HOW TO REDESIGN THE ROLE OF THE ELECTRICITY DISTRIBUTION SYSTEM OPERATORS?

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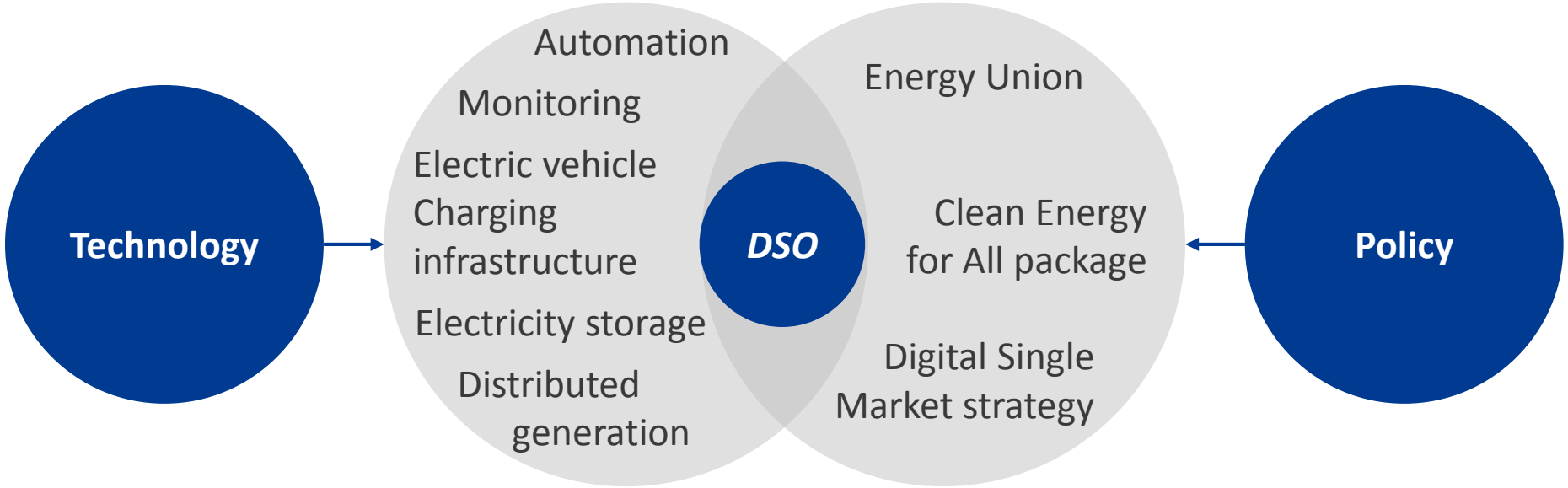
SUMMARY

1. BACKGROUND AND MOTIVATION
2. POLICY DELPHI APPLIED METHODOLOGY
3. RESULTS
4. CONCLUSIONS AND POLICY IMPLICATIONS

1. BACKGROUND AND MOTIVATION

The ongoing **energy transition** is driving a shift toward a **smarter** and more **sustainable electricity sector**.

For electricity **DSOs** this brings **new** possibilities for **service provision** resulting from changes in technology and policy.



(European Commission, 2014; Gellings, 2009; European Commission, 2015, 2015b; Mallet et al., 2014)

1. BACKGROUND AND MOTIVATION

The debate on **new services** focuses on how DSOs can manage **system flexibilities**.

This can be accomplished through **demand response** actions, management of **electric vehicle charging** infrastructure, management of **distributed generation** assets.

In this context DSOs have to sustain their **core** distribution **activities**, whilst **enabling innovation** that has an impact in the electricity system **upstream and downstream**.

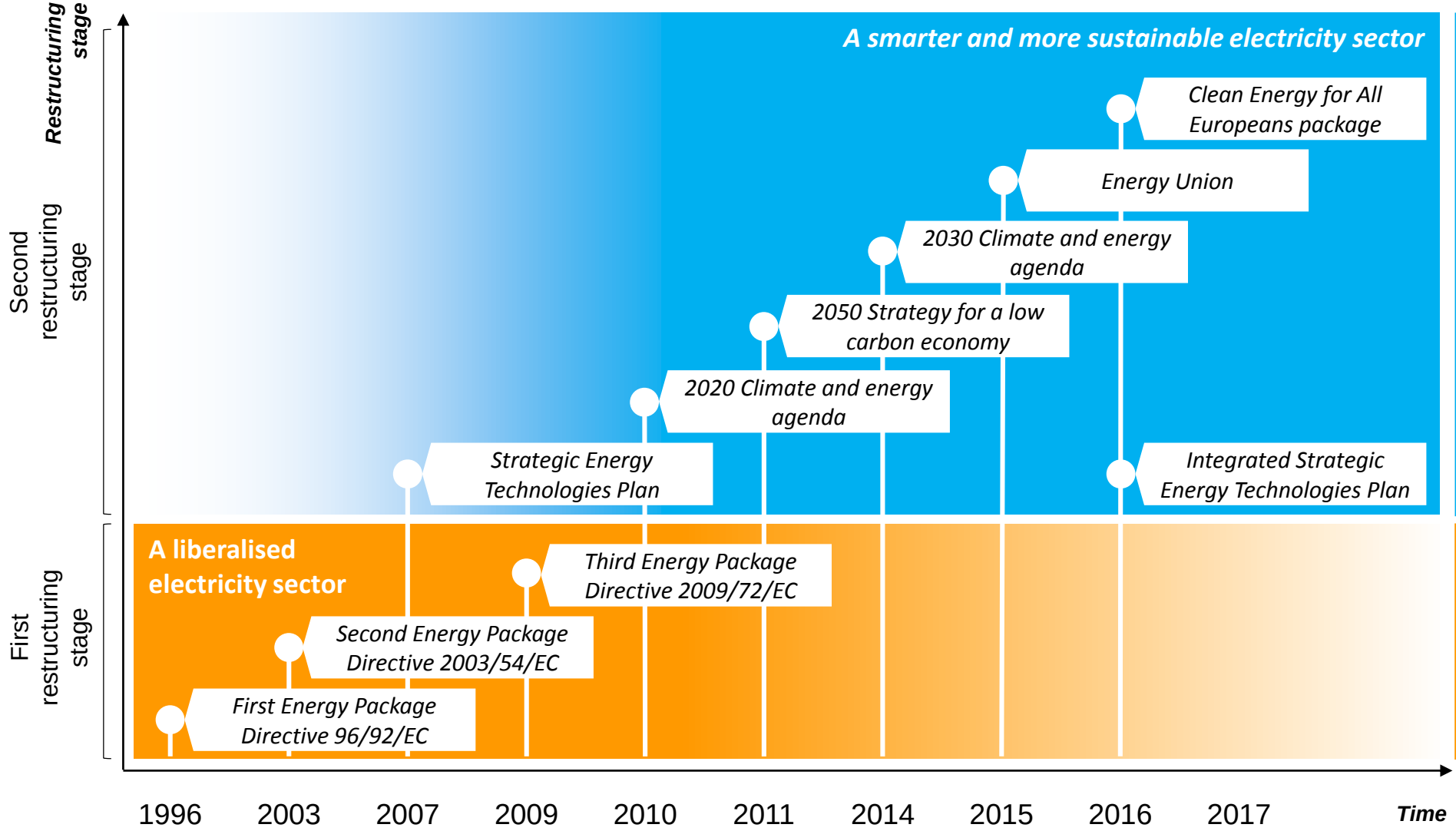
(Gellings et al., 2004; Gellings & Lordan, 2004; Oosterkamp et al., 2014)

1. BACKGROUND AND MOTIVATION

Alterations in electricity distribution services may require changes in **DSOs roles, activities, and responsibilities.**

As providers of a service of general economic interest, their roles have been **to a large extent policy-driven.**

Policy instruments shaping the EU electricity sector



Policy-driven changes for DSOs

- DSOs to adapt their operations for a scenario with growing clean energy sources
- DSOs to modernise grids, increasing automation, monitoring and control capabilities
- Ongoing debate on DSOs roles, activities, and responsibilities in a smarter and more sustainable electricity sector
- The Clean Energy for All Europeans policy proposals guide DSOs role in a new market deign with provisions on system flexibility, storage, electric vehicle charging infrastructure, and data handling

- DSOs operate as regional monopolies
- Separation from competitive market segments of generation and retail
- Expansion of DSOs responsibilities to include: energy efficiency, and demand side management
- DSOs expected to modernise infrastructure toward smart grids

1. BACKGROUND AND MOTIVATION

Alterations in electricity distribution services may require changes in **DSOs roles, activities, and responsibilities.**

As providers of a service of general economic interest, their roles have been **shaped to a large extent by EU policies.**

1st stage of restructuring	Liberalized electricity market		2nd stage of restructuring	Smart and sustainable electricity market
1996	2003	2009	2015	2016
Directive 96/92/EC	Directive 2003/54/EC	Directive 2009/72/EC	Energy Union	Clean Energy for All Europeans

- Increasing responsibilities for DSOs beyond distribution
- Added responsibilities include energy efficiency and demand side management
- Grid modernisation by deploying smart grids

Lack of clarity on the extent to which DSOs should be engaged in smart grid deployment.

- More clarity in terms of DSOs roles considering smarter distribution grids.
- Specific proposals cover:
  - Management of system flexibility
  - Electricity storage
  - Electric vehicle charging infrastructure

Not yet enacted in legislation.

1. BACKGROUND AND MOTIVATION

As **new operational areas** become conceivable at the distribution level, regulators are considering **which of these are adequate for DSOs**.

Core business areas	Grey business areas	Forbidden business areas
• Network building and operation; • System security; • Technical data and losses management.	• Smart metering; • Telecommunication; • Electric vehicles; • Demand response; • Flexibility services; • Connected consumer data; • Electricity storage.	• Electricity generation; • Electricity retail.

(Meeus & Hadush, 2016; Oosterkamp et al., 2014)

1. BACKGROUND AND MOTIVATION

The transition toward **a smarter grid framework**, has raised concerns about how **DSOs should position themselves**.

These concerns recognize the potential conflict **between the natural monopoly characteristics of electricity distribution network activities**, and **the responsibilities resulting from the diffusion of smart grid innovations.**

This results in **uncertainty** on the appropriate **roles for DSOs** in the future of the EU electricity market, and respective **market design**.

1. BACKGROUND AND MOTIVATION

This study aims to contribute to reducing this uncertainty.

What are the most adequate policies for DSOs operating in a smarter grid environment?

This is realized through a **foresight analysis on policy alternatives**.

2. POLICY DELPHI METHODOLOGY

The **Policy Delphi** method applied is typically used to gain **insight** into topics **marked by uncertainty and for which knowledge from experts is accessible.**

This **method** involves **iterative steps** through which experts' knowledge is **collected** and **analysed**.

It aims for **greater stability in responses across iterations**, to inform and **reduce the complexity** associated with the subject of analysis.

Notably, this method **does not seek consensus**. Instead, **it aims for stability in responses** from participating experts, which does not necessarily imply consensus among those experts.

(Linstone & Turoff, 2002, 2011)

2. POLICY DELPHI METHODOLOGY

The methodology designed for this study includes the following steps

1st Phase - Design

2nd Phase – Policy Delphi survey rounds

Policy Delphi Structuring	1st survey round	2nd survey round
Literature review	1st round Policy Delphi survey development	2nd round Policy Delphi survey development
Industry insight collection	1st round Policy Delphi survey pilot	2nd round Policy Delphi survey pilot
Policy alternatives generation	1st round Policy Delphi distribution	2nd round Policy Delphi survey distribution
Policy Delphi Experts selection	1st round Delphi analysis & feedback to experts	2nd round Policy Delphi analysis & feedback to experts

3. RESULTS

1st Phase - Design | **Policy Delphi Structuring**

The literature review resulted in the identification of three relevant areas of analysis for policy alternatives

Organisational	DSOs business model and strategy related aspects and how it adapts towards a smarter grid environment.
Technological	innovations resulting from R&D, piloting and deployment of new hardware and software to deliver the vision of a smarter grid.
Institutional	Policy, legal and regulatory aspects.

(Markard, 2011; Markard & Truffer, 2006; Praetorius et al., 2009)

3. RESULTS

The dimensions for analysis were further developed with industry insights leading to 57 policy alternatives across topics

Policy areas		Policy topics
Organisational →	Business Model Innovation	• Strategy, operations, and organisational adaptation ***(5)*** • Adaptation challenges ***(4)*** • Roles, activities, and responsibilities ***(19)***
Technological →	Technological Adaptation	• Engagement in R&D activities ***(3)*** • R&D approach ***(1)*** • Electricity distribution digital capabilities ***(6)***
Institutional →	Market Design	• European Union level policy action ***(7)*** • Member State level policy action ***(3)*** • R&D and innovation policy action ***(4)*** • Role of the DSOs in the electricity sector ***(3)*** • Electricity distribution transition trajectories ***(2)***

3. RESULTS

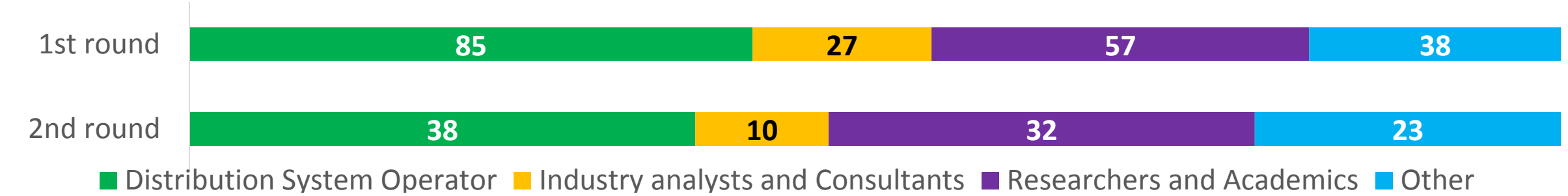
The survey models where designed to allow the pool of experts to assess each policy alternative using ordered rank scales.

These were then aggregated to categorise each policy alternative as: weak, uncertain or strong.

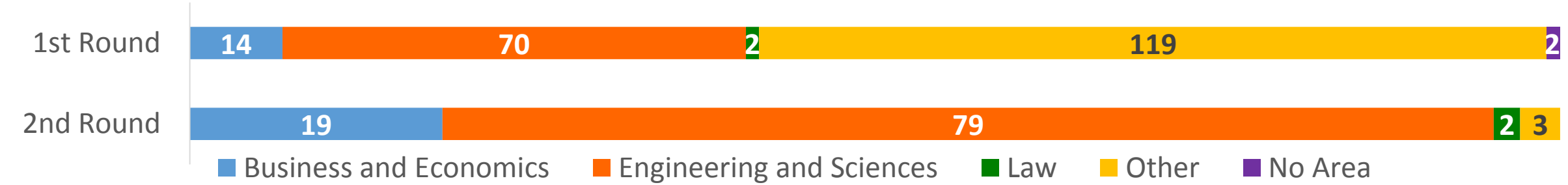
3. RESULTS

2nd Phase – Policy Delphi survey rounds | **1st and 2nd survey rounds**

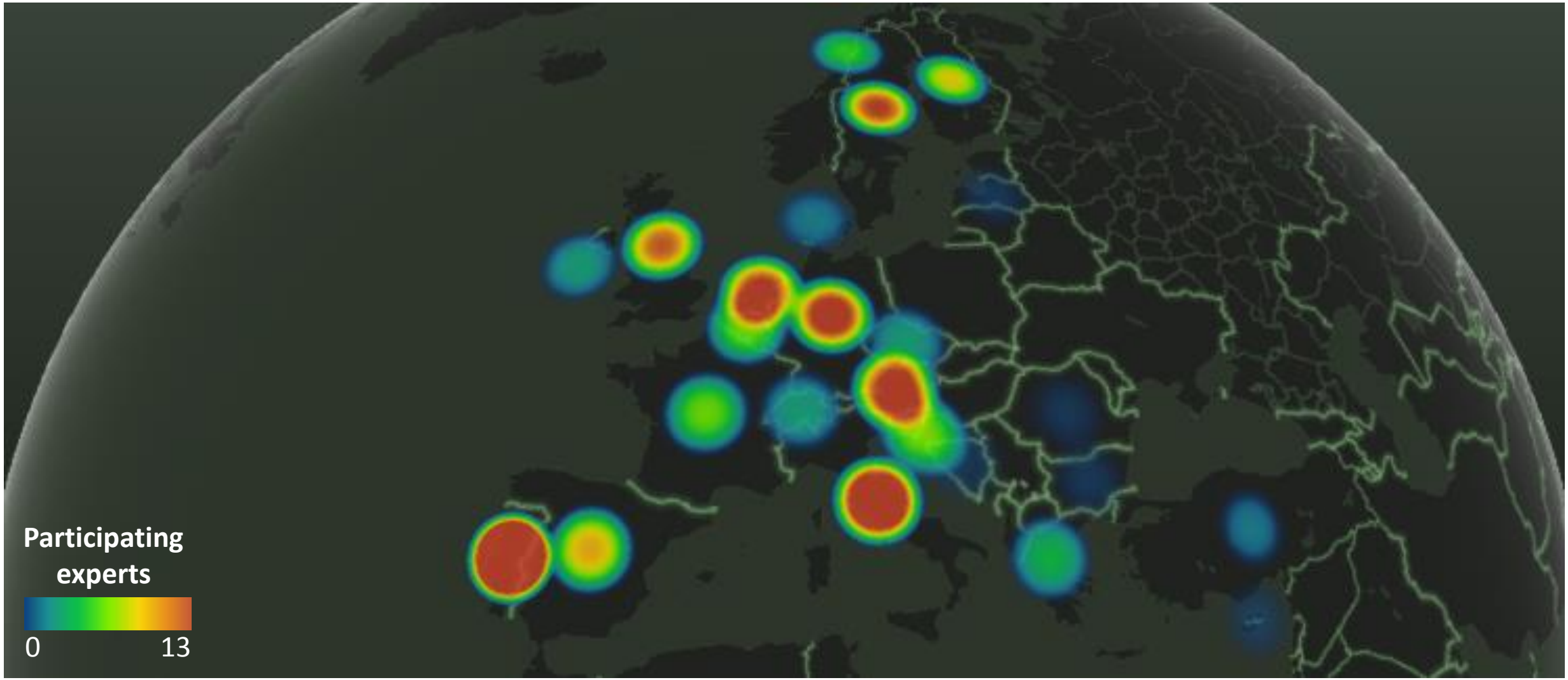
Expert profiles ***(1st round n = 207, 2nd round n = 103)***



Fields of expertise



3. RESULTS



3. RESULTS

Business Model Innovation

How should DSOs position themselves regarding business model and organizational innovation?		
Strategy, operations, and organisational adaptation		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
DSOs should **focus on adapting their organisational structure** to be ready for the opportunities resulting from a fully deployed smart grid (e.g. **skills, teams, responsibilities, departments**, strategy, resource allocation).	93.7%	Strong Policy Alternative
DSOs should **provide innovative system services** allowing for new sources of revenue.	86.5%	Strong Policy Alternative
DSOs should **test business models and strategies that challenge the current regulation** and disrupt the market (Such as: Uber, Airbnb, Lyft, eBay, Amazon, Tesla, Google have done in other industries).	70.0%	Strong Policy Alternative
DSOs should **focus only on grid operation and maintenance**, planning and expansion, and quality of service.	70.5%	Weak policy alternative
DSOs **should limit their business strategy to the possibilities allowed** by existing regulations.	81.6%	Weak policy alternative

3. RESULTS

Business Model Innovation

How do you perceive the difficulty of DSOs adaptation to a changing electricity sector?		
Adaptation challenges		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
DSOs will be able to **adapt** to a changing electricity **sector only with adapted regulation**.	42.7%	Uncertaianty in policy alternative
DSOs will be able to **integrate new technologies** to support the transition to smarter distribution grids.	62.1%	Weak policy alternative
DSOs will be able to **integrate new business processes and management practices.**	62.1%	Weak policy alternative
DSOs will be able to adapt their role in a **timely manner.**	83.5%	Weak policy alternative

There a significant perception of difficulty regarding DSOs adaptation.

3. RESULTS

Business Model Innovation

In the future DSOs should be involved in the following activities?		
Roles, activities, and responsibilities		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
Grid **management** (i.e. operation and maintenance).	97.1%	Strong Policy Alternative
Grid **planning** (i.e. expansion and reinforcement).	98.1%	Strong Policy Alternative
Smart meter deployment.	88.4%	Strong Policy Alternative
Data gathering (meter/smart meter information collection).	84.5%	Strong Policy Alternative
Integration of distributed generation technologies.	88.9%	Strong Policy Alternative
Smart meter ownership.	70.9%	Strong Policy Alternative
Neutral market facilitation (i.e. avoiding interference with competitive market activities).	76.8%	Strong Policy Alternative
Integration of electricity storage technologies.	84.5%	Strong Policy Alternative
Data storage and management	74.9%	Strong Policy Alternative

3. RESULTS

Business Model Innovation

In the future DSOs should be involved in the following activities?		
Roles, activities, and responsibilities		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
Providing **flexibility services** to end-users (i.e. flexible consumption, production, storage).	78.3%	Strong Policy Alternative
Managing a **data marketplace** (i.e. to enable the development of added value services).	75.7%	Strong Policy Alternative
Electric vehicle infrastructure deployment.	75.8%	Strong Policy Alternative
Indirect grid balancing (i.e. through price signals to other relevant market players).	77.8%	Strong Policy Alternative
Direct grid balancing (i.e. connecting and disconnecting consumers from the grid).	74.4%	Strong Policy Alternative
Management of electricity storage technologies.	75.8%	Strong Policy Alternative
Management of distributed generation technologies.	73.8%	Strong Policy Alternative
Provide energy efficiency and energy savings advise to end-users.	67.0%	Strong Policy Alternative
Electric vehicle infrastructure ownership.	45.6%	Strong Policy Alternative
Electricity retail.	81.6%	Weak policy alternative

3. RESULTS

Technological Adaptation

How should DSOs position themselves for technological innovation and research and development (R&D) activities?		
Engagement in R&D activities		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
DSOs should **pilot and demonstrate** the potential and impact of emerging technologies.	39.8%	1st Priority
DSOs should **exploit tested and proven technologies**, deploying external R&D results from universities, ICT firms, and other DSOs.	36.9%	2nd Priority
DSOs should **conduct exploratory R&D** activities for new technologies and innovative applications.	23.3%	3rd Priority
How should DSOs develop R&D activities?		
R&D approach		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
DSOs should explore technological innovation in **partnership with external entities such as universities, ICT firms, and other DSOs.**	97.1%	Strong Policy Alternative

3. RESULTS

Technological Adaptation

What is the importance of the following digital capabilities for DSOs new roles?		
Electricity distribution digital capabilities		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
Collection of data (e.g. from all the connected distribution networks and devices, such as distributed generation, smart meters, electric vehicle infrastructure, network monitoring points, substation monitoring).	93.2%	Strong Policy Alternative
Validation and quality certification of data (i.e. to ensure accuracy and validity of collected information).	90.8%	Strong Policy Alternative
Analysis and interpretation of data (e.g.: to increase the efficiency and quality of service, supporting the definition of flexibility schedules, forecasting network expansion and reinforcement needs).	89.9%	Strong Policy Alternative
Aggregation of data	91.3%	Strong Policy Alternative
Automation (e.g.: based on knowledge gained through collected data, implementation of distributed generation flexibility management algorithms).	85.0%	Strong Policy Alternative
Communication of data to other market participants.	77.3%	Strong Policy Alternative

3. RESULTS

Market Design

How important are the following policy-oriented actions in the ongoing DSOs transition?		
European Union level policy action		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
DSOs should **follow a common-vision of their most effective role in the electricity value chain**, to support and strengthen the development of the EU internal electricity market.	83.6%	Strong Policy Alternative
The DSOs and TSOs data management and exchange standards should be defined at the EU-level.	70.0%	Strong Policy Alternative
The EU strategy toward a Digital Single Market should provide guidance on the role of DSOs.	72.5%	Strong Policy Alternative
DSOs should have a specific EU-level directive, focusing on the operation of a smarter grid framework.	74.4%	Strong Policy Alternative
The DSOs and TSOs congestion management and balancing should be defined at the EU-level.	69.9%	Strong Policy Alternative
A new regulatory body should be established focusing on the transition to a smarter grid framework, with a strategy and incentives for DSOs to innovate.	62.1%	Strong Policy Alternative
The unbundling threshold, currently set to DSOs with 100 000 connected consumers should be re-considered as it can challenge the adaptation and innovation potential of DSOs.	49.5%	Uncertainty in policy alternative

3. RESULTS

Market Design

How important are the following policy-oriented actions in the ongoing DSOs transition?		
Member State level policy action		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
Member States should encourage DSOs to experiment with new services, technologies, business models and market designs, even if it requires overriding current regulations.	77.3%	Strong Policy Alternative
Member States should develop a **National Smart Grid Action** Plan to provide a deployment roadmap and the roles of actors in this context.	79.7%	Strong Policy Alternative
The role of the DSOs should only be specified at the Member State level, allowing each country to establish its role to fit the specific context.	42.7%	Strong Policy Alternative

3. RESULTS

Market Design

How important are the following policy-oriented actions in the ongoing DSOs transition?		
R&D and innovation policy action		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
There should **be specific support programmes for technological innovation at the DSOs level.**	82.6%	Strong Policy Alternative
A flexibility market governance model should be implemented to ensure the adequate intervention of different actors.	78.7%	Strong Policy Alternative
There should be specific support programmes for business model innovation at the DSOs level. (Such as: the establishment of new departments for smart grid operations, integration of new processes for asset management, new skills development).	79.7%	Strong Policy Alternative
DSOs regulation should be designed to facilitate innovation and investments in smart grid technologies.	94.2%	Strong Policy Alternative

3. RESULTS

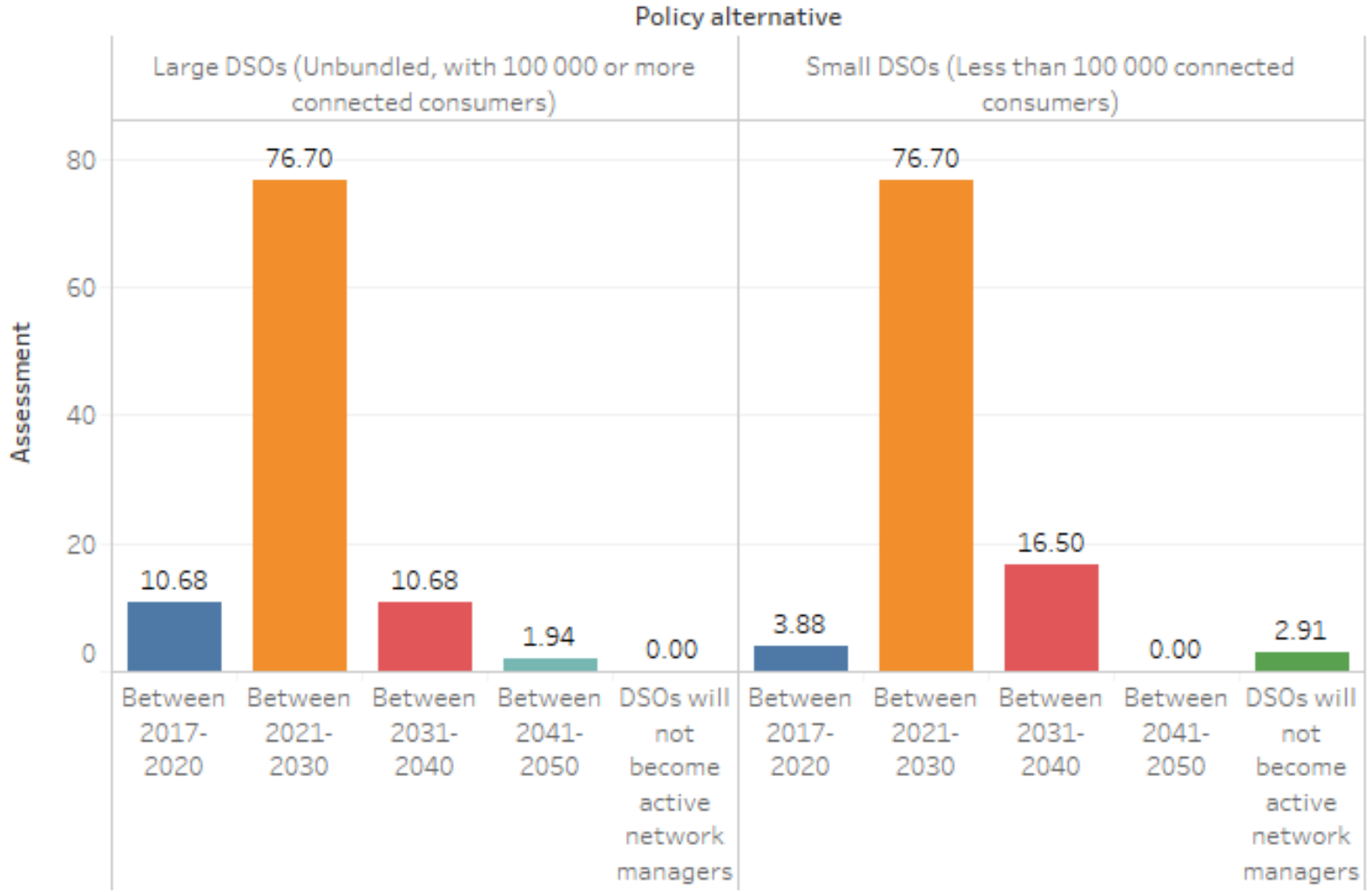
Market Design

What's the future of DSOs in the electricity sector?		
Role of the DSOs in the electricity sector		
Policy alternative	**Assessment**	
	%	**Alternative assessment**
DSOs will incorporate the full spectrum of smart grid capabilities, managing system flexibility as part of its operations, operating as active network managers.	84.5%	Strong Policy Alternative
DSOs will incorporate some additional coordination capabilities, handling congestions and other grid related issues at the operation stage, by restricting load and generation, operating as reactive network managers.	72.5%	Strong Policy Alternative
DSOs will continue with their traditional activities, solving most of the grid related issues at the planning stage, operating as passive network managers.	77.7%	Weak policy alternative

3. RESULTS

Market Design

When will DSOs fully evolve toward active network managers, procuring flexibility services?



3. RESULTS

Strong Policy Alternatives

- *Grid **planning** (i.e. expansion and reinforcement).*
- *Grid **management** (i.e. operation and maintenance).*
- *DSOs should **explore technological innovation** in partnership with external entities such as **universities**, ICT firms, and other DSOs.*
- *DSOs **regulation** should be designed to **facilitate innovation and investments in smart grid technologies.***
- *DSOs should focus on **adapting their organisational structure** to be ready for the opportunities resulting from a fully deployed smart grid.*

3. RESULTS

Uncertainty in Policy Alternatives

- *The **unbundling** threshold, currently set to DSOs **with 100 000 connected consumers** should be **re-considered** as it can challenge the adaptation and innovation potential of DSOs.*

- *DSOs will be able to **adapt to a changing electricity sector** only with **adapted regulation**.*

3. RESULTS

Weak Policy Alternatives

- *DSOs should **limit their business strategy to the possibilities allowed** by existing regulations.*
- ***Electricity retail.***
- *DSOs **will continue with their traditional activities**, solving most of the grid related issues at the planning stage, operating as passive network managers.*
- *DSOs should **focus only on grid operation and maintenance**, planning and expansion, and quality of service.*
- *DSOs will be able to integrate new technologies to support the transition to smarter distribution grids.*

4. CONCLUSIONS AND POLICY IMPLICATIONS

The results provide **foresight indicators regarding business model innovation, technological adaptation, and market design**.

The importance of **facilitating the adaptation of organisational structures** is highlighted.

And also, the need for DSOs to **balance** their **traditional** distribution **activities** with those related to the **integration of distributed energy resources** technologies.

As for market design, the **importance of innovation-friendly regulation is emphasized**, in parallel with the need for a shared EU-level vision regarding DSO responsibilities.

4. CONCLUSIONS AND POLICY IMPLICATIONS

Policy making possibilities include

- The development of a **common-vision for DSOs across the EU** by obtaining a detailed understanding of the existing technologies, processes, and practices.

- The **development** of **Smart Grid Action Plans**, similar to existing Energy Efficiency Action Plans or Renewable Energy Action Plans, could contribute for Member State commitment to deploy smart grids, by focusing on the expected costs and benefits.

- The **development of a smart grid governance model**, could contribute with guidance in terms of responsibilities and opportunities for different stakeholders.

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