
Energy
Ville
Towards integrated and coordinated markets
A journey of challenges and opportunities
FLEXCON 2023
Helena Gerard
KU LEUVEN
vito
imec
UHASSELT

About EnergyVille

We help **system operators, regulators and market parties** in preparing **the grid for 2030** at the lowest possible cost.

KU LEUVEN

imec

vito

UHASSELT

Helping grid operaters with the integration of (D)RES via smart grids

Energy market design for the integration of residential and industrial flexibility, storage

Assisting in human capital development

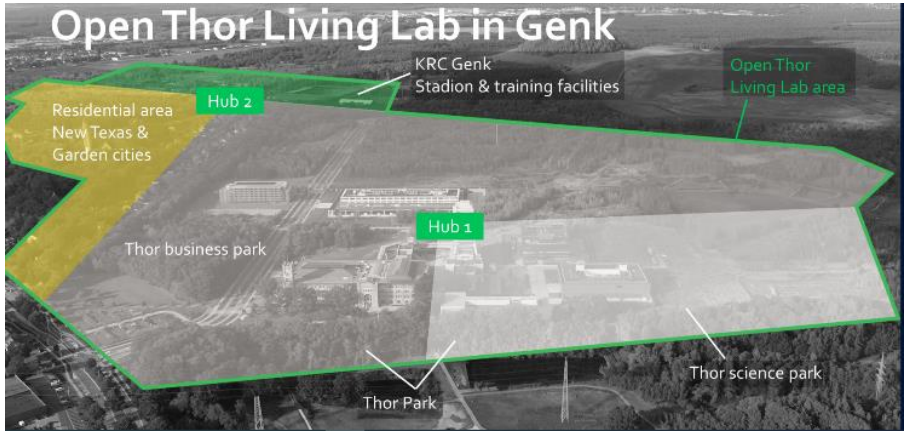
Enabling the participation of consumers in the energy transition via energy communities and innovative grid tariffs

406 colleagues

165 PhD

42 Nationalities

EnergyVille



Market Design - a corner stone of the energy transition

We help **system operators, regulators and market parties** in preparing **the system for 2030**

CONTEXT

THE CHALLENGE

Today's markets remain fragmented and business models are not fit-for-future

Integration is needed …

1. between energy and flexibility markets
2. between multiple services and products for TSOs and DSOs
3. multiple carriers and multiple sectors
4. explicit and implicit flexibility mechanisms
5. market constraints and physical grid constraints
6. of end consumers as active providers of flexibility services

INNOVATION

Market Concepts

Market algorithms

EnergyVille Simulation Environment

*Framework for market simulation, capturing **'real market actor behavior'**, allowing scaling-up of local demo results to assess system impact*

IMPACT

Robust future proof tooling

- Supporting **active system management**
- Focus on **market operators** and **system operators**

Policy advice

- EC, Regulators and policy makers
- Focus on **flexibility**, **implications** for **market design** and related **roles and responsibilities**
- Input for **Framework Guideline Demand Response, Digitalization of Energy Action Plan, Consultation Electricity Market Design**

The 2023 Challenge

The topic of flexibility is on the rise – supporting 2030 and 2050 goals

REPower EU

EUROPEAN COMMISSION

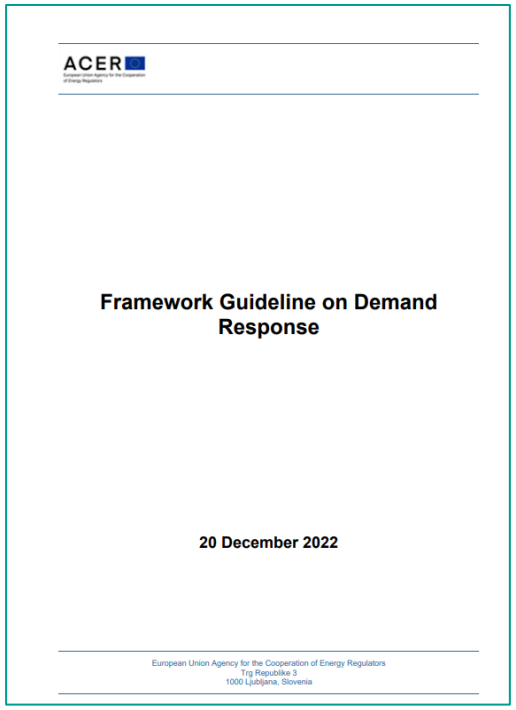
Brussels, 18.5.2022
COM(2022) 230 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE EUROPEAN COUNCIL, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

REPowerEU Plan

{SWD(2022) 230 final}

Framework Guideline Demand Response



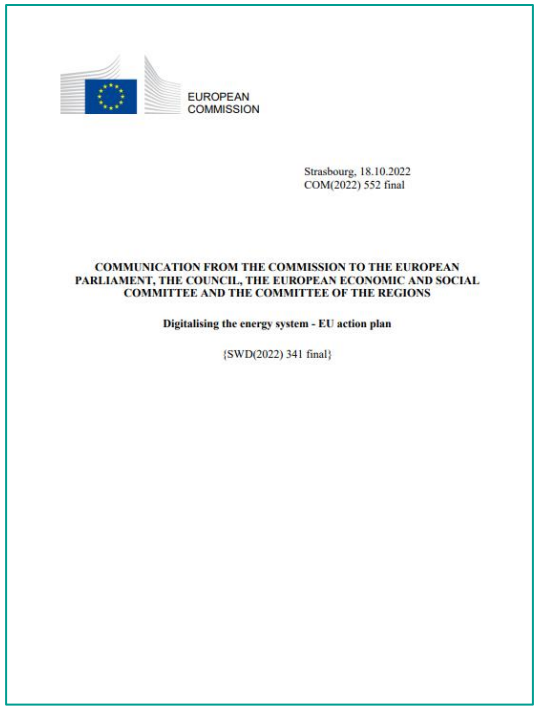
ACER

Framework Guideline on Demand Response

20 December 2022

European Union Agency for the Cooperation of Energy Regulators
Trg Republike 3
1000 Ljubljana, Slovenia

Digitalisation of Energy Action Plan



EUROPEAN COMMISSION

Strasbourg, 18.10.2022
COM(2022) 552 final

COMMUNICATION FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS

Digitalising the energy system - EU action plan

{SWD(2022) 341 final}

Reform EU Electricity Market Design

EUROPEAN COMMISSION

Strasbourg, 14.3.2023
COM(2023) 148 final

2023/0077 (COD)

Proposal for a

REGULATION OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL

amending Regulations (EU) 2019/943 and (EU) 2019/942 as well as Directives (EU) 2018/2001 and (EU) 2019/944 to improve the Union's electricity market design

(Text with EEA relevance)

{SWD(2023) 58 final}

The 2023 Challenge

The Consumer is ‘more than ever’ at the center of the public debate

Energy crisis resulting in extreme consumer prices

Electricity prices in Europe, October 2022-January 2023, GMK Center

E-Mobility taking up

Energy sharing and related community concepts

EU energy communities map

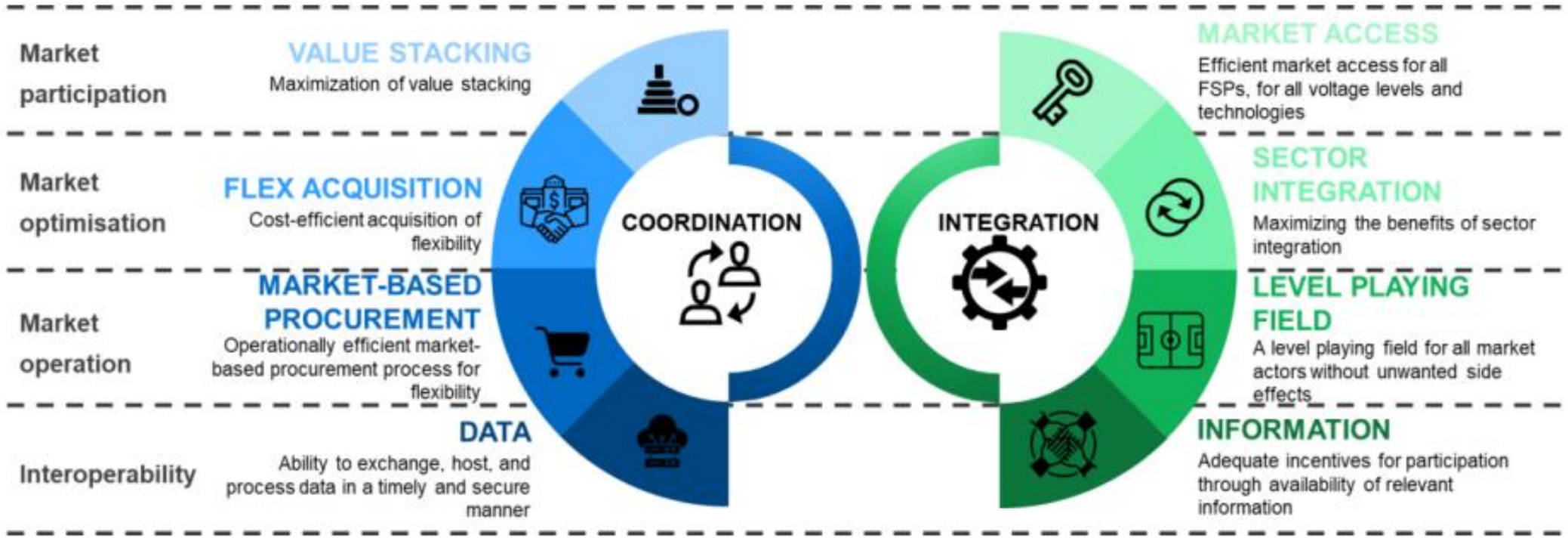
The 2023 Challenge

Towards coordinated, integrated and consumer-centric markets

Coordinated and integrated

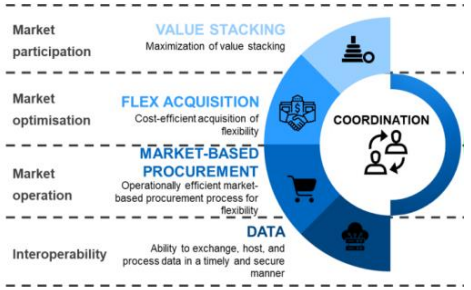
Process efficiency across the entire value chain

Equal level playing field for technologies and agents



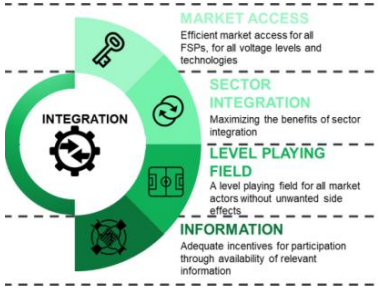
Source: OneNet (2023)

Barriers for a Pan-European Integrated Energy Market



Coordination objectives	Maximization of value stacking	B1 Insufficient coordination of flexibility markets for system services with energy markets with regard to timing.
		B2 Insufficient coordination of different system services over different timeframes, valid for all market phases, i.e., prequalification, baselining, procurement, activation, monitoring and settlement.
		B3 Lack of harmonization of flexibility products for system services for both TSO and DSO
		B4 Exclusivity clauses and non-harmonised contracts
	Cost-efficient acquisition of flexibility	B5 Coordination of explicit procurement of flexibility (flexibility markets) with implicit procurement of flexibility (tariffs, connection agreements,...)
		B6 No specific incentives in the regulatory mechanism (remuneration) that support a common approach between SOs for flexibility procurement
	Operationally efficient market procurement process for flexibility	B7 Limited cross-border coordination/integration
		B8 Limited coordination for procurement of flexibility by DSO and TSO
		B9 Lack of alignment in supporting processes such as prequalification, monitoring and settlement processes including baseline approach.
		B10 Lack of established methodology for network representation for the distribution grid
	Ability to exchange, host, and process data in a timely and secure manner	B11 ICT challenges: Large uncoordinated collection of data, timely exchange of (confidential) network information, etc.

Barriers for a Pan-European Integrated Energy Market



Integration objectives			
	Efficient market access for all FSPs, for all voltage levels, for all technologies	**B12**	No appropriate baseline methodology and process established for new flexibility markets and new types of flexibility providers (e.g. low voltage flexibility)
		B13	No uniform access and registration process/platform for assets willing to participate to flexibility markets.
	Ensuring an equal level playing field for all market actors without unwanted side effects such as market power or risk of gaming	**B14**	Risk of gaming due to exertion of market power and/or shortcomings in the market setting
	Maximizing the benefits of sector integration	**B15**	Lack of coordination of markets of different carriers
		B16	Quantification of the benefits of sector integration is missing
	Adequate incentives for participation through availability of relevant information (e.g., anticipated flex needs, etc.)	**B17**	Unavailability of adequate information allowing FSPs to anticipate the value of their participation and hence not being able to quantify their business case

Challenges and opportunities

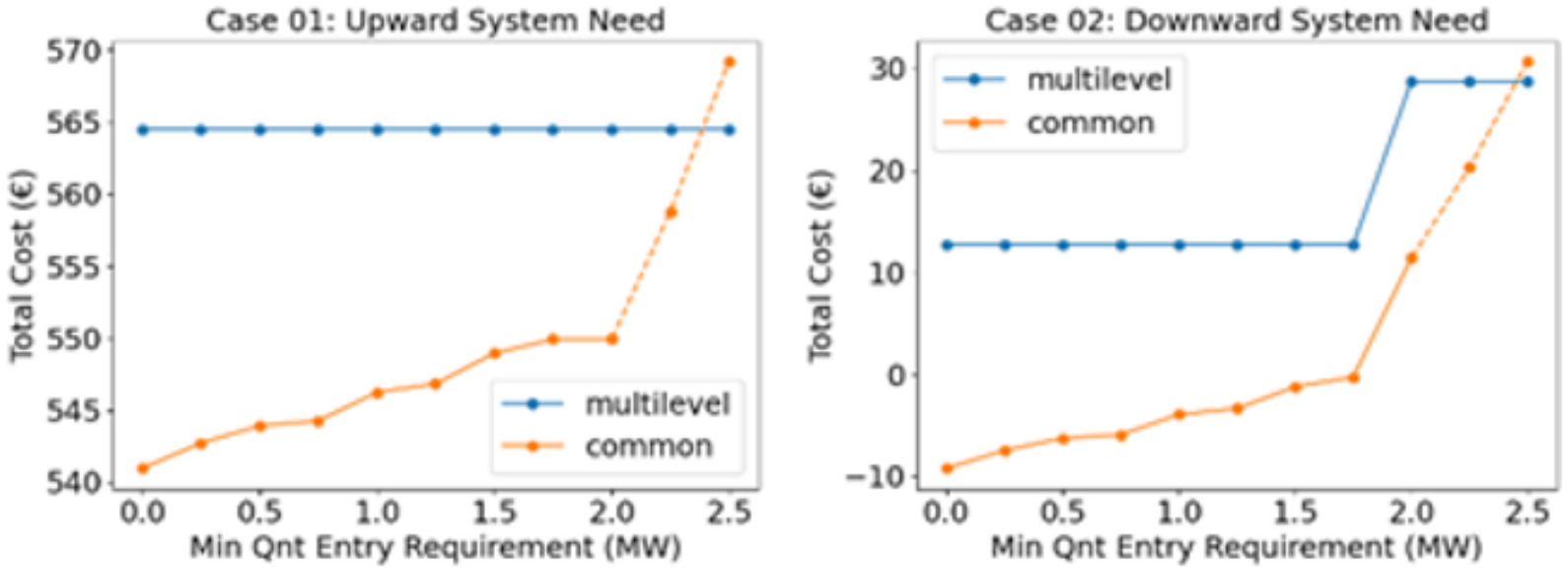
The Challenge

"PREQUALIFICATION"

How to organize the **energy and flexibility market** for **system services** to solve the problem at **lowest cost** while **maximizing synergies between system operators**, between flexibility products and between other system services

PREQUALIFICATION

Example of the impact of minimum bid size requirements on the total costs of the system



Impact of markets' minimum bid quantity entry requirement on their total

Supporting both cost-efficient flexibility acquisition and improved market access

Source: EnergyVille

Challenges and opportunities

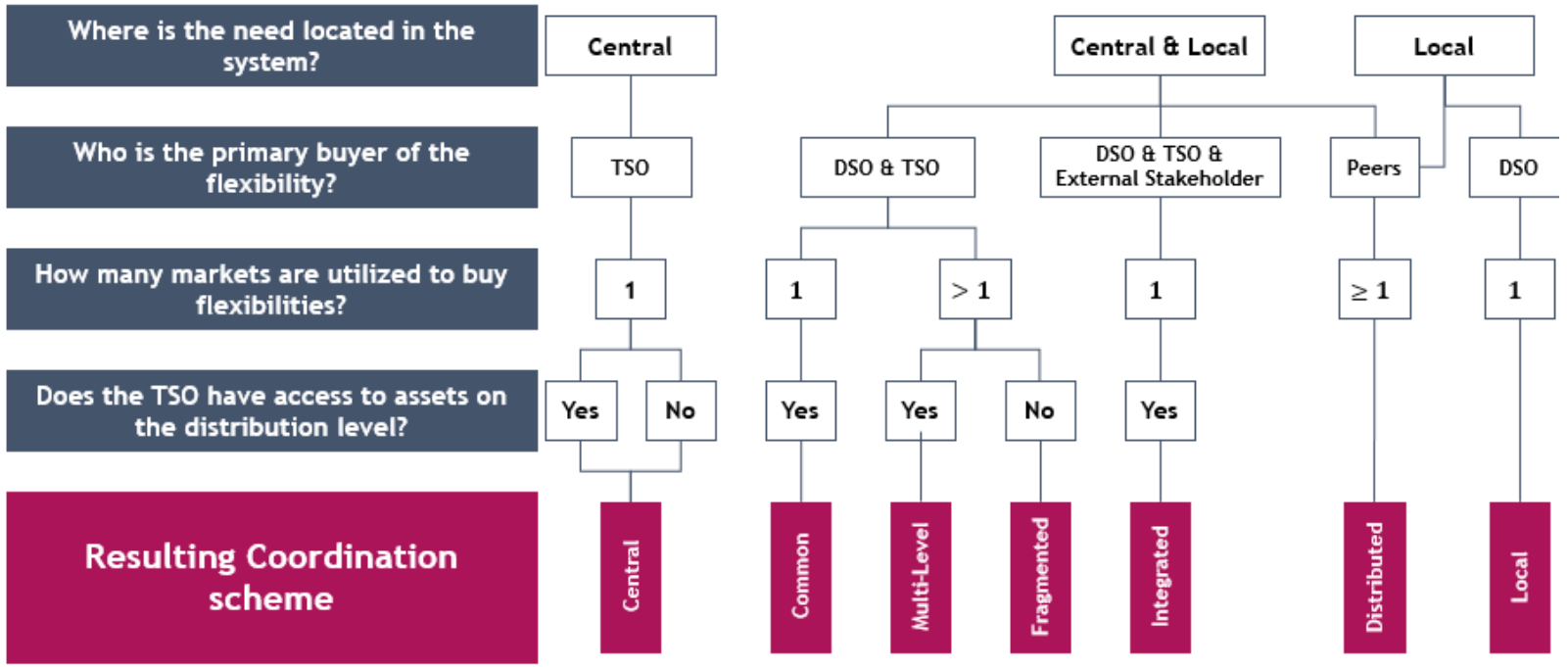
The Challenge

"PROCUREMENT"

How to organize the **flexibility market** for **balancing and congestion management** to solve the problem at **lowest cost** while **maximizing synergies between system operators**, between flexibility products and between other system services

TSO-DSO Coordination

"A strategic framework for coordination"



Source: VITO (CoordiNet)

Challenges and opportunities

The Challenge

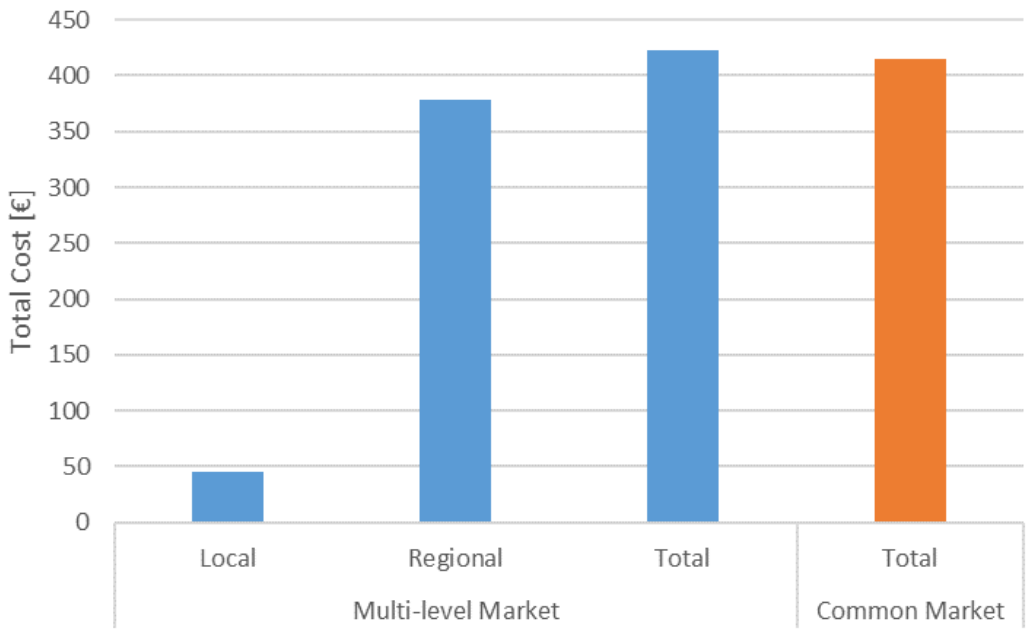
"PROCUREMENT"

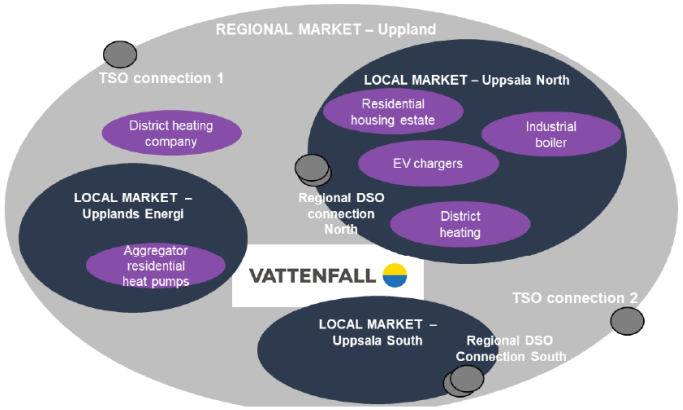
How to organize the **flexibility market** for **balancing and congestion management** to solve the problem at **lowest cost** while **maximizing synergies between system operators**, between flexibility products and between other system services

TSO-DSO Coordination

"Congestion Management on local and regional DSO levels (Sweden)"

What is the efficiency of a market for conges
the local DSO compared to a market without p





Drop in efficiency from common to multi-level markets

Source: VITO (Coordinet - 2021)

Total Costs in Multi-Level and Common Market Models

Challenges and opportunities

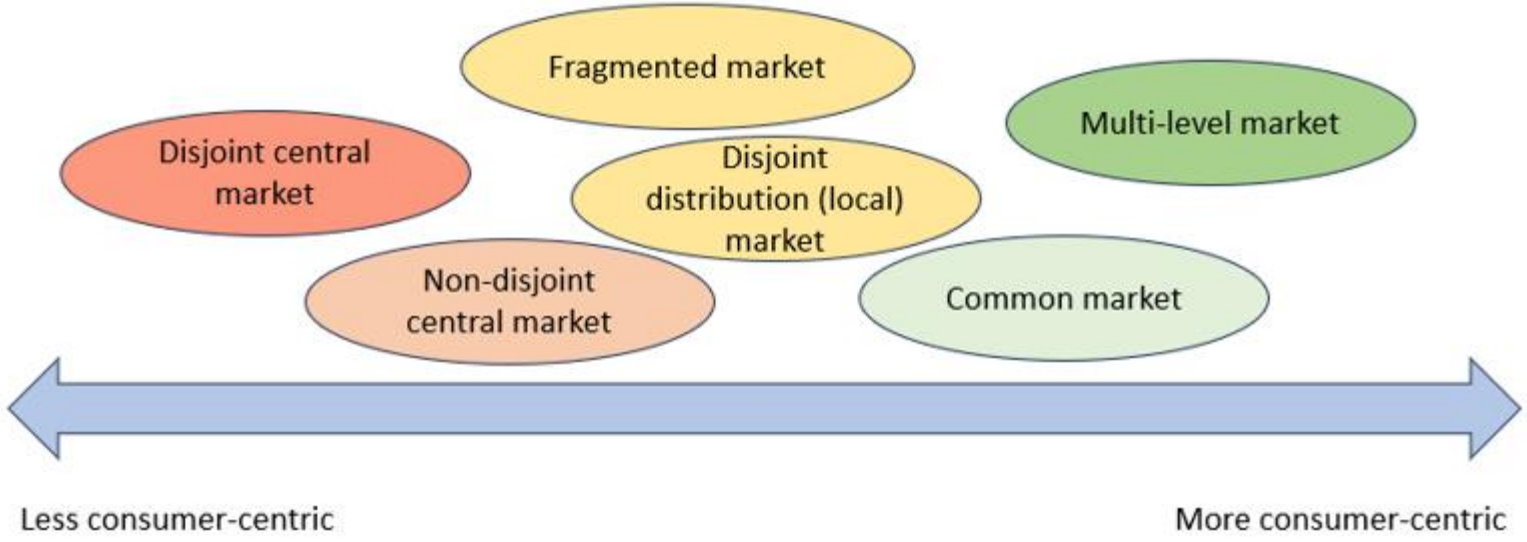
The Challenge

"PROCUREMENT"

How to organize the **flexibility market** for **balancing and congestion management** to solve the problem at **lowest cost** while **maximizing synergies between system operators**, between flexibility products and between other system services

TSO-DSO Coordination

Consumer centricity implicitly embedded in TSO-DSO coordination mechanisms



Ranking of the TSO-DSO coordination schemes and market models in terms of their consumer centricity

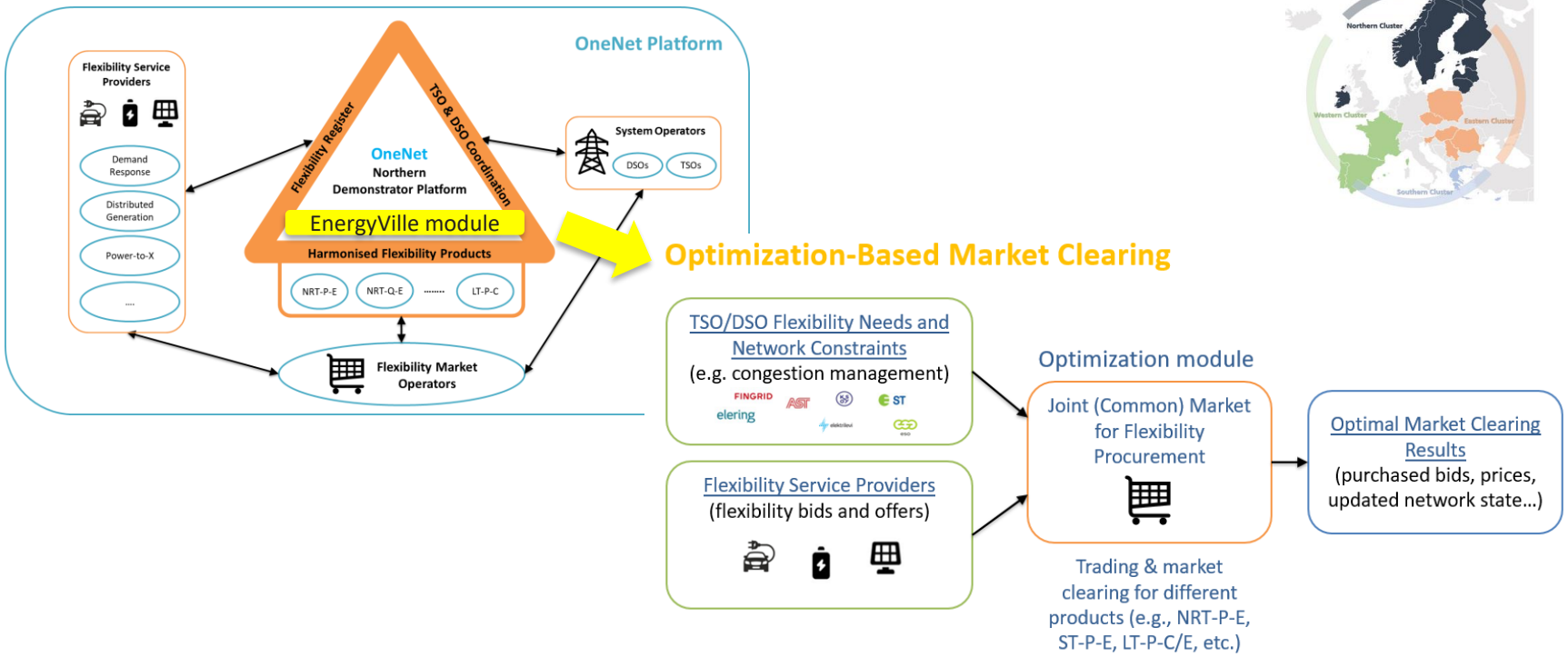
Challenges and opportunities

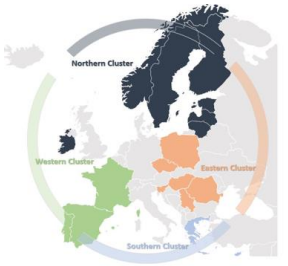
The Challenge

Smart **algorithm development** to support system operators in the **decision making** for **cross-service, cross-product, cross-border, cross-voltage level** flexibility optimization for multiple system operators

The integrated EU Solution

Tool development for market, system and platform operators





Reducing complexity while maximizing flexibility procurement at lowest cost, leveraging on cross-border cooperation

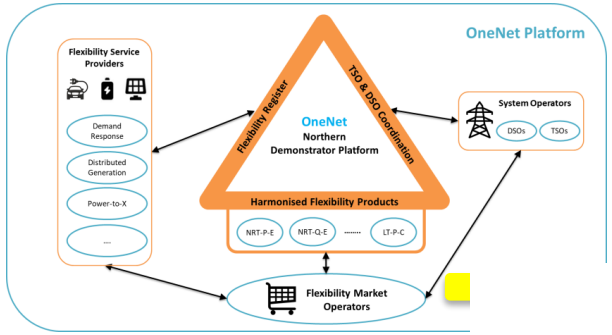
Challenges and opportunities

The Challenge

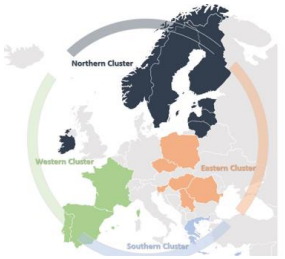
Smart **algorithm development** to support system operators in the **decision making** for **cross-service, cross-product, cross-border, cross-voltage level** flexibility optimization for multiple system operators

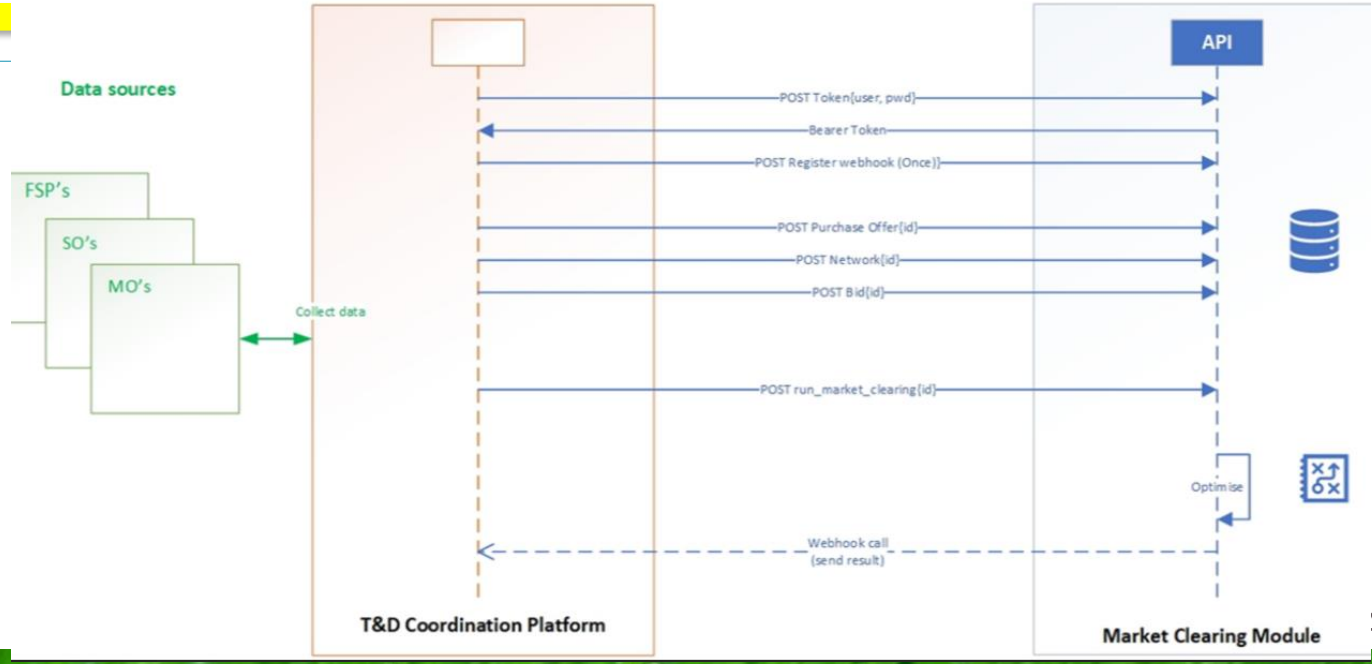
The integrated EU Solution

Tool development for market, system and platform operators



Smart algorithm development to support system operators in the decision making





Challenges and opportunities

The Challenge

"STRATEGIC BEHAVIOUR"

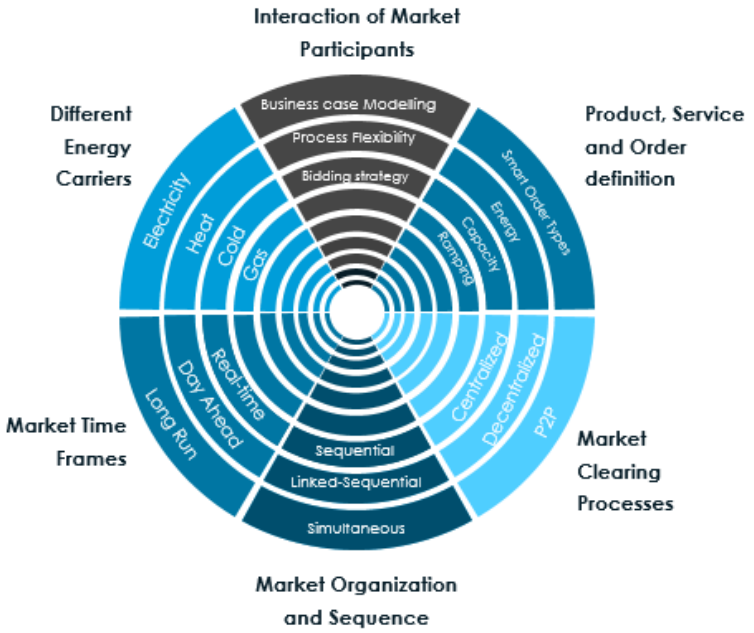
How can the bidding behavior of different FSPs influence the outcomes of the different market schemes

TSO-DSO Coordination

The case of strategic behaviour

How can the bidding behavior of different FSPs influence the outcomes of the different market schemes

- Case-study: Interconnected transmission-distribution system (14-bus, 69-bus, 141-bus)
  - ✓ Case 0: high liquidity (all bids available)
  - ✓ Case 1: low liquidity in transmission system
  - ✓ Case 2: limited liquidity in distribution systems
  - ✓ Case 3: low liquidity in distribution systems leading to market power



EnergyVille Market Simulator

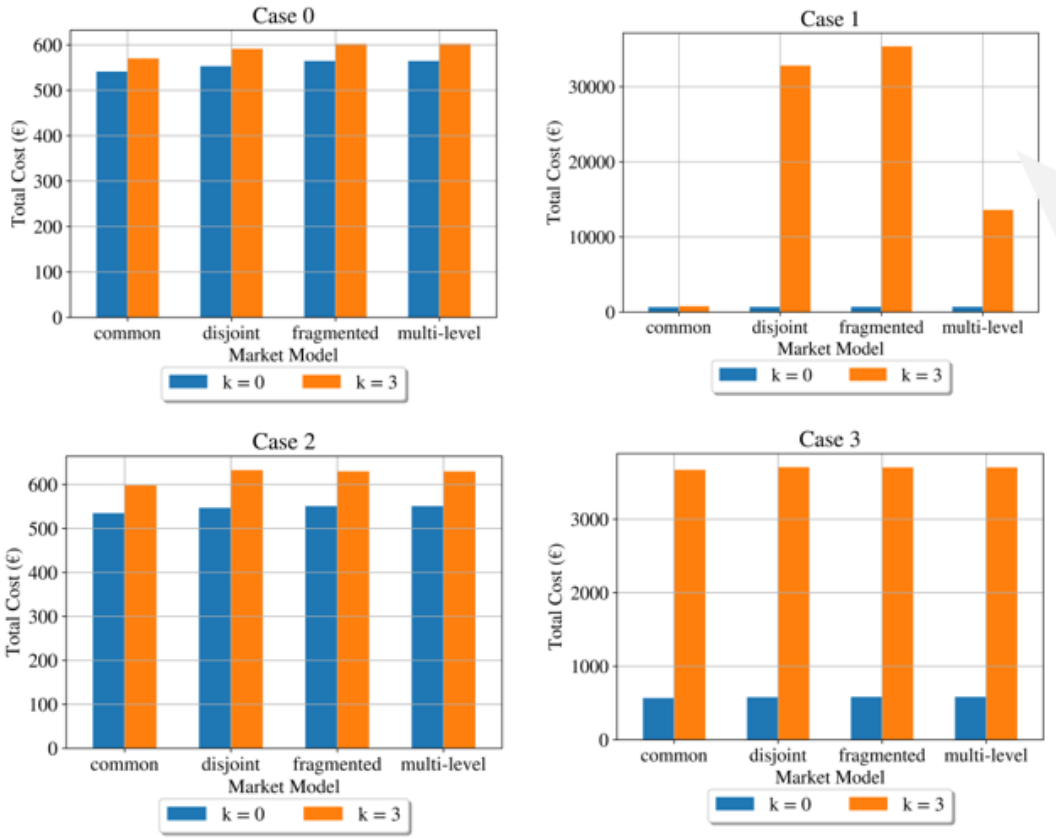
Challenges and opportunities

The Challenge

"STRATEGIC BEHAVIOUR"

How can the bidding behavior of different FSPs influence the outcomes of the different market schemes

TSO-DSO Coordination



- ✓ *Case 0: high liquidity (all bids available)*
- ✓ *Case 1: low liquidity in transmission system*
- ✓ *Case 2: limited liquidity in distribution systems*
- ✓ *Case 3: low liquidity in distribution systems*

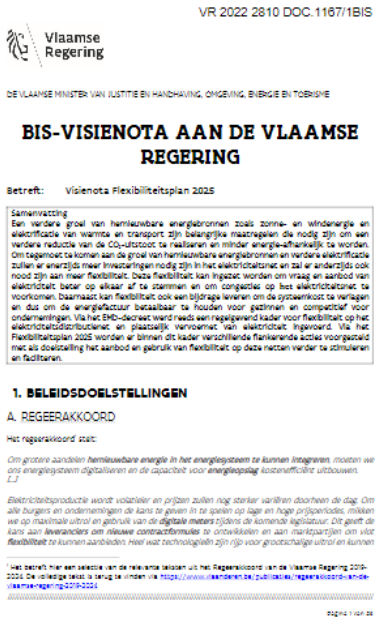
Significant impact of liquidity on the possible impact of strategic gaming behaviour in flexibility markets

The 2023 Challenge

Towards coordinated, integrated and consumer-centric markets

Awareness → ***Customer-oriented*** → ***Consumer-centric***

Consumer-centric



VR 2022 2810 DOC.1167/1BIS

Vlaamse Regering

DE VLAAMSE MINISTER VAN JUSTITIE EN HANDHAVING, OMGEVING, ENERGIE EN TOERISME

BIS-VISIENOTA AAN DE VLAAMSE REGERING

Betreft: Visienota Flexibiliteitsplan 2025

Samenvatting

Een verdere groei van hernieuwbare energiebronnen zoals zonne- en windenergie en elektrificatie van warmte en transport zijn belangrijke maatregelen die nodig zijn om een verdere reductie van de CO_2-uitstoot te realiseren en minder energie-afhankelijk te worden. Om tegemoet te komen aan de groei van hernieuwbare energiebronnen en verdere elektrificatie zullen er enerzijds meer investeringen nodig zijn in het elektriciteitsnet en zal er anderzijds ook nood zijn aan meer flexibiliteit. Deze flexibiliteit kan ingezet worden om vraag en aanbod van elektriciteit beter op elkaar af te stemmen en om congesties op het elektriciteitsnet te voorkomen. Daarnaast kan flexibiliteit ook een bijdrage leveren om de systeemkost te verlagen en dus om de energiefactuur betaalbaar te houden voor gezinnen en competitief voor ondernemingen. Via het EMD-decreet werd reeds een regelgevend kader voor flexibiliteit op het elektriciteitsdistributienet, en plaatselijk vervoernet, van elektriciteit, ingevoerd. Via het Flexibiliteitsplan 2025 worden er binnen dit kader verschillende flankerende acties voorgesteld met als doelstelling het aanbod en gebruik van flexibiliteit op deze netten verder te stimuleren en faciliteren.

1. BELEIDSDOELSTELLINGEN

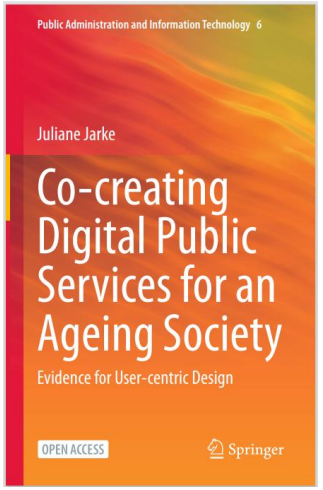
A. REGEERAKKOORD

Het regeerakkoord stelt:

*Om grotere aandelen **hernieuwbare energie in het energiesysteem te kunnen integreren**, moeten we ons energiesysteem digitaliseren en de capaciteit voor **energieopslag** kosteneffectief uitbouwen.*
[...]

*Elektriciteitsproductie wordt volatieler en prijzen zullen nog sterker variëren doorheen de dag. Om alle burgers en ondernemingen de kans te geven in te spelen op lage en hoge prijspieken, moeten we op maximale uitrol en gebruik van de **digitale meters** tijdens de komende legislatuur. Dit geeft de kans aan **leveranciers om nieuwe contractformules** te ontwikkelen en aan marktpartijen om vlot **flexibiliteit** te kunnen aanbieden. Heel wat technologieën zijn rijp voor grootschalige uitrol en kunnen*

Vlaanderen



Public Administration and Information Technology 6

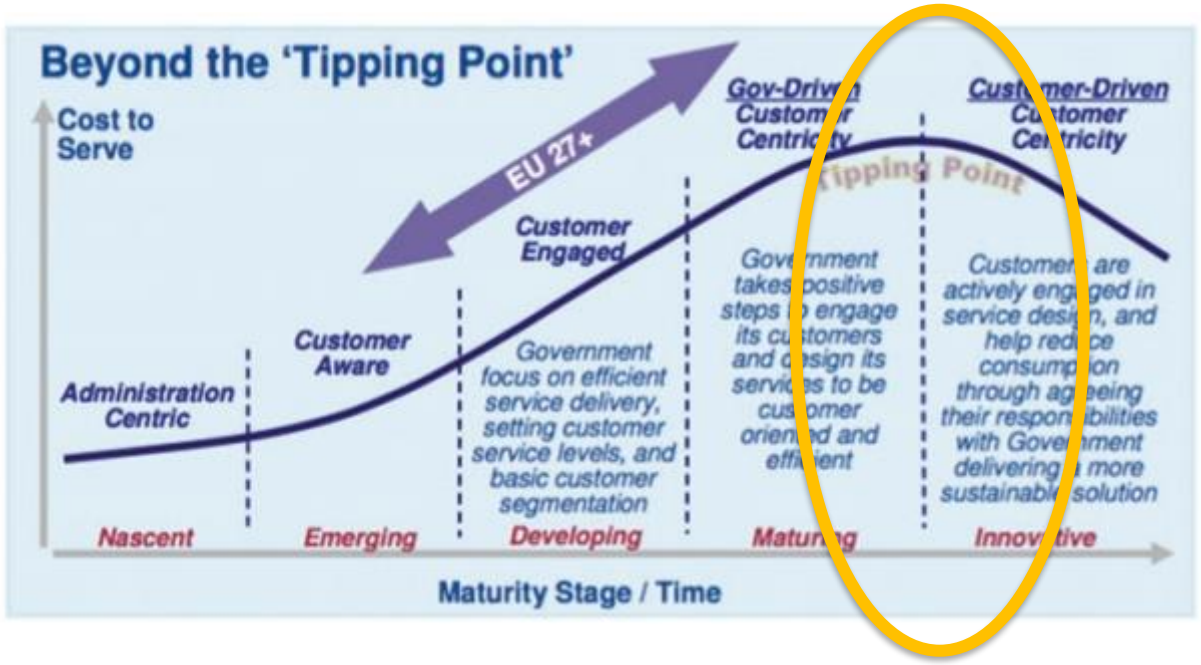
Juliane Jarke

Co-creating Digital Public Services for an Ageing Society

Evidence for User-centric Design

OPEN ACCESS

Springer



The 2024 challenge and beyond

Flexibility Plan 2025

The case of bounded rationality and heterogeneous preferences

Communication and awareness raising for specific target groups

The End user challenge

The Challenge

The **potential impact for the system operator of LV flexibility** (and by extension the potential of the digital meter) is dependent on the **level of knowledge and engagement of the consumers**

The Solution

*"A unified vision for low voltage flexibility, considering the **consumer**, the **grid** and the overall **system**"*

With support from

Increased understanding of heterogeneous consumer behaviour

- ✓ *Individual versus collective flexibility provision*
- ✓ *Drivers for consumer participation*
- ✓ *Role of consumer preferences in relation to the adoption of tariff schemes, traffic light concepts,…*

&

Operational models for secure procurement and activation of LV flexibility

- ✓ *Grid monitoring and control*
- ✓ *Traffic light concepts*
- ✓ *How flexibility can support congestion management*

&

Integrated BE framework for the use of LV flexibility

- ✓ *TSO-DSO coordination*
- ✓ *System impact in case of large-scale adoption of LV flexibility*
- ✓ *Integration of market flexibility with tariff structures and connection agreements*

? Which 'human factors' impact adoption of flexible technologies?

? Which 'human factors' impact provision of flexibility by end consumers?

The End user challenge

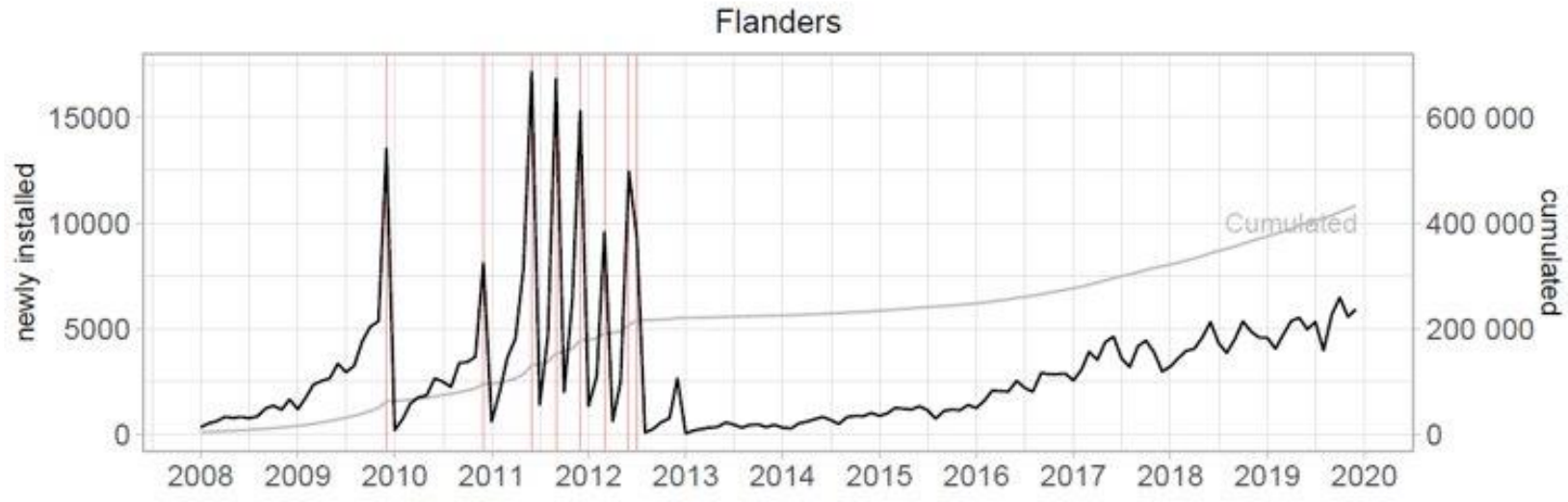
The Challenge

The **potential impact for the system operator of LV flexibility** (and by extension the potential of the digital meter) is dependent on the **level of knowledge and engagement of the consumers**

Individual preferences and non rational behaviour

"Consumer are not always acting in a rational way or have individual preferences that differ from their neighbour."

Question: what is the impact of increased subsidies for PV on the amount of newly installed installations?

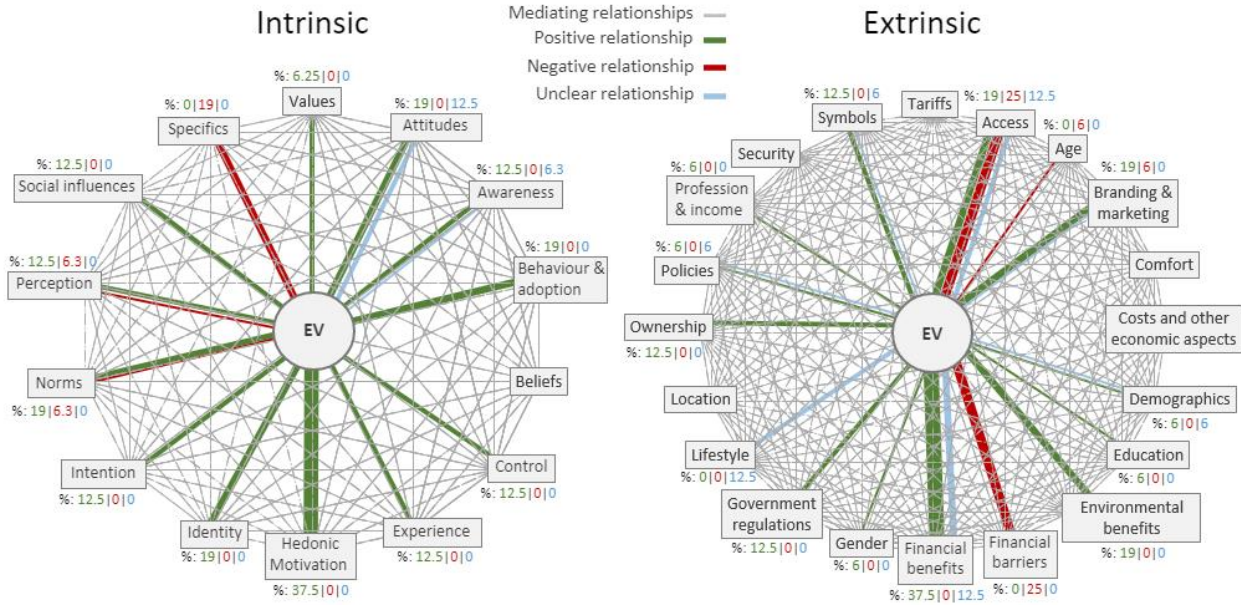


A rational reaction on a financial benefit or do other factors play a role?

Need for tailor-made solutions capturing 'real consumer behaviour'

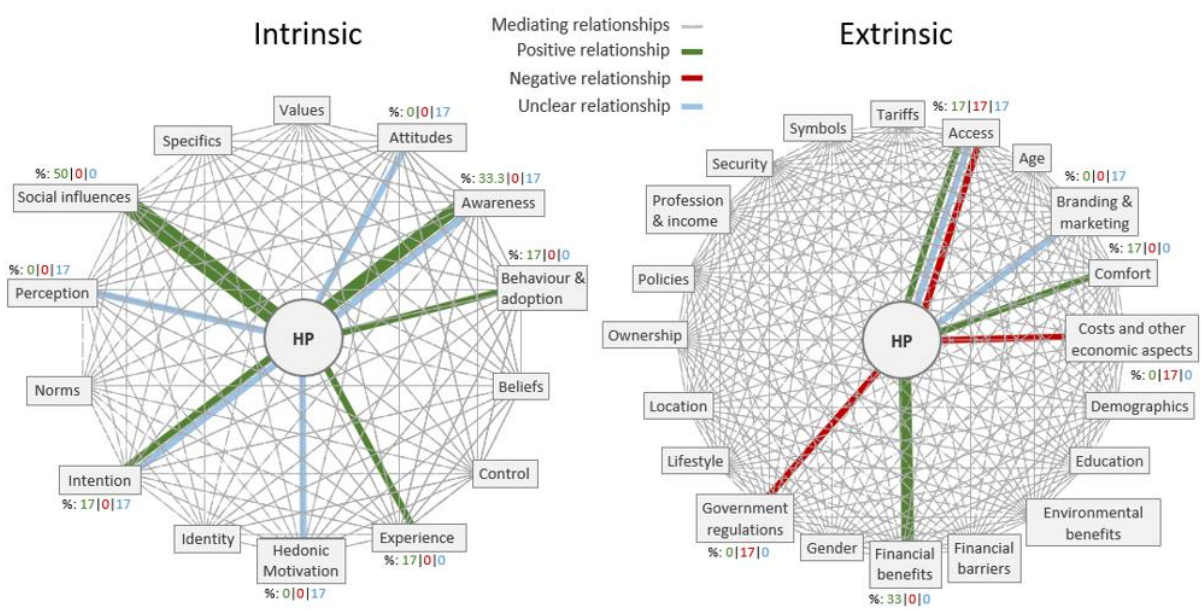
The End user challenge

Electric Vehicles



Adoption factors for Electric vehicles (EV)

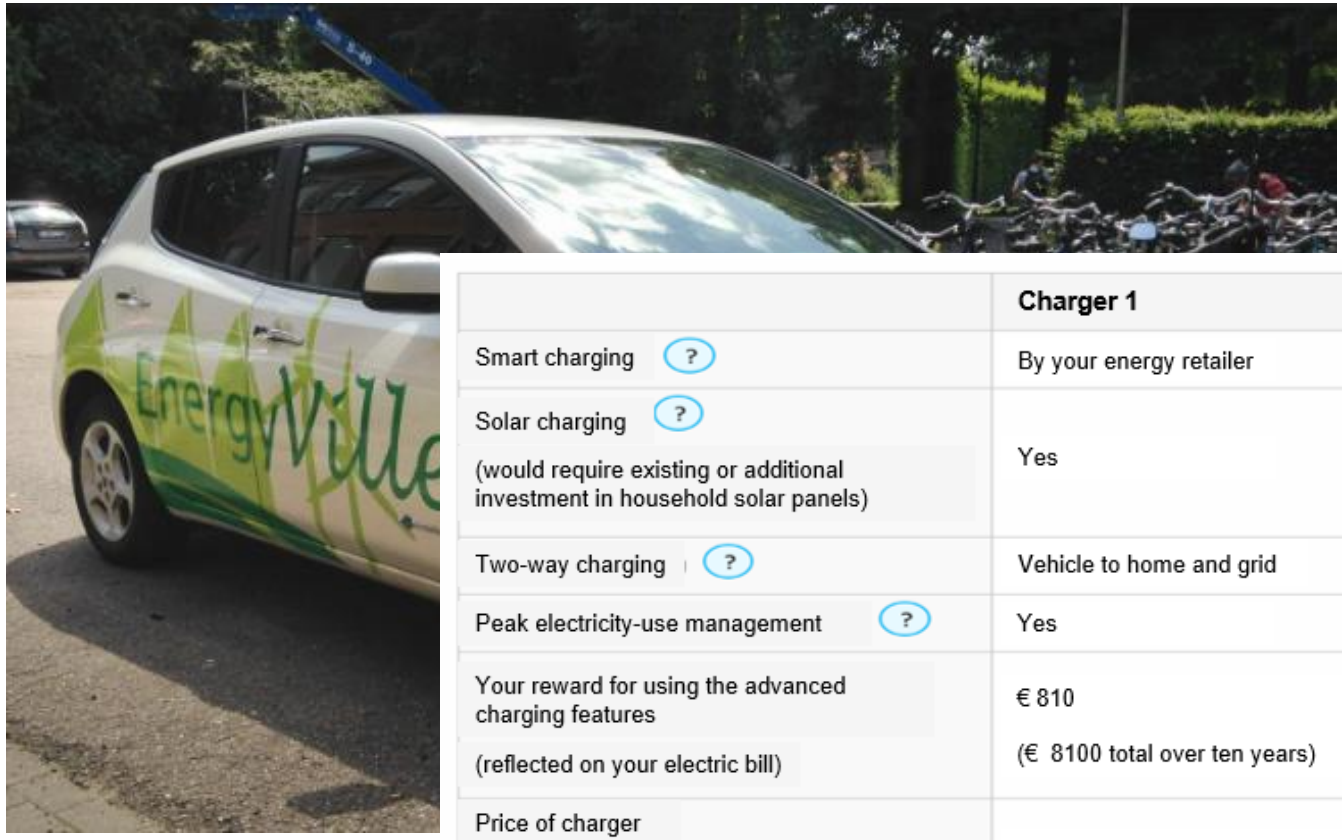
Heat Pumps



Adoption factors for Heat pumps (HP)

- ✓ *Drivers for consumer adoption differ significantly between technology*
- ✓ *In particular for EV, a large combination of human characteristics will play a role*
- ✓ *Factors for EV and PV more correlated compared to heat pumps*

The End user challenge

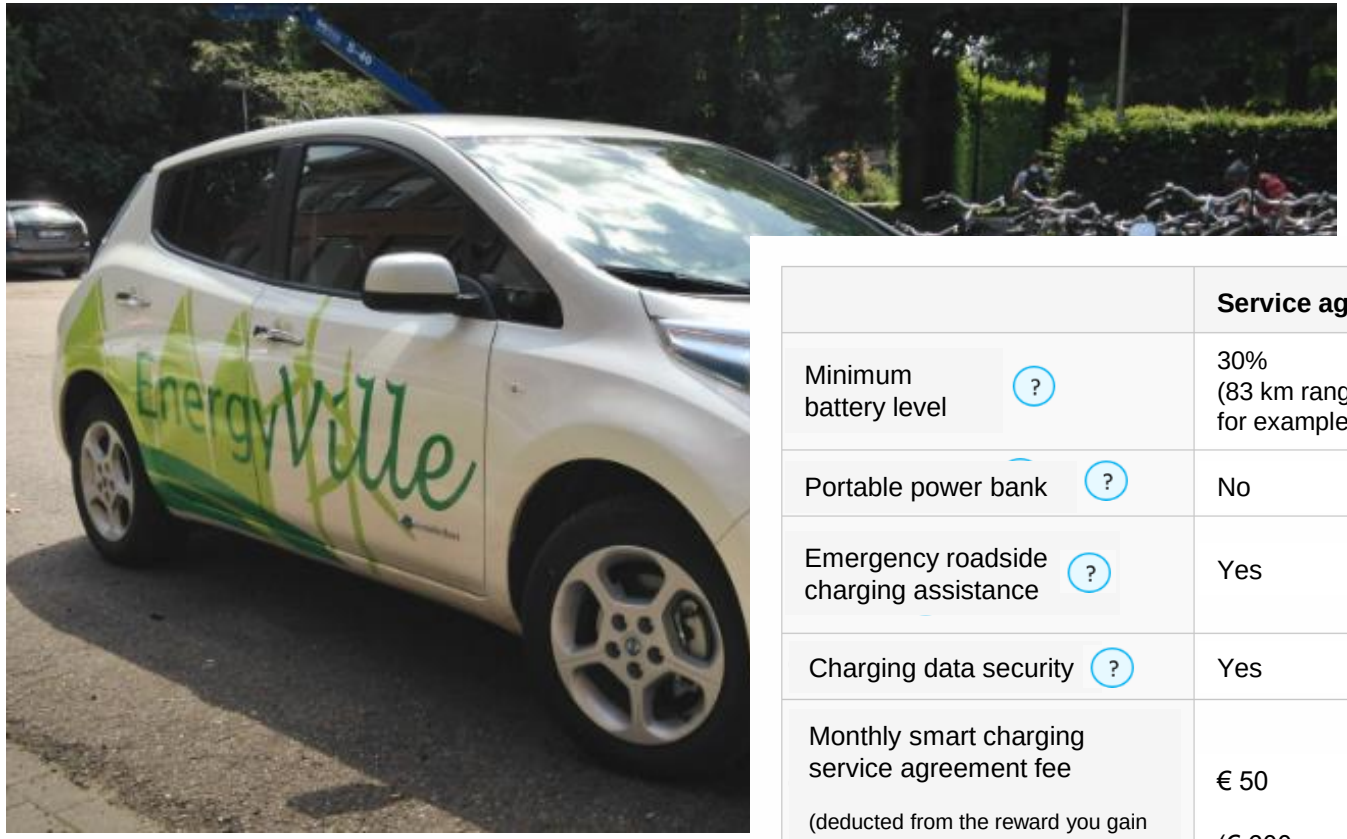


Discrete choice experiment to examine if the factors that impact the adoption of EVs also affect the decision to adopt smart charging?

	Charger 1	Charger 2	Use your current charger
Smart charging ?	By your energy retailer	By your energy retailer	The current charger has no advanced features. It simply charges your car at the regular price until it is fully charged.
Solar charging ? (would require existing or additional investment in household solar panels)	Yes	No	
Two-way charging ?	Vehicle to home and grid	Vehicle to home	
Peak electricity-use management ?	Yes	No	
Your reward for using the advanced charging features (reflected on your electric bill)	€ 810 (€ 8100 total over ten years)	€ 550 annually (€ 5500 total over ten years)	
Price of charger (including installation)	€ 4200	€ 2900	
	○	○	○

What individual (survey-taker) characteristics correlate with the decision to adopt smart charging features?

The End user challenge



If you drove an EV and had a charger capable of two-way charging and smart charging, would you pay for extra provisions of a service agreement?

	Service agreement 1	Service agreement 2	No service agreement
Minimum battery level	30% (83 km range for a Nissan Leaf, for example)	10% (28 km range for a Nissan Leaf, for example)	I will control the charger myself, charging at the hours when electricity is cheapest and selling electricity when it is most expensive, connect the charger to a smart home management system, or allow the car to begin charging at the regular price once it is plugged in.
Portable power bank	No	Yes	
Emergency roadside charging assistance	Yes	No	
Charging data security	Yes	Yes	
Monthly smart charging service agreement fee (deducted from the reward you gain by using the smart charging and two-way charging features)	€ 50 (€ 600 per year)	€ 10 (€ 120 per year)	
	○	○	○

Do individual consumers make a different trade-off between costs and perceived benefits?

Conclusions

- **Imperfect information**, **strategic behavior**, **a wide array of technologies,…** make the question ‘how to design a future-proof flexibility market’ complex
- Smart product and market design should support system operators in an **operational and economical efficient procurement and activation of flexibility**
- **Advanced market simulations** can estimate the outcome of different product and market set-ups, including how they drive the **behavior of market participants**
- A trade-off needs to be found between **harmonization and customization**
- **Consumer-centricity requires a fundamental rethinking of the overall energy system**

Conclusions (2)

Solutions for unlocking flexibility are not limited to the design of **new products, services**, **markets algorithms, platforms** and **rules for interoperability**

One of the **key enablers** will be an increased understanding of the **behaviour of consumers** and the **impact of decision making of consumers on the different market design options** for energy and flexibility services

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