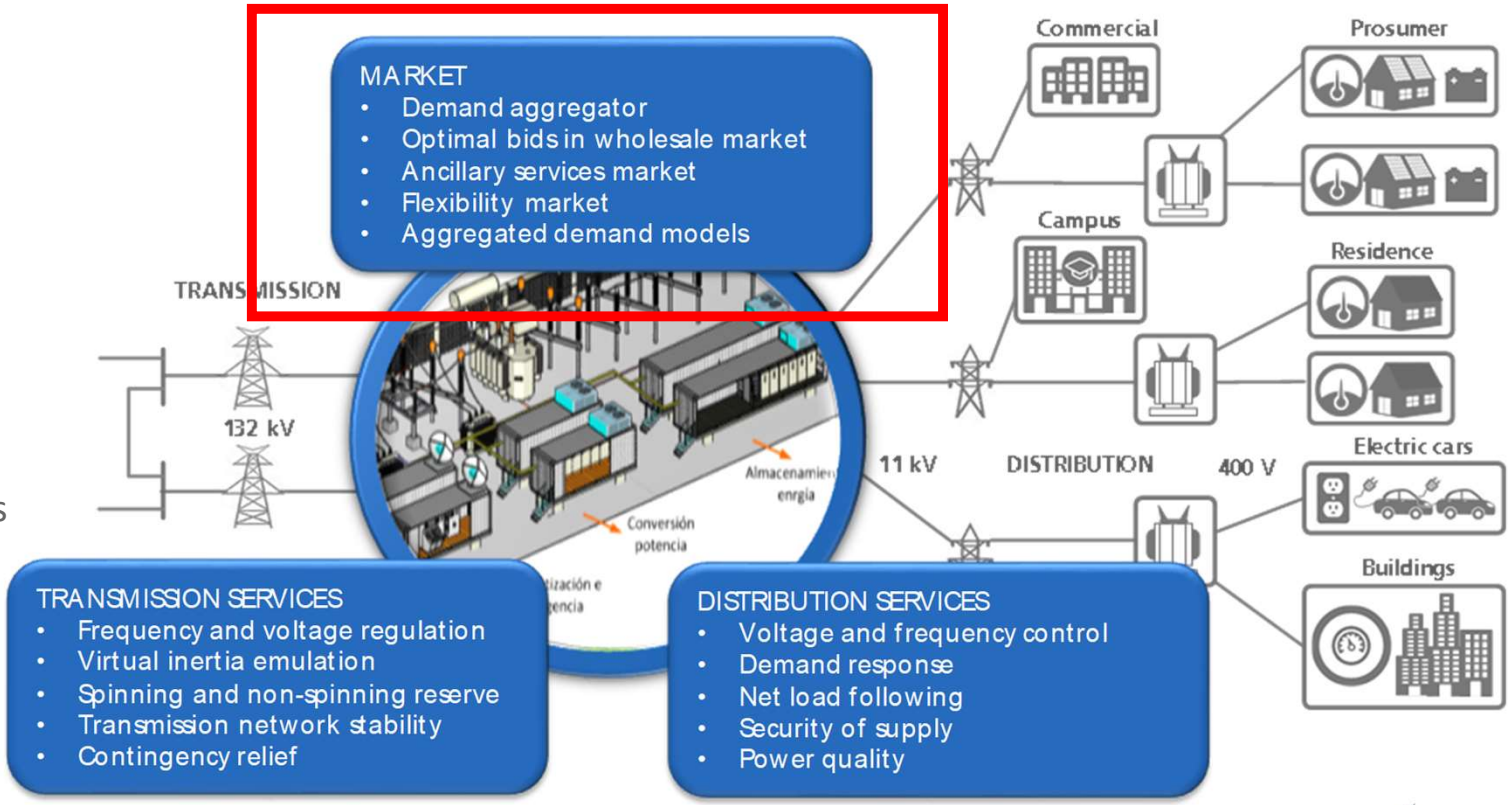
Source: M7 API_Invoicing_ID_Waitinglist Overview: API in production (Feb 18 update)

In 2018, 38% of APIs in production are developped by members themselves and 62% are provided by ISVs

Flexitranstore HIL demonstrator

Objectives:

- Demonstrate TSO/DSO active substation regulation and power management services (grid stability and reliability)
- Demonstrate integrating energy storage systems at WPP substation
- Implement advanced control systems for active substations and demonstrate active substations in the demonstration sites



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Flexitranstore – other areas

- CBA for flexibility, flexibility need from TSO perspective
- Unit commitment models to define market impact of flexible technology growth
- Market design space and metrics for flexiblity
- Growth of importance of short term markets – new products (EPEX), suspension of capacity market in GB&I
- Emerging cluster of enabling technology service providers – 'flexibility ecosystem'
- Routes to market for load flow devices
- New market settings; regulatory improvements; forecasting impact of CEP

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Summary

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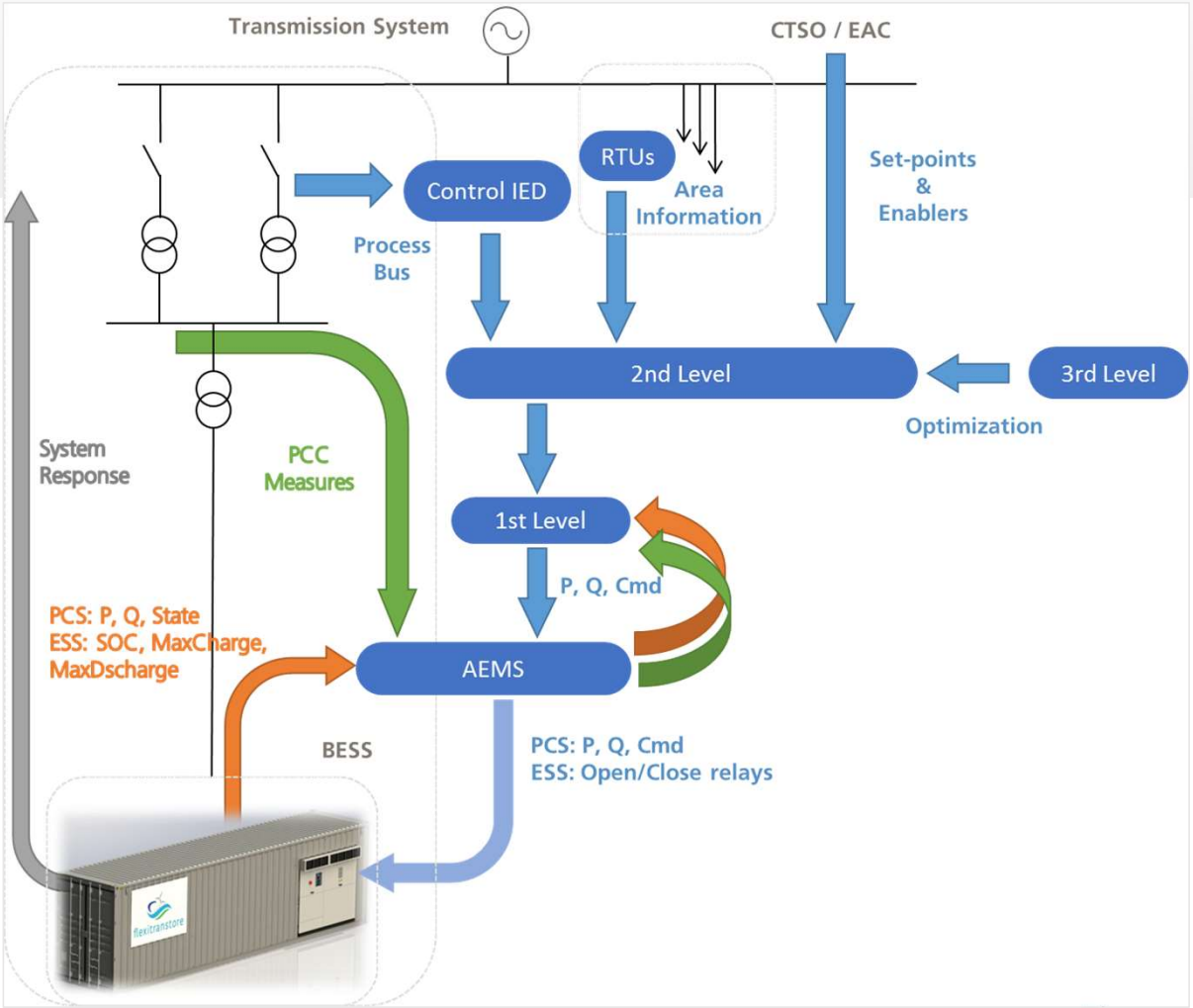
WP5 - ADN

ADN Control – Grid Services

- Grid services are still under study by LUA and ABG
- Services and/or working scenarios will be described to EAC and CTSO to be agreed



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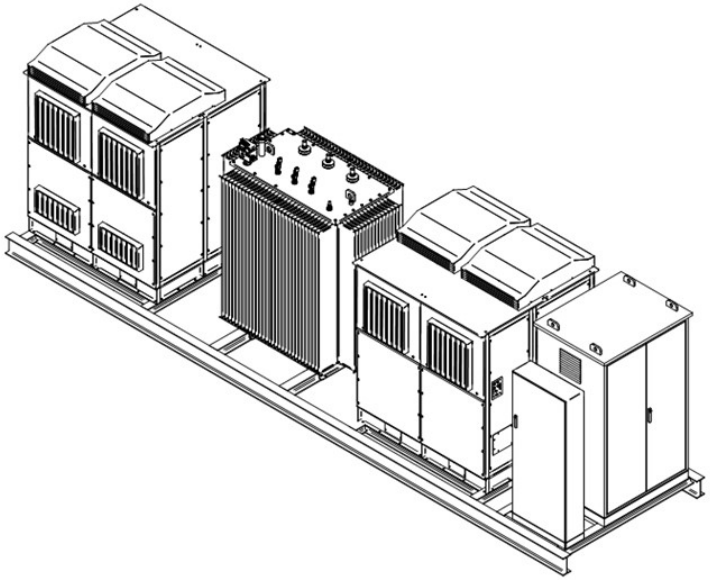
WP6 – WP-BESS

Work package number [9]	WP6	**Lead beneficiary** [10]	10 - JEMA
Work package title	Demo 2 – Wind Power Plant connected to Active Substation		
Start month	1	**End month**	38



Demo 2: Integration of a **BESS** of 2MW @ 2MWh in Aisimi substation, a 39,1MW wind park in the Northern Greece.

The main tasks of the project are:

- Electrical design of the 2MW converters.
- Electrical design of the 2MWh batteries.
- Analysis of the Greek code.
- Analysis of the substation communication to operate the BESS system.

WP6 – Wind + BESS

- Increasing number of commercial wind + BESS projects emerging

Ramp control	Frequency response	Arbitrage	Smoothing
• Use case is well known • Forced flexibility through PPA conditions (eg. Auwahi 21MW in Hawaii) • We could propose regulatory changes that take this approach	• Lots of projects • Mitsubishi / Eneco 48 MW/50 MWh in DE for time shift + Primary Control Reserve • Vattenfall 22 MW battery for the UK's Enhanced Frequency Response. • Toshiba and NRG Energy: 2 MW battery in Texas, high-speed frequency regulation services to ERCOT.	• Seen as low value - spreads aren't high enough • FIT shields from fluctuations	• In DE, obligation of wind farm owner to exactly follow their forecast generation schedule • Rationale for storage: avoided balancing costs / penalties for not meeting schedule • Forecasts matched through ID trading / balancing / storage • **Usually mitigation by ID trading cheaper**

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M12 → M12

Task 7.3: Demonstrating overload capacity and de-icing of cross border line with DLR

Installation of OTLM sensors and weather station – tower SM95

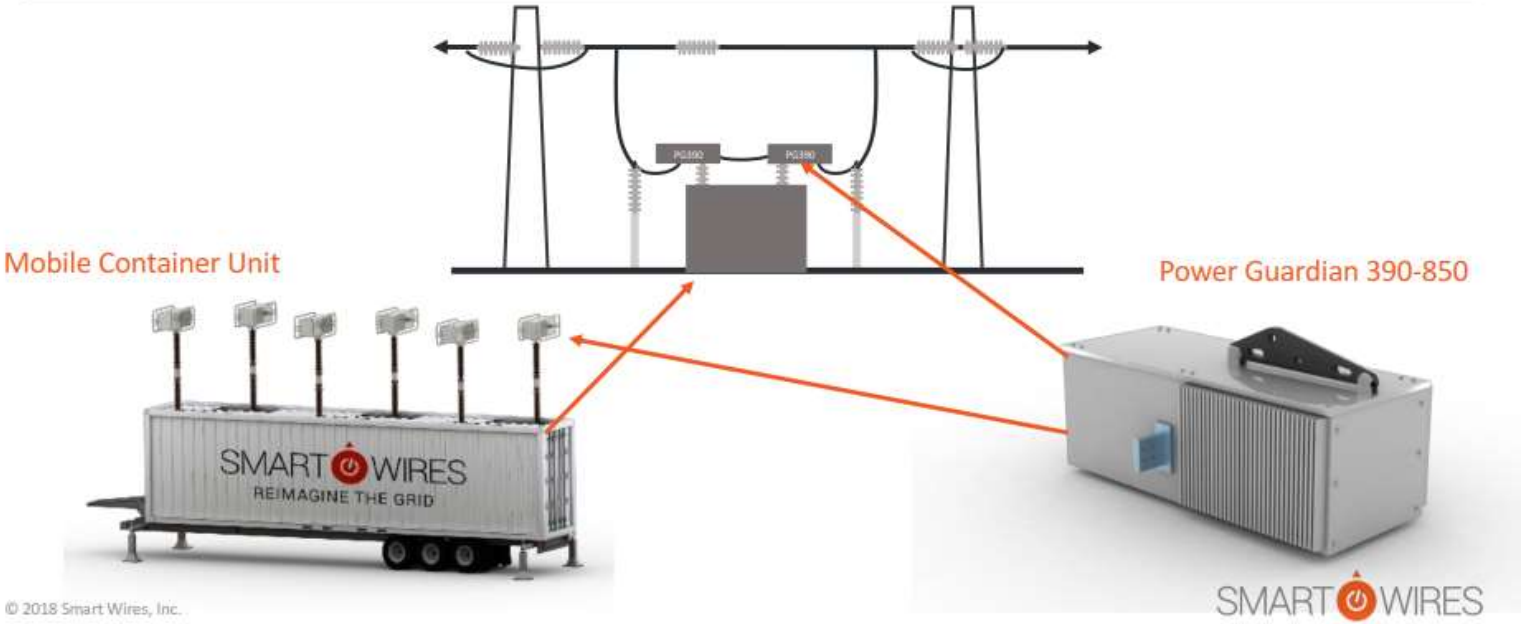




Project Plan

Deployment of the Smart Wires Mobile Solution

Item	Key Facts
Product	▪ 6x Power Guardian 390-850 ▪ 1x Mobile Container Unit
Objectives	▪ Test the ability to direct power flows on transmission and distribution lines with Modular Power Flow Control technologies; ▪ Increase network transfer capacity and to reduce RES curtailment; ▪ Demonstrate the mobility and redeployability of modular Power Flow Control solutions.



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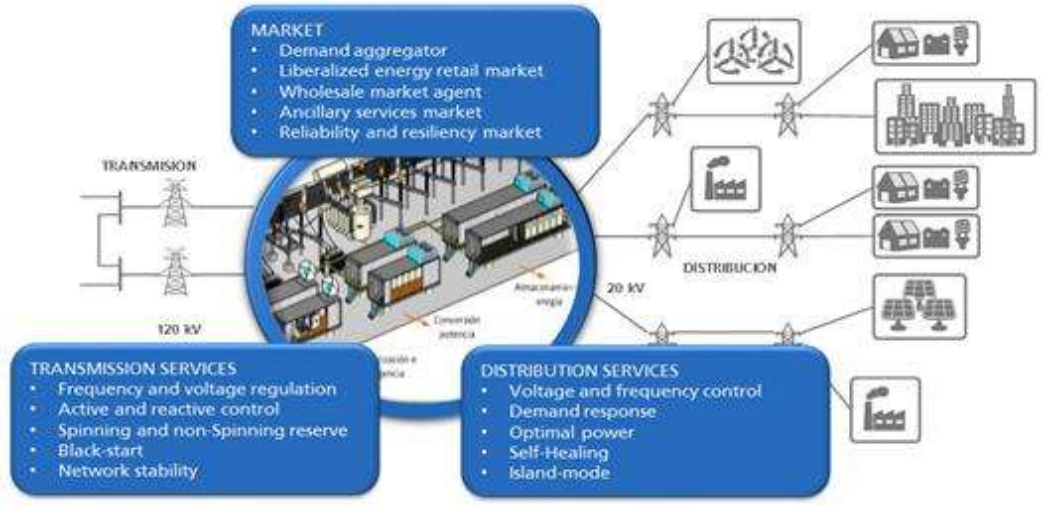
Objectives

1. To **design and implement** an innovative active substation, which integrates a **BESS**, for a WPP in order to provide flexible regulation and power management services to the TSO and to improve its interaction with the transmission network in order to enhance its regulation, stability and reliability.
2. To enable the usage of energy storage in a WPP active substation to demonstrate **reduction of the resource variability impact** on the performance of power systems with significant penetration of RES.
3. To design and implement a complete demonstration project of WPP controller and BESS in the SEE region.



Integrate a BESS in a 39,1MW wind plant.

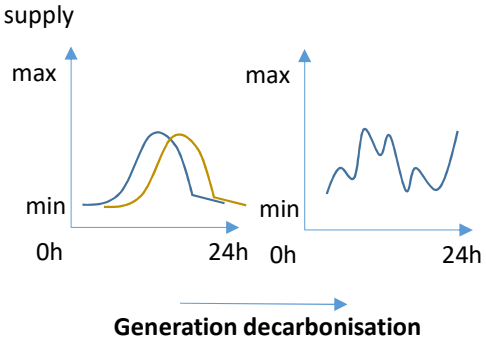
Study how a BESS can **improve the network by regulating freq, voltage reactive and active power.**

Storage energy in order to **reduce the active power peaks** that the wind technology generates.

Business models in the wholesale market

New actors, for example:
- Aggregators
- New sorts of BRP eg. municipalities
- New types of suppliers / generators
- Energy storage operators

Value prop.



Op model

GENERATION
Eg. CCGT

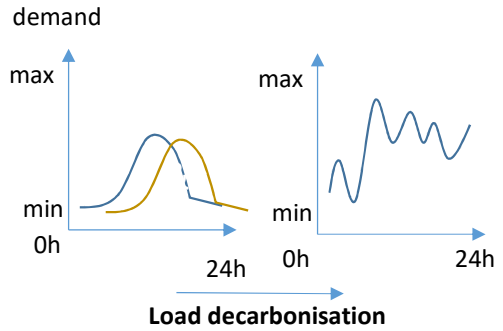
Value prop.

Wholesale Market
Day ahead
Intra-day
Balancing
Ancillary services

Value prop.

DEMAND
Eg. retailers

Op model



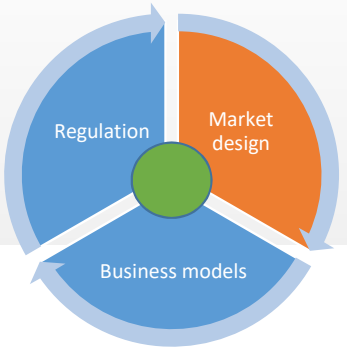
System operator

I "Business model" Cat I
New operating models to manage variability

II "Business model" Cat II
Solution to variability for others

III "Business model" Cat III – solution to variability from new actors

Metrics – balancing market



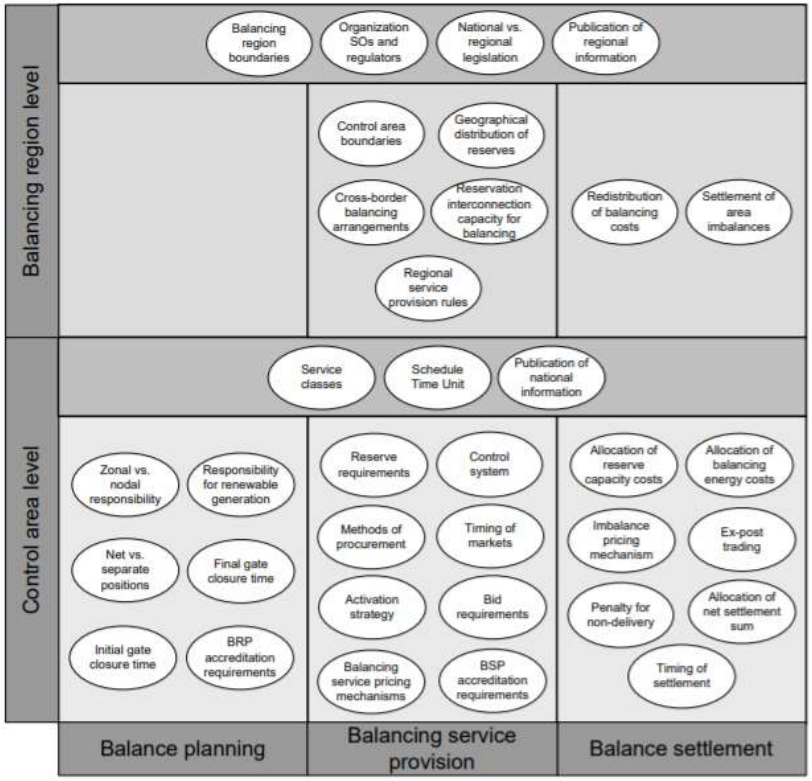


Figure 3.6 – Balancing market design space

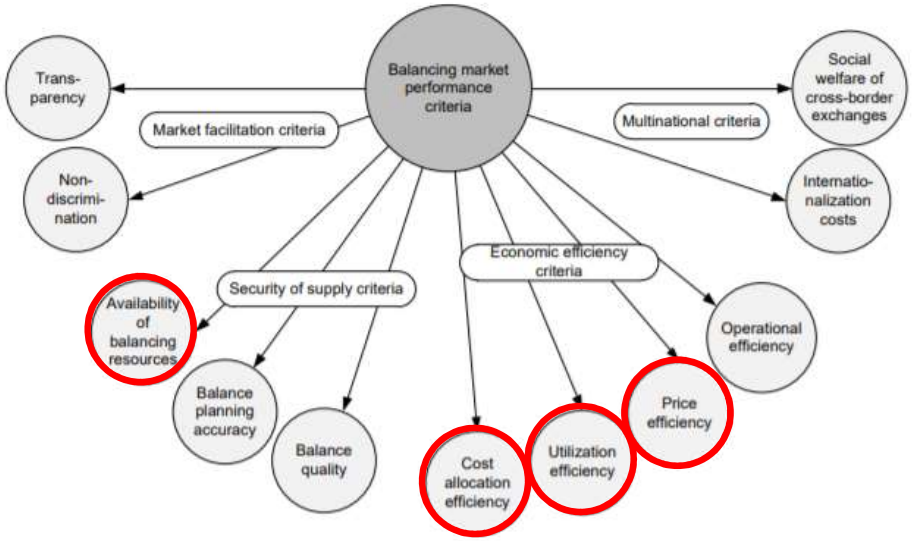


Figure 3.5 – Balancing market performance criteria set

+ curtailment metric

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