LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Énergie et de
l'Aménagement du territoire

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The Trans-European Networks for Energy: a Milestone Towards a Renewables-Powered EU

Moderated by:
Claude Turmes, Luxembourg Minister of Energy and Spatial Planning

Friday, 18 June 2021 • 09:30 – 13:30 CEST

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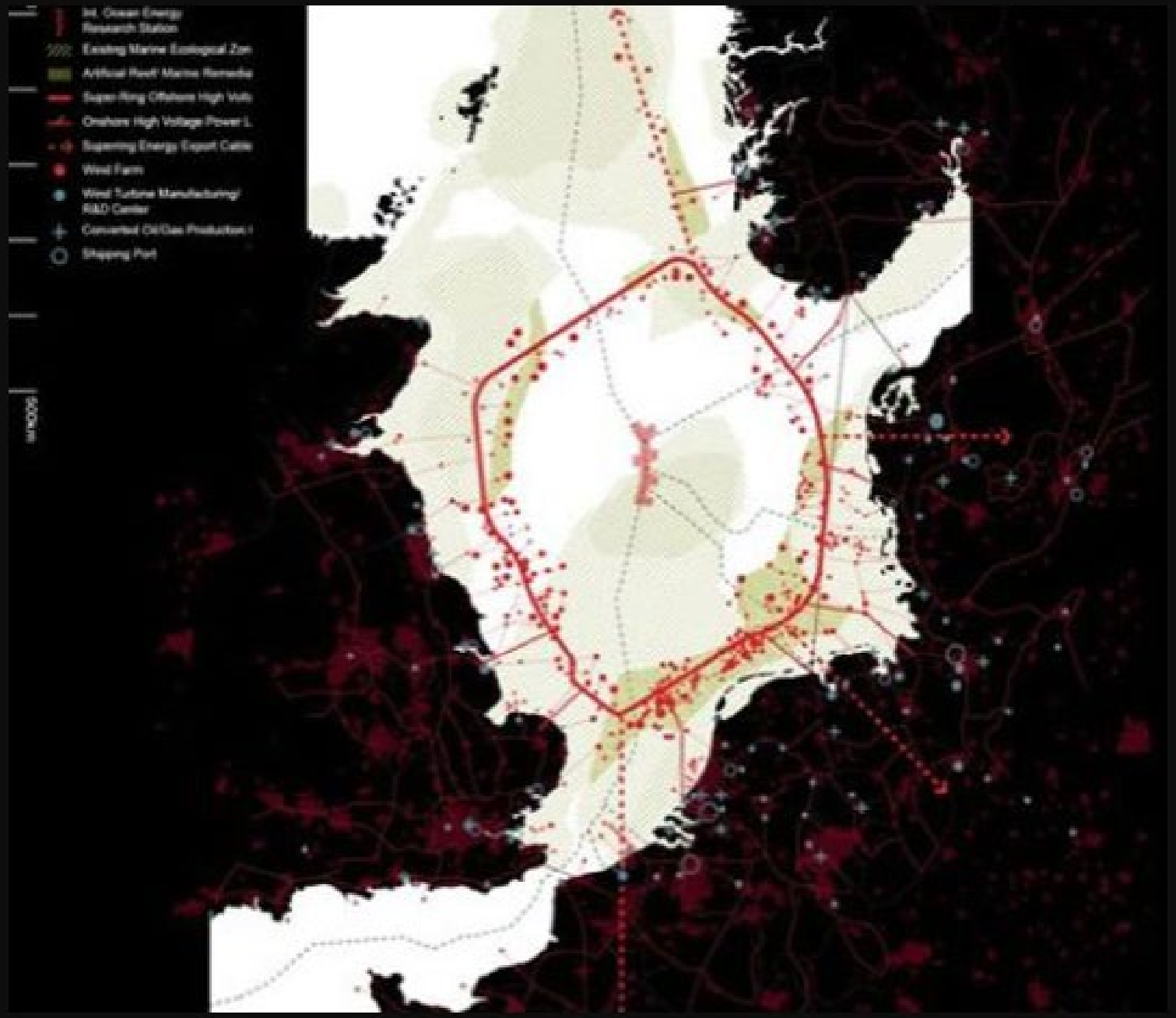
09:30 – 09:45	**Opening Remarks**
09:45 - 10:00	Scene-setter: What energy infrastructure to support 1.5°C scenarios?
10:00 - 11:00	**Panel I: The challenge of Integrating High RES Volumes into the Grid**
11:00 - 12:00	**Panel II: Including Flexibility and Assess Market Impacts in Scenario-Making**
12:00 - 13:00	**Panel III: Ministerial Panel** **Bridging Onshore and Offshore for an Integrated Electricity Grid**
13:00-13:30	**Conclusion and wrap-up**

Opening Remarks

Claude Turmes

Minister of Energy
Minister of Spatial Planning
Luxembourg


Int. Ocean Energy Research Station
Existing Marine Ecological Zon
Artificial Reef/ Marine Remedia
Super-Ring Offshore High Volta
Onshore High Voltage Power L
Supporting Energy Export Cable
Wind Farm
Wind Turbine Manufacturing/ R&D Center
Converted Oil/Gas Production
Shipping Port
500KM

Opening Remarks

Francesco La Camera

Director General IRENA

Opening Remarks

João Galamba

Secretary of State of Energy of Portugal

Presidency of the Council of the EU

Scene-setter:
What energy infrastructure to support 1.5°C scenarios?

Christopher Andrey

Director at Artelys

Artelys | OPTIMIZATION SOLUTIONS

Considerations on the energy infrastructure to support 1.5°C scenarios

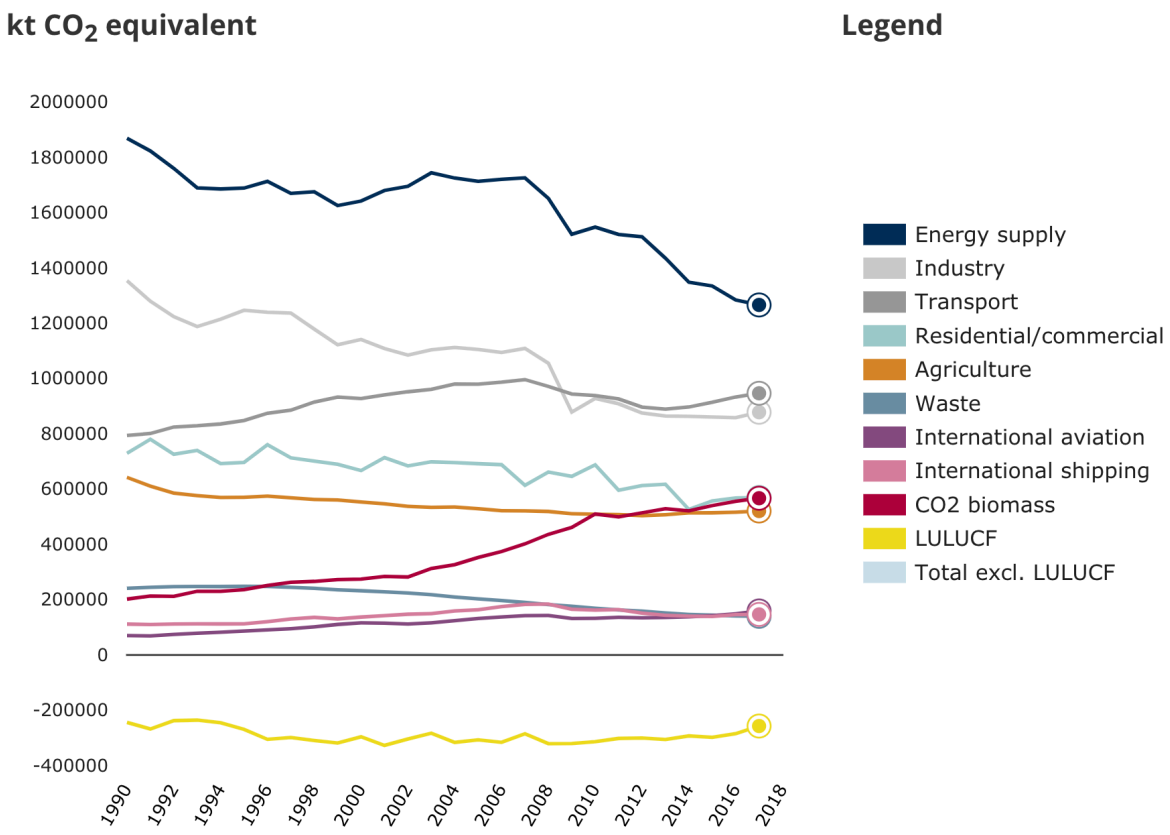
Setting the scene

Christopher Andrey

Contribution to the online conference *The Trans-European Networks for Energy - A Milestone Towards a Renewables-Powered EU* - 18 June 2021

How ambitious is net zero by 2050?

Decarbonising the EU economy is a huge challenge..



..but solutions do exist

- Energy efficiency
- Renewables
- Direct electrification of end-uses
- Indirect electrification via hydrogen & conversion processes
- Biomethane
- Flexibility solutions (networks, storage, active demand management, etc.)

The key question is **how to combine these solutions** so that (a) we maximise the probability of reaching net-zero and (b) minimise costs

How ambitious is net zero by 2050?

Decarbonising the EU economy is a huge challenge..

..but solutions are available

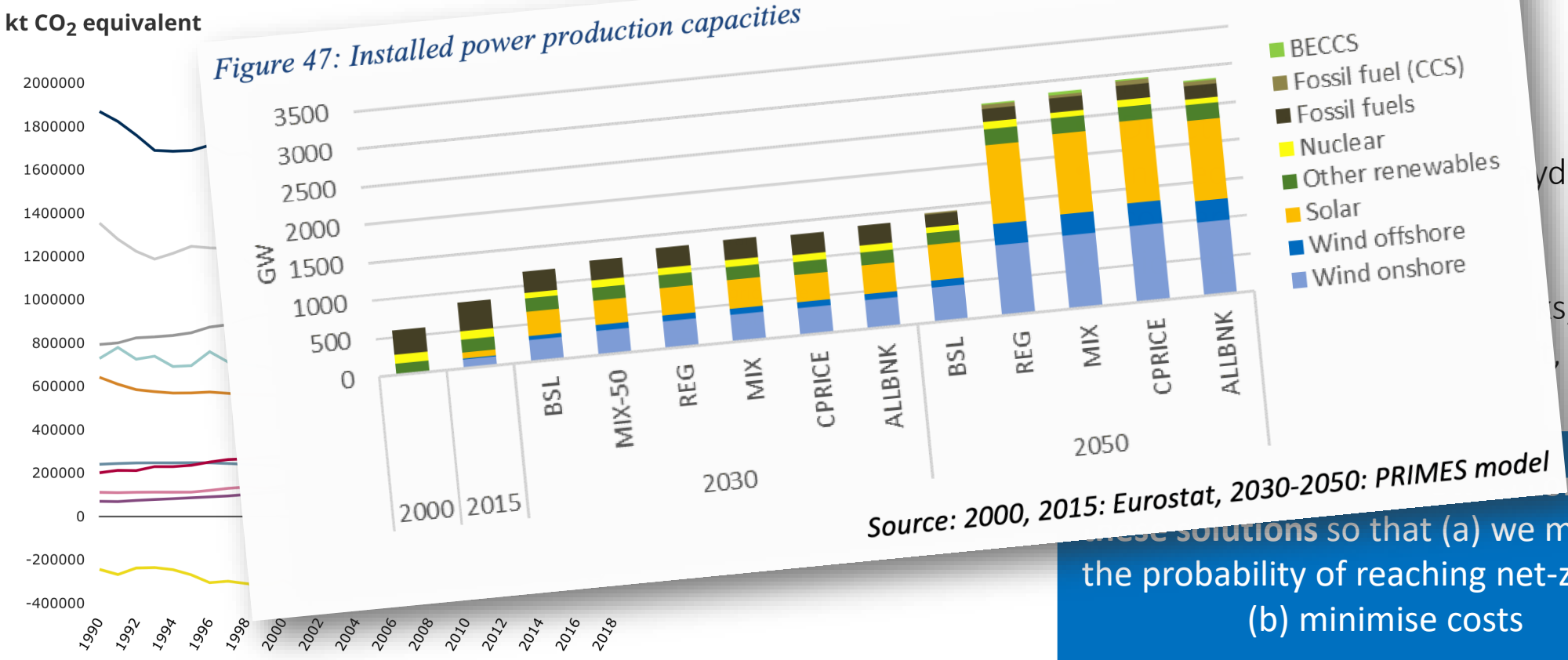


Figure 47: Installed power production capacities

Source: 2000, 2015: Eurostat, 2030-2050: PRIMES model

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How ambitious is net zero by 2050?

Decarbonising th

kt CO_2 equivalent

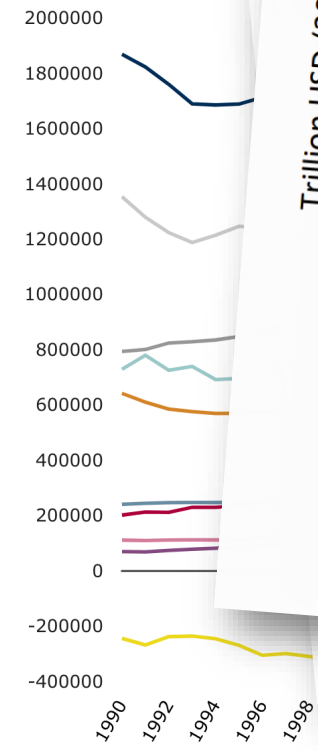
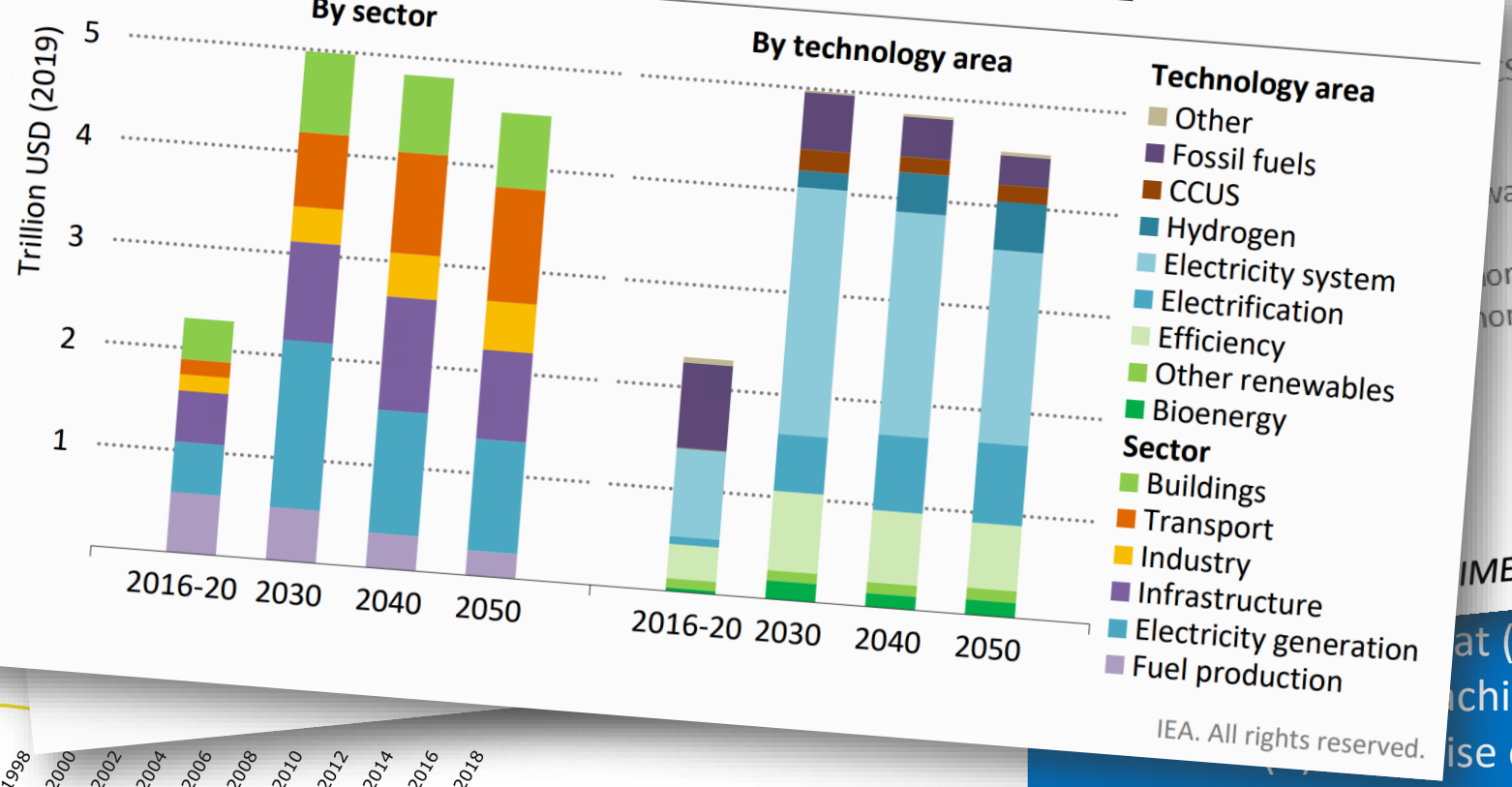


Figure 2.22 ▷ **Annual average capital investment in the NZE**



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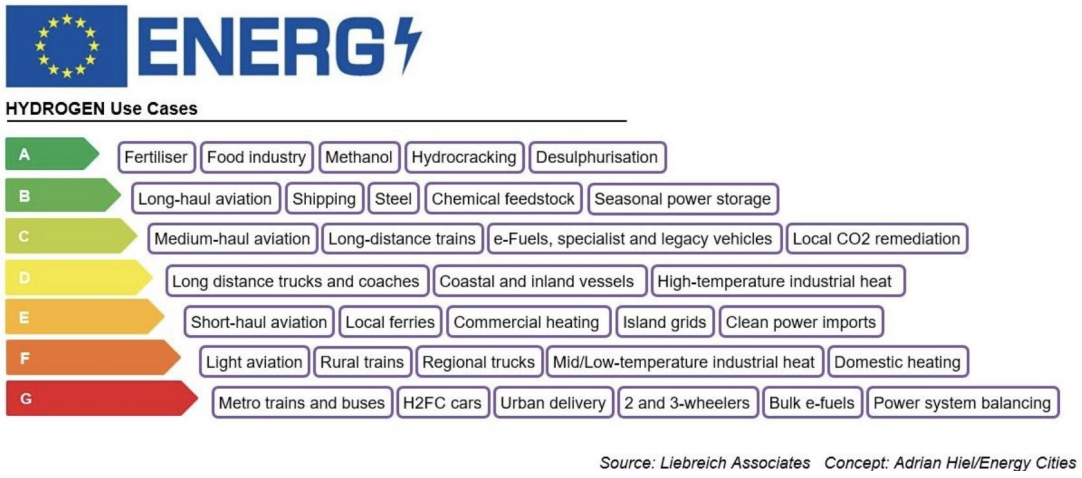
What are the key uncertainties?

- At this stage, scaling up RES and increasing efforts in energy efficiency are **no-regret options**.
- However, there are still **important uncertainties** on the decarbonisation route to follow to decarbonise a number of end-uses. Examples include:
  - **Transport**: balance between electricity and hydrogen for trucks, role of electricity in maritime sector, etc.
  - **Industry**: balance between electricity and hydrogen including for high-temperature processes, steel production (hydrogen as the reducing agent *vs* direct electrolysis of iron ore), etc.
  - **Heating**: role of biomethane and of (hybrid) heat pumps
- **Several plausible visions compete**, we need to scale up solutions fast, without making too many mistakes



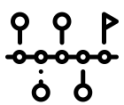
Source: Liebreich Associates Concept: Adrian Hiel/Energy Cities

There are strong links between **decarbonisation routes** and **infrastructure needs.**

A **holistic approach** is required to inform these choices

Synergies and interdependencies (1/3)

- The 3 key dimensions to consider when performing energy planning exercises to assess and select infrastructure projects:



Dynamics across time

Cooperation amongst regions

System thinking

Synergies and interdependencies (1/3)

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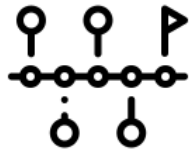
Dynamics across time | **Cooperation amongst regions** | **System thinking**

- **Dynamics across time**



  - **Fact**: infrastructure investments made today will likely still be around in the 2050s
  - What are the benefits of including a long-term outlook in planning exercises?

Identify synergies

- ✓ Detect **future-proof investments** by evaluating their role in a 2050 decarbonised system, in particular from a sustainability point of view
- ✓ Design **no-regret strategies** consistent with the 2050 objective

Avoid risks

- ✓ Avoid **stranded assets** (assets that can seems valuable when adopting a short-term view, but that are not compatible with a net-zero future)
- ✓ Avoid **lock-in situations** or risky strategies based on “silver bullets”

Synergies and interdependencies (2/3)

- **Cooperation amongst regions**
  - **Fact**: not all regions are endowed with the same potentials, cooperation is essential to reaching targets
  - What are the benefits of increasing spatial granularity and considering regional cooperation

Identify synergies

- ✓ Assess the **trade-off** between local RES and accessing better potentials in neighbouring regions
- ✓ Detect how the **existing infrastructure** can support decarbonisation (e.g. via repurposing of pipelines)

Avoid risks

- ✓ Avoid **over-investments** in e.g. balancing power plants by pooling flexibility resources
- ✓ Avoid inconsistent deployments of RES, electrolysers, and investments in wires and pipelines

Synergies and interdependencies (3/3)

- **System thinking**
  - **Fact**: the level of interlinkages between the various part of the energy system will only increase.
  - What are the benefits of integrated planning exercises?

Identify synergies

- ✓ Take into account the **flexibility** of the various sectors in a structural way
- ✓ Detect how **hybrid heat pumps** can decrease the need for electricity generation capacity and grids
- ✓ Detect how the **flexibility of the electricity sector** can help reduce the need for gas infrastructure
- ✓ Identify the potential role of electrolysers and hydrogen storage in the provision of **flexibility services**
- ✓ Evaluate the **GHG impacts** of different ways of operating electrolysers

Avoid risks

- ✓ Avoid planning investment in different sectors based on incompatible visions of the future
- ✓ Ensure that the deployment of onshore and offshore grids is well coordinated
- ✓ Ensure the deployment of electrolysers is consistent with the evolution of RES capacities (use of additional electricity, and not redirection of electricity towards low efficiency processes)
- ✓ Identify competition between biomethane and repurposing of pipelines

Synergies and interdependencies (3/3)

- System thinking
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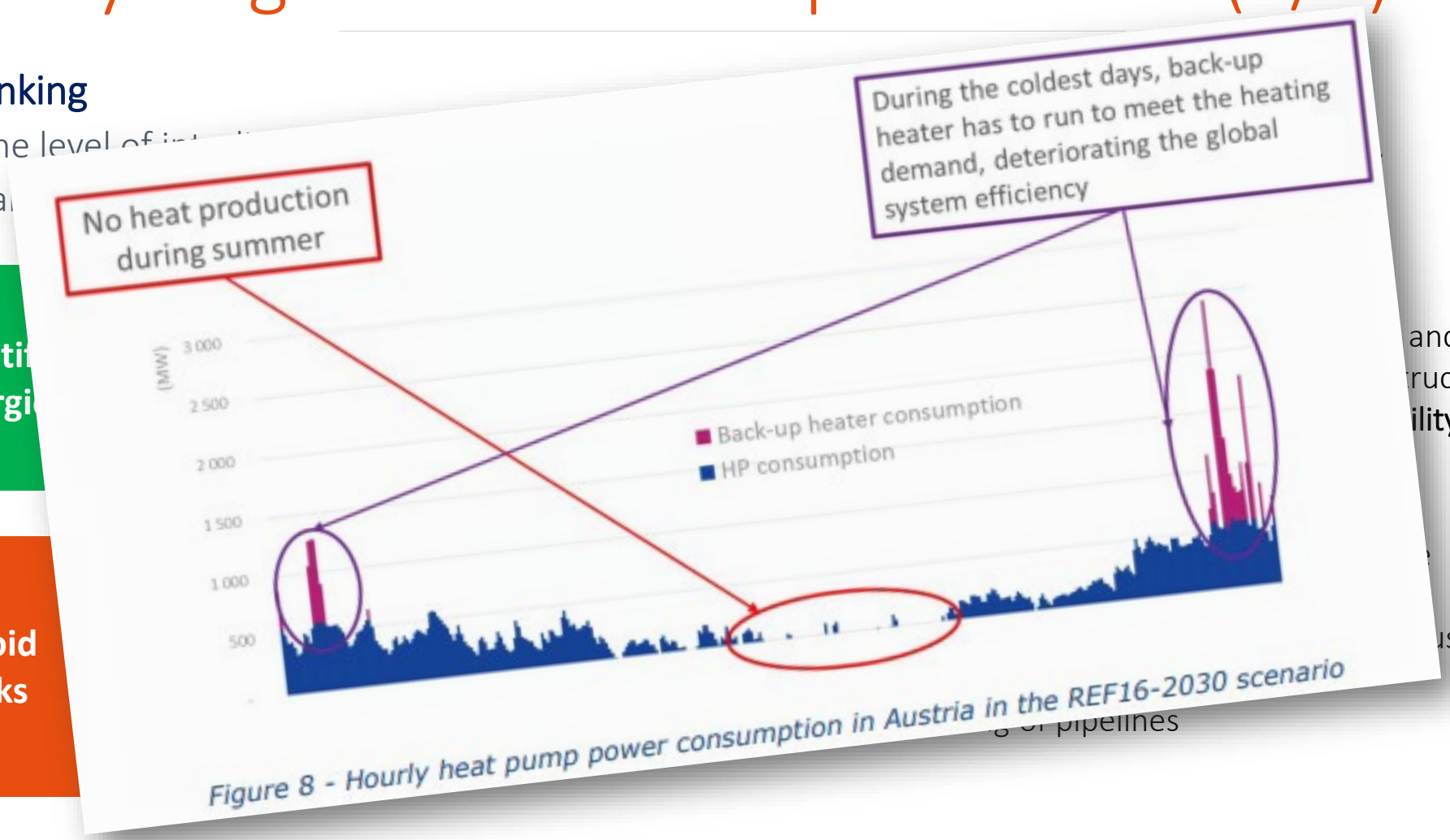

Figure 8 - Hourly heat pump power consumption in Austria in the REF16-2030 scenario

Synergies and interdependencies (3/3)

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The planning framework would benefit from an update

- Thanks to progress in simulation techniques and to the availability of datasets, current solutions allow us to make progress along all three dimensions when planning the future of the energy system.

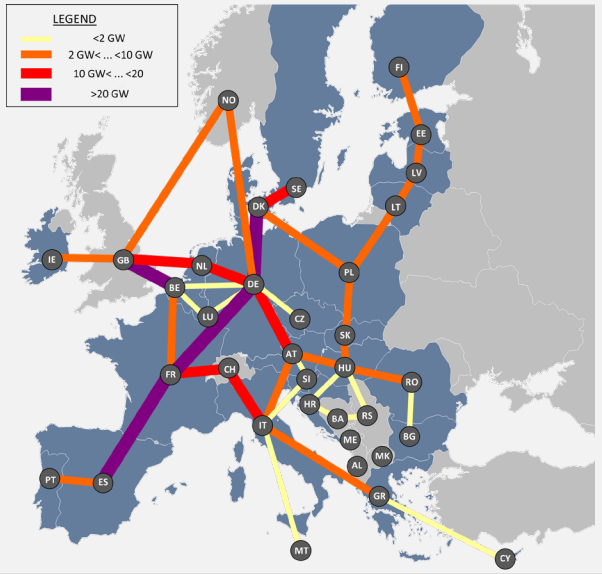
Dynamics across time **Cooperation amongst regions** **System thinking**

- One example showcasing the importance of system thinking and of an integrated approach to infrastructure planning is the recent study we have conducted on behalf of European Climate Foundation

Focus on ECF study on energy infrastucture to support 1.5°C scenarios

Objective: evaluate the needs for new electricity, hydrogen and methane infrastructure and the robustess of these results to key assumptions

Methodology: based on exogenous demand assumptions, we have optimised the investments in infrastructure using a multi-energy modelling approach with a country-level granularity and an hourly time resolution.



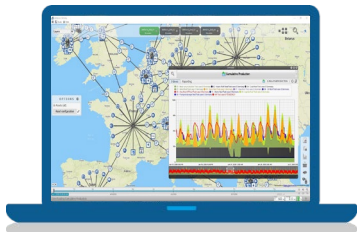
ECF 2050 Study – Overview of the methodology

Input parameters

- Installed capacities for RES, nuclear, hydropower, existing infrastructure, etc.
- Demand levels (electricity, H2, CH4)
- Catalogue of investment options
  - **Electricity** interconnectors
  - **Gas** pipelines
  - **Hydrogen** pipelines (considering repurposing of CH4 infrastructure)
  - **Electrolysis**, methanation and SMR processes
  - **Storage** assets (e.g. batteries, pumped-hydro storage)
  - **Gas-to-power** capacity (CCGTs, OCGTs)
- Technical and economic characteristics
- CO_2 price and commodity prices

Computation

Artelys Crystal SuperGrid

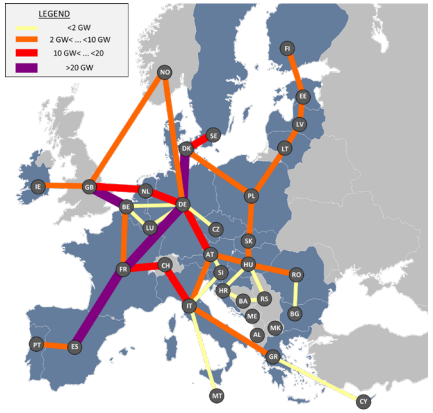


Objective

Jointly optimise investments and operations (cost-minimization approach) for a given scenario using an hourly time resolution in order to meet all energy demands

Key results

- Investments in infrastructure (see catalogue)



- Operational management of the power and gas systems (hourly dispatch, flows, etc.)

ECF 2050 Study – 3 main insights for TEN-E

Electricity

- All the considered scenarios require major investments in the electricity infrastructure
- The identified needs are robust to assumptions linked to hydrogen demand and RES location
- Insight for TEN-E revision: Procedures (e.g. permitting) have to be adapted to the deployment objective. Methodologies will probably be required for hybrid assets.

Hydrogen

- Investments in cross-border hydrogen infrastructure will be required.
- Uncertainty remains as needs are highly variable between scenarios (w.r.t. the level of colocation between RES and hydrogen demand, or w.r.t. the role of hydrogen)
- Insight for TEN-E revision: A pan-EU integrated approach is key to revealing the needs for hydrogen infrastructure. No-regret options can be examined via risk-based approaches

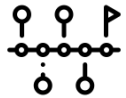
Methane

- No additional methane infrastructure required to meet EU security of supply
- There is a competition between biomethane and hydrogen for the use of existing gas pipelines
- Insight for TEN-E revision: The assessment of infrastructure projects over their entire lifetime is key to ensuring they are future-proof

Conclusions

- We have a **huge challenge** in front of us. We need to scale up our efforts, with only a limited number of investment cycles remaining between today and 2050. We need to get it right.

- Whilst a number of technological solutions already exist, there are **important uncertainties** on the way to combine them. A **holistic approach** can help detect synergies and avoid economic, security and environmental risks.



Dynamics across time

Cooperation amongst regions

System thinking

- **Regulatory frameworks and infrastructure planning practices should act as catalysts for the transition**, by embedding mechanisms incentivising the emergence of synergies and by including safeguards ensuring that structurally ineffective configurations do not materialise.

Thank you for your attention!

Christopher Andrey
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Panel I

The challenge of Integrating High RES Volumes into the Grid

PANEL I
The challenge of Integrating High RES Volumes into the Grid

Dan Jorgensen

Minister of Climate and Energy and Public Utilities of Denmark

Giles Dickson

CEO

Wind Europe

Dolf Gielen

Director

IRENA Innovation and Technology Centre

Werner Götz

CEO

TransnetBW

Siméon Hagspiel

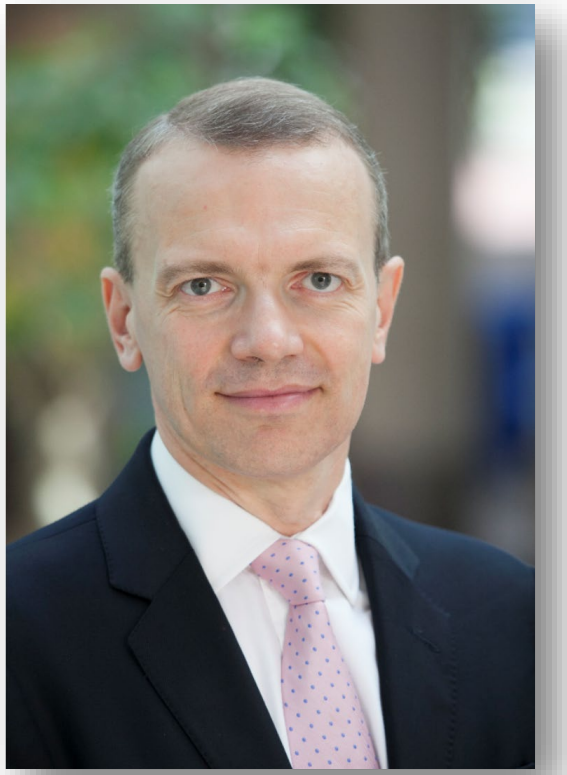
Energy Commissioner of Luxembourg

Energy islands in the Northern Seas: a new joker in EU‘s fight against climate change?

Dan Jorgensen

Minister of Climate and Energy and Public Utilities of Denmark

Towards a renewables-based power system



Giles Dickson

CEO Wind Europe

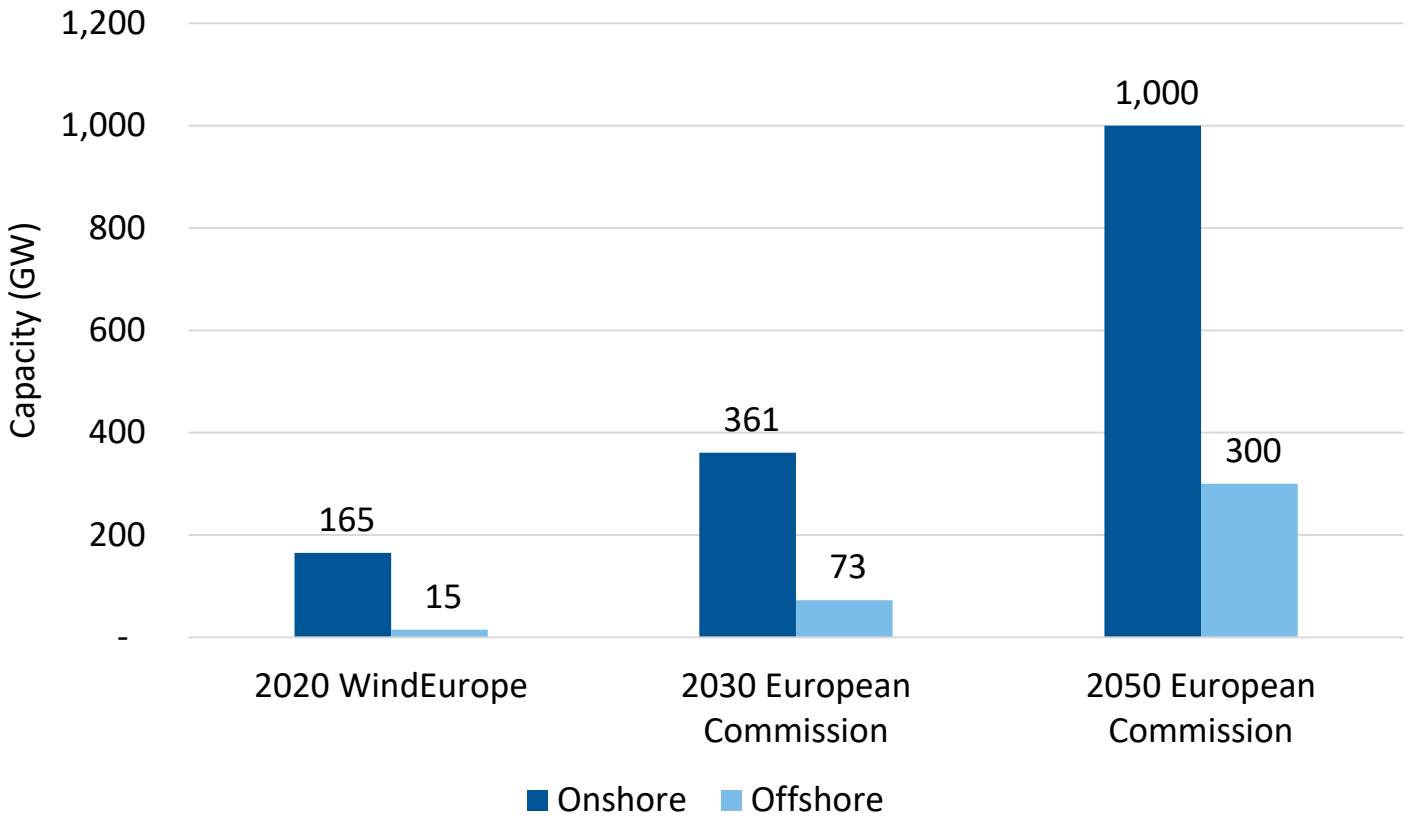
The challenge of integrating high renewable energy volumes into the grid

Giles Dickson, CEO WindEurope

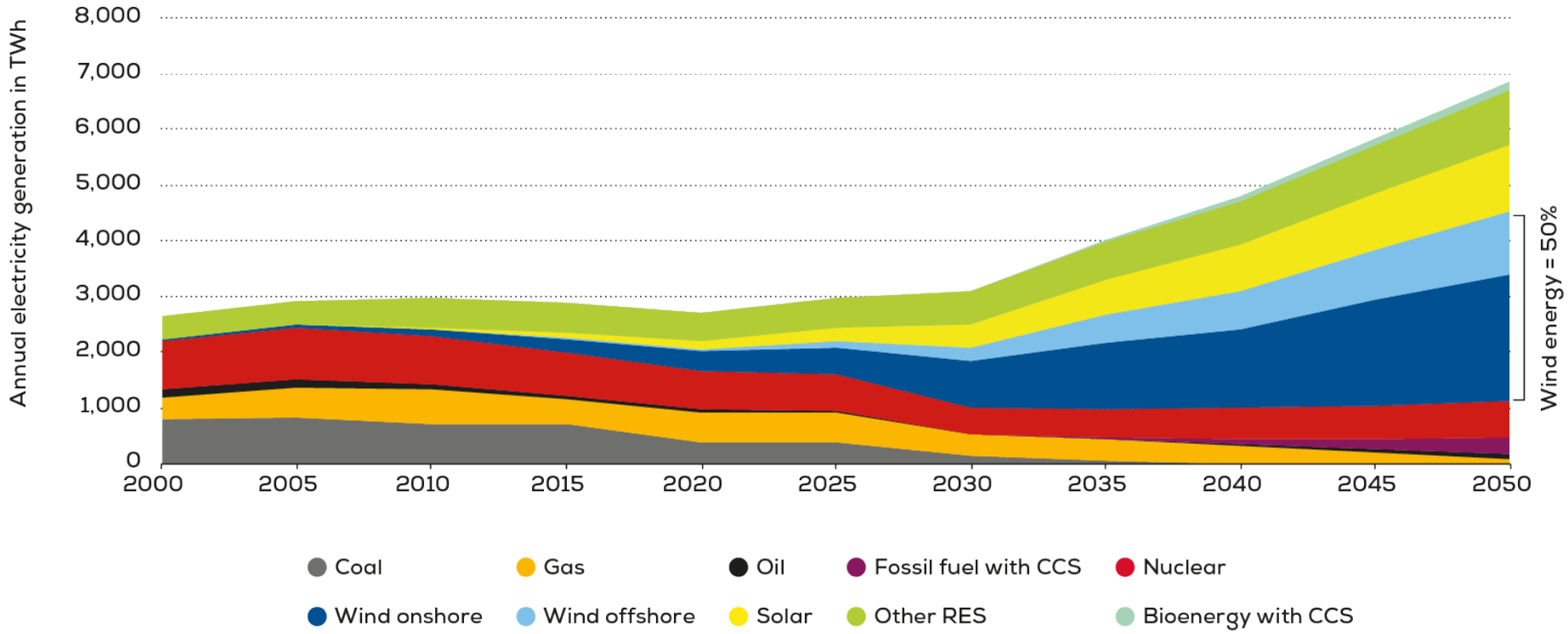
windeurope.org

June 2020

Huge increase in wind capacity coming



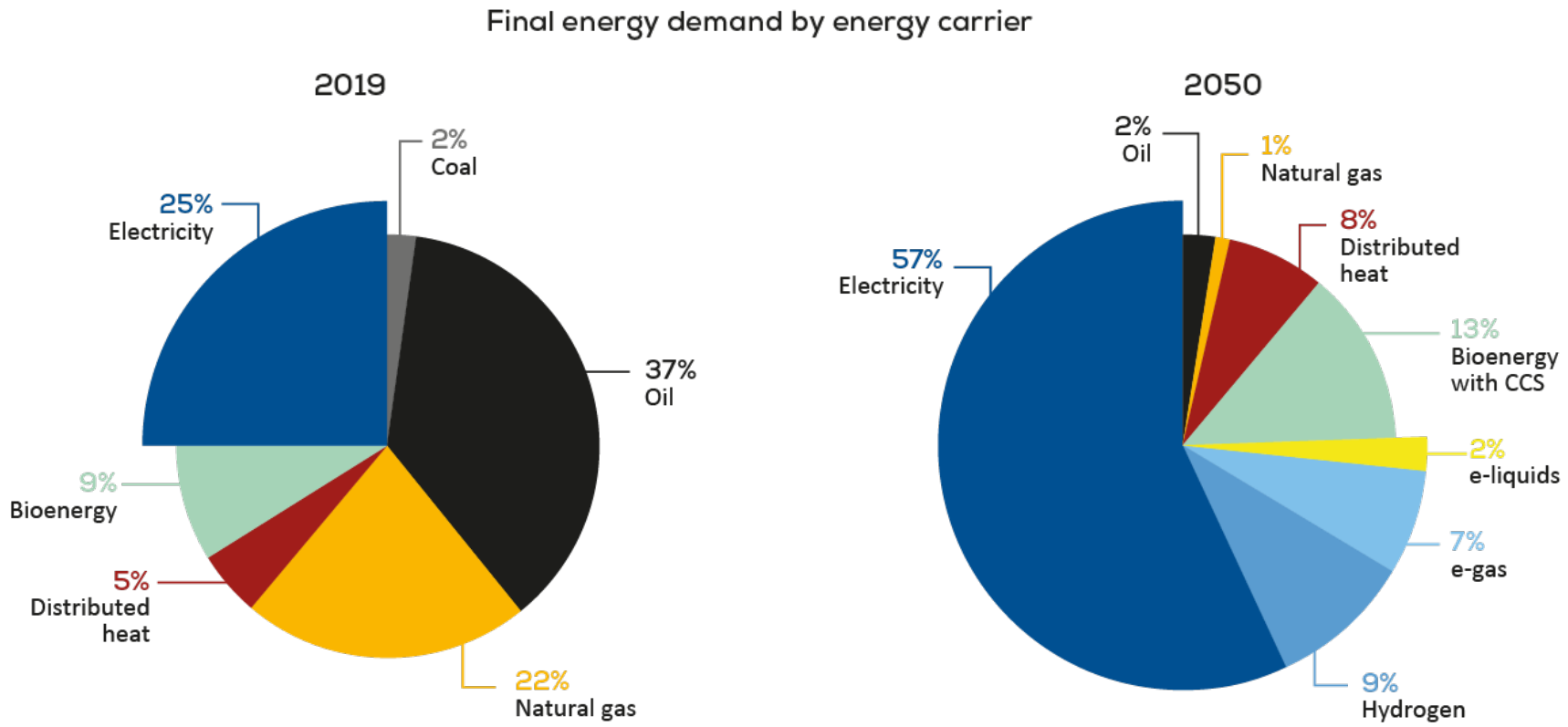
Electricity demand to double … wind will be half of it



Source: European Commission Impact Assessment, COVID MIX scenario, 2020

Wind EUROPE

Electrify, electrify, electrify



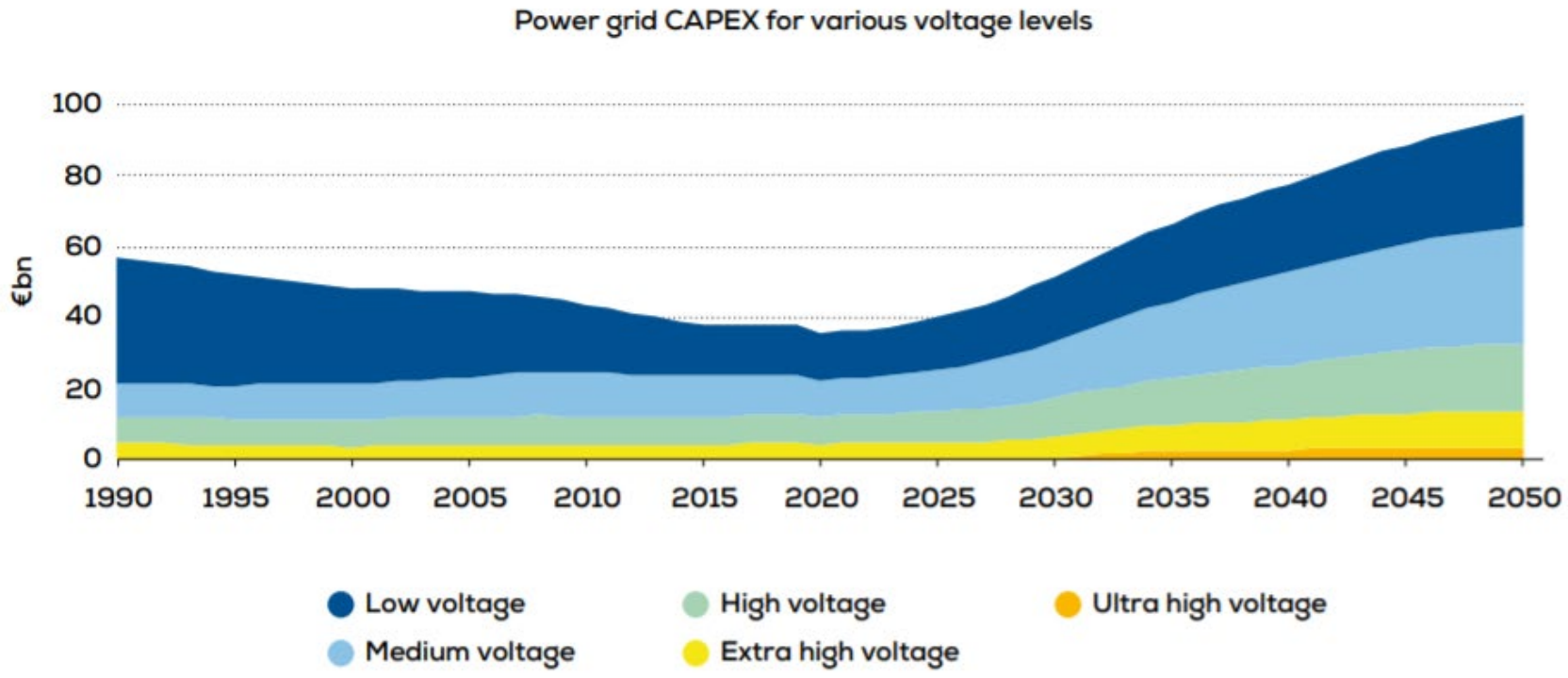
17,417 TWh

7,158 TWh

Source: European Commission Impact Assessment, COVID MIX scenario, 2020

Wind EUROPE

Grid investments need to double



NOTE: All power lines values are reflected as average. Low Voltage 0.4 kV. Medium Voltage 20 kV. High voltage 130 kV. Extra High Voltage 350 kV. Ultra High Voltage 800 kV

Source: ETIP Wind, WindEurope, Getting fit for 55 and set for 2050, June 2021

THANK YOU

windeurope.org

WindEurope, Rue Belliard 40
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Innovation Landscape for Power Systems Transformation

Dolf Gielen

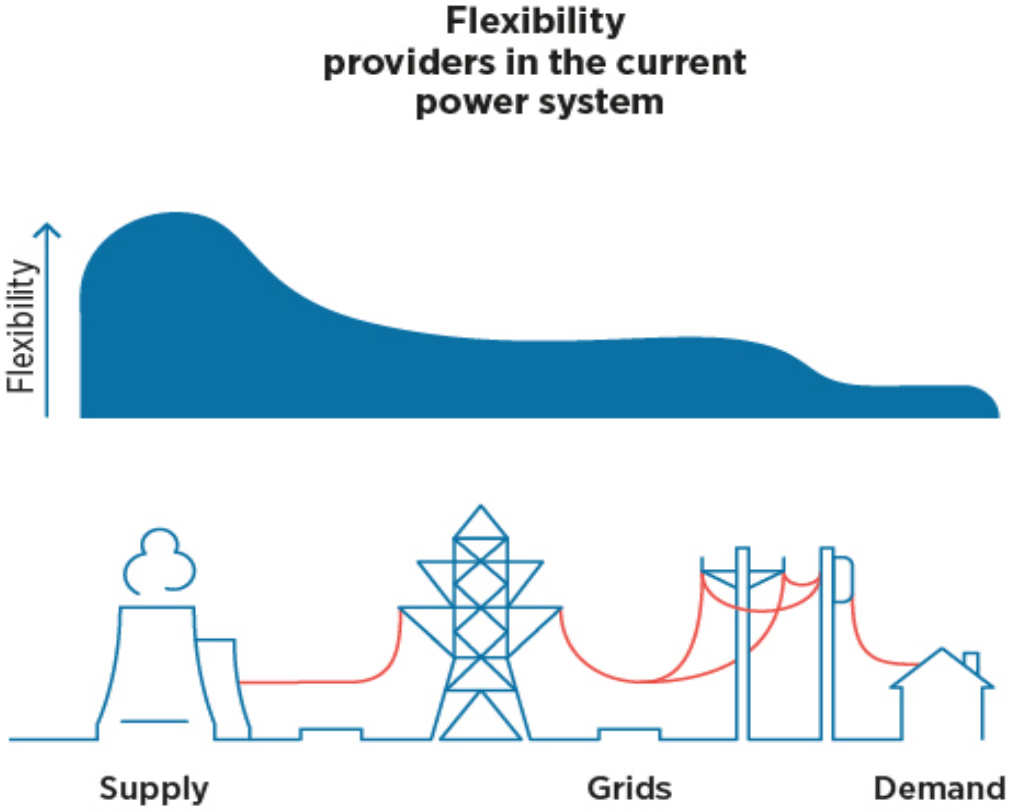
Director, IRENA Innovation and Technology Centre

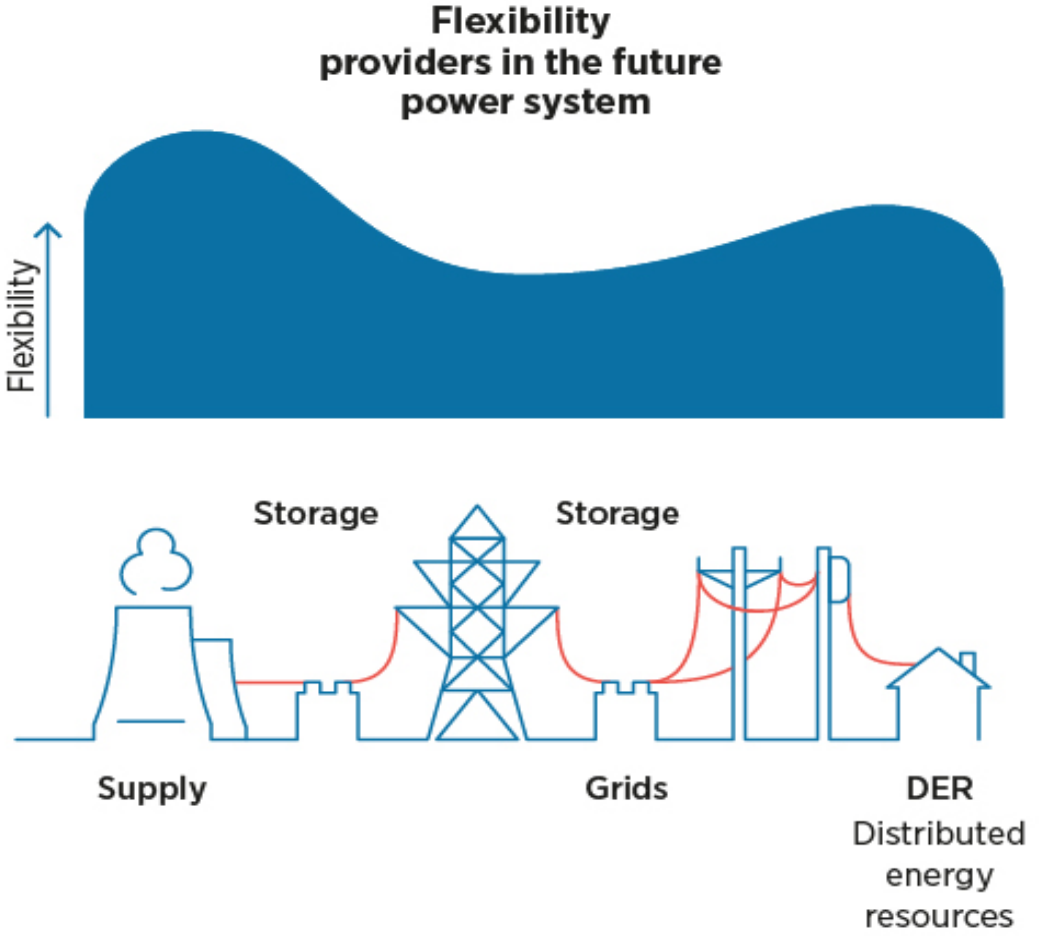
IRENA
International Renewable Energy Agency

Innovation Landscape for Power Systems Transformation

Dolf Gielen
Director, Innovation and Technology

Innovation unlocks flexibility across the power system





Flexibility sources: Flexible generation

Flexibility sources: Flexible generation; Regional interconnections and markets; Demand response; Storage; Power to X

Issues

1- Annual Energy demand: must come from renewables

2- Load profile: peak demand

Smart vs dumb electrification

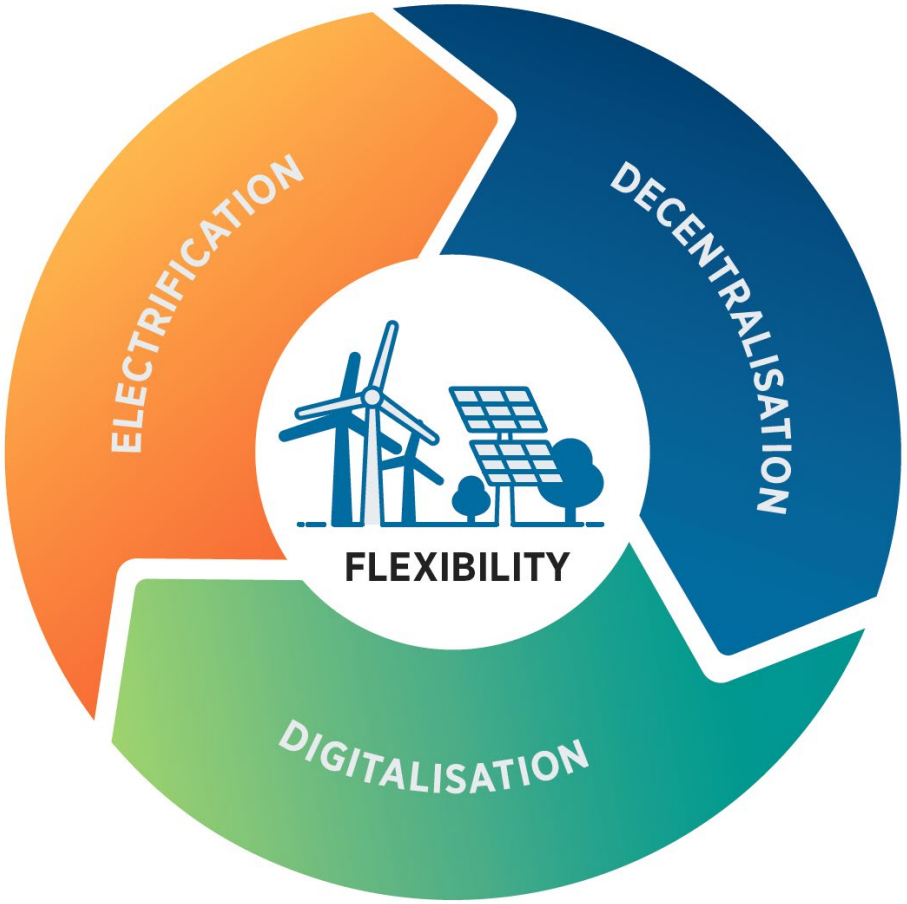
Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

Power sector transformation propelled by three trends

I. **Decentralisation – supply side.** Wind and PV is largely centralised today but distributed generation - notably rooftop PV, ~ 1% of all electricity generation today – is growing, bringing new flexibility opportunities at demand side

II. **Electrification – demand side.** It plays in two ways, may decarbonise end-use sectors through renewable electricity and, if done in a smart way, become a flexibility source to integrate more renewables in power systems

III. **Digitalisation – system integration.** Covert data into value by optimising complex systems with more actors involved, many small generation units and new type of loads

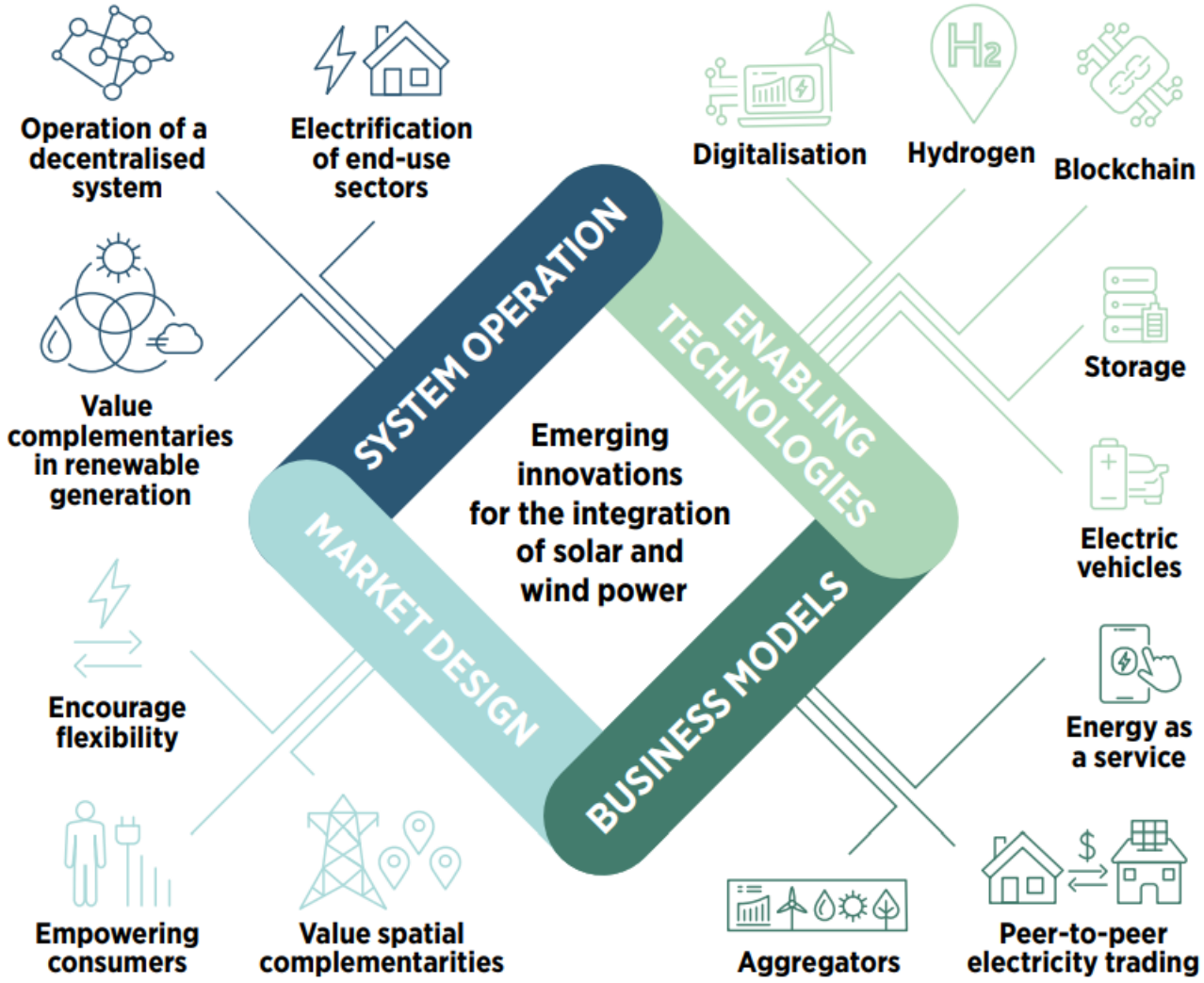


Source: IRENA (2019), Innovation landscape for a renewable-powered future: Solutions to integrate variable renewables

Need for a systemic innovation approach

Increasing flexibility through:

- Governments to create the enabling infrastructure (grids, EV recharging etc.)
- This creates new investment opportunities
- A key role for digitalisation and smart systems
- Changing supply and demand patterns and more variable electricity pricing create new business cases
- More attention for demand side flexibility



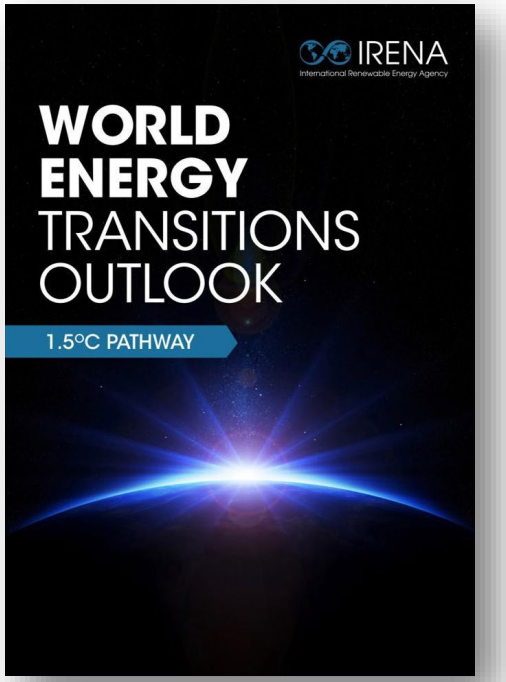
Based on IRENA (2019), Innovation Landscape for a Renewable-Powered Future: Solutions to Integrate Variable Renewables, International Renewable Energy Agency, Abu Dhabi.

Aging energy infrastructure

Ex. power grids

Equipment	**Upgrading/renewal of existing assets and advance protection systems** to provide extra capacity	**Digital substations/ transformers, advanced sensors and smart meters** to enhance grid monitoring, stability and control	**Redundant equipment, underground lines and back-up storage** (e.g. batteries) to increase security of supply	**Drones** for power grid geographical mapping and optimising maintenance
IT/OT Systems	**Systems** with faster access to data for grid management at **local/node level** (e.g. SCADA) and **edge computing**	**GIS and mapping systems,** including grid capacity maps and power flow analysis tools	**Cloud data storage and management** systems	**Cybersecurity software solutions** (e.g. malware protection)
Communications	**Telecommunication infrastructure** (e.g. optic fiber, mobile/broadband network)	**Communication protocols with third-party physical assets/systems**, including, aggregators or ESCOs	**Communication protocols** to connect DSO systems with renewable generators	
Advanced analytics	**Prediction** of load curve, generation or natural disasters	**Management and control** of the grid	**Predictive maintenance**	**Cybersecurity software solutions** (e.g. malware protection)

Source: ENTSOE/Deloitte 2021



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Strategic location of flexibility assets to overcome congestion

Werner Götz

CEO TransnetBW

TRANSNET BW

The Trans-European Networks for Energy a Milestone Towards a Renewables-Powered EU

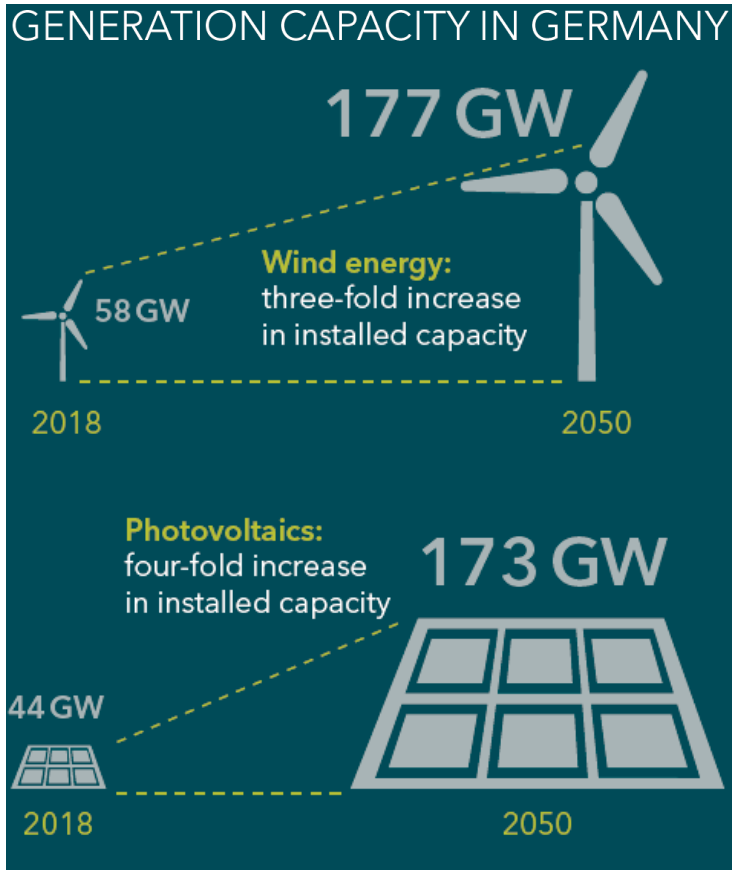
STRATEGIC LOCATION OF FLEXIBILITY ASSETS TO OVERCOME CONGESTION

DR. WERNER GÖTZ

18.06.2021

Strategic location of flexibility assets to overcome congestion

THE ENERGY TRANSITION THROUGH THE EYES OF A TSO



Source: Electricity Grid 2050 – A study by TransnetBW GmbH (2020).

Effects

- / Variable generation
- / Non-synchronous electricity production and demand
- / Grid and system stability
- / Transmission demand
- / Green electricity vs. green gas
- / Increase of importance of flexibility

Reactions

1. **Holistic planning of the energy system**
2. **Optimization of existing grid**
3. **Grid construction and expansion**

Strategic location of flexibility assets to overcome congestion

HOW TO OPTIMIZE THE EXISTING GRID?

Smart Grids

C/sells: a SINTEG project based on best practice solutions for a sustainable energy supply, considering key attributes of energy transition: cellular, participative and diverse.

Innovative System Management Strategies

InnoSys2030: Development and testing of innovative system management concepts, technologies and strategies for efficient utilization of the grid.

Flexibility Assets

Netzbooster: Higher capacity utilization of existing networks through reactive grid management.

Innovative Grid Control Methods

Dynamic line rating: Pilot project for dynamic adjustment of current limits for transmission lines based on wind speed and outside temperature.

Digitalization

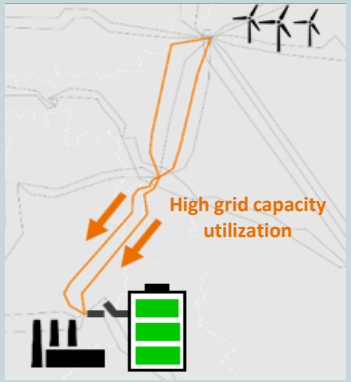
DAtenaustausch/Redispatch: Digital platform project for coordinating grid stabilization measures across all grid levels.

Strategic location of flexibility assets to overcome congestion

NETZBOOSTER: OPTIMIZING THE EXISTING GRID (1/2)

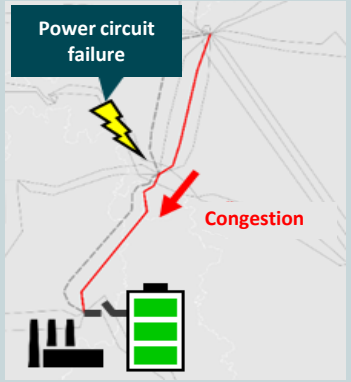
Mastering the challenge of the energy transition:
Netzbooster as an innovative tool for the reduction of additional line construction and redispatch

Initial Condition



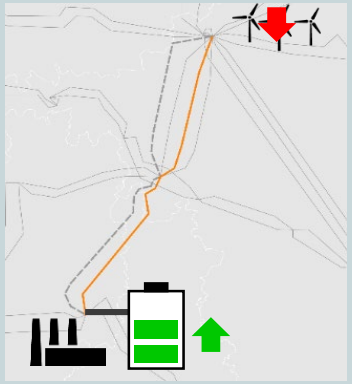
/ Grid utilization in (n-1) case > 100% (compared to utilization without grid stabilization system)
/ Storage charged in the south

Fault Occurrence



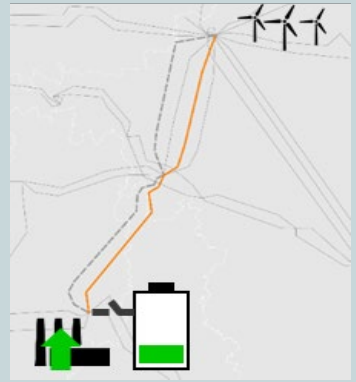
/ Failure of one power circuit leads to higher utilization of remaining power circuits

Deployment NB



/ Reduction of generation in the north
/ Use of storage in the south
/ Compliance with the thermal limits of the circuits

Curative Measures



/ Deployment of storage through shifting measures, feed-in management, or conventional redispatch

Strategic location of flexibility assets to overcome congestion

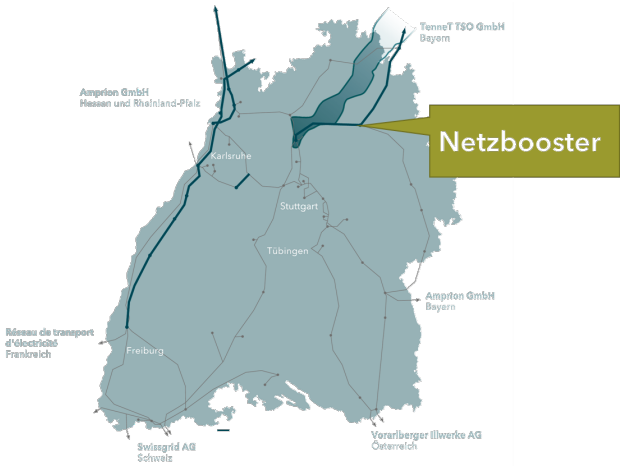
NETZBOOSTER: OPTIMIZING THE EXISTING GRID (2/2)

INNOVATION PROJECT

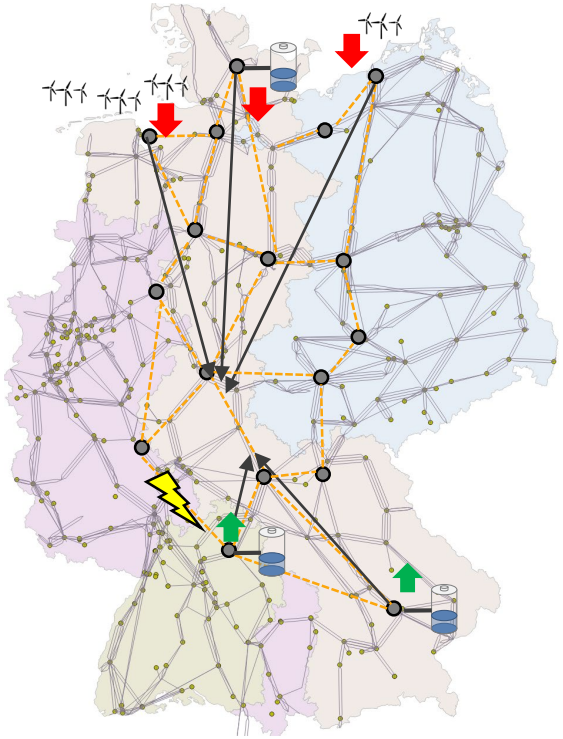
- **Pilot facility in Kupferzell, in Baden-Württemberg, Germany**
- Innovative system management
- Higher utilization of existing grid
- Power grid stabilization
- Security of supply for the region
- Reduced redispatch costs
- Flexible complement to grid expansion
- Larger volumes of renewable electricity from north to south of Germany
- Effect on transmission lines beyond the region

CHALLENGES

- Local public acceptance
- Regulatory requirements (e.g. TSO storage ownership)
- Technology proof of concept: innovative grid integration



TRANS-REGIONAL IMPORTANCE



from 2025

Experience buildup and overcome of challenges

to 2030 and beyond

The grid challenge in the Pentalateral region

Siméon Hagspiel

Energy Commissioner of Luxembourg

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Pentalateral Energy Forum

Benelux
SECRETARIAAT-GENERAAL
SECRÉTARIAT GENERAL

THE GRID CHALLENGE IN THE PENTALATERAL REGION

The Trans-European Networks for Energy – a Milestone Towards a Renewables-Powered EU

18 June 2021

Simeon Hagspiel

#pentalateral

PENTALATERAL ENERGY FORUM

The Pentalateral Energy Forum is ***the*** **framework for regional cooperation in Central Western Europe (BENELUX-DE-FR-AT-CH),** created by the Energy Ministers in 2005, **giving political support to a process of regional integration towards a European, secure, energy market**.

Ministers meet regularly to discuss energy policy matters and give guidance to this regional cooperation. Coordination is performed by the Coordinators. The work programme is implemented by **Support Groups consisting of experts from ministries, TSOs, regulators, European Commission, power exchanges and other market participants.** Continuity is ensured by the **Benelux Secretariat**.

The added value lies in its ability to **move faster**, to make **more specific recommendations** and to act as a **development center** for new ideas.

15 YEARS OF PENTA COOPERATION

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- 2021 — Penta Risk Preparedness
- Penta Hydrogen — 2020
- 2019 — Penta NECP Energy & Climate Plans
- PENTEX electricity crisis exercise — 2018
- 2015 — 2nd Political Declaration: flexibility workplan
- Flow based Market Coupling Adequacy Report — 2015
- 2013 — 1st Political Declaration: AT member +CH observer
- ATC Market Coupling — 2010
- 2007 — 1st Pentalateral MoU: objective & organisation
- Pentalateral Energy Forum — 2005

THE GRID CHALLENGE IN PENTA

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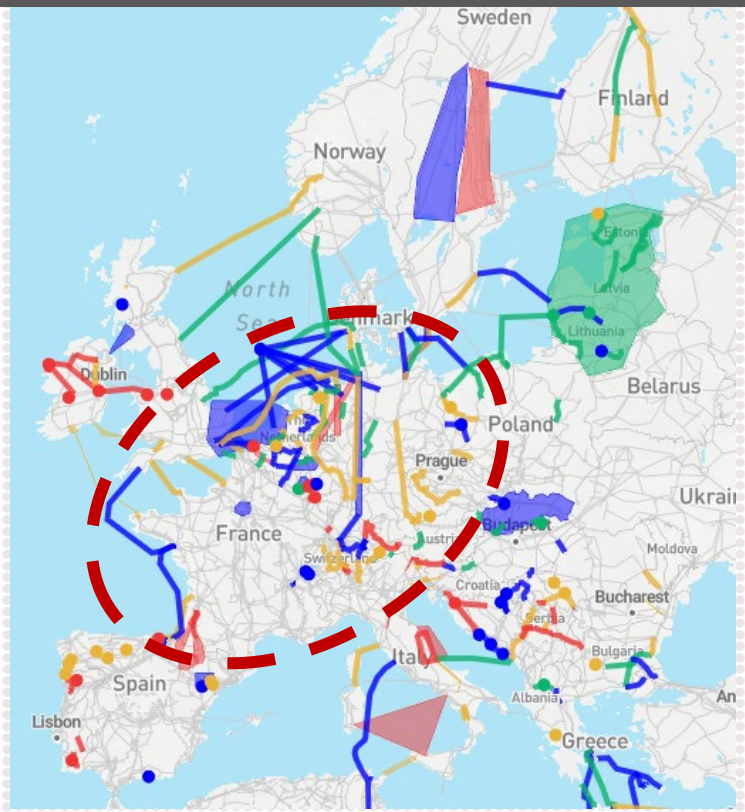
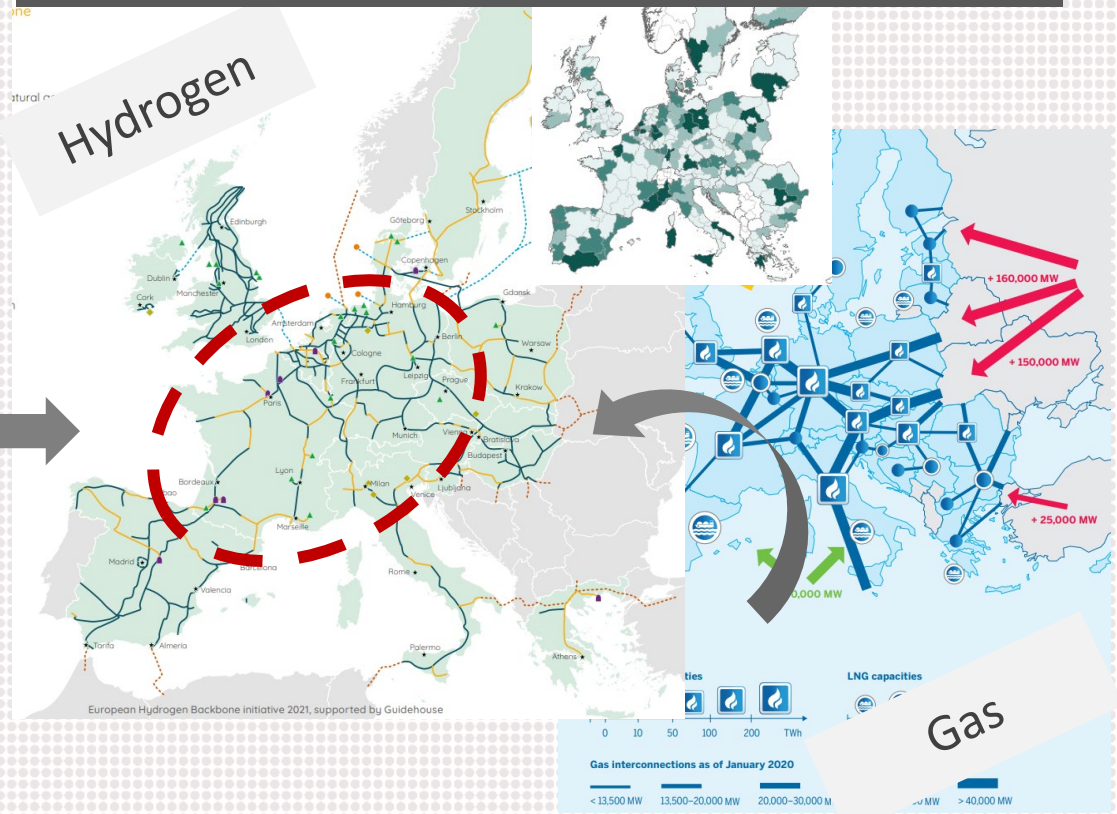
Electrons



Molecules



Shaping a future-proof renewable-based energy system requires a comprehensive approach and integrated systems crossing borders and sectors

Sources: ENTSO-E, ENTSOG and European Hydrogen Backbone

PENTA'S COMMON UNDERSTANDING

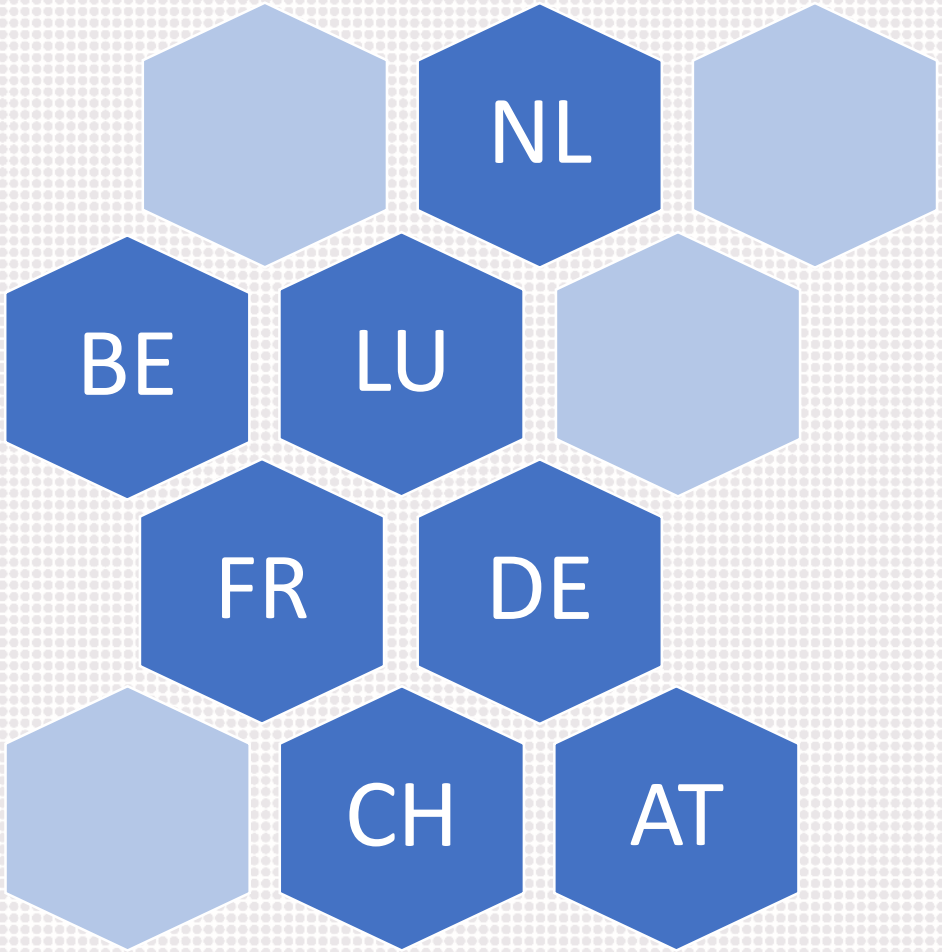
Already today, the energy system across Penta countries is highly integrated

- ✓ strong physical electricity and gas networks
- ✓ high levels of interconnection
- ✓ a comparatively high penetration of renewables
- ✓ reliable institutional market frameworks with advanced data and communication interfaces
- ✓ a shared commitment to maintain high levels of reliability of energy supply

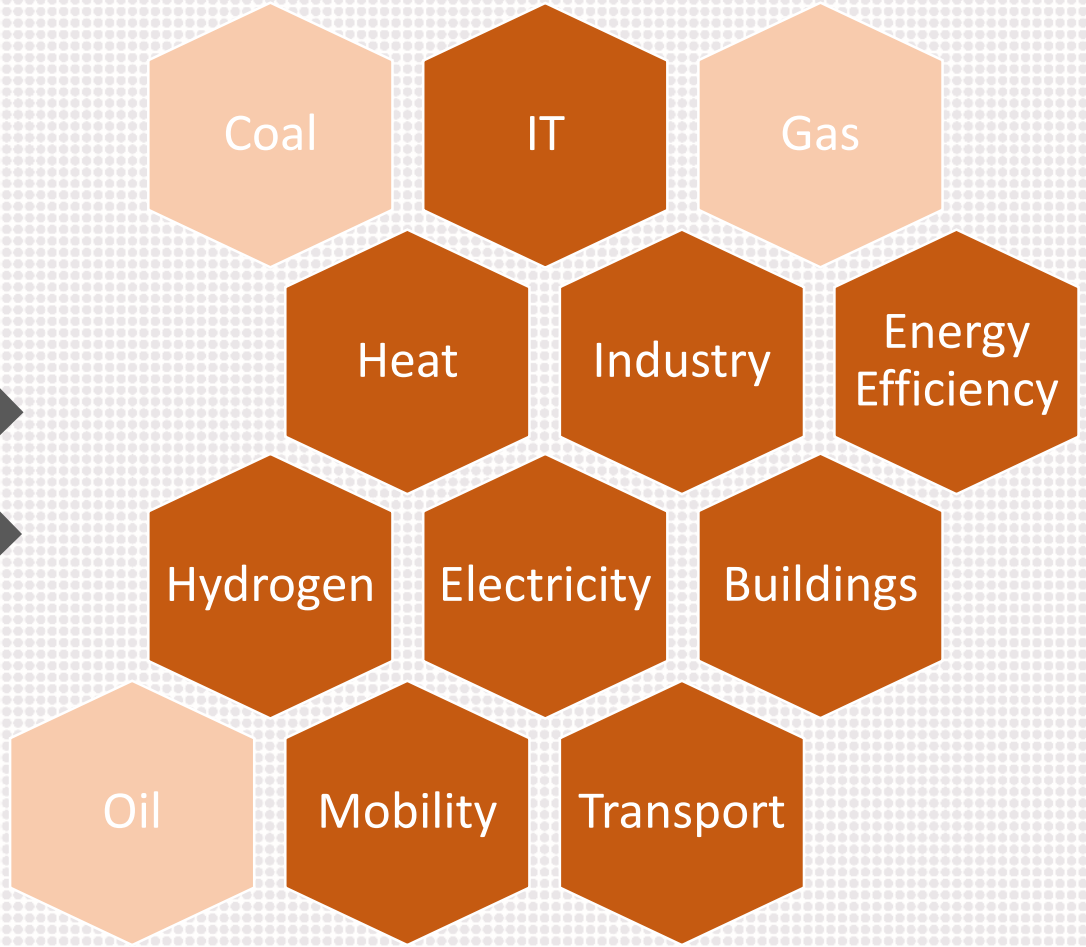
Ministers of the Pentalateral Energy Forum agreed at their meeting on 1st of February 2021 that a **common understanding on how an integrated system could look like in the region is key for a sustainable, decarbonized, reliable, and affordable supply of energy in each of our countries**

ENERGY SYSTEM(S) INTEGRATION

Regional integration



Sectorial integration



- Grid infrastructure: a key enabler of energy system integration

PENTA'S AMBITION

- → **Common Penta vision** on a decarbonized and integrated energy system
- → **Common understanding** on integrated energy infrastructure planning in the region
- → **Frontrunner** in the European ambition of an integrated and climate-neutral energy system
- → **Guiding questions and recommendations** for the upcoming EU legislative proposals
- → **Contribution** to the practical implementation of network development plans with a regional perspective

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THANK YOU!

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Q&A

The challenge of Integrating High RES Volumes into the Grid

Dan Jorgensen

Minister of Climate and Energy and Public Utilities

Giles Dickson

CEO

Wind Europe

Dolf Gielen

Director

IRENA Innovation and Technology Centre

Werner Götz

CEO

TransnetBW

Siméon Hagspiel

Energy Commissioner of Luxembourg

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Panel II

Including Flexibility and Assess Market Impacts in Scenario-Making

PANEL II
Including Flexibility and Assess Market Impacts in Scenario-Making

Gerald Kaendler

Vice-Chair of ENTSO-E's System Development Committee

Lisa Fischer

E3G

Arianna Vitali

Secretary General

The Coalition for Energy Savings

Kristian Ruby

Secretary General

Eurelectric

Thomas Östros

Vice-president

EIB

A renewed look at infrastructure planning

Gerald Kaendler

Vice-Chair of ENTSO-E’s

System Development Committee

Cooperation for a more open and transparent scenario making

Lisa Fischer

E3G

Energy efficiency first principle in network planning and operation

Arianna Vitali

Secretary General

The Coalition for Energy Savings

Flexibility solutions to reduce wholesale price volatility

Kristian Ruby

Secretary General Eurelectric

Electrolysers and batteries as investment opportunities?

Thomas Östros

Vice-president of the EIB

Q&A

Including Flexibility and Assess Market Impacts in Scenario-Making

Gerald Kaendler

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Panel III

Ministerial Panel

Bridging Onshore and Offshore for an Integrated Electricity Grid

PANEL III
Ministerial Panel - Bridging Onshore and Offshore for an Integrated Electricity Grid

Kadri Simson

EU Commissioner for Energy

Claudia Gamon

Member of the European Parliament

Teresa Ribera

Fourth Deputy Prime Minister for Ecological transition and the Demographic Challenge

Dan Jorgensen

Minister of Climate and Energy and Public Utilities, Denmark

René Neděla

Deputy Minister for Energy of Czech Republic

From fossil fuels to renewable energy sources

Kadri Simson

EU Commissioner for Energy

A TEN-E that facilitates renewables integration

Claudia Gamon

Member of the European Parliament

The Iberic peninsula: a green powerhouse in need of better interconnections?

Teresa Ribera

Fourth Deputy Prime Minister for Ecological Transition and the Demographic Challenge

Dan Jorgensen

Minister of Climate and Energy and Public Utilities, Denmark

Offshore energy for landlocked countries in Central Europe - what are the conditions of success?

René Neděla

Deputy Minister for Energy of Czech Republic

Q&A

Ministerial Panel - Bridging Onshore and Offshore for an Integrated Electricity Grid

Kadri Simson

EU Commissioner for Energy

Claudia Gamon

Member of the European Parliament

Teresa Ribera

Fourth Deputy Prime Minister for Ecological transition and the Demographic Challenge

René Neděla

Deputy Minister for Energy of Czech Republic

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Conclusion and wrap-up

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Claude Turmes

Minister of Energy
Minister of Spatial Planning
Luxembourg

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Francesco La Camera

Director-General of IRENA

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Ambroise Fayolle

Vice-President of the EIB

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THANK YOU FOR JOINING US!