Good Practices in DSO-TSO Collaboration in Network Planning

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DSO ENTITY
DSOs FOR EUROPE

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Contents

List of Abbreviations

DSO	Distribution System Operator(s)
TSO	Transmission System Operator(s)
NDP	National Development Plan
DNDP	Distribution Network Development Plan
TYNDP	Ten-Year Network Development Plan
SRG	Stakeholder Reference Group
TEN-E	Trans-European Networks for Energy
RED III	Renewable Energy Directive III
ECP-GSS	Electricity Connection Policy, Generation and System Services
MEC	Maximum Export Capacity
NECP	National Energy and Climate Plan
RES	Renewable Energy Sources
FNA	Flexibility Needs Assessment
ERAA	European Resource Adequacy Assessment
EV	Electric Vehicles
LV	Low Voltage
MV	Medium Voltage
HV	High Voltage

1 Executive Summary

Transmission–distribution system operator (TSO–DSO) collaboration in network planning is a cornerstone of enabling the European Union's decarbonisation and electrification objectives in a holistic manner. As electricity systems become more decentralised, data driven and investment intensive, effective planning across voltage levels is increasingly critical to deliver timely grid connections, optimise infrastructure investments and maintain security of supply.

Responding to the Copenhagen Infrastructure Forum's 2025 conclusions, this report provides a fact based overview of how TSOs and DSOs currently collaborate at national and regional levels. It does not assess performance or issue recommendations, but instead highlights established approaches that can inform system operators and regulators facing similar challenges across Europe.

The report examines three complementary categories of collaboration, including country specific practices of how tailored TSO–DSO coordination supports national policy goals, how transmission level considerations are increasingly embedded in DSO planning, and how different degrees of DSO participation in transmission planning shapes TSO National Development Plans. While cooperation across voltage levels is now dominant across Europe, shared decision making remains rare and regulation dependent.

Overall, the report finds that planning implementation stays with the allocated system operator but is evolving towards more structured and systematic TSO–DSO collaboration. Good practice is characterised by regular data exchange, joint scenario building, formal consultation processes, alignment of investment needs, shared modelling tools and ongoing coordination beyond formal planning cycles. Good practices in TSO-DSO collaboration in network planning are critical to demonstrate a resilient energy transition across Europe.

2 Introduction

2.1 Purpose of TSO-DSO collaboration

Close collaboration between system operators across voltage levels is a key factor that enables the decarbonisation of an increasingly decentralised energy system. European Regulations emphasise the criticality of this collaboration and identify several joint activities between Transmission System Operators (TSOs) and Distribution System Operators (DSOs). ENTSO-E and DSO Entity, as the representative associations for European TSOs and DSOs, are committed to facilitating this collaboration and driving the development of common deliverables through shared goals and institutional cooperation.

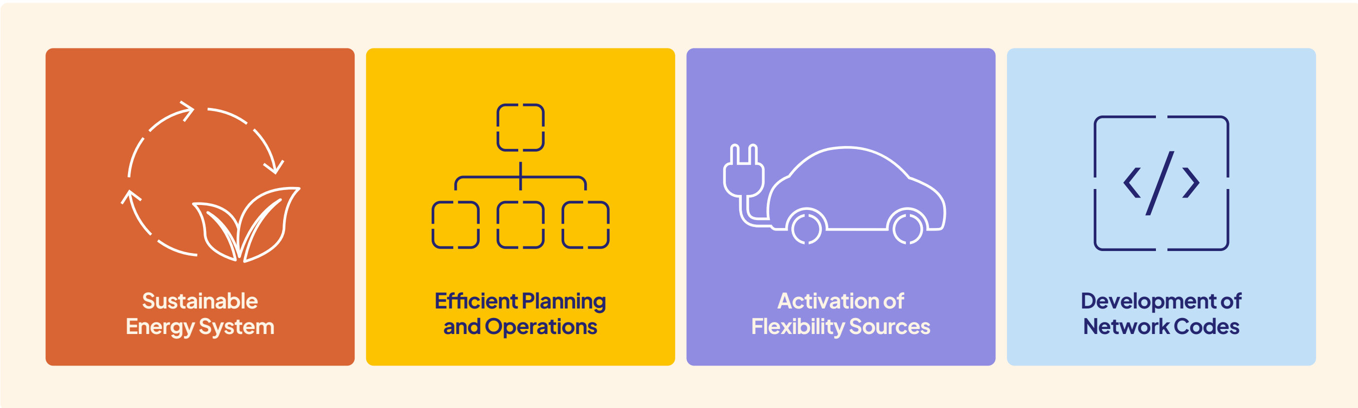

Figure 1 Shared Goals of Grid Cooperation

2.2 Context

Since DSO Entity's formation in 2022, DSO Entity and ENTSO-E have been formally collaborating, with increasing joint work areas and deliverables. In their 2026 work programmes, the Associations focus on several main areas of collaboration, half of which are directly linked to regulatory implementation priorities, while the other half are joint strategic initiatives. Current collaboration topics span from planning and investments over operations, security and resilience, all the way to smart grids and innovative solutions.

Additionally, the Associations collaborate through stakeholder forums or groups such as the European Stakeholder Committees for the development of each of the Network Codes and, the European Commission's Pact for Engagement and the Ten-Year Network Development Plan (TYNDP) Scenarios Stakeholder Reference Group (SRG). New areas of collaboration might evolve and are possibly covered by but not limited to topics including Digitalisation and AI for Energy, the Electrification Action Plan, or the new Trans-European Networks for Energy (TEN-E).

2.3 Background to this report

In line with article 57 of Regulation (EU) 2019/943, DSO Entity focuses on strengthening DSO–TSO collaboration in network planning at the national level. In line with the 11th Energy – "Copenhagen" -Infrastructure Forum's conclusions[1] under point three, DSO Entity and ENTSO-E were invited to develop a joint report on good practices in this area.

In this context, this report highlights good practices currently taking place between European electricity system operators. Although these examples are rooted in their own specific national contexts as there is no one-size-fits-all solution, these practices may guide DSOs and TSOs in addressing similar challenges they may face. This report thus aims to identify and document existing approaches to joint scenario development, alignment of planning methodologies, coordination of investment priorities, and management of connection backlogs. The outcome tries to support the creation of a common understanding of coordinated planning processes between DSOs and TSOs across Europe. Thus, focus of the analysis was placed on collecting facts on the current status quo regarding TSO-DSO national planning processes and interactions. This report does not aim to perform any sensitive analysis or provide recommendations as the investigated high-performing practices in TSO-DSO collaboration in planning implementation provide guiding evidence to the informed audience.

2.4 Identifying good practices

The interlinkages between flexible resources, non wire solutions, and anticipatory investments on one side, and coordinated grid planning between TSOs and DSOs on the other, are increasingly shaping how electricity systems are planned and operated.

Collaboration between TSOs and DSOs has always been practiced. Legal frameworks regarding the European Union's efforts to achieve decarbonisation targets has strengthened cooperation between voltage levels. In addition to regulatory priorities governed by EU law, such as the Network Codes on Demand Response and Cybersecurity and the Flexibility Needs Assessment Methodology, ENTSO-E and DSO Entity recognise several areas where structured exchanges, coordinated action or collaboration bring clear added value. These topics reflect shared strategic interests that go beyond mandated activities and support knowledge exchange and improved cooperation between the system operators. For that, efficient collaboration is facilitated through horizontal institutional frameworks by the two Associations, which ensure clear organisational structures that support the initiation of new workstreams, accelerate the development of joint activities, and improve the transparency and visibility of their collaboration.

Through this report, several measures of TSO-DSO collaboration were identified. The following chapter showcases three categories of applied TSO-DSO collaboration. Category 1 brings testimony to local actions between one or many DSOs and TSO on a country level. Category 2 brings forward general considerations and collection of regional planning between voltage levels from a DSO perspective. Category 3 consolidates commonplace degrees and standards for DSO collaboration in network planning from a TSO perspective. All three categories consider the identified practices to be good examples for European TSO-DSO collaboration.

1 11th Infrastructure Forum, 2 June 2025, Conclusions

3 Act locally, coordinate regionally and think European: Good Practices for TSO–DSO Collaboration

3.1 CATEGORY 1: Good practices by member state

DENMARK

Energinet and ca. 35 DSOs
Transparent, forward looking coordination for Denmark's National Development Plan and Capacity Map

Background

Coordination between the Danish TSO Energinet and the DSOs is an acknowledged and established element of Denmark's transmission NDP. Energinet is currently preparing the next NDP, scheduled for publication by the end of 2026. In general, TSO–DSO coordination prioritises transparency, structured dialogue, and expectation management, rather than introducing new or more data intensive coordination mechanisms. DSOs contribute primarily through qualitative inputs reflecting long term development needs that are not yet addressed through existing cooperation frameworks.

Process

Each year, the Danish Energy Agency produces the national analysis assumptions to be used by Energinet. For the current NDP, Energinet, uses the AF 25 edition together with input from DSOs. DSOs provide pipeline lists and other inputs to Energinet, which are used as a key source for the geographical decomposition of the AF25. Depending on scale and potential system impact, identified long term needs may be reflected in the NDP through supplementary descriptions of possible grid expansion requirements. In parallel, Energinet and the DSOs jointly maintain Denmark's capacity map (kapacitetskort.dk), a public transparency tool consisting of five maps:

- **Maps 1–2:** Available capacity in the distribution grid and at TSO–DSO interface transformers (DSO responsibility; updated quarterly).
- **Maps 3–4:** Available capacity in the transmission grid (Energinet responsibility).
- **Map 5:** Number of available connection points at TSO transformers.

To calculate available transmission capacity, Energinet relies on DSO provided information on existing and planned distribution connected projects above 3 MW (e. g. solar parks, battery installations). This data is collected via dedicated SharePoint workspaces, updated quarterly by each DSO, and includes e. g. capacity, location, and expected connection dates. Energinet uses the combined TSO and DSO datasets to simulate network impacts, identify reinforcement needs, and publish the results on the capacity map.

Benefits

This coordination framework ensures a common understanding of long term grid development needs while maintaining a clear and proportionate interaction model between TSO and DSOs. It enhances transparency for market participants, supports anticipatory planning of grid reinforcements, and enables consistent national analyses without increasing administrative or data handling complexity.

HUNGARY

MVM and MAVIR
Integrated TSO-DSO National Planning for Coherent Grid Investments

Background

Hungary applies an integrated national approach to electricity network development through a single Network Development Plan (NDP) covering the TSO (MAVIR) and all licensed DSOs, including MVM DSO. The plan focuses on high voltage with considerations made to medium and low voltage. The framework, defined in the Operational Code, establishes common methodologies, planning horizons, scenarios, and reporting structures. This approach aligns with the TEN-E Regulation and ENTSO-E Ten-Year Network Development Plan (TYNDP) principles, ensuring coordinated identification of system needs and consistent investment planning across voltage levels.

Process

The integrated NDP is developed through structured data exchange and continuous cooperation under MAVIR's coordination. TSOs and DSOs prepare plans in parallel using harmonised scenarios covering demand growth, electrification, and RES integration. DSOs provide detailed inputs on decentralised generation, load growth, flexibility limits, and regional bottlenecks, which feed into MAVIR's system-wide market and network analyses. Joint assessments ensure that distribution investments are reflected in transmission planning, particularly in high-growth areas.

Benefits

The Hungarian model enables transparent, systemwide identification of network development needs and improves investment efficiency in line with TEN-E objectives. Strong TSO-DSO coordination enhances planning robustness and facilitates effective integration of renewables, electrification, and demand growth, contributing to overall system resilience.

IRELAND

ESB Networks and EirGrid
Batch-Based Grid Connections to Accelerate RED III Delivery

Background

The regulator has established a group processing approach to ensure a coordinated and structured approach for TSO and DSO to process the large volumes of conventional, renewable & storage connection applications required in order meet Renewable Energy Directive III (RED III) targets. This process is called the Electricity Connection Policy, Generation and System Services (ECP-GSS). Commencing with a September 2025 application batch, it introduces twice-yearly windows to accelerate renewable targets (80% by 2030) and aligns with RED III permit-granting timelines, requiring only a complete (not fully granted) planning application to apply.

Process

The approach is structured so that there are two batches of applications processed by TSO and DSO each year (March and September) with targets for each system operator. Close coordination is required between TSO and DSO in this process to ensure a streamlined approach to connections. Applications with Maximum Export Capacity (MEC) >40 MW apply to the TSO and applications with MEC <40 MW apply to the DSO. The TSO and DSO have an agreed process for assignment of Transmission Nodes called the Node Assignment Ruleset. It should be noted that micro-generation(<11kVA) for domestic connections at LV and small-scale generators(<200kVA) are processed separately. The rules aim to establish an efficient screening process for allocating applications to the appropriate nodes at which the generation can connect to the Irish electricity grid.

A Pre-application Notification window opens for each batch. Both RED III and non-RED III projects are required to submit a “Pre-application Notification” to the relevant System Operator. Only applicants who have submitted a Pre-application Notification are entitled to apply for a grid connection in ECP-GSS.

Benefits

A key deliverable is the publication of the list of applicants that will be processed by the System Operator in an ECP-GSS batch. The process provides clarity for all stakeholders such as developers, regulator, government and system operators.

It enables prudent planning and optimised development of the distribution and transmission network and ensures alignment of new connections with the overall long term system development strategy. The process supports Ireland in achieving compliance with the Renewable Energy Directive III.

ITALY

e-distribuzione and Terna
Joint TSO-DSO Territorial Planning to Enable 2030 RES Targets

Background
Following the publication of the NECP (National Energy and Climate Plan) and the DDS (Documento di Descrizione degli Scenari) in 2024, the integration of Renewable Energy Sources (RES) set a highly challenging target for the electricity system in order to meet European decarbonisation goals. The expected growth outlined by the NECP forecasts an additional 74 GW of photovoltaic and wind capacity by 2030, further compounded by a large pipeline of connection requests already submitted to both TSO and DSOs. This scenario requires coordinated actions to ensure rapid connections and optimised network investments, while maintaining system efficiency and reliability.

Process
In 2025, e-distribuzione and the Italian TSO Terna jointly launched the “Efficient Territorial Planning” initiative, aligned with the 2030 RES integration scenario. The market-zone scenario defined in the DDS was translated at regional level through a jointly agreed methodology, combining historical and forecast data from both operators. This allowed the assessment of RES impact on individual Primary Substations, considering both distribution and transmission perspectives. Based on the regional and voltage-level allocation of forecasted capacity, e-distribuzione evaluated the required interventions for approximately 2.000 Primary Substations and shared those with potential impact on the TSO grid, also identifying synergies with existing or planned works.

Benefits
This coordinated process provides the TSO with a robust and reliable forecast of interventions on the DSO network, enabling more effective joint planning. By combining distribution-level insights with Terna’s transmission-level evaluations, it supports the identification of optimal solutions for new connections or repowering of existing primary substations. Overall, the approach enhances system efficiency, improves coordination between TSO and DSO, and facilitates the timely integration of large volumes of RES in line with 2030 targets.

LATVIA

AST and 10 DSOs

Data Exchange for Ten Year System Adequacy Assessment and National Development Planning

Background

National electricity infrastructure development planning in Latvia is closely linked to structured collaboration between the TSO, AST, and Latvia's ten DSOs. Although Latvia has around ten DSOs, the DSO AS Sadales tīkls represents approximately 99% of connected electricity consumption. The TSO–DSO collaboration ensures that long-term system development reflects realistic demand growth, generation trends, and network constraints.

Process

During the first half of each year, the AST initiates the system planning process by sending formal information requests to the most significant system users, including all DSOs. Separate letters and structured templates are used to collect harmonised data. DSOs are requested to provide historical consumption data from the previous year along with ten-year forecasts, detailed information on installed generation capacity and annual production by technology (including biomass, biogas, onshore wind, distributed combined heat and power, small hydro, solar, and battery energy storage systems), as well as expected maximum and minimum load forecasts for the same ten-year horizon. Once submitted, AST consolidates this information and performs a national adequacy assessment using three different development scenarios. The results of the adequacy assessment, once approved by the national regulator, form the analytical foundation for preparing Latvia's National Development Plan on the transmission level.

Benefits

This structured collaboration improves forecast accuracy, shapes system adequacy assessments, and ensures better alignment between transmission and distribution network planning. It enables early identification of capacity bottlenecks, supports the efficient integration of distributed energy resources, and reduces planning uncertainty across two vital TSO deliverables, adequacy and grid planning.

PORTUGAL

REN – Rede Eléctrica Nacional, S.A. and E REDES – Distribuição de Eletricidade, S.A.

Coordinated TSO–DSO Planning at the Transmission–Distribution Interface

Background

In Portugal, the TSO and the DSO maintain close coordination to ensure the secure, efficient, and compliant operation and development of the electricity system. This coordination is particularly relevant at the transmission–distribution interface, where evolving demand, new generation, and grid constraints require aligned planning and timely investments.

Process

The TSO and DSO regularly exchange information and hold coordination meetings to align on ongoing projects affecting both grids and to discuss emerging needs at the transmission–distribution interface. These exchanges typically address load demand trends at interface substations, verification of the adequacy of installed transformation capacity, and the need for reinforcements such as new bays to strengthen interconnection.

When medium-term demand growth forecasts indicate that the distribution grid may no longer accommodate demand without significant investment, joint technical studies are carried out. These studies assess whether reinforcing the distribution grid remains the most efficient solution or whether the development of new transmission substations to support the distribution grid is justified. The analysis considers grid development scenarios, compliance with safety and planning criteria established in legislation and regulation, fault current levels, losses, and investment costs across both transmission and distribution grids. The selected solution is then reflected in the respective grid development plans. The TSO and DSO also cooperate closely on the assessment and control of fault current levels at the transmission–distribution boundary, including the definition of mitigation measures when needed.

In addition, both operators coordinate on grid capacity for new connections, including generation, demand, and storage. This coordination ensures compatibility between distribution-level connections and existing or planned transmission infrastructure and includes regular updates of available connection capacity. When grid capacity is insufficient, Portuguese legislation allows power plant promotors to finance transmission and/or distribution reinforcements. In such cases, agreements are established between promoters and grid operators, with the TSO and DSO coordinating to define the most technically and economically efficient solution.

Benefits

This coordinated framework ensures continued satisfaction of load demand while complying with safety and planning criteria. It enables optimised investment decisions across transmission and distribution grids, supports the efficient integration of new generation, demand, and storage, enhances system reliability through fault current and voltage control, and provides transparent and predictable processes for grid users, project developers and national regulatory authorities.

3.2 CATEGORY 2: Integration of Transmission-Level Considerations in DSO Planning

Distribution System Operators are increasingly central to the energy transition, as their networks connect most consumers, producers, and prosumers and enable the integration of renewables, electrification, and new technologies. This shift places distribution networks at the core of a more decentralised and dynamic electricity system. Consequently, distribution network planning and Distribution Network Development Plans are increasing system-wide impacts, at transmission-distribution interfaces.

Efficient outcomes therefore depend on timely and structured coordination between DSOs and Transmission System Operators. Such coordination, spanning scenario development, data alignment, connection planning, operational constraints, and continuous dialogue, links long-term planning with system-wide needs.

COOPERATION

DSO-TSO cooperation is therefore a core enabler of Europe's decarbonisation pathway, as system planning and operation increasingly depend on distributed resources, sector coupling across households, services, industry, and stronger cross-voltage interactions. As electrification accelerates, an important aspect is to synchronise "what we need" and "when it will be available": scenarios, data and technical assumptions must be exchanged in time to support decisions at both system levels.

In practice, this means aligning network development timelines and reinforcement strategies, both in the long and short term, so that transmission and distribution investments, constraints and interfaces (e. g., connection points, hosting capacity drivers) remain coherent and do not shift bottlenecks across voltage levels. This alignment is supported and progressively refined through national and European frameworks that shape the future energy system - NECP, ERAA, TYNDP, DNDP and Flexibility Needs Assessments (FNA) - which link long-term system scenarios with short-term implementation.

Cooperation also evolves alongside the system. Increasing digitalisation further acts as a key enabler for more integrated planning and operations, supporting enhanced data exchange, shared methodologies, and Digital Twin use cases. These approaches strengthen cross-operator decision-making and improve the ability to anticipate and manage system interactions.

SCENARIO DEVELOPMENT, DATA ALIGNMENT AND PLANNING INPUTS

Scenario development is becoming more important in grid planning due to the energy transition goals set at EU and National level. RES integration and electrification of consumption deeply impact the grid, requiring consideration about how future drivers will affect power consumption. Some crucial points to consider in joint scenario definition are:

- Most new loads such as EVs, Heat Pumps and induction hobs will impact the distribution grids, with consequences that sometimes may also impact the transmission grid.
- Ports, large electric-vehicle charging stations, Storage and Data Centres will require strong coordination between TSOs and DSOs, for example through data exchange and joint working groups, in order to guarantee an efficient and quick connection of this type of customers, considering also that these are less subject to Scenario process (being "spot" requests).

- New loads will drive demand growth. TSOs and DSOs will have to continue their cooperation to guarantee the highest reliability of electricity supply.
- Energy demand increase will be met by secure production growth from Renewables, both impacting Low Voltage/Medium Voltage (LV/MV) and High Voltage (HV) grids. Impact of RES integration will affect DSOs planning inputs in order to guarantee their quick connection, while TSOs will have to manage not only fewer (but the largest) connections in HV, but also the new Primary Substation (or repowering of the existing ones) that will be needed to connect the MV/LV PV plants.
- LV connections may affect the grid also with MV interventions escalating to the transmission grid, engaging it indirectly due to the cumulative amount of small-scale solar plants.
- DSO/TSO scenarios have to rely on the NECPs principles and objectives, taking into account both TSO data and specific DSO inputs regarding renewables and the electrification of consumption, with particular attention to MV and LV loads and generation. Scenario definition should become a "joint working table" where all operators forecasts are integrated. The final decision, however, on how these scenarios are applied in distribution planning remains with the DSO.
- Energy transition process requires that DNDPs and TNDPs have to be aligned to the NECPs based on article 32.3 of Directive (EU) 2019/933[2].

Once the National Scenario is jointly defined by DSOs and TSO(s) on a country-specific level, taking into account both perspectives, planning principles are defined:

- Load and generation forecasts based on historical and scenario-based data guarantee a better understanding of what is happening on the entire grid, assuring coherence between TSO and DSO planning.
- Joint planned grid developments assure the correct coordination between TSOs and DSOs, guaranteeing efficient and quick connection of new plants. The final decision, however, on how these planning principles are applied remains with the DSO.
- Coordination on system constraints (such as flexible needs, bottlenecks, etc.) are also crucial for the TSO/DSO coordination, to ensure deeper collaboration based on mutual knowledge.

More accurate planning requires a reinforced and systematic cooperation between TSOs and DSOs in developing shared energy scenarios. Joint scenario building ensures consistency between national policy objectives, system wide perspectives and local network conditions. By aligning assumptions on demand evolution and renewable integration, coordinated scenarios underpin coherent network plans and a cost efficient, resilient energy transition.

2 article 32.2 Directive (EU) 2019/933

COORDINATING NETWORK DEVELOPMENT

The accelerating energy transition is significantly increasing the complexity of grid connection processes. Coordinated planning is required for the connection of Renewable Energy Sources, energy storage systems, industrial electrification, data centres, and electrification of mobility infrastructure including electric vehicles, ports, and airports, all of which place new and often simultaneous demands on the power system. Managing these developments effectively requires not only coordination within the distribution grid, but also early and continuous cooperation with TSOs.

From a network planning perspective, this requires assessing the growing volume and diversity of connection requests against both the existing grid topology and the forward looking evolution of the transmission and distribution networks. Decisions on individual connections increasingly depend on assumptions regarding future load growth, generation patterns, storage deployment, and flexibility potential. Early alignment between DSOs and TSOs is therefore essential to ensure that connection decisions are consistent with long term grid development plans and do not create structural bottlenecks or lock in effects.

In particular, capacity management at transmission-distribution interface points are increasingly becoming a core joint planning task. These interface points determine the feasible pace and scale of new connections. The rise of bi-directional power flows, higher peak demands, and clustered developments (e. g. data centres or large storage facilities) requires coordinated capacity assessments, shared planning assumptions, and transparent exchange of information between TSOs and DSOs. Planning at both grid levels must therefore be closely aligned to avoid mismatches between connection commitments and actual system capabilities, nonetheless, the DSO retains final decision-making for distribution network developments. Timelines between transmission and distribution network development are different and hence need to be closely coordinated to ensure best capacity provision to customers.

In this context, connection planning is evolving into a central coordination function, across grid levels, increasingly driven by network planning considerations. It can no longer be treated as a purely reactive or project specific activity. Instead, it requires structured, forward looking and institutionalised interaction between DSOs and TSOs, aligned planning horizons, and continuous coordination between operational assessments and long term target network planning. Such cooperation is crucial to ensure system-wide consistency, maintain security of supply, and enable the efficient integration of generation, storage, and demand in line with future network development.

COORDINATING SYSTEM OPERATION AND TECHNICAL CONSTRAINTS

Distribution network planning must reflect operational reality: system stability, voltage limits, and congestion/redispatch as they increasingly determine where, when, and how grids are reinforced or enhanced. Operational constraints feed planning in a continuous loop: recurring voltage issues and congestion patterns translate into targeted reinforcements, automation and flexibility solutions, while redispatch experience and outage or security considerations inform the design of network interfaces such as at substations and connection points. EU rules also explicitly recognise the need for coordination and data exchange between TSOs and DSOs in operational planning and close to real time operation[3]).

At the same time, increasing variability and uncertainty, driven by distributed generation and electrification, highlight planning approaches to account for system conditions and operational limits. Digitalisation is a key enabler: joint TSO-DSO work on Digital Twin use

3 Article 1 (b) Regulation (EU) 2017/1485

cases highlights coordinated planning, resilience and security assessment as practical areas where shared models and data improve decisions across voltage levels.

Across Member States, observability and controllability requirements are embedded in connection and operational frameworks, although their specific implementation and thresholds vary. This further highlights the importance of coordinated approaches and shared understanding between DSOs and TSOs.

ONGOING COORDINATION AND DIALOGUE

Coordination and dialogue between DSOs and TSOs are important in the context of accelerating electrification and the growing diversity of network users. System operators thus engage regularly across multiple organisational levels, from technical and engineering teams to senior management, ensuring alignment between strategic priorities and operational realities. These interactions enable timely and structured exchange of information, supporting coherent planning and decision-making at both distribution and transmission levels.

Coordination and dialogue take place through a range of formal and informal mechanisms, including:

- Regular coordination meetings and workshops addressing both strategic and technical topics, including regional and National Development Plans
- Project-specific engagements, particularly for large demand or generation connections, including joint planning sessions and technical assessments
- Exchange of planning information, including transmission and distribution development plans, demand and generation forecasts, and flexibility needs (e. g. through Flexibility Needs Assessments)
- Coordination on transmission–distribution interface assets (e. g. substations, transformers, and switchgears), including connection agreements and application processes
- Joint technical studies and data exchange to assess system impacts and define appropriate network solutions
- Information exchange in support of regulatory and approval processes

These mechanisms highlight the structured and continuous coordination that is reinforced by the emergence of new customer classes seeking connection, which enable more integrated approaches between system operators which also includes services to both TSOs and DSOs under respective contracts.

Overall, effective integration of transmission-level considerations into DSO planning relies on continuous, structured coordination between DSOs and TSOs across all planning dimensions. From strategic cooperation and scenario alignment to connection planning, operational integration, and ongoing dialogue, each element contributes to a more coherent and efficient development of the electricity system.

3.2.1 DSO Regional Planning Approach

In contrast to bi-directional and one-to-one exchanges between DSOs and TSOs, in Member States with large numbers of DSOs, such as Germany, regional cooperation mechanisms are established. Regional cooperation is a structured way for many DSOs to engage with the TSO(s). Its core value is harmonisation (when applicable), as it consolidates the perspectives of multiple DSOs and their customers into a consistent regional picture (assumptions, timing, locations), thereby giving TSOs visibility of regional developments and enabling more coherent reinforcement decisions at the distribution-transmission interface.

This additional coordination layer becomes particularly valuable, whereas in Members States with fewer DSOs, or even one national DSO, similar alignment can often be achieved through more direct exchanges. Nonetheless, structured approaches and shared standards remain beneficial in all cases.

- **Binding national frame:** TSOs develop the transmission Network Development Plan under §12a[4], updated every two years and based on standardised scenarios; it is reviewed by the German regulator (BNetzA) and feeds into the Federal Requirements Plan.
- **Planning regions (DSO-led) harmonise inputs:** DSOs translate the transmission NDP assumptions into regionalised forecasts while also adjusting to local insights which are not visible on national level (RES build-out, load growth such as data centres, spatial constraints) and align these regional scenarios across planning regions before interfacing with the TSO.
- **Interface coordination:** using shared datasets derived from the TNDP, TSO and DSOs coordinate capacity needs, reinforcement measures and timing at substations (HV 110–380 kV) and interconnection points - reducing the risk of bottlenecks shifting across voltage levels and improving planning certainty.
- **Continuous formats:** structured working groups, technical workshops and systematic data exchange ensure continuous coordination beyond formal planning cycles and support iterative refinement of assumptions and plans

Regional cooperation plays a key role in translating the binding national planning framework into regionalised and internally consistent scenarios, while aggregating multiple DSO perspectives into a single coherent input for the TSO. It supports joint decisions on capacity needs, reinforcements and their timing at transmission–distribution interfaces (substations and interconnection points) and helps manage planning dependencies in a system with increasingly bi-directional flows and fast-changing demand patterns driven by electrification. It also supports the harmonisation of diverse DSO Network Development Plans into more consistent and comparable formats.

By pooling and aligning local information (e. g., RES build-out and large loads), regional cooperation improves scenario quality and enables earlier identification of interface constraints, reducing late rework and bottleneck shifting across voltage levels. It increases planning reliability for both TSOs and DSOs by providing stable, coordinated regional signals, and is particularly valuable in Member States with a diverse DSO landscape. Even in systems with fewer DSOs, the use of shared templates, data standards, and structured coordination processes enhances consistency and comparability of planning outcomes for both DSOs and TSOs.

4 Electricity and Gas Supply Act (Energy Industry Act - EnWG) § 12a.

3.3 CATEGORY 3: DSO participation in Transmission network development planning

3.3.1 Degrees of DSO participation in transmission National Development Plans

Close coordination between system operators across voltage levels is a key enabler for affordable, secure, and decarbonised electrification. While a horizonal layer of 'Institutional Cooperation' provides the necessary foundation for collaboration on a European level, national TSO network planning also relies on DSO participation to develop and later operate a successful transmission grid. In doing so, different degrees of DSO participation in transmission infrastructure planning help to better understand established practices in infrastructure implementation. The following sub-chapter explores the outcome of ENTSO-E's 2025 System Development TSO survey on how the coordination with the distribution grid is incorporated in NDP infrastructure planning.

One way to measure the degree of participation is to consider to what extent DSOs are meaningfully integrated in the process of developing Transmission National Development Plans. Different degrees of participation determine the significance of contributions as there are several ways of classifying the role and scope of DSOs in developing national transmission infrastructure. While there are various interpretations to measure the degree of DSO participation, it is essential to include information about goals and expectations of each degree. Essentially, there are four degrees of DSO participation in national transmission system development planning and decision-making, with the fourth degree giving the greatest amount of authority to a DSO in transmission planning of the four degrees:

- **Consultation:** The level at which an organisation seeks feedback on input data, preliminary modelling results, economic analyses. DSOs' role is primarily reactive: they provide input, which respective TSOs consider. Their feedback is collected and evaluated as part of the decision support workflow, but control over the final decision remains with the TSO.
- **Involvement:** Building up on consultation, involvement requires recurring, structured interaction with DSOs throughout the project lifecycle to ensure their requirements, constraints, and expectations are continuously captured and factored into design and implementation decisions. The TSO integrates the DSO's input more directly into option development and advances factoring in DSO-related constraints and benefits into the transmission system planning. Involvement represents an active, ongoing exchange rather than one time feedback. The final decision stays with the TSO.
- **Cooperation:** Building from involvement, cooperation establishes DSOs as active participants in the solution development process. They contribute to generating alternatives, assessing impacts, and shaping preferred configurations. The TSO incorporates the DSO recommendations into decisions to the fullest extent feasible, reflecting a shared problem-solving model. Control over the final decision, however, continues to reside with the TSO.
- **Co-production:** Building on cooperation, co-production goes a step further by sharing elements of planning integration between TSOs and DSOs. This can include bottom-up progress of forecasts, needs, investment or infrastructure development. In practice, co production occurs in specific institutional contexts, for example where TSOs and DSOs operate within a single organisational structure. This arrangement exists only in a small number of European countries and is linked to national regulatory and historical conditions, rather than representing a generalised or recommended model, as in the case of Luxembourg and Slovenia.

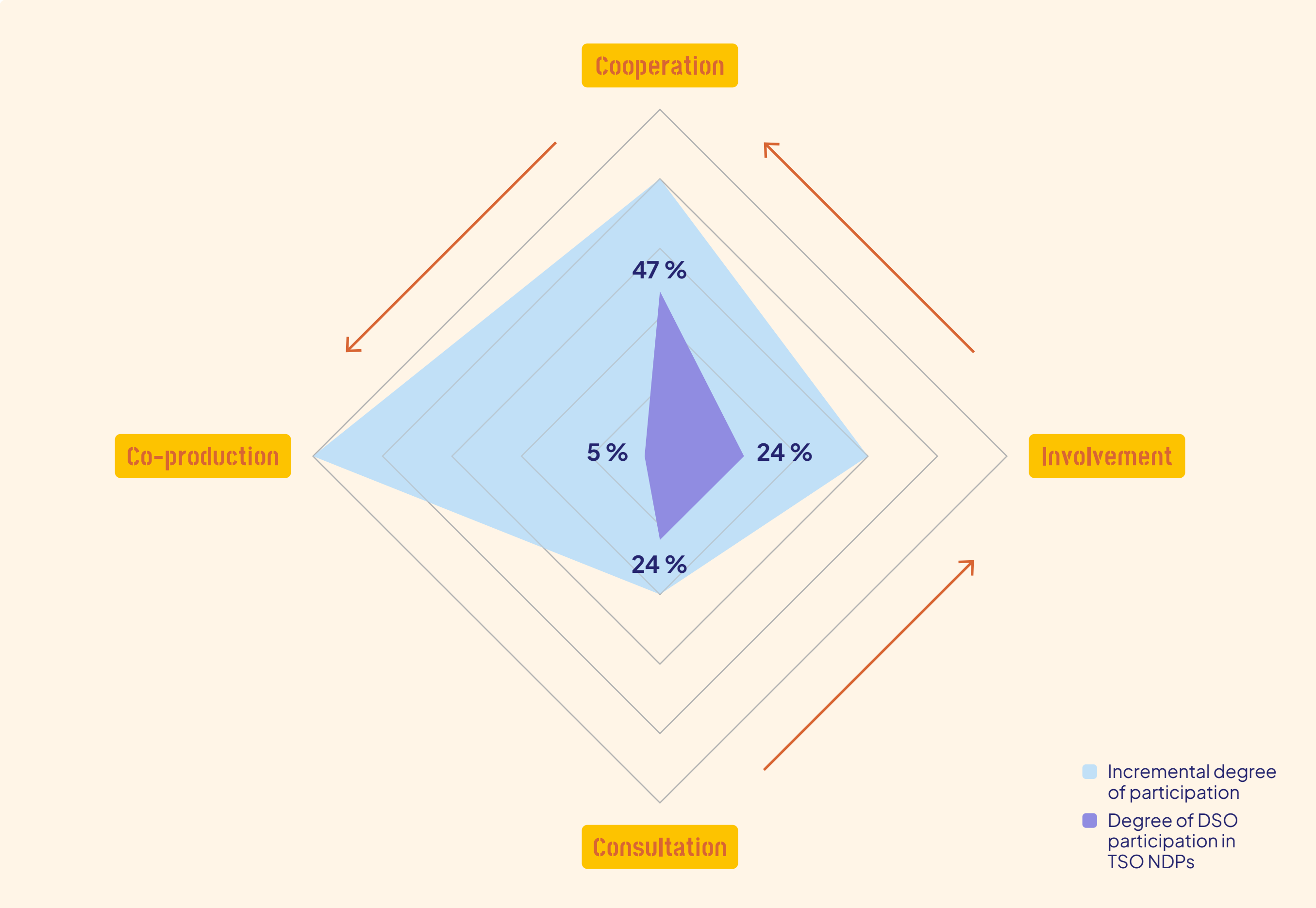

Figure 2 Degrees of DSO participation in TSO national development planning, ENTSO-E 2025 System Development TSO survey on infrastructure planning and National development Plans.

As shown in Figure 2, the incremental degree of participation is a theoretical framework that shows balanced increasing degrees of involvement. DSO participation in transmission network development planning can be measured by the same incremental degrees of participation, namely consultation, involvement, cooperation, and co-production.

Figure 2 compares the theoretical incremental degree of participation with the observed degree of DSO participation in TSO network development plans. The theoretical, incremental degrees of participation (light shading) suggest a balanced incremental growth of engagement by level of engagement, with co-production being the most developed stage. On the contrary, actual DSO participation (dark shading) is distributed more contrasted, highlighting a difference between theoretical and actual degrees of participation. Here, the actual incremental degree of DSO participation in TSO NDP development concentrates on cooperation as the most usual stage, building up on involvement and consultation. The following paragraphs deal with the analysis behind the measured degrees of DSO participation in TSO NDPs.

Of the 85% of TSO countries that responded to the ENTSO-E 2025 System Development survey on infrastructure planning and National Development Plans, 5% of national TSO planning frameworks reach the highest level: sharing final decision authority requires TSOs and DSOs to be part of the same utility or very mature governance frameworks that legally support joint planning mandates. Shared national planning authority is thus of very small existence in Europe, signalling strongly centralised national transmission planning and limited regulatory or structural incentives for deeper TSO–DSO integration.

Consultation and Involvement account for 48% of the degrees of DSO participation: DSOs provide feedback on an episodic basis (data checks, model inputs, etc.), but with limited influence, while the same number of DSOs and TSOs interact regularly and DSO contributions are integrated throughout the planning cycle. Accumulatively, almost half of all reporting TSOs operate with DSO participation that is reactive or technically helpful but not embedded in the planning. This suggests that in many countries DSO insight is used, but DSOs reside structurally outside the main decision pipeline.

Cooperation dominates the TSO-DSO collaboration techniques for national transmission planning: Nearly half of TSO-DSO interactions fall into cooperation, the third degree of participation. Cooperation means DSOs actively contribute to developing alternatives, help assess impacts, provide insights shaping the preferred solution, However, TSOs still retain full control of the final decision. Most national planning processes therefore recognise DSOs as important technical partners - DSOs influence but do not decide over TSOs' National Development Plans.

Overall, the survey shows a transmission centric planning landscape with growing emphasis on structured TSO-DSO collaboration. The dominance of cooperation indicates that DSOs are valued contributors, their data and forecasts materially affect the planning process, and interaction is shifting from one-way (TSO asks; DSO answers) to two-way collaborative modelling. Within this context, planning processes evolve primarily through enhanced cooperation rather than shared authority.

Finally, the degree and feasibility of collaboration are also shaped by the number, type and size of DSOs within each country. Where many small DSOs exist, representative arrangements or coordination mechanisms can help streamline interactions and improve the consistency and quality of data provided[5].

3.3.2 Identified Standards of Collaboration with the Distribution Grid in National Transmission Planning

Beyond the degrees of DSO participation, a successful transmission grid development process depends on structured and formalised collaboration between TSOs and DSOs. This collaboration is embedded in transmission NDPs through several coordinated workstreams and regulatory processes, thus creating good practice standards for collaboration with the distribution grid in national transmission planning[6].

A foundational element of this coordination is systematic **data exchange**. DSOs supply TSOs with high resolution forecasts for load, distributed generation, flexibility provision, and storage deployment, together with core planning assumptions. These inputs form a critical component of the modelling baseline used in NDP studies and ensure that transmission planning accurately reflects developments across all voltage levels.

In many regulatory frameworks, TSOs and DSOs also undertake joint **scenario development**. Through the alignment of assumptions on demand evolution, distributed energy resource growth, electrification trajectories, flexibility uptake, and policy-driven developments, both parties establish a harmonised long term outlook. This ensures coherence between transmission and distribution system planning and reduces systemic uncertainty.

5 MELETIOU, A., VASILJEVSKA, J. and VITIELLO, S., DSO Observatory 2024 - Unlocking Flexibility in Europe, Publications Office of the European Union, Luxembourg, 2025, JRC141953.

6 ENTSO-E 2025 System Development TSO survey on infrastructure planning and National development Plans (non-published document).

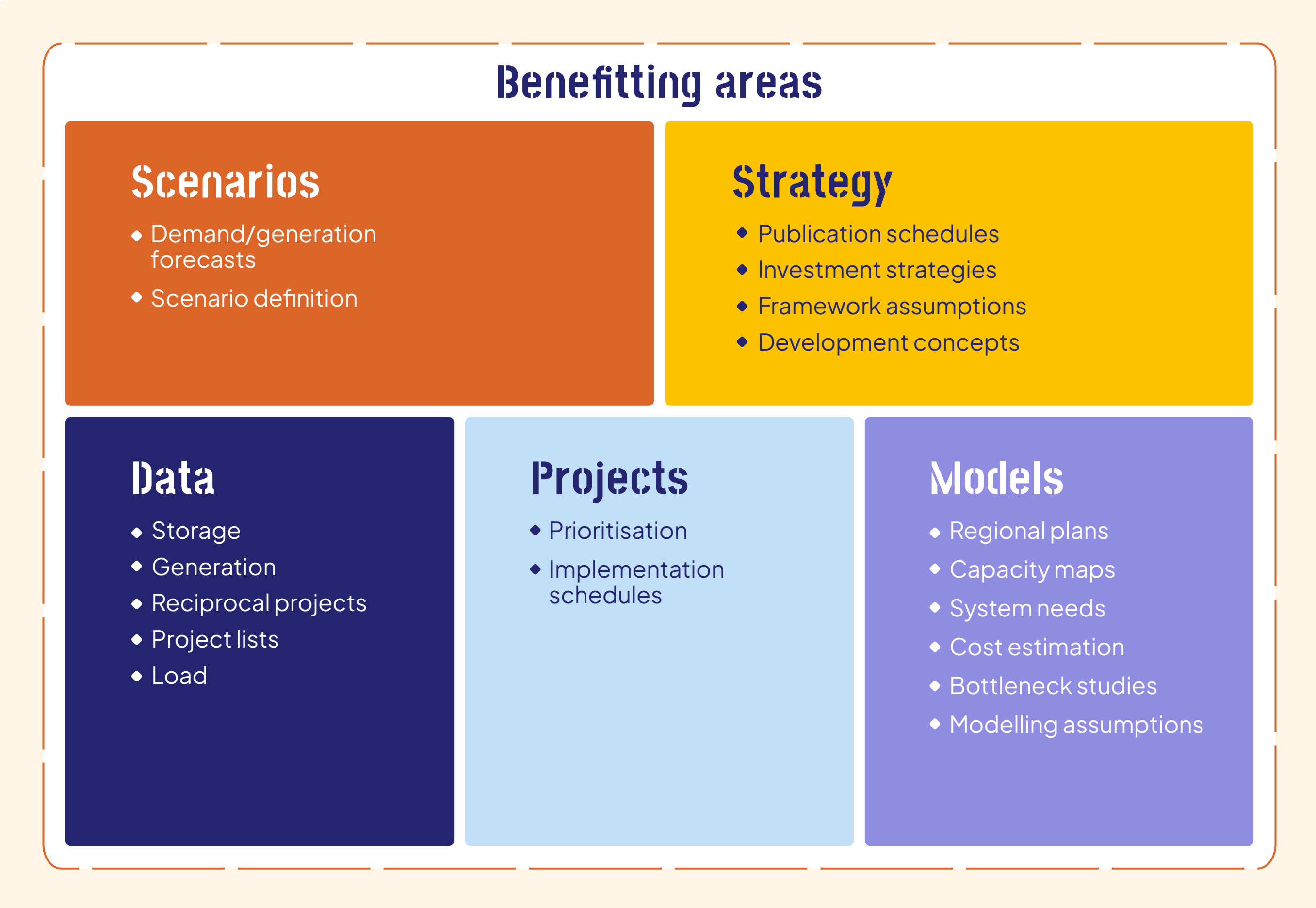

Figure 3 Recognised benefitting areas through TSO-DSO transmission grid planning collaboration, ENTSO-E 2025 System Development TSO survey on infrastructure planning and National development Plans.

Another structured coordination layer is provided by formal **consultation** procedures. DSOs contribute to public consultations, technical hearings, and bilateral workshops or recurring meetings during the NDP drafting phase. Distribution system feedback supports the validation of modelling inputs, the verification of local grid constraints, and the refinement of planning methodologies, thereby improving the accuracy and credibility of resulting transmission grid planning.

Some transmission NDPs systematically incorporate DSO identified or even jointly identified **investment needs**. This includes planned reinforcements, capacity upgrades, and local connection driven expansion projects. Aligning these distribution level developments with transmission level investment ensures that NDPs capture possible constraints and emerging grid needs.

The extent and formalisation of TSO-DSO coordination are strongly shaped by the **regulatory framework** at local, regional and EU levels. Network Codes, Guidelines, Terms and Conditions, Methodologies, and NDP specific regulatory requirements define legally binding expectations for information exchange, data quality, model transparency, consultation obligations, and joint planning activities. These instruments ensure that coordination is consistent, predictable, and aligned with broader national legislation and policy objectives.

To operationalise this collaboration, TSOs and DSOs increasingly rely on shared **models**, including the development of capacity maps, regional system development plans and regional renewable energy connection schemes. These tools support cross voltage transparency, allow for more accurate spatial planning, and facilitate efficient integration of renewable energy and new loads.

Coordination extends well beyond the periodic transmission NDP cycle. **Continuous collaboration** through bilateral working groups or recurring meetings, joint studies, dynamic data exchange, and synchronisation of project commissioning timelines enable TSOs and DSOs to respond effectively to evolving system needs and policy developments.

In some jurisdictions where the institutional setup explicitly integrates TSO and DSO responsibilities, holistic planning frameworks naturally encompass all voltage levels. In these cases, NDPs reflect a fully unified system development perspective, ensuring that joint system needs dictate national development planning in those member states in which DSO and TSO work under one roof.

Collaboration between TSOs and DSOs is embedded in NDPs through several coordinated workstreams and regulatory processes, thus creating good practice standards - data exchange, scenario development, consultation, investment needs, regulatory framework, models, continuity – for collaboration with the distribution grid in national transmission planning.

4 Summary

Effective electrification depends on close, structured coordination between transmission and distribution system operators across voltage levels. While European level institutional cooperation provides an essential framework, national transmission network development planning increasingly relies on meaningful DSO participation to ensure efficiency, security, and decarbonisation outcomes.

Distribution planning is therefore system-critical and closely linked to transmission systems. Efficient system development depends on structured and continuous collaboration with TSOs, particularly in scenario development, data alignment, connection planning, and the management of operational constraints. As electrification and decentralisation accelerate, cooperation focuses on aligning timelines, assumptions, and investments across grid levels to avoid bottlenecks and ensure coherent network development, supported by European and national frameworks. This coordination is further reinforced by digitalisation, shared tools, and ongoing dialogue, while regional cooperation mechanisms help aggregate DSO inputs and improve planning consistency in more complex systems, ultimately enabling a more reliable, efficient, and integrated energy system.

DSO involvement in NDPs reflects a shift from reactive information exchange toward integrated, two way collaboration, where DSOs actively contribute data, forecasts, and impact assessments, while TSOs retain final decision authority. Co production, involving shared planning mandates, remains rare.

TSO Survey evidence confirms a transmission centric planning landscape, but one that increasingly values DSO expertise as a critical input to credible and robust transmission planning. Good practice collaboration is characterised by systematic data exchange, joint scenario development, formal consultation processes, alignment of investment needs, shared modelling tools, and continuous coordination beyond the NDP cycle.

Looking ahead, new areas of collaboration might evolve and are possibly covered by but not limited to topics including Digitalisation and AI for Energy, the Electrification Action Plan, or the new Trans-European Networks for Energy (TEN-E). Assessing the learning outcomes from good TSO-DSO practices in planning implementation can help to find and apply effective collaboration across voltage levels where enabling the decarbonisation of an increasingly decentralised energy system is indispensable.

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