Energy Ville

ENERGY IN TRANSITION

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Powering the future: challenges for energy supply in digital infrastructures

Bram De Wispelaere

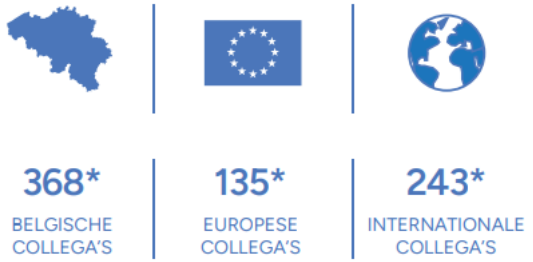
Bringing the right minds together to accelerate the energy transition

Energy Ville

KU LEUVEN vito imec UHASSELT

EnergyVille in numbers

- People : more than 700
- If which more than 600 researchers (50% international)
- More than 50 companies active in our laboratories
- 8 research lines:



Battery storage

Electrical networks

Energy for buildings and districts

Energy strategies and markets

Power electronics

Power-to-Molecules

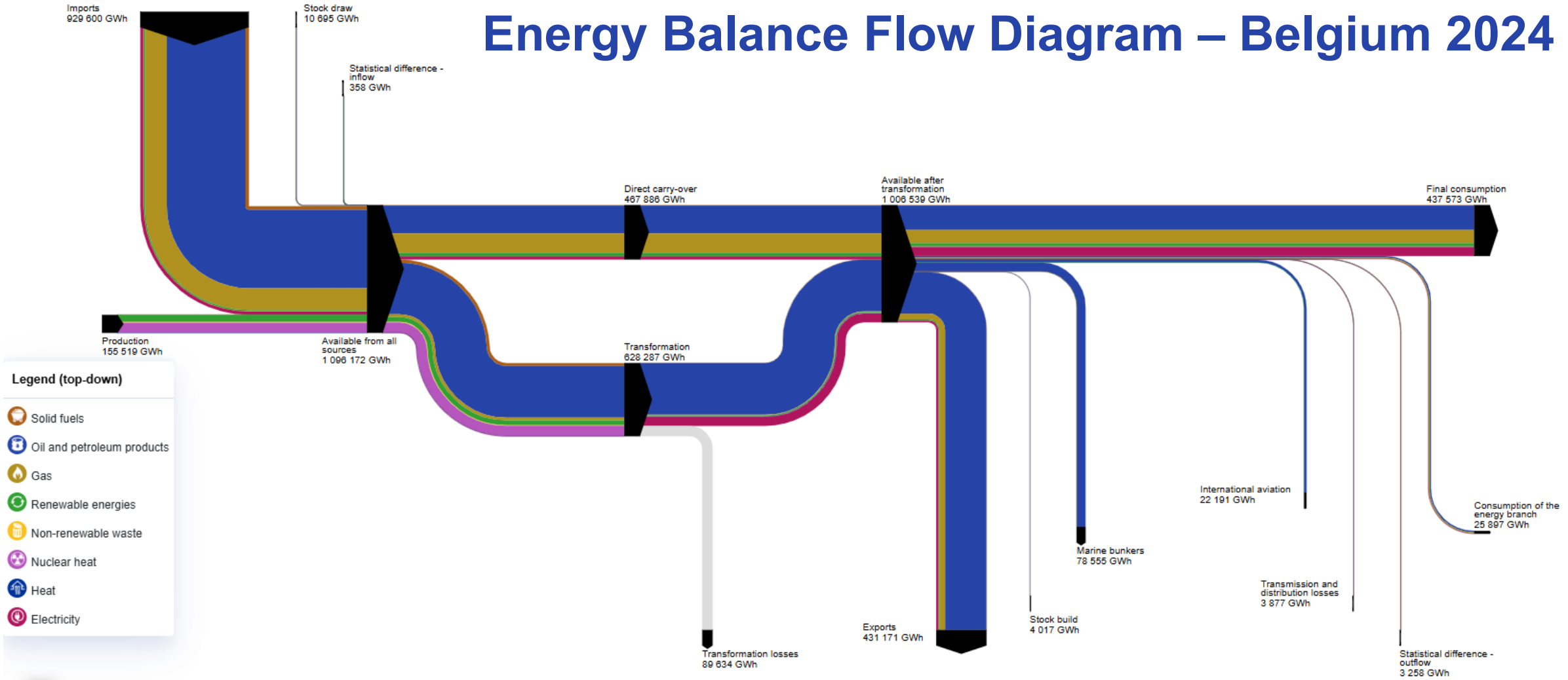
Solar energy

Thermal systems

From uncertainty to direction: why scenarios matter

Understanding today's energy system

Energy Balance Flow Diagram – Belgium 2024



PATHS 2050

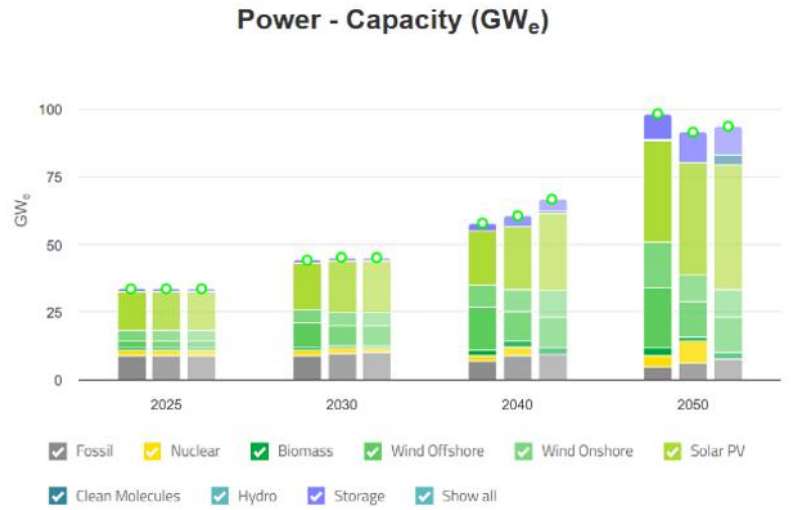
vito

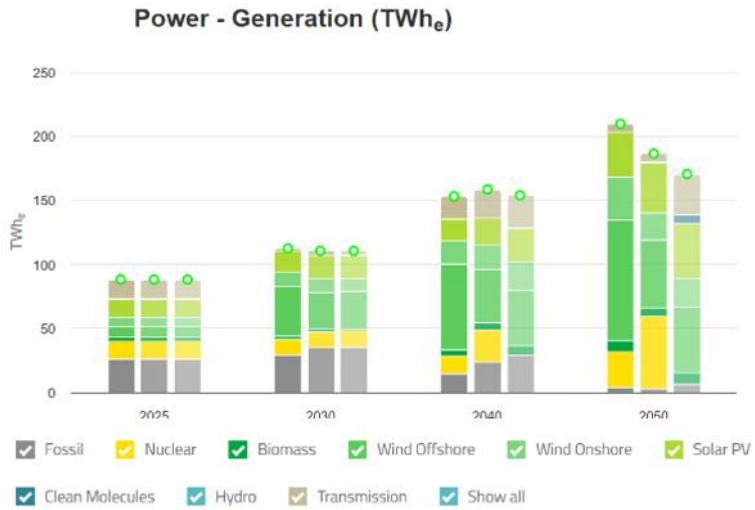
Scenario-based planning for robust investment decisions

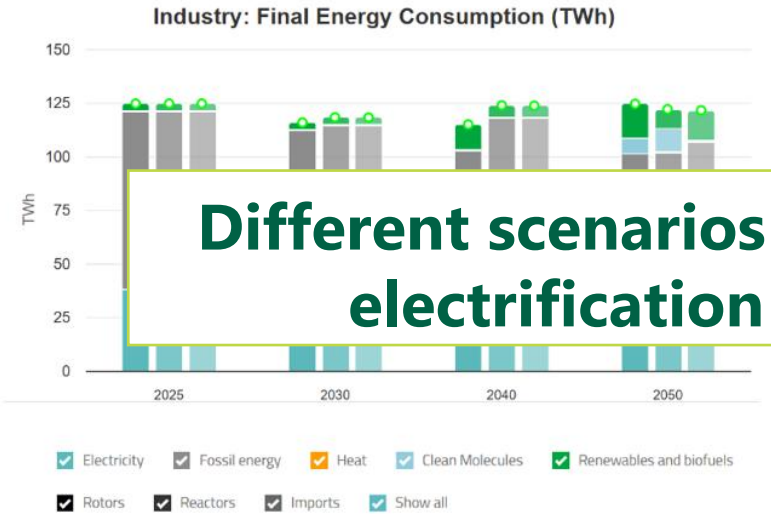
PATHS 2050 Coalition

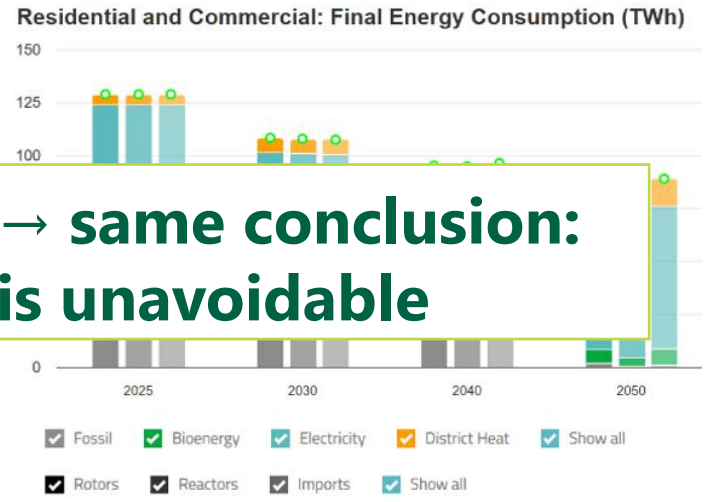
Long Term scenarios for Belgium/EU

ArcelorMittal
BASF We create chemistry
elia
fluxys
luminus
HOLCIM
otary
sck cen Belgian Nuclear Research Centre
ENGIE









Different scenarios → same conclusion: electrification is unavoidable

PATHS 2050

Electrification is a no-regret pathway — but demand is surging

- Today
  - 3,2 TWh electricity demand datacentres, of which
  - 1,4 TWh on Elia transmission grid

- Elia projections by 2034
  - + 15,8 TWh ‘reserved and allocated’ volume, which is much higher than what was expected to be build
  - Expected + 4,4 TWh on TSO&DSO level (Source: Elia Scenario 2023 -AdeqFlex2024-2034)

- PATHS2050 scenario assumption
  - Total of 12 TWh in 2050
    (which is more than the electricity use of the Flemish commercial sector today (11 TWh))

Datacenters = **non-linear growth driver**

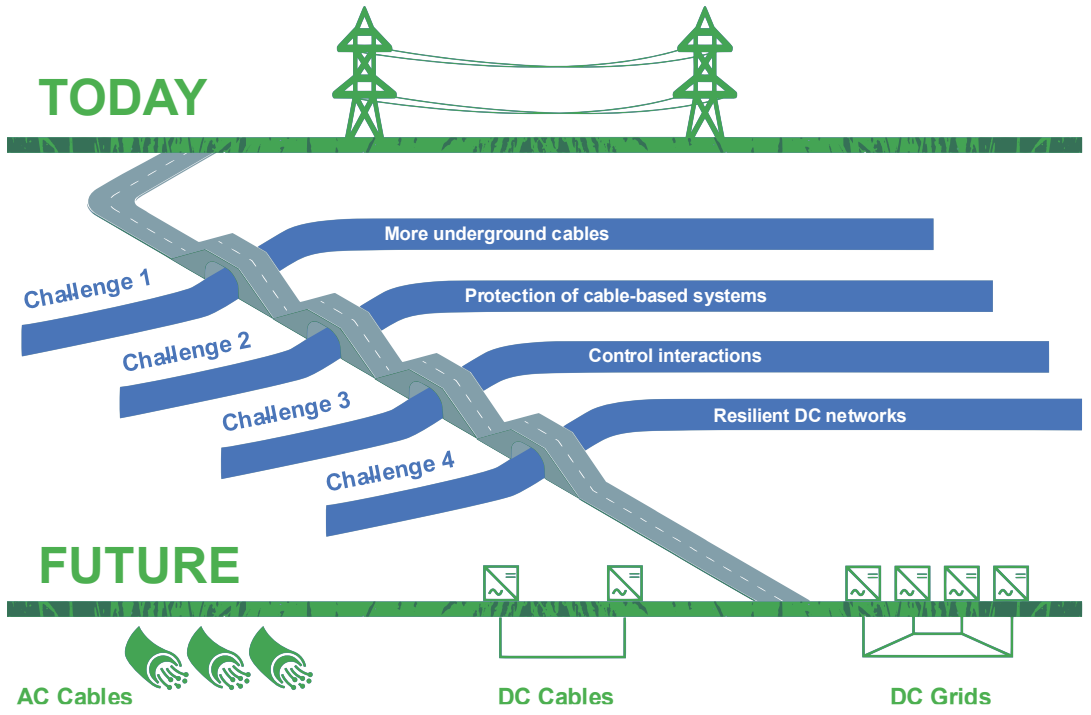
Implications for the energy system

Scaling grid infrastructure is necessary — but not sufficient

Etch: Energy Transmission Competence Hub

- The future transmission system shall be multi-gigawatt, **power electronics** based and **underground**
- Developing the future transmission system that is necessary to meet our sustainability goals is a mars-mission, which requires an acceleration to succeed, and this through coordination, cooperation and innovation
- To support this, Etch will:
  - **Research: underground (HVDC) grids**
  - **Collaborate with industry: partnership program**
  - **Develop workforce through training**
  - **Access to state-of-the-art research laboratory**

14 MEUR investment of Flemish government in research, laboratory and industry collaboration

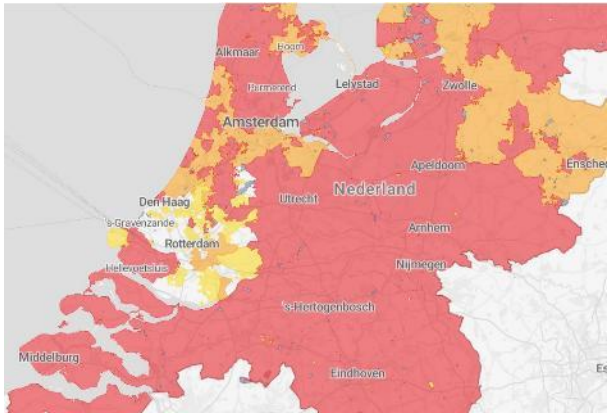


WEWIS
Departement Werk
Economie, Wetenschap
Innovatie & Sociale Economie

etch
Energy Transmission Competence Hub

A more complex and less stable power system

Congestion & System Challenges

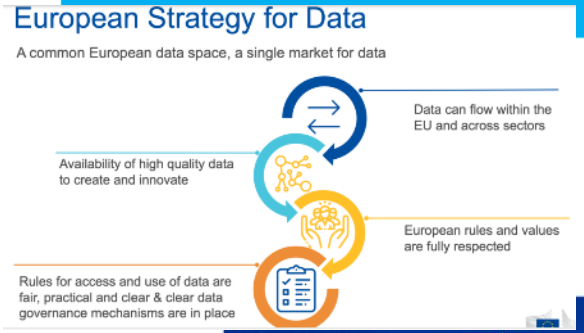


Volatility

Incompressibility

Low inertia

Digitalisation



Digital substation

Security & Resilience

Beyond infrastructure: smarter grids are essential

Advanced tools for active grid management

Extensive set of models and tools for active grid management

PMDSE: monitoren van distributienetten (en load flow berekeningen en andere optimalisaties) [openbaar]

LineCableModels: nauwkeurige modellen van kabels [openbaar]

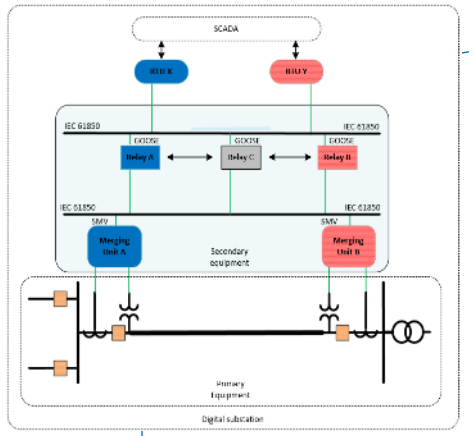
FlexPlan : **planning van transmissie- en distributienetten met hernieuwbare energiebronnen [openbaar]**

PowerSystemRestoration: optimaal herstel van het energiesysteem [*niet* openbaar]

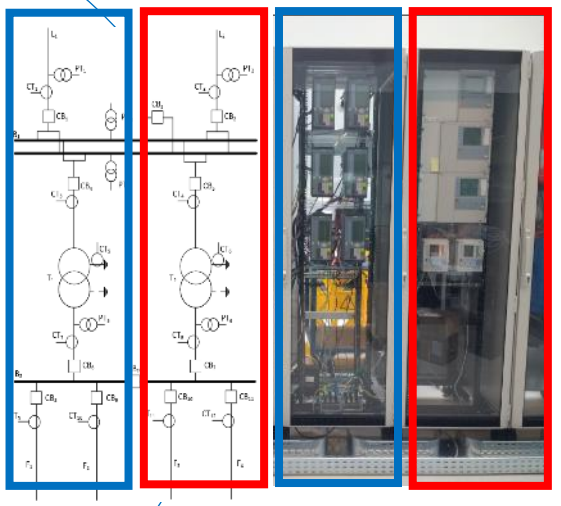
PMACDC: optimalisatie en load flow berekeningen voor AC/DC netten [openbaar]

Digital substations: towards smarter and more secure grids

Towards more efficient, simpler, and maintenance-friendly substations, including cybersecurity: Digital substations



DIGITAL SUBSTATION



Multi-vendor interoperability testing

CYPRESS

Improving coordination across grid levels

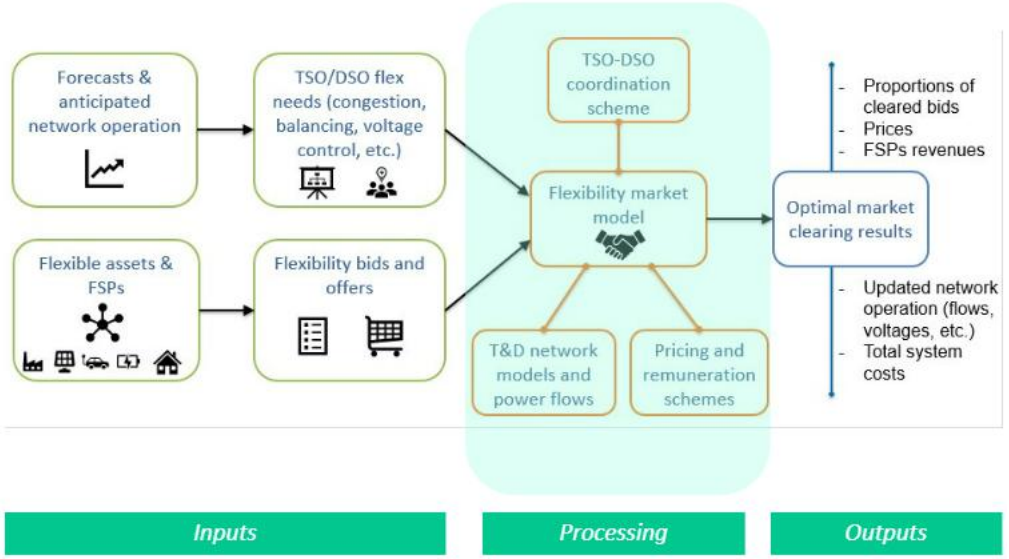
Operational tooling for TSO-DSO coordination

Key selling points

- ✓ Automatic
- ✓ Optimal
- ✓ Grid-aware
- ✓ TSO-DSO coordinated
- ✓ Market integrated

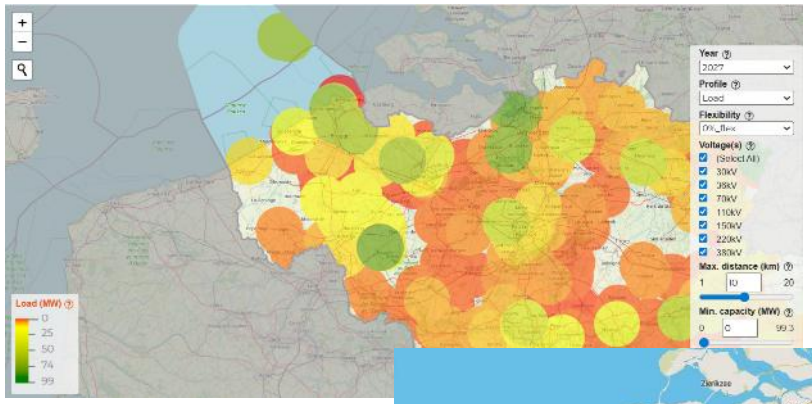
Optimization-Based Market Clearing Module

A market-clearing engine for flexibility markets allowing TSOs and DSOs to automatically and coordinately purchase flexibility bids at minimum cost

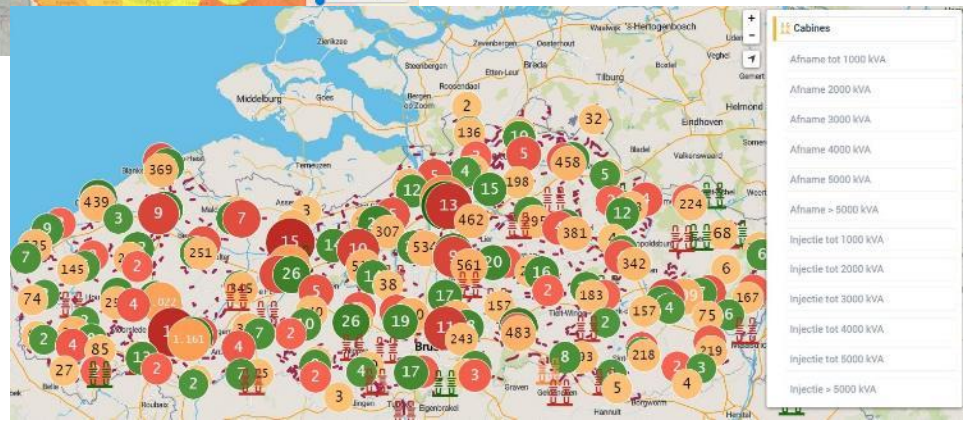


But this is not enough

Grid congestion is becoming a structural bottleneck



Source: Elia

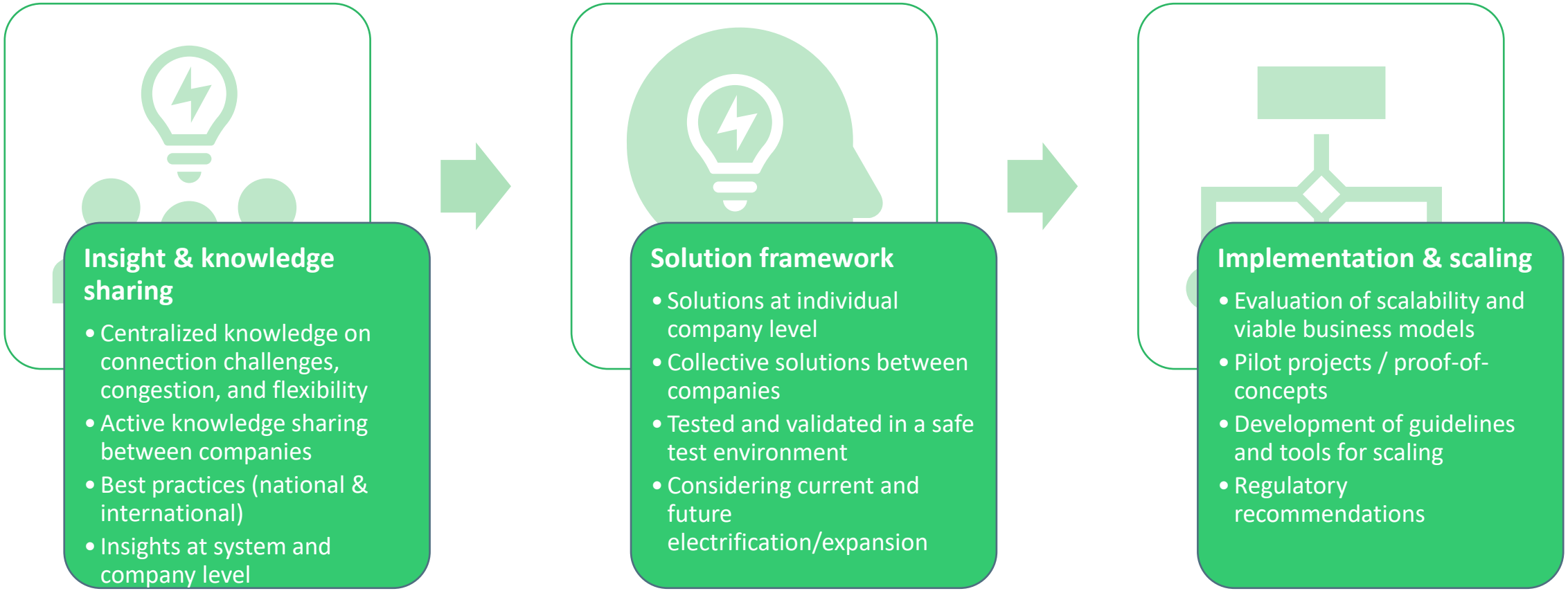


Source: Fluvius

- Rapidly increasing grid congestion and connection scarcity
- Delays sustainability targets and limits industrial growth
- Fragmented insights and limited shared understanding
- Uncertainty on impact and value of flexibility solutions
- Slow translation from insight → scalable solutions

From technical solutions to coordinated action

Unlocking solutions through coordination and knowledge sharing



Insight & knowledge sharing

- Centralized knowledge on connection challenges, congestion, and flexibility
- Active knowledge sharing between companies
- Best practices (national & international)
- Insights at system and company level

Solution framework

- Solutions at individual company level
- Collective solutions between companies
- Tested and validated in a safe test environment
- Considering current and future electrification/expansion

Implementation & scaling

- Evaluation of scalability and viable business models
- Pilot projects / proof-of-concepts
- Development of guidelines and tools for scaling
- Regulatory recommendations

“None of us is as smart as all of us”

Ken Blanchard
author of “The One Minute Manager”