Royal Belgian Society for Electricians 2021

Webinar
“Balancing the future grid”

Thursday 10/06/2021

The webinar will start in a few minutes

Royal Belgian Society for Electricians 2021

Webinar
“Balancing the future grid”

Thursday 10/06/2021

in collaboration with

HORIZON 238

Introduction

Introduction

KBVE/SRBE Webinar

3 sessions:

- ✓ April 22th 2021
- ✓ May 20th 2021
- ✓ June 10th 2021

Format:

- ✓ Introduction
- ✓ Speaker 1
- ✓ Speaker 2
- ✓ Speaker 3
- ✓ Q&A (chat)

Introduction

Prof. Erik Delarue KU LEUVEN **Dr. Kenneth Bruninx**

Energy Systems Integration & Modeling

"Quantitative models supporting the energy transition: the specific case of battery storage in short term balancing markets"

Introduction

Lien Van Schepdael

FLEXCITY by VEOLIA

Technical account manager

"The role of aggregators in balancing the grid"

Gonzalo Morollón Castro

entsoe

Market advisor

"Balancing – a pan-European vision"

KBVE Webinar - Balancing the future grid, June 10, 2021

Quantitative models supporting the energy transition: The specific case of battery storage in short term balancing markets

Erik Delarue & Kenneth Bruninx

Energy Systems Integration & Modeling (ESIM) Research Group

Agenda

- Modeling energy systems
    - Why models?
    - A suite of energy system models
    - Trends and challenges

- Battery storage in short-term balancing markets

Why models?

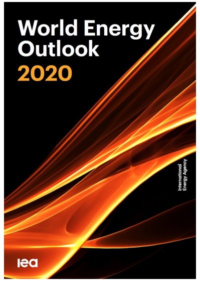
- Energy system in transition ("*Balancing the future grid*")
  - Both a complex and dynamic system
  - Precludes direct experimentation

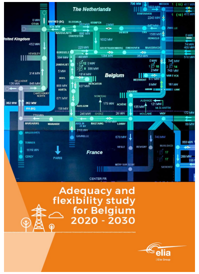
- Need "maps" or models
  - To understand mechanisms at work in the system
  - To identify what processes are important
  - To evaluate the outcomes of interest

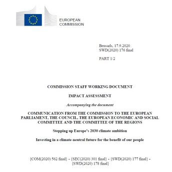
- *Mathematical models try to describe a system, and as such try to capture the behavior of this system, using mathematical equations or relationships. Based on observed/measured data and/or physical relationships, a set of equations can be defined that describe the dynamics of the system, and as such the relationships between system variables*

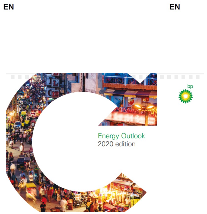
Why models?

- Control and operational decisions
- Forecasting
- Technical studies
- Market design studies
- Policy evaluations
- System transitions and scenario analysis
- …







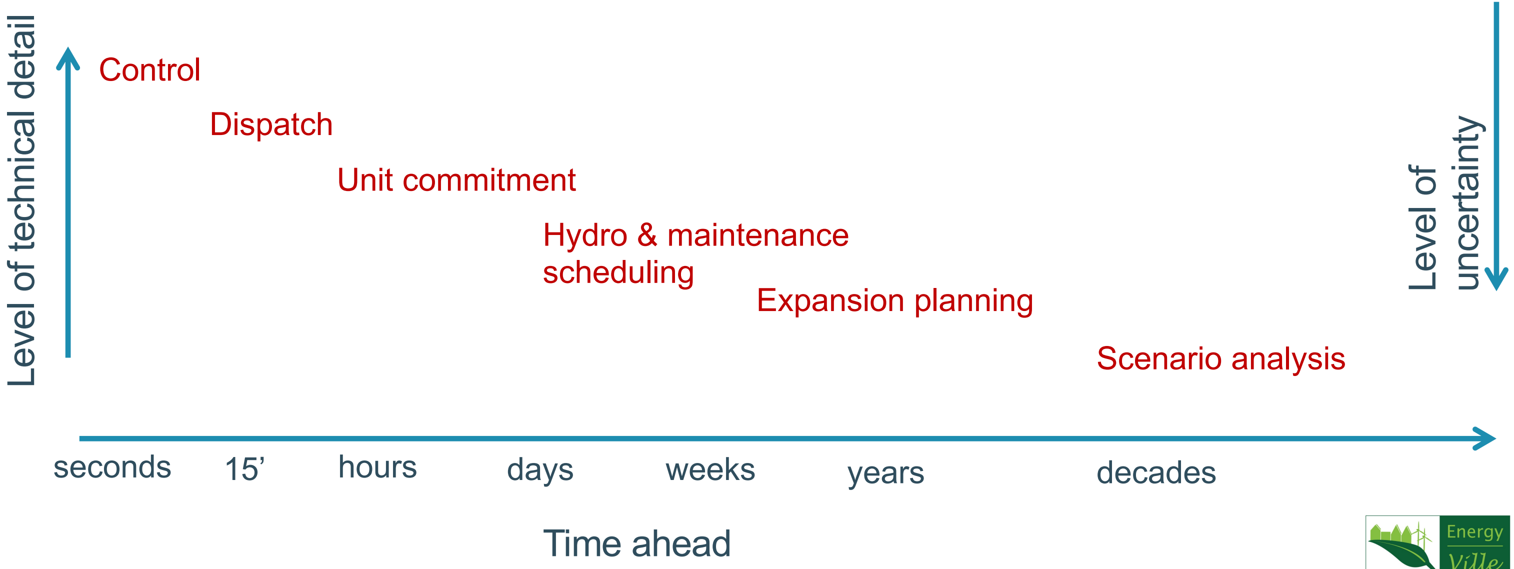


A suite of energy system models

- No single model serves all questions
  - Type of question relates to methods that can be used
    - Some examples in the field of energy:
      - What is optimal/efficient operation of device/system?
      - What is the optimal system/transition, how should system optimally evolve under boundary conditions?
      - How to realize desired operation or transition, with markets, policies and regulation?
  - Right scope and resolution
    - Increased shares of renewables require careful temporal representation

A suite of energy system models

- Energy system model dimensions: temporal, spatial, system layers, energy carriers, …
- Example for electricity system models: temporal dimension

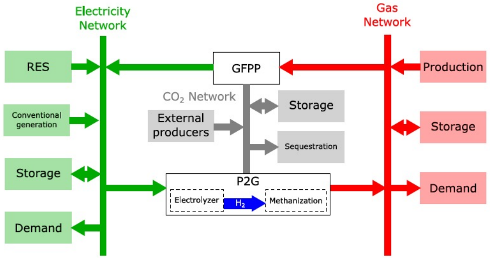


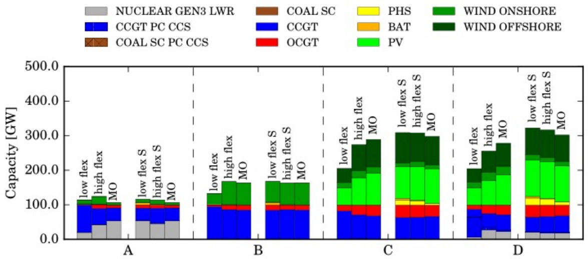
A suite of energy system models

- Wide range of software languages, solvers, commercial packages, …
  - Model verification, benchmarking, validation/calibration
  - Transparency and reproducibility?
  - Open-data and open-source modeling?

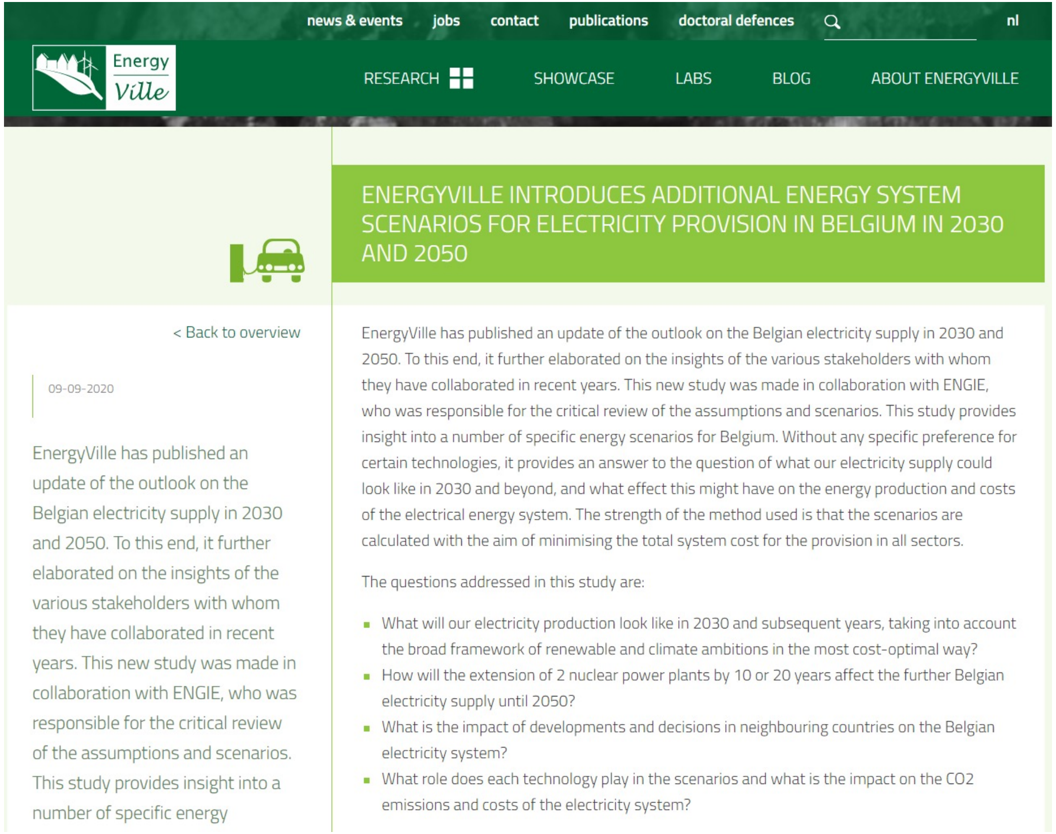
A suite of energy system models

- Modeling in ESIM research group
  - Operational model
    - Mixed-integer programming for unit commitment
    - Unpredictability: forecast errors, reserve sizing/allocation/activation
    - New technologies: e.g., CC(U)S, power-to-X, active grid elements, link to thermal systems in buildings
  - Expansion planning models
    - Improve operational representation and technical detail
    - Uncertainty, adequacy, interconnections and market elements
  - Equilibrium modeling
    - Including (strategic) behavior, incomplete markets
  - Agent-based modeling
    - More flexibility to account for incentives, boundedly rational decision process, and social interactions
  - Open toolboxes and models
    - SPINE, ELDEST





A suite of energy system models



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RESEARCH SHOWCASE LABS BLOG ABOUT ENERGYVILLE

ENERGYVILLE INTRODUCES ADDITIONAL ENERGY SYSTEM SCENARIOS FOR ELECTRICITY PROVISION IN BELGIUM IN 2030 AND 2050

< Back to overview

09-09-2020

EnergyVille has published an update of the outlook on the Belgian electricity supply in 2030 and 2050. To this end, it further elaborated on the insights of the various stakeholders with whom they have collaborated in recent years. This new study was made in collaboration with ENGIE, who was responsible for the critical review of the assumptions and scenarios. This study provides insight into a number of specific energy

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The questions addressed in this study are:

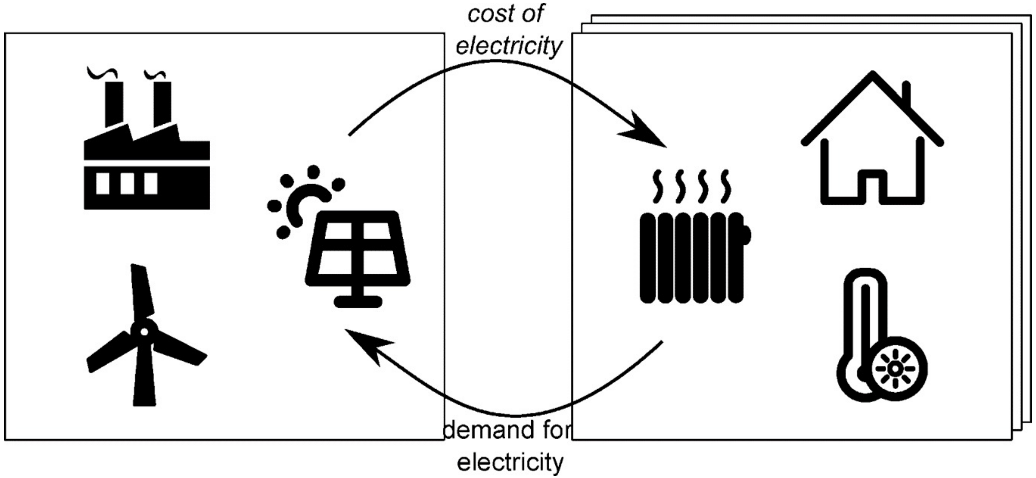
- What will our electricity production look like in 2030 and subsequent years, taking into account the broad framework of renewable and climate ambitions in the most cost-optimal way?
- How will the extension of 2 nuclear power plants by 10 or 20 years affect the further Belgian electricity supply until 2050?
- What is the impact of developments and decisions in neighbouring countries on the Belgian electricity system?
- What role does each technology play in the scenarios and what is the impact on the CO2 emissions and costs of the electricity system?

http://www.energyville.be/en

A suite of energy system models

Multi-energy systems: Electricity – Heat

- Thermal inertia to help balance the system



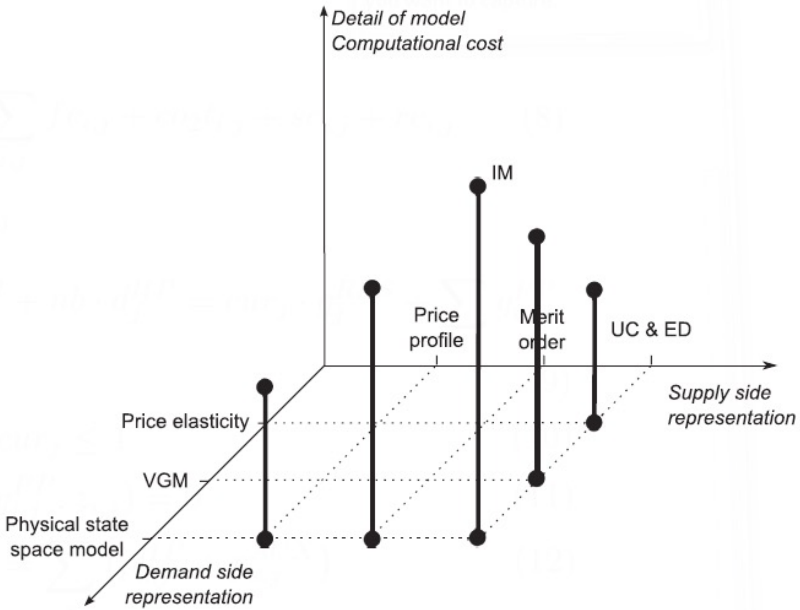
Complex interactions between demand and supply: how do you capture this in an operational model?

A suite of energy system models

Multi-energy systems: Electricity – Heat

Focus on supply side:
Simplified representations of the demand side flexibility in a unit commitment and economic dispatch model

Focus on demand side:
Simplified representations of the supply side in a detailed thermal building simulation or optimization model



A suite of energy system models

Multi-energy systems: Electricity – Heat

Integrated model: minimize total operational cost

- Thermal properties of buildings, aggregated in a **building stock model**

- Technical characteristics heat pumps
- **User behavior profiles**

- Power plants
- Demand
- **RES** profiles
- CO_2 price

Building stock ⟷ Thermal demand ⟷ Electric heating systems: heat pumps ⟷ Electricity price ⟷ Unit commitment and economic dispatch

Linear state-space model

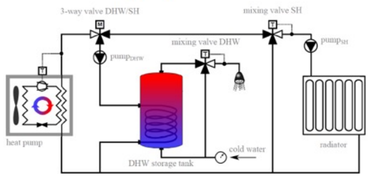
Different building types

Linear technical model

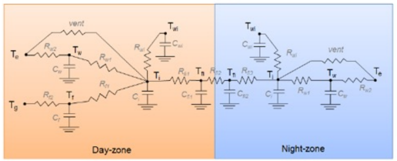
Different user behaviour types

Mixed integer linear programming model

Heating system models



Building (stock) models



User behavior and weather data

SPINE project

- Main goals:
  - Develop an open-source energy modeling toolbox
    - Open: Github, Python
    - Flexible: User friendly, direct link between data and model, facilitate soft-linking
    - Practical: GUI, convenient handling of input data, facilitate scenario creation and management, viewing functionalities
  - Develop an open-source energy-system optimization model generator, SpineOpt
    - Open: Github, Julia
    - Flexible: Long-term energy system optimization, detailed UC models, hydro scheduling, heat system optimization with building heating physics, etc.
    - Practical/fast: Julia, efficient formulation, parallelization

Spine

http://www.spine-model.org/
https://github.com/Spine-project

Trends and challenges

- Integrated energy systems
  - Including various carriers and networks (e.g., electricity, gas/molecules, heat, CO_2), conversions (e.g., P-to-X) and as such new types of flexibility providers, …
- Consumer-centric systems, increasing levels of distributed energy resources (DERs)
  - Incentive schemes, behavioral aspects, local markets, …
- ‘Optimal’ system transitions and corresponding markets and policies
  - Markets design (EU, local), (overlapping) policy instruments, …
- Model consolidation, transparency, reproducibility, data access
  - E.g., Energy Modelling Platform for Europe (EMP-E), EERA JP on Energy Systems Integration, …
- Data-driven approaches and computational efforts
  - Leveraging available data, solving problems at scale (European system, full year,..), considering uncertainty, …

Battery storage in short-term balancing markets

- Stacking revenue streams:
  day-ahead energy-reserve capacity markets & real-time balancing markets

- Participanting in these markets with battery storage: multitude of risks & challenges, amplified by energy-constrained nature of storage:

  - Financial risk: uncertainty on market outcome & revenue
  - Technical risk: mismatch between model – real-life technical limits battery system

K. Pandzic, K. Bruninx and H. Pandzic, "Managing Risks Faced by Strategic Battery Storage in Joint Energy-Reserve Markets," in *IEEE Transactions on Power Systems, 2021.*

  - Risk of unavailability of the offered reserve capacity in real-time

J. -F. Toubeau, J. Bottieau, Z. De Greve, F. Vallee and K. Bruninx, "Data-Driven Scheduling of Energy Storage in Day-Ahead Energy and Reserve Markets with Probabilistic Guarantees on Real-Time Delivery," in *IEEE Transactions on Power Systems, 2020.*

- Requires state-of-the-art quantitative tools, managing the risks without overly conservative strategies

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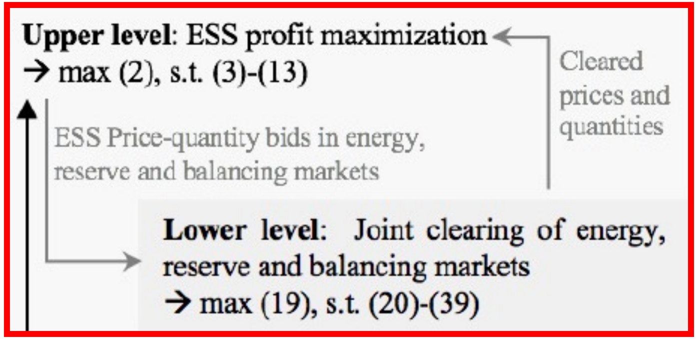
The problem at hand: risk of availability of reserve capacity in real-time

- Day-ahead decision problem: bid strategy for energy & reserve capacity markets, anticipating activation in real-time balancing markets vs. physical limits storage system
- Dedicated bid products for day-ahead energy market (e.g., only accept discharge bid if charge bid was accepted)
- Reserve capacity needs to be continosusly available during contracting period
- Example: assume you offer 1 MW of reserve capacity for the 24 hours of the next day
  - If you want to be sure that you're available when called upon, you need to have 24 MWh stored at the start of the day of delivery – *worst-case* approach, too conservative?
  - If have less energy stored at the start of the day, there is a possibility that you're unavailable when called – too risky?

- Challenge:

  Maximize the profit in energy-reserve capacity-balancing markets of the ESS owner, while keeping the risk of unavailability in real-time balancing markets in check.

The model: 3 key ingredients



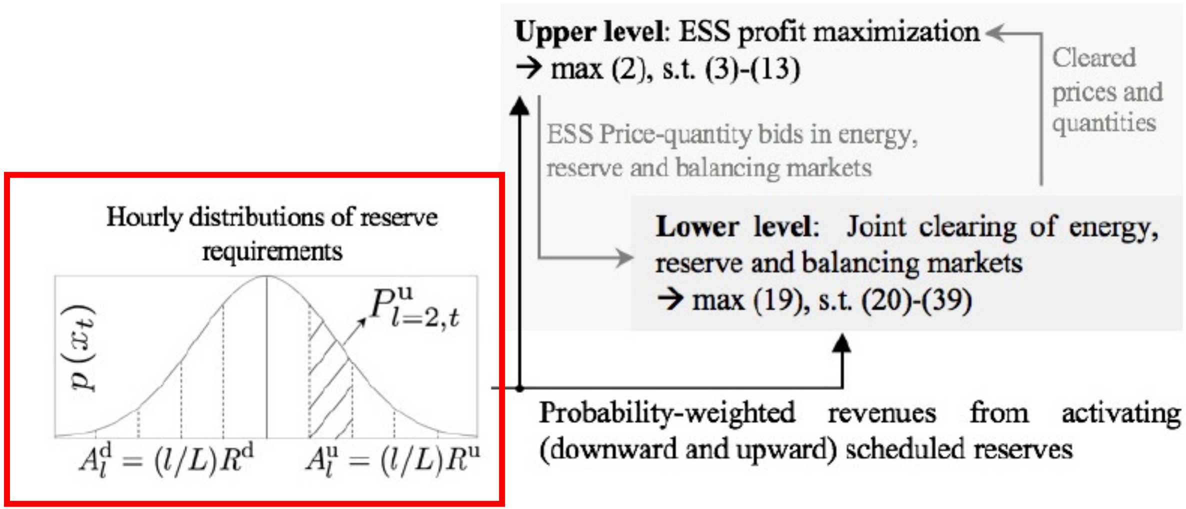
Upper level:

- Maximize profit
- Technical constraints
- Offered capacity on different markets

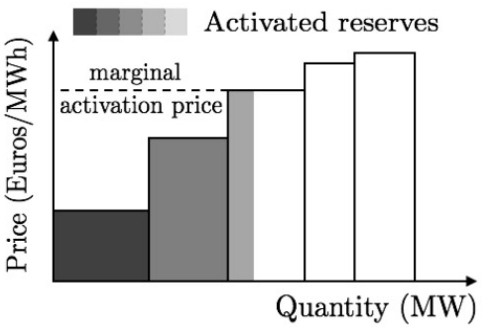
Lower level:

- Clearing of considered markets
- Cleared quantities & prices

The model: 3 key ingredients



- Empirical distributions of reserve activation
- Discretized in "*levels*" & embedded in market clearing to reflect "*merit-order based reserve activation*"
- To calculate expected profit



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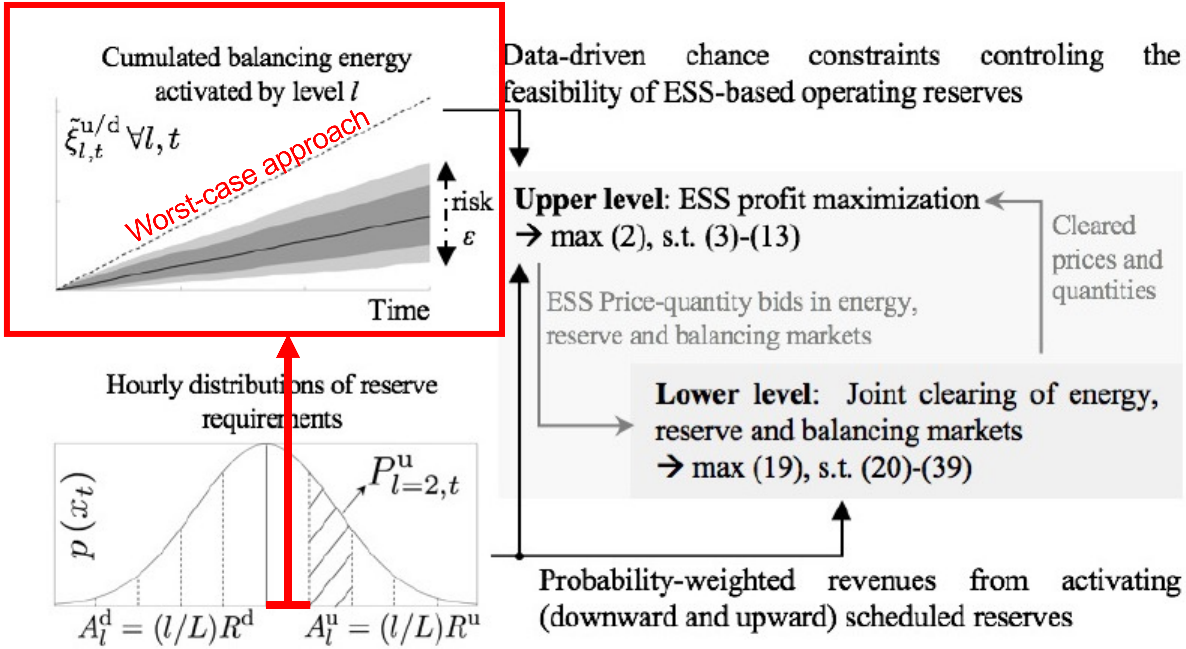
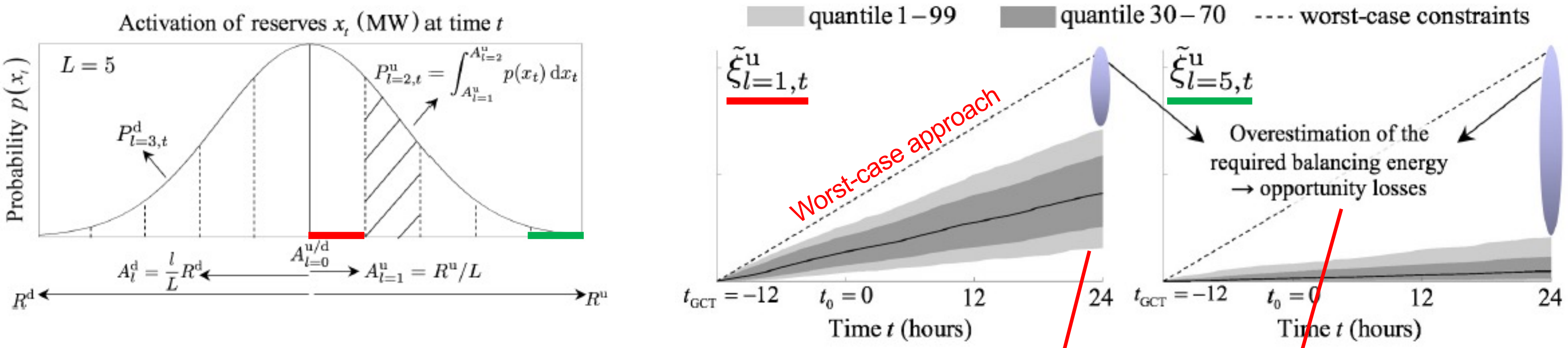


For each level:

- Empirical distribution of cumulative balancing energy
- How much energy we should store to offer reserve capacity in a “reserve level” *l*
- Allows enforcing probabilistic guarantees on real-time availability (see next slide)

Probabilistic guarantees on real-time availability

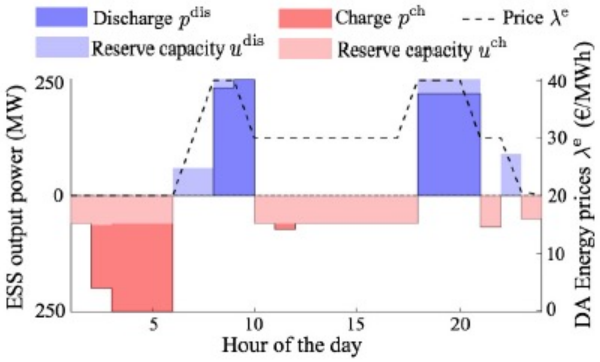


- Assume you offer 1 MW of reserve capacity for the 24 hours of the next day
  - If you want to be sure that you're available when called upon, you do not need 24 MWh stored at the start of the day of delivery
  - If have less energy stored at the start of the day, there is a possibility that you're unavailable when called, but you can control the probability with which this happens.

Illustration

- Power system inspired on Belgian system, focus on secondary reserves (aFRR, 150 MW up/down)
- One day, strategy evaluated on 365 measured reserve activation profiles with 1’ resolution (2018)
- 250 MW – 1200 MWh storage system

- Data-driven approach vs. worst-case: +9% in expected profit, 99.7% real-time availability
- If lower real-time availability is allowed, an optimal risk-attitude may exist, depending on the penalties for non-delivery or cost of alternative resources
- Strategy with 10% unavailability in real time increases expected profit by 10 pp.



	Expected reliability (%)	Ex-post reliability (%)	Ex-post mean profit (k€)
Worst-case	100	100	26.3
Ref, $\epsilon = 0$	100	99.7	28.7
Ref, $\epsilon = 0.05$	95	94.3	30.8
Ref, $\epsilon = 0.1$	90	92.7	31.3
Ref, $\epsilon = 0.2$	80	83.7	30.3

Conclusion

- Quantitative models may be powerful tools to support energy systems in transition
- No single tool fits all purposes
- Many challenges remain: solving problems with high sectoral-temporal-spatial-technical-uncertainty granularity, model validation/transparency,…

- Example: Quantitative tool to support participation battery storage in balancing markets
- Data-driven optimization framework allows extracting more value from asset, benefiting storage system owner and society as a whole.

Thank you for your attention!

Energy Systems Integration & Modeling (ESIM) Research Group

https://www.mech.kuleuven.be/en/tme/research/energy-systems-integration-modeling

Follow us on Linked-in: https://www.linkedin.com/company/esimrg

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FLEXCITY by VEOLIA

The role of aggregators in balancing the grid

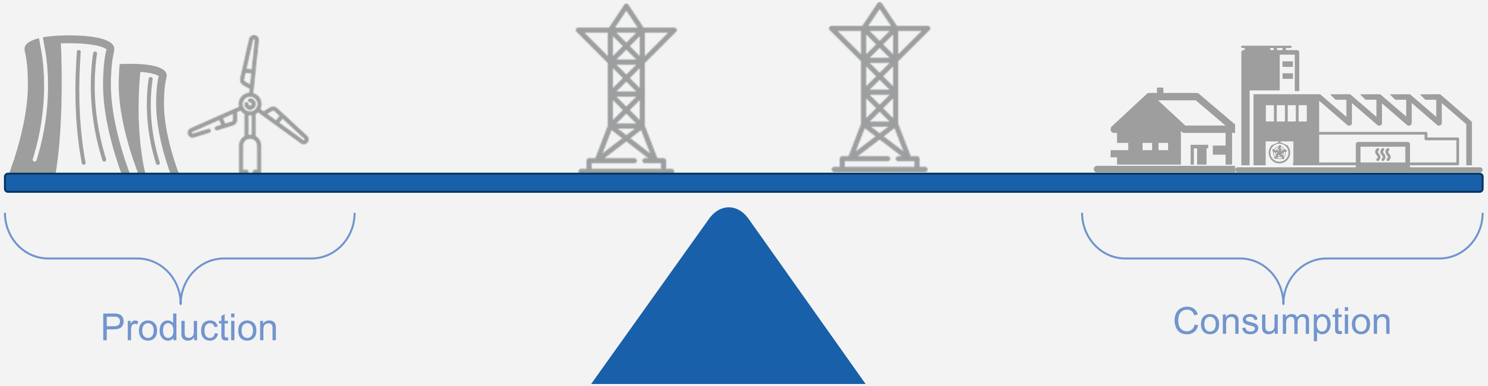
Lien Van Schepdael

10th of june 2021

operated by VEOLIA

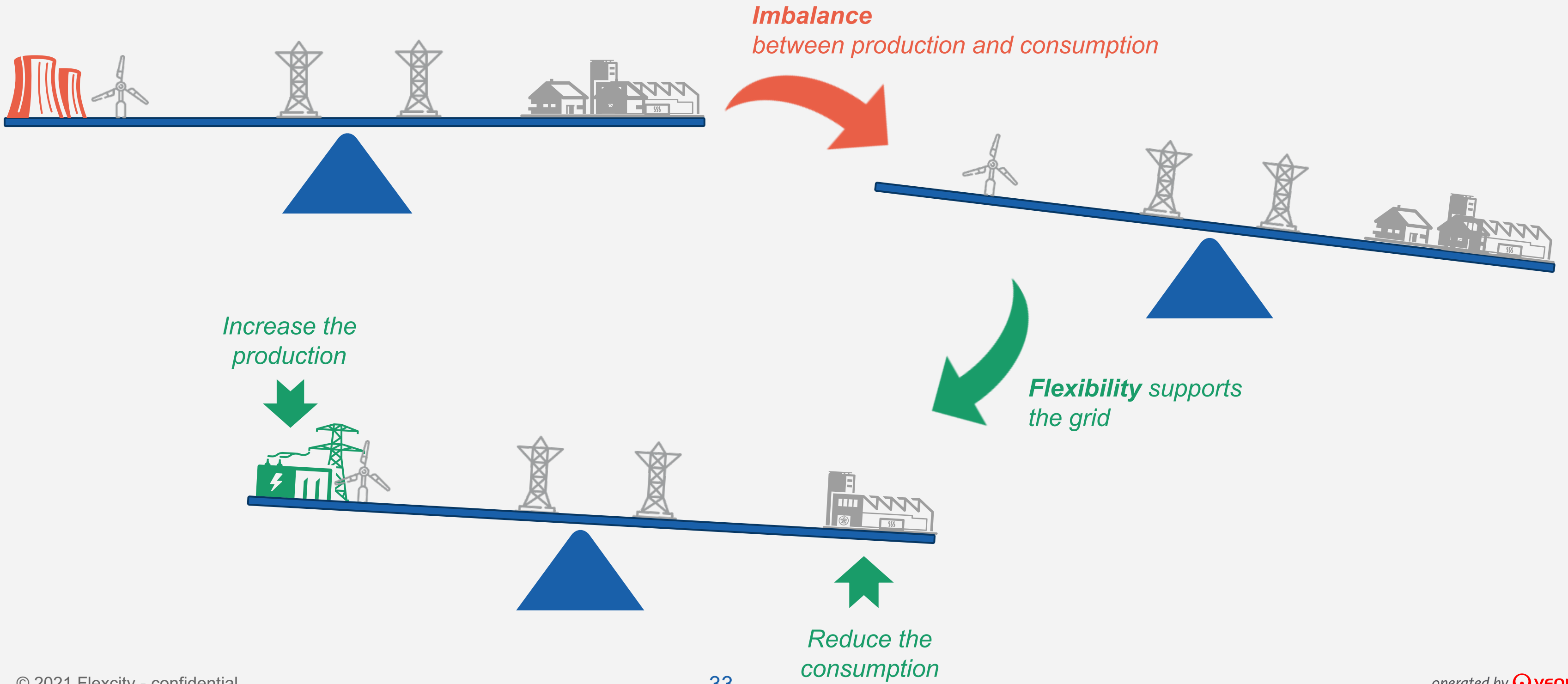
The electricity grid must always be balanced

In order to keep the lights on...



Imbalances can happen

… and require balancing via flexibility



You are remunerated to help balancing the grid

By being available at the right moment

Be Flexible at the right moment

€

Flexcity's impact

A European leader

> 1 GW

Our flexible power - a virtual nuclear plant

> 10 000 sites

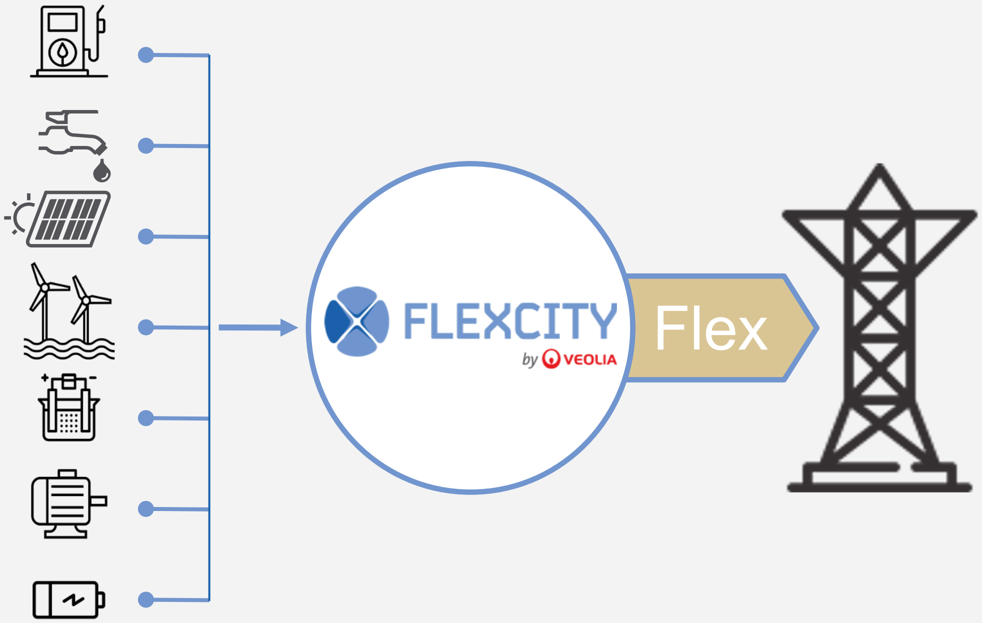
From 2 kW to 120 MW

An European actor

Belgium, Spain, France, Italy, Netherlands, Czechia

Flexcity enables industrial assets to support the grid

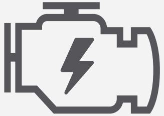
With minimal to no impact on their core activities



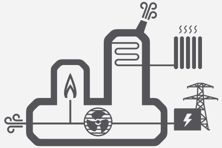
1. Energy transition
2. Supplementary remunerations
3. Grid support

Assets in our portfolio

Flexibility can be found everywhere!



Generator set



CHP

Cold storage

Electrolysis

Pumps

Batteries

Renewables

Furnace

...

Flexibility services in Belgium

Overview

Opening end 2020!

FCR

aFRR

mFRR

CRM

Balancing

Free Bids

Flexibility services in Belgium

Overview

Opening end 2020!

FCR

aFRR

mFRR

Role of the aggregator?

CRM

Balancing

Free Bids

Participating in grid support services

The role of the aggregator

1

Provide the technology

2

Optimal valorisation

Provide the technology

Identifying Flexibility

Communication with Elia platform

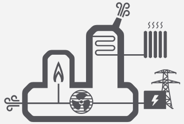
Hardware and technology delivery

Daily **valorisation**

Identifying Flexibility

Quantifying characteristics of core business

Genset



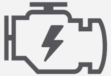
CHP

Renewable

Arc furnace

Electrolysis

Cooling



Pumps and compressors

Batteries

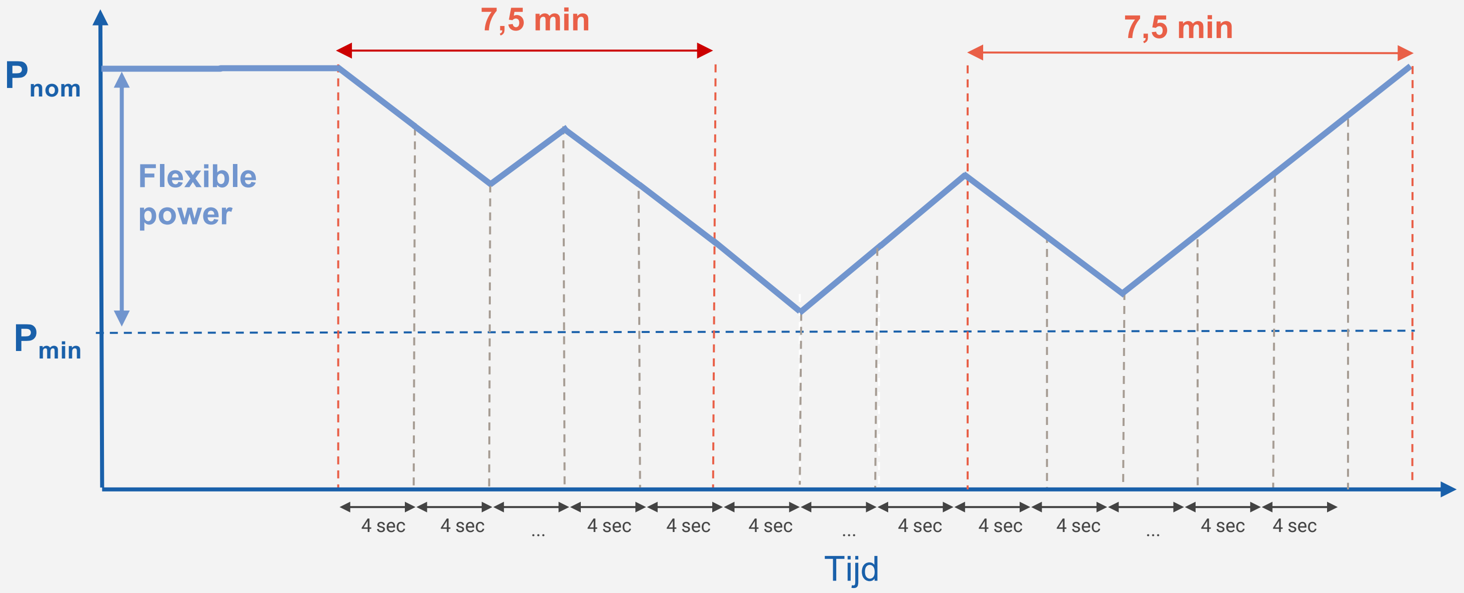
What is the **Flexible power**?

- Which asset?
- Exploitation profile
- Seasonal variations?
- Maintenances?

Identifying Flexibility

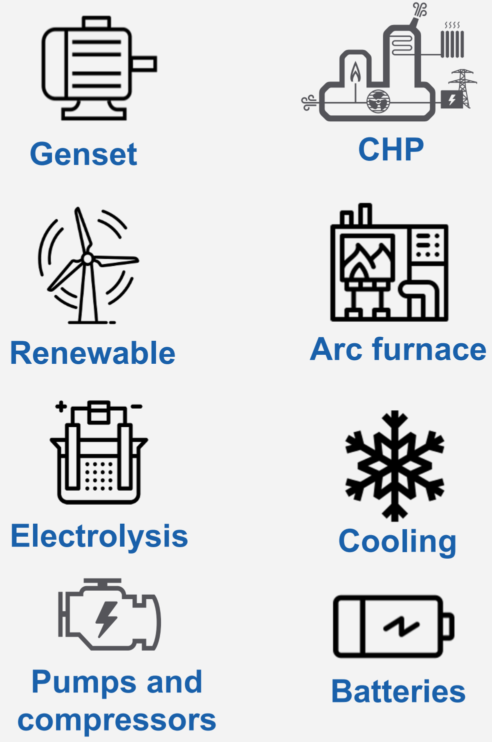
Quantifying characteristics of core business

Which
Flexibility service
fits best?



Identificeren van Flexibiliteit

Quantifying characteristics of core business

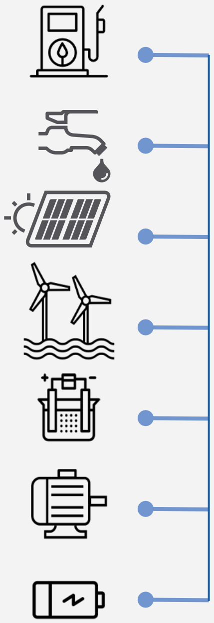


- Maintenance cost ?
- Green certificates?
- CHP Certificates?
- Backup boiler etc present?
- ...

What is the **value** of the flexibility

Communication with Elia platform

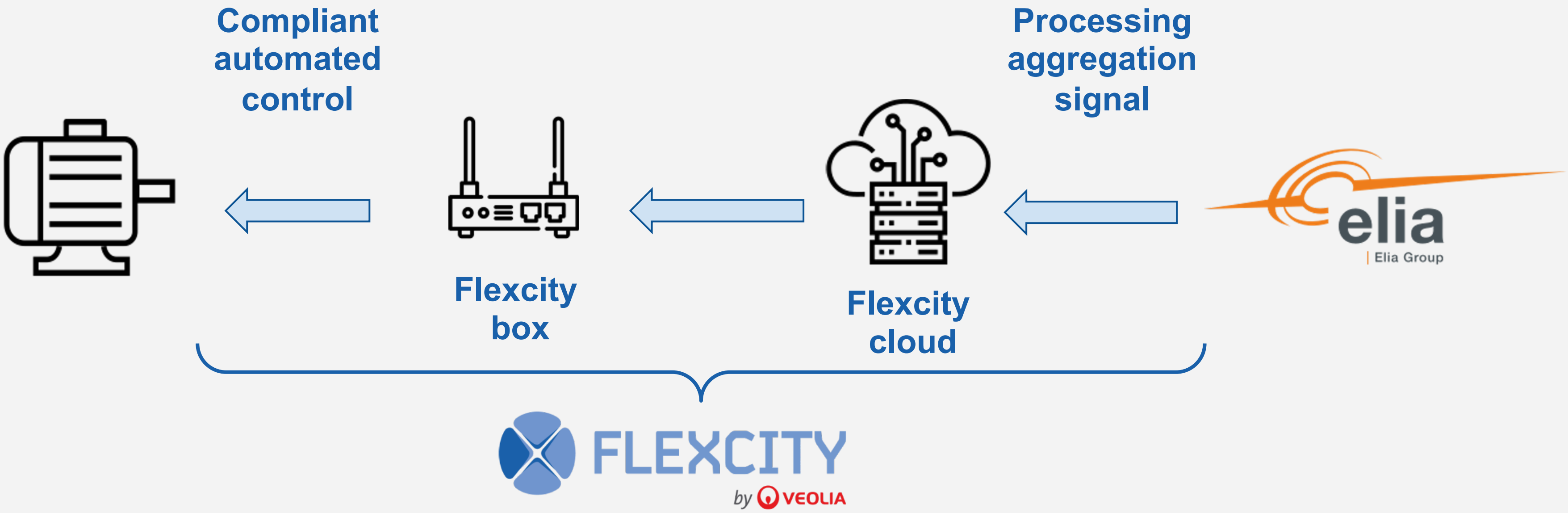
Aggregators are the interface between Elia and the flexibility providers



1. Expertise
2. Technology

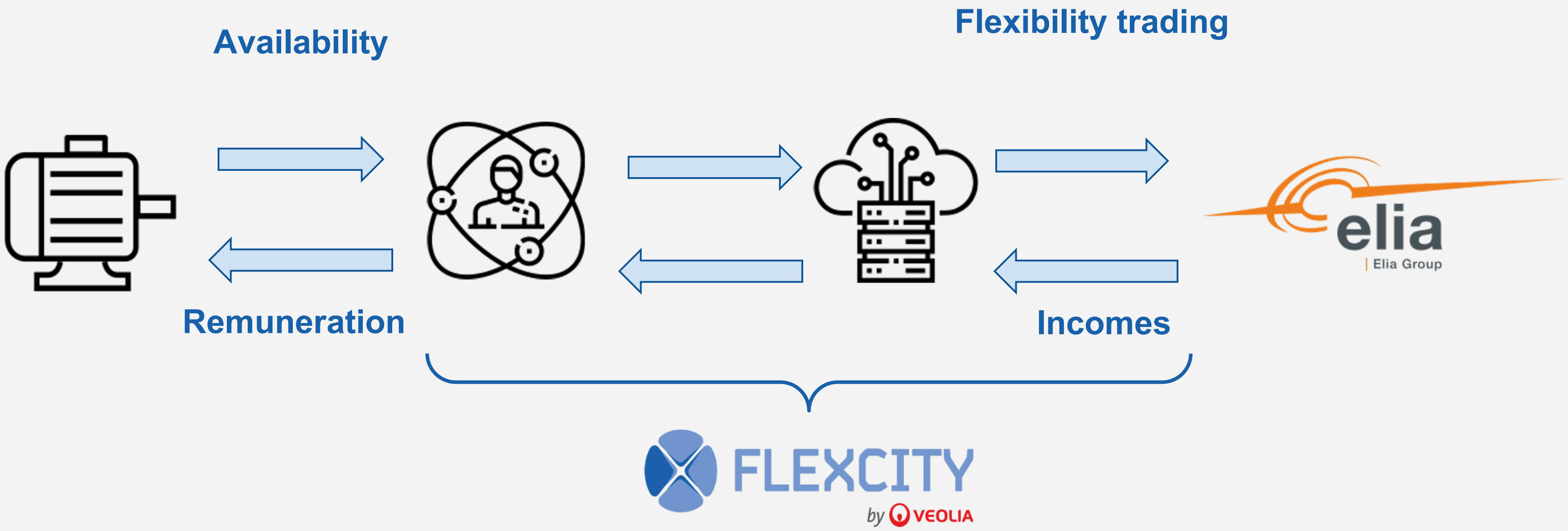
Hardware and technology delivery

Flexcity’s technology enables participation



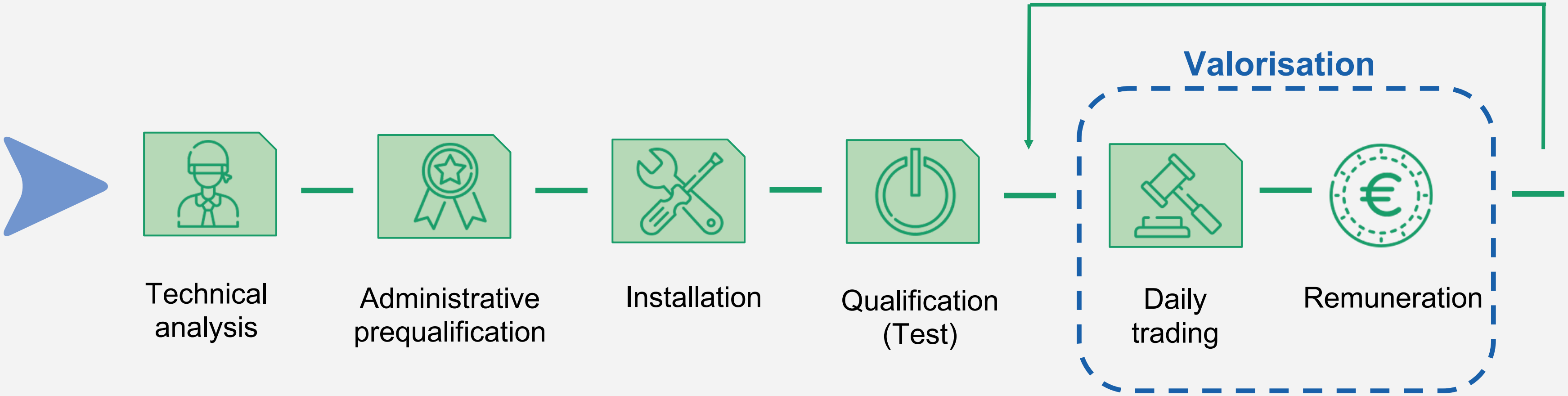
Daily valorisation

Flexcity trading optimises incomes



The role of the aggregator

Engages in the full process for you



Optimal valorisation

Market expertise for best <u>operational</u> and <u>financial</u> results

Managing **unavailabilities**

Pooling of Flexibility

Optimising flexibility: short and long term

Market expertise for best operational and financial results

Daily trading Flexcity

Two types of remuneration

Remuneration for AVAILABILITY

Fixed (€/MW/h)

Market defined

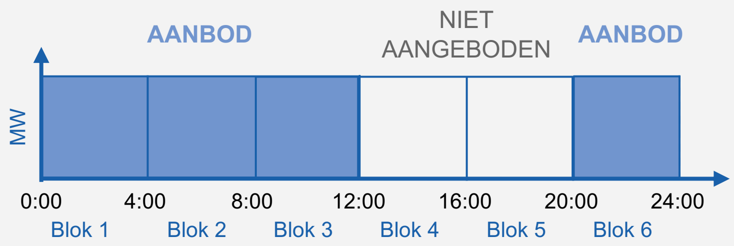
Daily bidding

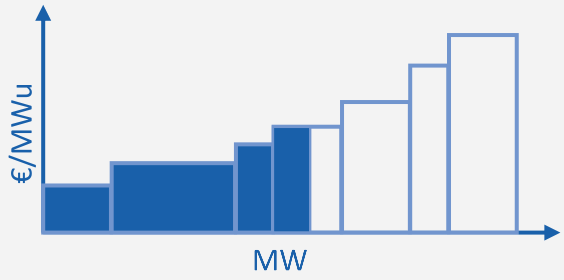
Remuneration for ACTIVATION

Variable (€/MWh)

Defined by flexibility provider

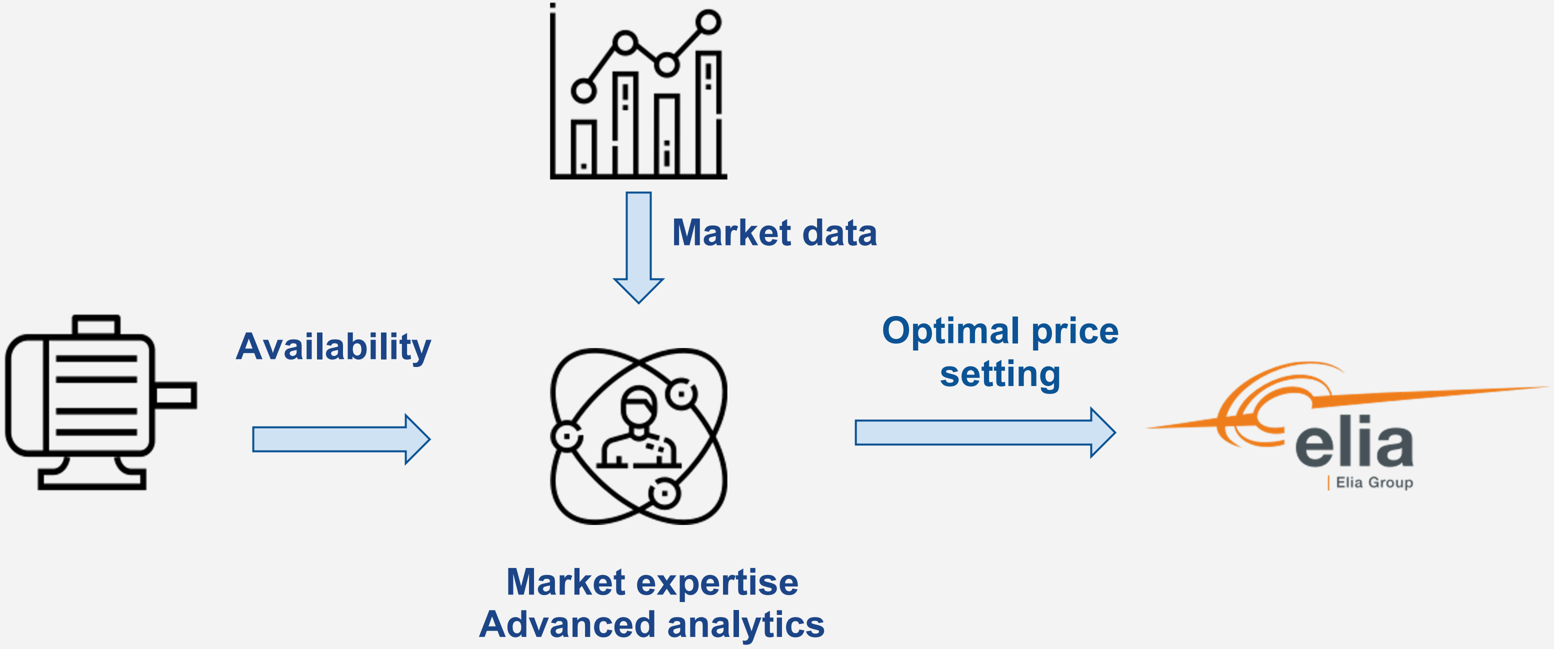
Defines duration and frequency of activations





Market expertise for best operational and financial results

Daily trading Flexcity

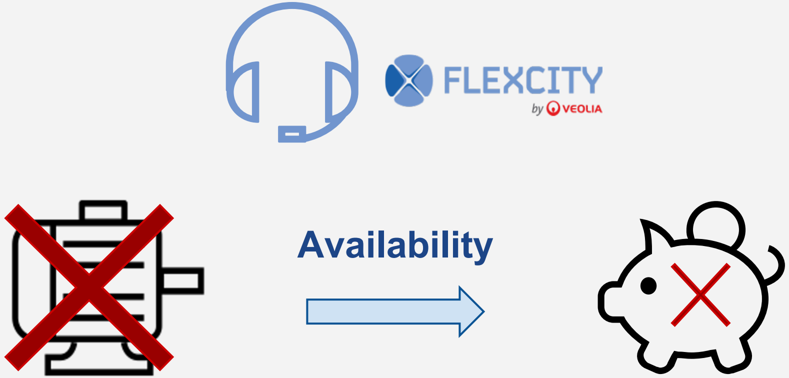


Managing unavailabilities

To minimise the risk of failed activations

Managing unavailabilities

To minimise the risk of failed activations



Managing unavailabilities

To minimise the risk of failed activations

Pooling of Flexibility

By combining complementary assets, more value can be obtained

1 + 1 = 3

- Combining assets for **more value**
- **Access to market** for **small assets**

Optimising flexibility: short and long term

Flexcity asesses continuously which (future) service captures value

Valorisation services	Subsidies
R1/FCR	CRM
R2/aFRR	
R3/mFRR	
Imbalance Optimisation	
Free bids	

FLEXCITY
by VEOLIA

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BALANCING: A PAN-EUROPEAN VISION ON FLEXIBILITY

Gonzalo Morollón Castro
Sustainable Power Grid Manager at ENTSO-E

Royal Belgian Society for Electricians

10 June 2021

entsoe
Reliable Sustainable Connected

1 What are flexibility services

2 Platform and functionalities

3 Flexibility marketplaces projects

EU Sysflex: Pan-European system with an efficient coordinated use of flexibilities for the integration of a large share of RES

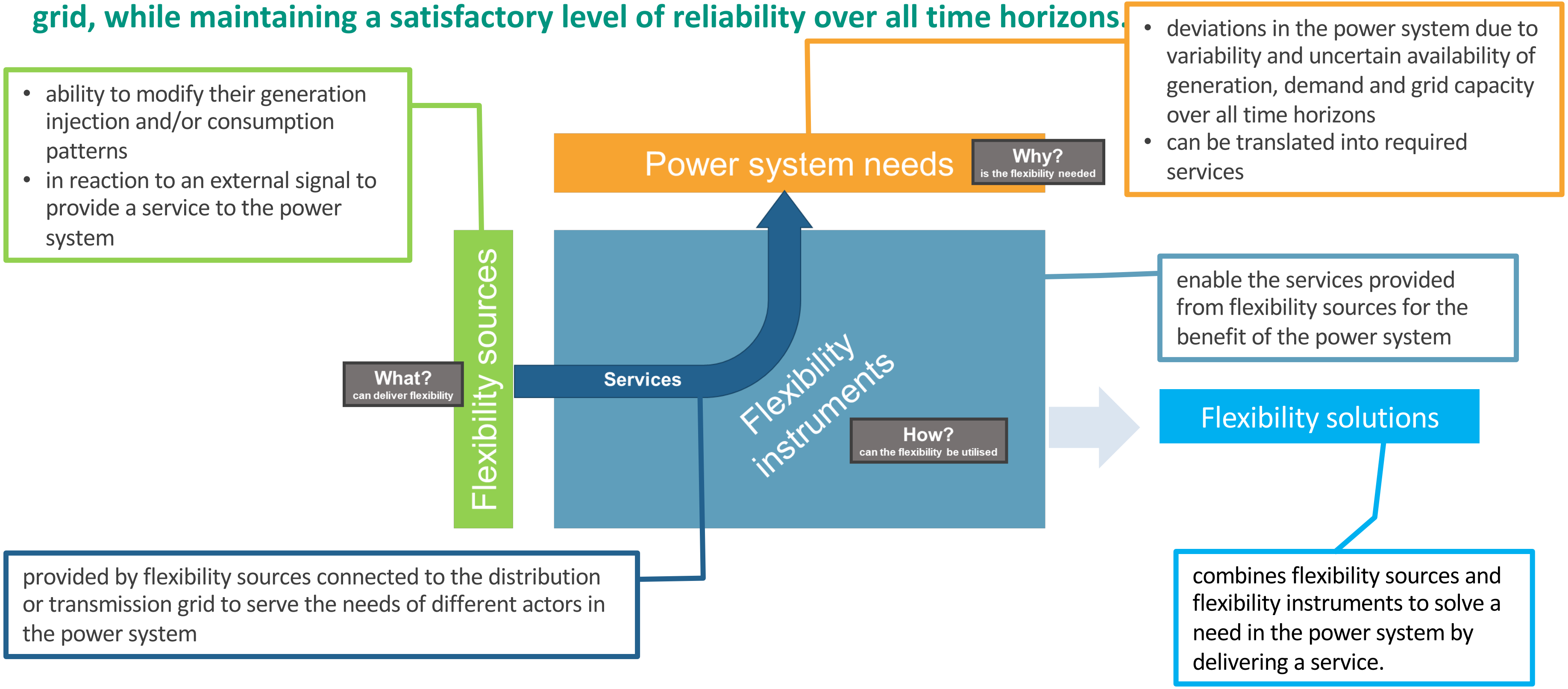
OSMOSE: Optimal System-Mix Of flexibility Solutions for European electricity

Flex Plan: Innovative grid planning methodology considering the opportunity to introduce new storage and flexibility elements in transmission and distribution electricity grids as an alternative to building new lines

Flexitranstore: An Integrated Platform for Incresed FLEXIbility in smart TRANSmission grids with STORage Entities and large penetration of Renewable Energy Sources

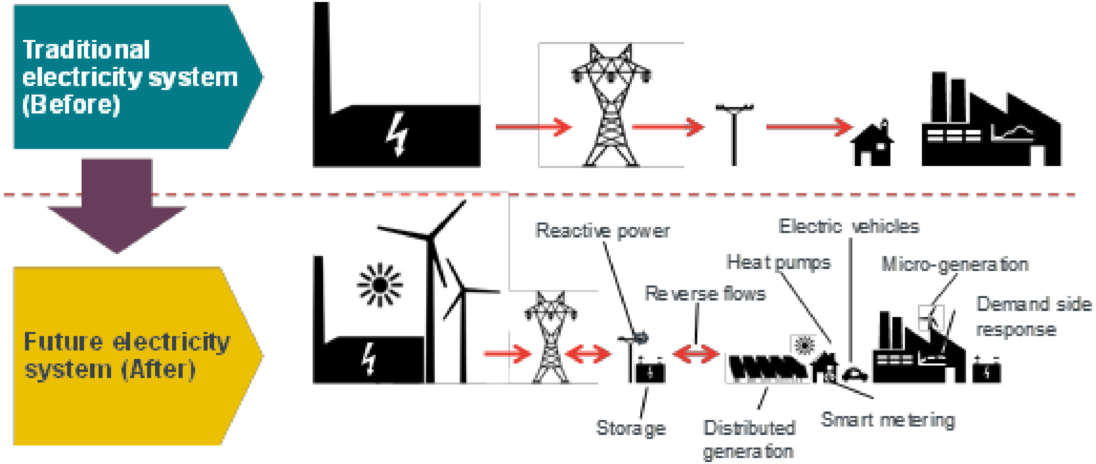
General framework for power system flexibility

Flexibility can be defined as the ability to cope with variability and uncertainty in demand, generation and grid, while maintaining a satisfactory level of reliability over all time horizons.



Evolving flexibility providers over the entire value chain

Flexibility can be defined as the ability to cope with variability and uncertainty in demand, generation and grid, while maintaining a satisfactory level of reliability over all time horizons.



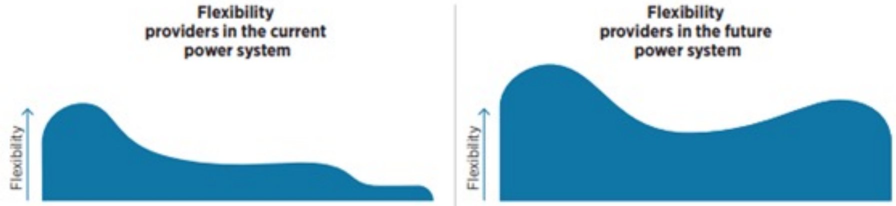
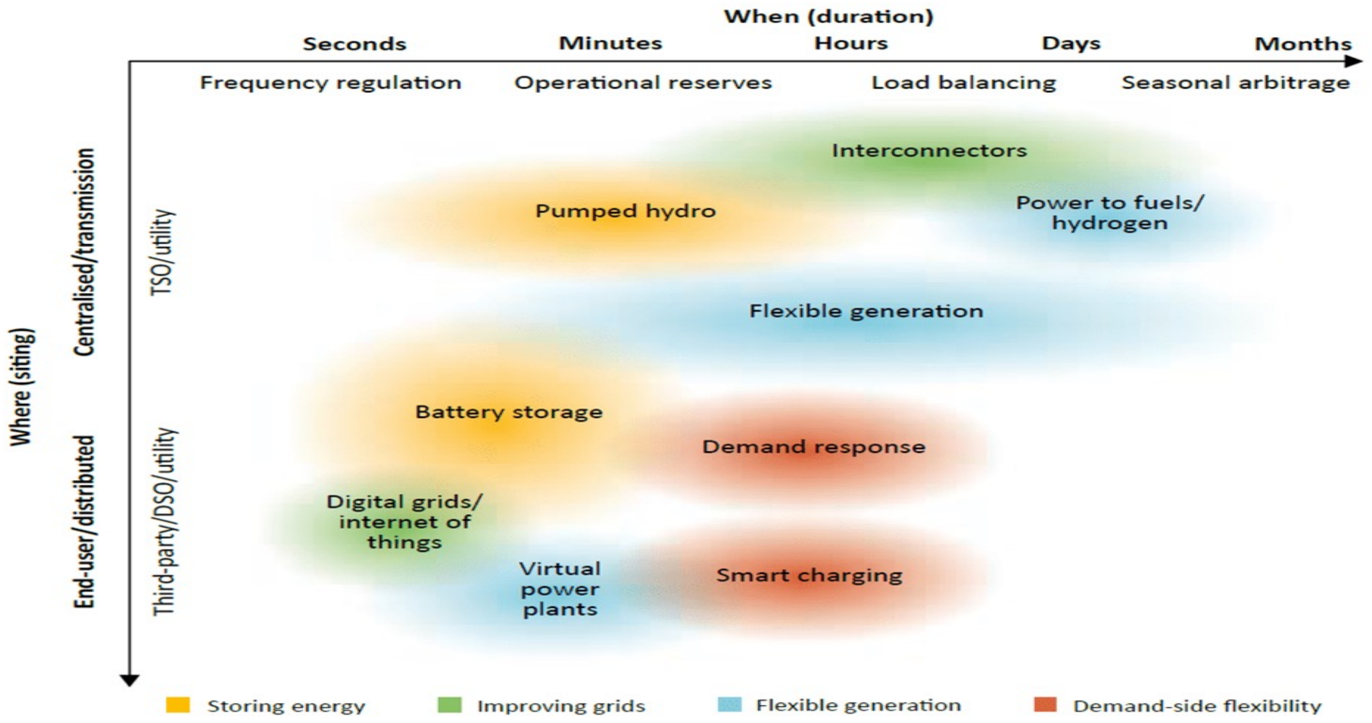


Figure 2 New flexibility options across the power sector unlocked by innovation

Source: IRENA report on innovation and renewables (2019)

Evolving flexibility providers over the entire value chain



Expansion of electrification, distributed generation and variable renewables will broaden the need and range of flexibility options

Source: IRENA report on innovation and renewables (2019)

Platform and functionalities

Category of platforms

Category of platform	Functionalities / definition	Services provided[1]
Aggregators (commercial)	Combines multiple customer loads or generated electricity for sale, purchase or auction in any electricity market	This includes dedicated independent aggregators, entities that perform an aggregation function alongside other services such as energy supply
Flexibility Market Places (commercial/regulated)	Facilitates or coordinates the trade, dispatch and/or settlement of energy or ancillary services Two categories: platform operator (be it TSO, DSO or both) and procurer (be it network/SO, buyer of energy)	This includes platforms that are self-contained marketplaces as well as platforms that act as an intermediary between market participants and existing ancillary services or wholesale markets
Data Exchange (commercial/regulated)	Considers the system architecture, or set of protocols, that facilitates the exchange of information between operationally distinct entities across the energy supply chain, but that does not by itself support market-based procurement or administrative dispatch of energy or ancillary services requirements	Three types of data they exchange, i.e., grid, market or meter data

Platform and functionalities (2/2)

Data exchange platforms

Grid data

- EDSN
- Open Networks Project
- SII (Italy)
- TDX ASSIST
- TSO-DSO communication platform (IO.E)
- TSO-DSO Flexhub

Market data

- Atrias
- ECCo SP
- Elhub (from Statnett)
- CROSSBOW: Wide Area Monitoring Awareness System

Meter data

- DataHub from Fingrid
- Energinet DataHub
- EDA Flex
- EDSN
- Elhub (from Statnett)
- Estfeed
- MRSO
- SIMEL

Flexibility platforms

Network operator

Network procurer

- ARGE FNB – 50Hertz
- bne Flexmarkt
- Baltic CoBa
- Coordinet
- CROSSBOW: Regional DSM Integration platform, wholesale, and ancillary market toolset
- DA/RE
- Dynamo Flexmarkt in Nijmegen-Noord
- EUniversal (German demo)
- EUniversal (Polish demo)
- EUniversal (Portuguese demo)
- FUSION
- GOPACS
- IGCC: imbalance netting project
- MARI
- NEBEF (Block Exchange Notification of Demand Response)
- Parity
- Participation of distributed flexibilities in the balancing market (RED Electrica)
- PICASSO
- Platone
- ReFlex (Enedis)
- TERRE
- X-flex

Concluded projects:

- InterFlex: Dutch pilot
- InterFlex: French pilot
- InterFlex: Swedish pilot
- Flexibility resource participation to Ancillary Services (Terna)
- FutureFlow
- OSMOSE: WP2, WP6
- Power Potential (TDI 2.0)
- SINTEG C/sells
- SINTEG C/sells: Comax
- SINTEG C/sells: ReFLEX Dillenburg

Independent operator

Any procurer

- pebbles
- FEVER: German pilot

Concluded projects:

- Cornwall Local Energy Market
- Enera (from SINTEG)

Network procurer

- NorFlex (NODES)
- IntraFlex (NODES)
- Sthlmflex (NODES)
- PicloFlex
- INTERRFACE (IEGSA)
- FLEXITRANSTORE: Wholesale and Clearing Market
- Orsted – Renewable Balancing Reserve
- Orsted – Market Price Optimisation
- Equigy
- Flexity
- eBalance Plus
- Merlon

Concluded projects

- Project TraDER (Orkney)
- SINTEG C/sells: Altdorfer Flexmarkt (ALF)
- SINTEG DESIGNETZ
- SINTEG New 4.0: ENKO
- SINTEG WindNODE: Flexibilitätsplattform

Aggregators

- Agregio
- AutoGrid
- Crowd Charge
- e2m
- Entelios
- ev.energy
- Innowatio
- Jedlix (VGI)
- Kaluza
- Limejump
- Newmotion
- Next Kraftewerke
- NextFlex (ENGIE)
- NUVVE
- Open Energi
- Powerhouse
- Resilience Energy
- REstore
- Sonnen
- Upside Energy
- Urban Chain
- Voltalis
- Yuso

Regulated domain ⟷ Commercial domain

Preliminary challenges of the platforms

Challenges to DER integration

- Prequalification requirements and DER participation in existing energy and ancillary services market
- High entry and transaction costs (operating a data centre, or requirements for dispatch validation) in order to participate in energy and ancillary services markets by DERs
- Limited observability and controllability of both generation and demand connected at the distribution level

Challenges to coordination

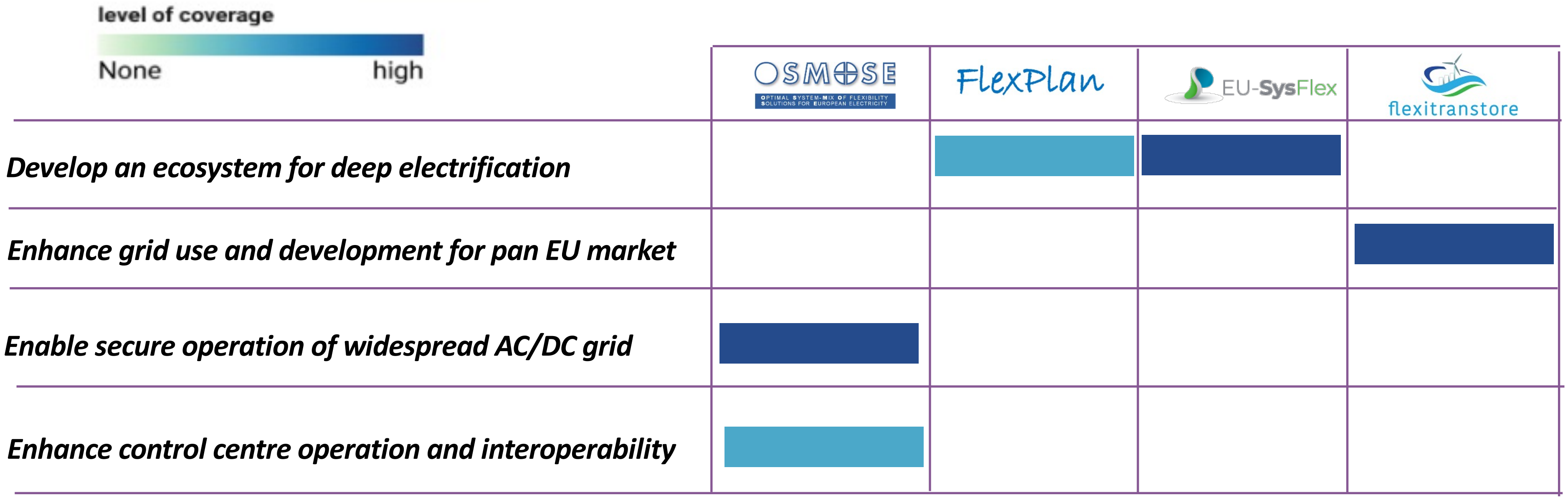
- Information sharing of distribution constraints in grid security analysis and relevant DERs for grid services
- TSOs as the first-mover advantage vs DSO in procuring of flexibility services

Challenge to market design

- Variation in the scope of platform services outsource vs taken up by SOs
- No harmonisation of products for congestion management purposes in the EU
- Possibility for strategic gaming behaviour by FSPs: generation schedules of plants are first increased in the wholesale market and then reduced on the flexibility market

Flexibility marketplaces projects

Overview of H2020 towards roadmap flagships



Scope of the project (From 2017 to 2021)

flexitranstore

Develop and demonstrate a comprehensive platform of tools and metrics for establishing **grid flexibility**.

- Using novel power flow controllers and Dynamic Line Rating (DLR) methods to increase flexibility in the transmission grid
- Developing and implementing novel demand-response mechanisms, thus creating new market actors and opportunities to increase flexibility in the distribution grid
- Testing novel Power System Stabilizers, to increase flexibility of conventional generators.
- Development of an integrated market platform, based on an enhanced EUPHEMIA market model, to increase flexibility within the wholesale electricity markets.

Objectives

Across the Energy Industry Value Chain:
Integrating Battery Energy Storage Systems (BESS) at different grid connection points: TSO/DSO border substations and Wind Farms and synchronous Gas Turbine Plants

In the transmission grid:
Power Flow Controllers for the first time in the SEE region, Dynamic Line Rating (DLR) sensors and algorithms, efficient controllers for active substations at the TSO/DSO border and Wind Power Plant (WPP) connections to High Voltage networks

In the distribution grid:
Enhancing demand-response mechanisms using the TSO/DSO controller

At conventional generators:
Installation of Power System Stabilizers (PSS), development of a representative grid model at plant level

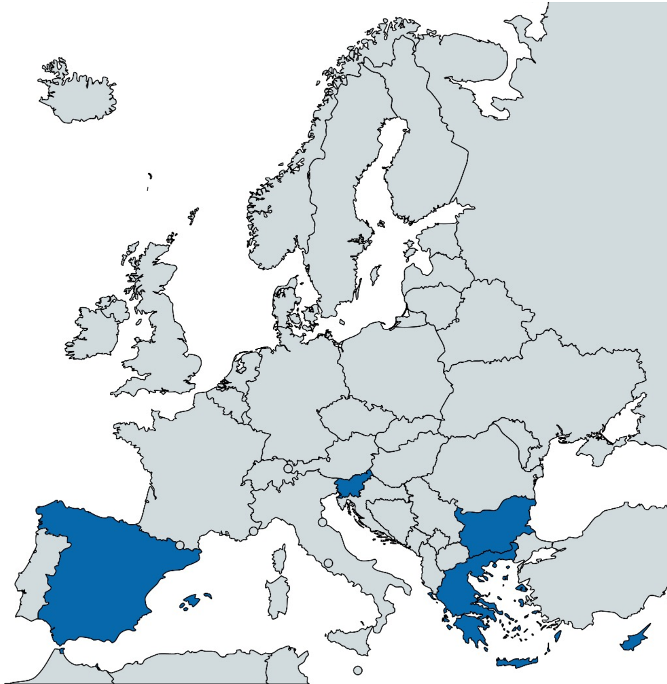
Within the wholesale electricity markets:
Integrated market platform based on an enhanced EUPHEMIA market model

Demonstrators

FLEXITRANSTORE will create 8 demonstrations in 6 countries.

The demonstrators are divided into three layers, according to their application point 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.



Power Flow Controller Installation Process in Greece

PHASE 1

- Installation of support structures (15 days)
- Preparation of overhead lines (2 day outage)

Image shows both support structures and Mobile Container

PHASE 2

- Preparation of Mobile Container (3½ days)
- Connection to grid (5½ hour outage)
- Establishment of communications (1 day)

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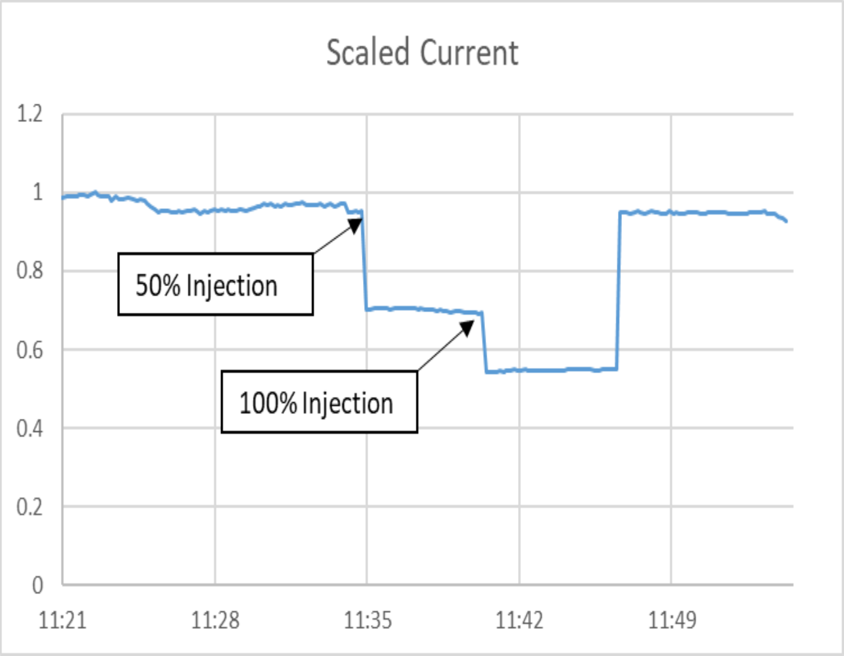
Power Flow Controller Installation in EHV Substation/Greece



Scope of the project (From 2017 to 2021)

The aim of the EU-SysFlex project has been to identify issues and solutions associated with integrating large-scale renewable energy and create a plan to provide practical assistance to power system operators across Europe. This requires defining the right amount of flexibility and system services to support transmission system operators (TSOs).

- Developing an IT perspective on data management in flexibility services and develops a customer-centric data exchange model for flexible market design

- Demonstration projects in seven European countries demonstrating new flexibility solutions, including centralized pump storage plants, batteries, wind and photovoltaics (PV), heat loads, electric vehicles (EV) and super-capacitors.

    - Portugal, Germany, Italy, Finland, France, Poland and Estonia.

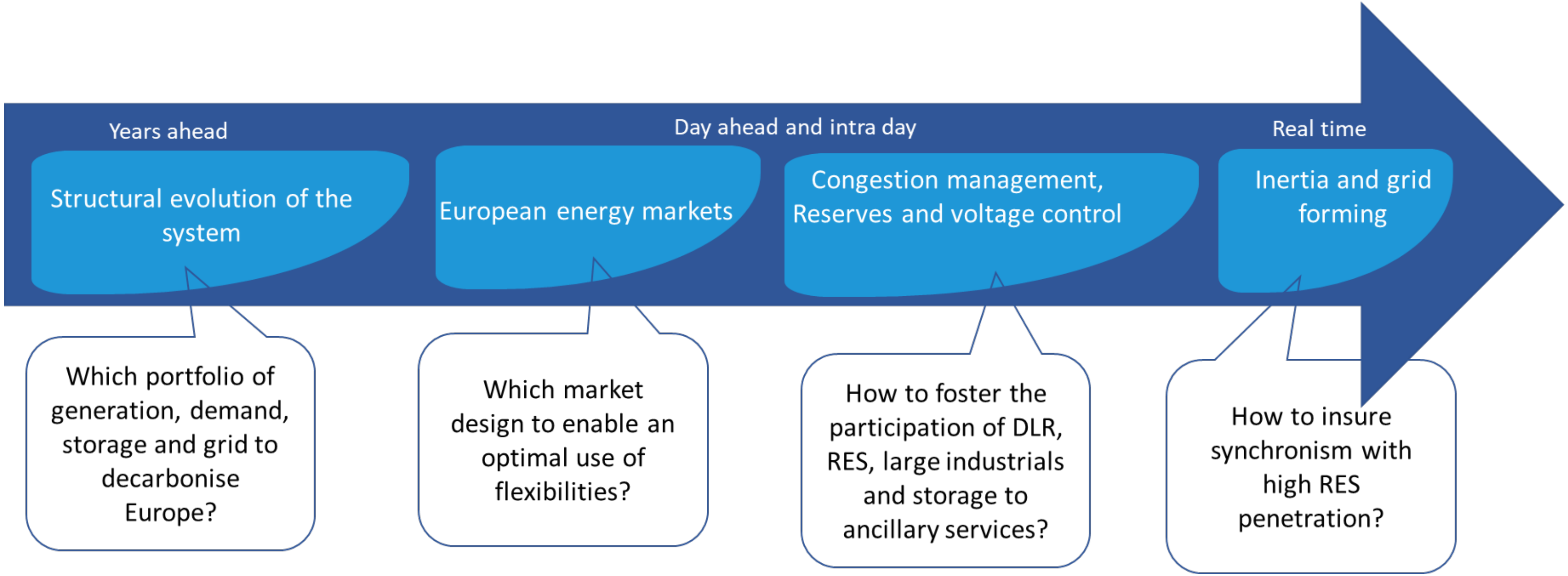
    - They provide evidence of how the timely provision of system services will be achieved using new approaches to coordinate the resources, actors and new technology mixes that will be present in the future European system.

Demonstration projects

Scope of the project (From 2018 – 2021)

OSMOSE
OPTIMAL SYSTEM-MIX OF FLEXIBILITY SOLUTIONS FOR EUROPEAN ELECTRICITY

The OSMOSE is composed by six TSOs, eleven Research partners and sixteen industry and market players (manufacturers, solution providers, producers, energy service companies capture synergies across needs for flexibilities and sources of flexibilities, such as providing multiple services from one source, or hybridising sources, thus resulting in a cost-efficient power system.



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Target and main workstreams

The OSMOSE has the following targets:

- Identify and develop flexibilities required to integrate a high share of renewables (RES) in the energy system.
- increasing the techno-economic potential of a wide range of flexibility solutions and covering several applications, i.e.: synchronisation of large power systems by multiservice hybrid storage;
- multiple services provided by grid devices, large demand-response and RES generation coordinated in a smart management system; cross-border sharing of flexibility sources through a near real-time cross-border energy market

The project carries out simulation-based studies which aim:

(i) to forecast the economically optimal mix of flexibility solutions in long-term energy scenarios (2030 and 2050) and

(ii) build recommendations for improvements of the existing market mechanisms and regulatory frameworks.

OSMOSE addresses interoperability and improved TSO/DSO interactions to ease the scaling up and replication of the flexibility solutions that will be demonstrated in the lifetime of the projects.

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Demonstration projects

OSMOSE
OPTIMAL SYSTEM-MIX OF FLEXIBILITY SOLUTIONS FOR EUROPEAN ELECTRICITY

Optimal mix of flexibilities

- ✓ Quantify the needs of flexibility in different long-term scenarios
- ✓ Define the best sources of flexibility in the scenarios
- ✓ Create advanced tools and methodologies to analyse flexibility

Market Designs and regulations

- ✓ Explore and propose some market-based solutions for the development of an optimal mix of flexibility sources in Europe
- ✓ Create advanced tools and methodologies for market design analysis

Near real-time cross border market

- ✓ Design a market which takes advantage of the flexibility near real-time
- ✓ Develop the software and platforms for bids creation, selection and activation
- ✓ Demonstrate the effectiveness and security of this market

Scaling up and replication

- ✓ Provide an optimization framework taking into account different time scales for voltage control on the DSO grid in coordination with the TSO
- ✓ Demonstrate the tool and its benefits in a demo in real-time simulation

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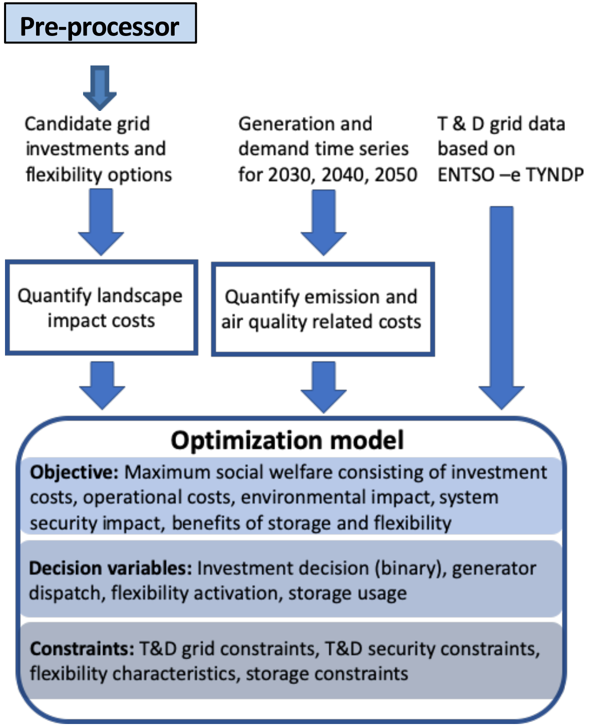
Scope of the project (From 2012 to 2019)

FlexPlan

1 – New planning methodology - Creation of a **new tool for optimizing T&D grid planning**, considering the **placement of flexibility elements** located both in transmission and distribution networks **as an alternative to traditional grid planning**: in particular, storage, PEV, demand response)

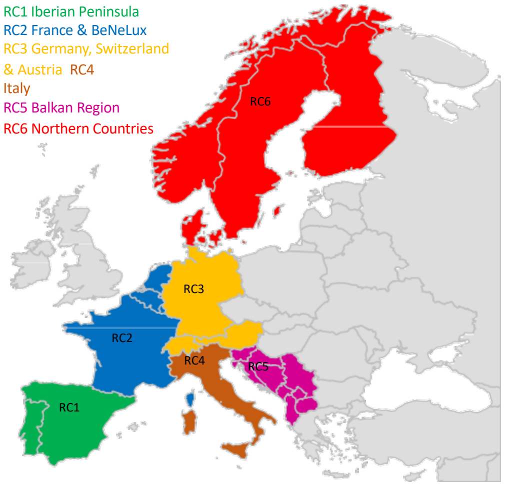


- Best planning strategy with a limited number of expansion options (mixed-integer, sequential OPF)
- T&D integrated planning
- Embedded environmental analysis (air quality, carbon footprint, landscape constraints)
- Simultaneous mid- and long-term planning calculation over three grid years: 2030-2040-2050
- Yearly climate variants (variability of RES time series and load time series) taken into account by a Monte Carlo process; the number of combinations reduced by using clustering-based scenario reduction techniques.
- Full incorporation of CBA criteria into the target Function
  Probabilistic elements (instead of N-1 security criterion)
- Numerical *ad hoc* decomposition techniques to reduce calculation efforts

Scope of the project (From 2012 to 2019)

2 – Scenario analysis 2030-40-50

New methodology applied to analyse **six regional grid planning scenarios at 2030-2040-2050.** A **pan-European scenario** will deliver border conditions to initialize in a coherent way the 6 regional cases.



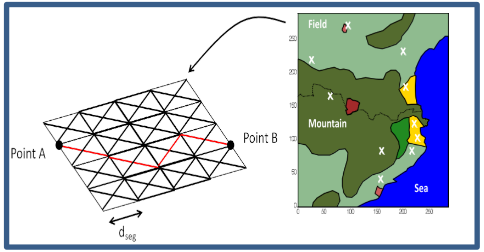
The main source for the scenarios considered in FlexPlan project is the Ten Year Network Development Plan (TYNDP) 2020, developed by ENTSO-E, which describes possible trends up to 2050. ENTSO-E's TYNDP describes three scenarios:

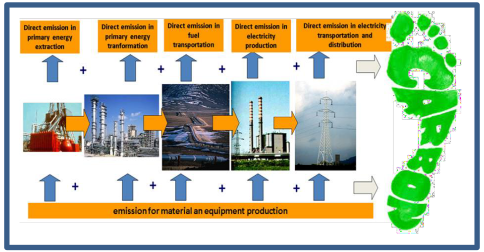
- National trends
- Distributed Energy
- Global Ambition

that added up over three grid years (2030, 2040, 2050) makes up 9 scenarios to be considered by FlexPlan. For 2050, the document "A Clean Planet for all" by the EC was also considered.

3 – Modelling of environmental factors

- Landscape impact modelling
- Air quality modelling
- Carbon footprint modelling





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Q&A

SRBE KBVE

Société Royale Belge des Electriciens — Koninklijke Belgische Vereniging der Elektrotechnici

Energy Communities

June 4th, 11th and 18th 2021

11 am - 1 pm

In collaboration with SIAPARTNERS

ENGIE Laborelec · SIEMENS energy · elia group · ABB HITACHI POWER GRIDS

SRBE KBVE

Thank you!