GRIDS & ENERGY SYSTEMS | *Expert Workshop*

Empowering *grids* from Planning to Practice

DAY ONE | 19 NOV
10:00 – 15:30 CET

Enhancing TSO-DSO Collaboration in Planning and Operations

DAY TWO | 20 NOV
10:00 – 15:30 CET

Methodology to Mandate: Implementing the Flexibility Needs Assessments

TenneT Offices
Square de Meeûs 38/40
1000 Brussels

Renewables Grid Initiative

Hosted by
TenneT

Co-funded by the European Union

WELCOME TO DAY 1

Enhancing TSO-DSO Collaboration in Planning and Operations

Renewables Grid Initiative

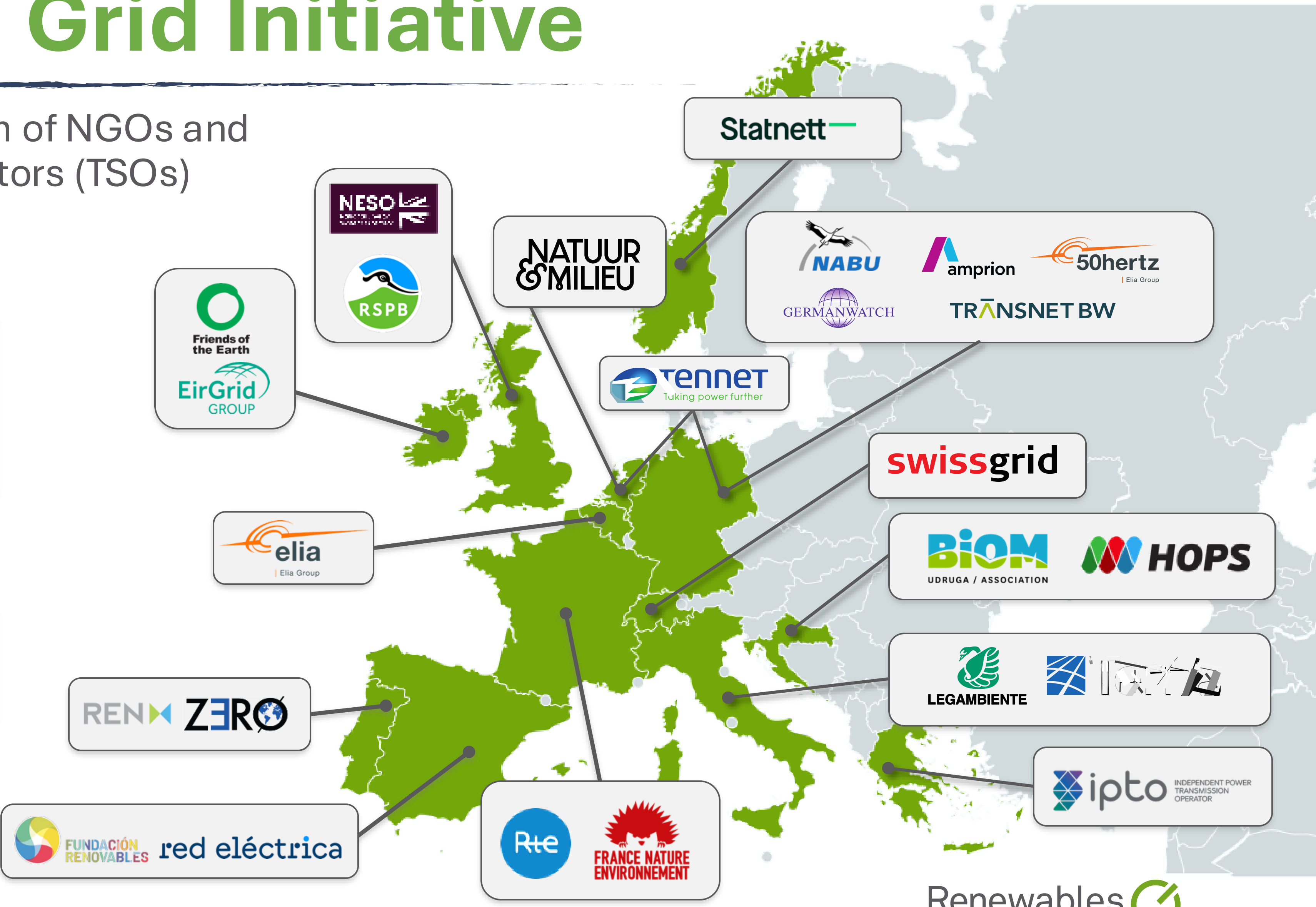
RGI is a unique collaboration of NGOs and Transmission System Operators (TSOs) from **across Europe**

EUROPEAN ORGANISATIONS

CAN Climate Action Network Europe
WWF
BirdLife International
BirdLife Europe
Bellona Europa
EMBER

SUPPORTING MEMBERS

europacable Try life without us
IUCN
T&D europe



Renewables Grid Initiative

About RGI

We engage in an energy transition ecosystem of actors and promote **fair, transparent, sustainable grid development** to enable the growth of renewables to achieve full decarbonisation in line with the Paris Agreement.

TRANSMISSIONSYSTEM OPERATORS (TSOS)

50hertz, amprion, elia, EirGrid, HOPS, ipto, NESO, REN, red eléctrica, Rte, TenneT, Terna, TRANSNET BW, Statnett, swissgrid

Renewables Grid Initiative

NON-GOVERNMENTAL ORGANISATIONS (NGOS)

BELLONA EUROPA, BirdLife International, BIOM, CAN Europe, EMBER, Friends of the Earth, Fundación Renovables, France Nature Environnement, Germanwatch, Legambiente, NABU, Natuur & Milieu, RSPB, zero., WWF

SUPPORTING MEMBERS

europacable, IUCN, T&D europe

How is our work structured?

As a solutions-driven organisation with focus on the electricity infrastructure implementation. We foster knowledge exchange, discussions on the needs of grid infrastructure, and best practices sharing within **three dimensions:**

GRIDS & ENERGY SYSTEMS

We enable discussions on how to **model, plan and implement** decarbonised and optimised clean energy systems, including different voices in the process.

ENERGY & NATURE

We ensure energy systems both onshore and offshore are developed in **coherence with nature and biodiversity**, promoting mitigation, enhancement and restoration measures.

ENERGY & SOCIETY

We include and engage **citizens, civil society and policymakers** on strategies towards full decarbonisation, building capacity on the role of grids within the energy transition.

Renewables Grid Initiative

Workshop contextualisation

Renewables scale up and electrification are driving profound changes in how Europe’s electricity network is planned, operated and stabilised.

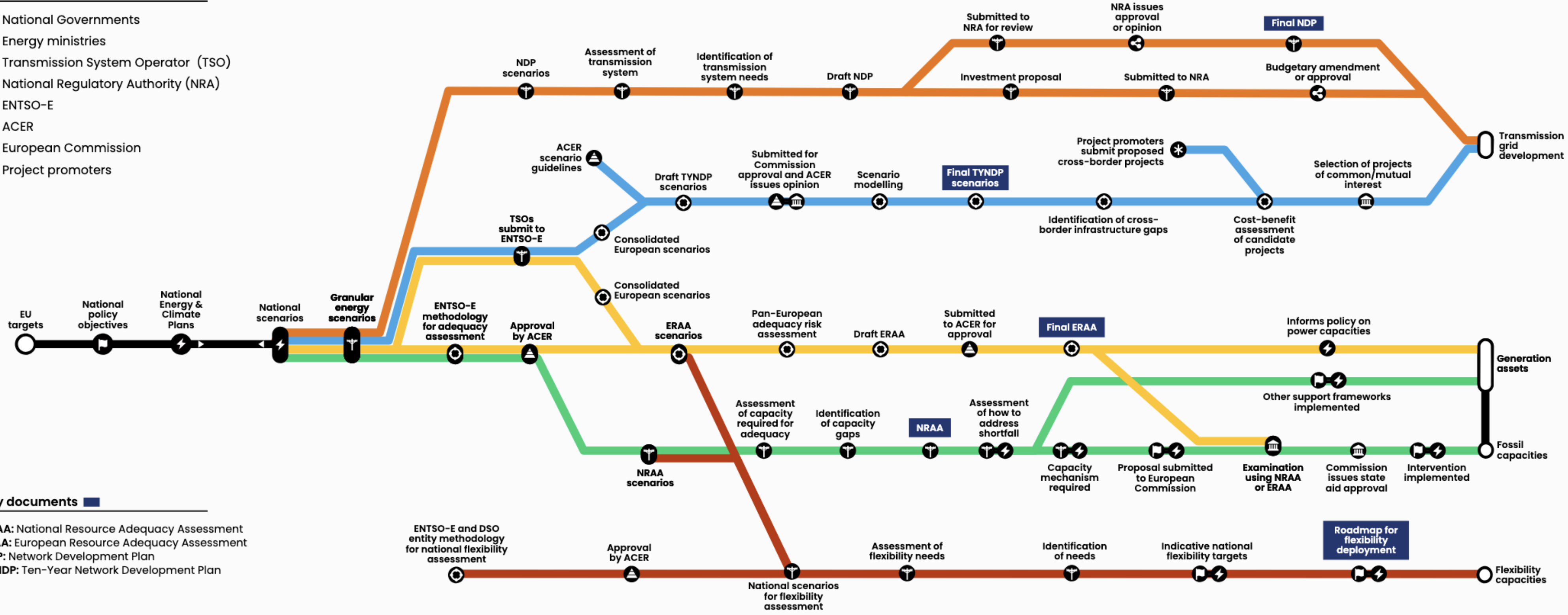
There are several **planning processes** that are shaping the future of European electricity grids:

Navigating power system planning in the EU

Europe's power system planning involves a wide set of processes carried out by EU institutions, national governments, regulators, and system operators. These processes include setting long-term policy targets, developing national energy and climate plans, assessing system adequacy and flexibility needs, and identifying priority infrastructure projects. Together, they form a complex but essential framework for coordinating investments and ensuring the reliability of the European power system.

Key actors

- National Governments
- Energy ministries
- Transmission System Operator (TSO)
- National Regulatory Authority (NRA)
- ENTSO-E
- ACER
- European Commission
- Project promoters



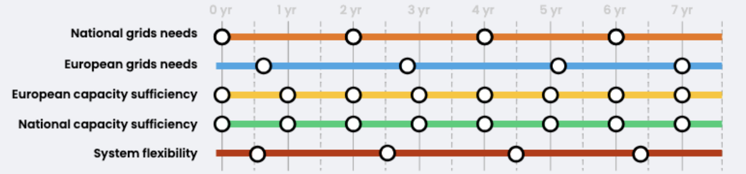
Key documents

NRAA: National Resource Adequacy Assessment
ERAA: European Resource Adequacy Assessment
NDP: Network Development Plan
TYNDP: Ten-Year Network Development Plan

Network lines and timetable

National grids needs Orange line	European grids needs Blue line	European capacity sufficiency Yellow line	National capacity sufficiency Green line	System flexibility Red line
Identifies national transmission system needs to support expected developments in the power system and to maintain stability and reliability.	Identifies where cross-border transmission lines are needed and evaluates candidate infrastructure projects to select Projects of Common Interest (PCIs) or Projects of Mutual Interest (PMIs).	Assesses the ability of the European power system to reliably meet electricity demand over the next ten years, including under extreme events.	Assesses the ability of the national power system to reliably meet electricity demand over the next ten years, including under extreme events.	Identifies system-wide flexibility needs (technology-neutral) at national and local levels to minimise renewable curtailment and manage variations in residual load.
Responsible Authority TSOs	**Responsible Authority** ENTSO-E, ENTSOG, ENNOH	**Responsible Authority** ENTSO-E	**Responsible Authority** TSOs	**Responsible Authority** TSOs
Frequency Biennially (average)	**Frequency** Biennially	**Frequency** Annually	**Frequency** Annually	**Frequency** Biennially

Frequency of service
All lines



Source: Ember
Infographic by Reynaldo Dizon and Elisabeth Cremona.

Workshop contextualisation

Ensuring alignment **between voltage levels** is essential to ensure the **coherence** of these planning exercises.

The relevance of **enhanced TSO-DSO collaboration** has been further emphasised in the **Electricity Regulation** and in the conclusions of the **Infrastructure Forum** 2024 and 2025.

Strengthening TSO-DSO collaboration on network development planning, including ensuring consistency between Union, national and local scenarios in line with energy and climate targets, transparency, meaningful consultations and timely data exchanges between system operators and with relevant stakeholders.

Best practices on TSO-DSO collaboration

Workshop objectives

Overarching objective: facilitate an exchange and knowledge transfer on **enhancing the cooperation between TSOs and DSOs**

- Discuss and understand current **gaps in TSO-DSO collaboration**
- Discuss **opportunities** for enhancing coordination and facilitate the emergence of new ideas for TSO-DSO collaboration
- Showcase and analyse **existing good practices**
- **Develop recommendations** to support such collaborations
- Create a bridge for **further discussions at Day 2**

Workshop background

21 June 2023

11 July 2024

19-20 Nov 2025

Renewables Grid Initiative

General information

15 Minutes Presentations

5 Minutes immediate Q&A

20-35 Minutes Discussion

We are recording for RGI internal use!

We are under Chatham House rules!

Agenda of today

Renewables Grid Initiative

9:30	**Registration and coffee**
10:00	**Welcome, agenda, and workshop's objectives** RGI
	Setting the scene
10:15	**Vertical coordination in liberalised and carbon-constrained energy systems: bridging network boundaries** Dimitra Apostolopoulou and Dr Rahmat Poudineh, Oxford Institute for Energy Studies *15 min presentation, 10 min direct and clarification questions*
	Session 1 | Collaboration for long-term planning

Agenda of today

Renewables Grid Initiative

Session 1 | Collaboration for long-term planning	
10:40	**Collaboration across voltage levels – experience from planning of the European system** Rodrigo Barbosa, ENTSO-E *15 min presentation, 5 min direct and clarification questions*
11:00	**National Case 1: Joint scenario building between a TSO and DSOs in the Netherlands** Tim Gaßmann, TenneT *15 min presentation, 5 min direct and clarification questions*
11:20	**National Case 2: The connection of renewables in France: planning of grid infrastructure implemented through close TSO-DSO cooperation** Alexis Cauzit, RTE *15 min presentation, 5 min direct and clarification questions*
11:40	**Discussion: Session 1** *35 min*
12:15	**Lunch Break (1 hour)**

Agenda of today

Renewables Grid Initiative

Session 2 | Collaborating for system operations	
13:15	**National Case 3: Collaborating for system operations – the case of Germany** Paula Munstermann and Valerian Watson, 50Hertz *15 min presentation, 5 min direct and clarification questions*
13:35	**National Case 4: TSO-DSO Synergy in Finland: FinFlex Congestion Management Market** Jutta Kallanto, Fingrid *15 min presentation, 5 min direct and clarification questions*
13:55	**Discussion: Session 2** *20 min*
14:15	**Coffee Break (15 minutes)**
14:30	**Interactive Session**
15:20-15:30	**Conclusions, next steps and end of the workshop**

Setting the scene

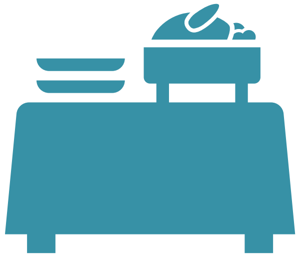
SESSION 1

Collaboration for long-term planning

Renewables Grid Initiative

LUNCH BREAK

12:20 – 13:20 (1 HOUR)



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SESSION 2

Collaborating for system operations

Renewables Grid Initiative

COFFEE BREAK

14:30 – 14:45

INTERACTIVE SESSION

14:40 – 15:20

Interactive session | What Makes TSO–DSO Collaboration Work?

Small groups *(10 minutes)*
4 groups in-person
Each refines one of these recommendations:

Each group discusses:
- **Is the wording clear and actionable?**
- **What nuance or detail would make it more realistic?**
- **What problem does this recommendation solve?**

1. Clarify shared roles & responsibilities in joint planning and flexibility assessments
2. Strengthen governance & regulatory alignment for TSO–DSO cooperation
3. Promote data interoperability & common modelling standards
4. Ensure transparency and stakeholder participation in co-planning processes
5. Use the FNA as a practical testbed for long-term flexibility integration

Interactive session | Identify Enabling & Success Factors *(20 min)*

Step 1: Individual brainwriting *(5 min)*

Each participant writes 1 idea per sticky note answering:

- **What conditions would allow this recommendation to work in real life?**
- **Which actors hold which responsibilities?**
- **What are risks if these enabling conditions are missing?**

Step 2: Group clustering *(5 min)*

Participants place notes on a flipchart and cluster ideas into:

- Governance / regulatory
- Data / tools
- Processes / procedures
- Capacity / capabilities
- Culture / trust / engagement
- Anything else?

Step 3: Group synthesis *(10 min)*

The group identifies:

- **Top 2–3 enabling factors**
- **Key actors responsible (TSOs, DSOs, NRAs, EC, market, platforms, etc)**
- **1 potential "quick win"**

Interactive session | Plenary summary *(10 min)*

Each group gives a 1-2 min summary:

- Final recommendation wording
- The top enabling factors
- Which actors are responsible/needed?

Renewables Grid Initiative

Conclusions and next steps

Nov 2025	**Follow up emails and sharing the (authorised) content presented today**
Dec 2025	**Summary report and factsheet presenting the outcomes and main messages from today**
Dec 2025	**Publication of Grids Package**
2025 – 2026	**We are keeping the momentum going, so stay tuned!**

GRIDS & ENERGY SYSTEMS

THANK YOU!

Andrzej Ceglarz
Director– Energy Systems

Alexandros Fakas Kakouris
Senior Manager – Energy and Policy systems

Amanda Schibline
Manager – Socio-energy systems

Renewables Grid Initiative

RGI social media:
linktr.ee/renewablesgrid

RGI website:
renewables-grid.eu

THE OXFORD INSTITUTE FOR ENERGY STUDIES

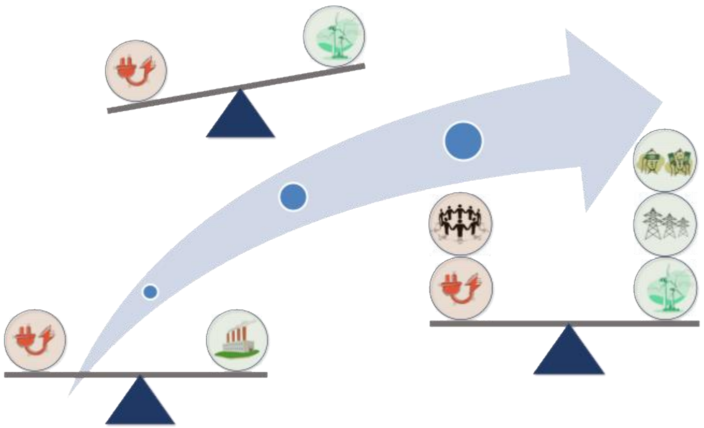
Vertical coordination in liberalised and carbon-constrained energy systems: *bridging network boundaries*

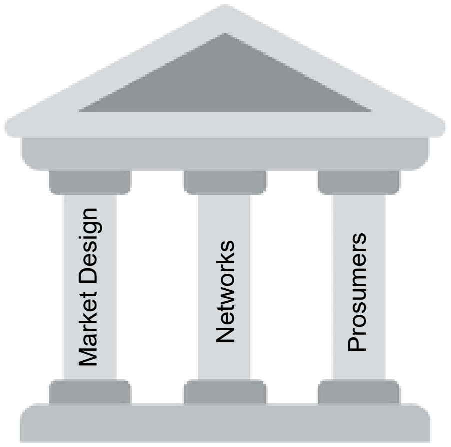
Dimitra Apostolopoulou and Rahmat Poudineh

Oxford Institute for Energy Studies – who we are and what we do

Academic research on strategic and commercial energy themes, structured across seven main programmes:

1. Oil research programme, 2. Natural gas research programme, **3. <u>Electricity research programme</u>,**
4. China energy research programme, 5. Hydrogen research programme, 6. Carbon management programme,
7. The energy transition





Electricity Programme: Work towards Decarbonised, Decentralised and Digitalised Electricity Systems

- Market design and integration of renewable energy resources
- Electricity networks and decarbonisation of economy
- Distributed energy resources, demand side flexibility and consumer participation

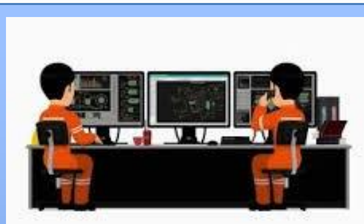
Decentralised Electricity Systems

- Distributed Energy Resources (DERs) have significantly grown over the past years due to
  - cost competitiveness
  - government support
  - dynamic pricing, and
  - Regulation
- Customers see reduced bills, increased reliability, achieve energy independence, and promote renewable energy

DER System Benefits

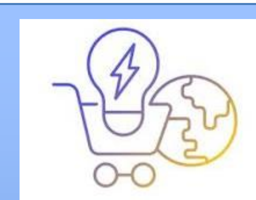
Reliability	Stability	Cost reduction
• Diversity • Close to end-user • Integrate renewable resources	• Flexibility • Voltage regulation • Frequency regulation	• Congestion • Losses • Network upgrade deferrals

Challenges of Increased DERs Penetration



System Operations
- Intermittency
- Reduced inertia
- Voltage regulation
- Lack of visibility
- Bi-directional flows
- Cybersecurity

System Infrastructure Planning
- DER growth
- Advanced metering infrastructure
- Increased number of investors

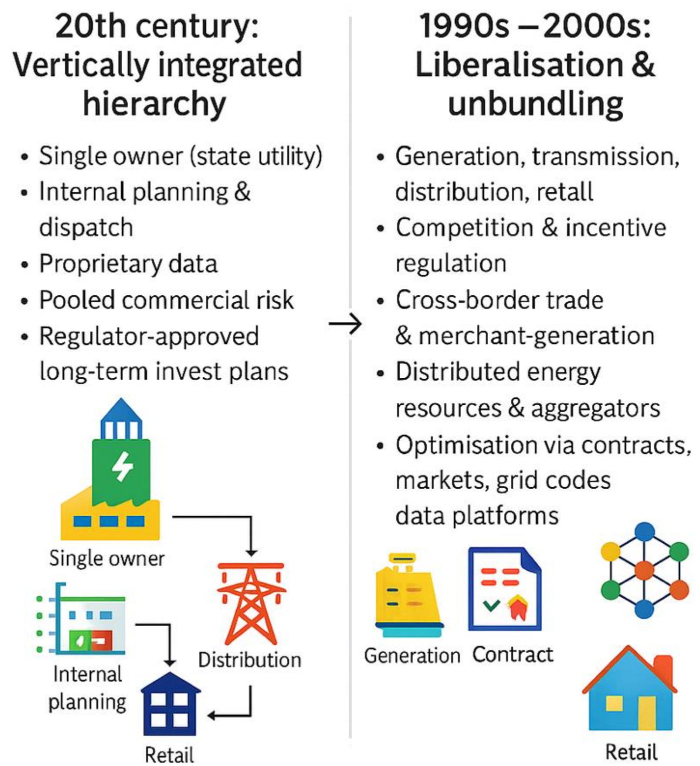


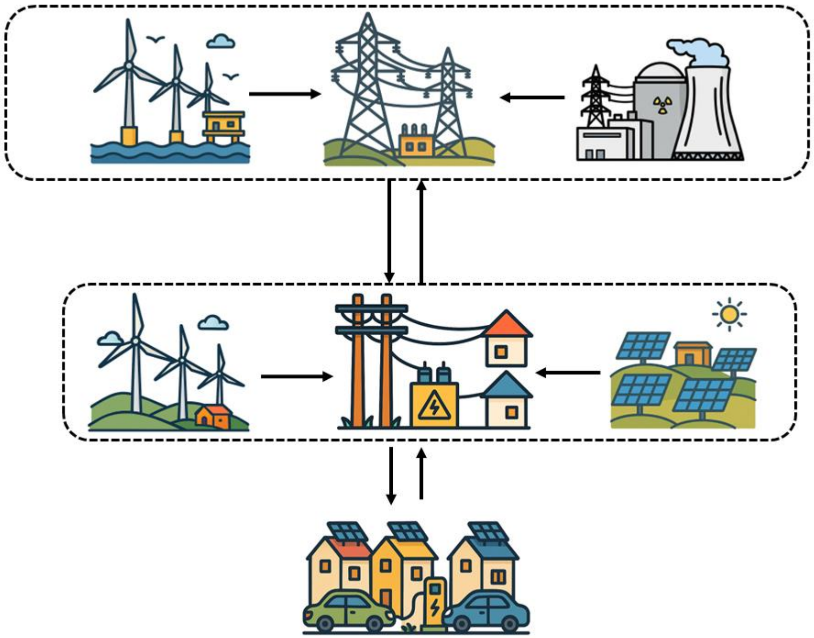
Market Issues
- Wholesale market participation
- Conflicting signals
- Network tariffs

Equity Issues
- Cost allocation
- Utility death spiral

Solution lies in Coordination

- Vertical coordination is the alignment of actors that sit at different tiers of the energy chain- typically an upstream “network owner” and one or more downstream users who rely on that network
- *How is this achieved?*



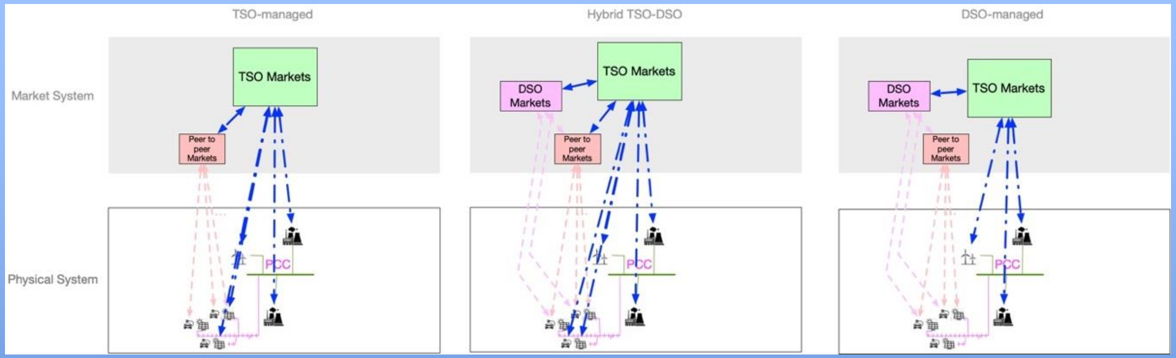


Zoom into Vertical Coordination

- Vertical mechanisms concentrate on contracts and governance
  - tariffs that remove inefficiencies
  - revenue-sharing rules that split the gains from joint projects
  - data interfaces that give each tier the state information it lacks
  - joint planning bodies that evaluate cross-layer investments
- When these instruments work, the chain behaves like an integrated asset
- When they don't each tier optimises in isolation and the combined system ends up over-built, under-utilised or, in the worst case, insecure

	Minimal DSO	Total DSO
Market structure	Central market run by TSO where DERs participate	Local market run by DSO
Energy prices	Set by bulk system	Set by local resources plus imports/exports from the bulk system
Network planning	Central planning	Each DSO is responsible for each T&D interface
Reliability and resilience	Central responsibility	Shared responsibility between DSOs and TSO
DER dispatch signals	From both DSOs and TSO	Only from DSO

Vertical Systems Coordination Challenges



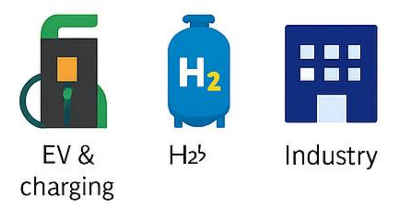
- Information asymmetry
- Misaligned incentives & cost recovery
- Regulatory silos
- High costs of data sharing
- Timing mismatches across markets
- Under-provision of security investments

Coordination Challenges in the Net-zero Era

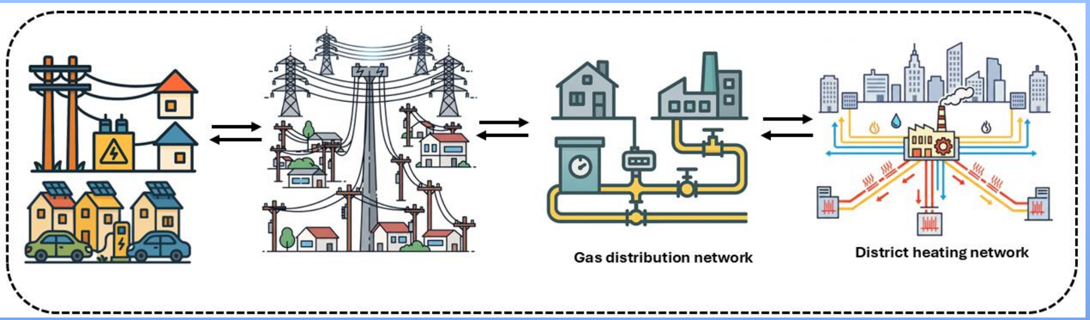
- *Physics of variable renewables*: scheduling is a multi-nodal, pan-regional choreography in which batteries, demand response and interconnectors must all "dance" to the same forecast
- *Mass electrification of end-uses*: Without common price signals, activation hierarchies and cybersecurity protocols can destabilise the system or strand upstream network investment
- *Sector coupling*: Coordinated planning of pipelines, substations and electrolysers to consume surplus renewable power blurs institutional boundaries
- *Net zero targets*: Compress the investment timetable and shift capital risk onto coordination itself

Net-zero era: Coupled, carbon-constrained system

- Legally binding targets & carbon budgets
- Grid must integrat high VRE
- Electrification of heat, transport, industry
- Cross-vector coupling: electricity ↔ gas ↔ hydrogen ↔ heat ↔ data
- Coordination challenges across network layers



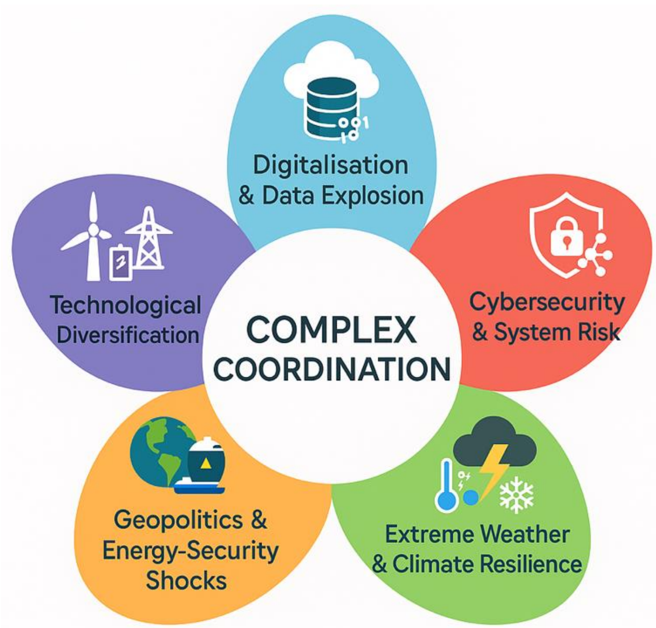
Zoom into Horizontal Coordination



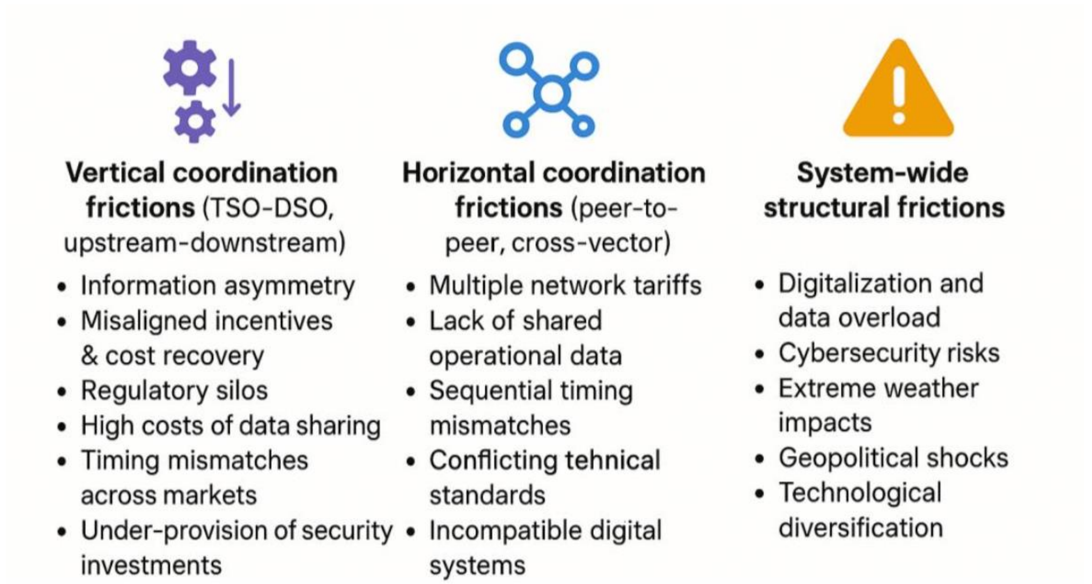
- Multiple network tariffs
- Lack of shared operational data
- Sequential timing mismatches
- Conflicting technical standards
- Incompatible digital systems

System-wide Challenges

- Liberalisation and net-zero goals are huge, but at least five other structural forces have also enlarged the coordination challenge across energy networks



Summary of Coordination Challenges



Vertical coordination frictions (TSO-DSO, upstream-downstream)	**Horizontal coordination frictions** (peer-to-peer, cross-vector)	**System-wide structural frictions**
• Information asymmetry • Misaligned incentives & cost recovery • Regulatory silos • High costs of data sharing • Timing mismatches across markets • Under-provision of security investments	• Multiple network tariffs • Lack of shared operational data • Sequential timing mismatches • Conflicting tehnical standards • Incompatible digital systems	• Digitalization and data overload • Cybersecurity risks • Extreme weather impacts • Geopolitical shocks • Technological diversification

How to Restore Useful Coordination?

- Three approaches of restoring useful coordination:

	MARKET 	NETWORK 	HIERARCHY 
Decision-making	Decentralised, price-driven	Collective/consensus among participants	Centralised, commands by public authority
Allocation mechanism	Prices & contracts	Agreements & reciprocity (bilateral/multilateral)	Planning & directives
Financial goals	Profit maximisation, value capture	Mutual gains, joint value	Public interest, service obligations
Role of public authority	Facilitator, rules & transparency	Participant, peer in agreements	Principal, directives & enforcement

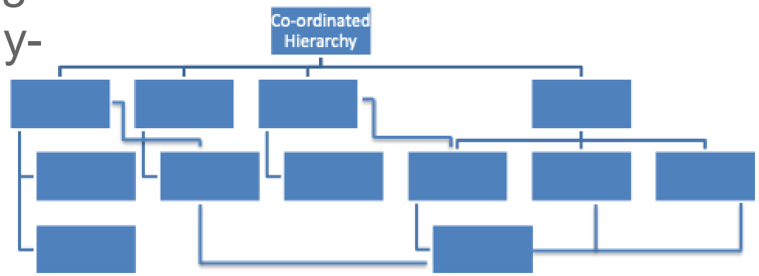
- The energy sector liberalision assumed that system coordination could be achieved through “pure market”

Why Market Fails?

- For markets alone to efficiently deliver decarbonization we need: perfect carbon pricing over decades; complete markets across time, space, and contingencies; deep hedging instruments for long-term risk; “well-behaved” technologies and perfect information
- Reality:
  - Information Explosion
  - Incomplete and Uncertain Carbon Pricing
  - Governments intervene
  - Grid investments are natural monopolies
  - Non-convex operations and missing money problem
  - Efficient operation requires shared governance and standards
  - Concerns over affordability and fairness drive interventions that weaken pure market signals.

Towards Co-ordinated Hierarchy

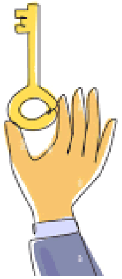
- Modern energy systems' complexity and binding net-zero goals push coordination toward a hierarchy-anchored hybrid
  - a public or quasi-public authority
  - markets and network mechanisms operate beneath that umbrella



- Net-zero converts policy goals into operational constraints
- Systemic-risk externalities rise with sector coupling
- Limits of pure hierarchy
- Hierarchy provides the non-delegable, system-wide guardrails (carbon pathways, cyber-security baselines, cross-vector reliability), while markets, platforms and network consortia reveal local information, drive competition and foster innovation inside that envelope
- Challenge is to calibrate the vertical scope of the hierarchy and create horizontal interfaces that keep markets and networks contestable and adaptive while meeting collective objectives: a resilient, cyber-secure, zero-carbon energy system

Key Takeaways

- Vertical coordination is essential to manage the challenges and unlock the full potential of DERs for system-wide benefits
- In liberalised markets, this coordination is enabled through tariff design, revenue-sharing mechanisms, and data interfaces
- Vertical coordination challenges form a subset of broader coordination challenges in the Net-Zero era, which also require strong horizontal coordination among actors
- Liberalisation and Net-Zero objectives create system-wide complexities that cannot be solved through pure market mechanisms alone
- There is a need to evolve towards a hierarchical, anchored-hybrid framework, where Net-Zero goals act as operational constraints guiding system behaviour
- Reducing systemic coordination frictions delivers greater overall benefits than pursuing marginal cost reductions in individual technologies.



Thank you!

dimitra.apostolopoulou@oxfordenergy.org

Questions 

Collaboration across voltage levels

TSO-DSO Cooperation on the European Union level

19/20 December 2025

DSO ENTITY
DSOs FOR EUROPE

entsoe
Reliable Sustainable Connected

AGENDA

TSO-DSO Cooperation on the European Union level

1. **Context** Shared Goals for Grid Cooperation
2. **Key Initiatives and Tools** At EU and national level
3. **Next Steps**

Shared Goals for Grid Cooperation

Sustainable Energy System

Efficient Planning and Operations

Activation of Flexibility Sources

Development of Network Codes

Regulation and guidance on DSO activity differs from that of TSOs
They must fit the relevant paradigm of the different voltage levels

DSOs manage many low-cost, short-lead-time MV and LV tasks once the locations and technical parameters are known, **whereas TSOs focus on few high-cost, long-lead-time EHV or HV projects requiring detailed scenario analysis.**

Network Development Characteristics	DSO for MV and LV	TSO for EHV & HV and DSO for HV
Project Volume & Scale	**Hundreds of thousands** of small-scale MV and LV projects annually	**Few** large-scale projects
Unit Cost	**Low** : hundreds to thousands € for LV; up to a few millions € for MV	**High** : tens of millions of euros or more
Lead Time	**Short**: weeks to months for LV; months to semesters for MV	**Long**: 5–10 years or more for EHV
Customer and stakeholder Interaction	**Minimal interaction** prior to connection application	**Extended engagement** during project development
Impact Scope	**Local**: individual customers, streets, cities	**Broad**: regional, national, cross-border

Planning Methodologies and Strategic Principles	MV and LV planning: first a strategic and global approach, then actual projects execute the strategic framework with marginal, if any, freedom	EHV & HV and HV planning: Extended studies, both at global scale and per asset
Planning Approach	1. Strategic & global planning to define programs targeting large volumes of similar LV / MV projects 2. Minimal per-asset study based on standardized processes and solutions	Specific optimization through complex studies & scenarios based on numerous impactful parameters
Decision drivers	1. Strategic program with scenario-building & long-term economic optimization 2. Responsive deployment of specific asset, triggered locally & just-in-time, based on actual need (connection requests or other grid needs)	Investment decisions supported by comprehensive studies, strategic scenario-building & long-term economic optimization
Relevance of scenario building	1. Program-level planning incorporates regional / national statistics & scenarios to ensure alignment with HV grid development 2. Scenario-building at the asset level is inefficient & potentially misleading due to the evolving nature of asset usage over its lifetime.	Due to high costs, long timelines & significant / broad impact of each asset on the electric system, detailed planning & scenario building per asset are justified.

At EU level – Cooperation on the TYNDP scenarios

Operationalising Cooperation – Stakeholder Reference Group

STAKEHOLDER REFERENCE GROUP
FOR THE TYNDP SCENARIOS

Examples of SRG commendations relevant for the DSO level

'The results from the scenarios shall be checked against the national grid development plans in electricity, gas and hydrogen, but also against the grid development plans of the DSOs in gas/hydrogen/electricity and district heating.'

'A group is set up between the DSOs in gas and electricity and European Heating Industry (EHI) and informed stakeholders to collect the most recent national statistical reports on the heating technologies installed to have reliable and current data for the reference year.'

SRG feedback on the preliminary 2024 TYNDP Scenarios results

Cooperation at national level – Examples

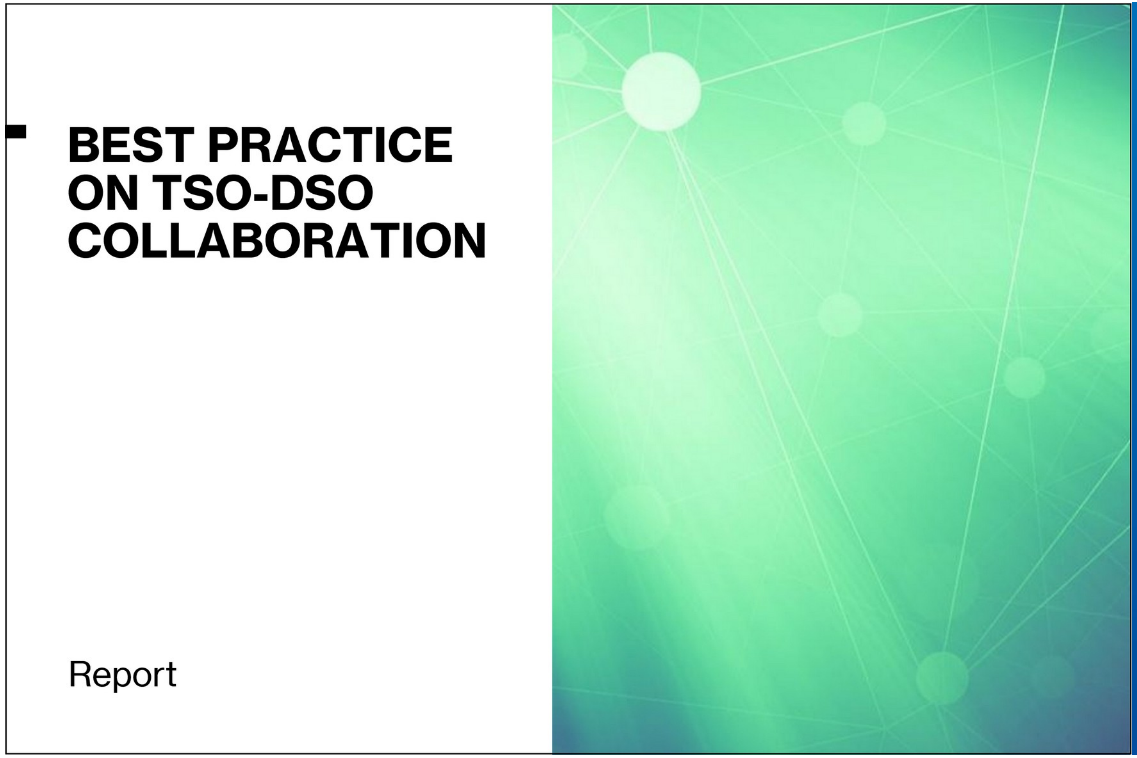
Operationalising Cooperation - How is coordination with the distribution grid incorporated in National Development Plans (NDPs)?

1. **Systematic Data Exchange**
   DSOs provide forecasts (load, generation, storage) and assumptions for NDP studies.
2. **Joint Scenario Development**
   Some TSOs and DSOs align scenarios and planning assumptions to ensure coherence.
3. **Formal Consultation**
   DSOs participate in public consultations and regular meetings during NDP drafting where possible.
4. **Integration of Investment Needs**
   DSO project proposals and priorities are reviewed and included in NDP.
5. **Regulatory Framework**
   Cooperation is mandated by some national laws, network codes, and regulatory oversight.
6. **Common Planning Utensils**
   Use of capacity maps, regional plans, and renewable connection schemes.
7. **Continuous Cooperation**
   Ongoing collaboration through joint studies, periodic meetings, and aligned commissioning dates.
8. **Holistic Planning**
   Where TSO and DSO roles merge, planning integrates both grids seamlessly.

From ENTSO-E 2025 System Development TSO survey on infrastructure planning and National Development Plans

Next steps

Best practice report on TSO-DSO collaboration to be presented at Copenhagen Energy Forum 2026



Our values define who we are, what we stand for and how we behave.
We all play a part in bringing them to life.

EXCELLENCE

We deliver to the highest standardss. We provide an environment in which people can develop to their full potential.

TRUST

We trust each other, we are transparent and we empower people. We respect diversity.

INTEGRITY

We act in the interest of ENTSO-E

TEAM

We care about people. We work transversal and we support each other. We celebrate success.

FUTURE THINKING

We are a learning organisation. We explore new paths and solutions.

We are ENTSO-E

Scenario development in the Netherlands

A joint approach of TSOs & DSOs

Tim Gaßmann

TenneT NL | Energy System Planning

Introduction

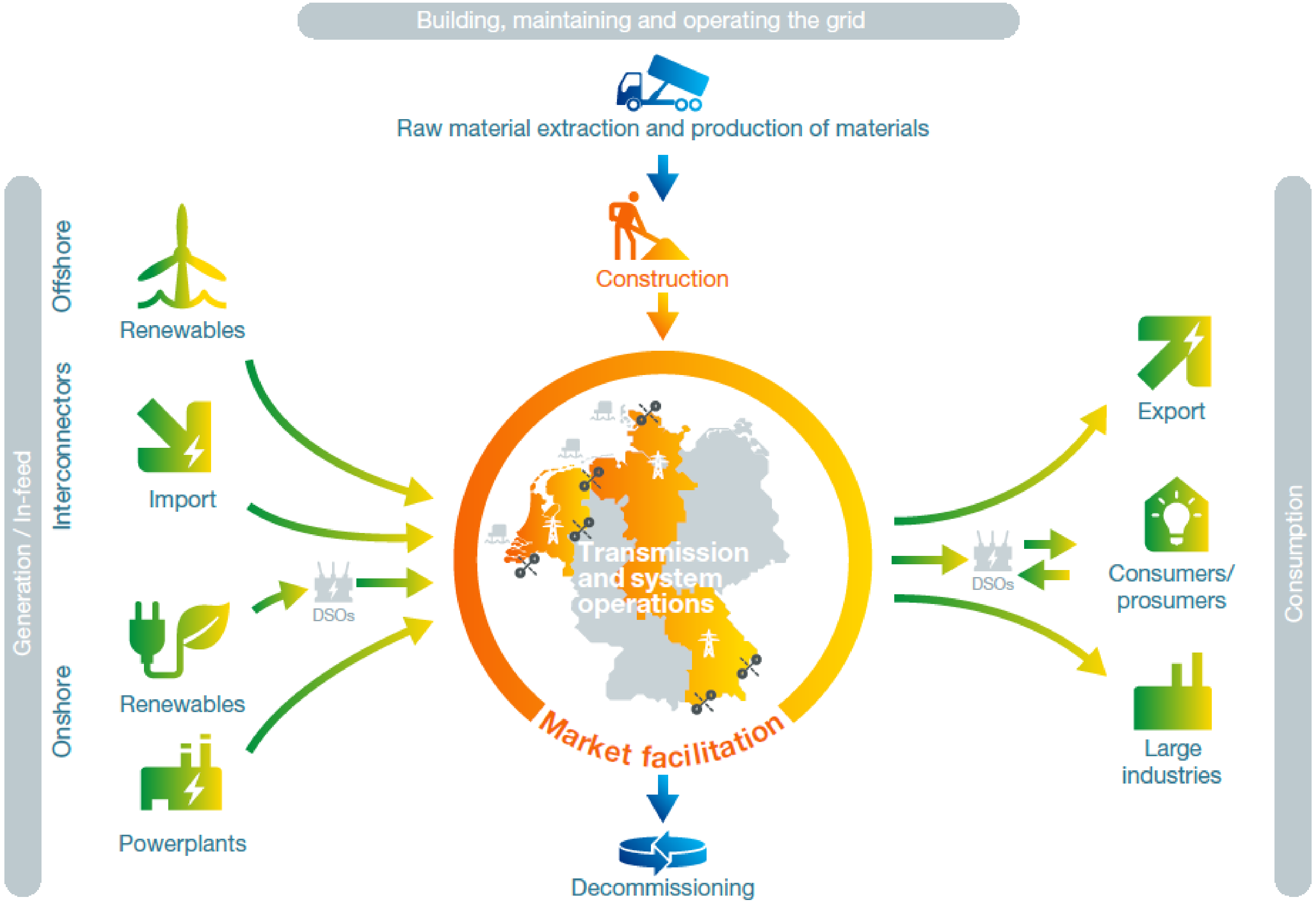
Introduction

Speakers overview

- **Tim Gaßmann**
- Msc. Electrical engineering & business administration (RWTH Aachen)
- Since 2013: Working enthousiatic on the energy transition at TenneT
- Current position: **Energy system scenario developer** in TenneT‘s business unit energy system planning focussing on scenario development, market- & adequacy analyses
- **Recent projects:** Investment plan 2026, TYNDP 2026, Monitor Leveringszekerheid 2025, Target Grid
- **Contact:** tim.gassmann@tennet.eu

Introduction

TenneT - At the centre of the energy transition



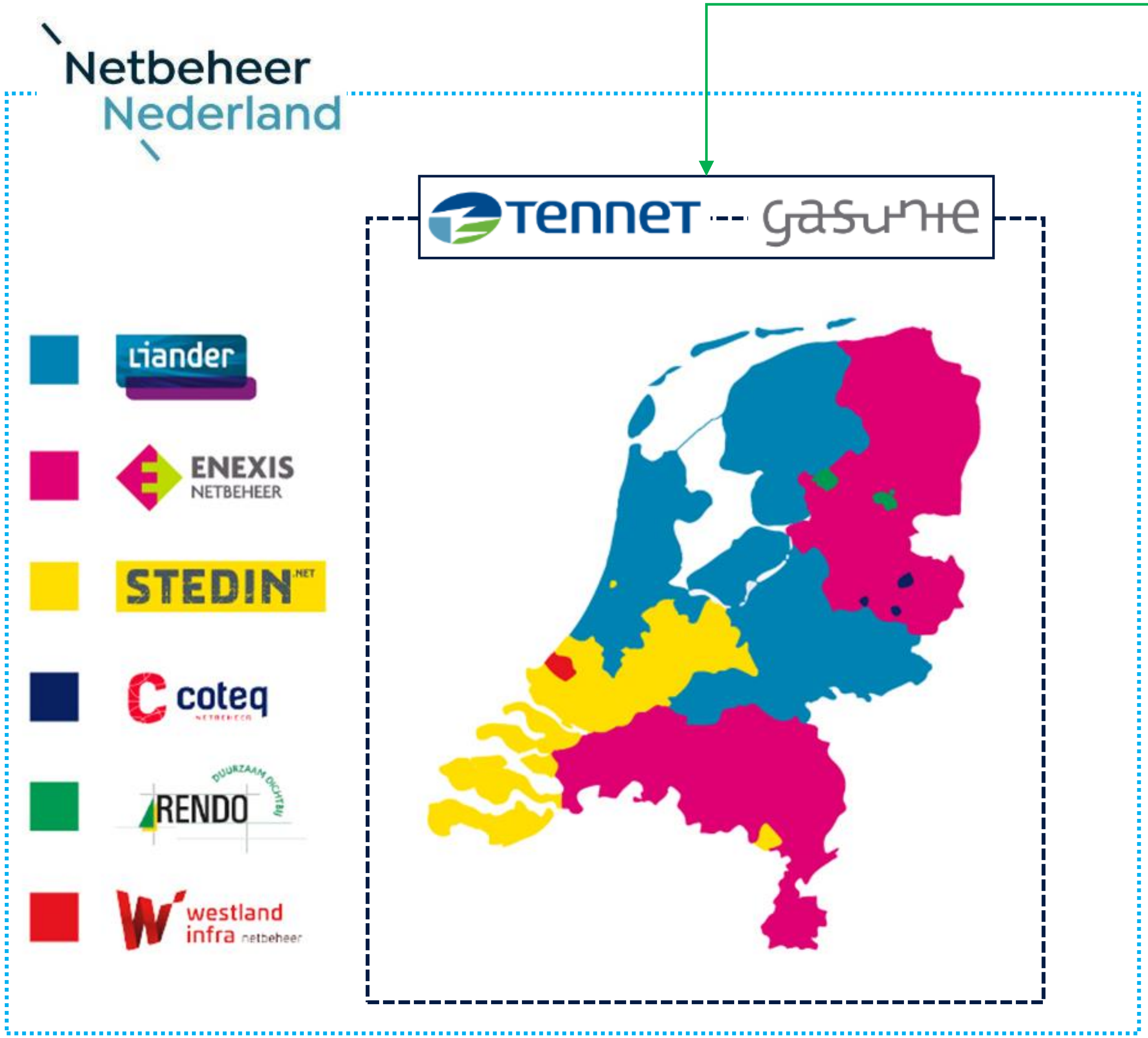
Transmission services
Ensure a robust and efficient high-voltage grid

System services
Maintain the balance of electricity, 24/7

Market facilitation
Facilitate an efficient and stable electricity market

Introduction

How are we organized as grid operators?



- **6 DSOs** supplying both electricity & gas to regional customers
- **TenneT & Gasunie** as national TSOs for electricity / gas, coordinating with other European TSOs
- National collaboration & joint stakeholder communication organized by Dutch grid operator association **Netbeheer Nederland (NBNL)**

Examples joint NBNL topics:

- Scenario development
- Grid congestion & flexibility
- Alignment technical specifications

Joint scenario development in the Netherlands

Joint scenario development in the Netherlands

Overall setup & scope

The Dutch TSOs & DSOs **jointly develop national energy system scenarios** on a regular basis, covering **all relevant energy carriers & sectors** and consulting a broad group of different stakeholders. Alignment takes place via Netbeheer Nederland (NBNL).

Together with all grid operators

Grid operator association

TSOs

DSOs

All energy carriers

Wind
Solar PV
Biomass
Geothermal
Electricity
Natural gas
Biomethane
Hydrogen
Ammonia
Nuclear
Coal
Oil
Heat

Consulted with stakeholders

Joint scenario development in the Netherlands

How do we get to scenarios?

- Energy Transition Model (ETM) as a **central scenario platform** where all information is gathered & transparently documented
- **Benchmarking of scenarios against national & European energy & climate targets**
- Basis for scenario variants, further studies & impact analyses

Scenario framework

Qualitative scenario storylines

Scenario quantification

Energy Transition Model (ETM)
https://energytransitionmodel.com/

Carbon Transition Model (CTM)
https://carbontransitionmodel.com/

Steel — TATA STEEL

Fertilisers — OCI, YARA

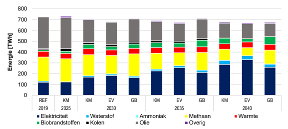
Chemicals — sabic, Air Liquide, OCI, AIR PRODUCTS, Shell, NOBIAN, DOW

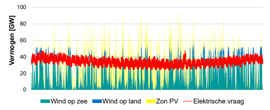
Refineries — EXXON, GUNVOR, Shell, bp

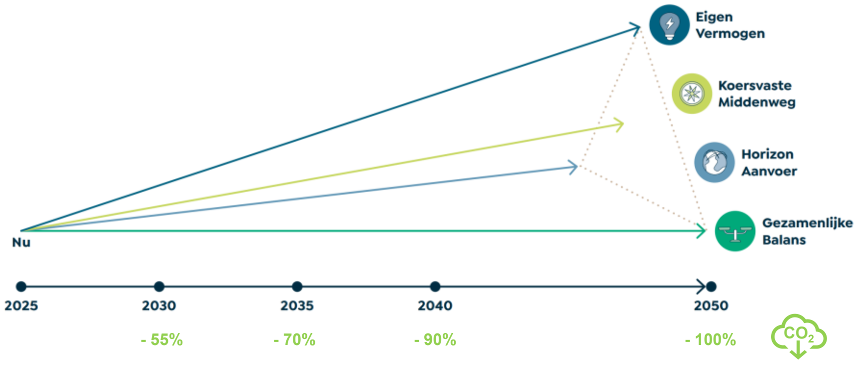
Stakeholder interaction

Analyses & reporting

Scenario documentation & publication







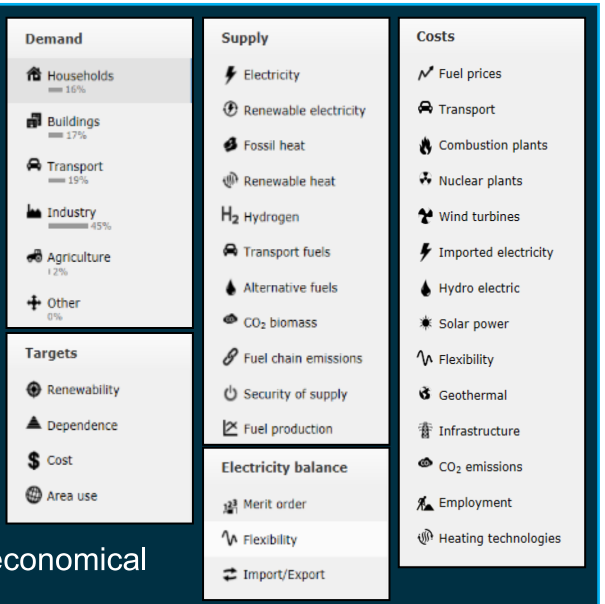
TenneT

Energy Transition Model (ETM)

What is it?

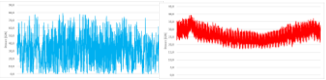
- **Open-source simulation model to build & explore energy system scenarios**, covering all relevant sectors & energy carriers
- Developed and maintained by Dutch consultancy Quintel Intelligence
- Used by different parties (e.g. grid operators, ENTSO, industry parties) across Europe for the purpose of scenario development
- User interaction via an **intuitive web interface** or alternatively **Automated Programming Interface (API)**

Scenarios



- Determine scenario parameters supply & demand
- Technical & economical parameters

Data import via automated programming interface (API)

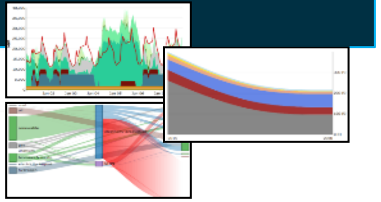


Model calculations

- Calculation of energy flows from energy supply sources to final energy consumption
- Modelling of hourly energy supply & demand (electricity, methane, hydrogen, heat)
- Supply and demand balancing by dispatching flexibility options and applying (simplified) market modelling
- Balancing of coupled energy carriers (hydrogen, methane, heat) using respective flexibility options (e.g. gas storage)

Analyses & data export

- Visualization of energy flows and balances in the energy system across different energy carriers & sectors
- Fast energy system impact analysis (e.g. emissions, costs, adequacy)
- Comprehensive export functionalities for all scenario inputs & outputs incl. hourly energy carrier profiles (electricity, methane, hydrogen, heat)



Scenario quantification

ETM as central platform

Today's energy system

Political framework (national, EU, global)

Technology developments

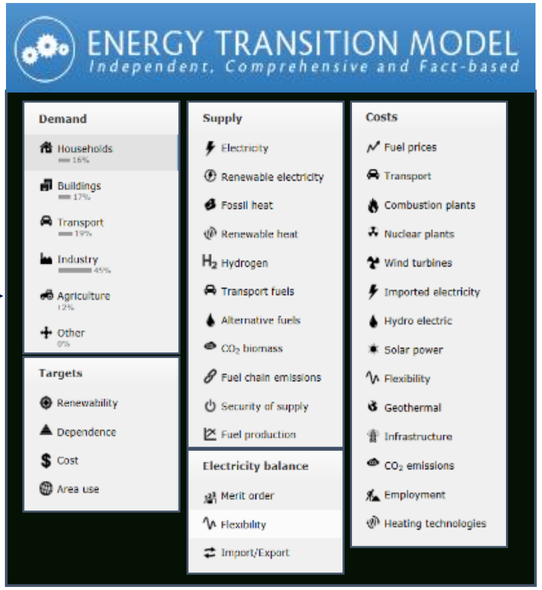
Market developments

Regional & sectoral plans

Internal / external studies

Stakeholder inputs

Achievement national & European energy & climate targets / ambitions?



Alignment with stakeholders

Adjustment of scenario assumptions

Our scenarios are fed by a large number of different sources. By using the ETM we compile them into consistent pictures of the future energy system and check whether they comply with the objectives and ambitions.

Joint scenario development in the Netherlands

Why do we do it?

- ✓ **Integrated perspective on the whole energy system**, both across energy carriers and different sectors
- ✓ **Aligned & recognizable quantitative starting points** for various grid operator & external studies
- ✓ **Efficiency gains** by largely using same methodologies & facilitating knowledge transfer
- ✓ **Consistent stakeholder communication & information of policy makers**
- ✓ **Coherence obligations by national Dutch regulator (ACM)**

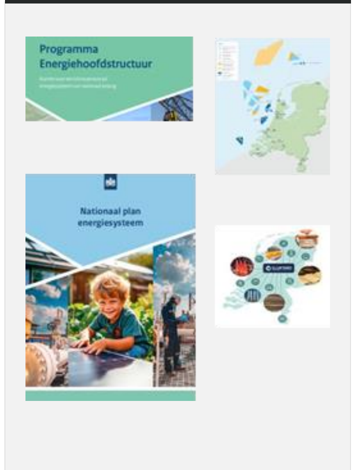
Scenario publications

Investment plans

Adequacy studies

System studies

Governmental analyses



Joint scenario development in the Netherlands

What enables us to work together?

- ✓ Organization within **national grid operator association** (e.g. working groups, communication)
- ✓ Use of **Energy Transition Model (ETM) as joint scenario platform**
- ✓ **Mutual trust in each others expertise & open (low-barrier) communication**
- ✓ Relatively small number of grid operators / parties involved

But:

- Different internal processes require adaptivity
- Sometimes different (strategic) interests
- Alignment requires time investment!

Joint scenario development in the Netherlands

Increasing cooperation of TSOs & DSOs

2017

TenneT & Gasunie

2018

DSOs & TSOs

2021

2023

2025

2020

2022

2024

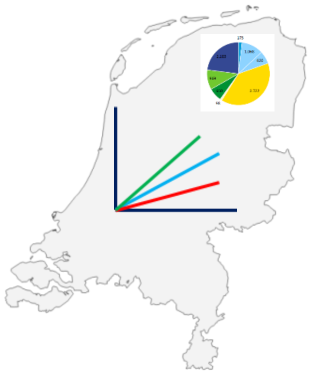
One of the success factors: **Start small and grow bigger**

TenneT

Outlook

Further cooperation opportunities?

(Largely) harmonized



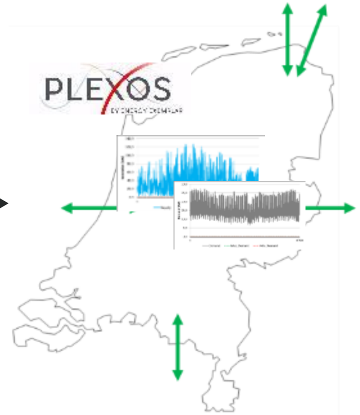
Scenario development

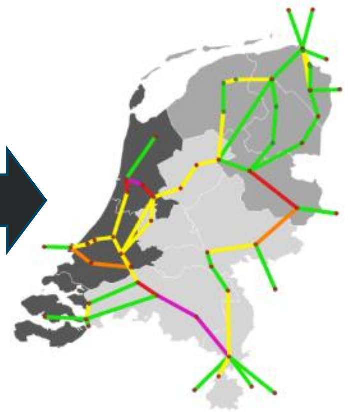
- Driver analyses & storylines
- Quantified supply / demand / flex & prices on <u>national</u> level

Regionalization

- Locations of supply / demand / flexibility

TenneT





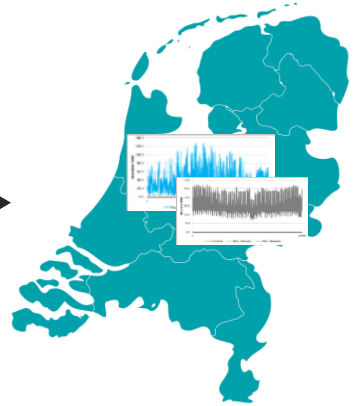
Market simulations

- Simulation of electricity market (8760 h / year)
- Cost optimal dispatch of <u>price driven</u> supply / demand / flex
- Market exchange with surrounding countries

TSO grid calculations

- Simulation of power flows in 110 / 150 / 220 / 380 kV electricity grid(s) & analyses of bottlenecks
- Definition of grid measures

DSOs



Profile modelling

- Based on measured data
- Future behaviour of supply & demand

DSO grid calculations

- Simulation of flows in regional grid(s)
- Analyses of bottlenecks
- Definition of grid measures

Gasunie

Thanks for your attention!

Any more questions?

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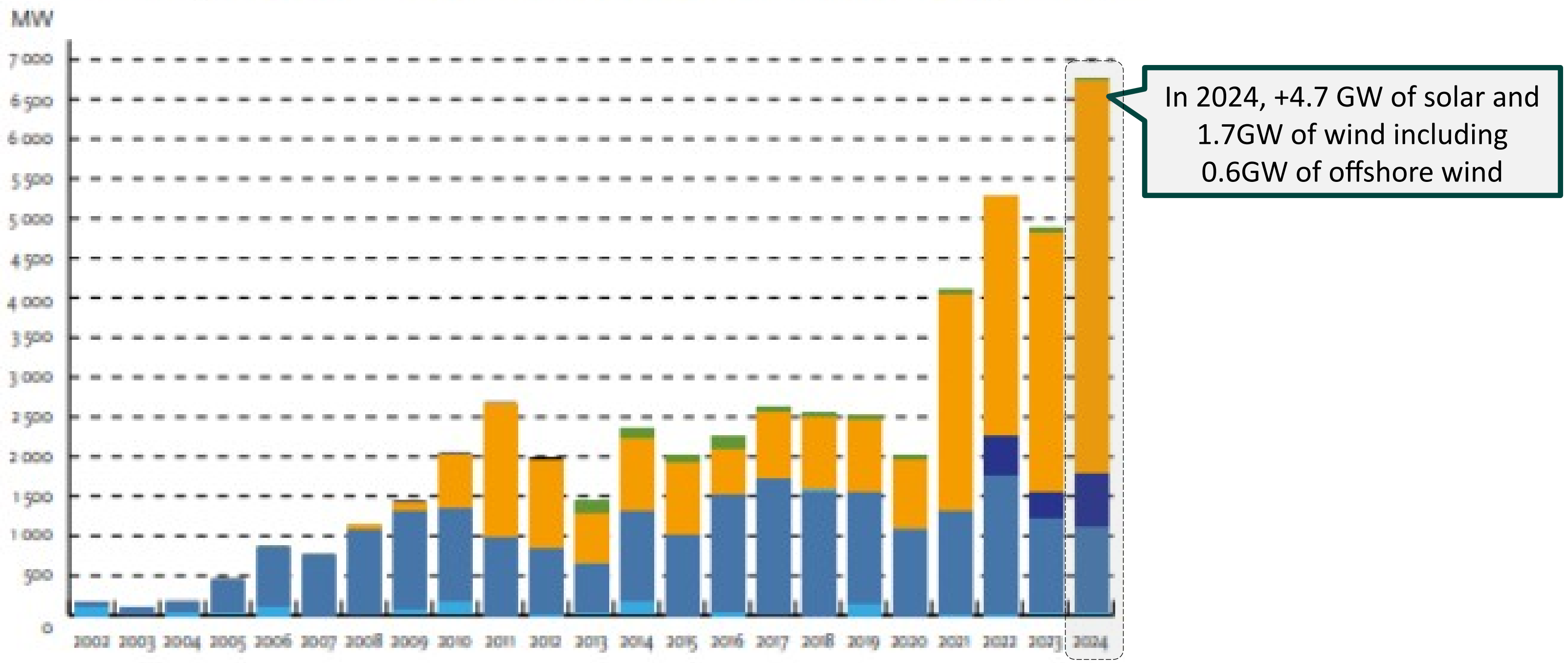
RGI Bruxelles – planning and connection rules dedicated to REs

November 19th, 2025

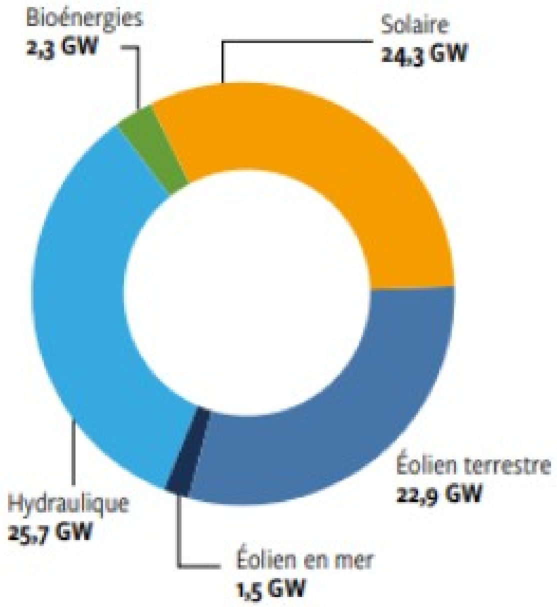
Restricted

After a decade of slow growth, REs capacity have strongly increased mainly driveny by solar energy and offshore wind

Yearly connected RES Power connected (GW)



Cumulated installed capacity at end december 2024 (GW)



- All in all, French DSOs and TSO connect 4-5 GW/year, including offshore wind
- The dynamic of solar projects connection has been driving the energy transition for 4 years
- Before, wind power dynamic was the main driver and it is slowly decreasing because of a lower acceptability

The french TYNDP (SDDR) of RTE: the industrial strategy pillars of RTE over the next 15 years

3 main industrial priorities for RTE

Renewal and climate change adaptation

Reinforcement of the Grid infrastructure

Low Carbon Installations connection

Low Carbon Installations connection

Producers	*Consumers*
« Nouveau nucléaire »	New industries
Offshore Wind	Existing Industries in the process of decarbonization or electrification of their uses
Renewable energies and batteries	

- Planning and connection of Renewable Energies is one of the strategic pillars of RTE's TYNDP
- This strategic axis is shared by *Enedis* (main french DSO)

The SDDR gives a reference strategy for renewable energies development

Reference strategy

Prioritize the existing and already identified transmission works in order to match the **volume of onshore renewable energy planned by the government**, without exceeding it

Prepare the next REs development planning (S3REnR) and ensure consistency between regional and **national objectives**

Continue the network optimization policy by encouraging producers to connect their new installations to available infrastructure, and by sharing infrastructure with other users.

Strengthen existing high-voltage grids

The prospective infrastructure is forecast by using REs project developpers' pipeline and other inputs

❖ **In order to design the future planning of distribution and transmission works, some inputs are required:**

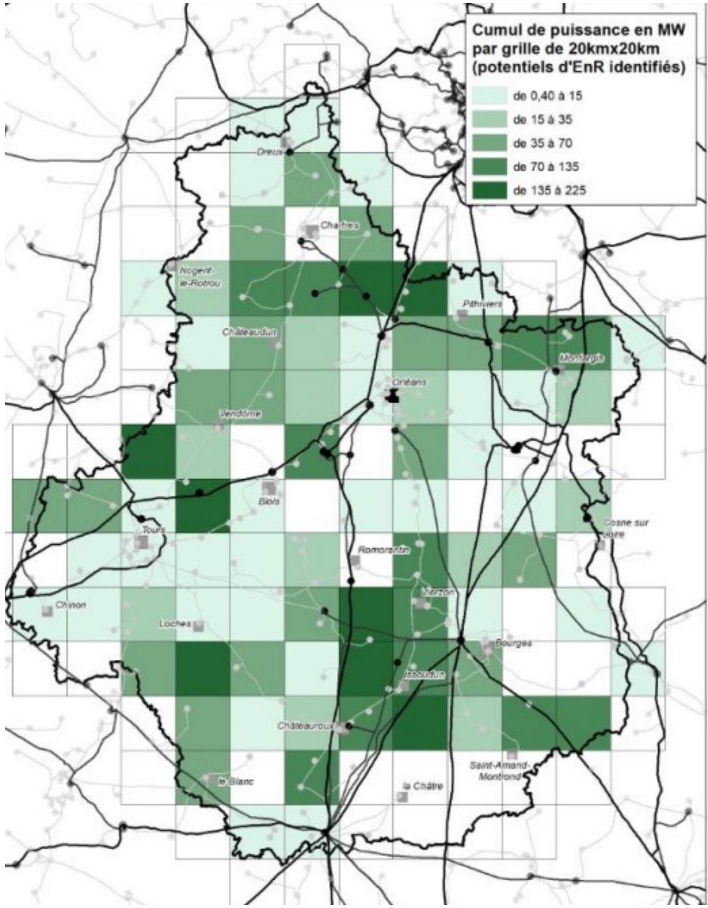
- Pipeline of projects declared by producers through an internet plateform *
- Low voltage projects, *as projected by DSO*
- Repowering projects, as *projected by producers consortiums*

After stakeholder concertation, a projected amount of future connections is determined. Grid infrastructure works are planned depending on the assumed localisation of projects.

❖ **For the Centre-Val de Loire region (representing 4 GW of connection's capacity target), € 350 Mn works are planned**:

- Around 20 additional smartgrid systems
- 25 new transformers
- 6 new EHV-HV substations
- Around 300 km of renewed or new HV-EHV lines

TSO and DSO new infrastructures will be deployed gradually, depending on their priorities



Centea-Val de Loire inputs to forecast the infrastructure works plannings

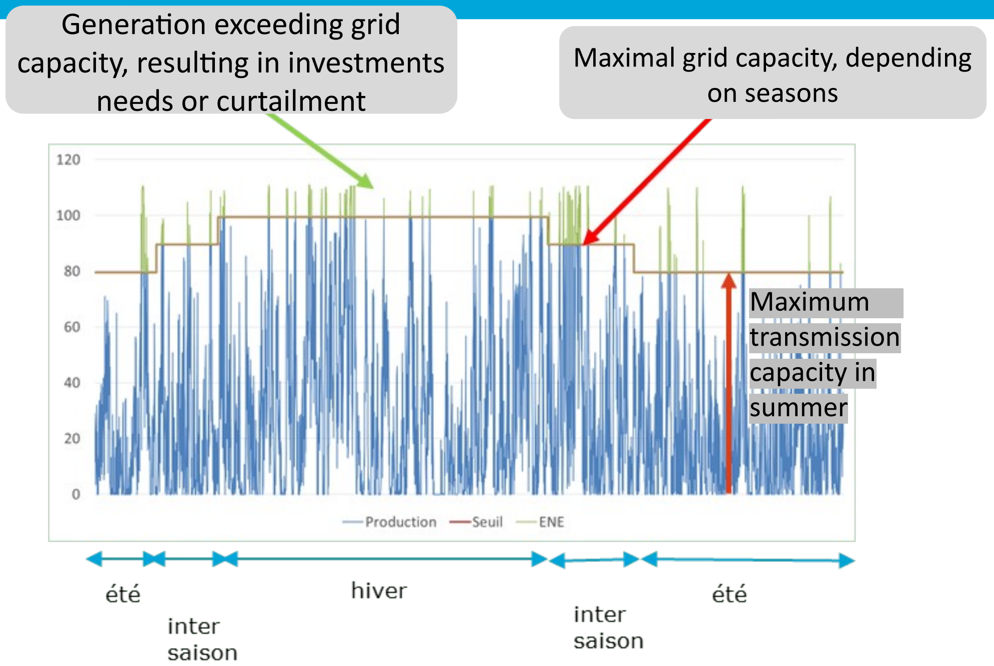
DSO and TSO work in a close collaboration to ensure a reliant infrastructure planning

RTE in is charge of the confidentiality of these declared future RE projets

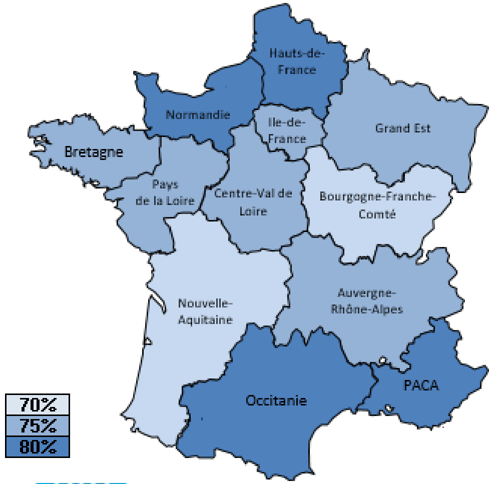
An optimal design by using flexibility at DSO and TSO level

- RTE performs a technical and economic analysis to identify the best solutions between:
    - Grid development ;
    - Smartgrids solutions (owned by RTE or offered by market players) ;
    - REs curtailment both at TSO or DSO levels.

This methodology called optimized grid development is based on natural REs flexibility and variability



For each power line, RTE will engage grid development works **only if congestions are expected when future renewable production is genarating at 70% load capacity**



The “grid optimized development” implies the **forecast** of REs generation, the **monitoring** and **control** of REs facilities in real time, as well as curtailing power generation when needed.

The objective of RTE’s connection reform : accelerate customers connection

- As observed with storage systems and new consumers, the queue is very high for RE producers.
- **A key objective would be to select only mature projects through using the « first-ready – first served » approach**

Three areas of focus (consumers)

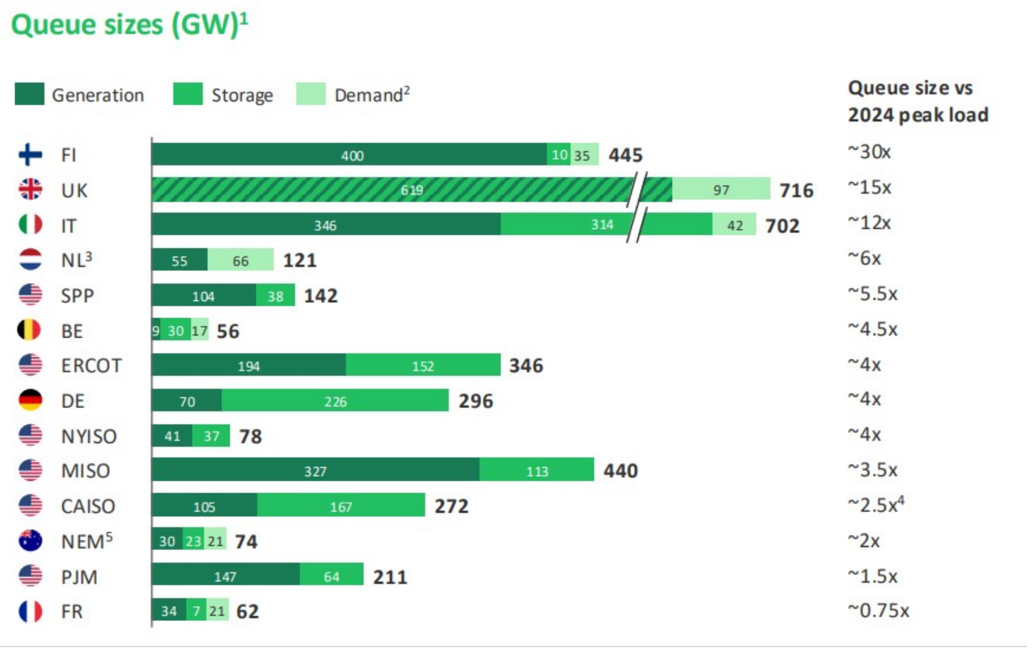
- **Optimise :** reconsider financing models to incentivise connection in « ready to connect » areas

- **Anticipate :** reinforce the planning process to create new 'ready to connect' zones.

Target

Move away from first-come, first-served approach and prioritise the most mature customers

These rules have made it possible to control the queue

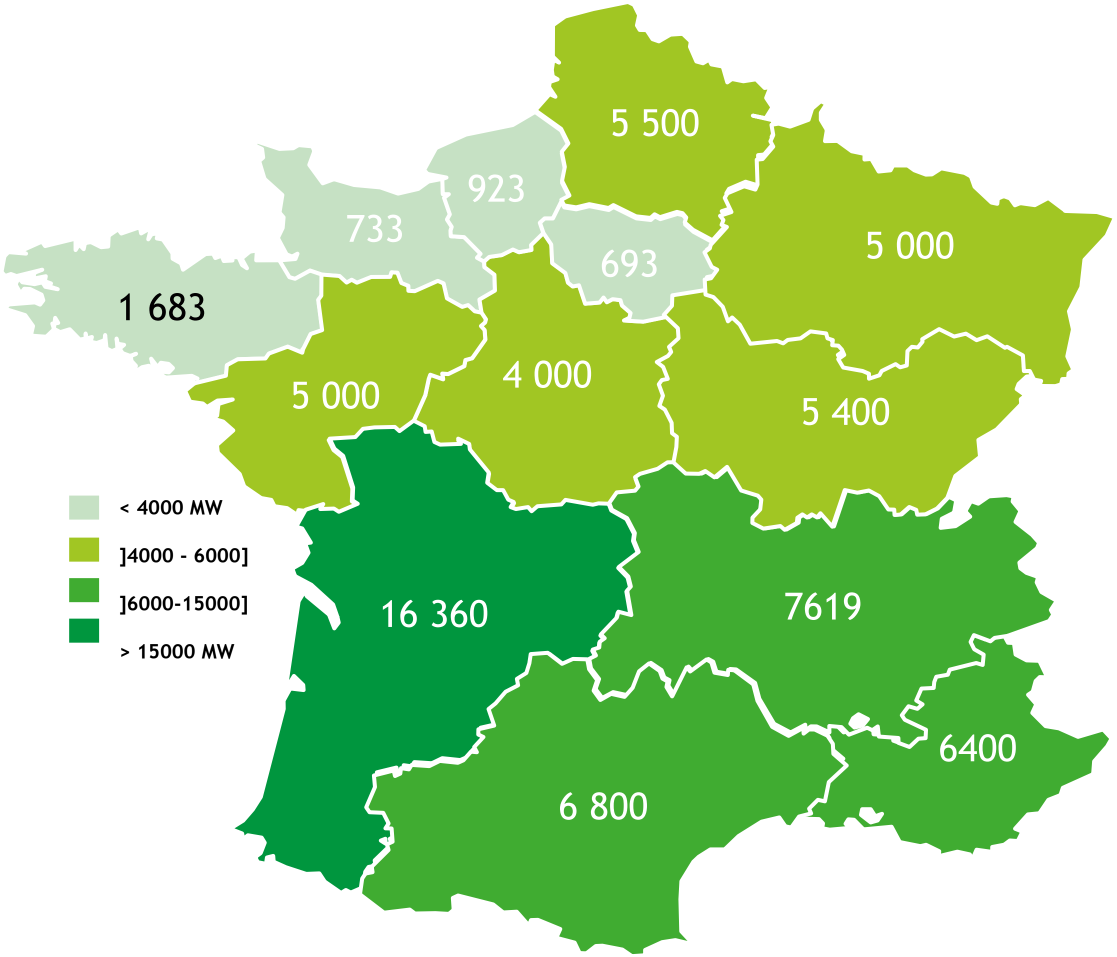


*Source: BCG report: mind-the-queue-connection-reform-for-the-electricity-grid-r.*pdf

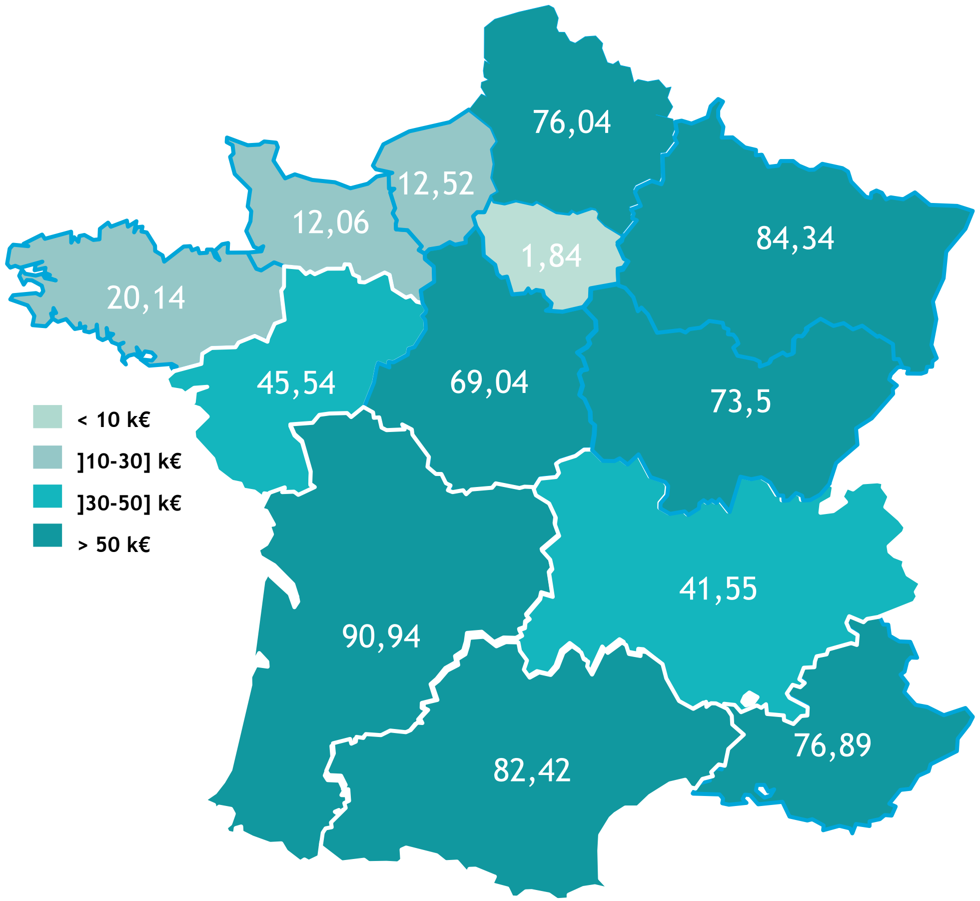
A connection reform for consumers based on « first ready-first served » is in process.
At the European level, RTE will contribute to the « Grid Package of the EC ».

63 GW have been developed for REs connection capacity. A € 70 k/MW levelized participation to the shared costs of grid development (i.e. quota) is paid by producers.

Grid capacity dedicated to RE connection per Region for 5-7 years



Quota per Region (k€/MW)

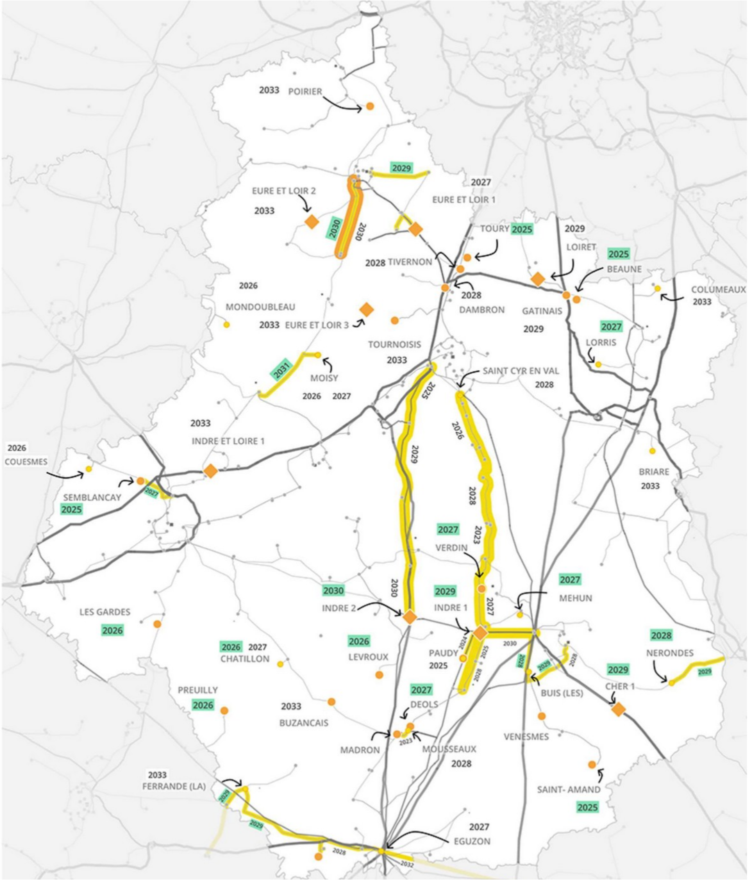


At regional level, the capacity dedicated to RE connection is decided by the regional administrative authority

Annex

The S3REnR is an operational infrastructure works planning implemented by both DSOs and RTE

Planning of HV/VHV Infrastructure works



For each administrative region

Global capacity and **dedicated capacity** for REs in each substation

Works schedule on the Transmission and Distribution grids

Estimated **costs**

Estimated schedule for each work

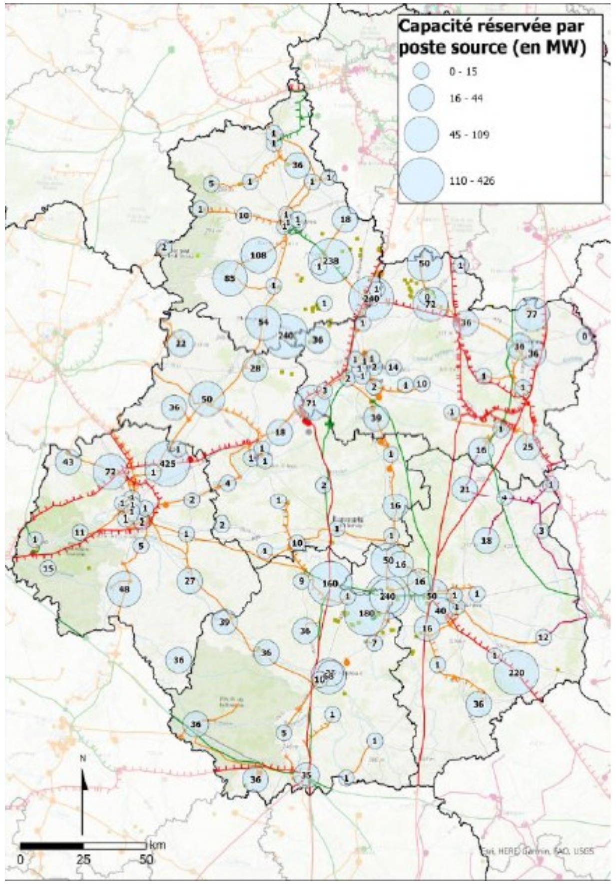
New dispositions to implement in the next planning

Technico-economical criteria

Prioritized infrastructured

Potential additional works

Connection capacity is dedicated during 10 years



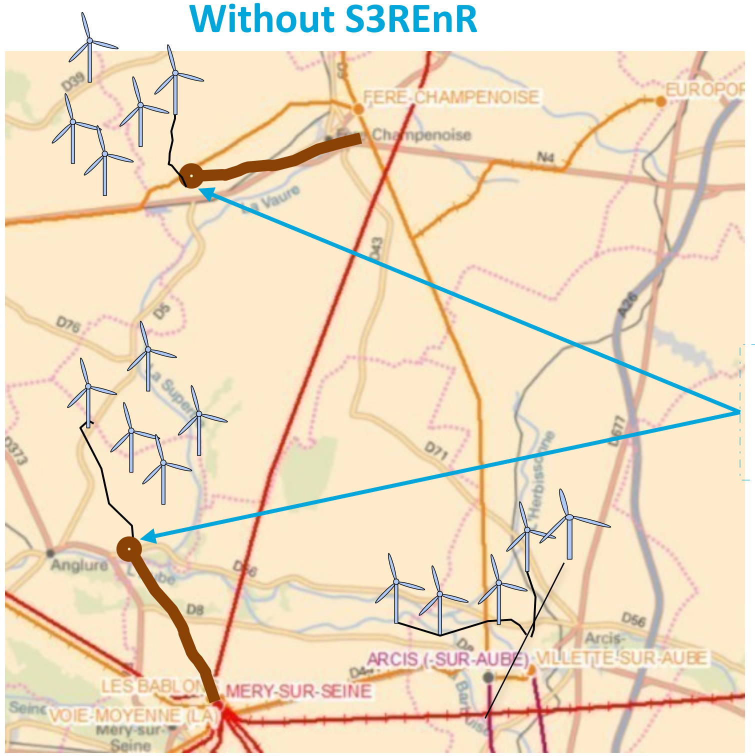
- A global, consistent and long-term planning at the right scale is a way to optimize costs
- The technical and economical efficiency of this system requires a close cooperation between RTE and the DSO in charge

Main principles of S3REnR : visibility and anticipation through a planning and dedicated connection capacities

The RES connection main principles are based on:

1. An infrastructure planning, at a regional scale, with capacities dedicated to RES connection (S3REnR)
2. Specific financing rules

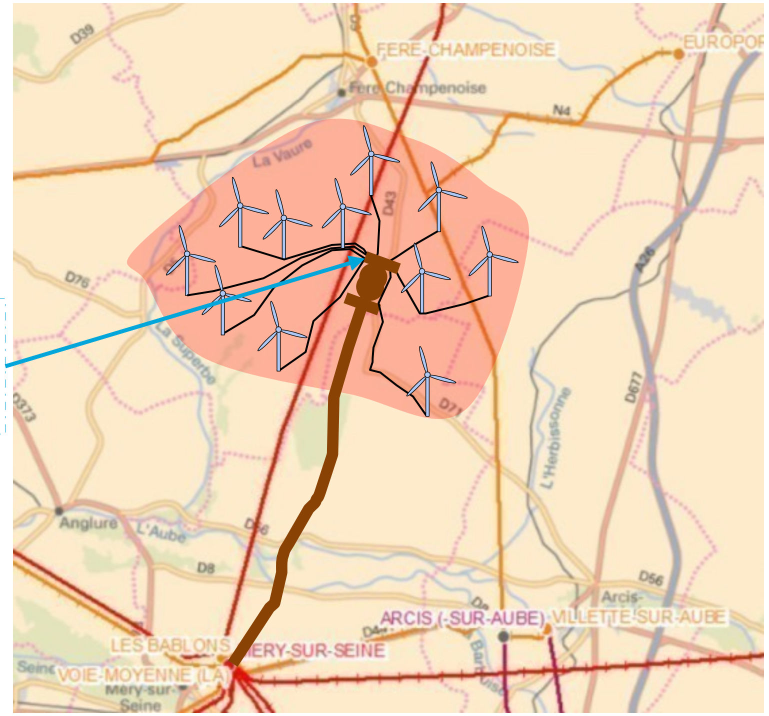
Without S3REnR



- Investments needed for each RES project set on a *first-come first-served* basis.
- Costs born by the applicant project, even if other projets profit of it.

New Substation with HV line

With S3REnR



- Optimized DSO and TSO Investments to connect identified projects in once.
- Costs mutualised between RES projects and TSO/DSO.

agree on the **RES connection potential** and **capacity**

increase the capacity to connect RES to the grid with limited new assets

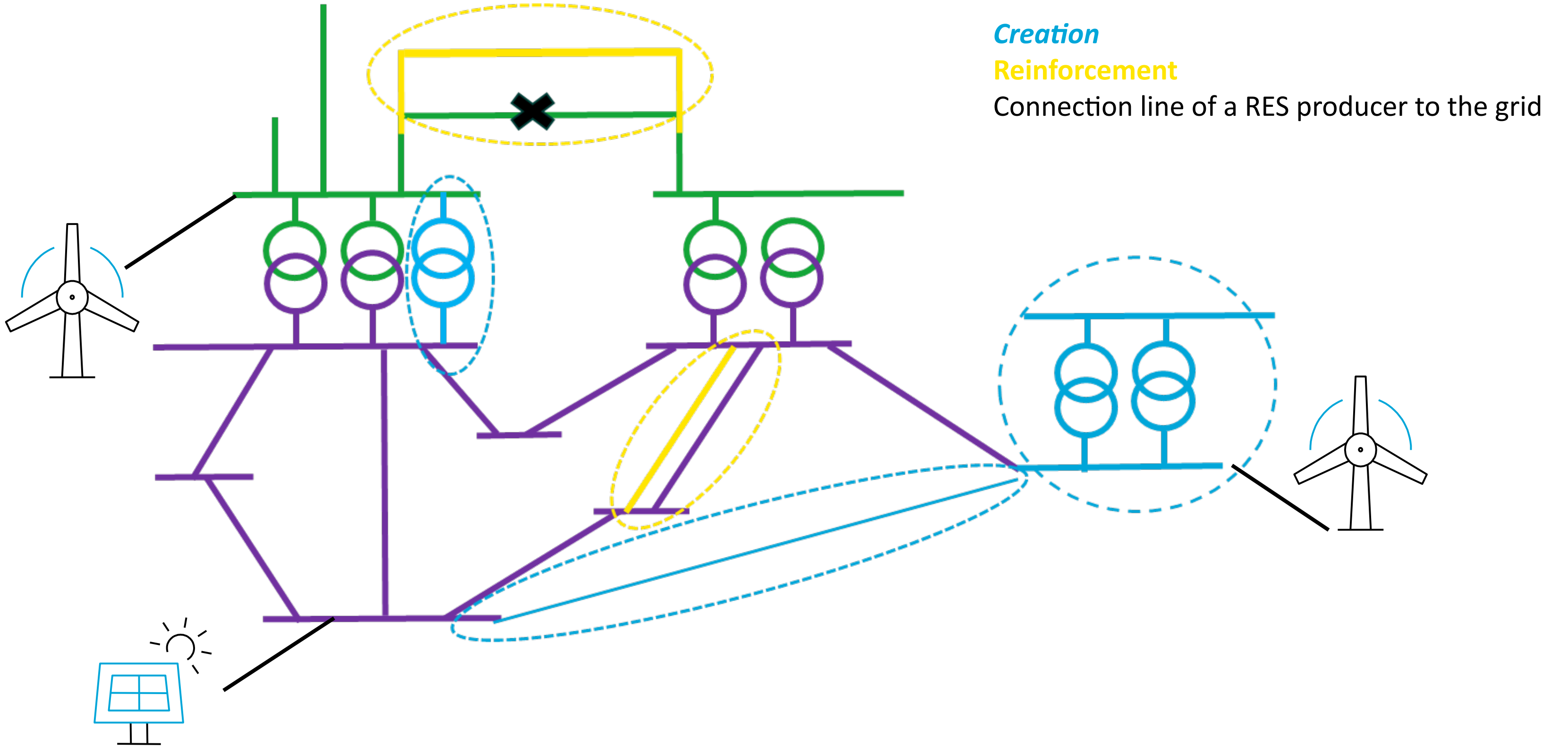
provide **visibility** on the location of the planned *developments* &*reinforcements*

anticipate grid developments to facilitate RES development

share the costs of grid *developments* between RES installations

Developers and Grid operators share the grid development costs

S3REnR infrastructure planning is based on two types of works, both differently financed, *Creation* and *Reinforcement*



For the connection of its RES production installation, a developer pays:

1. **The HV line from its site to the grid infrastructure**
2. **A contribution to the total cost of creation: Power of the site*Quota**

- **The creation work are financed by the producers via a *quota* in k€/MW**
- ***Reinforcements* are paid by the grid operators depending on voltage level**
- **The producer pays for project's connection new line to the substation**

Le réseau
de transport
d'électricité

Thanks !

TSO-DSO cooperation for future-proof system operations

19 November 2025, Brussels

Agenda

- **Institutionalized TSO-DSO cooperation in the 50Hertz control area**
- Case study: Cooperation to ensure efficient reactive power allocation
- Outlook

“ARGE FNB Ost + 50Hertz” has been established to ensure a structured cooperation between 50Hertz and the directly connected DSOs.

Overview & Background

ARGE FNB OST + 50Hertz

TSO

50hertz | Elia Group

DSOs

Sachsen Netze	WEMAG Netz	Mitnetz Strom
Avacon	Stromnetz Berlin	Netze Magdeburg
E.DIS	Thüringer Energienetze	Hamburger Energienetze

– The increasing transformation of the electricity system with regards to renewables has an impact on all levels of grid and system operations.
– The TSO 50Hertz and the directly connected DSOs in its control area are faced with multiple challenges, which require a closely aligned assessment and solution development
– 9 key initiatives to ensure a stable and future-proof electricity system that require close cooperation of the TSO and DSOs have been identified
– All parties have committed to a cooperation to collectively develop the initiatives.

The operational work is coordinated by a central committee in accordance with the managing directors.

Structure and way of working

Schematic

Managing Director's Committee

Strategic guidance & decision making

Sets guidelines and makes overarching strategic decisions

Presents results and requests strategic guidance

Meets twice a year

Coordination Committee

Topic & project group coordination

Allocates assignments & establishes project groups

Identify pressing topics

Meets twice a year

Project Groups

Implementation of assigned work packages

Voltage control	Frequency control	Operations management
Supply restoration	Grid expansion	IT & Communication
Security	Forecasting	
Controllability check	…	…

Meet as required, respectively

Organizes meetings and installs standardized ways of working

Editorial Team

Organizational & operational support

Meets as required

= Permanent work groups

= Temporary work groups

The structure has strengthened a level-eyed culture of collaboration and dialogue.

Structure and way of working

Managing Director's Committee

Strategic guidance & decision making

Sets guidelines a
overarching

Meets tw

Coordination Committee

Top

Project Groups

ages

Operations management

IT & Communication

…

ely

- All committees are staffed by representatives from all ARGE FNB Ost + 50Hertz members.
- The centralized coordination committee encourages participation and provides a platform for dialogue.
- Nevertheless, the structure allows for an efficient level of autonomy within the project groups.
- A tradition of regular on-site meetings with rotating hosts strengthens informal exchange and a culture of collaboration.

Organizational & operational support

Meets as required

= Permanent work groups

= Temporary work groups

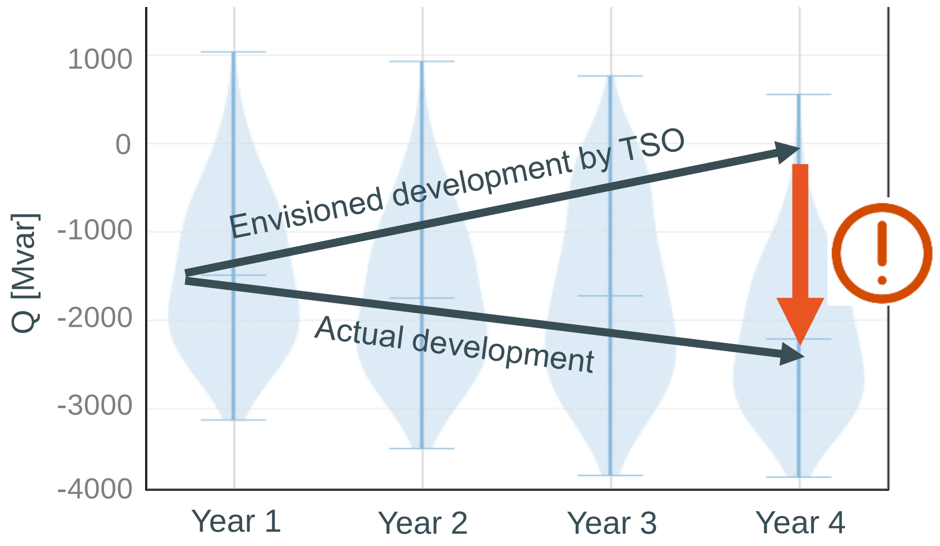
Agenda

- Institutionalized TSO-DSO cooperation in the 50Hertz control area
- **Case study: Cooperation to ensure efficient reactive power allocation**
- Outlook

ARGE FNB Ost + 50Hertz implemented a project to strengthen the DSO's role in voltage control.

Project overview

Distribution of reactive power transfers from TSO to DSO per year[1)]



1) Exemplary years

Background

- The demand of reactive power from both DSOs and TSOs is increasing while sources of reactive power are decreasing, posing situational threats to system stability
- The required reactive power was mainly procured by the TSO and distributed to DSOs, resulting in the TSO being key driver of voltage control
- The TSO envisioned a stronger commitment of DSOs in voltage control, yet reactive power flows developed in opposite direction

Project goals

- Develop aligned understanding of TSO's and DSO's responsibilities in voltage control
- Develop contractual agreements for cost allocation of reactive power procurement, taking into account the needs of all parties in ARGE FNB Ost + 50Hertz

Project group Voltage Control and a temporarily created task force developed the reactive power cooperation contracts.

Project setup

Schematic

Managing Director’s Committee
Strategic guidance & decision making

Sets guidelines and makes overarching strategic decisions

Presents results and requests strategic guidance

Meets twice a year

Coordination Committee
Topic & project group coordination

Allocates assignments & establishes project groups

Identify pressing topics

Meets twice a year

Project Groups
Implementation of assigned work packages

Voltage control	Frequency control	Operations management
Supply restoration	Grid expansion	IT & Communication
Security	Forecasting	
Task Force react. power contr.	…	…

Meet as required, respectively

Organizes meetings and installs standardized ways of working

Editorial Team
Organizational & operational support

Meets as required

= Permanent work groups

= Temporary work groups

The organizational depth of ARGE FNB Ost + 50Hertz was key to organize multi-stakeholder projects.

Project setup

Schematic

2022

Start of negotiations for reactive power DSO-TSO exchange guidelines

2023

Publication of DSO-TSO guidelines & start of negotiations for reactive power cooperation contract

2023-25

Iterative negotiations in different formats:
- All members
- Technical vs market
- Task force
- Steering committees
- DSO internal groups

2025

Signature of reactive power cooperation contracts

- Pilot phase in 2025
- Start of billing in 2026/2027

The reactive power cooperation contract underscores the joint commitment for coordinated voltage control measures.

- The organizational structure of ARGE FNB Ost + 50Hertz **enabled a multi-stakeholder project** to be implemented, taking into account the requirements of all members.
- The flexibility allowed the creation of a **temporary task force** that focused on the project implementation.
- The Editorial Team and Coordination Committee encourage **decision making** that includes all cooperation members.

An organized cooperation structure helped delivering the project, yet a dedicated project manager may facilitate decision making.

Key takeaways

Liked

- On-site meetings strengthened informal exchanges
- Use of common SharePoint
- Common technical understanding of the challenge
- Implementation of pilot phase allows efficient testing before go-live

Learned

- Focused task force can speed up the process
- Align stakeholders at an early stage in order to commit to deadlines
- Dedicated project manager could speed up the decision-making process

Lacked

- Dedicated project manager who coordinates information between project group and committees

Agenda

- Institutionalized TSO-DSO cooperation in the 50Hertz control area
- Case study: Cooperation to ensure efficient reactive power allocation
- **Outlook**

ARGE FNB Ost + 50Hertz will continue to implement 9 key initiatives to ensure a stable and future-proof electricity system.

Outlook

Grid expansion

1. Establish collective foundation to develop the legally required **planning processes**
2. **Coordinate** and **align** grid expansion throughout the control area

System operations/ system services

3. Develop future-proof **frequency control processes**, taking into account intercorrelations between grid levels
4. Unlock potentials for voltage control using future assets for **reactive power provision**
5. Cooperate on required developments for **operation management**
6. Identify the effects of the changing producer landscape and derive **measures for supply restoration**
7. Exchange experiences and best practices to enable the **physical and IT security** of the grid

Internal and external communication

8. Develop methods for **data and information exchange** to ensure future proof processes
9. Exchange knowledge on effects of regulatory measures and **communicate** towards different **industry associations**

TSO-DSO cooperation for future-proof system operations

19 November 2025, Brussels