Welcome to

Statnett's R&D Conference 2019

Statnett

International Session and Closing Session

Challenges in the Nordic Power System	Håkon Borgen	Statnett
Illustration of Etip Snet and synergies with TSOs innovation efforts	Antonio Iliceto	Etip Snet
Presentation of R&D in Europe	Guido Guida	ENTSO-E
Presentation of ongoing R&D in Fingrid	Jussi Matilainen	Fingrid
Presentation of ongoing R&D in Svenska Kraftnät	Göran Ericsson	Svenska Kraftnät
Presentation of ongoing R&D in Landsnett	Magni Þór Pálsson	Landsnet
Presentation of ongoing R&D in Energinet (including North Sea Hub)	Anders Bavnhøj Hansen	Energinet
New Statnett R&D programs and formal closure of the conference	Sonja Berlijn	Statnett

Challenges and solutions for a changing Nordic Power System

Statnett's R&D Conference 2019 - Håkon Borgen EVP

Oslo, 3rd April 2019

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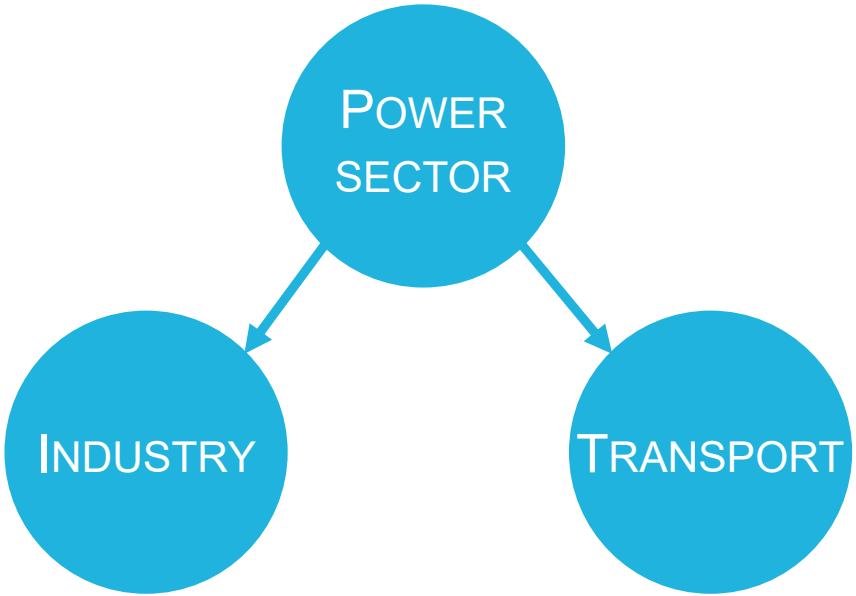
We are in a complete energy transition



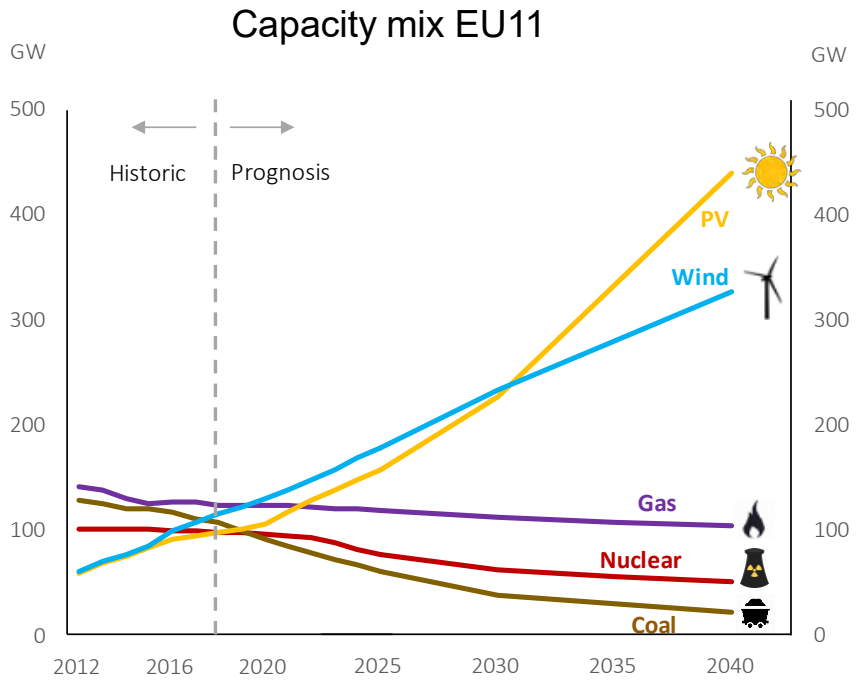
DRIVERS:

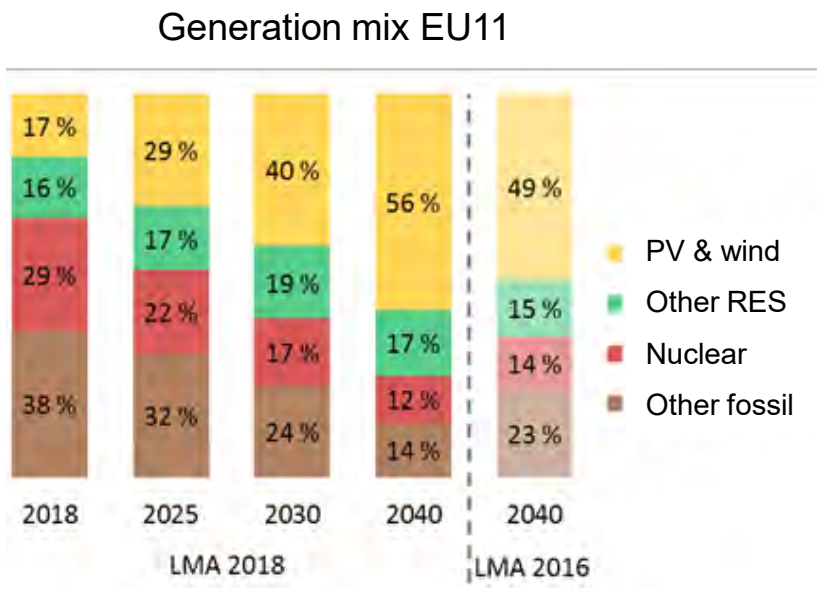
1. Cheap renewables
2. Strong carbon price
3. Persistent consumer power

Bilde: Equinor

The possibilities for electrification are accelerating…

Wind and solar power is winning





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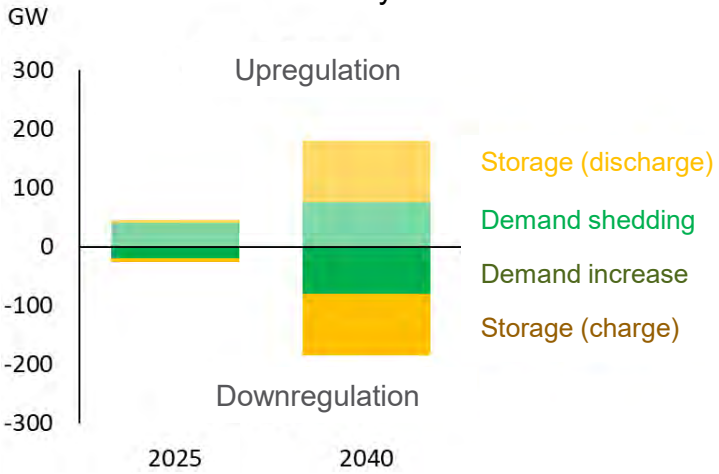
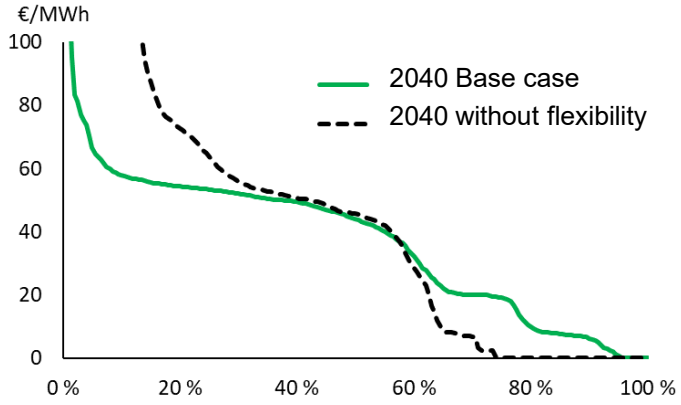
Need for more flexibility

- More demand response and storage is necessary in 2040
- Difficult to achieve more than 50% solar and wind share without this flexibility
  - Replaces thermal plants
  - Much more efficient integration of solar and wind power

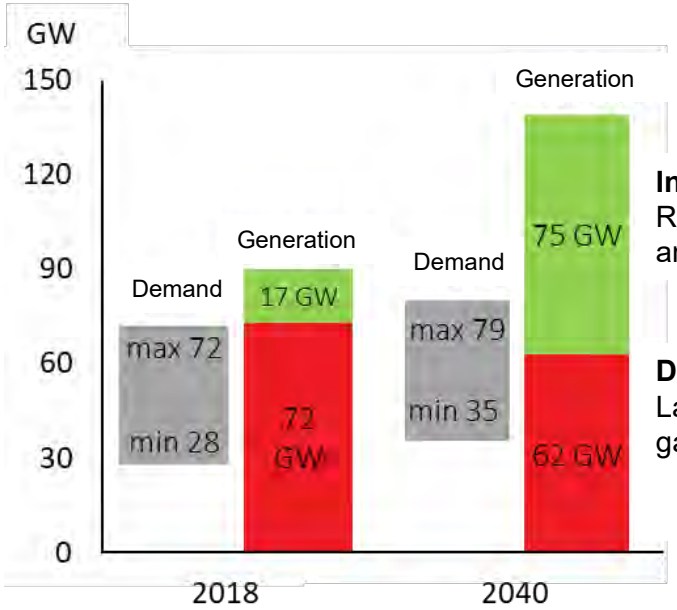
Flexibility EU11



German price with and without flexibility



And intermittent RES will dominate the Nordic area

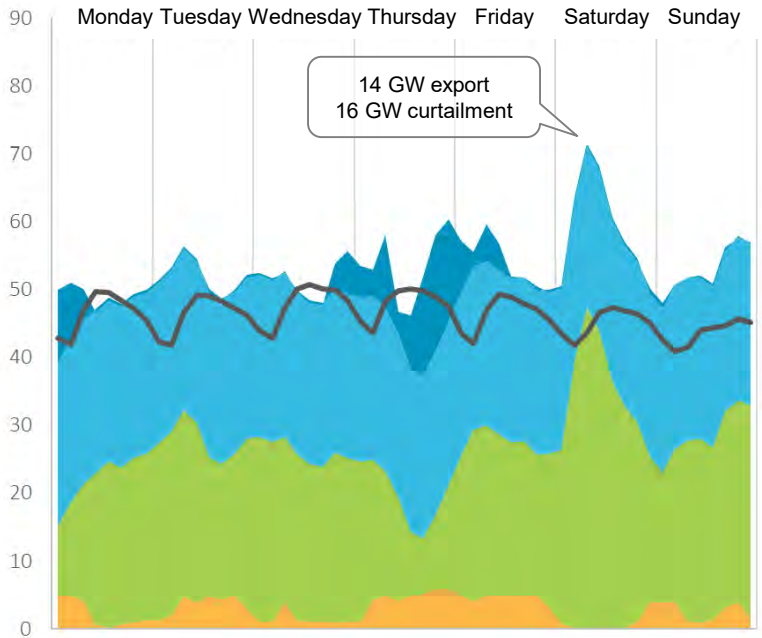


Intermittent sources:
Run-of-river hydro, wind and solar

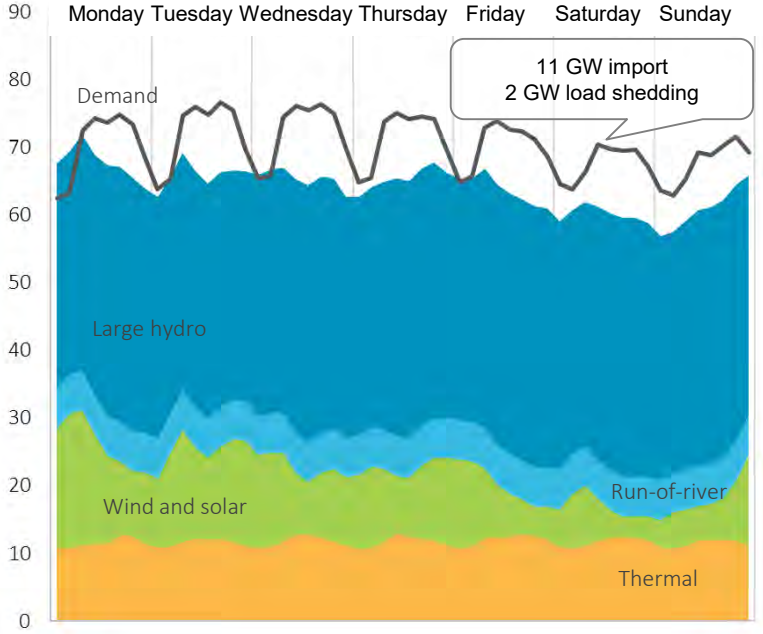
Dispatchable sources:
Large hydro, nuclear, coal, gas and bio

That gives some fundamental challenges..

High intermittent generation week



Low intermittent generation week



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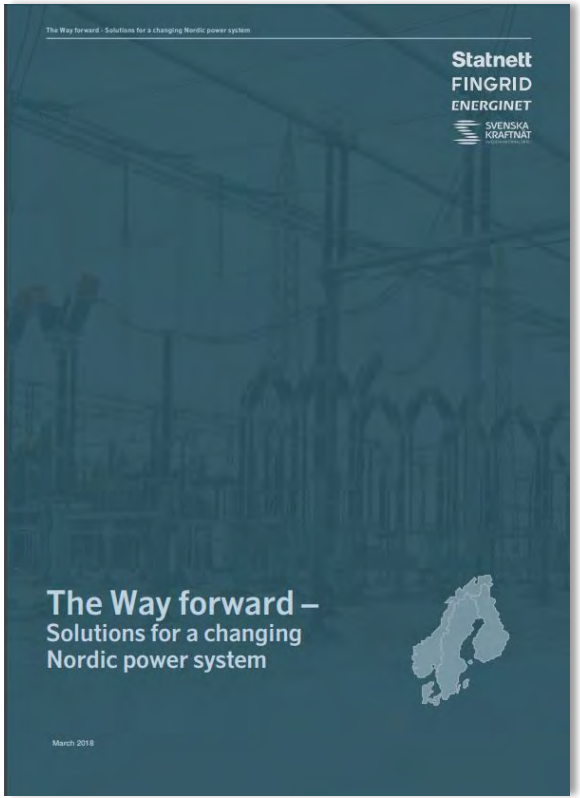
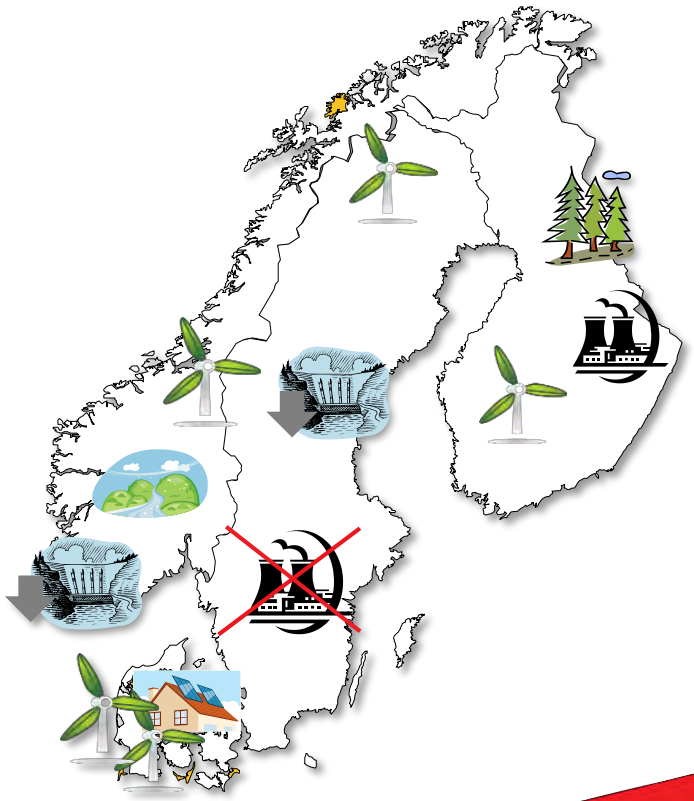
Solutions for a changing Nordic power system





Cooperation on three levels

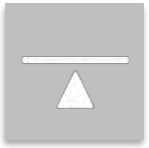
1. Nordic energy policy on political high-level

2. Common system solutions by broad cooperation

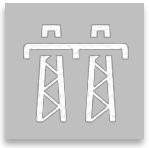
3. Dedicated solutions by technical cooperation

The TSOs are working on four types of solutions

Market development



Balancing of the power system



Grid development

ICT solutions

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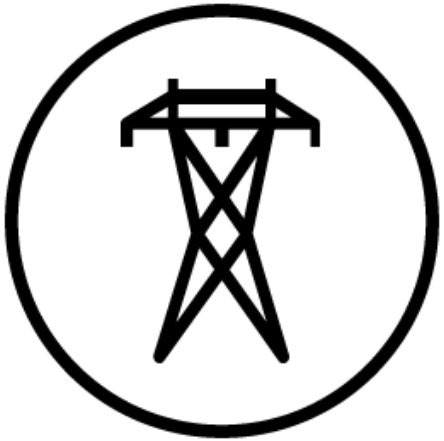
Rapid development requires coordination and efficiency

Digitalisation



Technology development

Cost efficiency

Co-operation is essential for R&D – get the Wins together!

- Enhance Cross functional solutions
  - Market
  - Operation
  - Planning
  - Digitalization /ICT

- Ambitious Flagship projects are also needed in regions and between them
  - According to 'pipeline' principle

    The 'inventors', the 'users' and the 'commercialisers' in one project
  - Significant innovations
  - Large resource investments

Co-operation is essential for R&D

prioritize, share scarce resources, inspire and harmonize

Norwegian level

smartgrid The Norwegian Smartgrid Centre

energi 21

Forskningsrådet

Nordic level

Nordic R&D Group

ENERGINET FINGRID

LANDSNET

SVENSKA KRAFTNÄT Statnett

Nordic Energy Research

European level

ETIP SNET

entsoe

International level

ENERGY TRANSITIONS COMMISSION

ISGAN INTERNATIONAL SMART GRID ACTION NETWORK

iea International Energy Agency

http://www.statnett.no/Samfunnsoppdrag/Forskning-og-utvikling/
http://www.statnett.no/en/Sustainability/Research-and-Development-/

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SMART NETWORKS FOR ENERGY TRANSITION

The European perspective

Etip Snet platform and synergies with TSO innovation efforts

Stattnett's R&D Conference
Oslo, April 3rd 2019

ANTONIO ILICETO [co-chairman ETIP SNET & chairman WG1]

Outline

ETIP SNET = European Technology and Innovation Platform for Smart Networks for Energy Transition

- About ETIP SNET
- Recent achievements & current activities
- ETIP SNET Vision 2050 & European funded R&D programs
- Roadmap & Implementation Plans
- Integrated and sustainable energy system
- Synergies with TSO innovation efforts

From a fragmented EU advisory approach to an integrated platform

EEGI
EUROPEAN ELECTRICITY GRID INITIATIVE

SMARTGRIDS

GRID+

GRID+ STORAGE

Main objective is to address the innovation challenges in **energy system** and **market evolution** necessary for achieving climate protection and **renewables integration** with affordability and security of supply

2017 →

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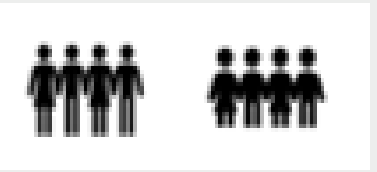
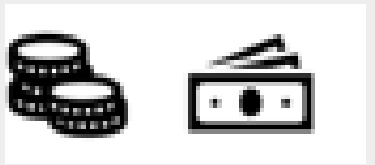
Beyond smart electricity grids → whole energy system

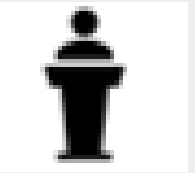
ETIP SNET Missions

- Integrated approach among all stakeholders of the energy value chain

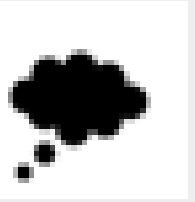


- Pull together RD&I efforts and search of synergies on 3 dimensions:
  - Geographical footprint: European and national/regional level
  - Actors: Research centers <-> Utilities <-> Industrial sector
  - Public/private innovation: public-funded projects and private initiatives

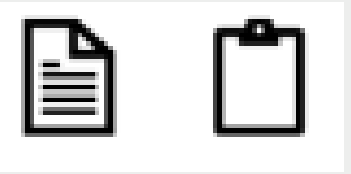




- Enhance knowledge-sharing activities to foster RD&I results to deployment phase



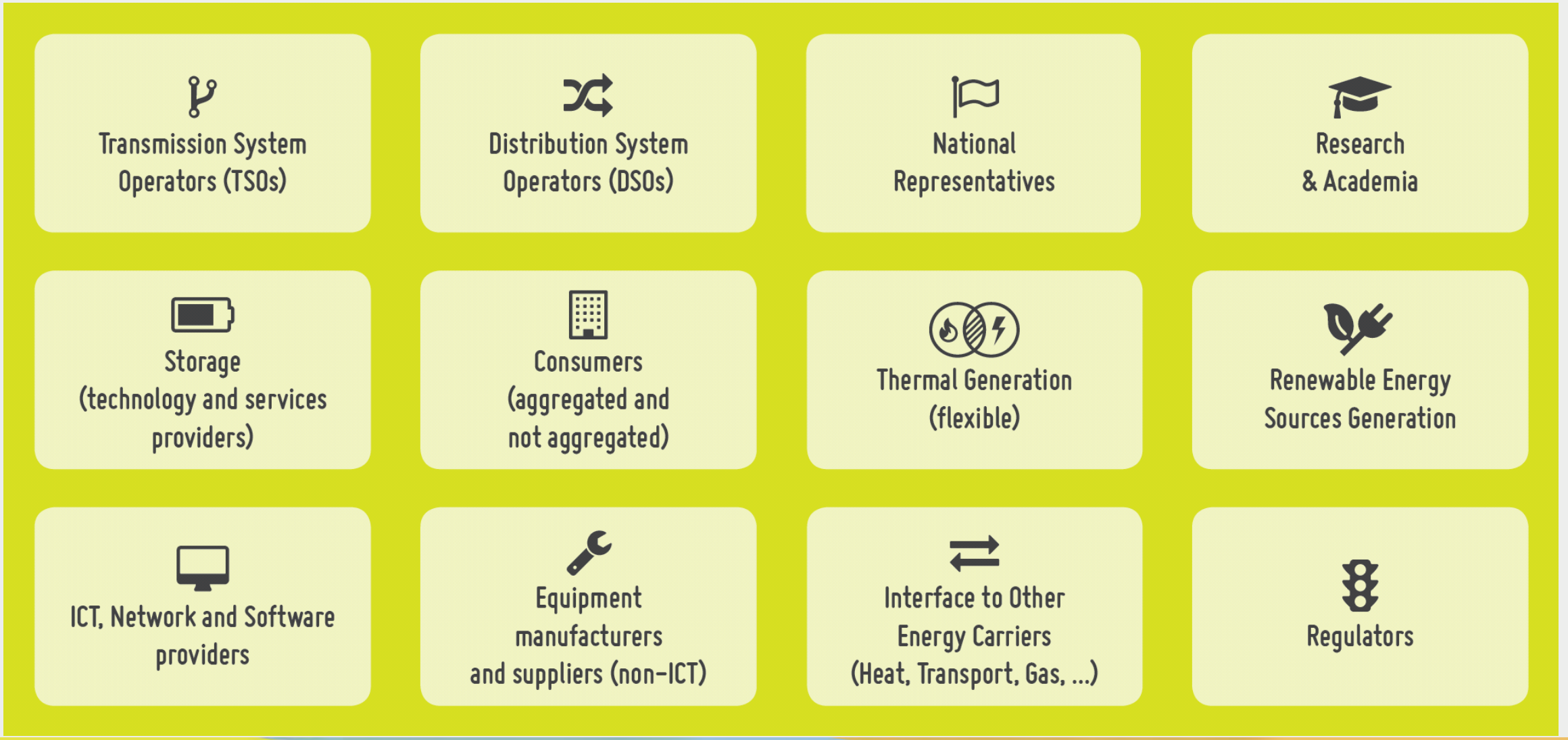
- Identify innovation barriers, notably related to regulation and financing
- Prepare consolidated stakeholder views on Research and Innovation as authoritative input to European Energy Policy initiatives



ETIP SNET workstreams

- Set-out a **vision** for RD&I for Smart Networks for Energy Transition and engage stakeholders in this vision
- Prepare and update the Strategic Research and **Innovation Roadmap**
- **Monitor** the outcomes and **applications** of **RD&I projects**
- Organise regularly multi-disciplinary **workshops** on projects' results
- Provide **input to SET Plan action 4 (**addressing technical challenges raised by system transformation)
- Collect **structured and shared information** (state-of-the-art and perspective) on specific innovation topics in the form of White Papers

ETIP SNET's Stakeholders



ETIP SNET's Organisation

European Commission

Governing Board
(30+ members representing key European stakeholders)
Exco (9 members)

ETIP SNET Secretariat
(Intensys4EU)*

Experts coordination
via Working Groups
(5 permanent WGs)

National stakeholders coordination
(Ministry representatives, funding agencies, regulators, national platforms)

* Intensys4EU is a coordinating consortium formed under the European Commission's Horizon2020 initiative which supports ETIP SNET in delivering RD&I monitoring reports, Roadmaps and implementation plans.

WG1
Reliable, economic and efficient smart grid system

WG2
Storage technologies and sector interfaces

WG3
Flexible Generation

WG4
Digitisation of the electricity system and customer participation

WG5
Innovation implementation in the business environment

NSCG
National Stakeholders Coordination Group

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Recent achievements & current activities

White Papers: expressing shared sector's views

Holistic Architectures:
this White Paper sets out the holistic architecture vision that should inform future demonstration projects that would enable large-scale rollout of the new control paradigms

Digitalisation:
The objective is to address the use and impact of the Information and Communication technologies as a pervasive tool along the entire value chain of the power generation, transportation and use, and mainly on enabling customer participation

Knowledge sharing through Regional Workshops

2018 editions:

- Zagreb: 13 projects presented, 65 registrations
- Helsinki: 11 projects presented, 53 registrations
- Brussels: 11 projects presented, 121 registrations
- Madrid: 12 projects presented, 103 registrations

- For 2019, organization of 2 workshops between September and November
- All TSOs are asked to contribute with relevant projects, just finished or in final stage

- Addressing both European projects and national ones
- Focus on the results of the projects: collect main recommendations and needs for Roadmap and IP
- Focus on topics for Horizon Europe and the next period of work

Monitoring Report

The objective of the monitoring activity is two-fold:

1. To analyse and to disseminate results from RD&I projects towards the energy community

2. To measure the coverage degree of each RD&I item of the roadmap and decide which topic deserve to be maintained or can be removed (“gap analysis”)

Advocacy and public awareness

Communication & advocacy activities

- ETIP Mission promotion for Horizon Europe
- Advise EC on Horizon Europe funding priorities
- Release of “Enegy stories” for improving public awareness and social acceptance of infrastructures

Cooperation with hubs of technological excellence

Cooperation with JRC (Joint Research Center of the EC):

§ Establishing a structured cooperation on topics of common interest

§ Proposal for topics:

- Interoperability and energy system integration aspects
- respective contributions in the RD&I value chain for "battery related energy system integration"

Collaborations with CIGRE

Collaborations with CIRED

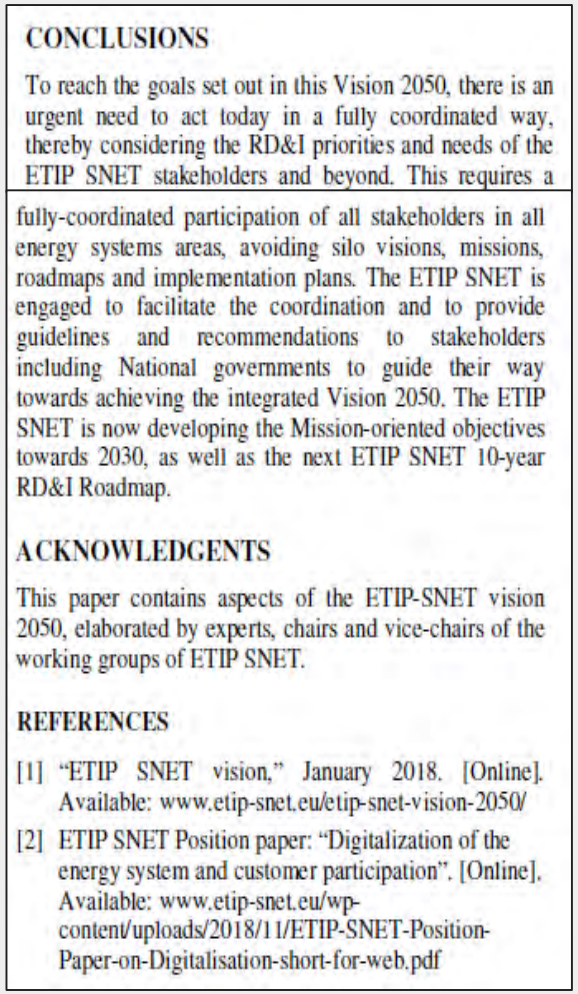
Own stand hosted at CIGRE – last Paris session

- A MoU has been signed between Cigre and Etip Snet, with double-folded aim:
- promote knowledge and technical stance of ETIP SNET
- gather state-of-the-art infomration on worldwide (extra-European) R&D efforts and results

Activities with CIRED

CIRED general session 2018 and 2019 (Madrid, 3-4 June 2019):

- **Each year, technical papers submitted and presented in the general session**
- **A specific round table on Etip Snet Vision and Roadmap, with benchmarks towards international experiences has been organised and will be lead by Etip Snet**



CONCLUSIONS

To reach the goals set out in this Vision 2050, there is an urgent need to act today in a fully coordinated way, thereby considering the RD&I priorities and needs of the ETIP SNET stakeholders and beyond. This requires a fully-coordinated participation of all stakeholders in all energy systems areas, avoiding silo visions, missions, roadmaps and implementation plans. The ETIP SNET is engaged to facilitate the coordination and to provide guidelines and recommendations to stakeholders including National governments to guide their way towards achieving the integrated Vision 2050. The ETIP SNET is now developing the Mission-oriented objectives towards 2030, as well as the next ETIP SNET 10-year RD&I Roadmap.

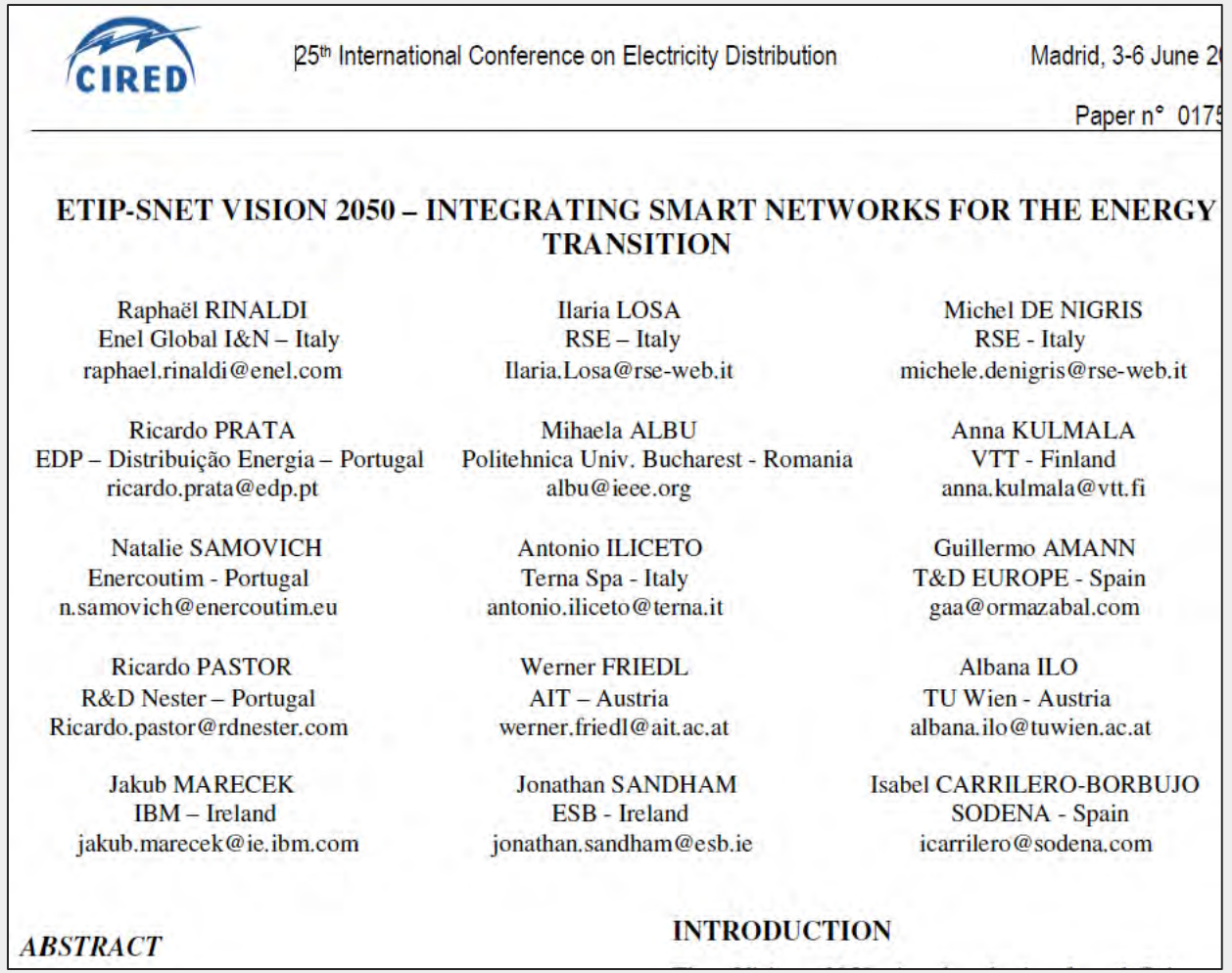
ACKNOWLEDGENTS

This paper contains aspects of the ETIP-SNET vision 2050, elaborated by experts, chairs and vice-chairs of the working groups of ETIP SNET.

REFERENCES

[1] "ETIP SNET vision," January 2018. [Online]. Available: www.etip-snet.eu/etip-snet-vision-2050/

[2] ETIP SNET Position paper: "Digitalization of the energy system and customer participation". [Online]. Available: www.etip-snet.eu/wp-content/uploads/2018/11/ETIP-SNET-Position-Paper-on-Digitalisation-short-for-web.pdf



CIRED 25th International Conference on Electricity Distribution Madrid, 3-6 June 2

Paper n° 0175

ETIP-SNET VISION 2050 – INTEGRATING SMART NETWORKS FOR THE ENERGY TRANSITION

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ABSTRACT

INTRODUCTION

International Outreach

- CONSIDERS 33 INITIATIVES:

- EUROPE:
  - 3 ETIPs
  - 5 EERA
  - 1 EIP
  - 4 ERANets
  - 3 SET PLAN IWGs
  - 4 PPPs
  - 1 JU
- GLOBAL
  - 4 CEM
  - 6 IEA TCPs
  - 2 MISSION INNOVATION

SYNERGIES AND COMPLEMENTARITIES OF EUROPEAN AND INTERNATIONAL INITIATIVES TOWARDS ENERGY TRANSITION

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Vision 2050

& European R&D funded Programs

Vision 2050

- **Released through major event in Brussels in June 2018**
- **In this document, the ETIP SNET stakeholders present their vision of a longer time horizon (2050) with a particular focus on low-carbon energy systems' integration needs for all involved users**

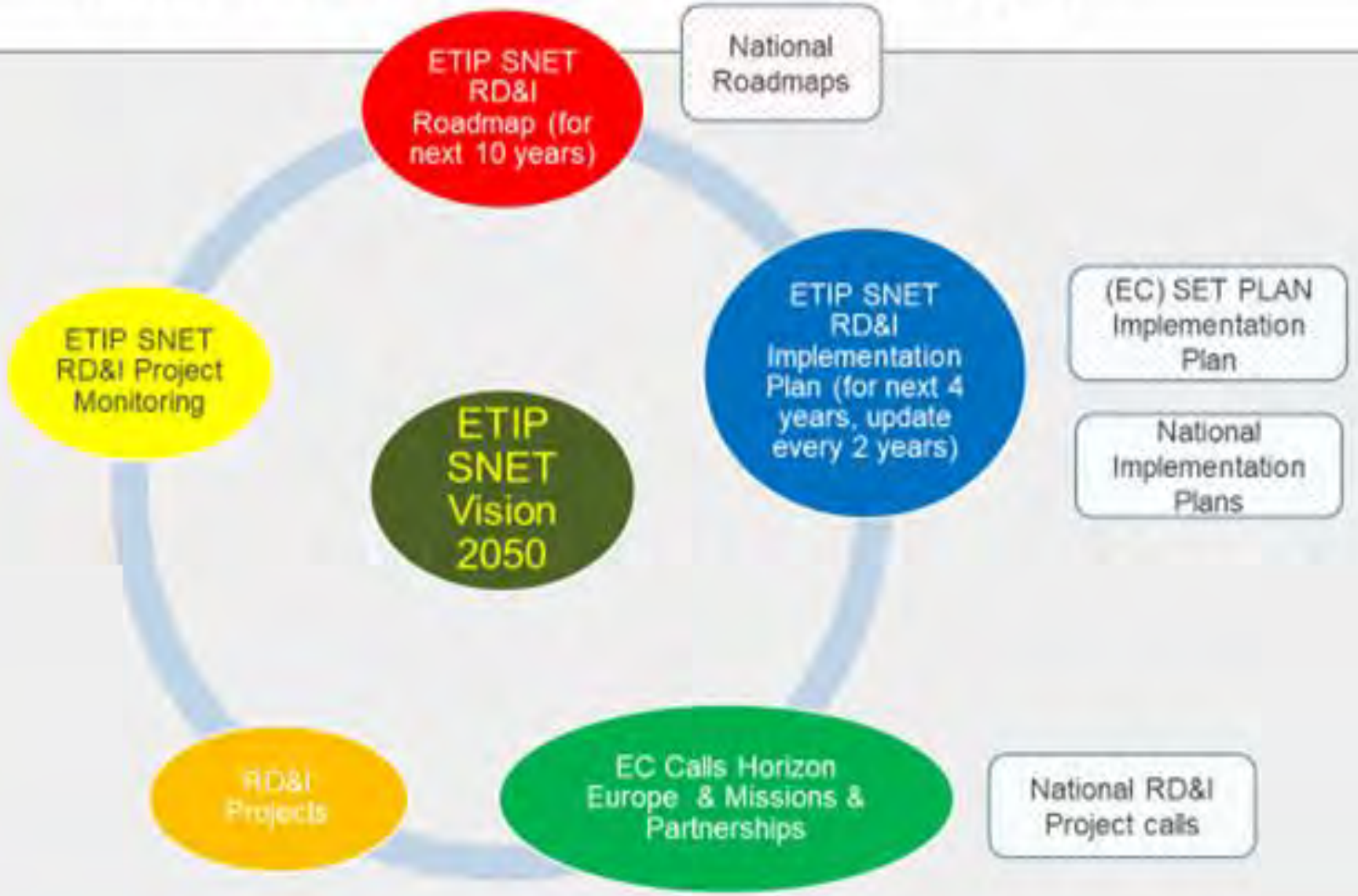
A low-carbon, secure, reliable, resilient, accessible, cost-efficient, and market-based **pan-European integrated energy system**

supplying the whole economy and paving the way for a **fully CO2-neutral and circular economy by the year 2050**,

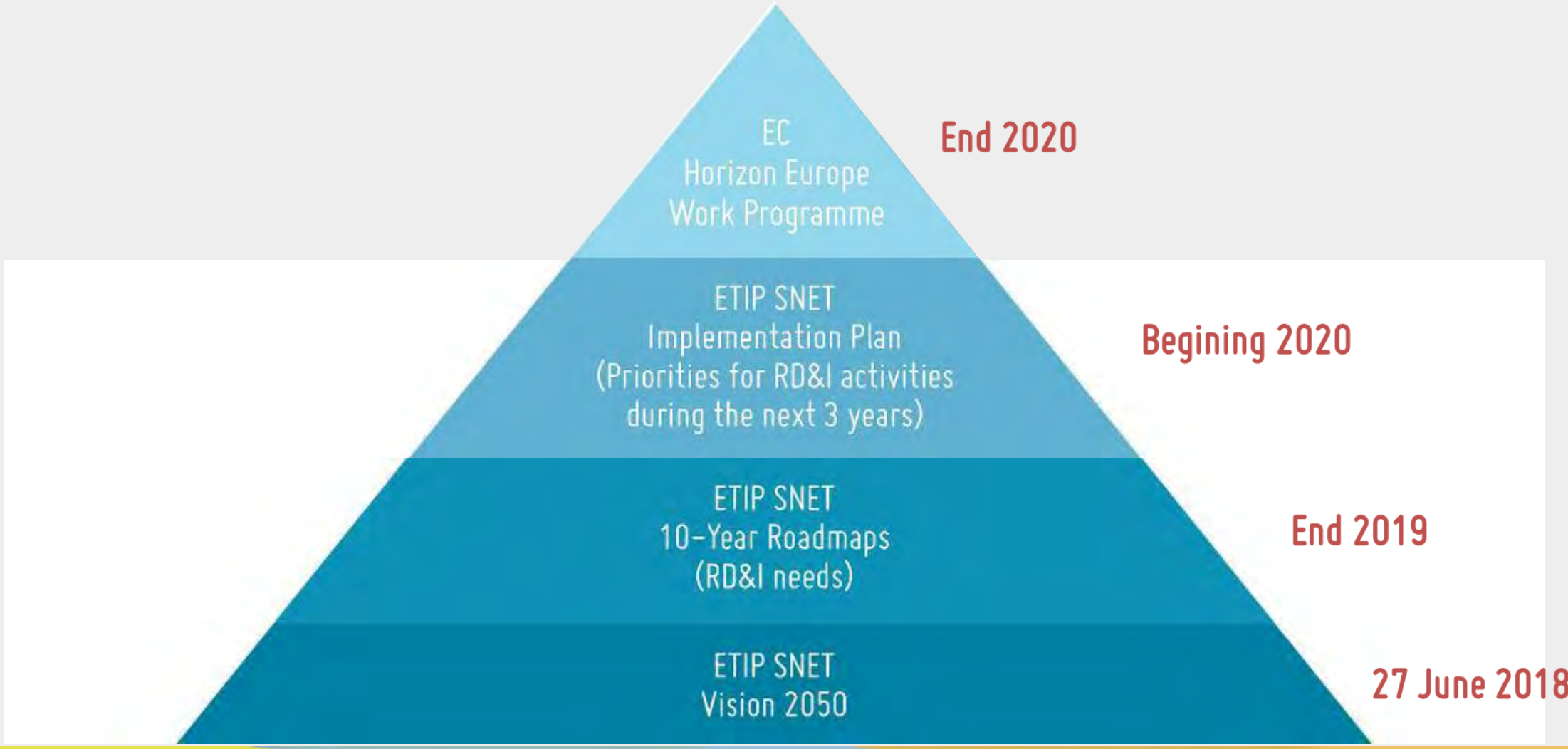
while **maintaining and extending global European industrial leadership** in energy systems during the energy transition.


VISION 2050
A SYSTEM OF SYSTEMS
Wind farm
Cross-border connections
Farm
Biogas production
Carbon capture & use
Biogas Cleaning
Methanation
Electrolyzer
Pumped Hydro Storage
Underground gas storage
Compressor station
Power to gas
HV/MV substation
Gas substation
Positive energy house
100% RES community
grid-forming inverter
Solar PV plant
small scale battery
Air/air Heat pump
AC/DC Converter station
Nuclear power plant
Off-shore wind farm DC network
Airport
Combined Cycle Gas Turbine
Large scale battery
Electric substation
ICT network for digitalization of energy system
Zero energy building
Fast charging station
Hybrid bus
Demand Response
Industry park
Gas to Power
Liquid fuel
Harbour
Peer-to-peer energy trading
Peer-to-peer energy trading
Biomass CHP plant
Electric tram
Vehicle-to-grid
small scale storage
Hydrogen station
Solar thermal
Liquid fuel station
Air/water Heat pump
Geothermal Heat pump
NETWORKS
Electricity
Heating & Cooling
Gas
Data
ETIP SNET

The ETIP SNET RD&I value cycle



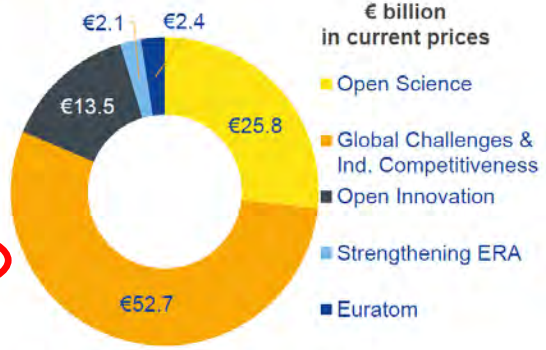
ETIP SNET deliverables and scope



Horizon Europe - Missions

Budget: €100 billion* (2021-2027)

Clusters	Budget (€ billion)
Health	€ 7.7
Inclusive and Secure Society	€ 2.8
Digital and Industry	€ 15
Climate, Energy and Mobility	€ 15
Food and Natural Resources	€ 10
Joint Research Centre	€ 2.2



* This envelope includes EUR 3.5 billion allocated under the InvestEU Fund.

European Commission

Specific objectives of the Programme

Support the creation and diffusion of high-quality knowledge

Strengthen the impact of R&I in supporting EU policies

Foster all forms of innovation and strengthen market deployment

Optimise the Programme's delivery for impact in a strengthened ERA

Pillar 1
Open Science

- European Research Council
- Marie Skłodowska-Curie Actions
- Research Infrastructures

Pillar 2
Global Challenges and Industrial Competitiveness

Clusters
- Health
- Inclusive and Secure Society
- Digital and Industry
- Climate, Energy and Mobility
- Food and natural resources

- Joint Research Centre

Pillar 3
Open Innovation

- European Innovation Council
- European innovation ecosystems
- European Institute of Innovation and Technology

Strengthening the European Research Area

- Sharing excellence
- Reforming and Enhancing the European R&I system

Three key areas for the strategic planning

- Global Challenges
- Missions
- Partnerships

European Commission

ETIP SNET Mission promotion: a task force with active members has been set-up

Lessons Learned
from Horizon 2020 Interim Evaluation

Key Novelties
in Horizon Europe

Support breakthrough innovation → European Innovation Council

Create more impact through mission-orientation and citizens' involvement → R&I Missions

Rationalise the funding landscape → New approach to Partnerships

R&I Missions: a possible case

Carbon neutral and clean air cities

Europe Commi

Lessons Learned
from Horizon 2020 Interim Evaluation

Key Novelties
in Horizon Europe

Partnerships will represent an enhanced channel for R&I joint actions

- Need to **link** the R&I partnerships to future EU R&I missions and/or strategic priorities
- Need to improve the **openness** and transparency of R&I partnerships
- Need to **rationalise** the European R&I partnerships landscape

European Commission

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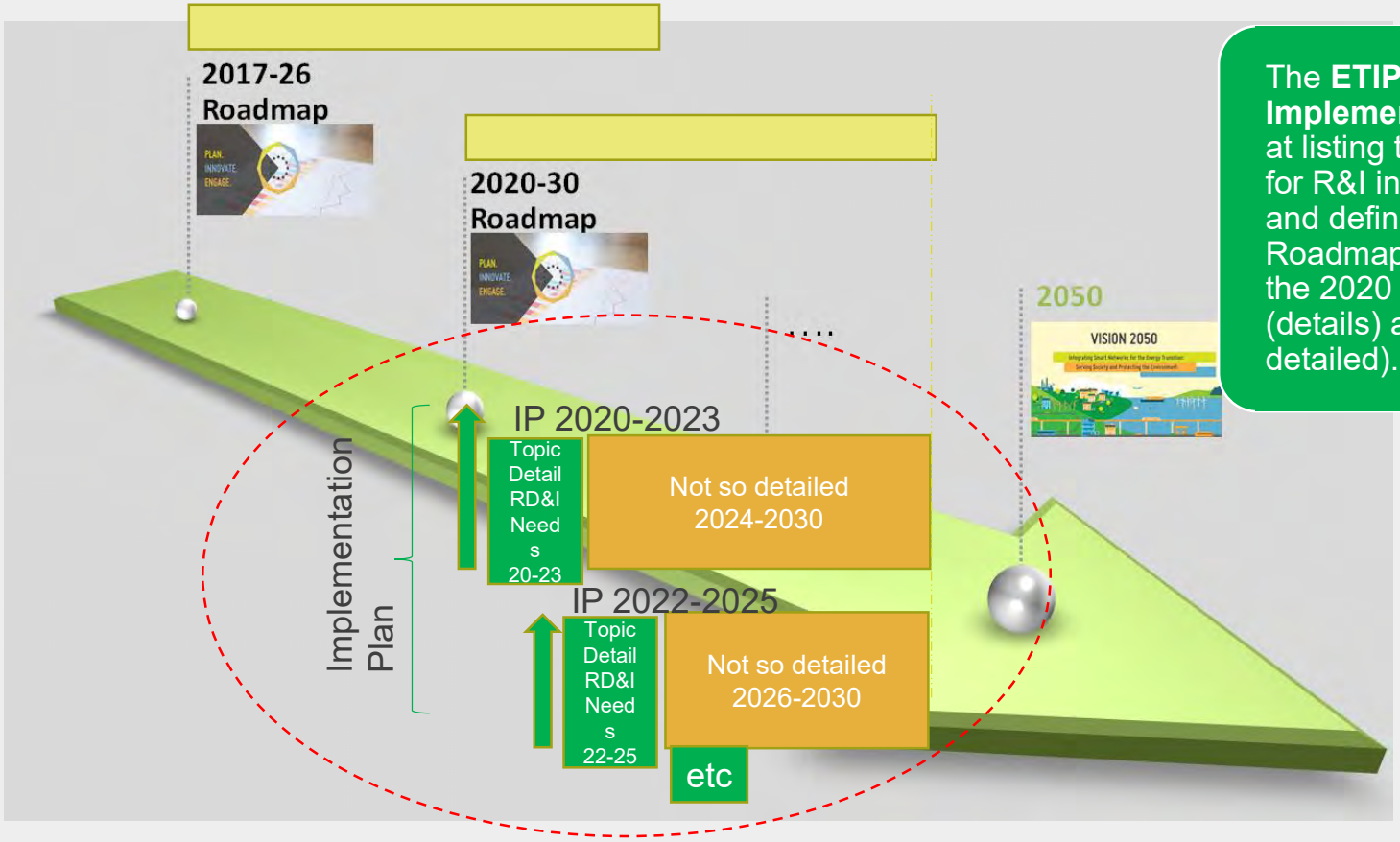
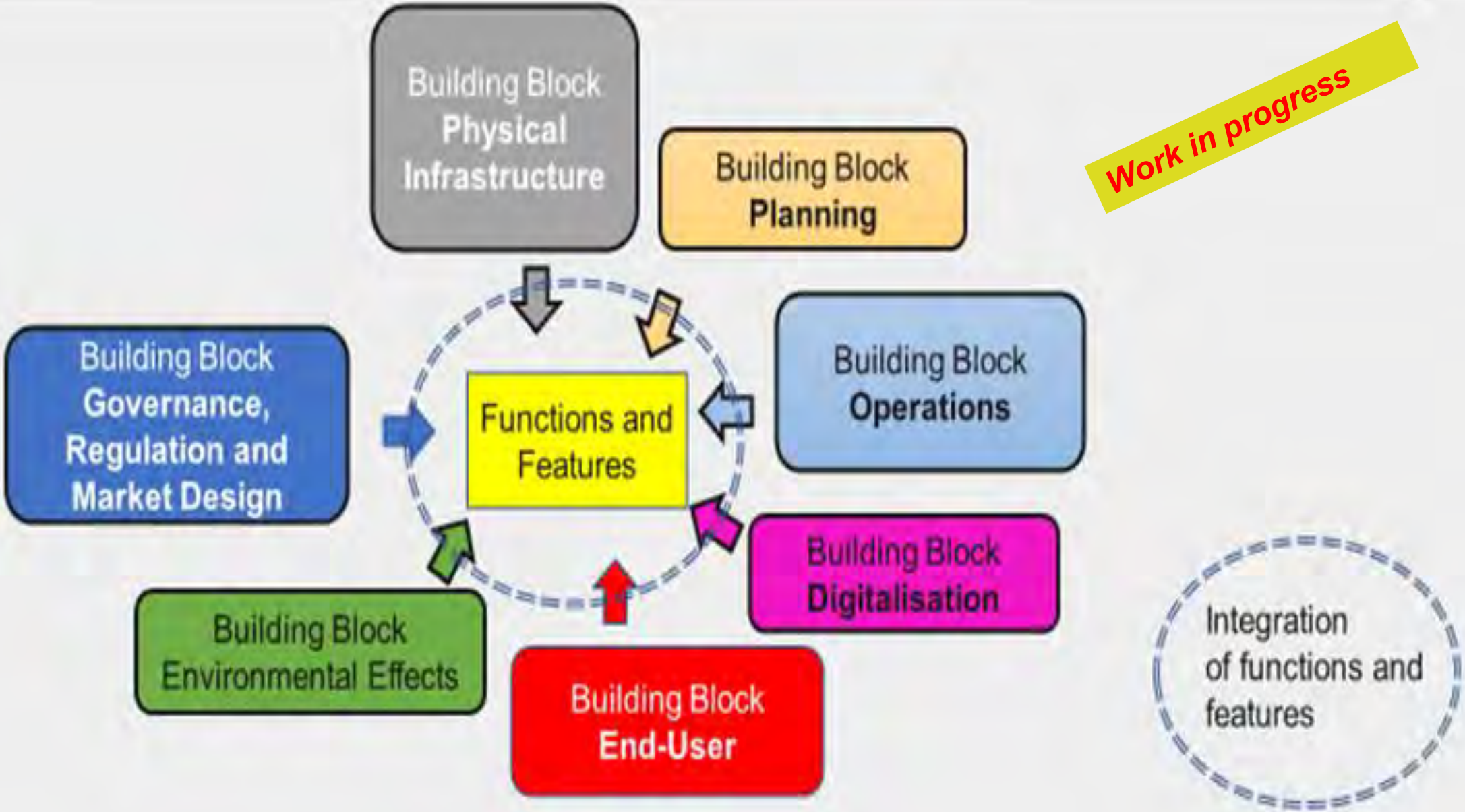
R&D Roadmap and Implementation Plan

Updating Roadmap and Implementation plan



The **ETIP SNET Implementation Plan (IP)** aims at listing the short-term priorities for R&I in ETIP SNET's vision and defined in the ETIP SNET Roadmap 2020 – 2030, within the 2020 – 2023 horizon (details) and 2024-2030 (non-detailed).

Structuring the RD&I Roadmap 2020-2030



Entso-E comments to ETIP SNET Roadmap structure

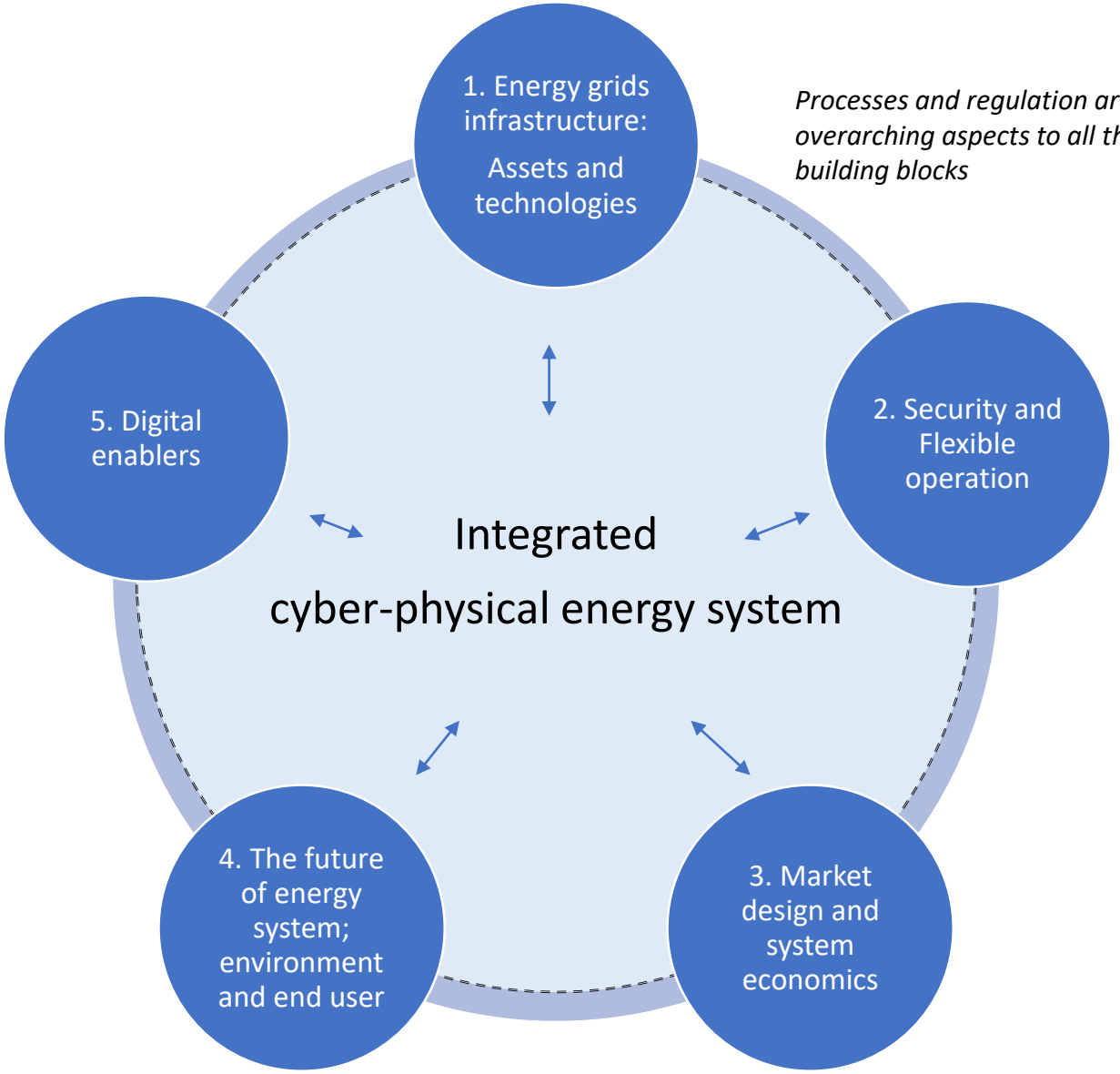
1- **Energy grids infrastructure: Assets and technologies**
- Electric physical infrastructure (assets & technologies, maintenance)
- Non-electric physical infrastructure (conversion, storage,…)
- Digital infrastructures

2- **Security and flexible operation**
- Grids operation & System operation: measurements, observability,
- Monitoring, control, reliability, resilience, flexibility (storage, DSR, non electric systems), quality of service

3- **Market design and system economics**
- Efficiency
- Energy system economics
- Market design
- Business models
- Energy system governance

4- **The future of energy system**
- **E**nvironment and end users
- System design, grid planning, scenario setting
- Sector coupling and interface
- Energy end-user needs and applications
- Sustainability & environmental impact reduction
- (circular economy, green economy)

5 – **Digital enablers**
- Data access and acquisition
- Data processing
- Integration of SW & platforms, interoperability and standard needs
- Automation
- Critical infrastructure protection (CIP) and cybersecurity



Processes and regulation are overarching aspects to all the building blocks

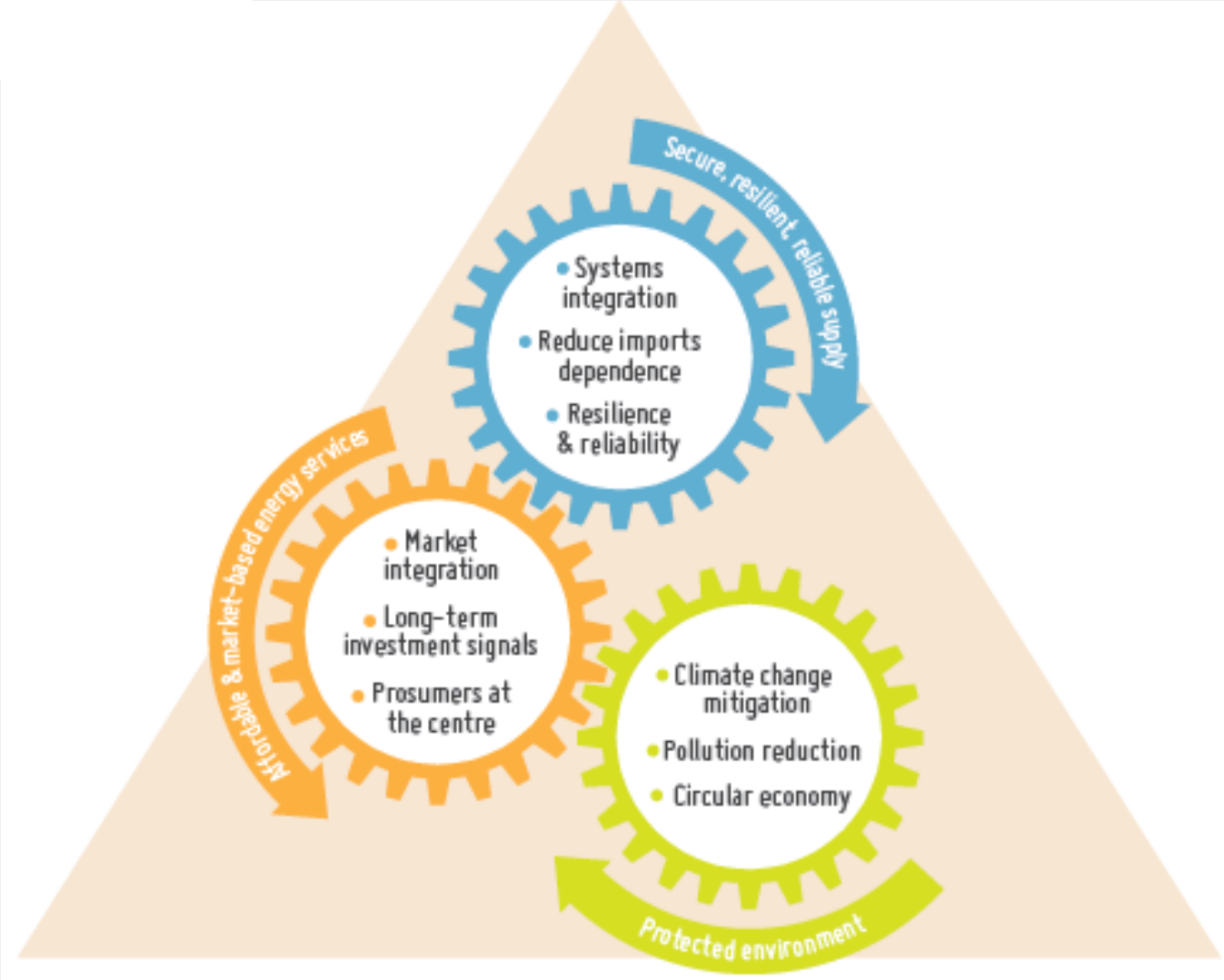
PLAN.
INNOVATE.
ENGAGE.

ETIP SNET
EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM
SMART NETWORKS FOR ENERGY TRANSITION

Integrated and sustainable energy system

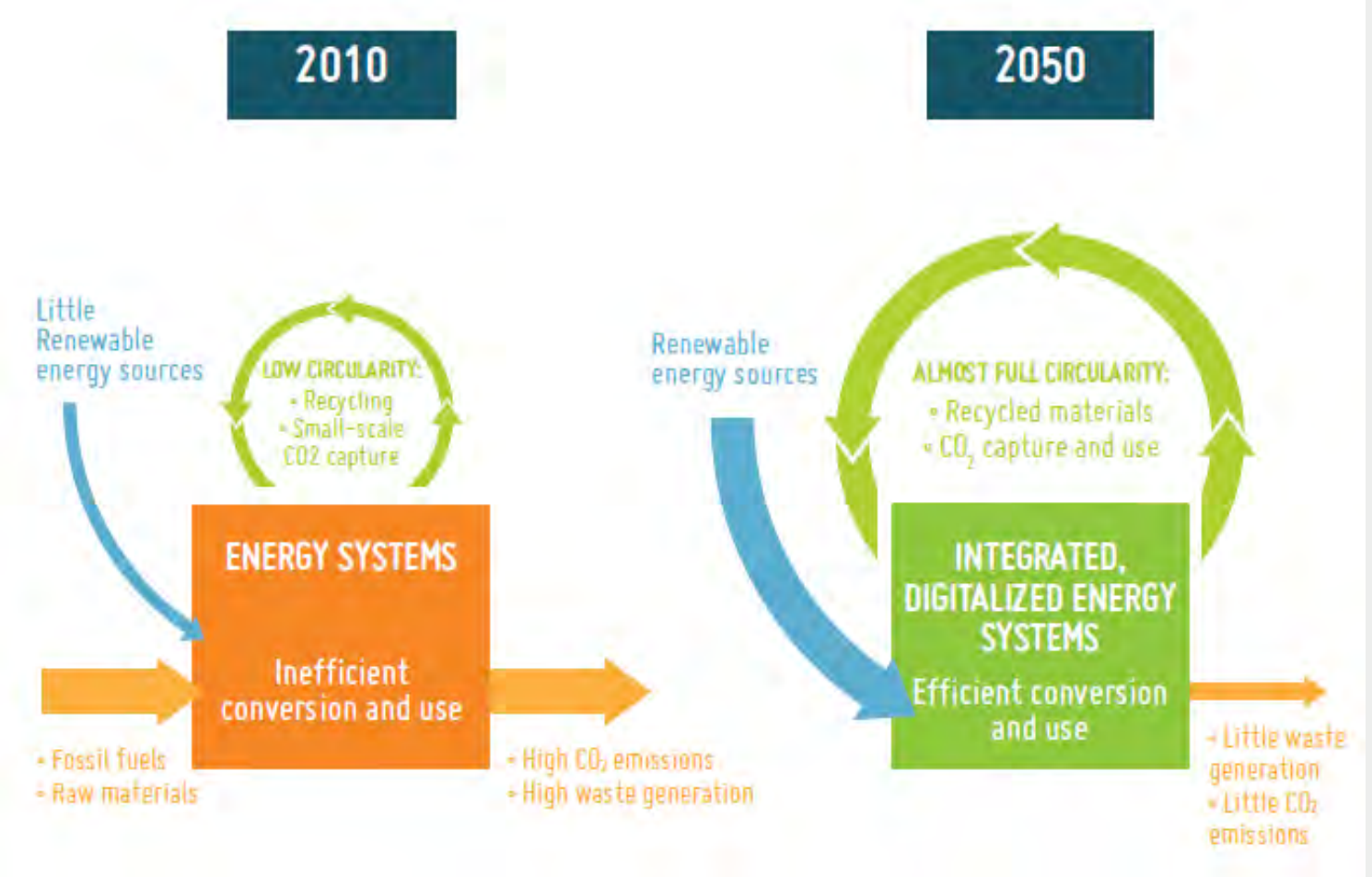
The 3 goals of European energy policy

1. Protecting the environment
2. Creating affordable and market-based energy services
3. Ensuring security, reliability and resilience of energy supply



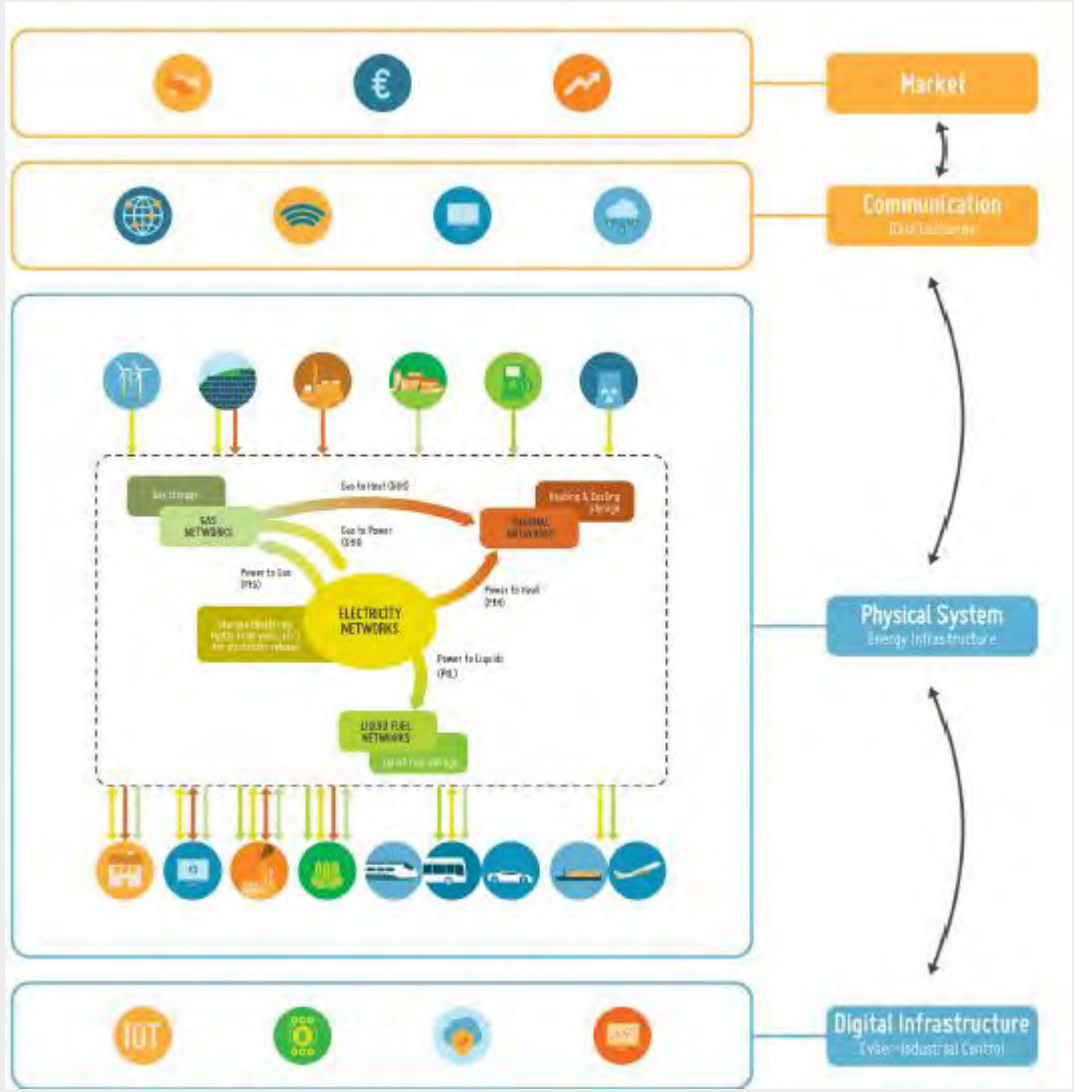
Leveraging on de-carbonisation to reach a sustainable economy

- A low-carbon, secure, reliable, resilient, accessible, cost-efficient, and market-based pan-European integrated energy system …
- supplying all of society and paving the way for a fully carbon neutral circular economy …
- while maintaining and extending global industrial leadership in energy systems during the energy transition



Regulation needs to follow the technological transition

- Most of today's energy network infrastructures (electricity, gas, heating and cooling, liquid fuels) will still be in operation in 2050
- However, they will be used in different ways
- Capacity expansion, transaction policies, and tariffs for infrastructure uses will need to be redesigned and adapted to the enhanced features of the fully integrated energy systems and markets



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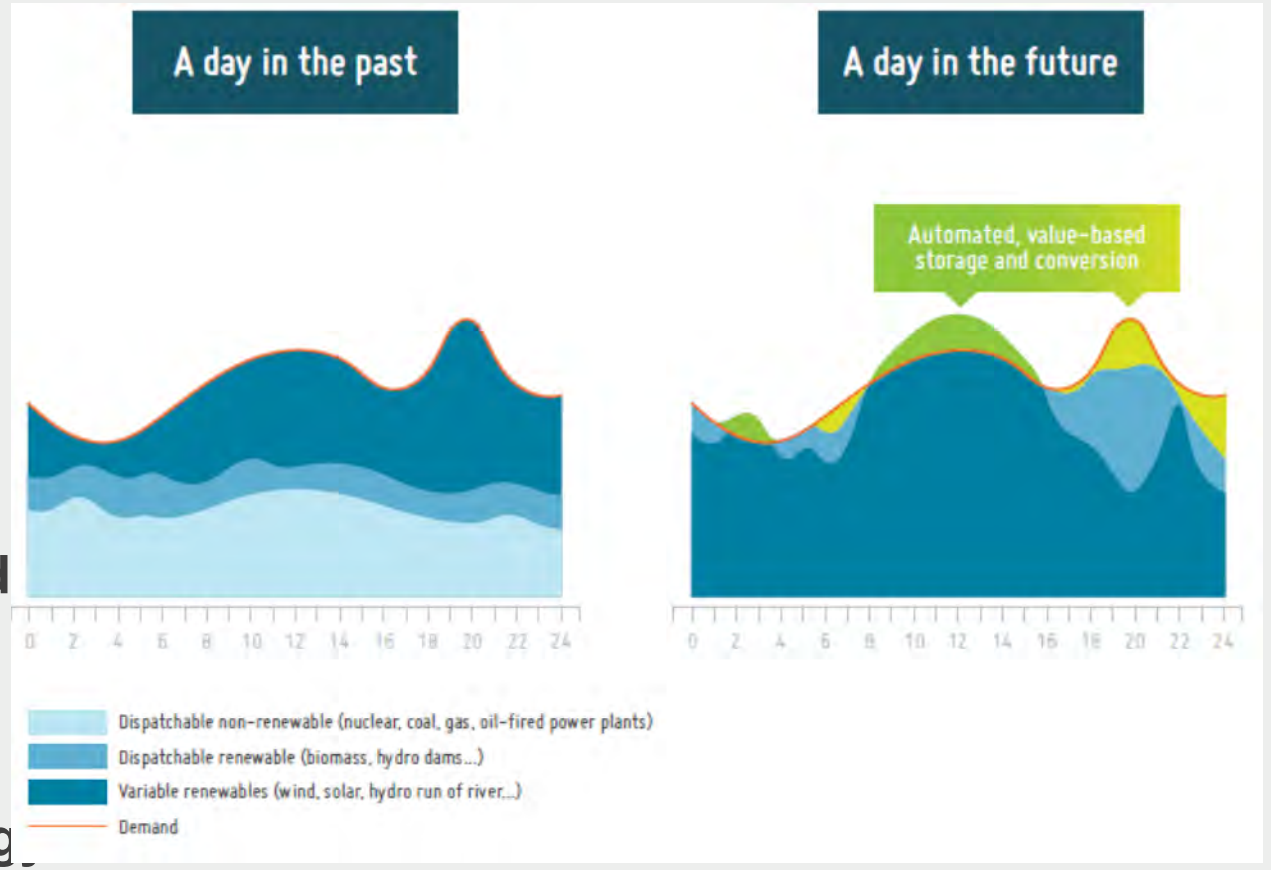
SMART NETWORKS FOR ENERGY TRANSITION

Synergies with TSO innovation efforts

Efficient system, but with sharp variability

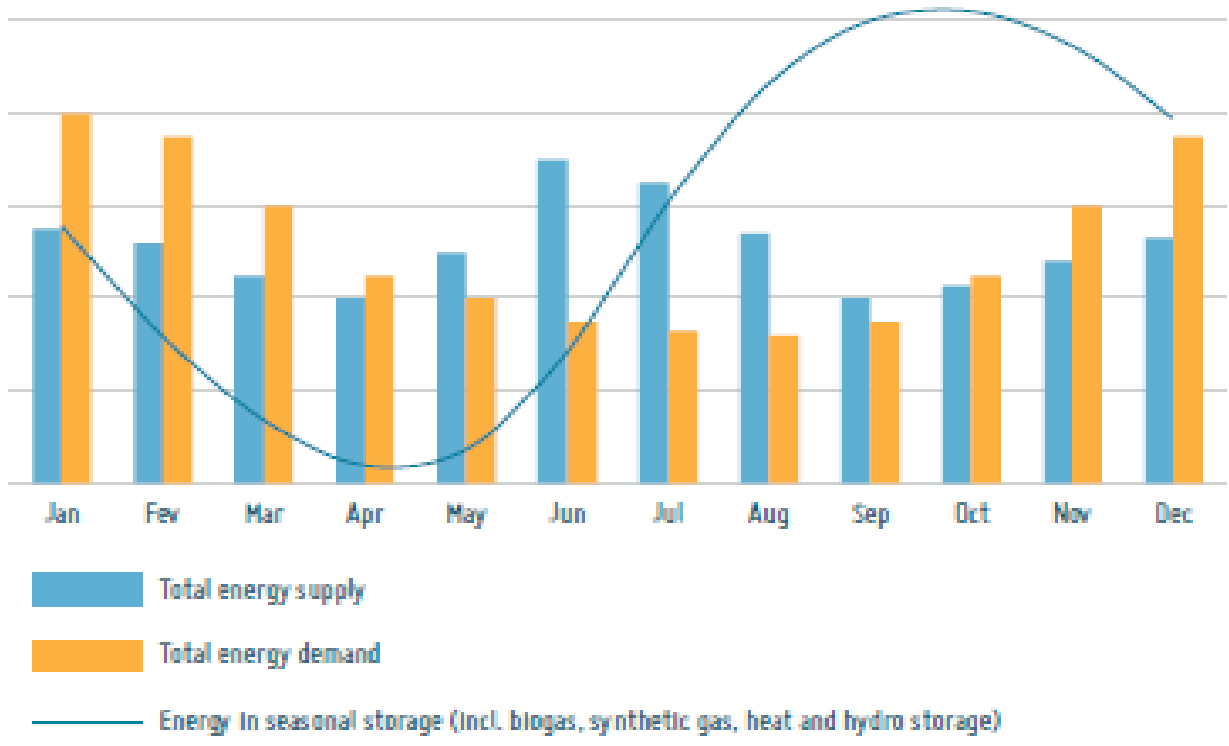
- The future energy system will use overall less energy than today, due to energy efficiency (industry and buildings)
- Still, daily and seasonal differences between energy demand and especially wind and solar availability will require a very flexible system
- Cost-reflective market price signals should lead to lower demand in response to high prices during low wind and sunshine
- Grid/system operators shall ensure a safe energy balance, managing the nomination of both energy sources and system services through smart algorithms optimizing the overall techno-economic performances



Converting & storing energy are the key to success

- Power conversion and flexible energy storage shall play a key role in energy systems
- A high level of integration will be achieved through the deployment of:
  - power conversion units enabling the coupling among all energy carriers
  - installation of storage units for each energy carrier
- This ensures also a higher security of supply

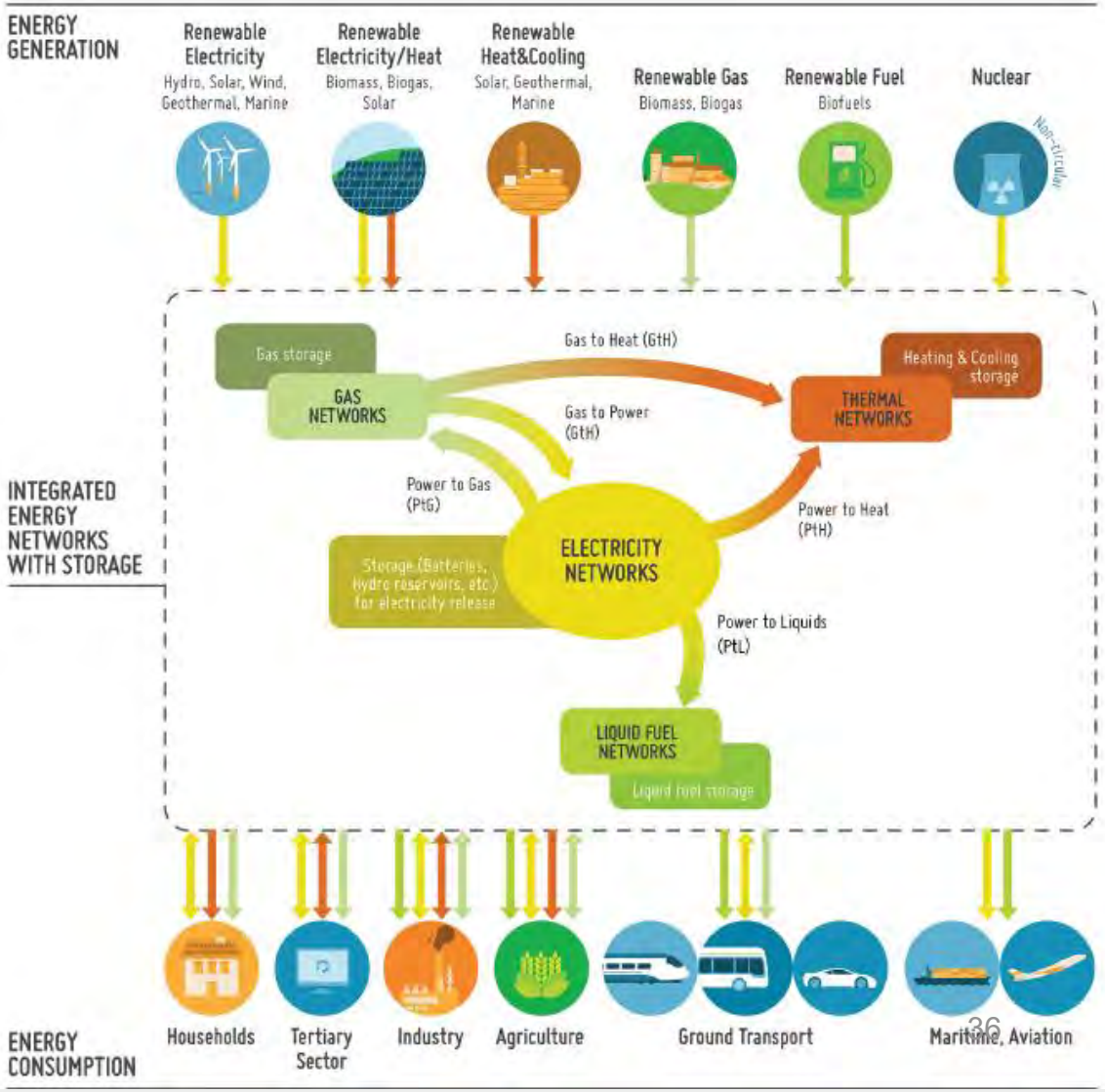
Figure 4. Outcomes of integrated energy markets across multiple energy carriers



With injections in daily or seasonal energy storage such as pumped hydro, batteries, hot water reservoir thermal storage, or Power-to-Gas (PtG) conversion, whenever the value of energy in storage is higher than the value from additional energy use

Electricity network shall remain the backbone of the wider energy system

- The electrification of Europe's energy systems will be the backbone of its societies and markets
- This will require the incremental coupling of electricity and gas networks, via the production of carbon-neutral synthetic gases (methane), to ensure long-term security of supply (seasonal storage)
- A low-carbon European economy will also include the coupling of:
  - electricity and heating and cooling systems,
  - electricity and liquid fuels, supplemented with biofuels, for heavy-duty vehicles, maritime transport and aviation



Strategic role for wider economic competitiveness

- European decision-makers must consider the strategic nature of low-carbon energy systems; indeed all emerging and developed economies will proceed to decarbonisation
- Therefore strong support is advisable to European industries, enhancing competitiveness at all levels
- Support to R&D efforts and Innovation initiatives, at all TRL stages, is paramount
- **TSO engagement in steering platforms having high stance towards the decision makers (like Etip Snet) is a strategic move**

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EUROPEAN TECHNOLOGY AND INNOVATION PLATFORM
SMART NETWORKS FOR ENERGY TRANSITION

Thanks for your attention

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RD&I European perspective

Guido Guida , Chair RDIC ENTSO-E

3 April 2019 , Oslo

RDIC: mandate, knowledge hubs , European presence and cooperation

1

Mandated tasks by regulation

❑ Research Plans

2

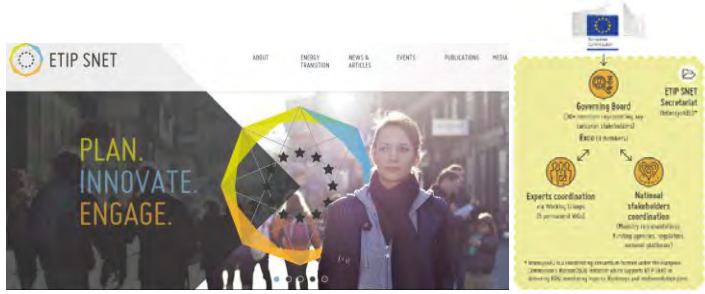
Cross committees cooperation
Future of the power system

❑ Knowledge hubs

3

European presence

❑ ETIP SNET - vision



❑ EC funded R&I projects

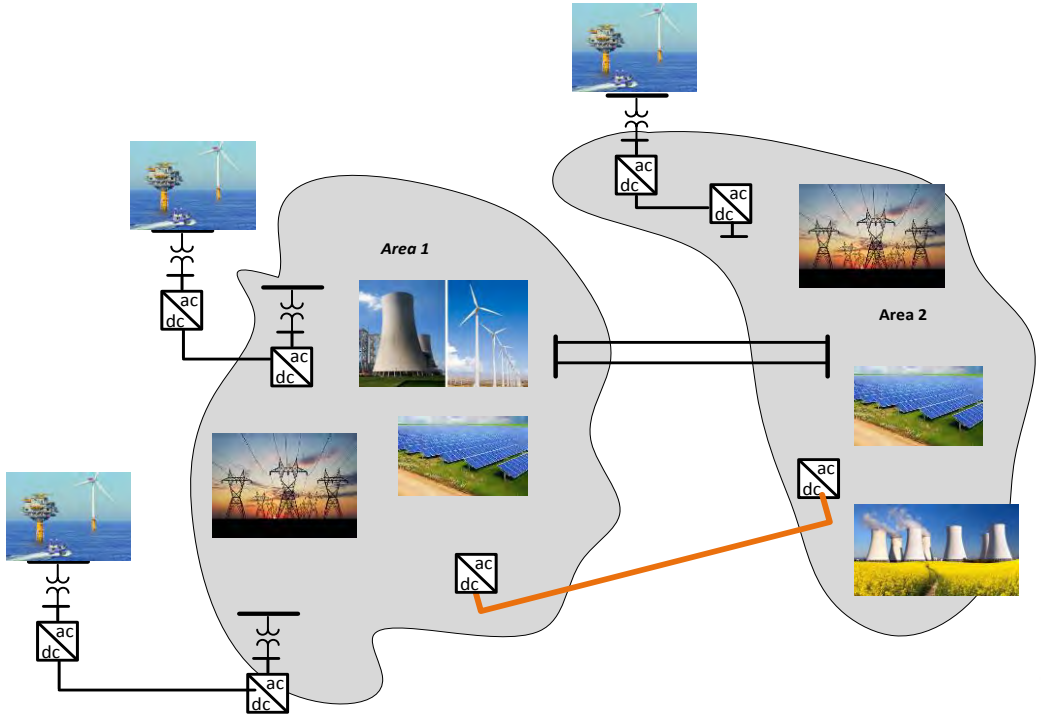
Power System Modernization

Cooperation with ESA

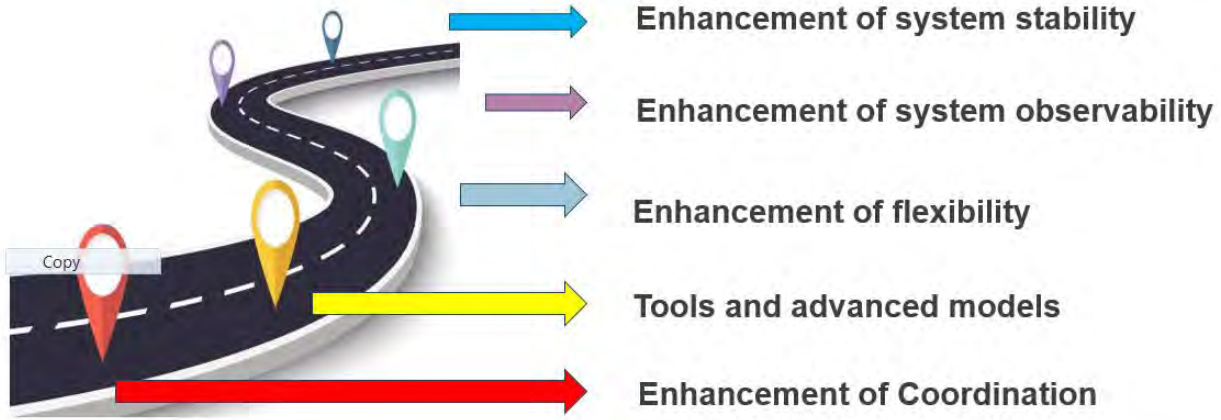
Using satellite technology to optimise the power grid - ESA & ENTSO-E to start a cooperation

Mapping of transmission technologies – TYNDP 2018

Security and system stability

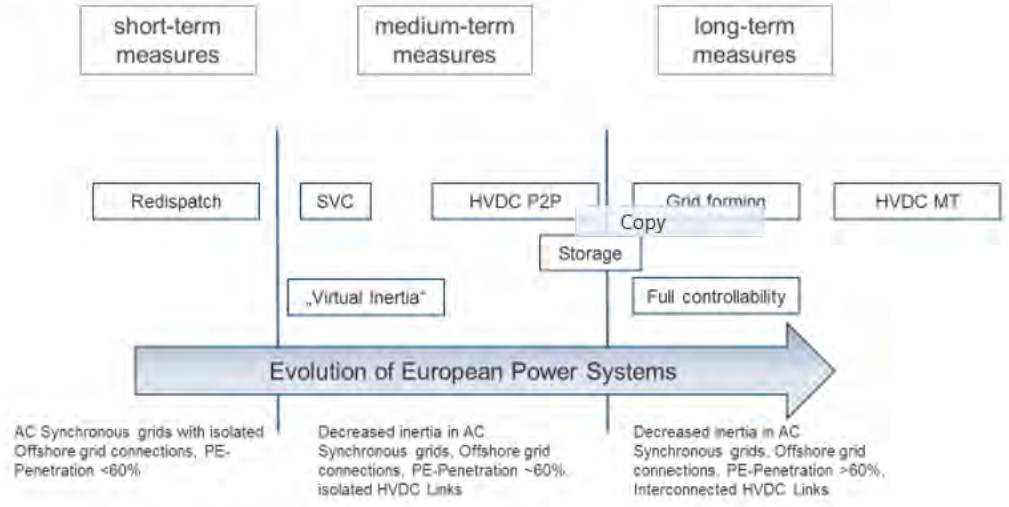


System Operation vision 2030



→Accommodate more Power Electronics and what do we do to maintain the same levels of security of supply?

High Level of PE - Technology Trends

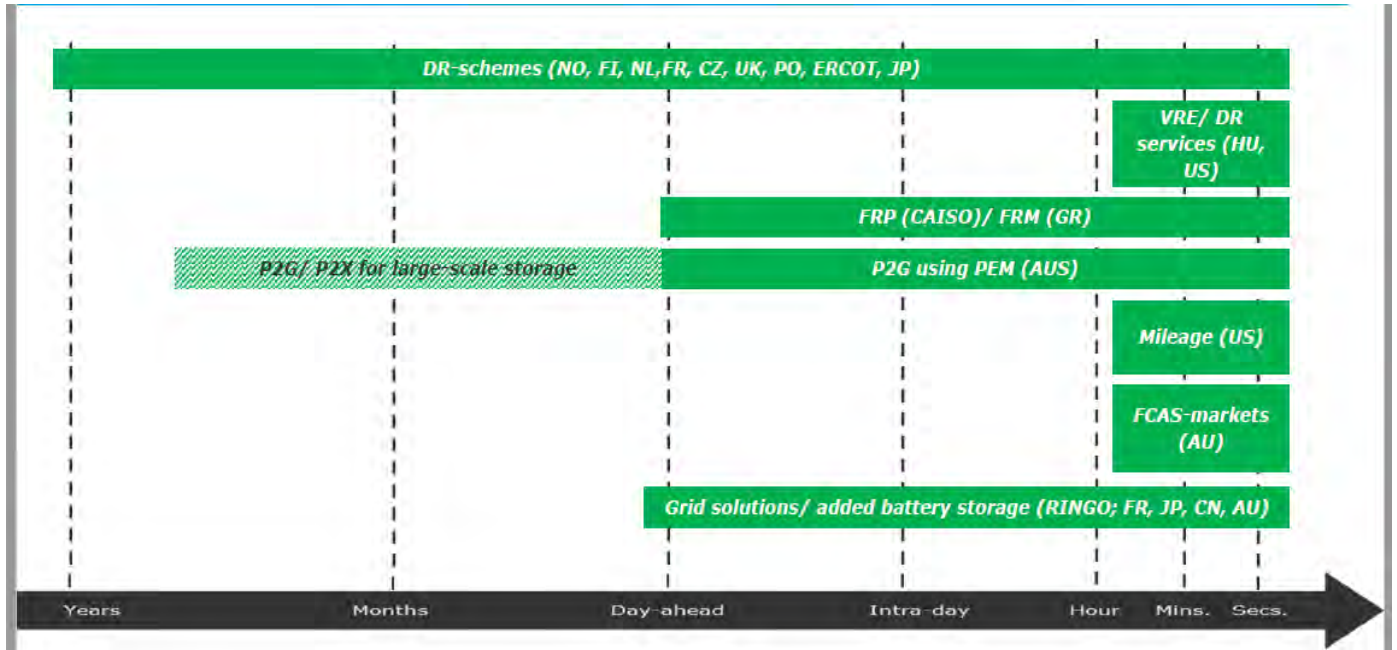


Flexibility and digital technologies

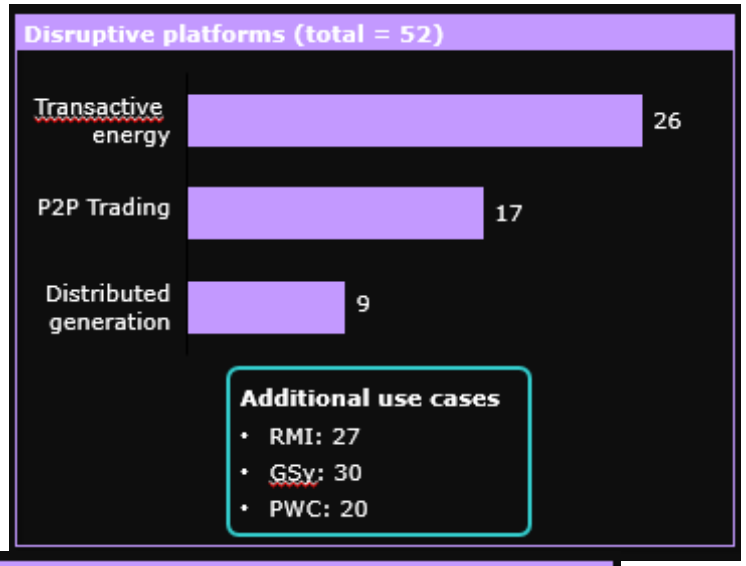
Conclusions from the Workshop

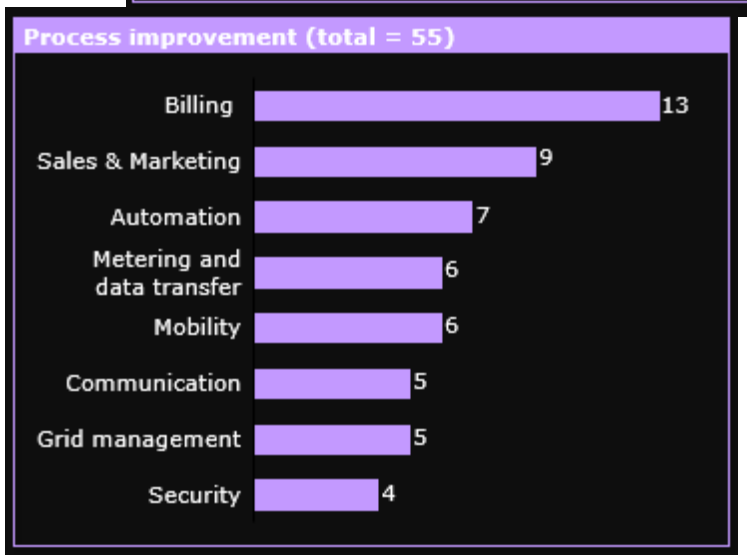
1. **Overview** of **flexibility services**: focus on balancing for different time horizons across EU and USA, China, Australia, Japan, South Korea: 1) **Europe is a frontrunner in developing a multitude of projects; 2) Relevant market experiences in USA and Australia for services and products**
2. **Sources of flexibility**: experience from EU: **storage** –hydro-pumped, batteries, hydrogen, eV -, **Demand Response (DR)** – heating and cooling, eV, large and medium size customers, small customers through aggregators - , **Grid** as flexibility option, **DR** versus **Storage** versus **RES**
3. **Flexibility services and products** in different time frames : future for sector coupling, optimization of flexibility solutions and integration of the results of the H2020 funded projects (EUSYSFLEX, OSMOSE, CROSSBOW, FLEXITRANSTORE)
4. **Need for future developments** : potential for flexibility from different sources and for different services, costs , business cases , new actors, technologies including digital
5. **Regulatory framework** very diversified across Europe: more harmonization to unleash the potential of flexibility sources and in depth comparison EU-USA

entsoe



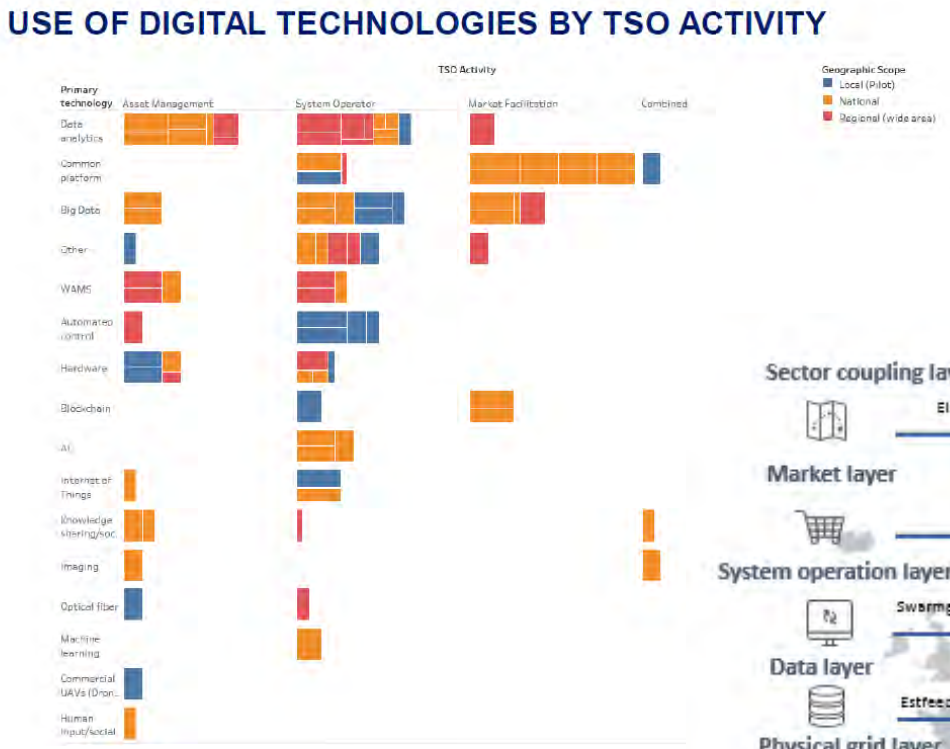
Blockchain

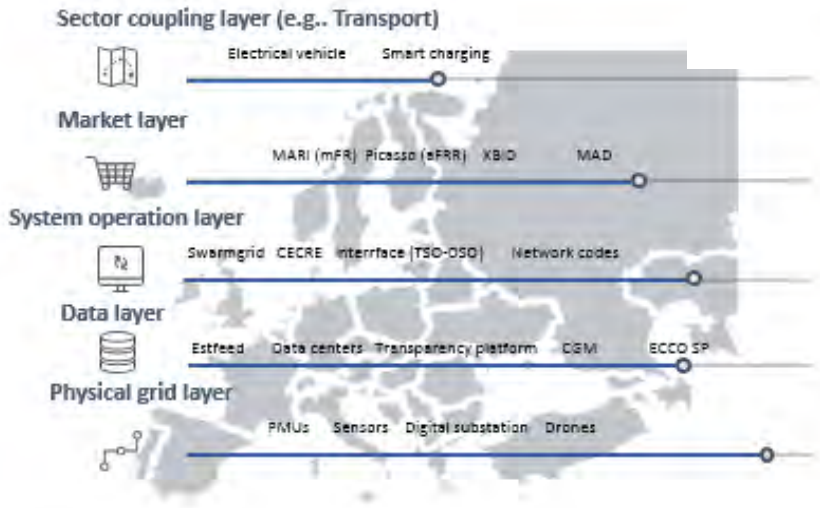


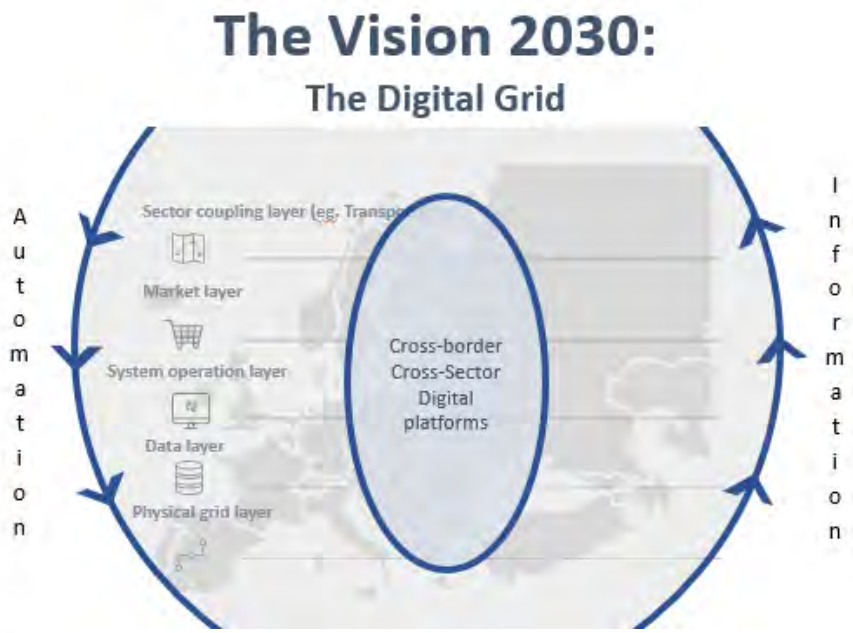


Digitalization Report

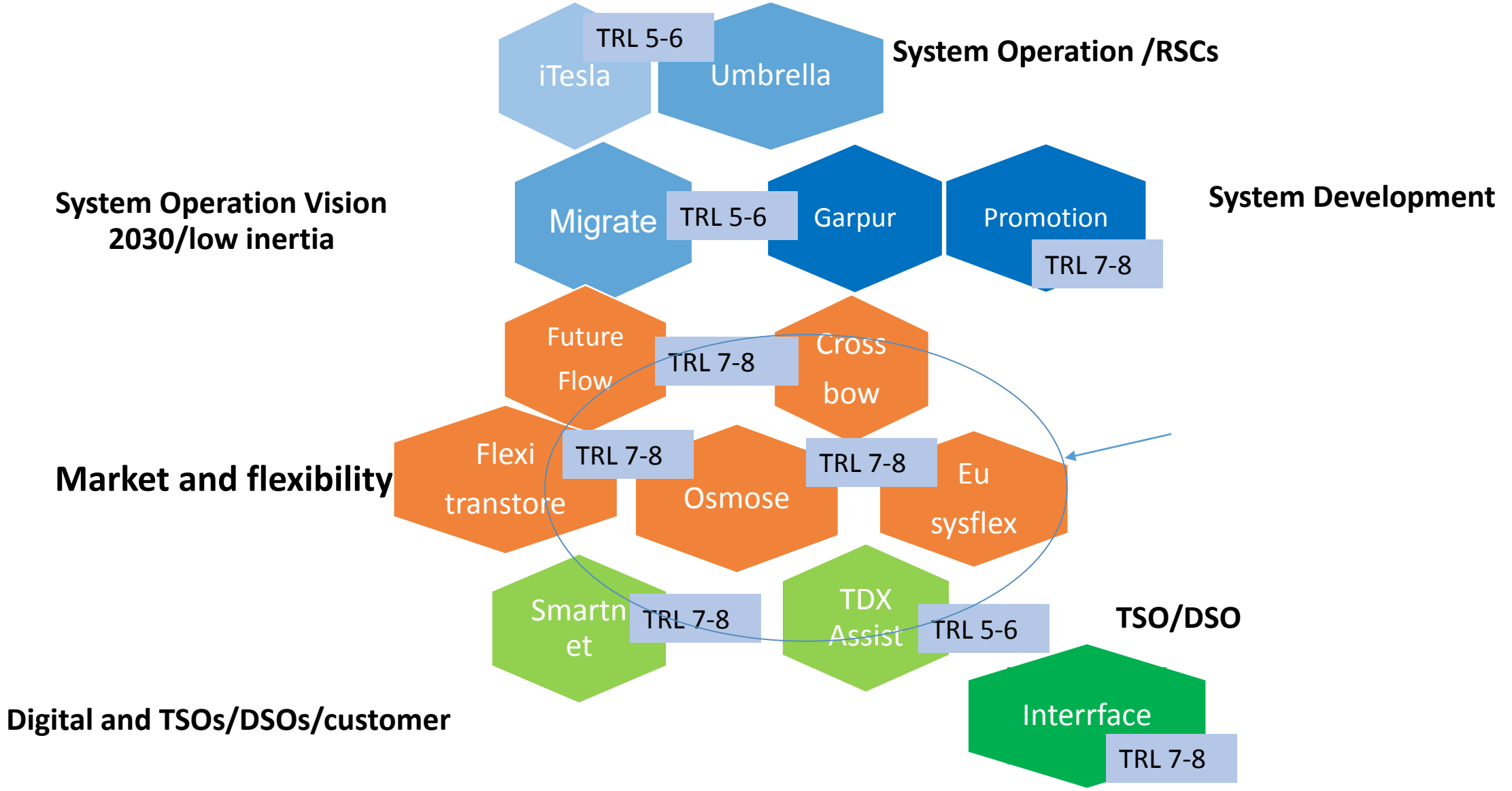
100 projects surveyed







Cross Committee Cooperation and success of EC funded projects



Multi sided actors and collaborative projects

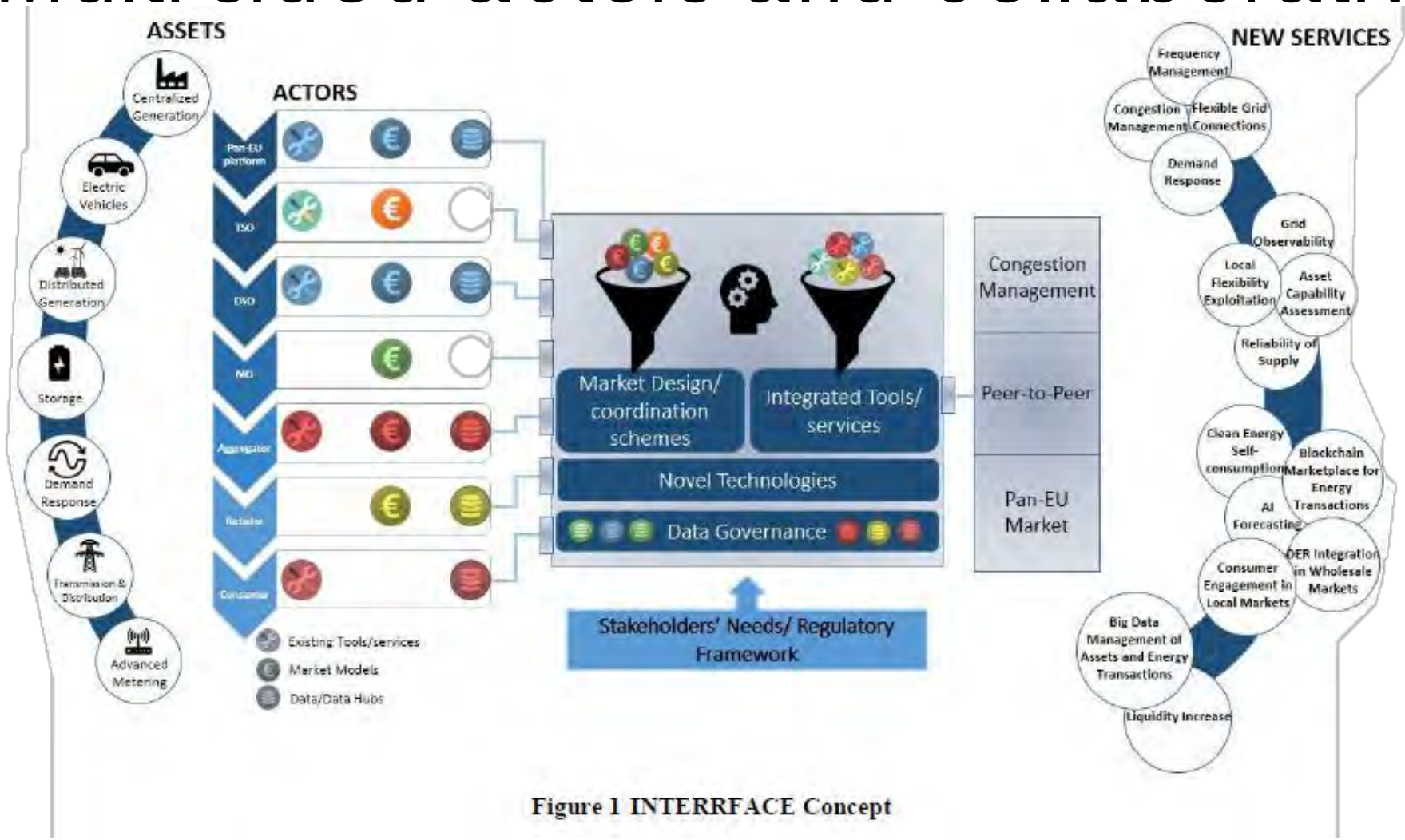
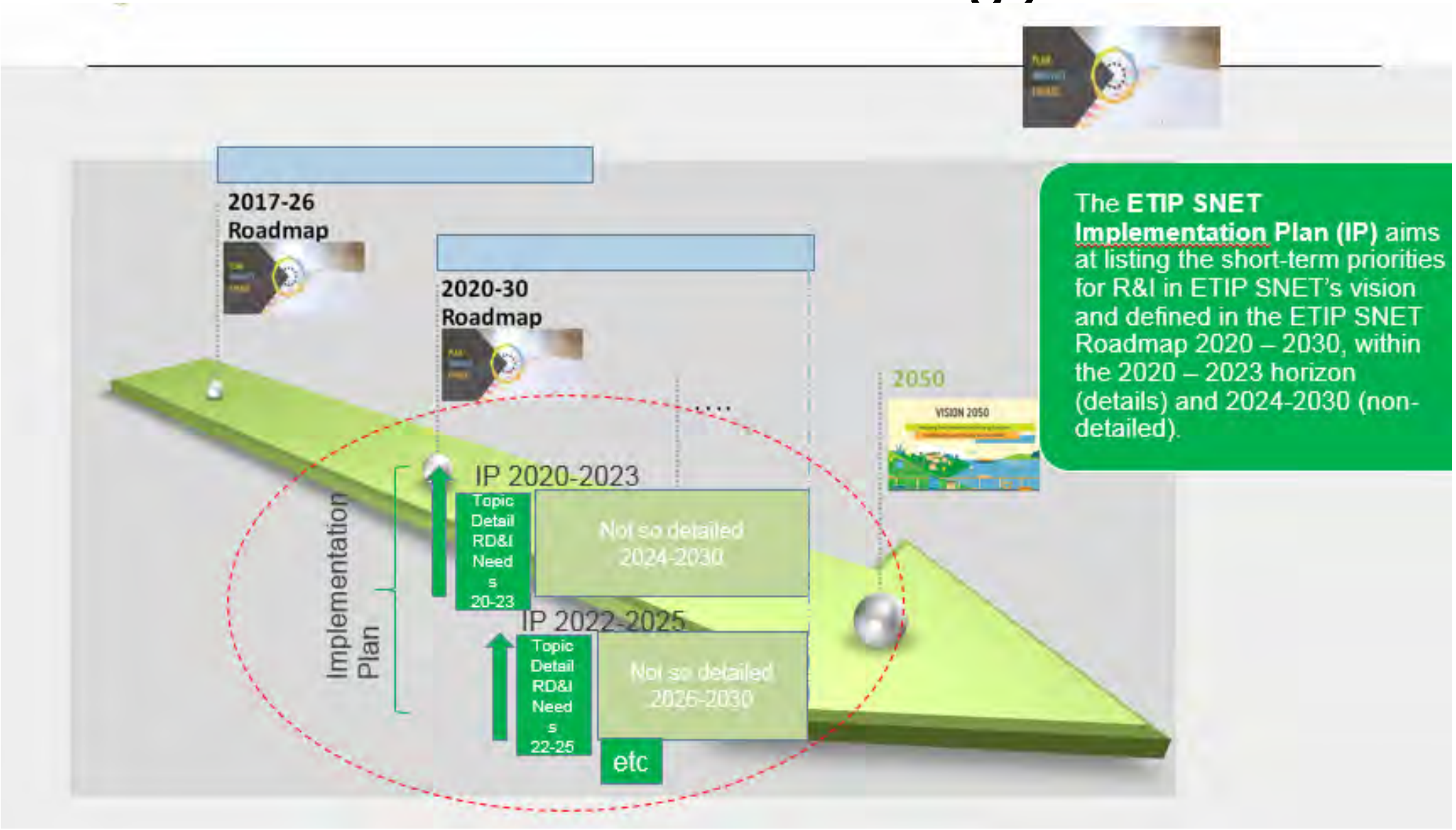


Figure 1 INTERRFACE Concept

ETIP Smart Network for Energy Transition



Last but not least: Horizon Europe

Specific objectives of the Programme

Support the creation and diffusion of high-quality knowledge

Strengthen the impact of R&I in supporting EU policies

Foster all forms of innovation and strengthen market deployment

Optimise the Programme's delivery for impact in a strengthened ERA

Pillar 1
Open Science

- European Research Council
- Marie Skłodowska-Curie Actions
- Research Infrastructures

Pillar 2
Global Challenges and Industrial Competitiveness

Clusters
- Health
- Inclusive and Secure Society
- Digital and Industry
- Climate, Energy and Mobility
- Food and natural resources

Joint Research Centre

Pillar 3
Open Innovation

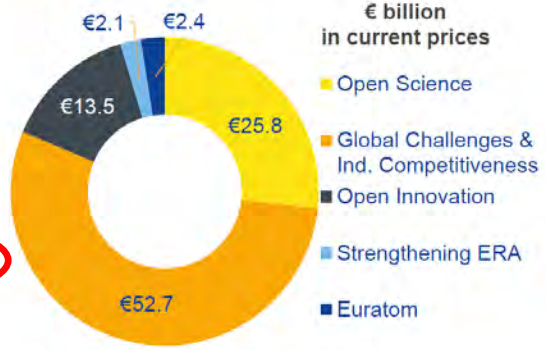
- European Innovation Council
- European innovation ecosystems
- European Institute of Innovation and Technology

Strengthening the European Research Area

- Sharing excellence
- Reforming and Enhancing the European R&I system

Budget: €100 billion* (2021-2027)

Clusters	Budget (€ billion)
Health	€ 7.7
Inclusive and Secure Society	€ 2.8
Digital and Industry	€ 15
Climate, Energy and Mobility	€ 15
Food and Natural Resources	€ 10
Joint Research Centre	€ 2.2



* This envelope includes EUR 3.5 billion allocated under the InvestEU Fund.

European Commission

Three key areas for the strategic planning

- Global Challenges
- Missions
- Partnerships

European Commission

Roadmap clusters
Future activities

WG4: Future of Energy System

T1: Optimal grid design
T2: Stakeholders, end users and environmental effects
T3: System of systems
T4: Scenarios
T5: Integration with non electrical network

WG1: Assets and Technologies

T1: Assset Management
T2: New tech and materials
T3: Ecodesign and lifecycle Assets
T4:Digital assets

WG2: Security and operations of tomorrow

T1: Grid Observability
T2: Grid controlability
T3: Expert systems and tools
T4: Reliability and resilience
T5: Enhanced ancillary services for system stability
T6: Flexible grid use

WG3: Flexibility and economics

T1: Storage and flexibility
T2: Demand side flexibility
T3: Generation flexibility
T4: Market design and business models

WG5: Digital & Communication

T1: Data access and acquisition
T2: Data processing
T3: Integration of SW & Platforms, interoperability and standard needs
T4: Automation
T5: Critical information and Infrastructure protection

Innovation within ENTSO-E and TSOs: Innovation hubs

- Inputs cross committee: System Operation 2030, TYNDP, Market 2030
- Position Papers: Digital Grid 2030 Vision
- Reports: Technology Mapping, Monitoring
- Surveys and TSOs mapping: flexibility, e-mobility, blockchain, R&I project
- Knowledge sharing (10 workshops over 1 year) : Blockchain, Flexibility, Electromobility, HVDC/ HVAC, Grid Forming, Open source models, Digitalization, Data access, Use of probabilistic approaches, iTesla , Umbrella , Garpur projects
- Tool for technologies mapping (website)
- Innovation management

Coordination at EU level

- Coordination with European Commission: Comments on EC work program, inputs to Horizon Europe

- Participation in H2020 projects: INTERRFACE, Intensys4EU, TDX assist

- Coordination of projects & letters of support

- Relation with ACER: Incentives for innovation

External presence

- Innogrid 2019: Dissemination or R&I results

- Business Network for innovation (CGM, etc**…)**

- Cooperation with Innovation platforms: ETIPSNET (Vision 2050, IP, Monitoring, Roamap))

- Cooperation with international reference groups: CIGRE, EPRI

- ESA cooperation

- Cooperation with other EU Associations: EDSO, Eurelectric, Smarten, emobility

BUSINESS NETWORK INNOVATION

Ecosystem of **energy transition** players driven by **business perspective**

Bridge between ENTSO-E and start-ups, citizen initiatives, opinion leaders, institutions, energy businesses

Over **130 members**: Tesla, GE, Utrecht University, ESA, Ampacimon

Webinars and luncheons: Storage, Dynamic Line Rating, Artificial Intelligence, Common grid model and energy data architecture...

Join today #InnovationENTSO-E

www.entsoe.eu/research-and-innovation/business-coalition/

Thank you


INNOGRID2020+
the innovative power conference
May 13-14 2019 • Brussels
Connecting physics and digits:
Power Platforms on the rise


RSC Conference
Copenhagen - 8 October
NORDIC
RSC


Celebrate 10 years of TSO cooperation
12/13 November - Finland

Jussi Matilainen

Statnett's R&D Conference

2-3 April 2019

Research, development and innovation at Fingrid

FINGRID

WHY?

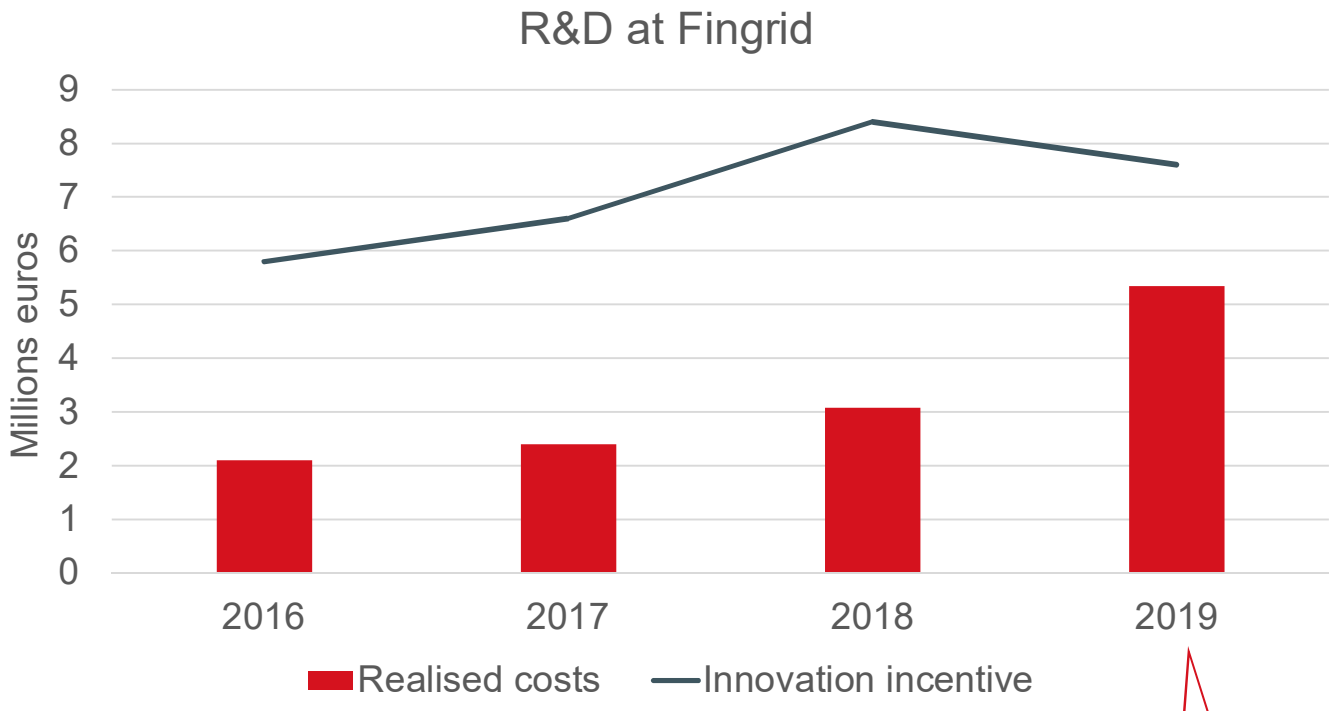
Role of R&D is increasing

Main goals for R&D

- Controlled and market-based transition to clean energy system
- Cost-efficiency and quality
- Benefits for customers and the whole society

Main areas of R&D

- markets for flexibility
- digitalization of asset management
- maintaining system security in a power system with RES and DER



~ **50-60** projects
~ **2/3** outsourced

FINGRID

What?

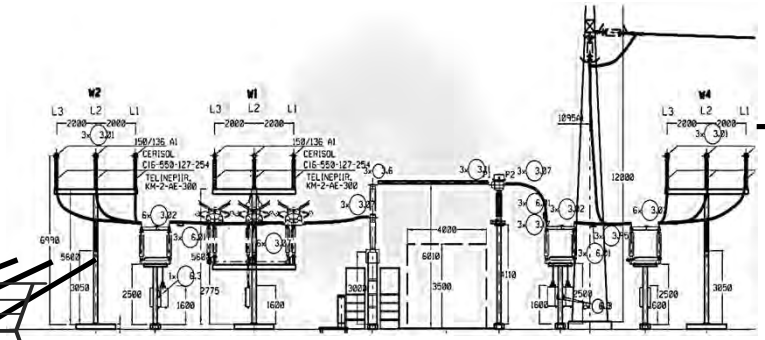
Examples of ongoing projects

Digitalization of asset management

Why:

1. *Securing grid quality:* Better understanding of the assets condition, possibility to foresee development of defects.
2. *Improving grid availability*: Reducing the amount of outages for asset monitoring.
3. *Improving cost effectiviness*: Maintenance work will be allocated on need basis, based on the sensor data.

The logic



Service provider

Sensors:
_vibration
_current
_temperature
_humidity
_water leakage
_etc

DATA:
messaging
storage
processing

Something is wrong

FINGRID

Ongoing sensor projects

1. Monitoring of acoustic emission + other sensors

Full-range of operational characteristics with developed IoT-unit.

2. Monitoring of control buildings

Temperature/humidity/water leakage detection.

3. Monitoring of insulators

MEMS-sensors for acoustic emission analysis.

4. Temperature monitoring of primary components

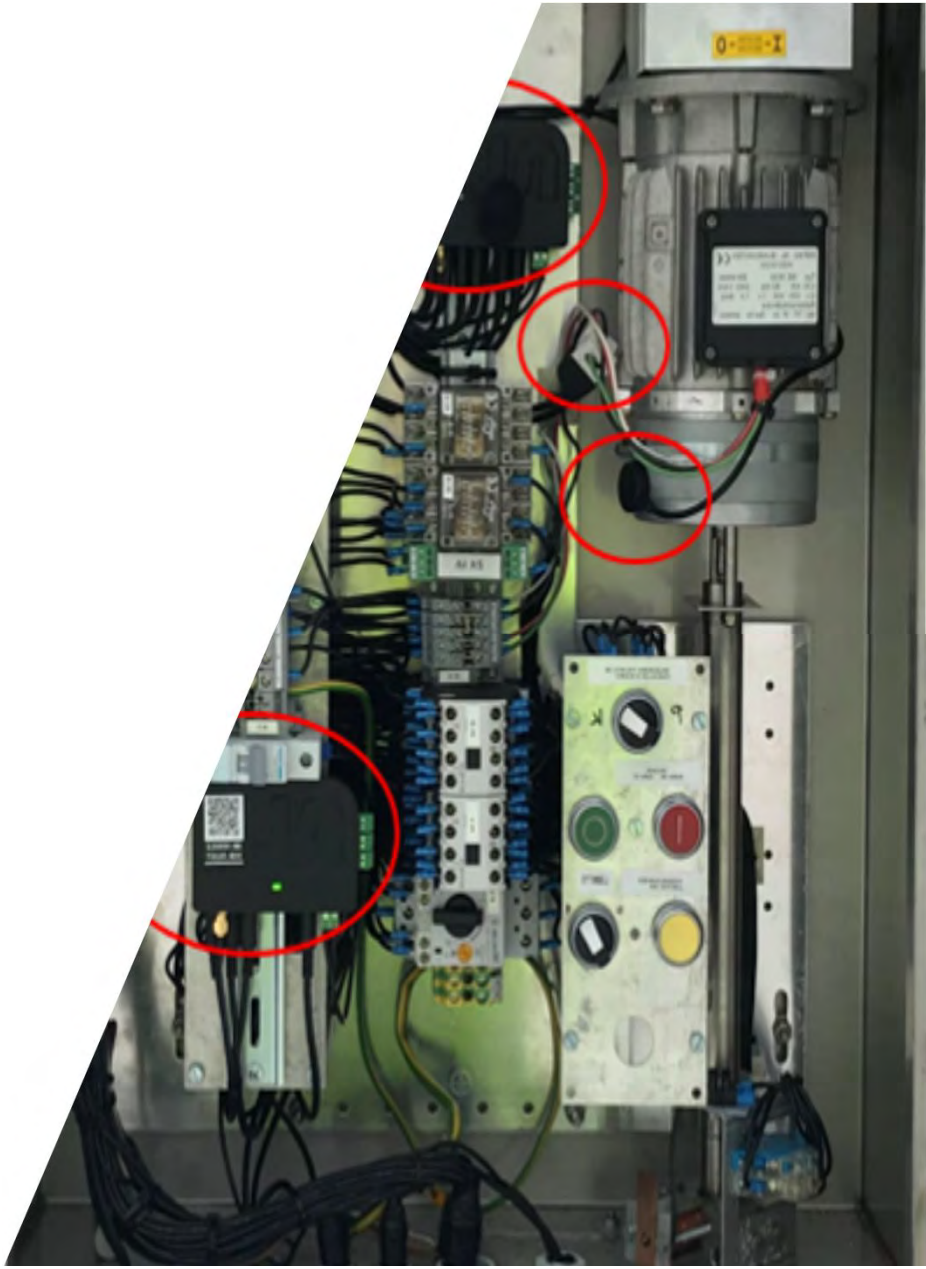
Sensor-based solution and wireless NB-IoT heat camera.

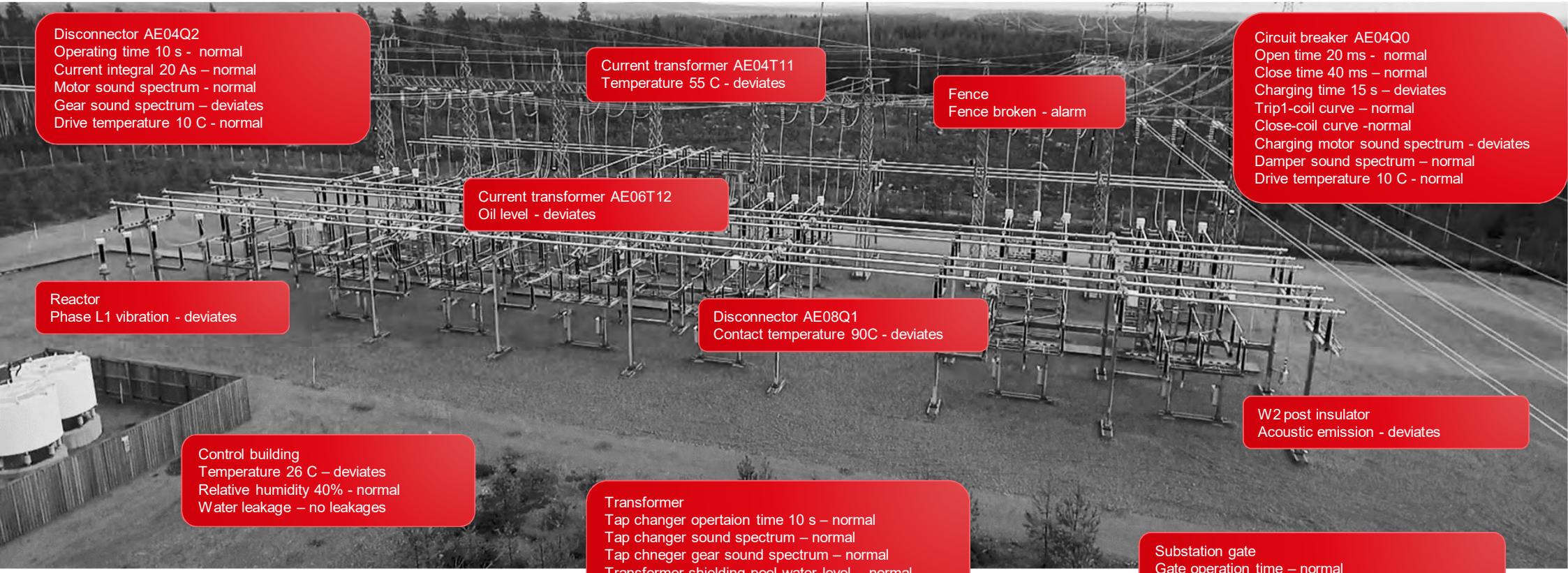
5. SF6-monitoring

WIKA sensors implemented on IoT telemetry gateways.

6. 400 kV GIS monitoring in Länsisalmi substation

400 kV breaker monitoring by ABB MSM units on ABB Ability platform





- Acoustic emission+ other sensors
- Cloud platform
- Data processing
- Machine learning

- Detect/predict failures
- Avoid visits to the remote locations

Future:
EDGE-computing
Advanced ML

Examples of ongoing projects

Building a smart energy system

Smart Grid Group Proposals by Ministry of Employment and the Economy

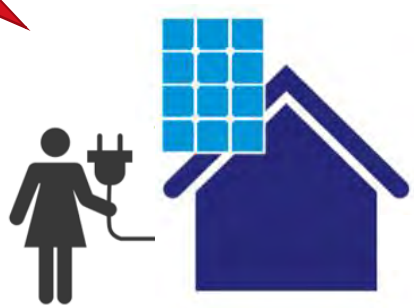
Why:

1. *Increasing the system flexibility:* Rules, roles and technologies to enable and incentivize new flexibility sources to the market
2. Lowering the cost of flexibility: Utilization of existing and new distributed flexibility resources (prosumers&storages) instead of investing on traditional (more expensive) flexibility sources

Building blocks of smart and customer-centric electricity system

Clarification of roles and rules in the electricity markets

Creation of sufficient technical preconditions



Enabling market-driven incentives

Increasing cooperation across sectoral boundaries

Electricity storages as a competitive business

Creation of sufficient technical preconditions

Clarification of roles and rules in the electricity markets

- Maximum benefit when storages can be utilized to different needs (balancing, congestion management, voltage control, ...)
  - Ø ownership and operations shall be mainly market-based action (not network business)
- Electricity storages should not be taxed as storing is not consumption
  - Ø Electric battery can be as an non-taxed storage since 1st April 2019

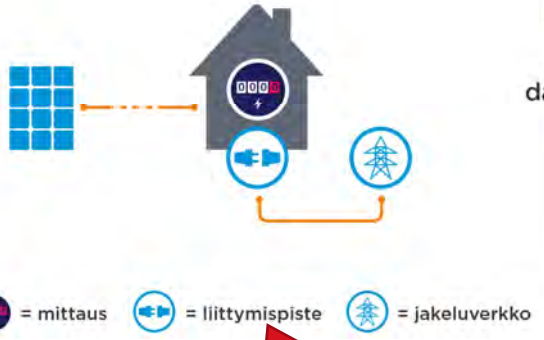
Enabling different energy communities

Clarification of roles and rules in the electricity markets

Within one property

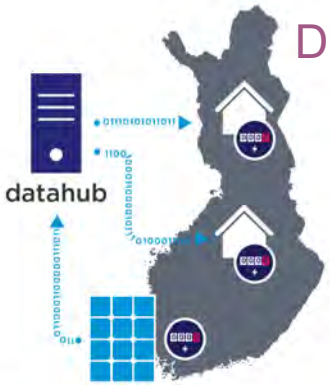
- E.g. solar panel on top of a block of flats
- **Problem**: self-produced energy flows only in the building network but through DSO meters à distribution fee and taxes
- **Proposal**: electricity that doesn't flow in DSO grid should not be charged
- Computational separation of self-production in IT systems

Crossing property border (direct line)



- E.g. neighboring property has better conditions for PV
- **Problem**: building distribution lines crossing property borders is DSO business
- **Proposal**: allowing to build a direct line from the production unit to consumption crossing border

Distributed



- E.g. energy produced in summer cottage PV is consumed in permanent house
- Netting energy between different consumption points is allowed but generally not offered à datahub facilitates
- Distribution fees and taxes should be paid normally as the energy flows physically through the D/T grid

Regulation to promote use of flexibility in grid management

Enabling market-driven incentives

- Currently DSOs are investing heavily in traditional network
  - security of supply requirements
  - regulatory framework
- Proposal: Investments and flexibility shall be equal options in network business
- Distributed flexibility can be used to various needs è gains more income sources (value stacking)
- Proposal: TSO-DSO cooperation to coordinate the use of flexibility and enable easy value stacking to the customers

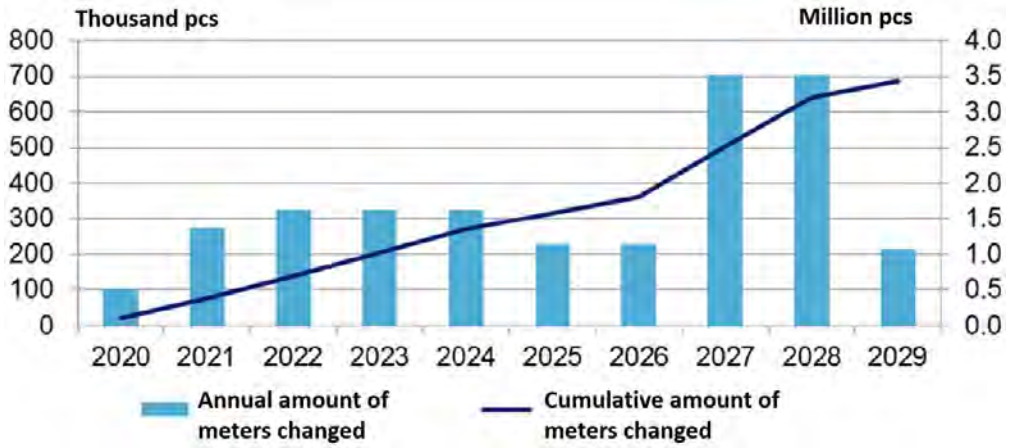
2nd generation smart meters to support DR and real-time electricity markets

- Smart meters are DSOs' responsibility
- DSO can have an interface for smart meter –based control but cannot act as a flexibility service provider
- 2nd generation smart meters provide more data in more real-time
- Load control capability will be included in the meters (alternative: load control is only market-based service)
  - Significant amount of customers with easy load control
  - Standardized control interface for flexibility services
- Other technologies can offer more comprehensive flexibility services

Creation of sufficient technical preconditions

Clarification of roles and rules in the electricity markets

2nd generation roll-out schedule



FINGRID

Examples of ongoing projects

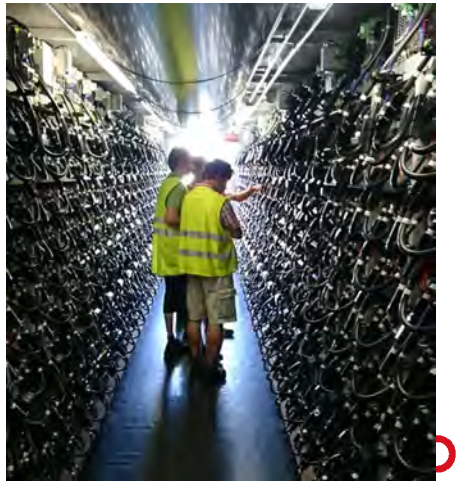
Battery energy storage for multiservices

Why (TSO perspective):

1. *Maintaining system security by having new balancing resources:* Learning the capability and requirements of BESS for ancillary services
2. *Reducing balancing costs by promoting new technologies*: Encouraging markets to offer BESS solutions

The battery energy storage system project

- First and the largest grid-scale, multifunctional use battery storage pilot in the Nordics
  - paved the way for upcoming (market-based) applications
  - 5/2016 – 6/2019
  - 1,2 MW/0,6 MWh (lithium-ion titanium oxide)
  - 30% investment subsidy
  - located in Helsinki, connected to a 10 kV MV grid of the local DSO
- Energy retailer and producer (Helen) owns the BESS
  - TSO (Fingrid) and DSO (Helen Electricity Network) to utilise its services
- Goal: to study and test the capabilities of BESS and to develop new business models based on energy storing
- After the pilot, the BESS will be in a commercial use as part of Helen's infrastructure



Use cases for multifunctional applications

Tested cases

- frequency control (FCR-N)
- voltage and reactive power regulation (maintaining the grid voltage)
- active power balancing (metro train load, solar power plant)
- peak shaving (office loads)

Potential cases

- frequency control for disturbances (FCR-D, inertia?)
- power oscillation damping
- as a black start for reserve power plant
- grid congestion management, to postpone investments
- back up power for critical loads

Conclusions

- BESS is excellent for fast and accurate power regulation
- The availability of the battery system in the frequency markets can be considerably improved with state of charge optimization
- Profitability of BESS increases when several functions can be applied
  - Ø methods for optimization and rules for prioritization are required
- BESS improves the power quality at the customer's premises or on the network side
  - tested by moderating a quickly altering metro train load

How?

Coordination and cooperation increase the impact of R&D

Top-down for long term R&D

- in line with corporate strategy and selected focus areas
- select & steer projects, follow the portfolio

Bottom up for shorter term R&D

- needs from the business

Cooperation: 1+1 > 2

- Use the best expertise: Start-ups, universities, technology providers, stakeholders...
- Synergies: TSOs, DSOs, other energy sectors (National, Nordic, European)
- Other benefits: new thinking, commitment, business opportunities, brand, competence building, lean organisation

Open data & open innovation: R&D with best competence and external resources

- Fingrid's open data plattform: 30 Million requests in 2 years

Thank you!

Great Place To Work.
Suomen parhaat työpaikat
Finland 2018

FINGRID

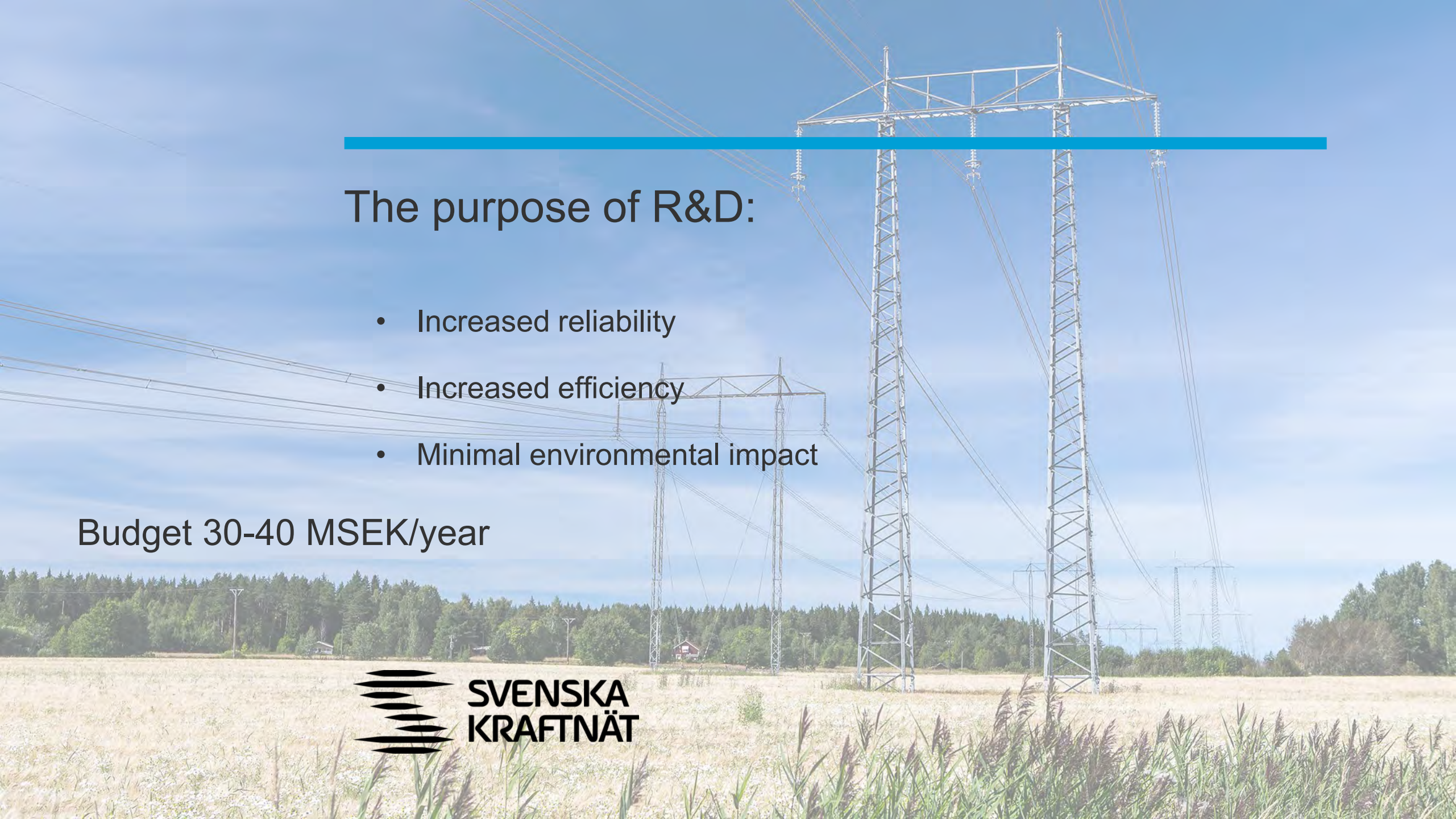
Research and Development at Svenska kraftnät

Statnett R&D conference

April 3, 2019

Göran Ericsson
Robert Eriksson
Johan Nissen

SVENSKA KRAFTNÄT

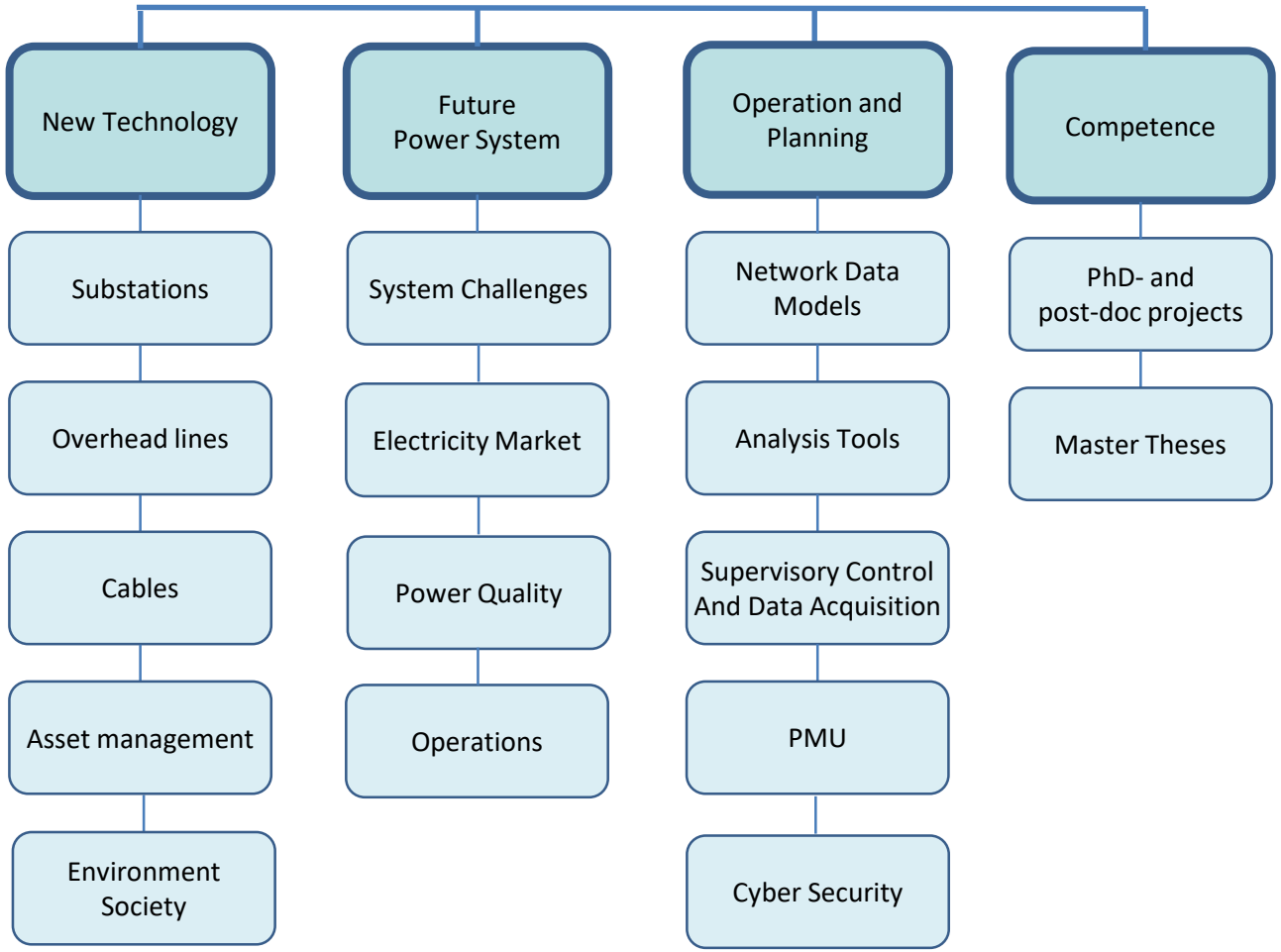


The purpose of R&D:

- Increased reliability
- Increased efficiency
- Minimal environmental impact

Budget 30-40 MSEK/year

SVENSKA KRAFTNÄT



SVENSKA KRAFTNÄT

Some examples …

Ongoing and recently finished projects

Portfolio New Technology

Portfölj

Dynamic Line Rating

Measure critical data on a power line in order to optimize power flow

Part 1: possibility to implement at Svenska kraftnät?

Part 2: Pilot study, establish DLR on a few spans.

SVENSKA KRAFTNÄT

Dynamic Line Rating

Continuously measure:

- Conductor temperature
- Current
- Vibrations
- Air temperature
- Clearance (LiDaR)

Installation on 220 kV power line in Stockholm county, September 2018.

SVENSKA KRAFTNÄT

Improving life conditions for wild bees

- **1/3 of the worlds crop production depends on pollinating insects.**
- **The value of pollinating insects in Sweden is estimated to 260-466 mnkr.**
- **Worldwide the value of pollinating insects exceeds 150 billions €**

SVENSKA KRAFTNÄT

SVENSKA KRAFTNÄT

For what reason do Svenska kraftnät care about bees?

> Passability – a big issue when planning new overhead lines is permission.

> To demonstrate that an overhead line also means something positive.

> Improve the reputation of Svenska kraftnät.

The project

> Identify sandy areas.

> Remove the vegetation cover and make some areas easy accessible for wild bees.

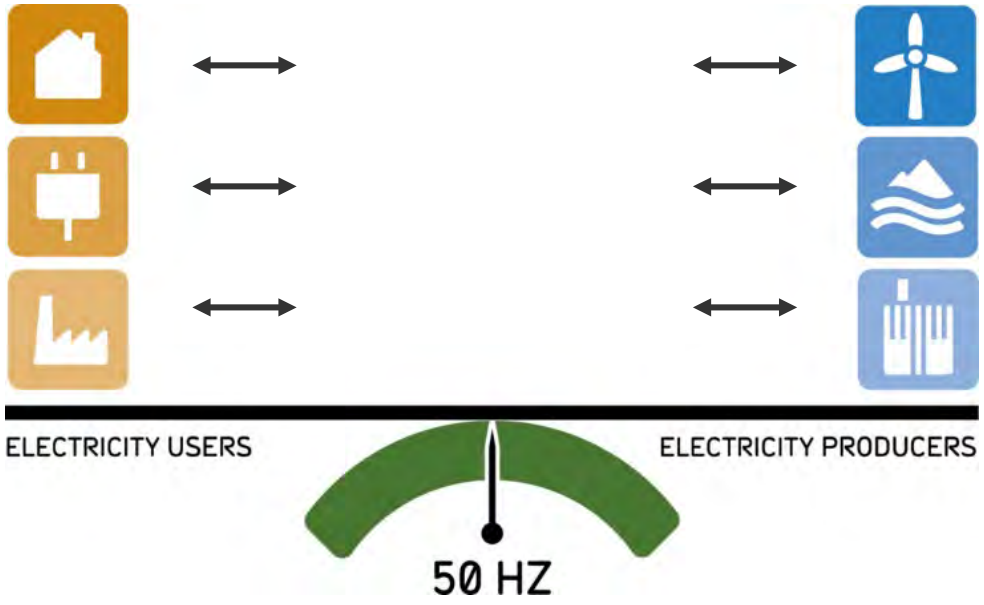
> Check how it works!

> Corporation with a county government and Swedish University of Agricultural Sciences.

SVENSKA KRAFTNÄT

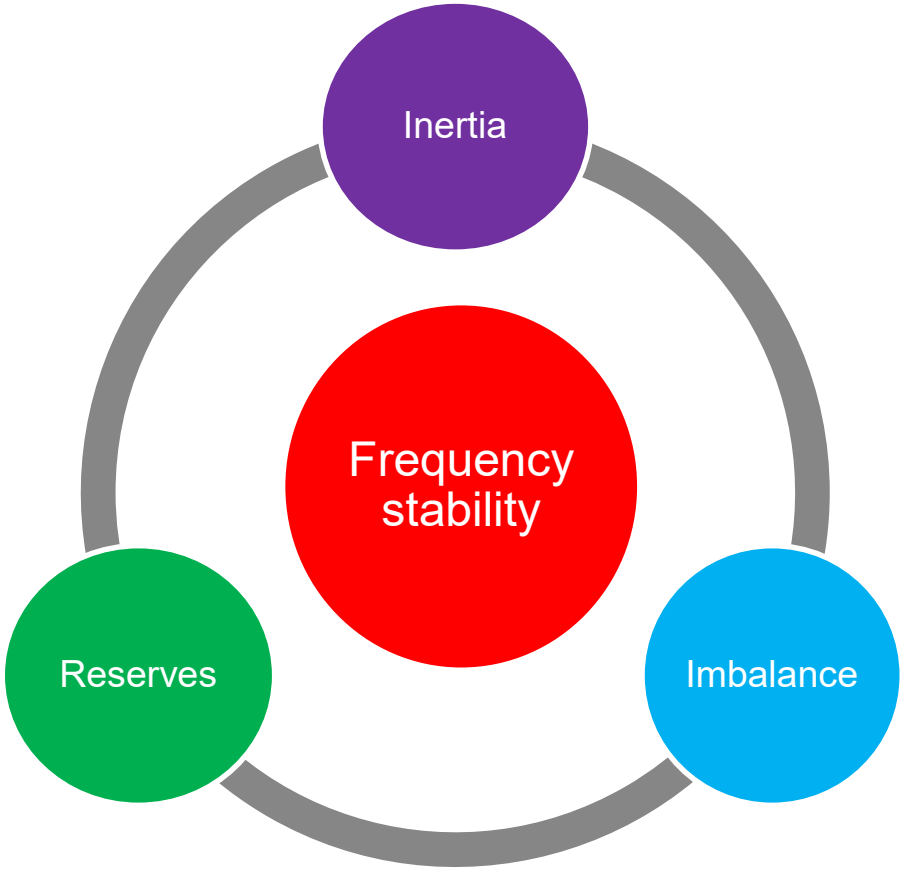
Balancing the power system

> System services – FCR, FRR, …
(active power)

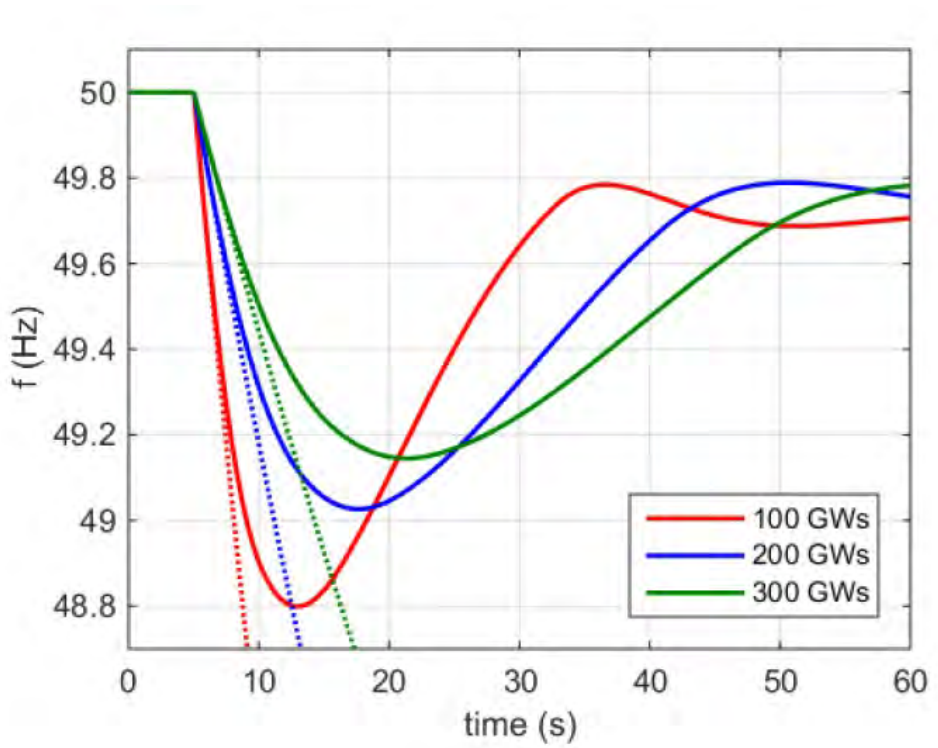


SVENSKA KRAFTNÄT

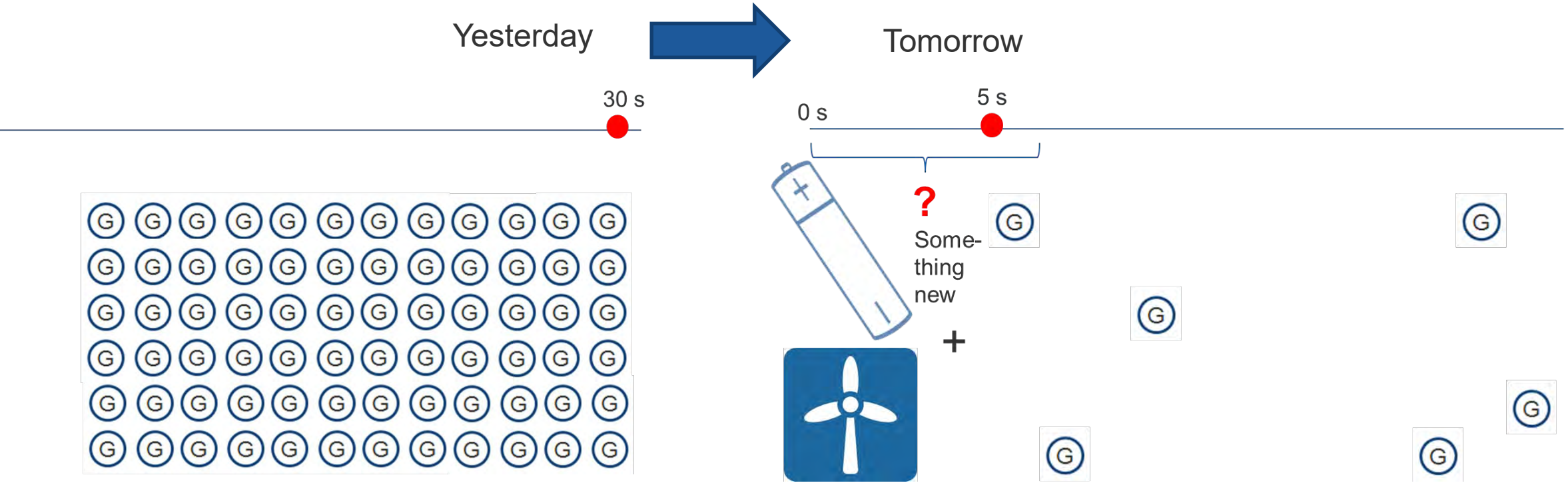
Frequency stability - Fast balancing



Power system response



Need for faster balancing reserves



SVENSKA KRAFTNÄT

New balancing services – R&D projects

> Load flexibility

> Wind power

The Swedish demonstration

DSO Vattenfall Eldistribution (WP-leader)

DSO E.ON Energidistribution

TSO Svenska Kraftnät

Todays challenges in Sweden

EKONOMI 29 november 2018 10:00

Eon varnar för elbrist i Skåne – tågen får klara sig med nödlösningar

Svenska kraftnät och Eon varnar för svår elbrist i Skåne. Storkunder kan få det kärvt att teckna nya leveransavtal. Först efter lång väntan fick Trafikverket elavtal för den nya fyrspåriga järnvägen mellan Malmö och Lund.

Erik Magnusson FÖLJ SKRIBENT

Uppsala har slagit i eltaket

Lyssna

Uppsala har slagit i taket när det gäller elförbrukning. Kapaciteten i elnätet hänger inte med i den snabba utbyggnaden av staden.

Maria Lindblom 07:00 | 2018-12-10

Cirka 200 timmar per år är det kapacitetsbrist i Uppsala läns elnät. Det gör det svårare att etablera vissa nya verksamheter här. Vattenfall har bland annat tvingats att tacka nej till etablering av serverhallar. För en tid sedan fick även en batterifabrik avslag i Uppsala på grund av att kapaciteten i elnätet är otillräcklig. Batterifabriken behövde 300 megawatt, lika stor effekt som hela Uppsala län har.

– Bristen på kapacitet i elnätet är ett jättestort problem som inte bara drabbar oss, utan hela Mälardalen, säger Jonas Eriksson, på region Uppsala.

Det är Svenska kraftnät som står för utbyggnaden av det nationella stamnätet. Just nu görs stora investeringar, men att bygga fler kraftledningar tar lång tid, kanske 5–10 år innan det är fullt utbyggt, enligt Niclas Damsgaard, marknadsstrateg på Svenska kraftnät.

– När det gäller nya bostadsområden och företag så är det en utmaning utifrån ett elnätsperspektiv. Det behövs effektiva tillståndsprocesser, men också att kommuner, regioner, lokala energibolag med flera är engagerade i att hitta fler lösningar, säger Niclas Damsgaard.

Alla nya företag och byggherrar måste i dag ställa sig i kö för att få sina effektbehov godkända av sin lokala eldistributör innan de kan starta ny verksamhet. Kommunerna kan och vill inte neka företag att etablera sig här. Men för att komma runt problemet så kommer nu fler dialoger att ske vid nyetableringar.

ANNONS

– Det här är att jämställa med infrastrukturen för vägar och vattensystem i länet. Elnätet har inte hängt med i den snabba utbyggnaden av bostäder och verksamheter, säger Anna Karlsson, på

Gotland blev strömlöst på nytt

Gotland blev utan el för tionde gången sedan junimånad. Vid klockan 15.50 meddelade Geab att stömmen åter var tillbaka.

Tredje kabel till Gotland het valfråga efter strömavbrott

VALET 2018 Efter den senaste tidens strömavbrott på elkabel till fastlandet upp på nytt som valfråga.

Energiministern anser att Gotland ska bli världsledande

ENERGIFÖRSÖRJNING Samordnings- och energiminister Ibrahim Baylan (S) besökte under tisdagen Gotland i samband med att Energimyndighetens förstudie presenterades.

SVENSKA KRAFTNÄT

Todays challenges in Sweden

Customers are moving faster than ever:

> Significant increase in requests for capacity as industry and transportation sector strive to become fossil-free

> Rapid urbanisation

> Shorter planning horizon and high uncertainty

> Challenges in the national grid because of higher demand from load and less capacity with windpower in the North and

And society can`t keep up:

> TSO has constraints

> Regulatory demand for high security of power supply

> Reduced power generation in larger cities

> Increased lead-time for new and renewed power lines

Battery industry 300 MW/ piece

Fast chargers 0,4-1,5 MW/ installation

Data centers 15-200 MW/ installation

Bus charging 3-6 MW/ installation

Greenhouse hydrogen industry 5-20 MW / installation

Charging at home and at work 2-10 kW/ installation

Competence

- MSc projects
- PhD theses
- Industry PhD
- Affiliated / adjunct professors - KTH

Challenges

- Personnel – how to find adequate and sufficient number
- “We will travel 300 km, but the sight is only 30 meters” – how to navigate?
- Funding arena – any changes?

SVENSKA KRAFTNÄT

Thanks! Questions?

Göran, Robert and Johan – are here!

SVENSKA KRAFTNÄT

LANDSNET

R&D ACTIVITIES AT LANDSNET

Overview of on-going research on TSO-level in Iceland

Statnett's R&D Conference, Oslo 2019

Magni Þór Pálsson, Program Manager R&D

Why R&D?

- Establishing international contacts
- Acquire new knowledge
- Contribute our knowledge
- Develop new methods for
  - System operation
  - System planning
  - System asset management
  - etc

LANDSNET

Levels of R&D

International R&D projects

- (GARPUR)
- MIGRATE
- ICEBOX

Nordic R&D projects

- SPARC (SC)
- NEWEPS (TRG)
- Verification of motion detection technique

National R&D projects

- Bird collision
- Environmental impact on transmission structures
- Environmental cost of OHLs
- Impact of undergrounding on system
- POLG

LANDSNET

GARPUR

Statnett · Elia · Rte · ESO EAD · ČEPS a.s. · ENERGINET.DK · LANDSNET

SINTEF · Háskólinn í Reykjavík · KU Leuven · Université de Liège · Aalto University · TU Delft · Strathclyde Glasgow · Západočeská univerzita v Plzni · NTNU Norwegian University of Science and Technology · Universität Duisburg Essen · Technion Israel Institute of Technology · DTU

TECHNOFI

MIGRATE

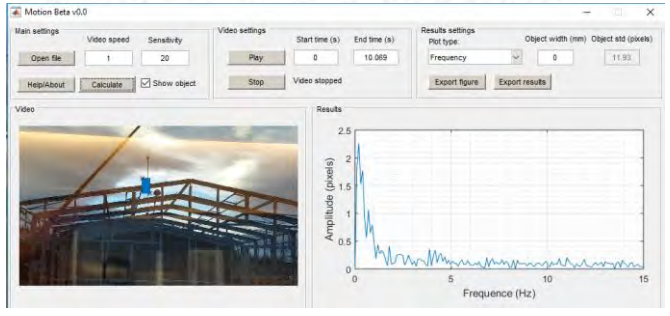
TTU elering · LANDSNET · FINGRID · TenneT · amprion · TU · SP Energy Networks · Manchester · UCD · EirGrid Group · TenneT · TU Delft · ARTS ET METIERS · Schneider Electric · Rte · TECHNOFI · ETH zürich · EDAV · ELES · ensiel · Terna · circe · Red Eléctrica de España

I²G INDEPENDENT INSULATION GROUP

Specification S171017-05
08/05/2018

Specification

Verification of motion detection technique



Icebox

Statnett
EFLA
KVT
I2G
Cicero
EFLA IS
NCAR
UiT
Landsnet

SynchroPhasor-based Automatic Real-time Control (SPARC)

SINTEF · NTNU · KTH Vetenskap och Konst · Statnett · Svenska Kraftnät · ENERGINET · FINGRID · GE · LANDSNET

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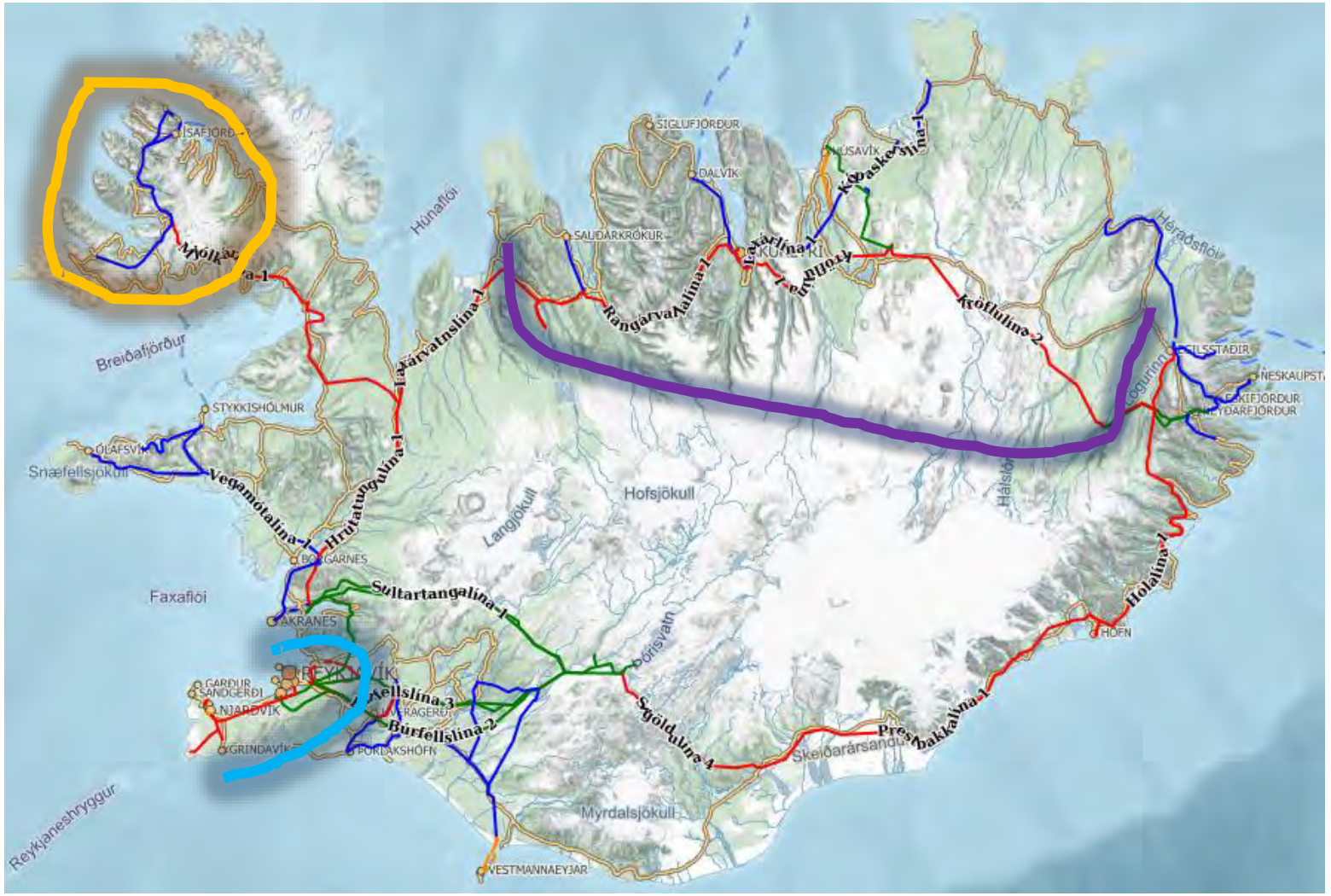
Impact of undergrounding

- Purpose is to assess some area specific “quota” for UGCs
- Systematic approach
  - Short-circuit capacity
  - Open-end voltage
  - Voltage step
  - Compensation
  - Resonances
  - Harmonics
  - Under-excitation of gens



Impact of undergrounding

The Grid West Project

EIRGRID

1/6

ENERGINET

Energinet
Tonne Kjærsvej 65
DK-7000 Fredericia

+45 70 10 22 44
info@energinet.dk
CVR-nr. 28 98 06 71

Dato:
28. september 2018

NOTAT

DANSK RESUMÉ – TEKNISK REDEGØRELSE OM ANVENDELSE AF KABELANLÆG VED UDBYGNING AF 400 KV-NETTET I SYD- OG VESTJYLLAND

h transmission system. However, given its
h any area and use on one project reduces
e development. A partially undergrounded
es, such as major water crossings, when

URY | PORTER NOVELLI

3. Fremtidsperspektiv:

3.1 Elnettet forandrer sig – kabler skal bruges med varsomhed

Transmissionsnettet er et stort sammenhængende net, og mange kabler ét sted begrænser mulighe-den for anvendelsen af kabler andre steder. I fremtidens udbygning af transmissionsnettet vil der sandsynligvis også blive brug for at kabellægge nær særlige naturområder eller nær byer. Samtidig vil der blive introduceret endnu flere kabler i transmissionsnettet i forbindelse med nettilslutning af kommende havmølleparker.

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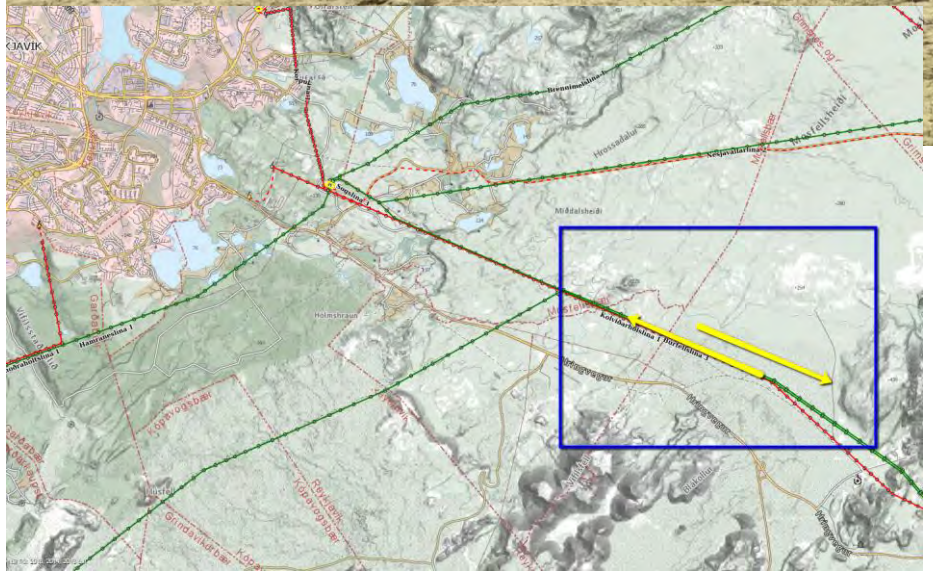
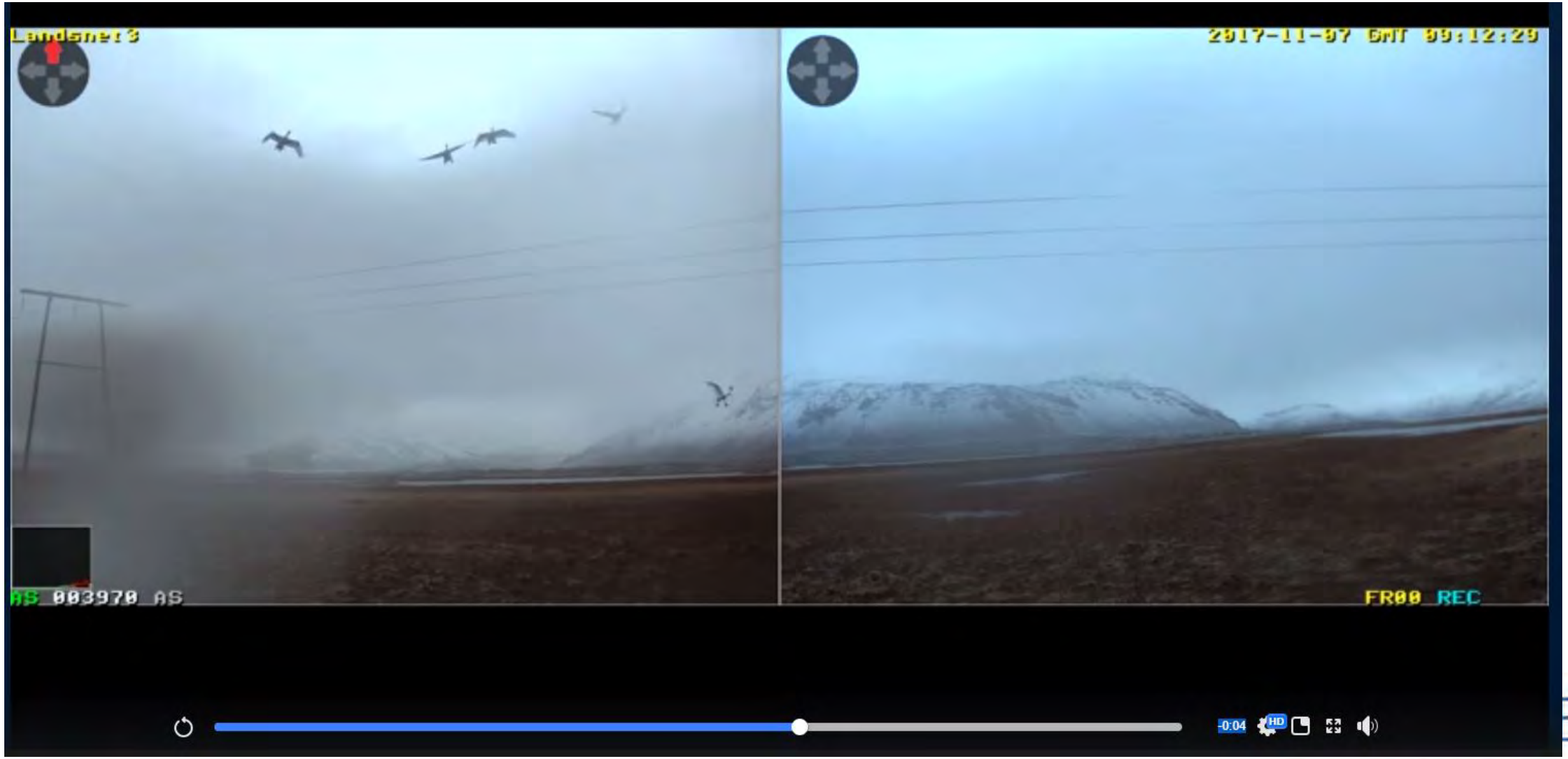
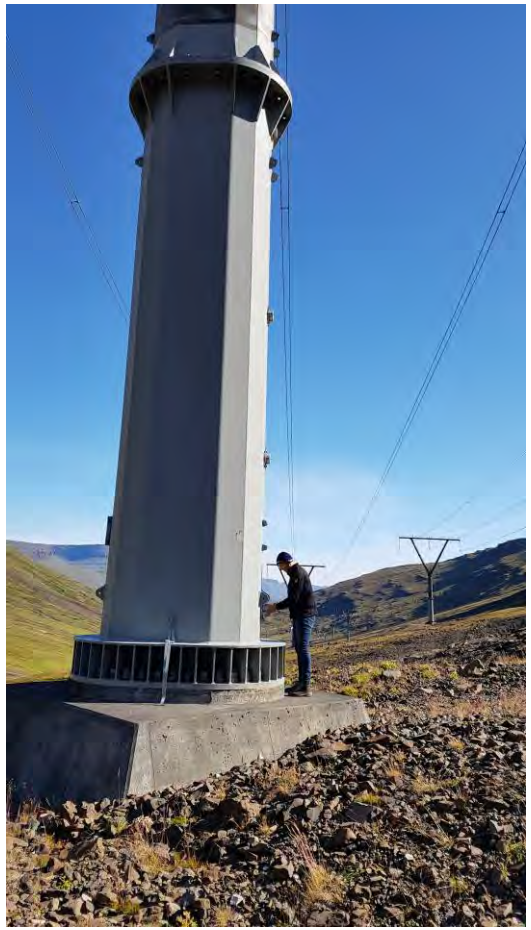
Bird collision



Bird collision – video surveillance



Avalanche monitoring



PowerOnLineGenerator

PARTNERS

LANDSNET FINGRID SIEMENS Technology Development Fund Horizon 2020 European Union Funding for Research & Innovation

LAKI POWER


HIKVISION
Live View
Playback
Picture
Configuration
admin
Help
Logout
03-20-2019 Wed 15:22:42
PTZ
4
1 Preset 1
2 Preset 2
3 Preset 3
4 Preset 4
5 Preset 5
6 Preset 6
7 Preset 7
8 Preset 8
9 Preset 9
10 Preset 10
11 Preset 11
12 Preset 12
13 Preset 13
14 Preset 14
15 Preset 15
16 Preset 16
17 Preset 17
18 Preset 18
19 Preset 19
20 Preset 20

LANDSNET

LAKI HOME LOG OFF

TE1 - TURN 21 | SU3 - MAST 3 | KR4 - TURN 14 | BR1 - TURN 11 | FL4 - TURN 19

ONLINE | Settings | History as table | History as graphs | Trends | Camera | Map | Last updated 20.3.2019 15:28:56

HIKVISION DOME

ON

CURRENT STATE
ON

OUTPUT 2

OFF

CURRENT STATE
OFF

OUTPUT 3

ON

CURRENT STATE
ON

OUTPUT 4

OFF

CURRENT STATE
OFF

GSM MODULE

ON

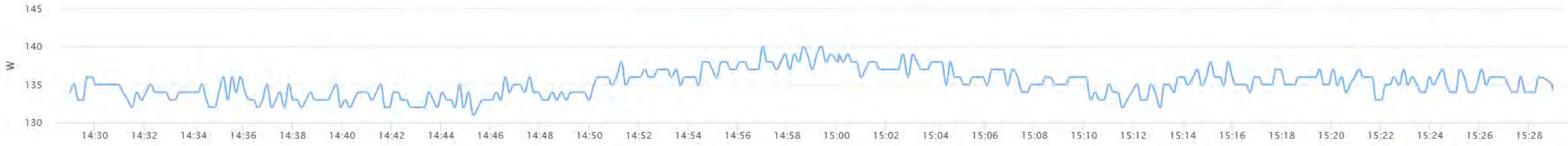
CURRENT STATE
ON

POWER BUDGET

CAMERA FEED

LIVE GRAPH

OUTPUT 1 | OUTPUT 2 | OUTPUT 3 | OUTPUT 4 | GSM MODULE | POWER BUDGET | AMBIENT TEMPERATURE | LOAD CELL | LIDAR | SALINITY | PITCH | PRIMARY V | BATTERY V | CHARGE CURR | DC/DC TEMP | INTERNAL TEMP | ROLL



AMBIENT TEMPERATURE

-0.12 °C

LOAD CELL

-86 Kg

LIDAR

255 Cm

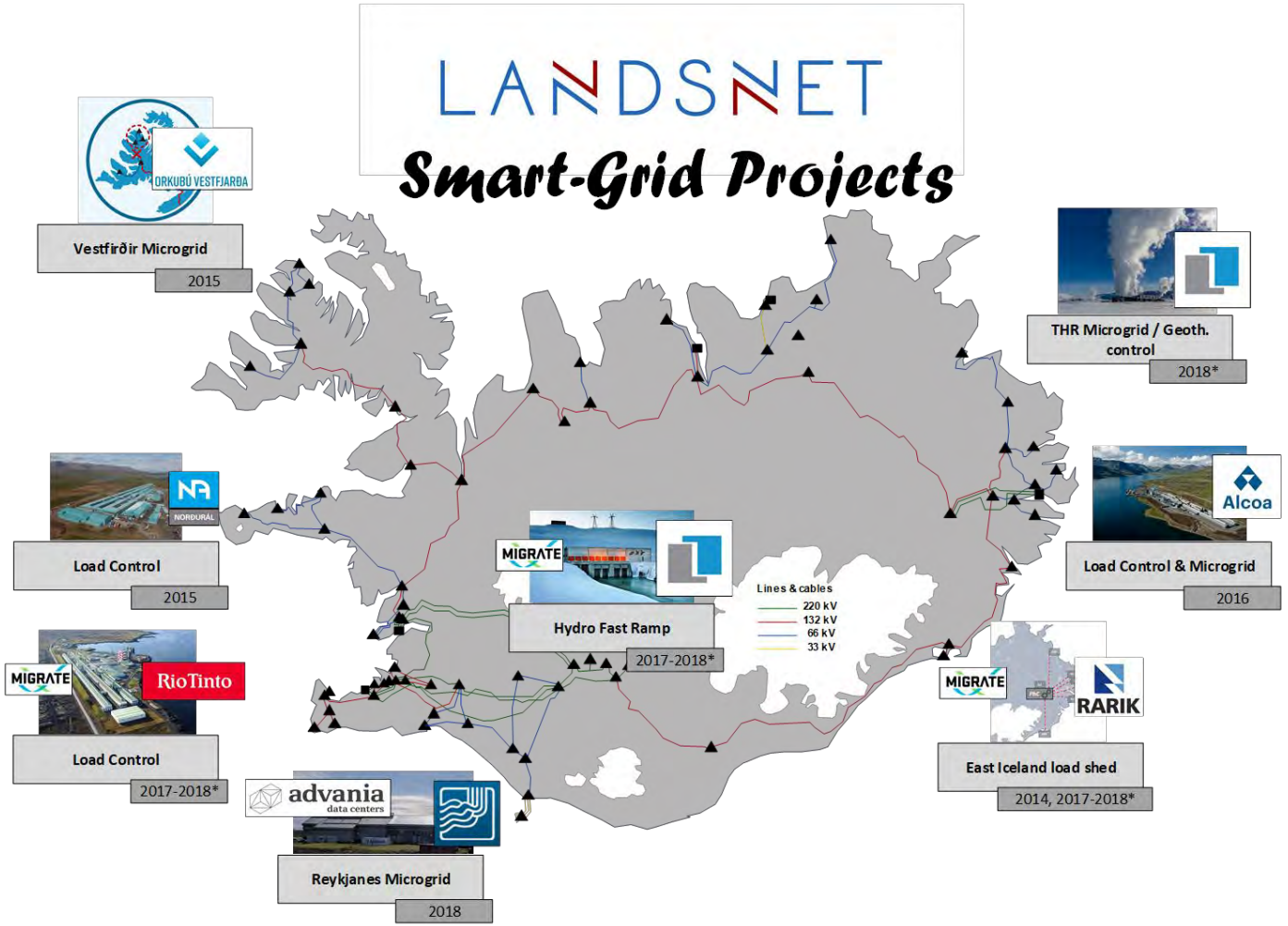
SALINITY

1000000 Ohm

PITCH

5.52 Degrees

Smart-Grid projects at Landsnet



LANDSNET

http://www.epcc-workshop.net/

https://iwais2019.is/

LANDSNET

PRESENTATION OF ONGOING R&D IN ENERGINET (INCLUDING NORTH SEA HUB)

Statnett's R&D Conference 2019

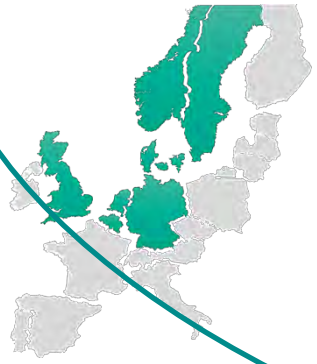
Anders Bavnhøj Hansen, abh@energinet.dk
Chief Engineer
Energinet, Electricity System Operator

ENERGINET

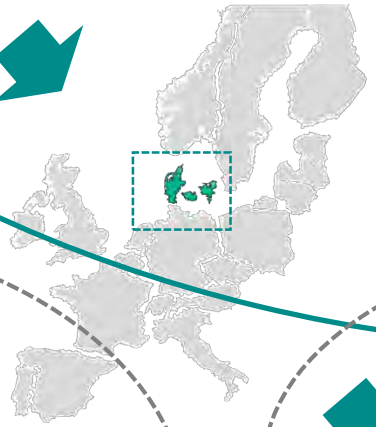
DISPOSITION

ENTSO-E/G
TYNDP18 scenarios

1: International Energy Scenarios

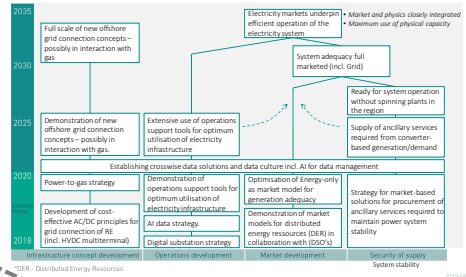


2: System Perspectives at TSO level



3: Interaction between
Distributed and central ressources

4: R&I Targets and focus areas



INTERNATIONAL SCENARIOS FROM ENTSO-E/G

ENERGINET

Content of the 3 European TYNDP 2018-scenarios

GCA-scenario (Global Climate Action)

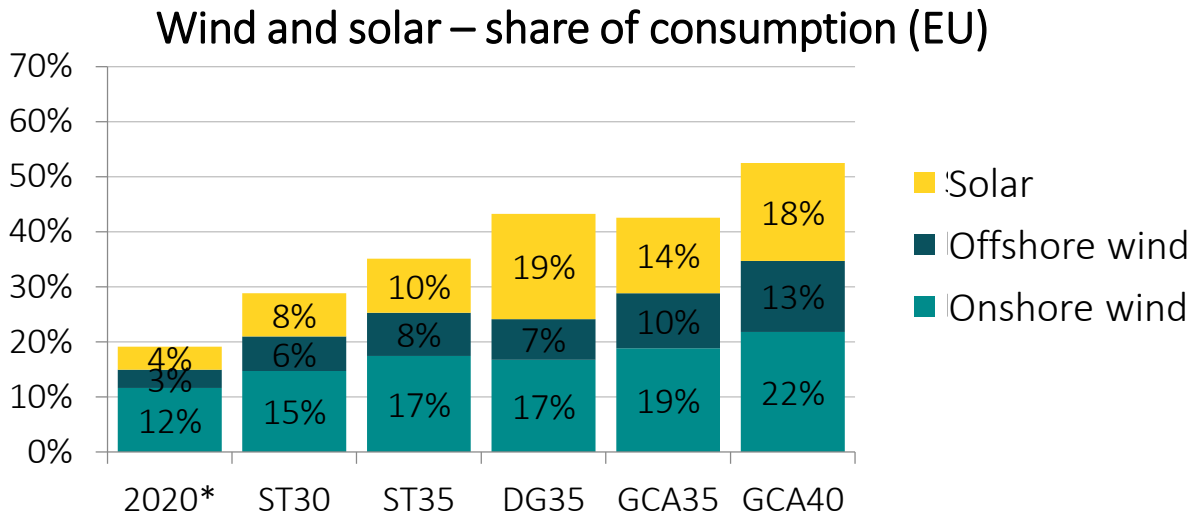
- "On track" with EU current climate targets
- Strong international, green cooperation
- Moderate oil price –high CO_2-price (IEA 450 PPM)

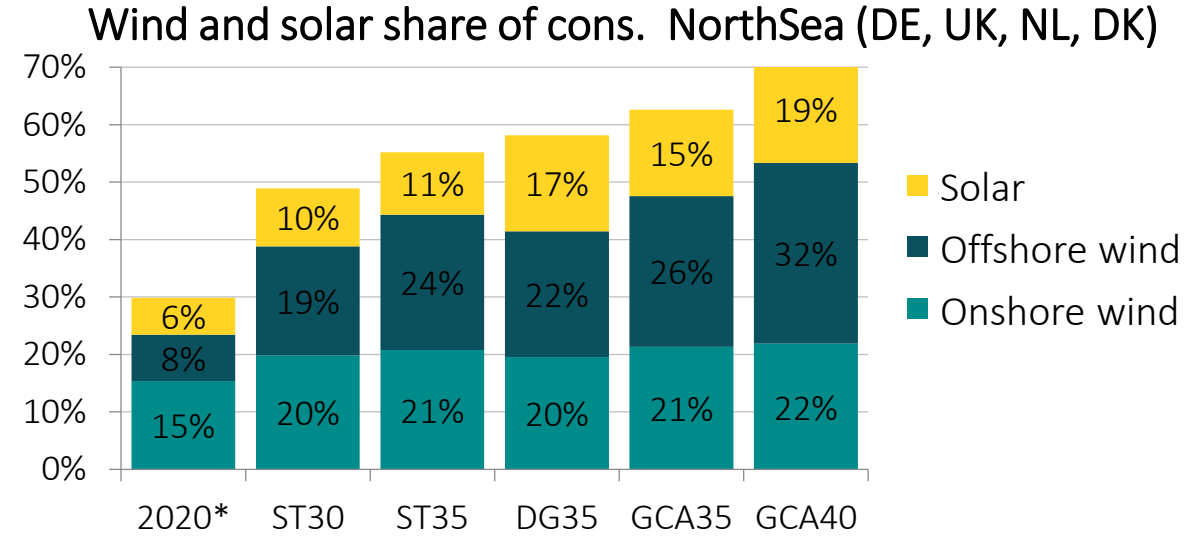
DG-scenario (Distributed Generation)

- "On track" with EU current climate targets
- Wide spread local distributed solutions (solar/batteries)
- High oil price (IEA New Policy) – high CO_2-price

ST-scenario (Sustainable Transition)

- "Not on track" with EU climate targets
- Low oil and natural gas prices
- Moderate CO_2-price(IEA Low Oil price scenario)





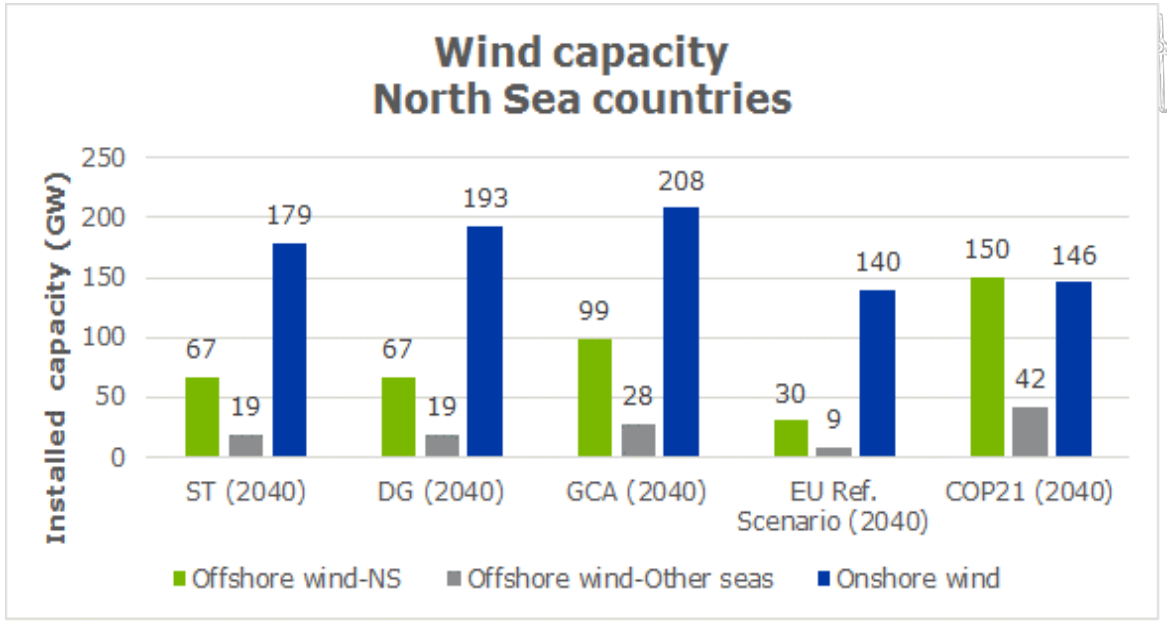
ENERGINET

...MUCH MORE WIND IN THE NORTH SEA

OFFSHORE WIND IS ESSENTIAL AND INCREASES SIGNIFICANTLY ACROSS SCENARIOS

70 – 150 GW by 2040

7-15 times current installed capacity

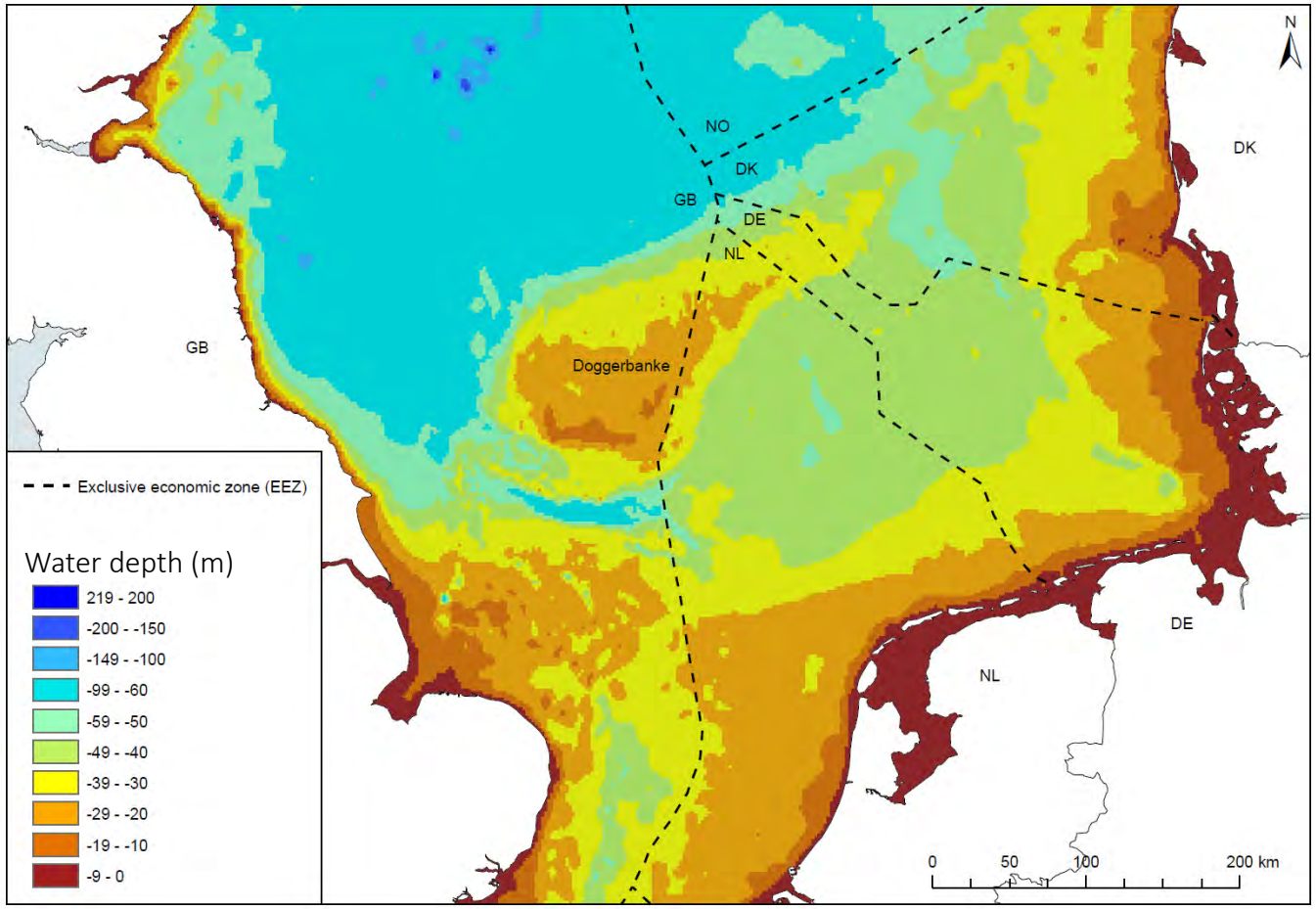


ENERGINET

THE NSWPH VISION AND PARTNERS

1. Planning regional integration of large scale wind across the North Sea area

2. Exploring a first and concrete hub- and spoke concept combining grid integration of wind power and interconnectors between countries



TenneT Taking power further

gasunie crossing borders in energy

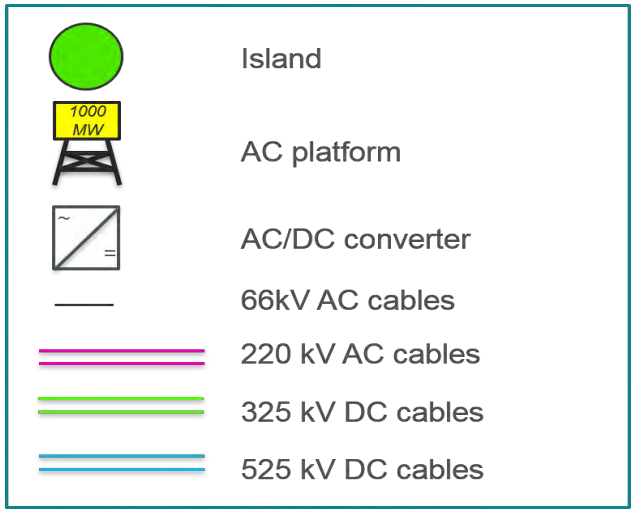
ENERGINET

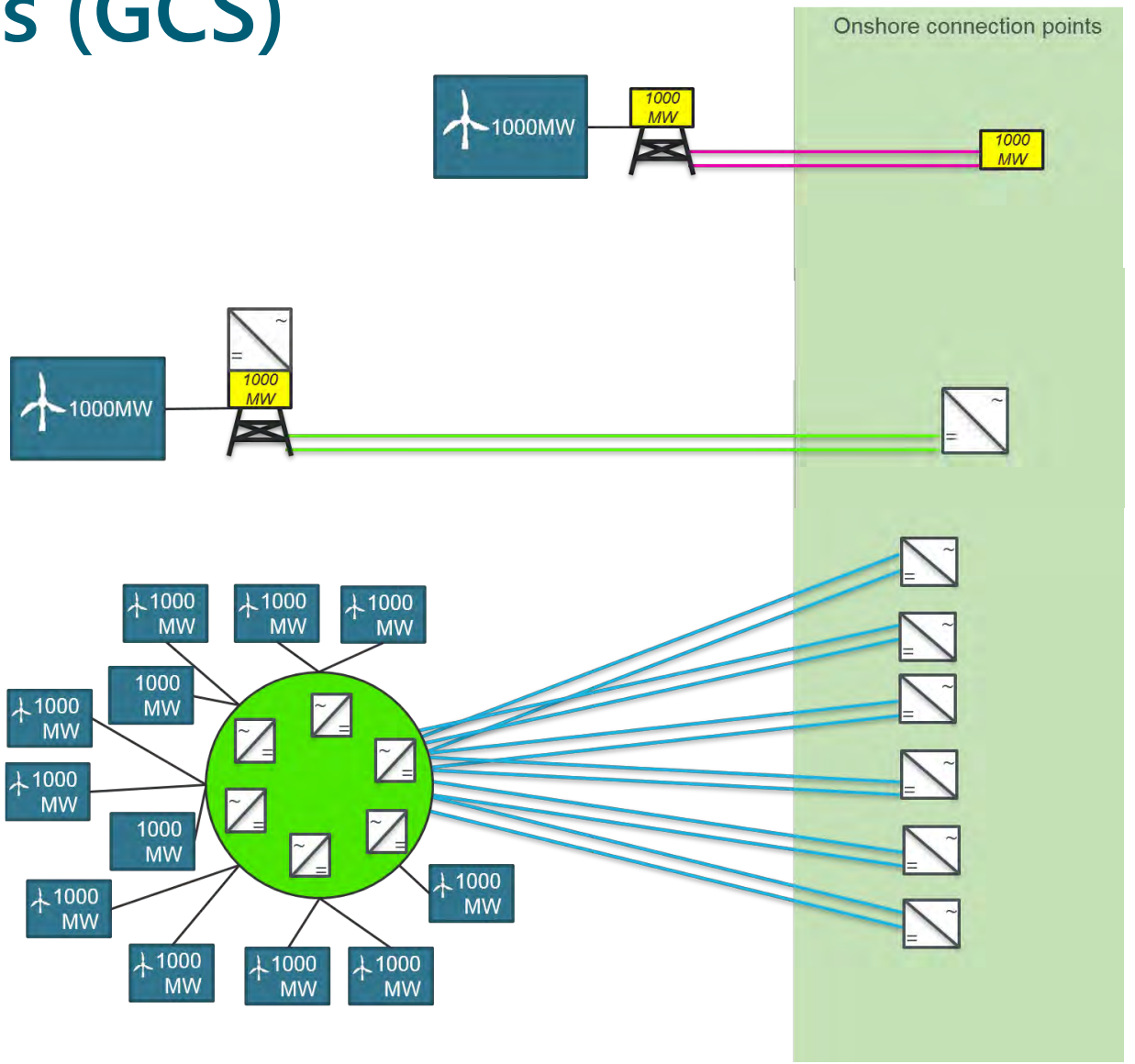
Port of Rotterdam

ENERGINET

Grid Connection Systems (GCS)

- AC radial
- DC radial
- Hub & Spoke



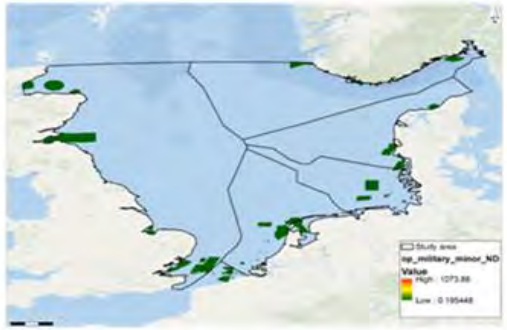


ENERGINET

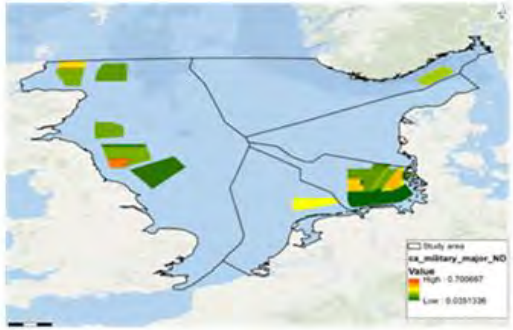
EXAMPLE OF LAYOUT..

ENERGINET

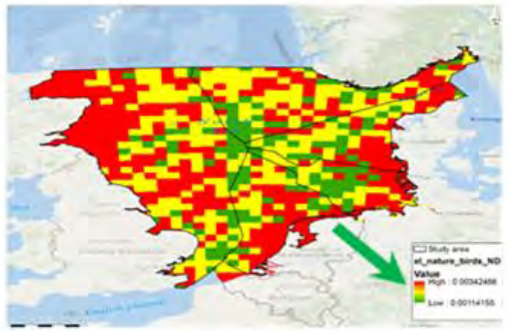
NORTH SEA USER FUNCTIONS AND SPATIAL PLANNING RISKS



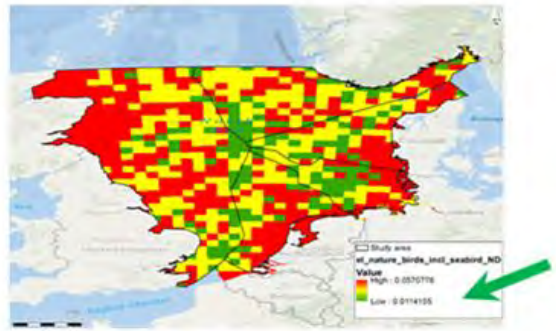
Small military zones



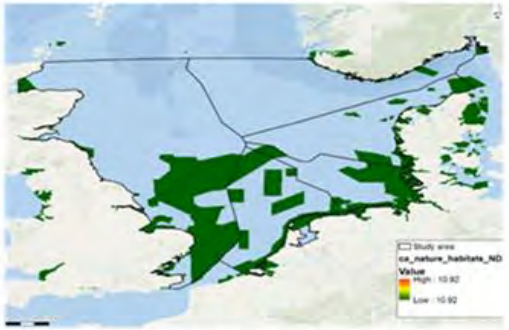
Large military zones



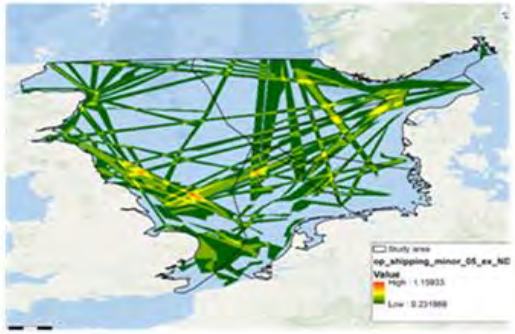
Birds (migratory peaks only)



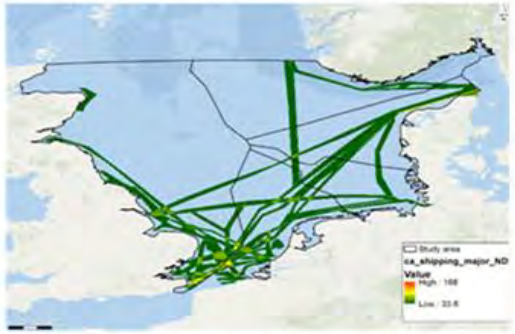
Birds (migratory & sea birds combined)



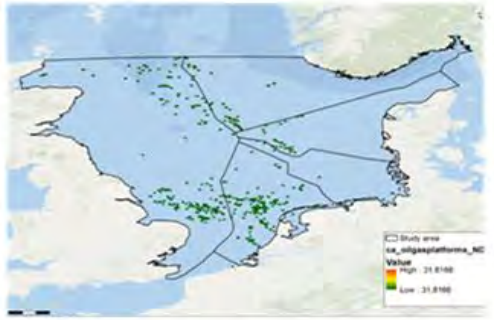
Protected habitats



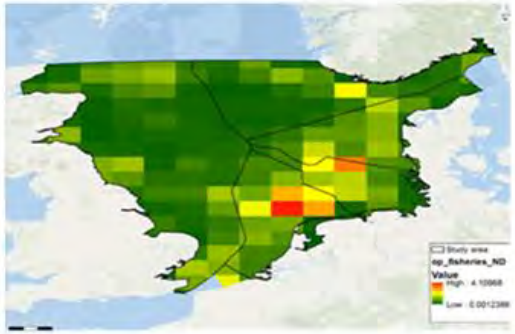
Minor shipping routes



Major shipping routes



Oil & gas platforms



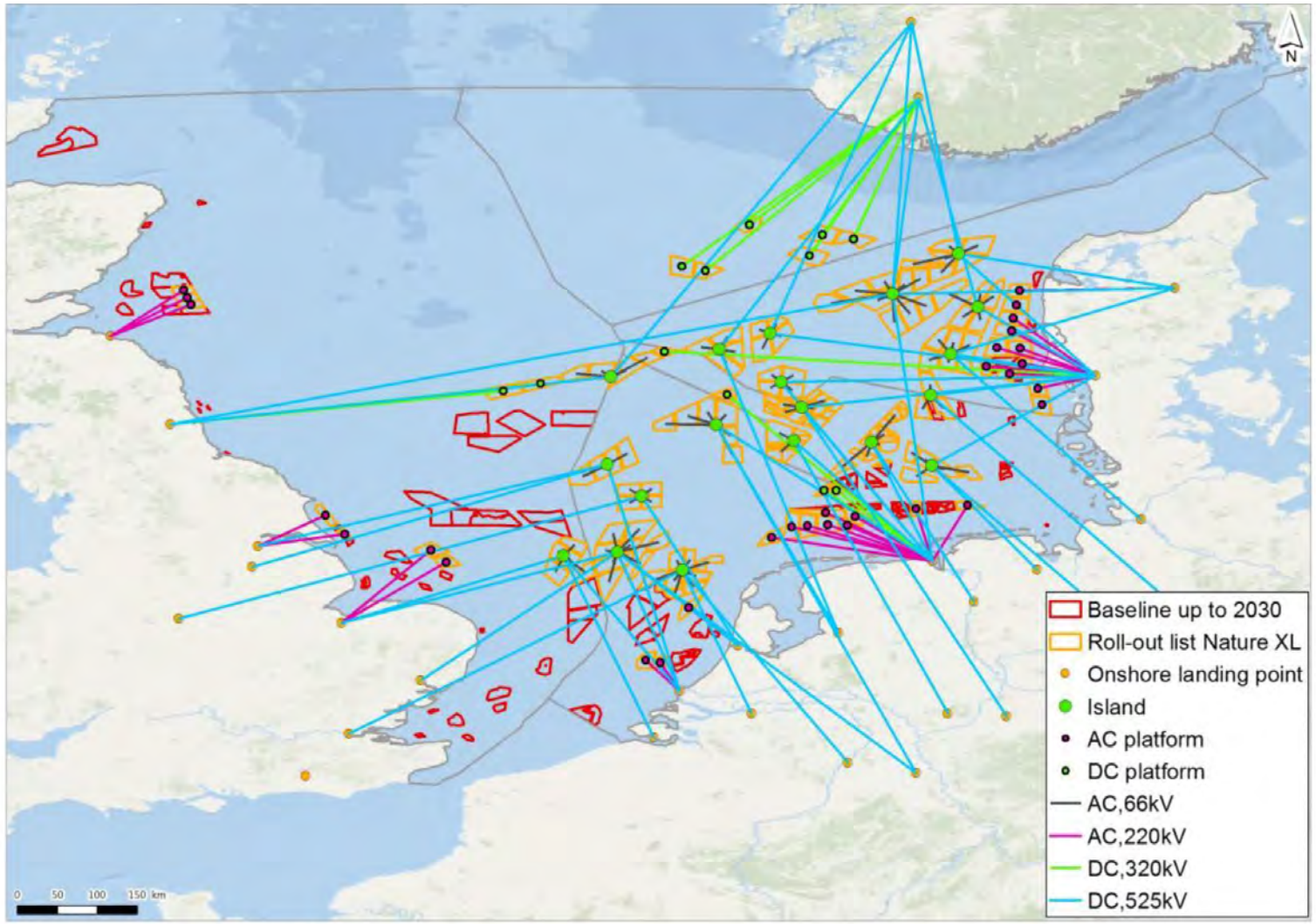
Fisheries

Cables & pipes

Sand mining

Legends: monetary value in million euro per reference park of 280 km2

EXAMPLE LAYOUT OF A HUB CONCEPT



Source: LCoE-mapping model developed in this study

ENERGINET

SOLUTIONS FOR EFFICIENT INTEGRATION OF +50 PCT. WIND/SOLAR

Power-integration – Power as final energy service

Over distance: Power Grid Expansion

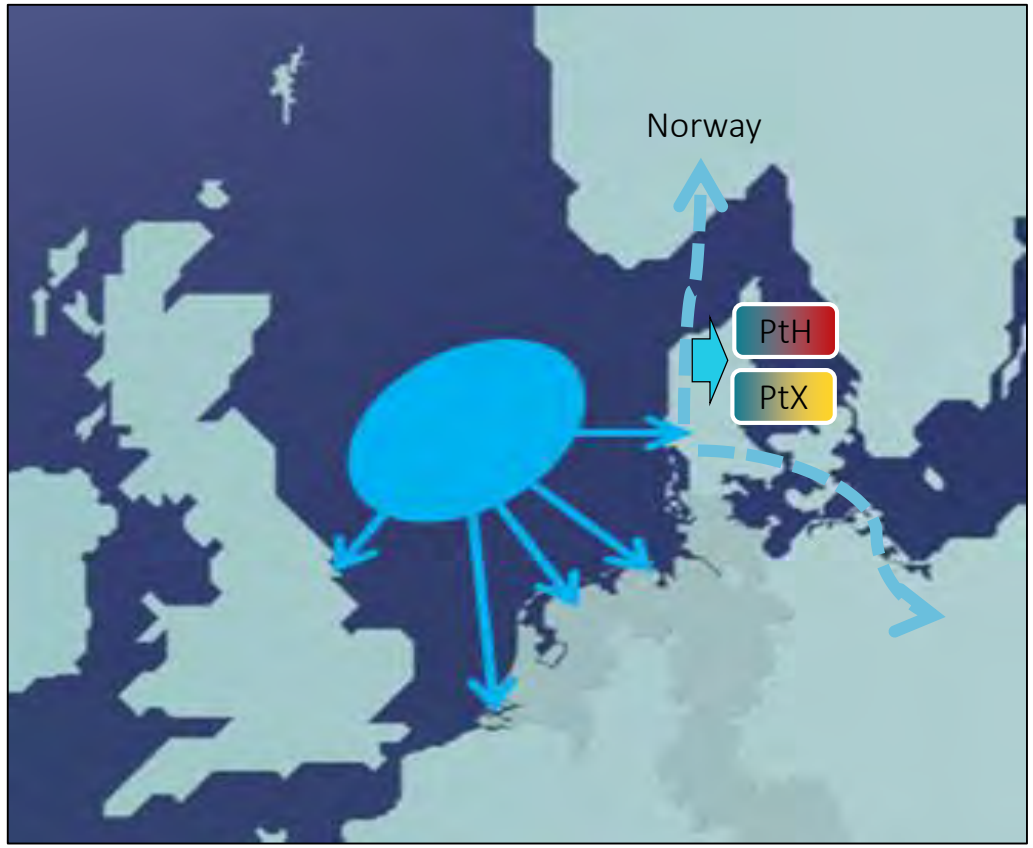
1. (Further) integration with Nordic hydro
2. Integration between Western and Eastern Europe

Over time: Power-to-Power Storage

3. Eg. Battery, CAES, Fly Wheels, Pumped Hydro

Conversion of power for other purposes - electrification

4. Power-to-Heat and Thermal Storage PtH
5. Power for Transport
6. Power for high value Products (Electrolysis / PtG / PtX) PtX



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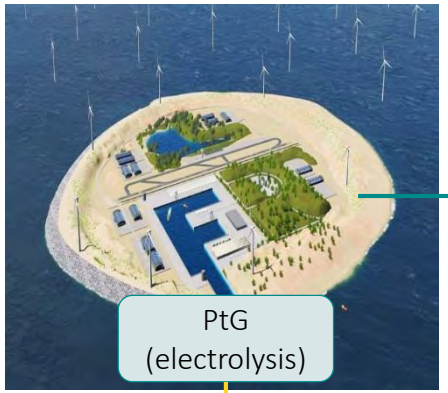
PTG/PTX ANALYSED AS A POTENTIAL SUPPLEMENT TO GRID

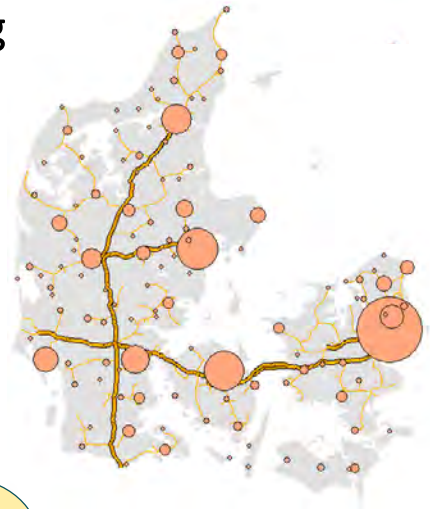
Offshore PtG
(supplement to grid)

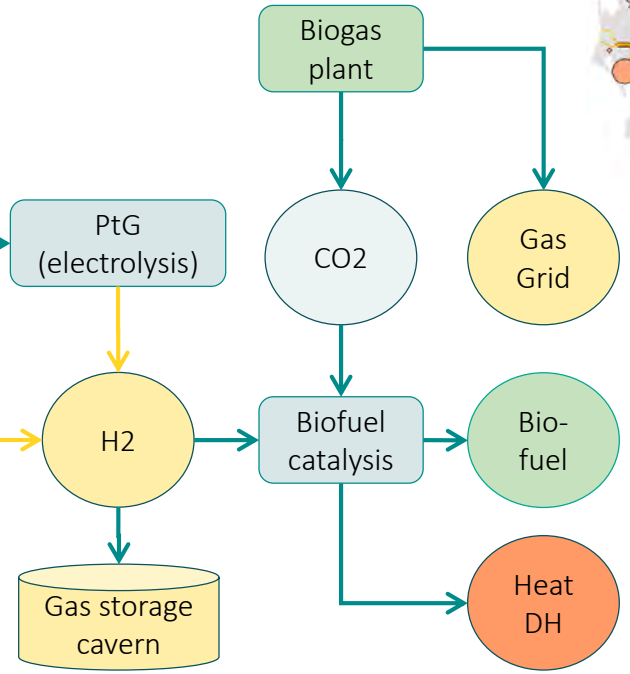


Electricity

H2
pipeline

Example with onshore refining
hydrogen to RE-fuels etc.





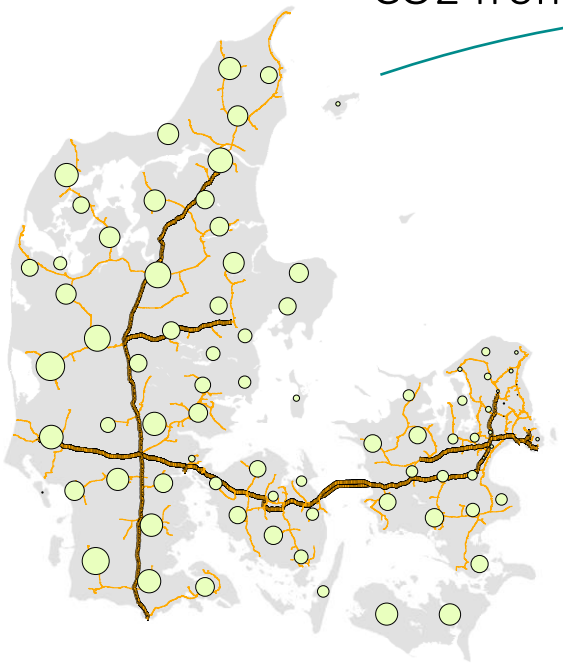
Salt cavern

Tesla Wall

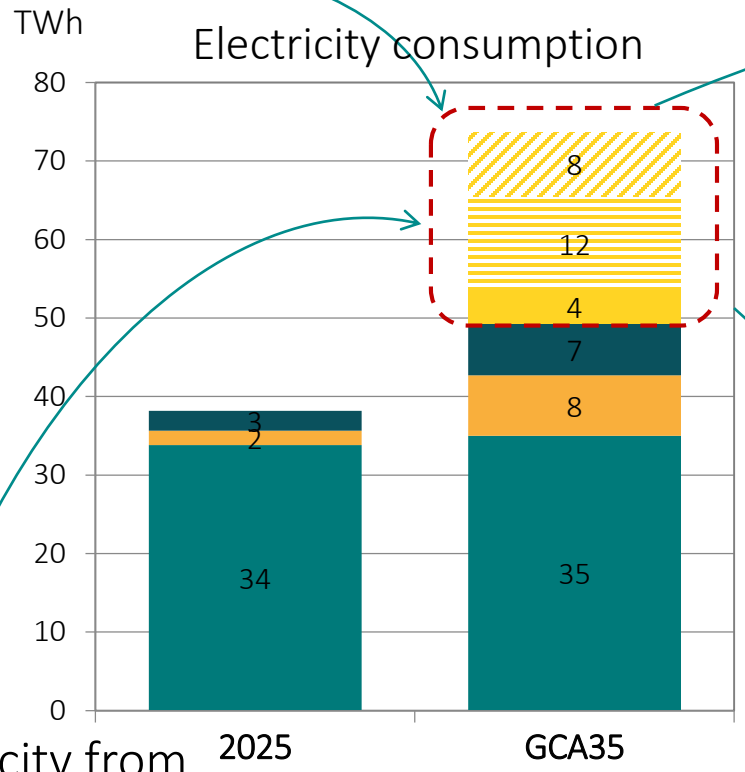
Volume 1 cavern:
1.000.000 m3 → 240 GWh
(6.1 ktons H2)
~ 24.000.000 Tesla power walls of 10 KWh !

SECTOR COUPLING

CO2 from biogas



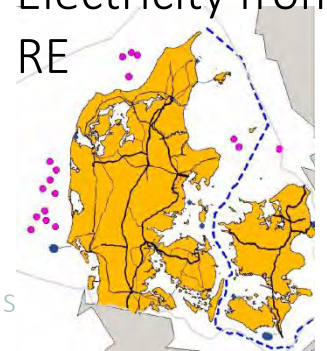
- Biogas + SNG (CO2+PtG) ressource > 90 PJ
- KV+Proces ca. 40 PJ
- På sigt kan GtL blive relevant



Heat to DH

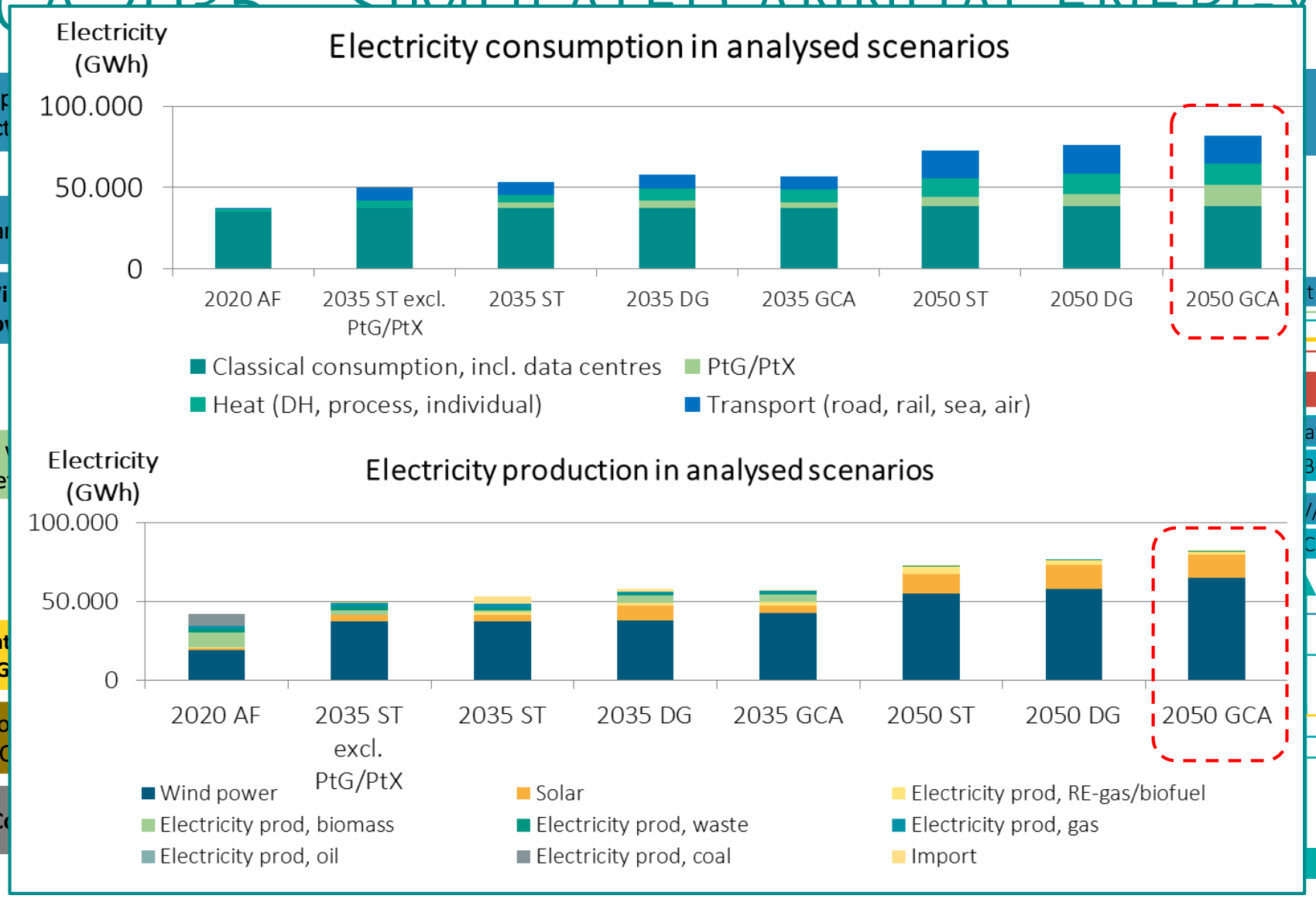
DH-demand for 5-15 GW PtG/PtX

Electricity from RE



PtX highvalue products

GCA 2035 – SIMULATED ANNUAL ENERGY FLOW



- Consumption doubled towards 2050 – Electrication:
  - Heating
  - Transport
  - PtG/PtX
  - Data centers
- Wind/solar covers (annually) more than 80% of production after 2035 and 95% in 2050
- A very high need for use of flexibility to balance system, ancillery services and enhanced use of grid

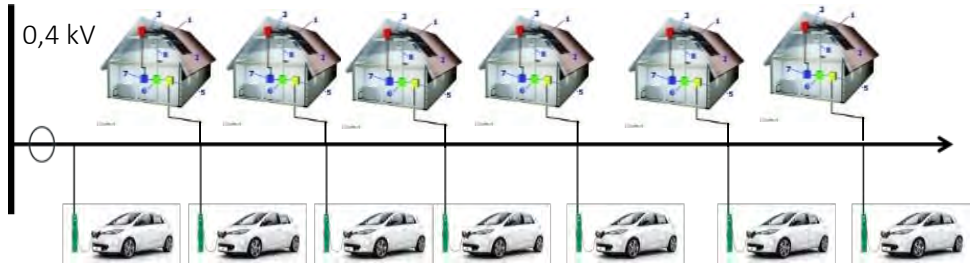
SMARTGRID MANDATORY TO HANDLE GRID EDGE

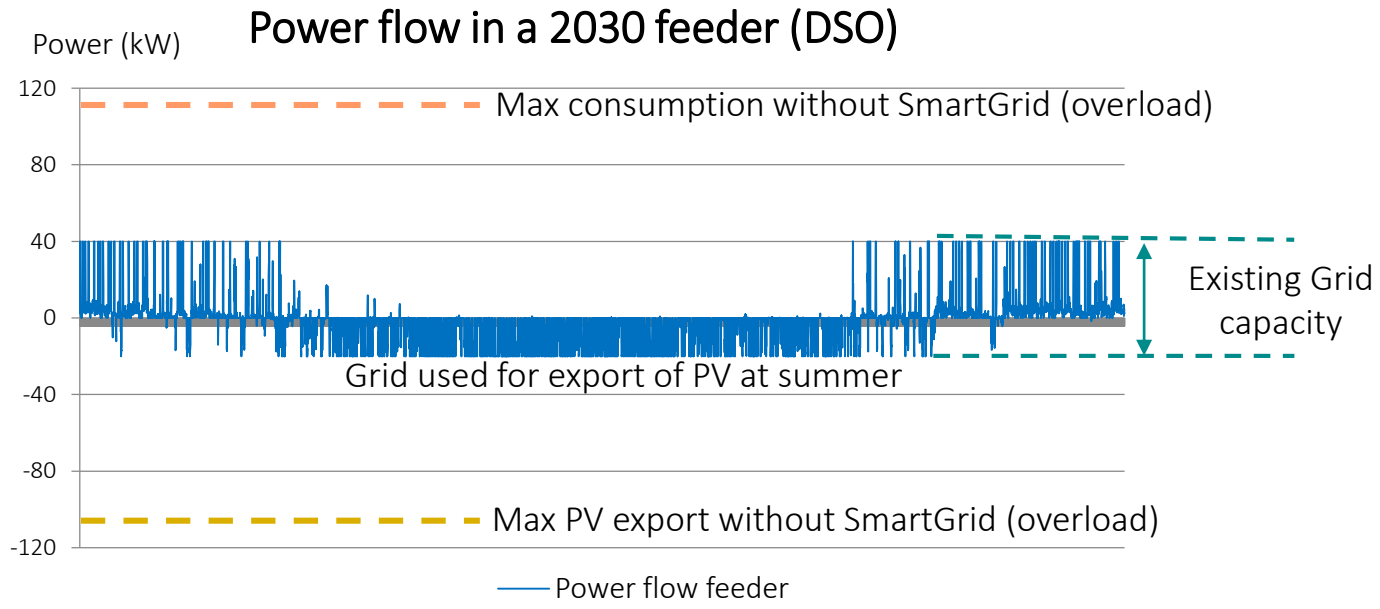
Towards 2030 a typical house could have PV-solar, EV-charger and a battery storage

The analysis:
Analysis of a typical 0,4 kV feeder in single house area in 2030 with EV and heatpump

Analysis results:

- Investment in up to 12 kW solar and 10-25 kWh battery
- Offgrid is not economical feasible (more than 150 ”Teslawalls” is needed!)
- Without SmartGrid a very high need for grid reinforcement is found
- With SmartGrid the electrification is efficiently handled without very high reinforcement





SmartGrid solutions and TSO/DSO market integration mandatory to handle DER’s

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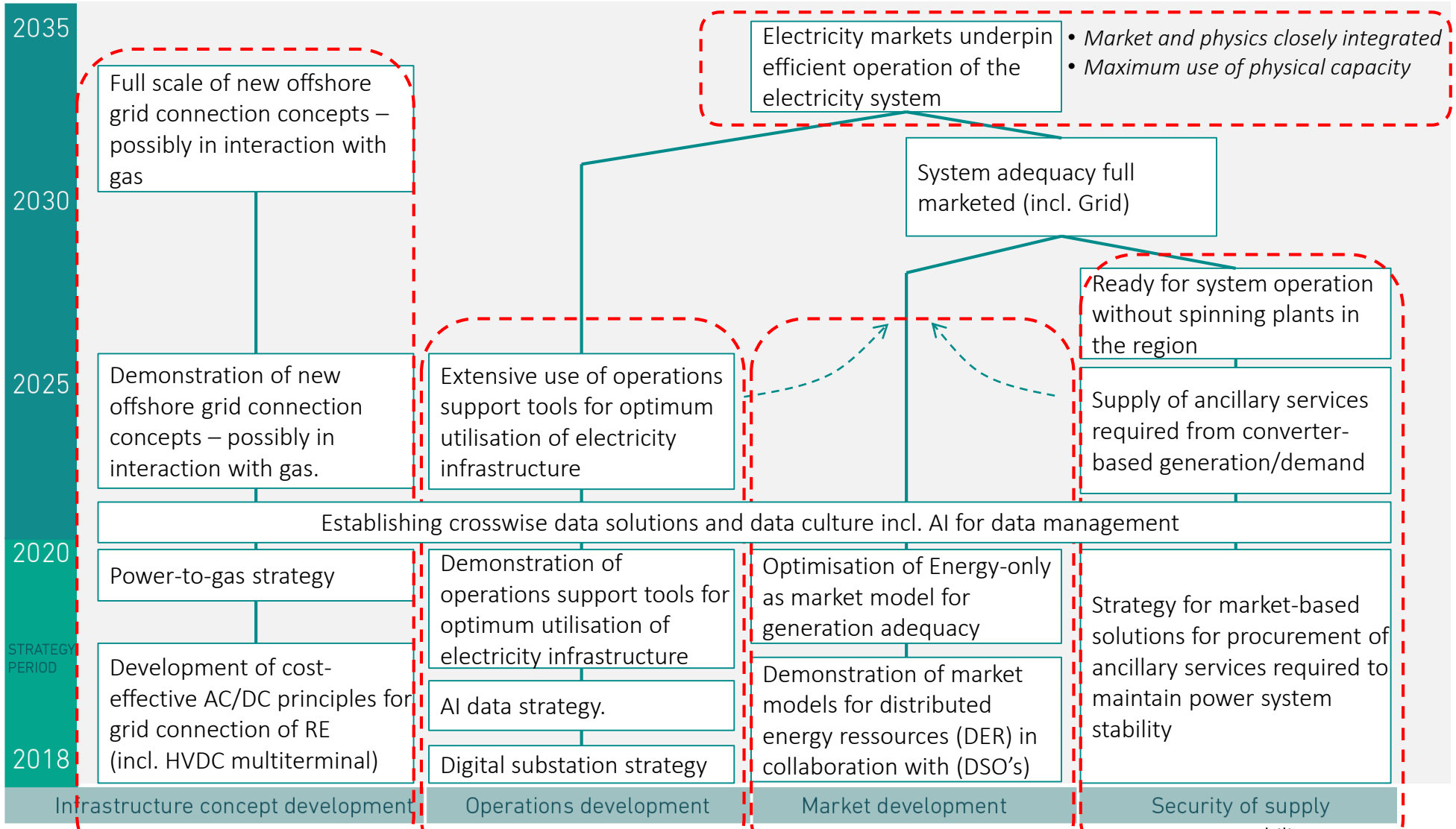
R&I ROADMAP – ELECTRICITY



ENERGINET

SUMMING UP

1. A need for large amounts of offshore wind to realise fossil independency towards 2050 (DK target)
2. North Sea Area is a huge RE power-ressource, essential for EU transition towards low carbon energy in 2040/2050
3. North Sea Windpower Hub (NSWPH) Hub-and-spoke concepts analysed
   – significant perspectives identified in the concept for windressources >100 km from shore
4. Sectorcoupling (power, RE-gas, RE-fuels and districtheat) is essential for integration of wind/solar efficient in the energy system
5. TSO/DSO cooperation on SmartGrid solutions to handle distributed ressources (PV, EV, batteries) essential to manage future high power-capacity at grid-edge
6. A significant need for R&I in power and gas system solutions including system-concepts (PtG), market solutions and systemoperation to realise the full potential using the power and gas-grid.
7. More use of digital technology (AI and big-data) mandatory to handle the more complex energy system in an optimal operation

Thanks for your attention

http://WWW.ENERGINET.DK/sys35

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Wow, it’s been a blast

Sustainable

Future

Developing

Inspired

Informative

Innovative

Sollutions

Researching

Smart

Added Value

Electric

Safe

New Statnett R&D programs

Prof.dr.techn.ir Sonja Berlijn MBA @sonja_berlijn

SVP R&D Statnett

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Stanett's R&D conference - Oslo, 3rd of April 2019

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Highlights

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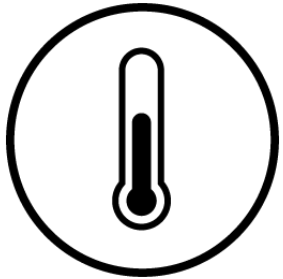
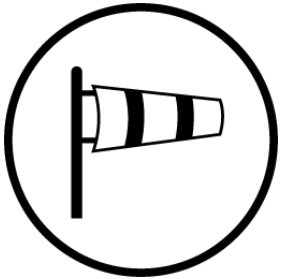
R&D Challenges – they are plenty





More BAMM R&D?

- Bold
- Ambitious
- Mission Driven
- Mega Cool

R&D vision 2020–2023

Stimulate and encourage innovation in the realization of a fully electrified Norway

Statnett's R&D efforts will lead to increased know-how, innovation and added value in a safe, secure and sustainable power system

New programs

Data driven decision support in real time

Co-operation in the future energy system

Digital, safe and
cost-effective infrastructure

Continuous knowledge generation

Statnett

Data driven decision support in real time

Know-how and innovations

- Security of supply
  - Prevent possible outages
  - Detect possible failures
  - Reduce outage time

With focus on

- Digitalisation (real time and automised)
- Secure and Cyber Secure
- Human – Machine Interface

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Digital, safe and cost-effective infrastructure

Know-How and Innovations

- Cost reduction through
  - Extend life time
  - Retrofit technologies and methods
- Optimal System utilization

With focus on

- HSE
- Infrastructure
- Cost effectiveness
- Digital possibilities

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Co-operation in the future Energy System

Know-how and solutions

- Sustainable Energy System
  - Flexible resources
  - Flexible Capacity
  - Planning

With focus on

- Value creation for Norway
- Cost efficiency

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Continuous knowledge generation

Build new strategic know-how

- Needed for the future power system
  - Universities
  - Research institutes
  - Industry and TSOs and DSOs

With focus on

- Value creation for Norway
- Know-How

Do you have a project proposal?

- Send your project proposal to fou@statnett.no
- https://www.statnett.no/en/about-statnett/research-and-development/do-you-have-a-project-proposal-/

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Thank you all for participating and making the conference a success!

Have a safe trip home