WEBINAR

CURRENT
Enabling Network Technology throughout Europe

The Benefits of Innovative Grid Technologies: Make Europe Fit for 55

Launch of the consentec Study

8 DEC | 14:30-16 CET

Agenda

Welcome by currENT Board Chair, **Susanne Nies**

Key report findings by **Christoph Maurer** and **Thaddäus Kreisig**, Consentec

Roundtable with

- **Giles Dickson**, WindEurope
- **Jan Kostevc**, ACER
- **Gert Brunekreeft**, Jacobs University Bremen
- **Antonella Battaglini**, Renewables Grid Initiative
- **Alan Croes**, ENTSO-E

Roundtable and Q&A moderated by **Siobhan Hall**, Montel

Conclusions by **Anders Skånlund**, currENT Board member

INTRODUCTION

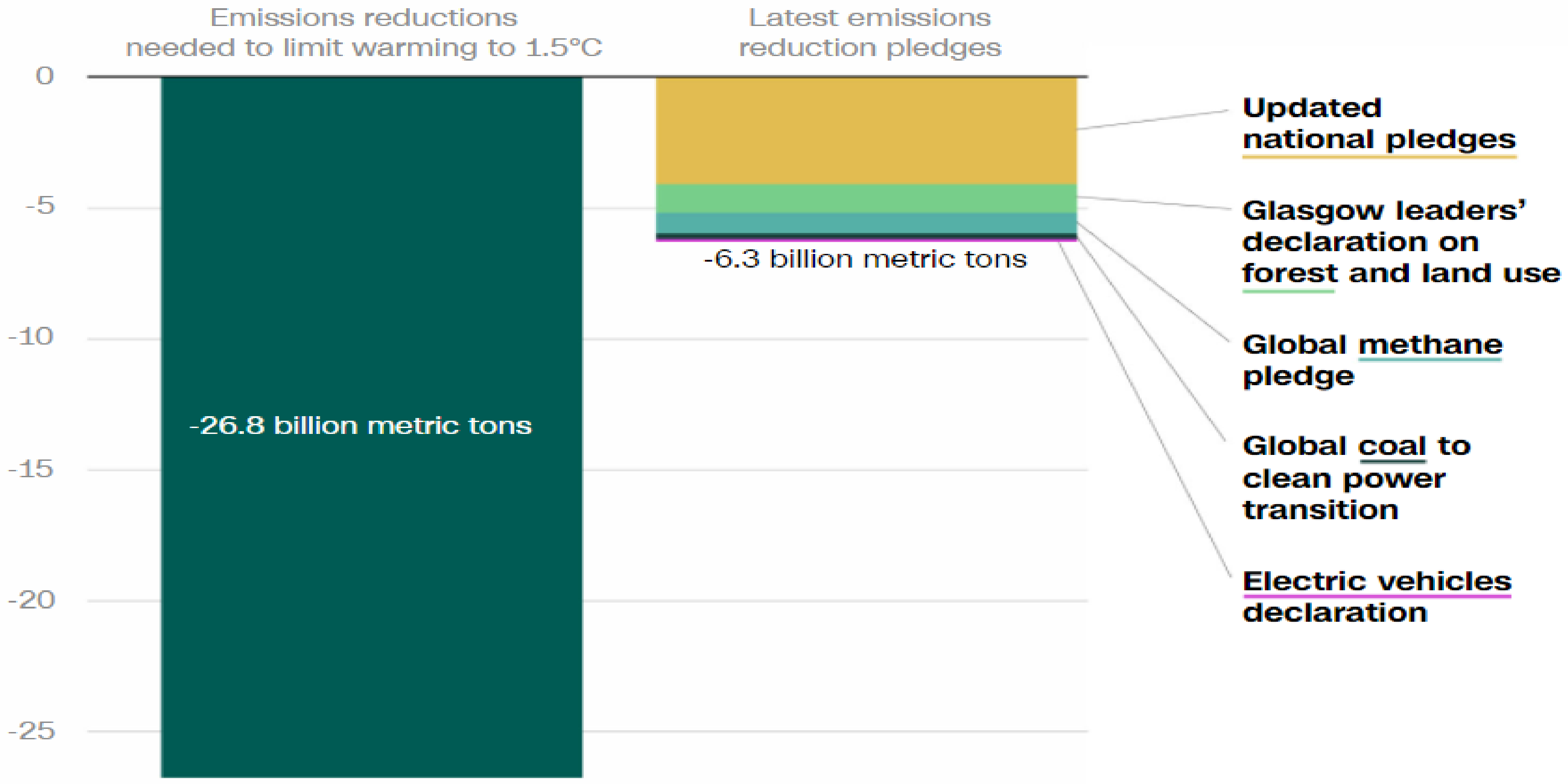
SUSANNE NIES

BOARD CHAIR
CURRENT EUROPE

CurrENT
Enabling Network Technology
throughout Europe

4,2 times more effort to reach Net Zero by 2030

Estimated reductions in annual global greenhouse gases by 2030, compared to current policies, in billion metric tons of CO_2 equivalents.



Note: Chart uses average estimates for current policy level projections and median estimates for emissions leading to 1.5°C of warming.

Source: Climate Action Tracker
Graphic: John Keefe, CNN

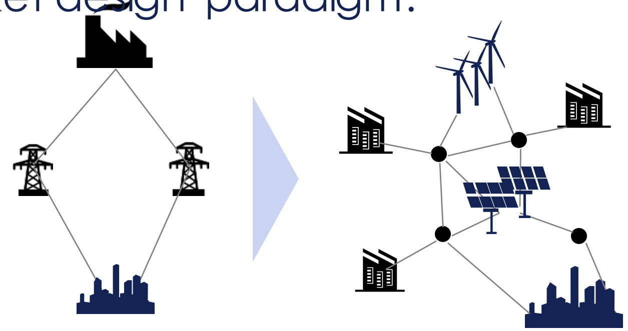
Why is the Grid essential?

It's the nexus of the energy transition …

Net Zero by 2050 … Annual investment in European grids needs to **double from €30 bn to €60 bn per year by 2030**[1]

[1] European Commission Communication, COM (2020) 741

Energy Transition … renewable energy adoption, distributed generation, electrification, storage, e-mobility … a new market design paradigm.



Integrated Digital Grid … a single holistic multi-directional system …the critical platform to unleash the Energy Transition.

"currENT's Vision is a European power network using innovative grid technologies to realise an efficient, renewable and decarbonised power system"

currENT : who we are

currENT: the industry association representing innovative grid technology companies operating in Europe.

amsc
SUPERNODE™
GWP greenwood power
LINEVISION
VISION ELECTRIC Super Conductors
Ampacimon Smart solutions for a dynamic grid
OTLM KNILL GRUPPE
SMART WIRES
HEIMDALL POWER
depsys

How can we modernize The Grid?

Digitalization provides real-time data, analysis and control

- Innovative grid technologies…data analytics and modeling, topology optimization, dynamic line rating and modular power flow control.
- Innovative Grid technologies = digitalization = real-time awareness, analysis and control … solving:
    - Congestion
    - Resilience
    - Harmonics
    - Optimization
    - Future Proofing
- Unleashing the Energy Transition … delivering a green economy, innovation, jobs and addressing climate change.

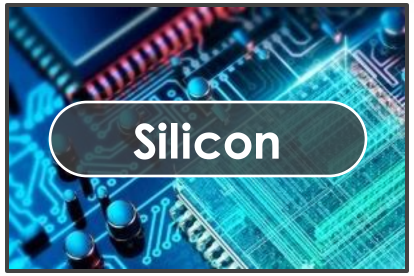
Transition to a digital grid

TODAY'S GRID

+

and costs rise! Copper ca € 14000, + 1000 in a month..

FUTURE GRID



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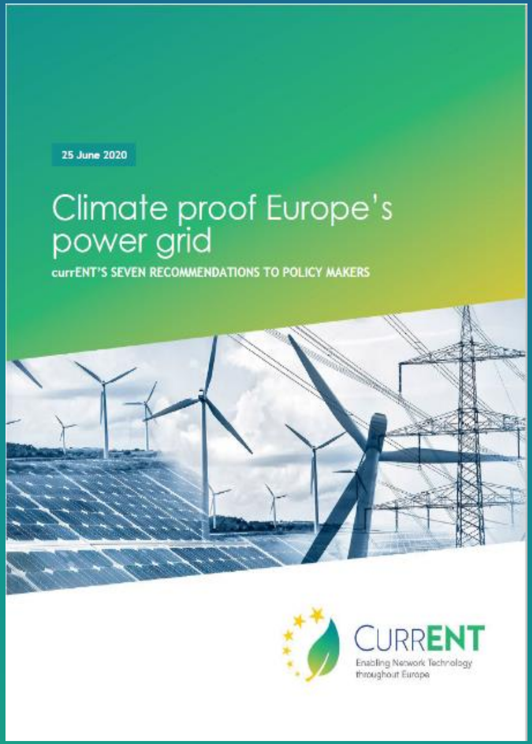
ACER just published its report

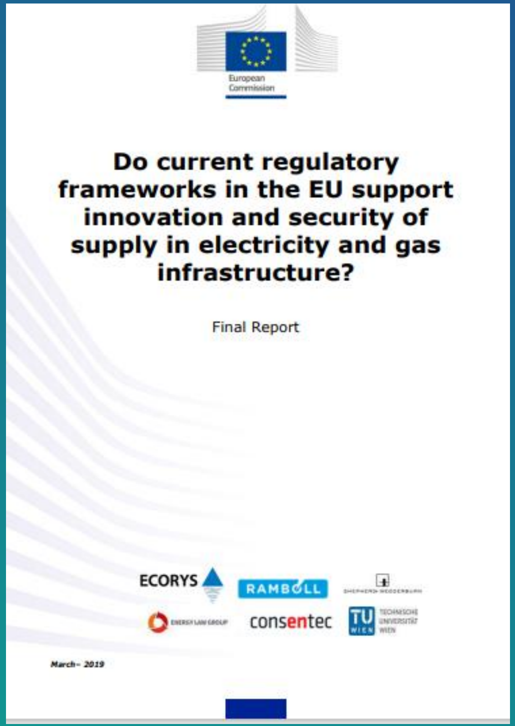
Released on 22nd November 2021

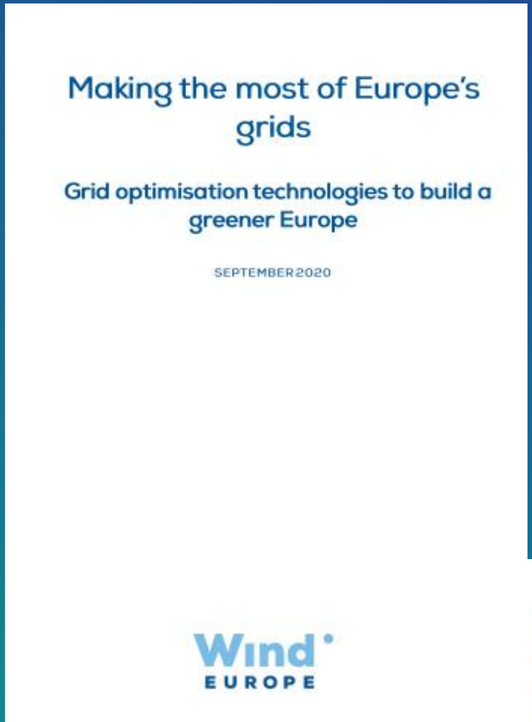
ACER
European Union Agency for the Cooperation of Energy Regulators

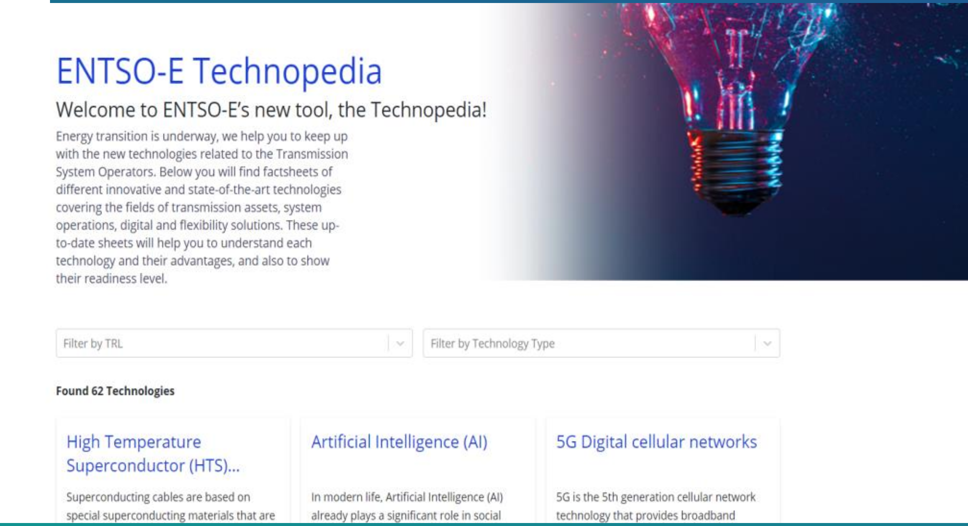
Position on incentivising smart investments to improve the efficient use of electricity transmission assets

It has all been said! Why is it not happening?









CurrENT
Enabling Network Technology throughout Europe


CHRISTOPH MAURER
MANAGING DIRECTOR
CONSENTEC
THADDÄUS KREISIG
CONSULTANT
CONSENTEC

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Scope of the Study

Background	▪ Long-distance transmission of electrical energy intensified significantly over the past decades and will continue to increase ▪ Driven by electrifying all energy sectors ▪ Rapidly growing share of renewable energy power generation, often installed at a great distance from load centers ▪ Grid reinforcement is needed and planned, but has fallen behind due to public resistance ▪ Innovative technologies available to help to ensure cost-efficient grid reinforcement
Objective	▪ **Quantify benefits that are achieved by using three different innovative technologies (see next slides)** ▪ **Qualitative analysis of the three technologies (see report)**
Methodological approach	▪ Study focusses on savings in redispatch costs possible due to applying innovative grid technology in the target year 2030 ▪ Cost savings are calculated by comparing a reference scenario without the three technologies to four different technology scenarios: one for each technology and one, where all three technologies are combined

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Technologies considered

Dynamic Line Rating (DLR)

TRL 9[1)]

- (Static) line ratings (SLR) are the most important reference for contingency analysis carried out by TSOs
- Sensor-based dynamic line rating considers weather conditions directly at the line → can reduce security margins
- *Base case: max. line rating 140% of SLR // max. 3.6 kA*
- *DLR scenario: max. line rating 150% of SLR // max. 4.0 kA*

Static line ratings are commonly set to defensively account for high temperature and low wind speed

In both scenarios all lines were equipped with DLR

Modular Static Synchronous Series Compensator (M-SSSC)

TRL 7 – TRL 9[1)]

- M-SSSCs allow for controlling power flows in AC power grid by injecting a controllable voltage into a circuit
- Key contribution of M-SSSCs: capability to relief congested lines and redistribute flows to lines with lower utilization
- *M-SSSC scenario: Implementation of 17 M-SSSC sites*

Further operational benefits like acting as sources of reactive power were not considered

Superconductor DC system

TRL 5 – TRL 6[1)]

- Superconducting cables have close to no resistance and can transmit very high currents at low voltages (down to 100 kV)
- Can be applied for bulk long-distance power transmission
- *Base case: Suedlink (2x2GW HVDC) excluded from simulation*
- *SC-DC scenario: SC-DC system with 2x4.5 GW implemented at Suedlink grid connection points*

According currENT, costs for the 2x4.5 GW SC-DC system should be similar to cost estimated for Suedlink in GER-NDP

1) *TRL: technology readiness level awarded by ENTSO-E technopedia*
TRL 9 – system ready for full scale deployment demonstrated
TRL 8 – system incorporated in commercial design
TRL 7 – integrated pilot system
TRL 6 – prototype system verified

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Scenario for Target Year 2030 – Assumptions

Market simulation

- Green Deal approximated
- Flow-based market coupling in Core region → 70% MinRAM applied
- Gas-fired power plants more profitable than lignite and hard coal (EUR 80 per tCO_2)
- Cross-border trade intensifies
- Germany becomes net importer

Load flow and redispatch simulation

- Power grid modelling for entire Continental Europe
- Fully integrated cross-border congestion management in France, Belgium, The Netherlands, Luxembourg, Germany, Denmark West, and Austria
- All grid expansion projects assumed to be commissioned on time (rather optimistic)

Except for one HVDC connection within Germany, for which a design with superconductors was explored

Quantitative Assessment of Innovative Technologies

Modelling steps

(1) Defining scenarios

(2) Flow-based market coupling

(3) Power grid simulation

(4) Redispatch simulation (reference)

(5) Sensitivities w/ innovative technologies

Results

Steps (1)–(2):

- Market-based infeed of generation assets
- Nodal load and power injections into the power grid

Step (3):

- Congestion in the power grid
- Identify areas with high overloads

Steps (4)–(5):

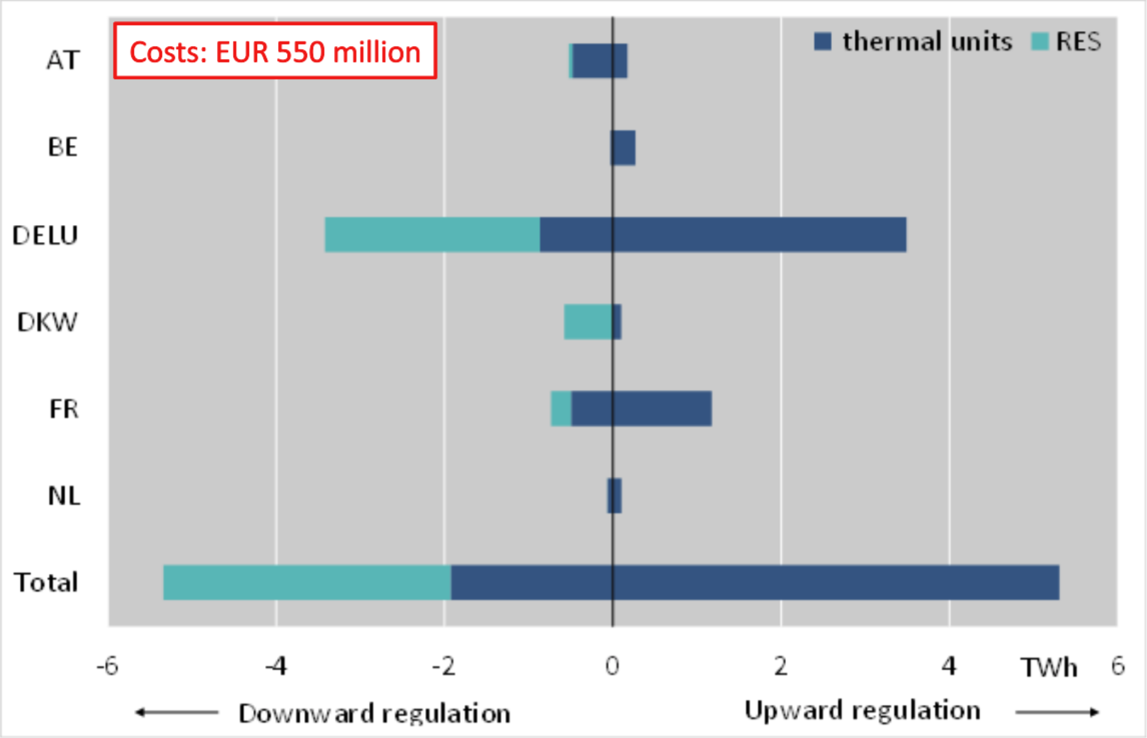
- Minimize CM cost s. t. maintaining system security
- Calculate CM cost savings brought by innovative technologies:
  - High penetration of **sensor-based DLR**
  - Extensive deployment of **M-SSSCs** for load flow control
  - Additional HVDC connection in Germany realized with **superconductors***

Main outcome of the study are savings in congestion management costs

Further benefits of innovative technologies were considered qualitatively

Modelling Results

Congestion Management in Reference Scenario



- Redispatching volume relatively low due to optimistic assumptions on grid expansion
- Most of the redispatching located in Germany
- Significant RES curtailment in DE (of which 80% is related to onshore wind)

5.3 TWh of redispatch in upward and downward direction

EUR 550 million cost for redispatching measures

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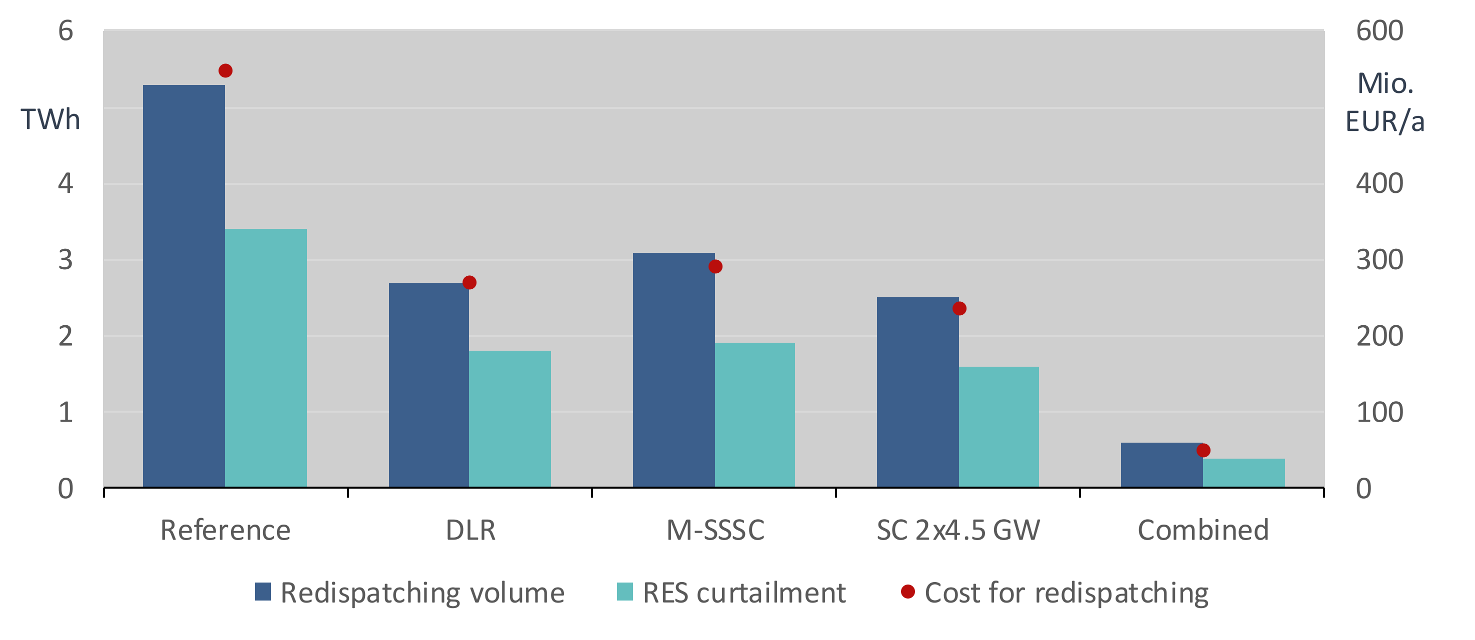
Modelling Results

Impact of Large-Scale Deployment of Innovative Technologies



In the considered scenario, Dynamic Line Rating and Smart Valve technology each reduce the volume of redispatch and costs by roughly 40%-50%

Additional HVDC connection with Superconductor technology could reduce the redispatch costs by roughly 60% (or 30% compared to normal HVDC cable at same cost level)

Combining the three technologies results in CM volume and costs savings of roughly 90% compared to the reference case, proving complementarity of approaches

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Main Messages & Conclusions

Significant impact

- Dynamic Line Rating, M-SSSCs and Superconductors can each significantly reduce the volume of congestion and congestion management costs in highly loaded transmission systems, thus helping to integrate RES generation and limiting need for RES curtailment

Complementarity

- While each of the innovative technologies will help optimize the power network individually, our study shows the complementary benefit of those technologies, too

Additional benefits possible

- Further benefits might include improved integration of markets, reduced price differences, faster employment of renewable generation, faster electrification of fossil fueled consumption and more emission cuts
- Explicit analysis has not been part of the present study

No substitute for grid expansion

- Efficiency and optimization using innovative technologies and the investments in reinforcement, and expansion of networks should be considered together to ensure a secure and cost-efficient green energy transition to society

MODERATOR

SIOBHAN HALL

BRUSSELS CORRESPONDENT
MONTEL

SPEAKER

GILES DICKSON

CEO
WINDEUROPE

SPEAKER

JAN KOSTEVC

ENERGY INFRASTRUCTURE TEAM LEADER
ACER

Energy transition can only be achieved if the grid is ready for it

ACER
European Union Agency for the Cooperation of Energy Regulators

The predominant “rate-of-return” regulatory frameworks have a **high CAPEX**-heavy investment bias

ACER
European Union Agency for the Cooperation of Energy Regulators

Key to incentivise grid innovation

Stick or carrot?

- Creativity cannot be forced (stick)…
- But, it can be **invited** (carrot)

- Need to **bridge the gap** between classical investment and lower-cost solutions
- Ultimately, it is the **network user** who benefits most from innovation

Don't miss: ACER paper on incentivising smart investments

SPEAKER

GERT BRUNEKREEFT

PROFESSOR ENERGY ECONOMICS
JACOBS UNIVERSITY BREMEN

GRID ENHANCING TECHNOLOGIES

Consentec, 2021, Benefit of Grid Enhancing Technologies, p. i:

> 2 The study and the related scenario show that the combination of Dynamic Line Rating, M-SSSC and Superconductors reduces the congestion and redispatch costs by more than 90% and the congestion-related curtailment of renewables infeed by 3 TWh in 2030. The value of other benefits from using these innovative technologies that might range from improved integration of markets, reduced congestions, and price differences to faster employment of renewable generation, faster electrification of fossil fueled consumption and more emission cuts, have not been part of this study.

Smart alternatives to grid expansion are highly beneficial

Despite convincing benefits, the implementation seems to be quite low as yet. This raises the following key questions:

1. Why is implementation low?
2. What can we do to improve this?

► Adjusting network regulation may address these two points.

INCENTIVE BIASES IN REGULATION

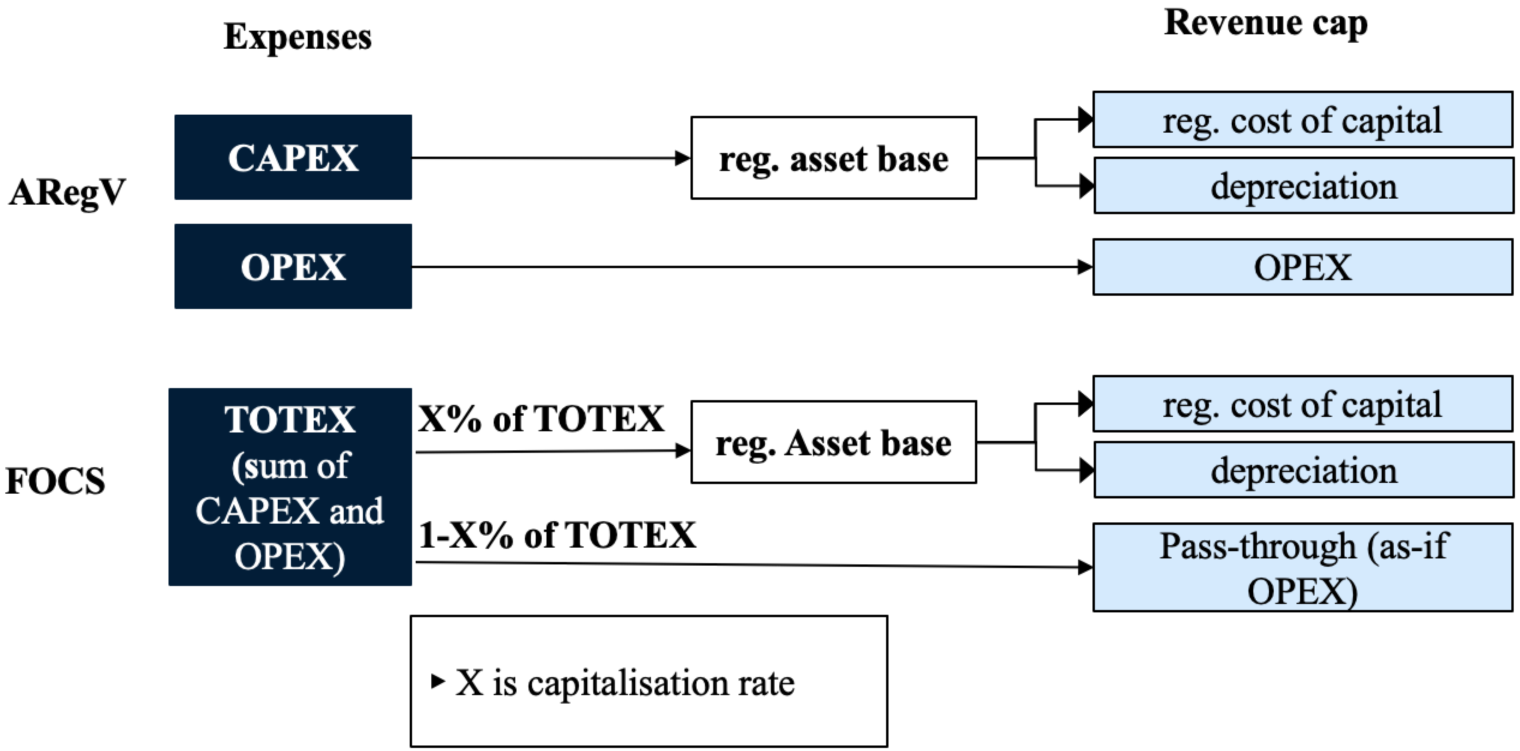
Problemarea	Incentive bias	Possible solutions
External – Costs and/or benefits are incurred by third parties, not by decision maker	New roles for network operators: *value creation*. Mostly not incentivized	Output-oriented regulation (OOR)
Internal – Cost and benefits are incurred by decision maker - aim of incentive regulation	• Base-year problem • OPEX—CAPEX-bias • Low incentives for pass-through cost-items (dnbK)	• Fixed-OPEX-CAPEX-Share(FOCS) • Project-specific budget-approach
Innovations & experiments: • Technical innovations • Regulatory innovations	• Uncertainty & risks • Free-rider problems	• Experimentsbudget • Regulatory Innovation Trial • Pionieerbonus

Brunekreeft et al, 2021, Weiterentwicklung der Anreize für Digitalisierung und Innovation in der Anreizregulierung der ÜNB, Study for TransnetBW, Stuttgart.
https://bremen-energy-research.de/wp-content/paper/211103_Bericht_TBW_FINAL.pdf

FIXED-OPEX-CAPEX-SHARE (FOCS)

A tool to address the OPEX-CAPEX-incentive-bias

FOCS is a variation of TOTEX-regulation, as implemented in the UK by eg. Ofgem.



- ► Ideally, FOCS makes the firm indifferent between CAPEX and OPEX; hence, the firm always chooses the least-cost option
- ► FOCS can be project-specific

Note: ARegV is the ordinance for incentive regulation in Germany

BUDGET APPROACH WITH SHARING FACTORS

A tool to address base-year effects

Budget approach

- Ex-ante predetermined project-specific budget; can be specified annually
- OPEX- and CAPEX-specific sharing factors
- Cross-network-operator implementation allows cooperative projects

Benefits

- Base-year effects addressed, as the starting year *is* the start of the project.

Challenges

- Budget must be settled with the regulator
- Strategic incentives to inflate the requested budget

Three extreme variations, depending on the sharing factors:

- Option 1: TOTEX-budget
- Option 2: OPEX-true-up
- Option 3: OPEX-budget

SPEAKER

ANTONELLA BATTAGLINI

CEO
RENEWABLES GRID INITIATIVE

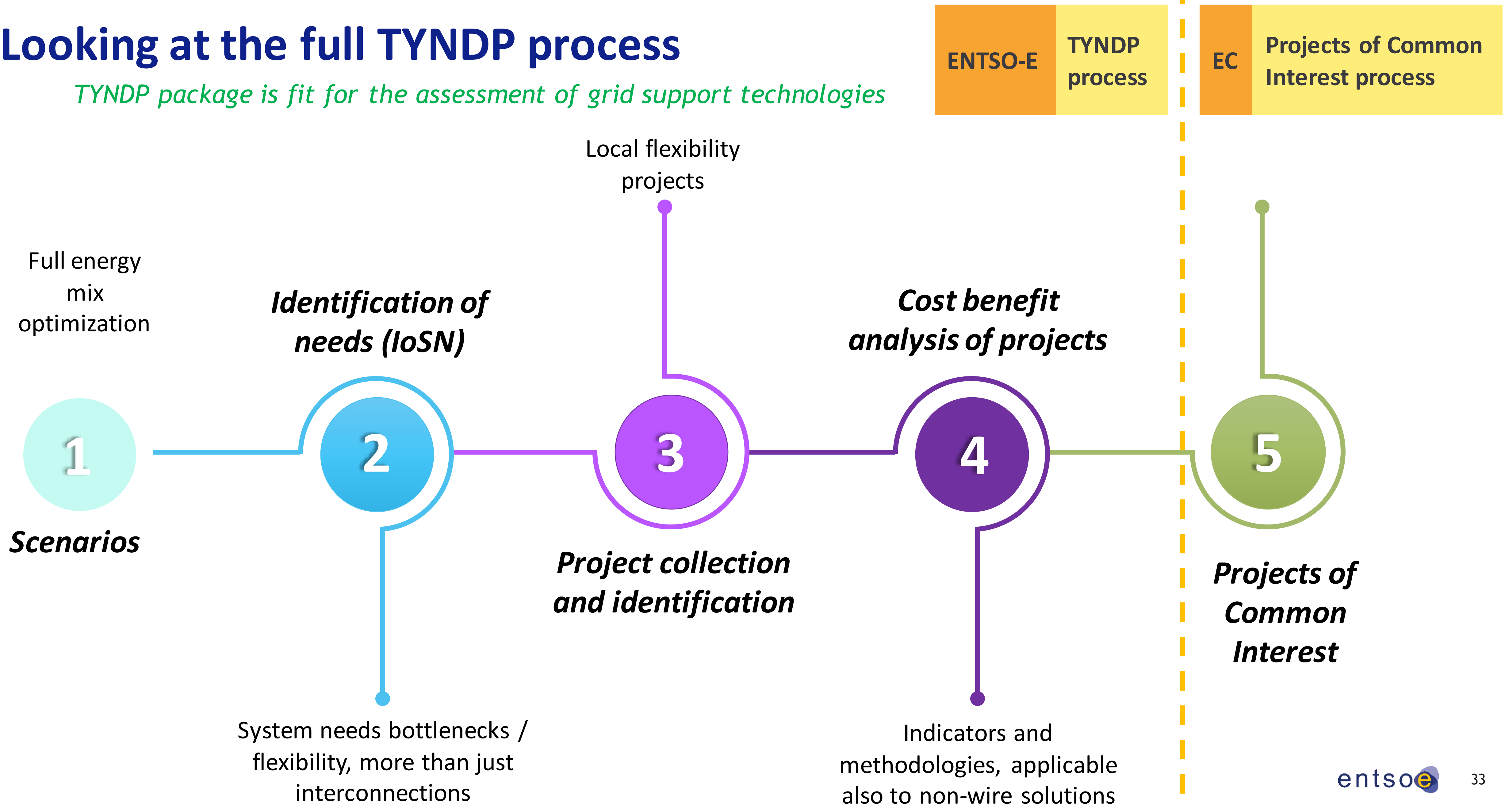
SPEAKER

ALAN CROES

CONVENOR SYSTEM DESIGN STRATEGY
CO-CONVENOR SCENARIO BUILDING STEER. GROUP
ENTSO-E

Looking at the full TYNDP process

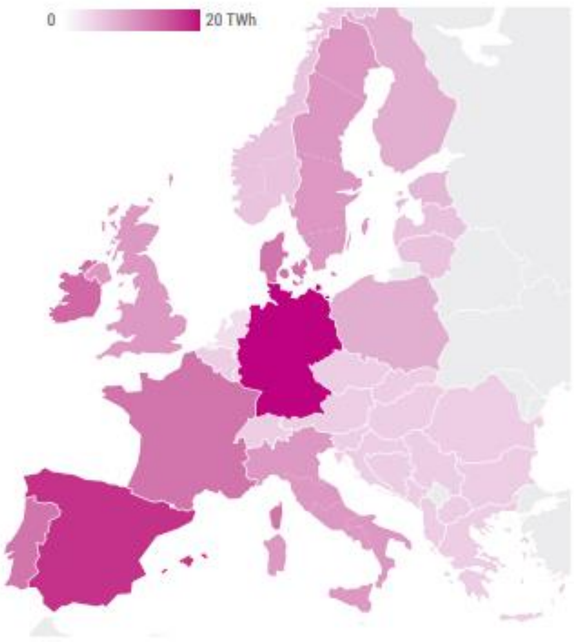
TYNDP package is fit for the assessment of grid support technologies



Flexibility and other technologies in 2020 and 2022 IoSN

IoSN 2020

Curtailed energy in TWh in 2040 - Countries with curtailed energy left in the SEW-based needs 2040, representing a total of 81 TWh that could be captured by other technologies (i. e. storage projects).



IoSN 2022

For IoSN on **2040 horizon**, interconnectors, **storage flexibilities and peaking flexibilities will be used as investment candidates.**

- ✓ Additional investment candidates in IoSN 2022 are planned to include storage and peaking needs
- ✓ Storage and peaking flexibility assumptions will be aligned with those used to develop TYNDP 2022 draft Scenarios
- ✓ Storage needs will represent hydro pump and battery storage investment candidates
- ✓ Peaking flexibilities are planned to be carbon-free

Expected output: an **optimal power system in 2040 with needs for transmission capacity increases on borders, and storage and peaking units needs per country**

ENTSO-E Technopedia

A new tool to guide through innovative & state-of-the-art technologies related to the world of TSOs

Assets and smart solutions	Flexibility	Digital
34 Factsheets	23 Factsheets	8 Factsheets

The primary technologies related to the energy transmission system according to the current TRL

CONCLUSIONS

ANDERS SKÅNLUND

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Cybersecurity, Digitalisation, and the Electricity Grid in Europe

How Dynamic Line Ratings Optimise the Grid

The Role that Direct Current (DC) Grids Can Play

Optimised Power Grids for a Clean and Green Future

Massive Renewables Uptake through enhanced grids: A transatlantic perspective

Working Group for Optimising Power Grids: Aligning Incentive Regulation with Public Interest

Accelerating the Energy Transition: Moving towards a Coordinated Approach
– TEN-E and European Grid Infrastructure

Spain’s Power Network towards a Zero Emissions future: The Role of the Grid and Innovative Technologies