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Implementation map on barriers and success factors for E1st in buildings

BPIE
IEECP
TU WIEN Technische Universität Wien Vienna | Austria
IREES research for future.
Fraunhofer ISI
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Project Acronym	Enefirst
Project Name	Enefirst – Making the Energy Efficiency First principle operational
Project Coordinator	IEECP Vlasis Oikonomou (vlasis@ieecp.org) Jean-Sébastien Broc (jsb@ieecp.org)
Project Duration	September 2019 – February 2022
Website	http://enefirst.eu

Deliverable No.	D4.2
Dissemination Level	Public
Work Package	WP4 Analysis of specific policy option for implementing E1st in the EU buildings sector
Lead beneficiary	BPIE
Contributing beneficiary(ies)	RAP, IEECP, Fraunhofer ISI, CEU, TU Wien
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Date	
File Name	Implementation map on barriers and success factors for E1st in buildings

To quote this reference, please use:

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 839509.

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EXECUTIVE SUMMARY

From definition to implementation, the Horizon 2020-funded ENEFIRST project aims to implement the "Efficiency First" (E1st) principle in practice and operationalise it in various policy areas. It seeks to improve understanding of the relevance of the E1st principle for decision processes related to energy demand and supply, and its broader impacts across sectors and markets, linked to the energy use of the building sector in EU Member States. E1st means prioritising investments in energy efficiency and other demand-side resources whenever these options are more cost-effective than investments in energy supply, including generation and distribution network, from a societal perspective in meeting the policy objectives.

The research in this report builds on ENEFIRST (2021) which identified policy approaches for implementing the E1st principle in the policy areas of buildings, the power sector and district heating with the potential to be fully implemented across the EU, bringing considerable benefits to consumers.

This report analyses in three steps the barriers and success factors specific to nine previously selected policy approaches. Starting with the systemic identification of barriers and success factors to each policy approach, we then discuss the main factors hampering and enabling these E1st policies in an expert consultation. The results are visualised in so-called 'implementation maps' summarising the main barriers and possible solutions to the implementation of the E1st concept as well as the related legislative and non-legislative changes required.

As shown in our previous research (ENEFIRST 2020a-d), full implementation of E1st requires the concerted action of several stakeholder groups along the decision-making process as well as better harmonisation of EU and national regulatory frameworks. Our analysis generally shows that adaptation of EU legislation is needed to overcome (some of) the barriers but that many institutional barriers require interventions by national and local authorities to enable capacity building and additional resources in regulatory agencies and implementing organisations to realise the concepts and policy approaches.

The consultation with EU and national experts confirmed that more specific guidance is needed from EU level but that implementation of the E1st principle also requires close cooperation between national and regional levels, especially in the buildings and district heating sectors where most decision-making takes place locally.

1 INTRODUCTION

Since its adoption in the EU, the Efficiency First (E1st) principle has been taken up in some national and regional strategic documents but has not been implemented systematically in energy policymaking, planning and investment. This is crucial to decarbonise the energy system most efficiently. E1st as an overarching principle prioritises investments in energy efficiency and demand-side resources whenever these options are more cost-effective than investments in energy supply from a societal perspective in meeting the policy objectives.

This report presents the main barriers specific to implementing a selection of E1st policy approaches in the policy areas of buildings, district heating and the power sector. It thereby adds to research into conceptualising and operationalising the political concept across energy policy. It builds on previous work carried out in the Horizon 2020 ENEFIRST project which defined the E1st principle (ENEFIRST, 2020a), collected international experience in the form of 16 examples (ENEFIRST, 2020b) and analysed their transferability (ENEFIRST, 2020c) to the EU policy framework as well as the main general barriers (ENEFIRST, 2020d) to a broad implementation of E1st. In a parallel work stream, the project analyses the impacts E1st implementation can have on the energy system and total system costs.

To make full use of the concept, E1st should be implemented at the heart of all decision-making – it should be inherent in all decisions and plans regarding the energy system, and thus be put into practice in relevant policy areas. ENEFIRST (2021) identified priority policy approaches, specific policy instruments and legislation, incorporating the E1st principle in policy areas relevant to the EU building sector. Figure 1 shows the selected policy approaches which were analysed regarding their main barriers and success factors for implementation.

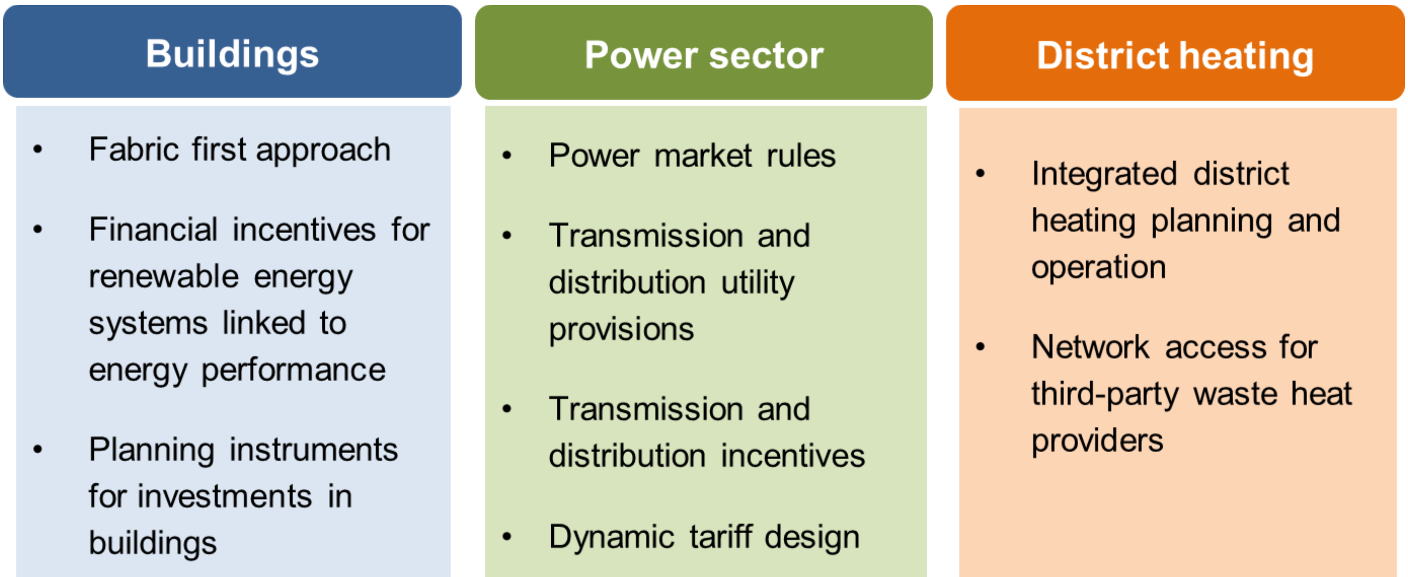

Figure 1: Policy approaches selected for further analysis in ENEFIRST (2021)

Up to now E1st has been a recognised concept in EU policymaking which still lacks implementation in the Member States, on national, regional or local levels. Our research identifies the existing barriers in policy design and implementation alongside the respective stakeholders who are required to take action to solve the persisting issues and create an enabling framework for the realisation of E1st.

In the complex stakeholder landscape of the building sector and related energy systems, tailored guidelines for specific actors on how to implement E1st in a structured approach are crucial. This report aims to provide input to the ongoing work of the European Commission in this regard, and to summarise the key aspects identified in our research on each of the nine policy approaches previously selected.

2 METHODOLOGY

The methodology of analysing the main barriers and success factors in this report follows a three-step approach.

In a **first step**, barriers and success factors to each selected policy approach are identified based on the examples identified in the ENEFIRST project, the literature and the consortium's expert judgement. The collection of barriers and success factors follows the framework of Figure 2 and includes the stakeholder group affected by the barrier or responsible for the success factor as well as a categorisation of factors. The results from this first step are presented in a separate annex (Annex I: Identification of barriers and success factors to Energy Efficiency First implementation in buildings and related energy systems).

Policy area [e.g. building polices, power market]					
Policy approach [e.g. financial subsidy linked to energy performance]		Existing examples of the policy approach			
[Insert summary of the policy instruments/ approach]		[Insert real life examples]			
Identification of barriers					
Key barriers to the policy approach	Type(s) of barrier	Barrier to [Please select]		Stakeholder type facing the barrier	Why is it a barrier to E1st implementation (and not a traditional barrier)?
		Policy design	Policy implementation		
Identification of success factors					
Key success factors of the policy approach	Type(s) of success factor	Success factor in [Please select]		Stakeholder type responsible for the success factor	Which prerequisites/ enabling factors are important?
		Policy design	Policy implementation		

Figure 2: Analytical framework for collecting barriers and success factors to E1st application

In a **second step**, a **consultation workshop** was organised to discuss, validate and rank the barriers and success factors **with EU and national experts**. This online workshop was carried out in an interactive format (using a MIRO board) to receive as much feedback and input from the participants as possible. The discussions were organised in dedicated sub-groups for each of the three selected policy areas: **a) buildings policy, b) power sector policy,** and **c) district heating policy**.

The 41 external participants were invited to give feedback, based on their expertise, on the barriers and success factors identified by the ENEFIRST team in the first step described above. They could add additional aspects that might have been overlooked in our analyses. Having the development of specific policy guidelines in mind, the barriers and success factors were structured by stakeholder type to overcome the barriers at each policy level (EU, national, regional, local). Then each break-out group ranked the updated list of barriers and success factors in terms of what interventions/efforts and which stakeholders should be prioritised to achieve a full operationalisation of the E1st principle.

The minutes of the consultation workshop are available in a separate annex (Annex II: Minutes of the ENEFIRST Expert Online Workshop from April 15th, 2021).

The **third step** of the methodological approach summarised the research and consultation results in "implementation maps" presenting the main barriers and possible solutions as well as the related legislative and non-legislative changes required for each policy approach. These implementation maps are presented below. They are also available separately as standalone documents on the ENEFIRST website.

3 IMPLEMENTATION MAPS FOR E1ST IN BUILDINGS

3.1 Key issues for the implementation of E1st in buildings

The Impact Assessment of the 2030 Climate Target (European Commission, SWD(2020) 176 final) showed that the energy demand of buildings in the EU has to be decreased significantly over the next decade in line with the EU Green Deal and the new EU climate target of a 55% reduction in greenhouse gas emissions (compared to 1990). The Renovation Wave represents the EU Commission's strategy for a transformation of the building sector in line with the needed 60% reduction in greenhouse emissions by 2030 compared to 2015 which the Impact Assessment suggests (European Commission, 2020).

To achieve this target most cost-effectively, energy efficiency improvements and a full decarbonisation of the heating supply need to be optimised, which requires a careful assessment of supply- and demand-side options. Deep renovations can significantly lower the energy consumption of buildings and thus replace the expansion of energy supply capacities if considered in large-scale energy system planning. An energy efficient building envelope is also a prerequisite for distributed low-carbon heating installations, such as heat pumps, to work efficiently and keep the energy required – in this case electricity – to a minimum.

To prevent lock-in effects, the assessment of investment options and decision-making in buildings today needs to take a long-term perspective in light of the objective of achieving a climate-neutral building stock in 2050. Cost-benefit analyses (CBA) should cover a broad scope including multiple impacts building renovations can generate (e.g. improved health and wellbeing). Decisions can be taken at the single building level or for the energy system as a whole, for example when discussing the public financial resources allocated to renovation programmes and energy supply infrastructures, respectively.

For a full decarbonisation of the energy system, energy efficiency measures in buildings need to be assessed carefully. These may be regulated for example in the form of nearly zero-energy building (nZEB) standards for new buildings, or existing buildings in case of major renovations. Whenever demand-side measures are more cost-effective compared to supply-side options after a full assessment of the (societal) benefits, they should be given priority in energy planning and decision-making. This needs to be reflected in policy instruments.

Decision-making and stakeholder groups in the buildings sector

1) Options considered	2) Assessing the options	3) Making the decision
Replacing heating systems Insulating the building envelope	Considering the societal costs and benefits (Multiple impacts, long-term view)	Enabling decisions that implement E1st

Currently, decision-making in the building sector faces several barriers that hinder E1st, including limited information and advice, a strong focus on short-term or narrow cost-effectiveness neglecting multiple benefits, and cultural barriers in the industry.

There are many stakeholder groups involved in decision-making and implementation of energy efficiency measures in the building sector. This diverse stakeholder landscape can create barriers to implementing E1st in buildings, as shown in Table 1.

Stakeholder group	Roles in decision-making related to the implementation of E1st in buildings
National authorities	Definition of national targets Design, and possibly implementation, of the policies and regulations that influence investment decisions
Regional/local authorities	Design, and possibly implementation, of support measures (information/ capacity building campaigns) to ease policy implementation Provision of additional local financial support schemes Coordination of local stakeholders
Energy agency/implementing body	Possible implementing body of policies; information hub for building owners and market actors providing information to guide decision-making
Energy efficiency experts/ energy auditors	Implementation of regulations and policies (energy audits, information and advice on building investment decisions)
Contractors/construction industry	Information and advice on investment decisions in buildings Development of comprehensive offers (or conversely, working in silos)
Industry actors (heating system manufacturers and installers; insulation companies)	Implementation of building renovation and (renewable) heating installation projects for own interests Involvement in public consultation and information campaigns
Industry and trade associations	Information and capacity building on building/heating systems and components Participation in standardisation processes (DIN, CEN etc.)
Building owners	Decision-makers about investments in buildings
Residents/tenants	Subject to the results (benefits) of the measures implemented, and possibly involved in decision-making process

Table 1: Stakeholder groups and their related role in E1st decision-making

Selected policy approaches to implement E1st

To implement the E1st principle in investment decisions for buildings, three policy approaches have been selected for the analysis:

- Fabric-first approach
- Financial incentives for RES linked to energy performance
- Planning instruments for building investments

The fabric-first approach is a general policy approach prioritising ambitious energy performance levels for the building fabric over the installation of heating systems to achieve nearly zero-energy buildings with a good indoor quality in the most cost-effective manner.

To reflect this prioritisation and the role of an improved energy performance in existing buildings, the second approach links financial incentives for renewable energy systems (RES) to a certain energy performance level, while the last concerns planning instruments for building investments to prevent lock-in effects.

3.2 Fabric-first approach

Introducing the policy approach

A “fabric-first” approach to building design and renovation aims to **maximise the energy performance of the components and materials** that make up the building fabric itself in a cost-effective way over the building’s life-cycle. Only then are the installation of heating systems and other building services to **achieve ambitious energy efficiency levels** considered. It can either be applied directly in building regulations to cover new as well as existing buildings or as a general approach in renovation subsidy schemes.

Business as usual	E1st scenario
Nearly zero-energy building (nZEB) standards calculated according to the EPBD Annex I methodology vary across Member States, lack ambition and can be achieved with RES	Low energy building standards are achieved by **prioritising the thermal performance of the building envelope** of existing and new buildings with high quality fabric design
Renovation subsidy schemes support both upgrades of heating systems and energy performance improvements depending on cost-optimality for the building owner	Renovation support schemes implement fabric-first through **eligibility criteria prioritising cost-effective efficiency measures** and/or binding financial incentives for the achieved energy performance levels

Table 2: Business as usual vs. E1st scenario for the fabric-first approach.

Implementation map of barriers and success factors for E1st in buildings

The implementation maps are presented in the next two pages: the first shows the barriers related to policy design and the second the barriers related to policy implementation.

For further reading:

- ENEFIRST report "Priority areas for implementing Efficiency First":

  Chapter 3.1.3 Identified policy approaches in the buildings sector

  Chapter 3.7 EU funding mechanisms

  ENEFRIST international examples:

- ENEFIRST example 15: Fabric first approach under the Better Energy Communities grant scheme
- Stenlund, S. (2016). Applying Fabric First principles: Complying with UK energy efficiency requirements (FB 80). BRE (Building Research Establishment).
- BPIE (2021). Nearly Zero: A review of EU Member State implementation of new build requirements. Buildings Performance Institute Europe.

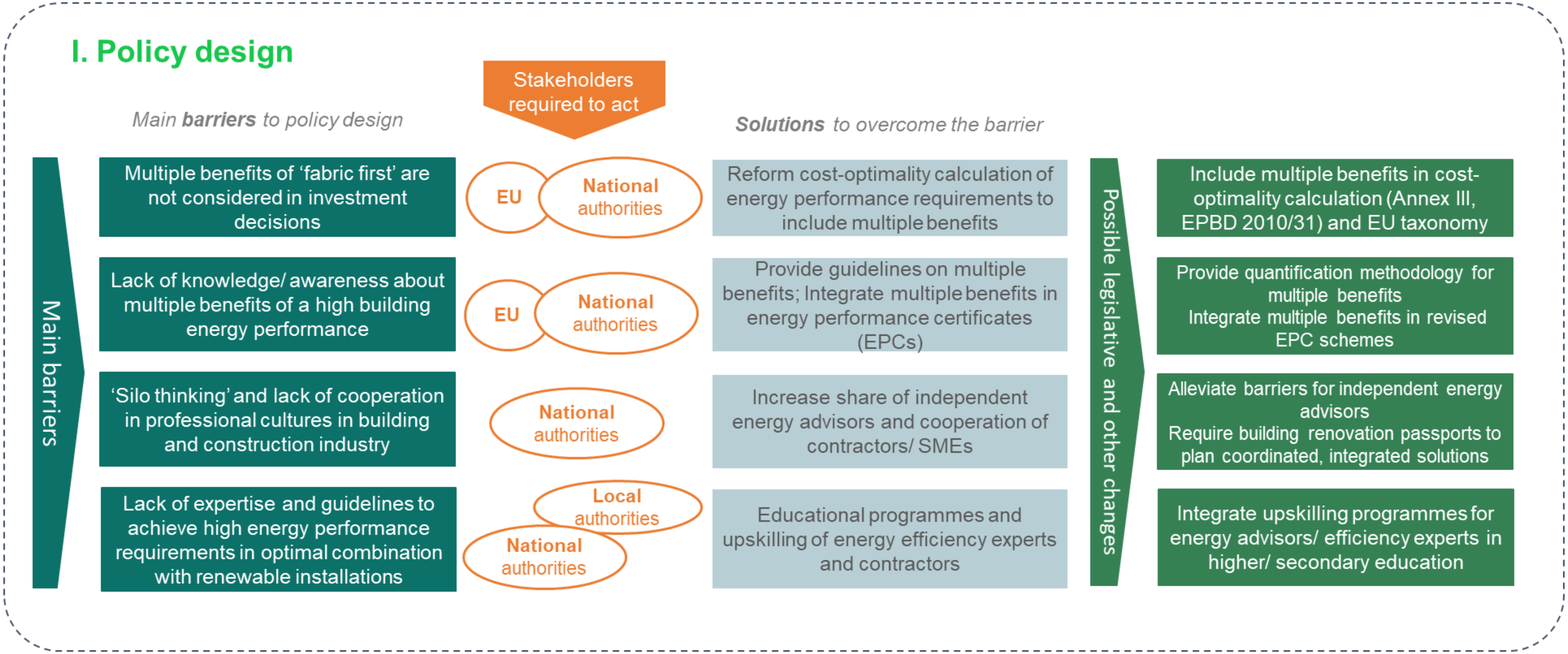

Figure 3: Implementation map for the *fabric-first* approach – Part 1: Overcoming the main barriers related to policy design

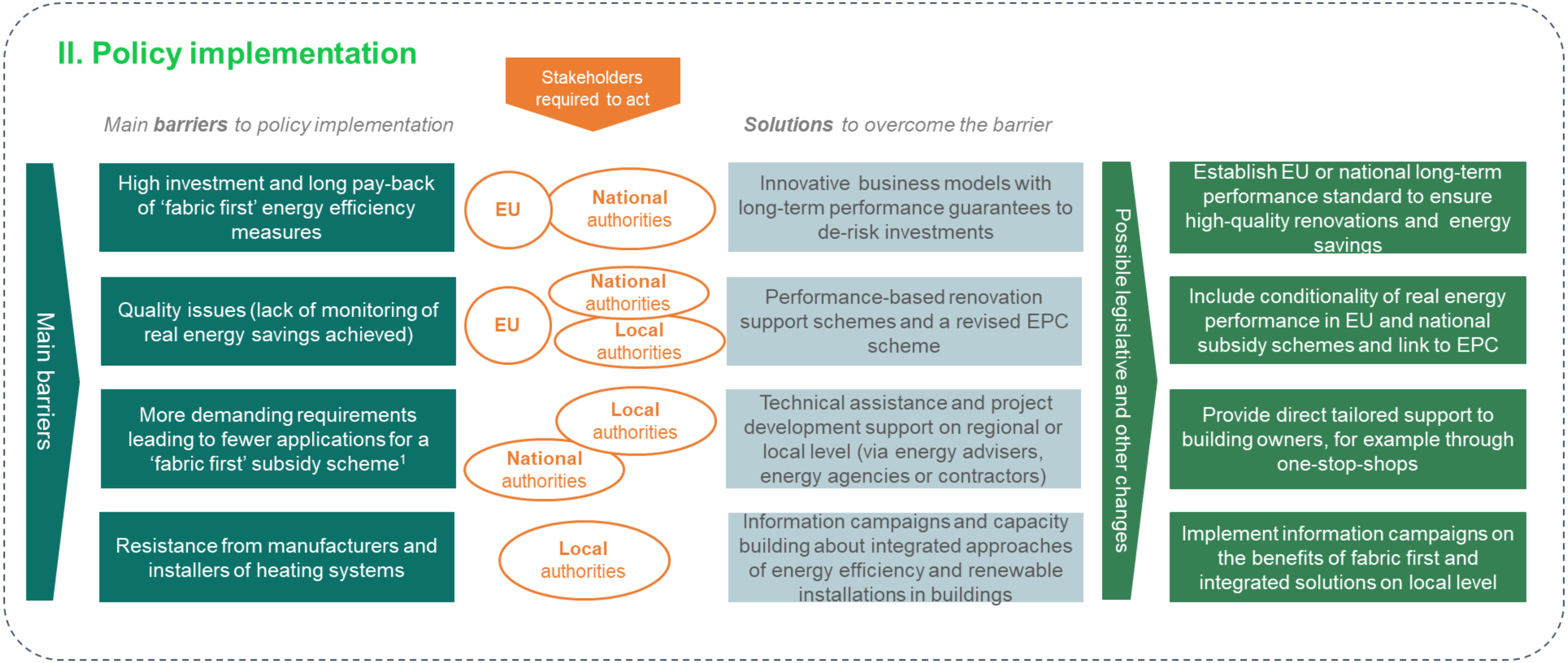

Figure 4: Implementation map for the *fabric-first* approach – Part 2: Overcoming the main barriers related to policy implementation

[1] Experience with the integration of 'fabric first' requirements in Irish subsidy schemes (Better energy communities) administered by the Sustainable Energy Authority Ireland.

3.3 Financial incentives for RES linked to energy performance

Introducing the policy approach

Financial support schemes for distributed renewable energy installations should be **subject to predefined energy performance levels of the related building** or energy efficiency requirements. This ensures the renewable energy system performs as efficiently as possible, is sized adequately thereby limiting its energy consumption, and takes advantage of trigger points, helping to **avoid lock-in effects** (e.g., for roof insulation when installing PV panels).

Business as usual	E1st scenario
Financial incentives for renewable energy systems are available without energy requirements	Financial schemes (grants, feed-in tariffs etc.) **require a certain heat loss/ energy performance level** before investing in the RES
No legal requirements when installing e.g. a heat pump or PV panels	**Energy efficiency requirements** (e.g. roof/ wall insulation) are included in RES incentives (use of trigger points)

Table 3: Business as usual vs. E1st scenario for the "financial incentives for RES linked to energy performance" approach

The implementation maps are presented on the next two pages: first the barriers related to policy design, and second those related to policy implementation.

For further reading:

- ENEFIRST report "Priority areas for implementing Efficiency First"
  - Chapter 3.1.3 Identified policy approaches in the buildings sector
  - Chapter 3.7 EU funding mechanisms
- ENEFIRST international examples:
  - Case study 1: Building energy performance requirements of the Irish heat pump system grant
  - Case study 16: Linking renewable support to building energy performance

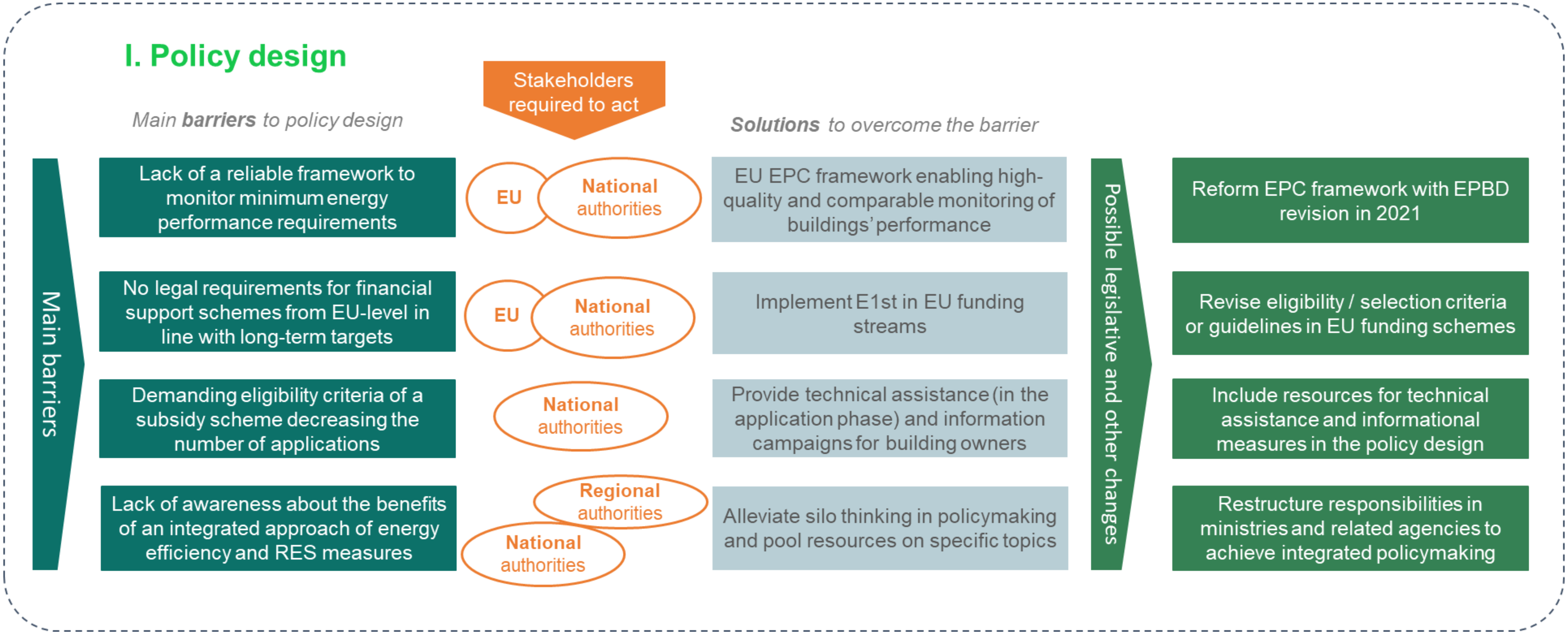

Figure 5: Implementation map for the *financial incentives for RES linked to energy performance* approach - Part 1: Overcoming the main barriers related to policy design

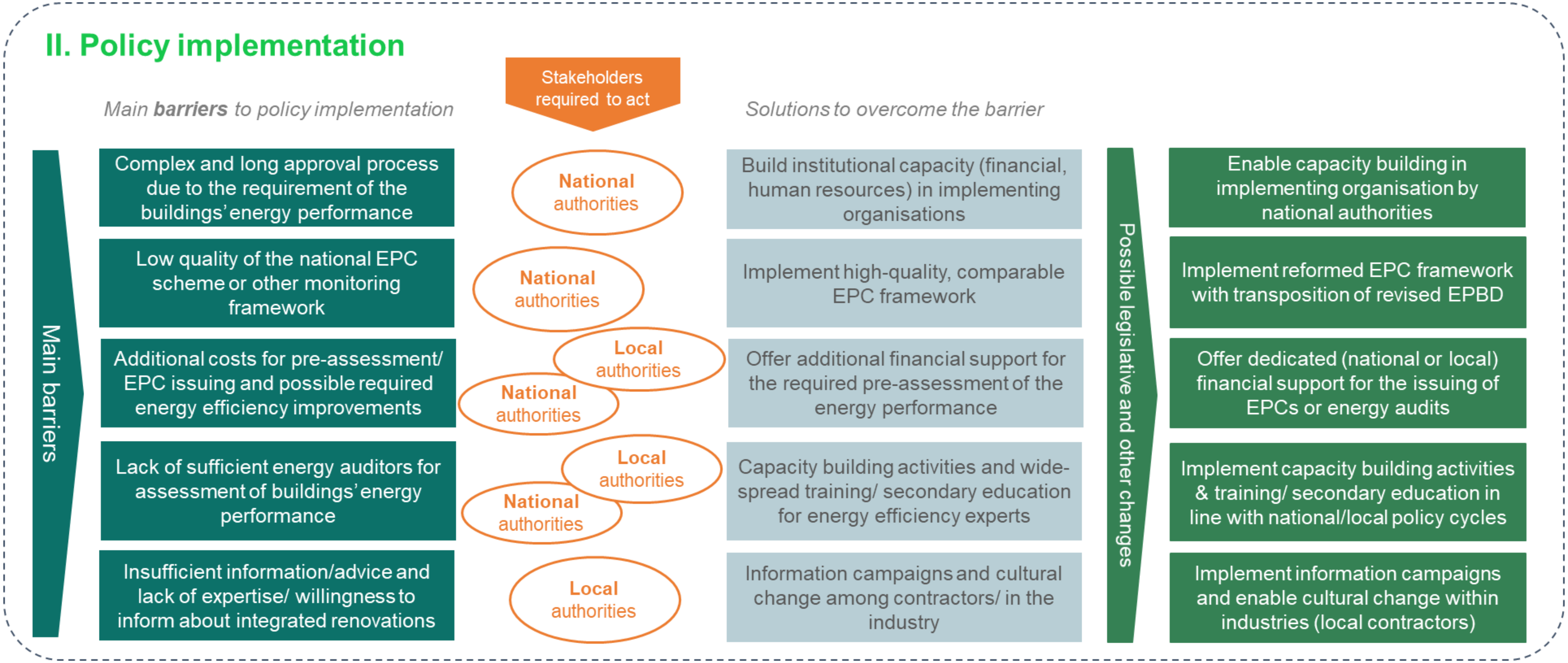

Figure 6: Implementation map for the *financial incentives for RES linked to energy performance* approach - Part 2: Overcoming the main barriers related to policy implementation

3.4 Planning instruments for investments in building performance

Introducing the policy approach

Buildings have long lifecycles and **are only renovated at certain intervals** which makes them prone to lock-in effects if different renovation measures are not coordinated well in terms of cost efficiency and E1st. Planning instruments and services can prioritise energy efficiency measures by **facilitating the comparison of renovation scenarios or patterns**, making the process of renovating easier, more transparent and more efficient.

Business as usual	E1st scenario
Building renovation investments are based on a cost-benefit decision by the building owner/energy advisor at one point in time	Renovation scenarios **towards deep renovation are planned with a long-term perspective** coordinating different measures to prevent lock-ins
Building owners lack full information and expert advice regarding technical renovation measures, benefits and financing options	Consultation by energy advisors involves planning instruments (e.g. building renovation passports), **considers all renovation options across building trades** and informs about multiple benefits and available financial schemes
Financial incentives for building renovation are available without energy requirements	Financial schemes (grants, subsidies etc.) require **a certain energy performance level after renovation** in their eligibility criteria

Table 4: Business as usual vs. E1st scenario for the "Planning instruments for investments in building performance" approach

The implementation maps are presented in the next two pages: first the barriers related policy design, then those related to policy implementation.

For further reading:

- ENEFIRST report "Priority areas for implementing Efficiency First"
  - Chapter 3.1.3 Identified policy approaches in the buildings sector
  - Chapter 3.7 EU funding mechanisms
- ENEFIRST international examples:
  - Case study 12: Building Logbook-Woningpas: Exploiting efficiency potentials in buildings through a digital building file
  - Case study 13: Optimizing building energy demand by passive-level building code
- BPIE & INIVE (2020). Technical study on the possible introduction of optional building renovation passports. European Commission, May 2020

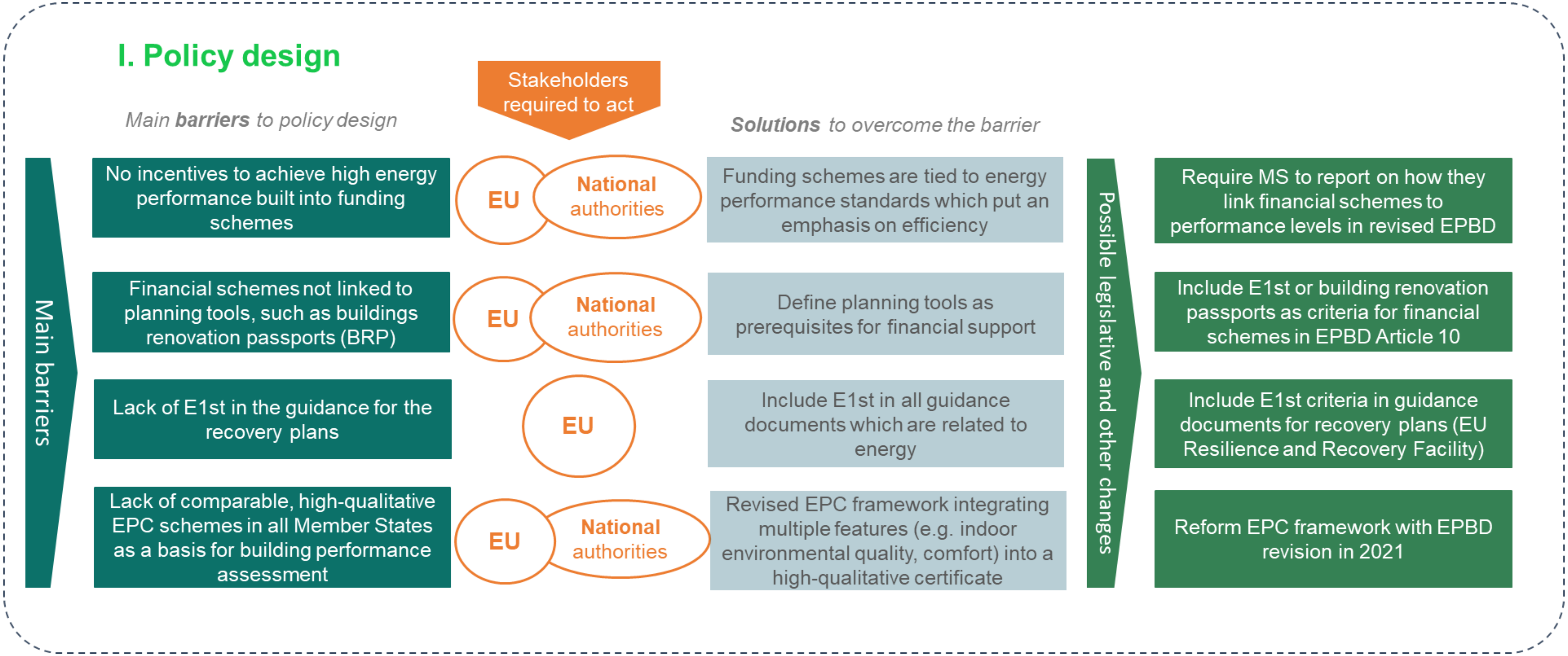

Figure 7: Implementation map for the *planning instrument for building investments* approach - Part 1: Overcoming the main barriers related to policy design

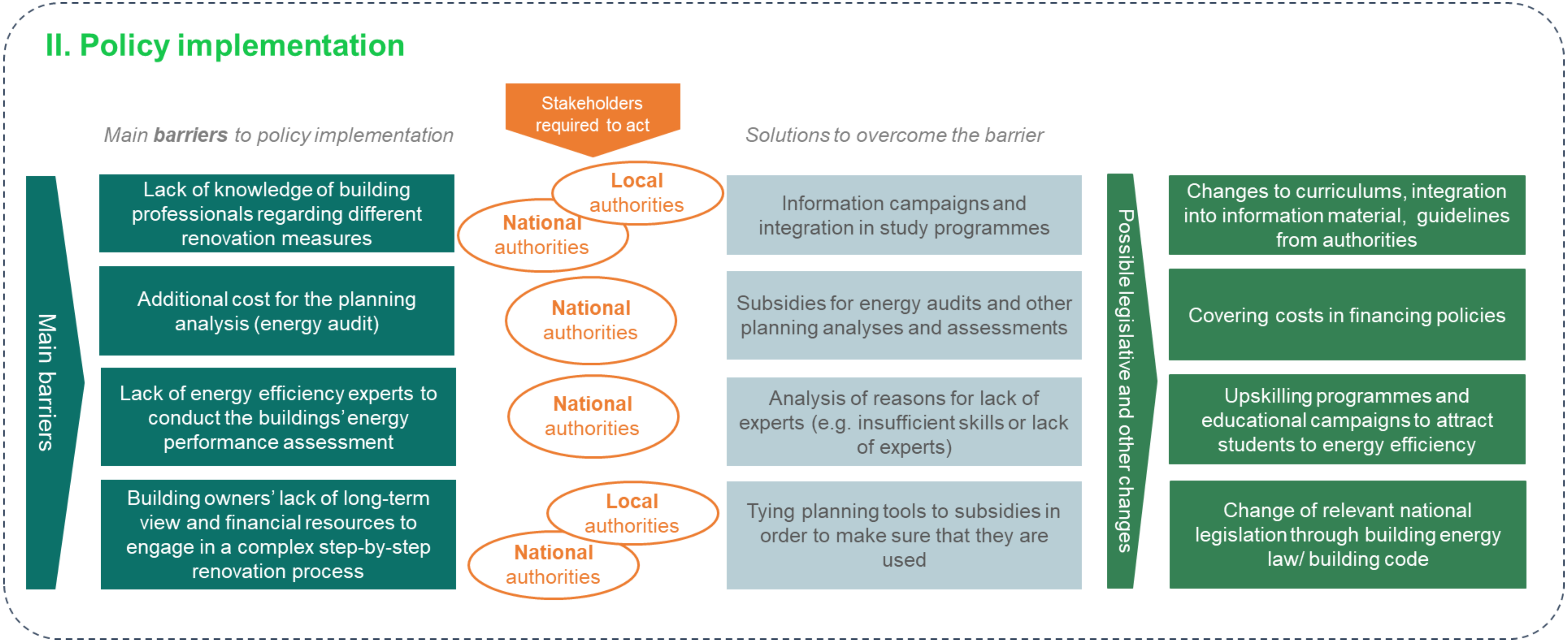

Figure 8: Implementation map for the *planning instrument for building investments* approach - Part 2: Overcoming barriers related to policy implementation

4 IMPLEMENTATION MAPS FOR E1ST IN THE POWER SECTOR

4.1 Key issues for the implementation of E1st in the power sector

The selected key policy approaches in the power sector have been defined in the new EU power market design adopted in 2019 (Electricity Directive and Electricity Regulation). The requirements set forth in the European legislation, however, need to be transposed and translated into concrete national-level regulations. Even though the key actor for all these policy approaches is the national regulatory agency (NRA), several stakeholders are required to cooperate for the effective integration of demand-side resources. The EU Member States are at various stages of this process.

Decision-making and stakeholder groups in the power sector

There are several stakeholder groups involved in decision-making and implementation of E1st in the power sector with the national regulators being at the centre (Table 5).

Stakeholder group	Roles in decision-making related to the implementation of E1st in buildings
National authorities	Design, and possibly implementation, of broad policy directions that guide regulation and influence investment decisions
Energy agency/implementing body	The national regulator is the key actor in devising both power market regulation and the regulation of network companies (distribution/transmission system operators – DSOs/TSOs)
Distribution system operators	DSOs are key potential users of demand-side resources in operating grids reliably and at lowest cost
Aggregators	Aggregators are third-party actors or suppliers that pool demand into larger units that are sizable enough to enter the various power markets
Energy suppliers	Energy suppliers can be required in the framework of energy efficiency obligations (EEOs) to invest into energy efficiency in buildings
Consumers	Consumers are the key decision-makers to provide power system services either via tariff-induced behaviour or by directly selling their flexibility in the power markets (most often via aggregators)

Table 5: Stakeholder groups and their related role in E1st decision-making

Selected policy approaches to implement E1st

We selected four policy approaches to implement the E1st principle in the power sector. The first two relate to the competitive segment of the power sector: the consumer (dynamic tariffs) and the rules guiding the access of demand-side resources to the various markets. The latter two focus on the regulated segment: rules governing the inclusion of demand-side resources in the planning process of network companies, and the incentives provided in their revenue regime to use these resources.

Dynamic tariff design	Power market rules	Transmission and distribution utility provisions	Transmission and distribution company incentives

4.2 Dynamic tariffs

Introducing the policy approach

Network and retail tariffs can incentivise a smart or responsive use of flexible loads such as heat pumps, water heaters or EVs by consumer, thereby reducing peak load and the need for investment in the grid.

Business as usual	E1st scenario
The energy and network tariff paid by consumers is **independent** from market and system conditions	Consumers pay less in case of abundant generation and network supply and more in scarcity periods
Load is considered to be **inelastic**	Consumers **do respond** to prices

Table 6: Business as usual vs. E1st scenario for the "dynamic tariffs" approach

The implementation maps are presented in the next two pages: first the barriers related to policy design, then those related to policy implementation.

For further reading:

- ENEFIRST report “Priority areas for implementing Efficiency First”
  - Chapter 3.2.3 Identified policy approaches in the power sector
- Weston, F. (2000). Charging for Distribution Utility Services: Issues in Rate Design. Regulatory Assistance Project (RAP).
- LeBel, M. and Weston, F. (2020). Demand Charges: What Are They Good For? RAP.
- IRENA (2019). Innovation landscape brief: Time-of-use tariffs, International Renewable Energy Agency, Abu Dhabi.

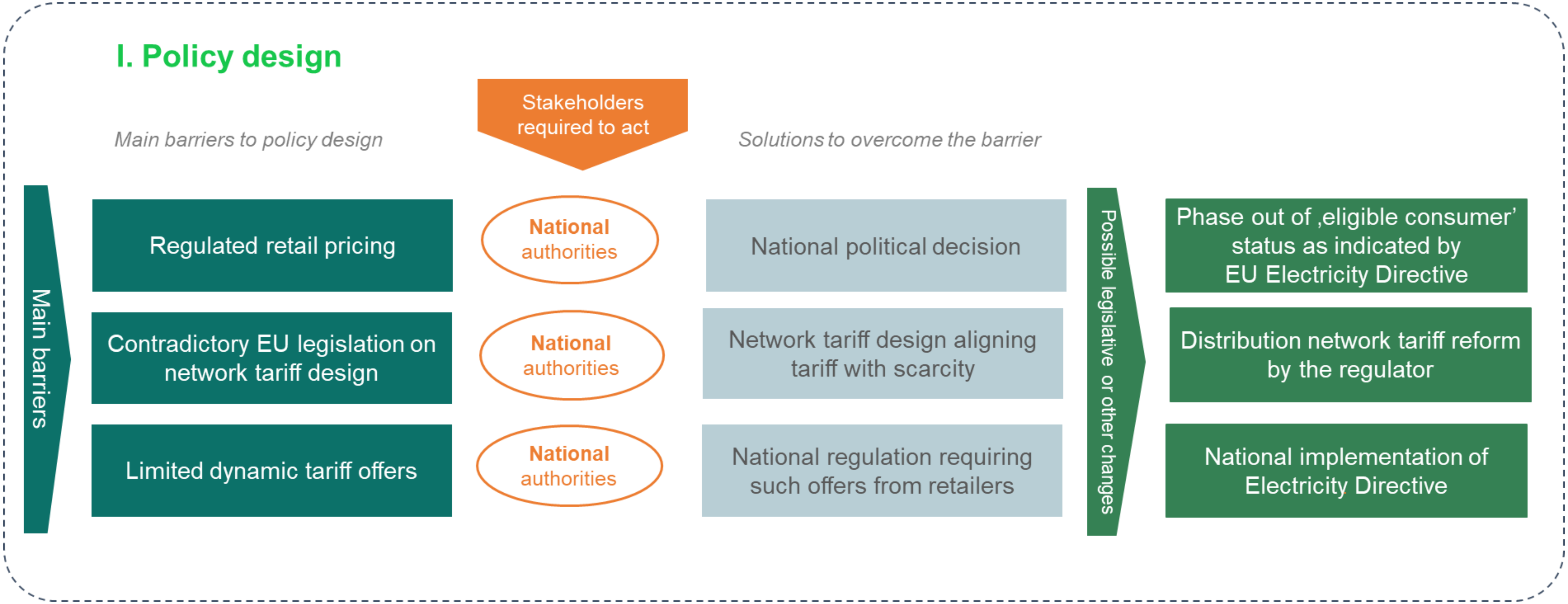

Figure 9: Implementation map for the *dynamic tariffs* approach - Part 1: Overcoming barriers related to policy design

Note: "National authorities" can refer to different national entities given the organisational structure in each Member State. The phase-out of regulated prices is usually a political decision taken by the ministries, whereas the implementation of new tariff designs is the competence of the national regulator.

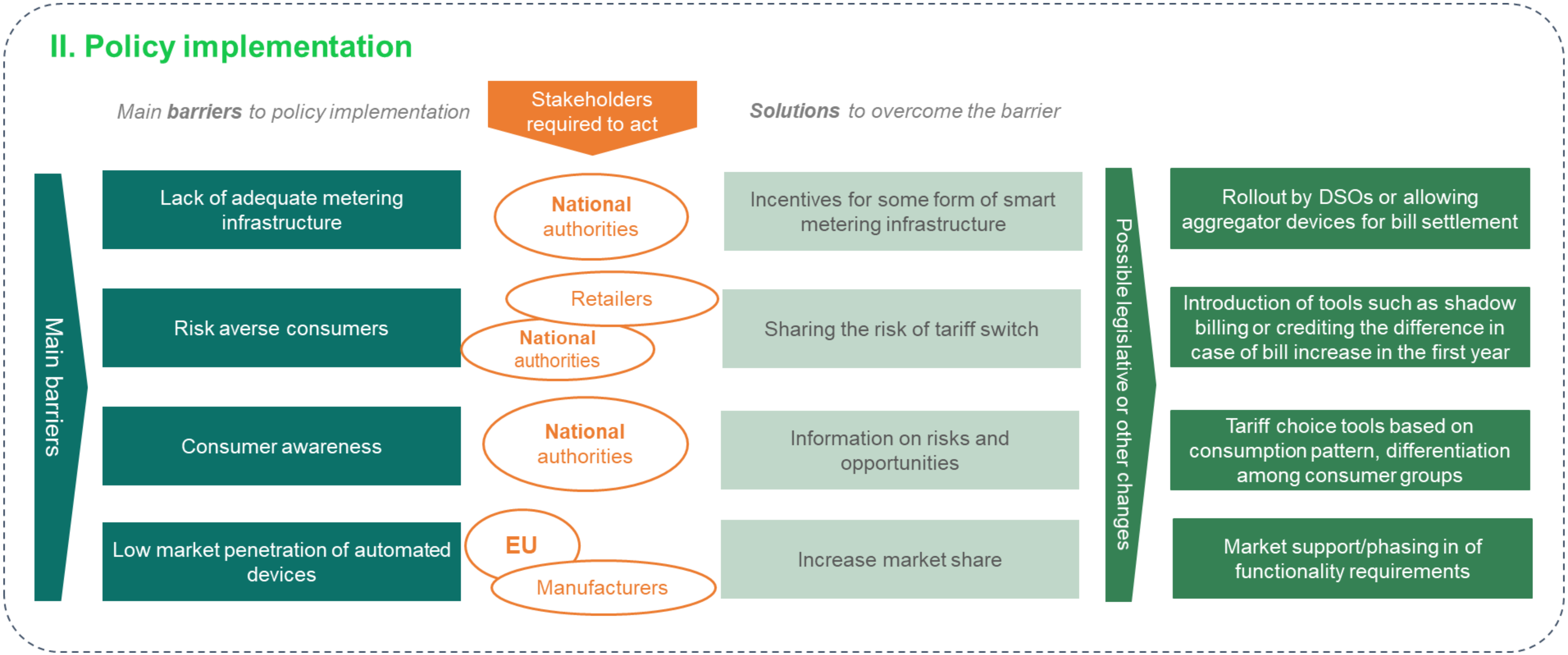

Figure 10: Implementation map for the *dynamic tariffs* approach - Part 2: Overcoming barriers related to policy implementation

4.3 Power market rules

Introducing the policy approach

Demand-side resources can be mobilised next to generation to guarantee that supply and demand in the power system **are balanced at all times**. However, this requires market rules that provide their access to the various power markets (wholesale, balancing) and the capacity mechanisms, where applicable.

Business as usual	E1st scenario
Only generation units compete in the various power markets	Demand-side resources have access to these markets not only de jure but **de facto** as well
Power markets are designed for large-scale units only	**Aggregation** of smaller capacities (across generation and demand) is allowed, and these aggregated resources are treated **as single units** in the market

Table 7: Business as usual vs. E1st scenario for the “power market rules" approach

The implementation maps are presented in the next two pages: first the barriers related policy design, then those related to policy implementation.

For further reading:

- ENEFIRST report “Priority areas for implementing Efficiency First”
    - Chapter 3.2.3 Identified policy approaches in the power sector
- Hogan, M. (2017). Follow the missing money: Ensuring reliability at least cost to consumers in the transition to a low-carbon power system, *The Electricity Journal* 30(1): 55-61.
- Pató, Z., Rosenow, J. & Cowart, R. (2019). Efficiency First in Europe’s new electricity market design — how are we doing? Proceedings of the ECEEE 2019 Summer Study, 495-502.

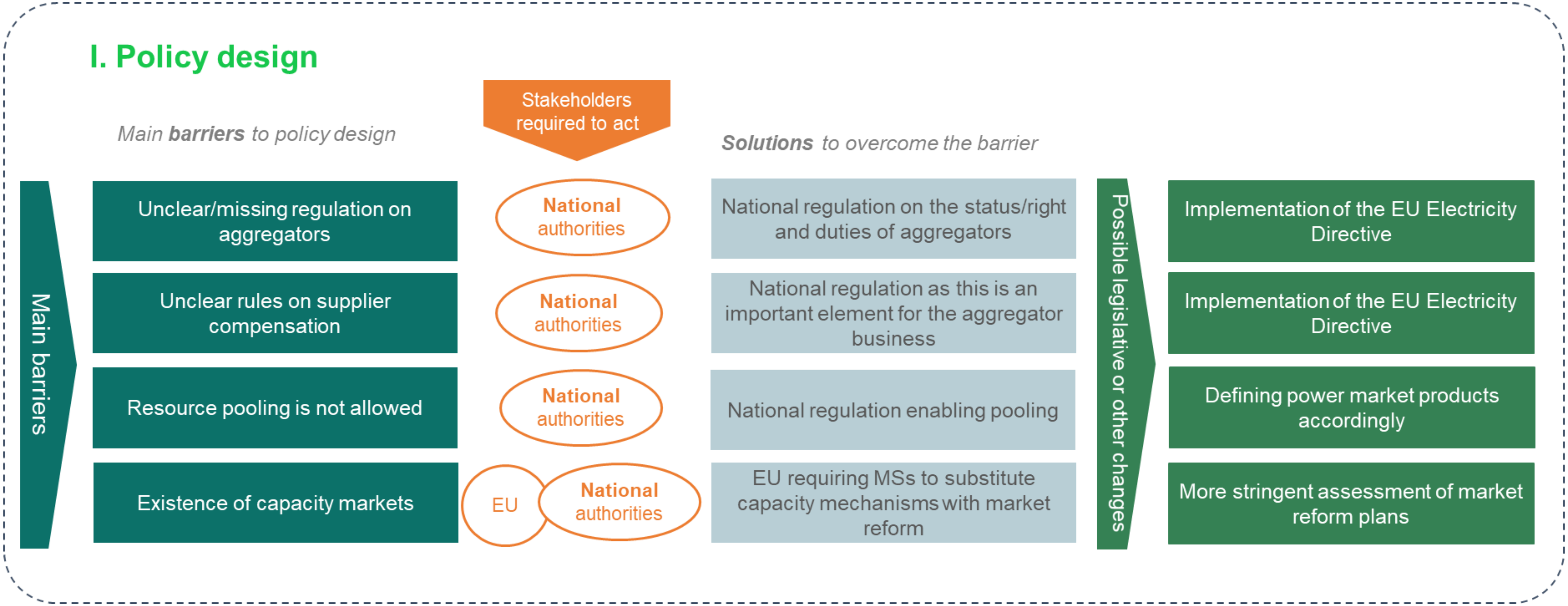

Figure 11: Implementation map for the *power market rules* approach - Part 1: Overcoming barriers related to policy design

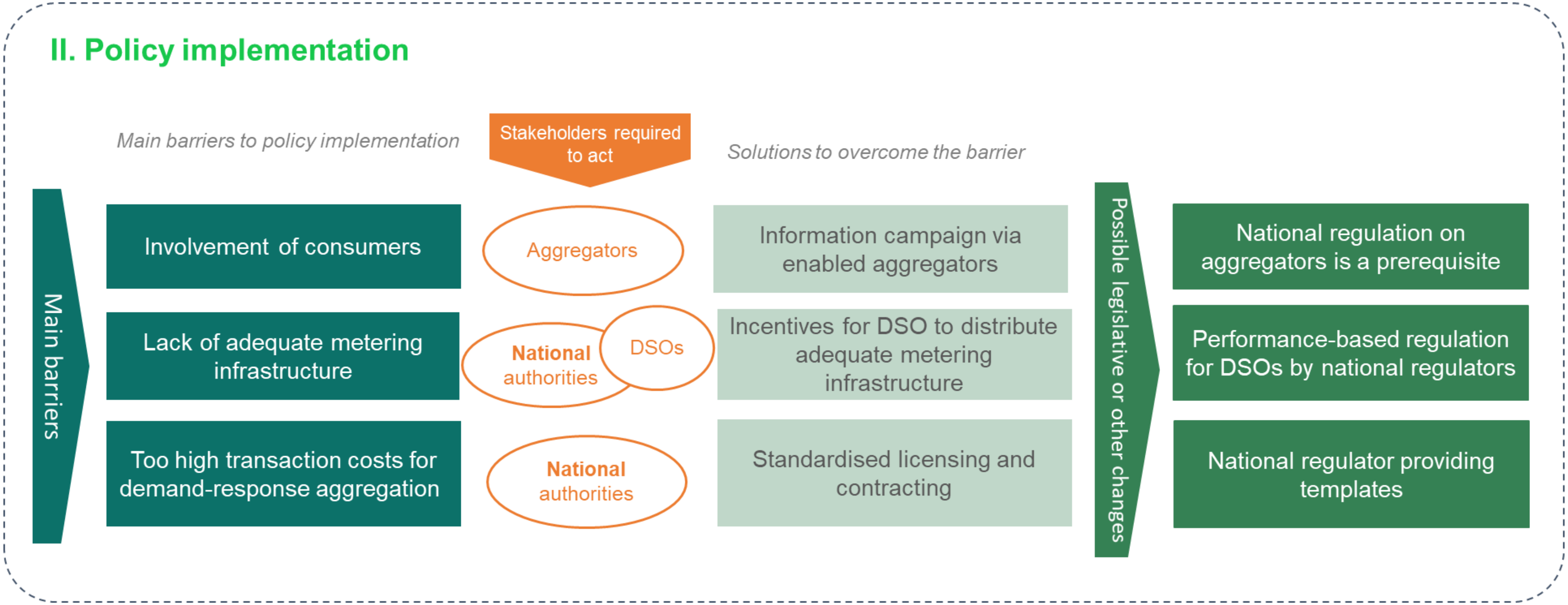

Figure 12: Implementation map for the *power market rules* approach - Part 2: Overcoming barriers related to policy implementation

4.4 Transmission and distribution company incentives

Introducing the policy approach

Financial incentives can encourage regulated network companies (DSOs, TSOs) to consider and invest in demand resources as an alternative to building new grid capacities.

Business as usual	E1st scenario
Network companies have an **incentive to invest** into their assets as they earn a rate of return on the investment	The same revenue can be earned on **all types of costs** incurred (CAPEX or OPEX)
Network companies have **no incentive** to actively innovate and **align with the power system transition**	**Performance-based incentives** could reduce the inertia of network companies and increase their appetite for more risky but potentially more efficient solutions

Table 8: Business as usual vs. E1st scenario for the "transmission and distribution company incentives" approach

For further reading:

- ENEFIRST report "Priority areas for implementing Efficiency First"
    - Chapter 3.2.3 Identified policy approaches in the power sector
- Pató, Z., Baker, P. and Rosenow, J. (2019) Performance-based regulation: Aligning incentives with clean energy outcomes. RAP

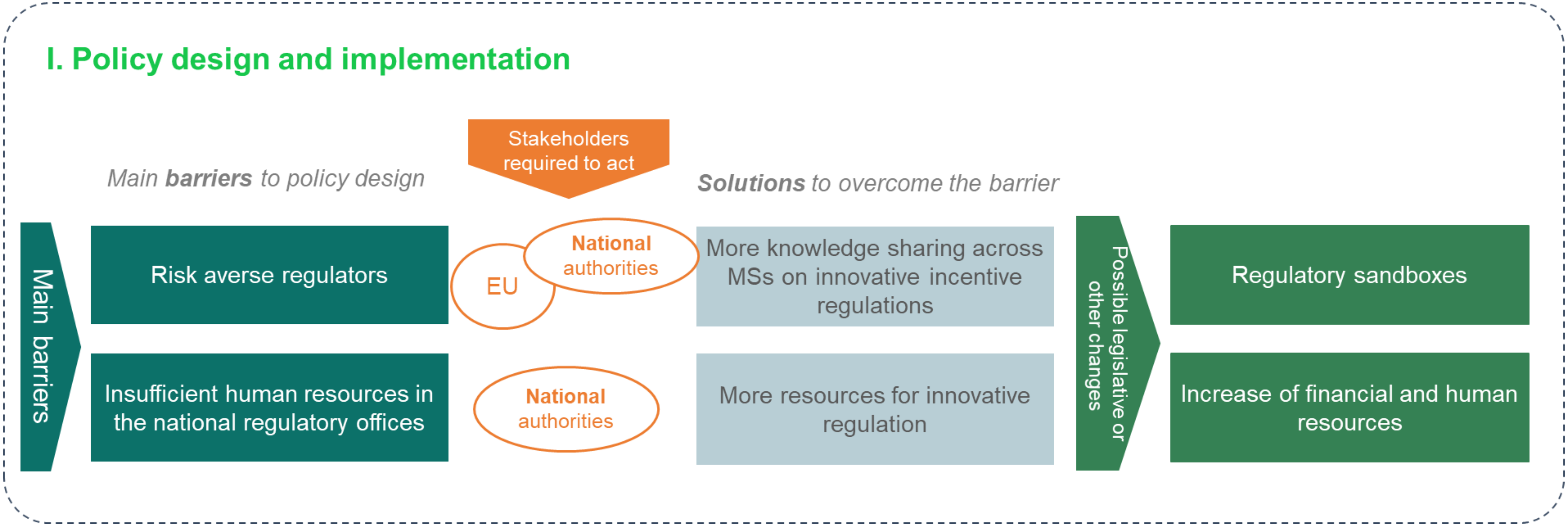

Figure 13: Implementation map for the *transmission and distribution company incentives* approach

4.5 Transmission and distribution utility provisions

Introducing the policy approach

Legal provisions are introduced requiring network companies – at both transmission and distribution levels – to consider demand-side resources in grid planning and operations.

Business as usual	E1st scenario
Planning by TSOs and DSOs is based on forecasted peak load and a fit-and-forget approach.	TSOs and DSOs have to assess the potential and the cost of mobilising demand-side resources and **use them as alternatives** to network investment whenever they provide more net benefit
Development plans are not public and only discussed with the national regulator	Network planning is **public** so that the need for demand resources and their availability can be matched

Table 9: Business as usual vs. E1st scenario for the *transmission and distribution utility provisions* approach

For further reading:

- ENEFIRST report “Priority areas for implementing Efficiency First”
  - Chapter 3.2.3 Identified policy approaches in the power sector
- CEER (2020). CEER Paper on DSO Procedures of Procurement of Flexibility. Council of European Energy Regulators.

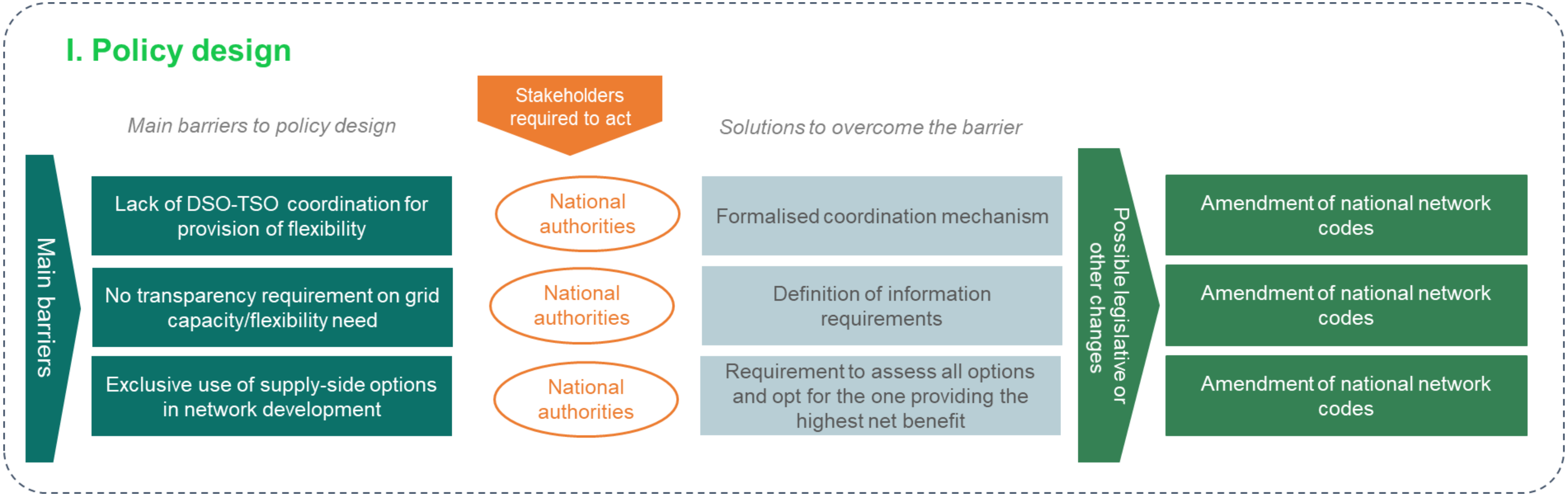

Figure 14: Implementation map for the *transmission and distribution utility provisions* approach - Part 1: Overcoming barriers related to policy design

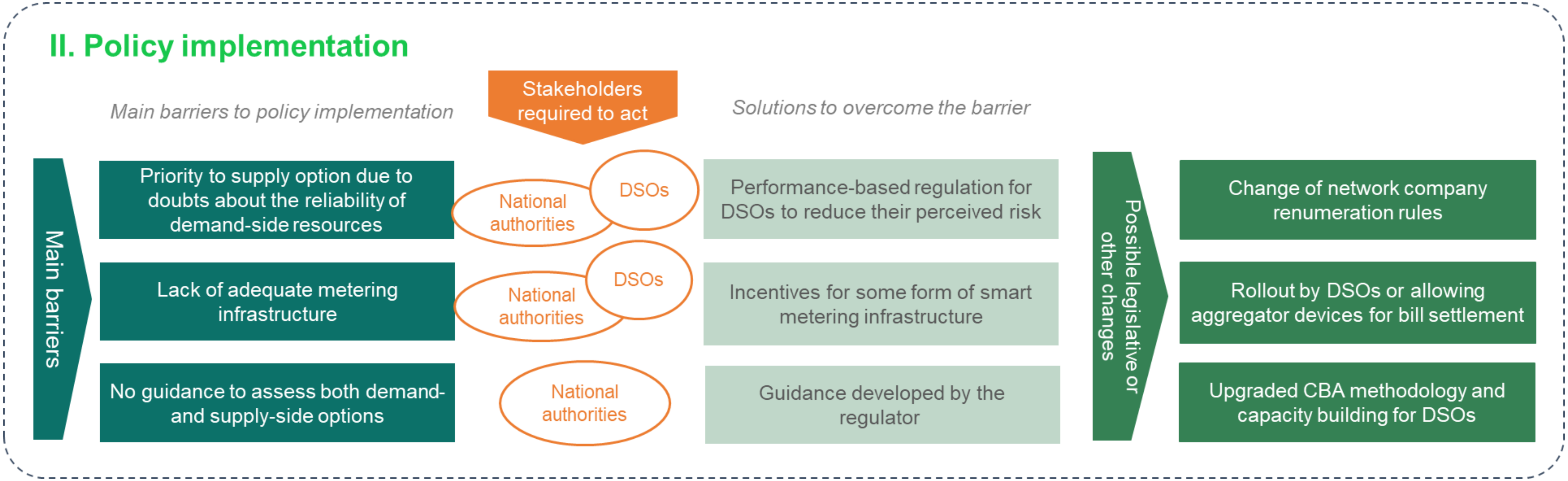

Figure 15: Implementation map for the *transmission and distribution utility provisions* approach - Part 2: Overcoming barriers related to policy implementation

5 IMPLEMENTATION MAPS FOR E1ST IN DISTRICT HEATING

5.1 Key issues for the implementation of E1st in district heating

District heating (DH) networks are regarded as a **key element for the transition of Europe's heating sector**. The European Commission (2016)'s Heating and Cooling Strategy acknowledges DH systems as key infrastructures in densely populated areas to reduce energy dependency and greenhouse gas emissions, and to cut costs for households and businesses. Today, there are **more than 7,000 DH networks in Europe**, which serve approximately **60 million citizens** (Rutz et al., 2019). According to the Heat Roadmap Europe project, almost half of Europe's heat demand could be met by DH by 2050, depending on the strategies and policies adopted by the Member States. The **new generation of DH systems** are versatile and flexible enough to supply low-temperature heat for space heating and domestic hot water, and to integrate various heat supply sources, especially from renewable energy sources and waste heat (Lund et al., 2014).

DH infrastructure assets are highly **capital intensive** and thus prone to **long-term lock-in effects**. Moreover, any infrastructure implies proximate environmental and societal impacts, depending on the energy source(s) used and the heating costs for building occupants. Implementing the E1st principle in the district heating sector is then about **determining the cost-optimal mix of demand- and supply-side resources** to meet consumer demand for heated buildings and domestic hot water, from a societal perspective and with explicit consideration of non-monetary impacts.

For example, the E1st principle can question the relevance of investing in new renewable heat generation capacities, if this is to supply buildings with a low energy efficiency. This might indeed result in oversized heating capacity that is expensive in comparison to potential energy savings in buildings, when considering lifecycle costs and multiple impacts of both options. Depending on the local context, however, changing the supply source can be a priority, especially when the source is coal and when heat plants reach their end of lifetime or need major maintenance.

Recent studies have explored the interplay of building renovation – as a major demand-side resource – with supply-side heat strategies in urban DH system planning (e.g. Harrestrup et al., 2014 ; Delmastro et al., 2020). These studies confirmed the need to consider first the energy efficiency improvement of buildings, as this facilitates the transition to cleaner heat not only by reducing peak capacity but also by proving increased flexibility (e.g., improved building thermal mass). The studies also highlight the **necessity of taking a comprehensive view on DH planning and operation –** including both demand- and supply-side resources.

However, demand- and supply-side planning for DH systems in Europe are typically detached from one another. This is related to the **ownership structures and business models** of DH systems and their implications for how costs, benefits, risks and rewards of investments are shared among actors. In essence, two ownership models for DH systems can be distinguished (Rutz et al., 2019):

(1) In the **fully public model**, investment is implemented by a public utility company, and the financial risk is covered by the municipality. In theory, municipalities can thus consider in an integrated way investments in demand-side resources (e.g., renovation programmes) and in the DH system.
(2) In the **private model**, investments are made by private investors seeking to maximise profits. By default, such DH companies have no direct incentive to bring about demand-side savings as this diminishes the amount of heat supplied and thus the company's established form of revenue. In theory, municipal

authorities could foster the E1st principle by prescribing forms of utility remuneration that can create incentives for considering demand-side resources in system investment planning.

Regardless of the ownership model, a key concern for any DH system is its **economic viability** (cf. competition with alternative forms of heat supply). End-use efficiency measures in buildings might reduce heat density and thus revenue for DH companies, eventually leading to higher tariffs. In the meantime, buildings with high thermal standards require lower supply temperatures, which is an important enabler for low-temperature supply from renewable energy sources (e.g., geothermal and solar thermal, heat pumps) or waste heat in fourth-generation DH systems (Lund et al., 2014). Likewise, reducing the heat demand in buildings allows more buildings to be connected to the same network, increasing the company's customer base (Rutz et al., 2019).

The **legal framework for DH** at EU level is rudimentary. Design and regulation of DH systems are ultimately determined by national legislative frameworks and municipal governments. Key EU legislation for DH systems with respect to the E1st principle and the aspects of demand- and supply-side efficiency are:

- **Energy Efficiency Directive** (EED, 2012/27/EU and (EU) 2018/2002), with Article 14 on promotion of efficiency in heating and cooling, Annex VII on potential for efficiency in heating and cooling and Annex IX on cost-benefit analysis: the EED provides an opportunity for integrated district heating and cooling planning. However, the **provisions** are **mostly focused on supply-side efficiency** and ignore the possible contribution of demand-side efficiency measures in meeting heating and cooling needs aside from general assumptions on demand growth.
- **Renewable Energy Directive** (RED II, (EU) 2018/2001), with Article 15 on administrative procedures, regulation and codes, and Article 24 on district heating and cooling: RED II requires that the deployment of DH plants takes into account E1st, with a focus on **third-party access of waste heat and renewable energy supply to enhance supply-side efficiency**. However, existing provisions are considered too weak to fundamentally change the situation of waste heat providers intending to feed in.

Decision-making and stakeholder groups in district heating

Municipalities are usually the central actor for decisions related to DH, as they most often either own the DH company or contract a DH company. Moreover, they are responsible for local energy planning. DH companies are also key actors, as they prepare and implement the investments related to DH.

The in-house capacities of municipalities can vary significantly. National and regional authorities or agencies can therefore play an important role in providing technical support, and in facilitating experience sharing. This role can also be taken by associations of local authorities or DH companies.

Table 10 provides an overview of the stakeholder groups and their possible role(s) related to E1st decision-making.

Stakeholder group	Roles in decision-making related to the implementation of E1st in district heating
National authorities	Set the general legal framework for DH, and possibly for regional and local energy planning Responsible for implementing EED Article 14 (cf. comprehensive assessments and setting the conditions for cost-benefit analysis)

	May set objectives for the development of DH, targets for the share of RES in DH supply, or other objectives as part of the national energy policy May provide funding for the development of DH, or for R&D related to DH
Regional authorities	Responsible for regional energy planning, that may identify opportunities for DH and the use of waste heat May provide funding for the development of DH (for example, as part of regional operational programmes co-funded with EU funding)
Local authorities	Responsible for local energy planning, and especially for deciding whether to develop DH or not May own, partly or fully, the DH company, or may issue the call for tenders to select a DH company Set the contract of the DH company, including a set of technical objectives, the remuneration and pricing framework May implement local programmes for the renovation of buildings or support the local implementation of regional or national programmes (possibly focusing on areas connected to the DH network) May own some of the buildings connected to the DH network (e.g., municipal buildings, schools, sport facilities, social housing), which can facilitate integrated planning
District heating companies	Make the investments in the DH infrastructures that, in the case of public ownership, are in line with the objectives set by the municipality Operate the DH system, and in charge of efficiency in the supply of heat May be involved in projects to optimise the heat demand (but very rare up to now, apart from pilot projects)
Energy agency or technical institutes	May do studies related to DH, and especially provide support to public authorities (national, regional or local) in the assessment of DH potentials May provide methodologies for regional/local energy planning, assessment of DH potentials, etc. May lead or supervise R&D related to DH May facilitate experience sharing between municipalities and DH companies
Building owners	May be willing or reluctant to connect to the DH network May be willing or reluctant to take part in renovation programmes
Residents/ tenants	May complain in case of dissatisfaction about thermal comfort or heating price/bills
Associations of DH companies or local authorities	May promote changes in the legal framework May facilitate experience sharing between municipalities and DH companies
Third-part heat providers	May promote changes in the legal framework May provide data about potentials for the use of waste heat (or other heat sources) and related costs

Table 10: Stakeholder groups and their related role in E1st decision-making

Selected policy approaches to implement E1st

DH systems can be considered from **two perspectives** as regards the E1st principle:

1) **Comparing investment options for end-use efficiency** (e.g., building renovation, demand response) **and for heat supply** (e.g., heat generation and distribution)
2) **Considering efficiency in the supply-side** (e.g., lower heat temperature and lower losses in heat distribution) as a complement to end-use efficiency (Rutz et al., 2019).

The first perspective emphasises the need for **integrated planning**, considering altogether the planned changes in heat demand (e.g., decrease due to higher energy efficiency in buildings), the planned changes in connected areas (e.g., DH extension) and the planned changes in the supply (e.g., increase in the share of renewable energy sources).

The EU objective of promoting the **use of waste heat** (cf. EED Article 14) is related to the second perspective.

We therefore selected two policy approaches to implement the E1st principle in the district heating sector, each related to one of the two perspectives mentioned above.

Integrated district heating planning and operation

Network access for third-party waste heat providers

Integrated DH planning may benefit an urban settlement through cost-optimal deployment of demand- and supply-side resources from a societal perspective. In addition, from the perspective of investors, it may spread risk around different resource options, thus enhancing the security of expected returns. As such, integrated DH planning may foster long-term confidence in DH systems from the viewpoint of both DH companies and their customers. Due to the long investment cycles related to building refurbishment and heat supply infrastructure, many decisions must be made today to ensure a climate-neutral heat supply in 2050. Integrated DH planning is to be considered as part of a broader *integrated heat supply planning* laying the foundation necessary for the transition to renewable heat supply, both in areas with DH networks as well as within areas with individual heating systems. *Integrated heat supply planning* should identify and determine the following (Peters et al., 2020):

- Forms of renewable heat supply available and where they can be used
- Land required to do this
- Excess heat potentials
- Suitable neighbourhoods which can be supplied with a DH network
- Heat supply in areas without DH networks
- Climate-neutral heat supply for new commercial and residential areas
- Energy efficiency upgrades that can help reduce costs for delivering and running the DH system.

Implementing an integrated approach to DH planning faces several challenges. First, determining technology potentials and implementing them is a complex process that concerns various stakeholders, including heat suppliers (including waste heat from industry); DH operators; housing associations; building owners; end users; local policymakers, and more (Rutz et al., 2019). To ensure acceptance of the measures, it is important to establish committees and institutions for decision-making. Second, scrutiny must be applied to the economic viability of the DH system if end-use efficiency measures are to reduce heating demand. This depends on the characteristics of the buildings and DH system under consideration. Finally, the economic viability of the DH system also depends on its supply-side competitors. The added value of the broader *integrated heat supply planning* lies in the fact that all stakeholders – including municipal decision-makers, the administration with its specialist departments, energy companies as well as the broader public – are provided with a roadmap for the coming decades.

According to Papapetrou et al. (2018) Europe holds a technical potential of about 300 Terawatt-hours per year in **waste heat** from industrial and commercial installations that can be recovered in DH networks and other applications. Further scrutiny is required in terms of how to adjust the EU regulatory and legal framework so that cost-effective levels of waste heat are exploited in DH systems.

To enable the use of waste heat in DH networks, its providers require adequate network access to DH systems. Removing entry barriers for waste heat providers comes down to opening the value chain stages of production and trade (upstream market) and distribution (downstream market) to free competition.

Besides regulatory and technical aspects, third-party waste heat feed-in is also hampered by economic barriers. DH is in fierce competition with numerous other heat generation technologies, e.g. heat pumps. DH companies thus need economic security regarding consistent feed-in of third-party waste if they are to enter the network.

The implementation maps for the two policy approaches (integrated district heating planning and operation; and network access for third-party waste heat providers) are presented in the next sections.

5.2 Integrated district heating planning and operation

Introducing the policy approach

In light of the E1st principle, district heating planning and operation should determine an optimal mix of both various **supply options** (generation, network, storage) and **demand-side measures** (e.g., thermal renovations in buildings). Such an integrated planning approach essentially **requires guidelines** for national and local authorities and DH companies to evaluate the costs and benefits of all relevant investment options, as well as effective **regulatory instruments** to incentivise private DH companies to exploit demand-side potentials.

Business as usual	E1st scenario
District heating system expansion and upgrades based on **exogenous energy demand**	District heating system expansion and upgrades based on **endogenous energy demand** (e.g., taking into account expected impacts from energy efficiency policies)
District heating companies have **no direct incentive** to bring about demand-side energy savings	District heating companies are incentivised to bring about demand-side energy savings through **demand-side management measures**

Table 11: Business as usual vs. E1st scenario for the "integrated DH planning and operation" approach

The implementation maps are presented in the next two pages: first the barriers related policy design, then those related to policy implementation.

Further reading

- ENEFIRST report "Priority areas for implementing Efficiency First"
  - Chapter 3.4.3 Identified policy approaches about district heating
- Chittum, A. and Ostergaard, P. (2014). How Danish communal heat planning empowers municipalities and benefits individual consumers. *Energy Policy* 74: 465–474.
- DEA, 2017. Regulation and planning of district heating in Denmark. Danish Energy Agency.
- Rutz, D. et al., 2019. Upgrading the performance of district heating networks. Technical and non-technical approaches. Munich: WIP Renewable Energies.

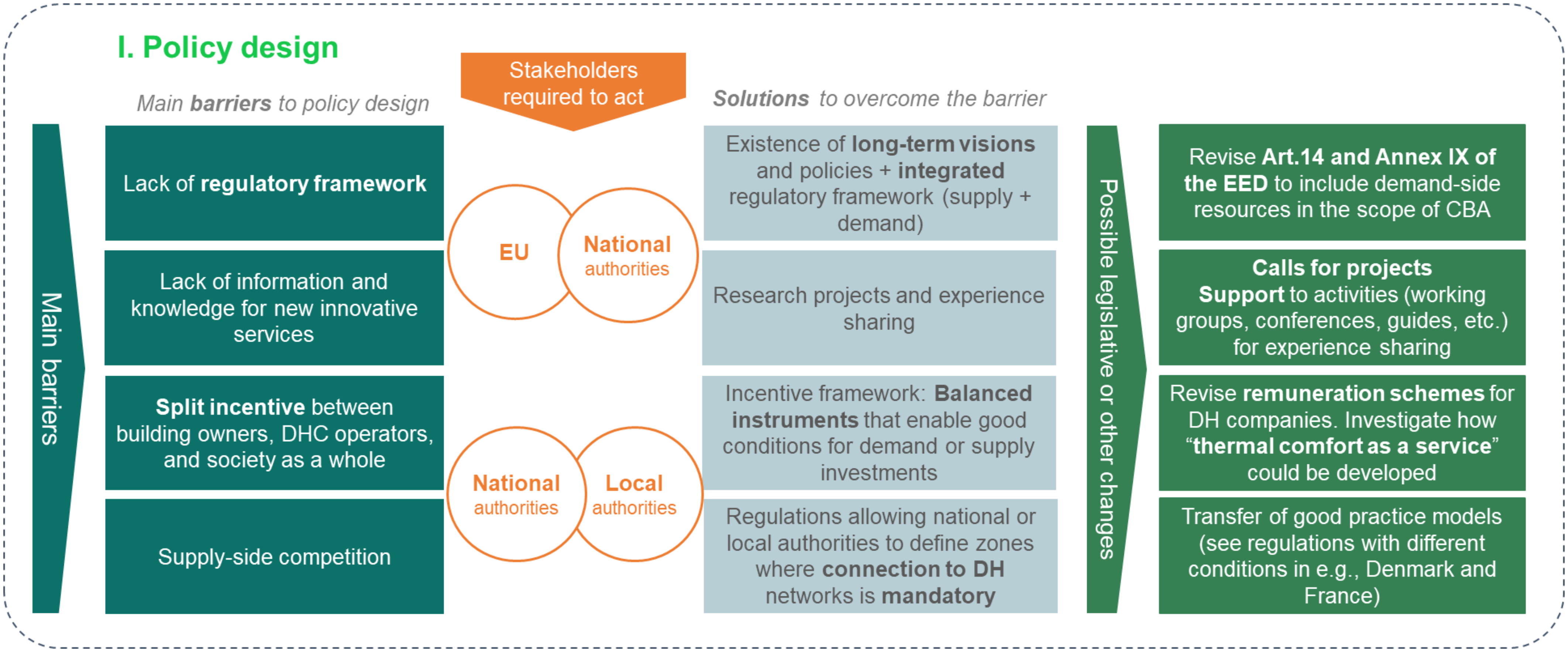

Figure 16: Implementation map for the *integrated district planning and operation* approach - Part 1: Overcoming barriers related to policy design

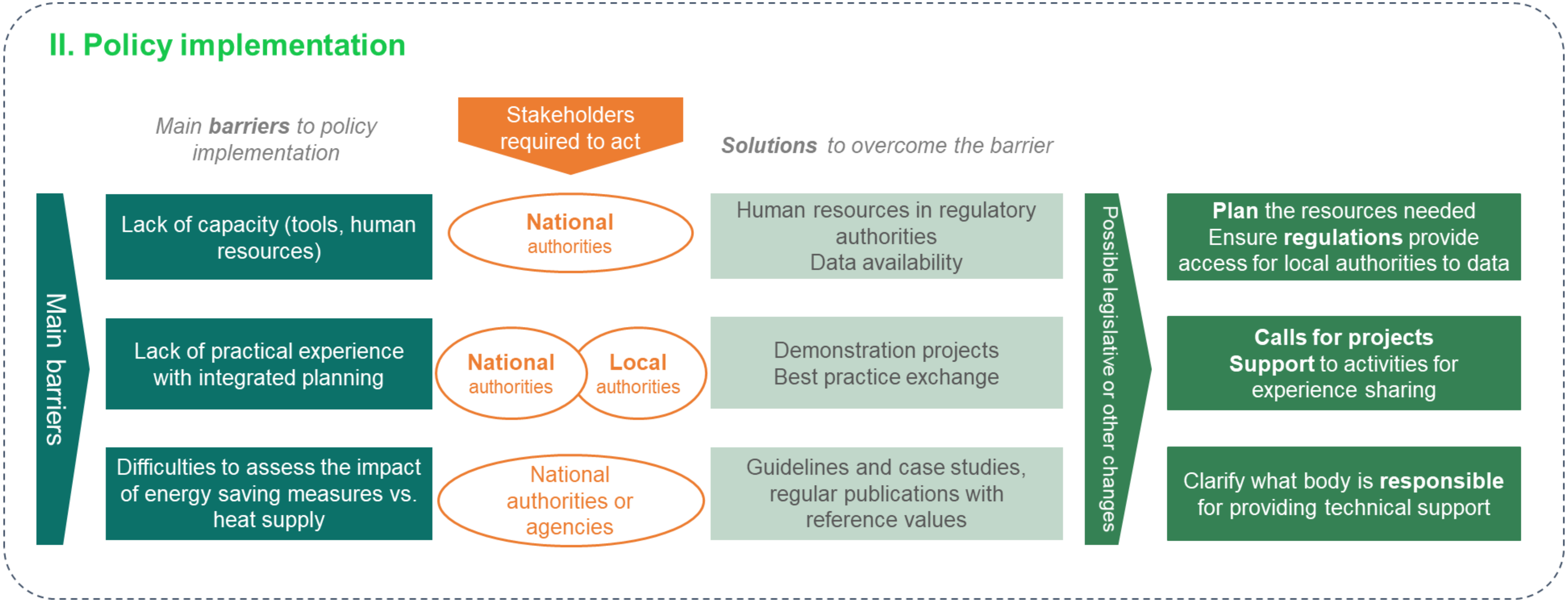

Figure 17: Implementation map for the *integrated district planning and operation* approach - Part 2: Overcoming barriers related to policy implementation

5.3 Network access for third-party waste heat providers

Introducing the policy approach

Integrating waste heat in DH systems enhances **supply-side efficiency**, i.e., the amount of primary energy needed to supply a unit of heat delivered to consumers for purposes of space and water heating. To establish a level playing field between third-party waste heat providers and conventional DH generation, adequate **market access regulation** needs to be in place.

Business as usual	**E1st** scenario
Network access negotiated on **voluntary basis**	**Non-discriminatory network access** for third-party waste heat providers
Significant transaction costs in negotiation of third-party network access	**Low transaction costs** in negotiation of third-party network access

Table 12: Business as usual vs. E1st scenario for the "network access for third-party waste heat providers" approach

The implementation maps are presented in the next two pages: first the barriers related to policy design, then those related to policy implementation.

Further reading:

- ENEFIRST report "Priority areas for implementing Efficiency First"
    - Chapter 3.4.3 Identified policy approaches about district heating

- Bürger, V. et al. (2019). Third party access to district heating systems – Challenges for the practical implementation. *Energy Policy* 132: 881–892.
- Holzleitner, M. and Moser, S. (2019). Energy efficiency in the district heating sector – an analysis of the Renewable Energy Directive regarding alternative feed-in options. Proceedings of the ECEEE 2019 Summer Study.
- Papapetrou, M. et al. (2018). Industrial waste heat: Estimation of the technically available resource in the EU per industrial sector, temperature level and country. *Applied Thermal Engineering* 138: 207–216.

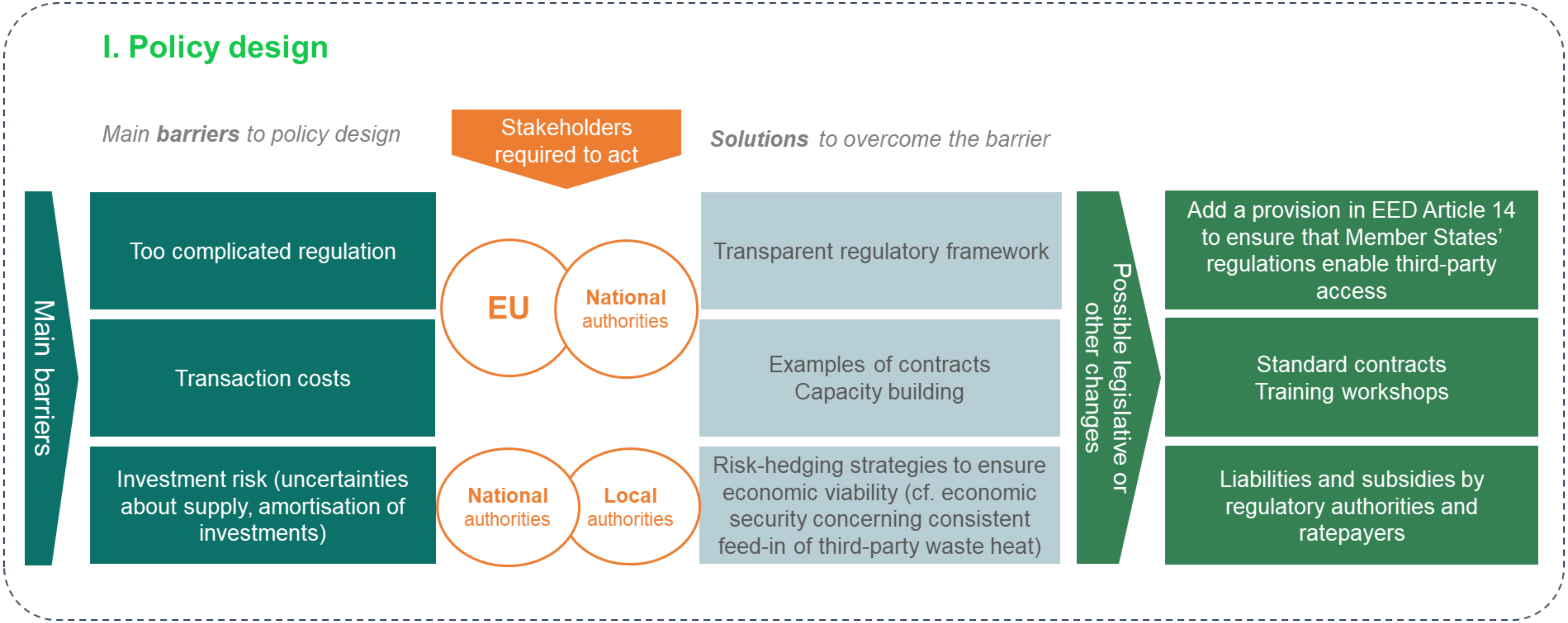

Figure 18: Implementation map for the *network access for third-party waste heat providers* approach - Part 1: Overcoming barriers related to policy design

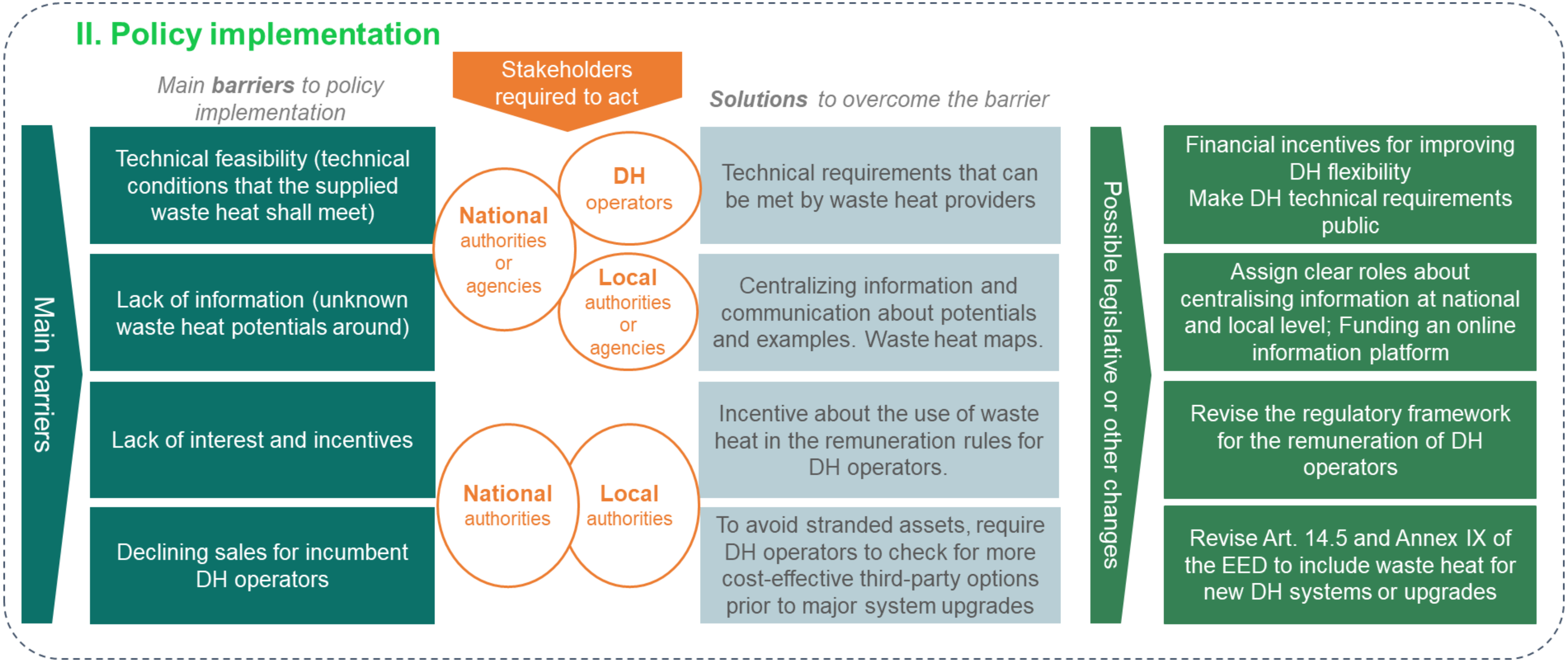

Figure 19: Implementation map for the *network access for third-party waste heat providers* approach - Part 2: Overcoming barriers related to policy implementation

CONCLUSION

The implementation maps presented in this report provide solutions to the main barriers to implementing the E1st principle in EU Member States. We have identified possible legislative and non-legislative changes and actions to be taken on different governance levels and by various stakeholders to overcome the barriers and operationalise the E1st principle.

As shown in our previous research, full implementation of E1st requires concerted action by several public and private actors as well as effective cooperation between and harmonisation of EU and national regulatory frameworks. The full national transposition of the EU directives is a prerequisite for any progress. The analysis generally shows that legislative changes at EU level are needed to overcome (some of) the barriers but that many institutional barriers require interventions by national and local authorities to enable capacity building and additional human and financial resources in the (regulatory) agencies to implement the concepts and policy approaches.

The consultation with EU and national experts confirmed that more specific guidance is needed from EU level but that an implementation of the E1st principle also requires close cooperation between national and regional levels, especially in the buildings and district heating sectors where most decision-making takes place locally.

The consultation in the **building policy groups** affirmed the importance of multiple benefits in cost-benefit analyses and stressed the difficulties of their quantification and consideration in business cases on the micro and macro level. There is a consensus that a key barrier to a wide application of E1st in the buildings sector is the complex decision-making of homeowners and the lack of knowledge on the benefits of deep renovation, which should be addressed in tailored informational measures at the regional and local level.

Another important aspect to ensure the full exploitation of *efficiency first* is reliably measuring energy performance after renovations through real energy consumption monitoring. Performance (energy or indoor environmental quality/comfort) based schemes could support implementation of the fabric-first approach but require a high-quality performance monitoring framework, such as an improved EPC scheme. The latter is also crucial to tie performance standards to financial incentives or subsidies.

Planning tools can offer a solution to bring deep renovations forward by giving advice to homeowners and providing information on benefits of renovation measures as well as funding opportunities. The diffusion of instruments such as building renovation passports or renovation roadmaps in the market should go hand-in-hand with breaking the silos of different building trades. Moreover, they can help reveal the synergies rather than the rivalry between energy efficiency and renewables and help energy advisors offer integrated solutions for deep renovation.

In the **power sector** a closer cooperation between TSOs and DSOs as well as more transparency in grid planning would enable a realisation of the discussed policy approach of transmission and distribution utility provisions. The implementation of a dynamic tariff design was discussed most controversially given the perceived reluctance of various stakeholders to expose consumers to price risks for altering their behaviour. The need of consumer acceptance in this policy approach shows the importance of capacity building among consumers and safeguards that facilitate their moving away from flat tariffs. Although the regulatory framework needs to implement the incentives required in the EU legislation, successful penetration of dynamic tariffs among consumers is contingent upon these complementary policies.

In the **district heating** sector, the role of municipalities is essential to improve integration between demand and supply sides in local energy planning. Facilitating a more integrated DH planning would require an enabling regulatory framework. At present, DH companies have little incentive to pursue innovative activities in line with E1st. New forms of utility remuneration are a key issue in this regard. Lack of capacity in DH companies in terms of quantitative modelling tools and human resources might also be an important barrier. This can be overcome by reinforcing human resources and ensuring data availability (e.g., technology costs) for DH companies to structure their cost-benefit analysis in a way that adequately reflects demand-side resources. Demonstration projects as well as venues to exchange on best practices can help tackle the frequent lack of practical experience with integrated planning. Difficulties in quantitatively assessing the impact of energy-saving measures (both ex-ante and ex-post) can also create an important barrier.

For integrating waste heat in DH systems, the barrier of supply risk is critical: DH companies require economic security concerning consistent feed-in of third-party waste heat to ensure economic viability. This could possibly be addressed through liabilities and subsidies by regulatory authorities and ratepayers. As for integrated planning, the lack of an enabling regulatory framework is an important barrier to third-party access for waste heat providers: the present framework is considered too complex for DH companies and providers to engage in delivery contracts. Technical feasibility is another important barrier: feed-in must have pressure, temperature and aggregate state that correspond to the condition of the conduit pipe of the DH network. Lack of information can also mean that DH companies may not be aware of surrounding waste heat potentials; in turn, third-party providers may be unaware of the possible economic revenues from network feed-in.

The EU policy framework is subject to a comprehensive revision to align the energy and climate policy landscape to the new 2030 climate target of 55% net emissions reductions. It is crucial that the window of opportunity of a reform of the central energy policy directives (EED, RED, EPBD) considers E1st provisions carefully. As far as possible, we will take the proposals of the Fit-for-55 package expected mid-July 2021 into account in the development of our upcoming policy guidelines.

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See also the references per policy approach in the respective sections (cf. "further reading").

ANNEX I: IDENTIFICATION OF BARRIERS AND SUCCESS FACTOR FOR THE IMPLEMENTATION OF E1ST

See separate document.

ANNEX II: MINUTES OF THE CONSULTATION EXPERT WORKSHOP

See separate document.