

Break-out session

Grid Congestion & Infrastructure

4TU x DSO MATCHING SYMPOSIUM

Date: 2 June 2026
Time: 10:00-16:00
Place: Liander Duiven

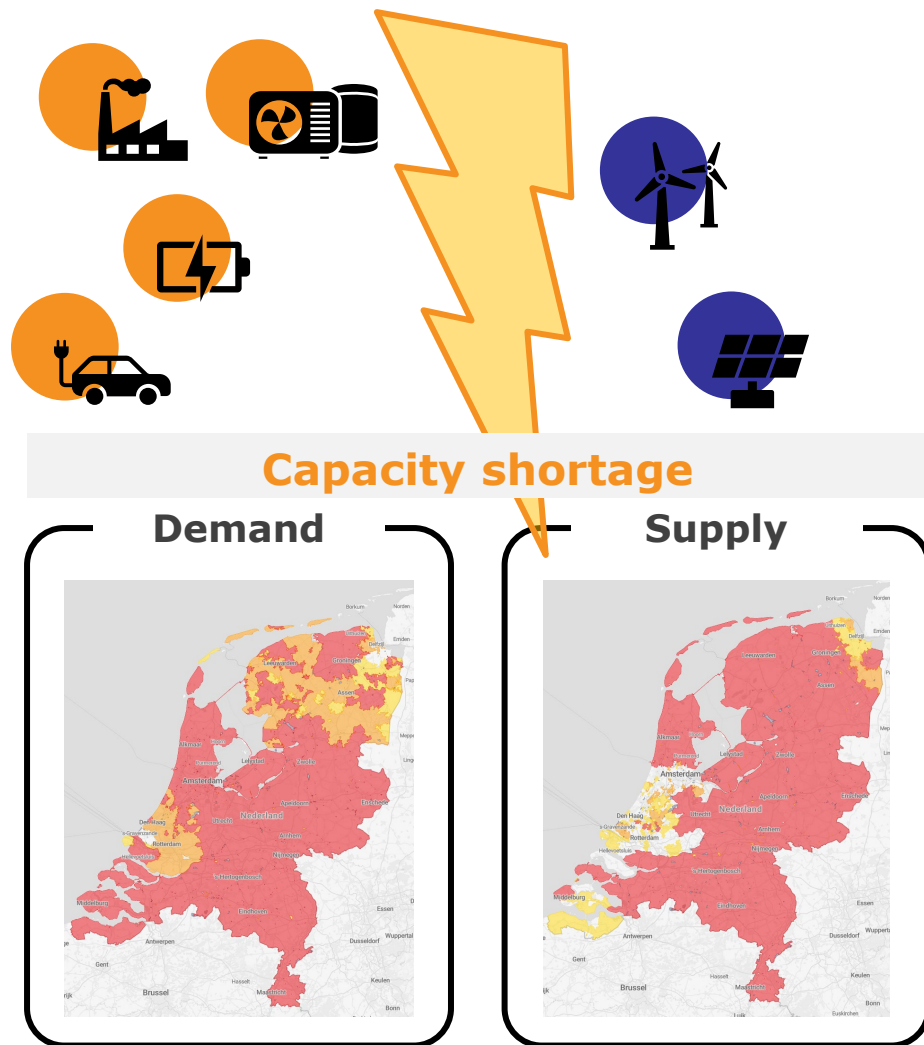
Topics:
Grid Congestion & Infrastructure
Flexibility in the Energy System
Energy Hubs

GCSC
Kwetta
Netbeheer Nederland
ENEXIS NETBEHEER
alliander
STEDIN
VORTECH
TNO
TU Delft
TU/e
UNIVERSITY OF TWENTE
WAGENINGEN UNIVERSITY & RESEARCH
4TU+
university of groningen
TILBURG UNIVERSITY

Moderator:

Dr. Elke Klaassen (Enexis, TU/e)

Grid Congestion & Infrastructure



[NBNL Landelijke capaciteitskaart](#)



Insights and solutions

Grid Congestion & Infrastructure



Dr. Elke Klaassen
Enexis, TU/e



Dr. Arjan van Voorden
Stedin, TUDelft



Dr. Irena Dukovska
Alliander, TU/e

Program 11:00 – 12:30

DSOs and industry pitches

● *Small coffee break* ●

Academia pitches

Discussion and wrap-up



Mike Lazelle
Kwetta



Conor Richards
Kwetta



Dr. Elham (Eli) Shirazi
UTwente



Dr. Nataly Bañol Arias
UTwente



Aditya Pappu
UTwente

How to handle capacity shortage?

Dr. Elke Klaassen

Strategisch Expert at Enexis

Assistant Professor at TU/e

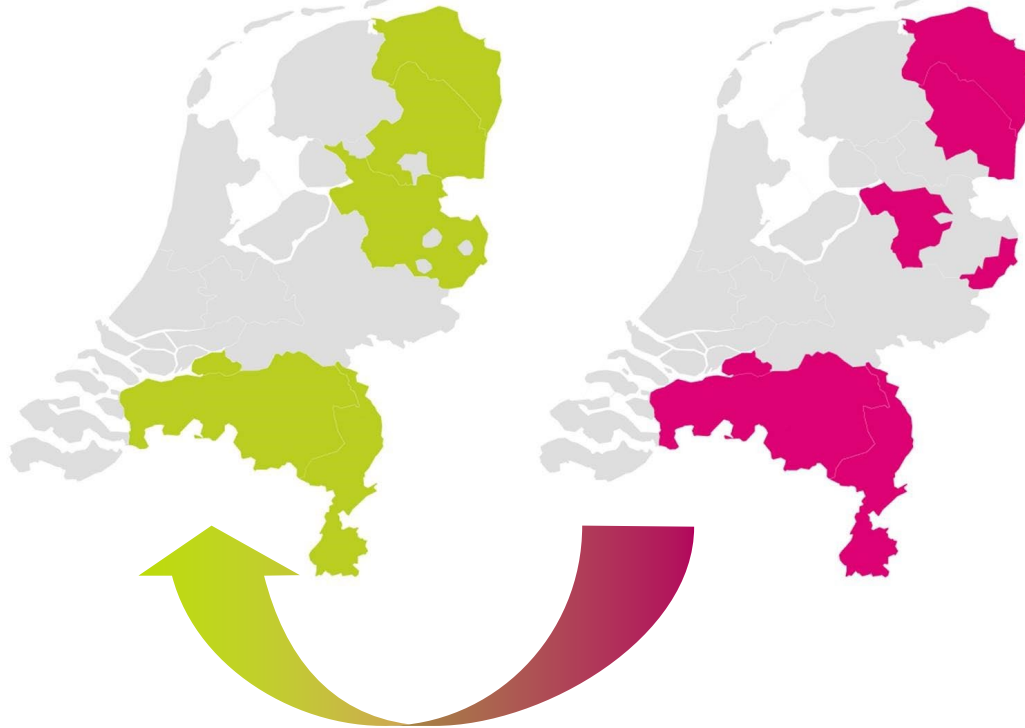


The impact of the energy transition on Enexis

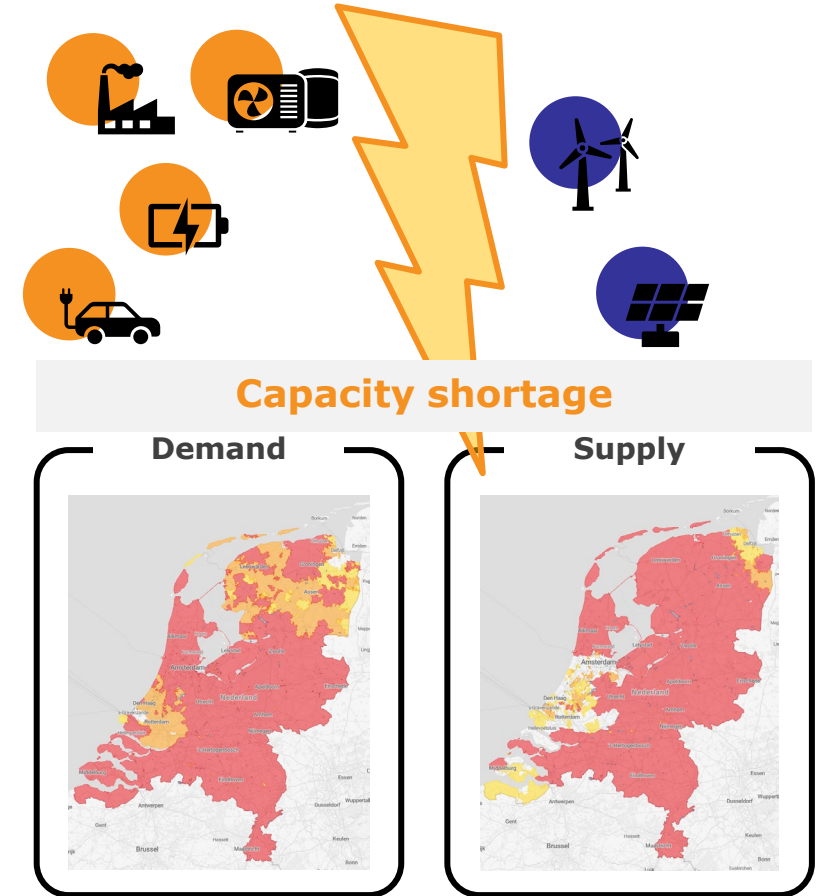
Electricity and gas networks operated by Enexis

Elektriciteit

Gas



As a result of the energy transition, the electricity grid is becoming the **backbone of the future energy system**, with electricity demand expected to **double** or **triple** by 2050.



[NBNL Landelijke capaciteitskaart](#)

Not just NL

Belgian grid operator publishes grid capacity map

Belgian network operator Elia says its new grid map shows available capacity, in addition to existing and already reserved capacity. The map, which considers growth in residential load and generation, shows that there might still be enough free capacity for 3.3 GW of solar and 2.8 GW of storage.

DECEMBER 15, 2023 El

Austria publishes map of locations with available grid capacity for PV

The Austrian government introduced the Electricity Industry and Organization Act (ElWOG) two years ago, leading to the creation of a map of locations with available grid capacity for solar. The ElWOG require grid operators to be transparent about grid-connection capacity.

AUGUST 7, 2023 SANDRA ENKHARDT

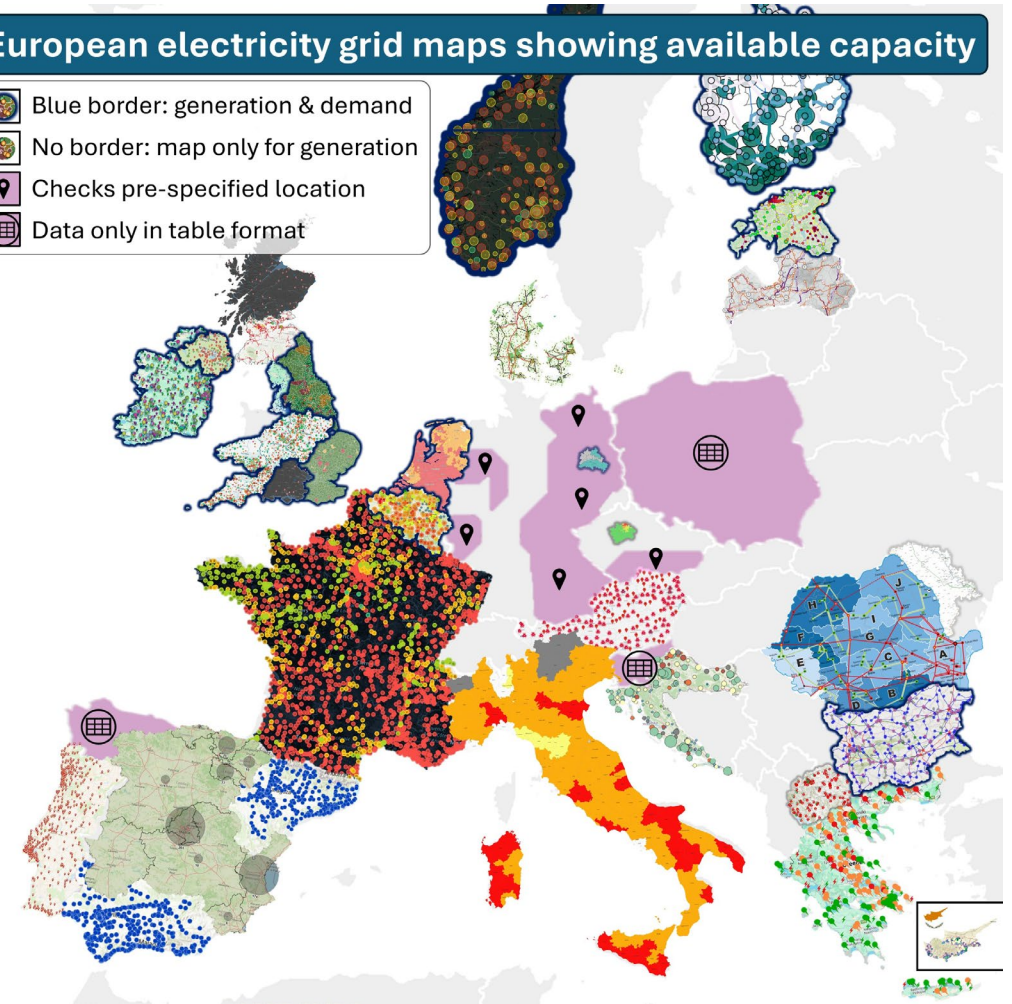


Home > All news items > Map of hosting capacities for storage Add to favorites

RTE publishes a map of hosting capacities for storage. It displays, for each electrical substation, the highest hosting capacity (in MW) available for a storage facility without power limitation.

European electricity grid maps showing available capacity

- Blue border: generation & demand
- No border: map only for generation
- Checks pre-specified location
- Data only in table format



[European Grid Capacity Maps](#) developed by Maarten Staats

HOW TO HANDLE CAPACITY SHORTAGE



Grid investments



Sweating the assets



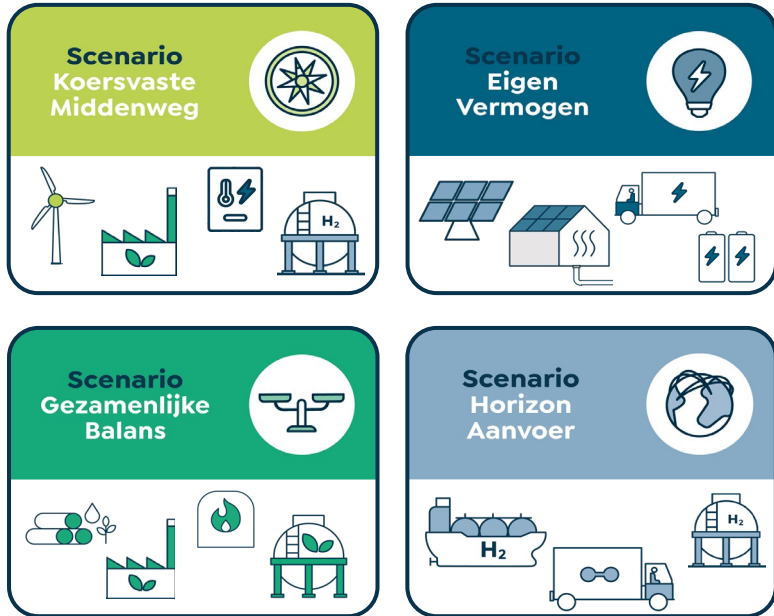
Flexibility



Optimize the system

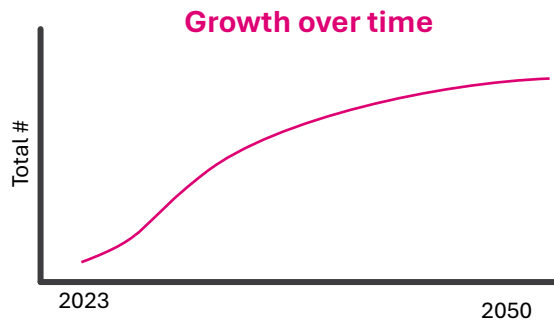
Design of the future energy system

Future scenarios – knowing **when**, **where** and **what** is needed and try to **limit impact**

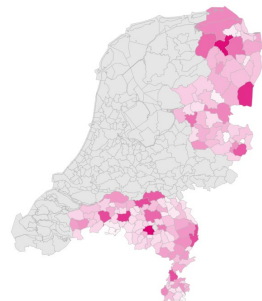


<https://www.netbeheernederland.nl/publicatie/netbeheer-nederland-scenarios-editie-2025>

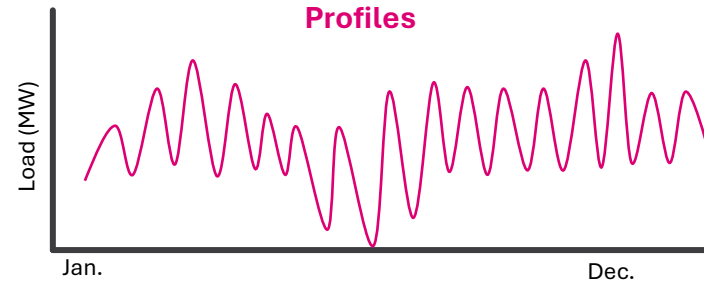
Per driver



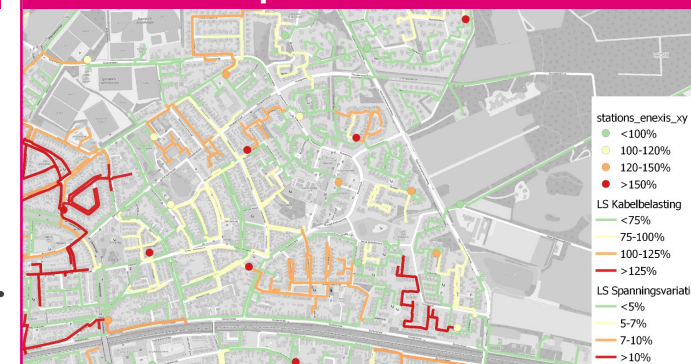
Regionalisation



Profiles



Impact on assets



Stedin, TUDelft

ARJAN VAN VOORDEN

The focus on the integral energy perspective

Arjan van Voorden, PhD.

Head of Strategic Planning of the Energy Systems

Research fellow TU Delft



SYSTEEMINTEGRATIE

Voor een betrouwbaar, betaalbaar, veilig en duurzaam energiesysteem

HUDIGE SITUATIE

Het huidige energiesysteem is niet houdbaar

HET ENERGIESYSTEEM IS GEBASEERD OP POSSIELE BRONNEN

DE ENERGIEKOSTEN STIJGEN

DE ELEKTRICITEITSVRAAG GROEIT 3X IN 2050

MEER HERNUEWBAAR ELEKTRICITEIT OPWERKEN 16X MEER WINDENERGIE + 22X MEER ZONNE-ENERGIE IN 2050

HET ENERGIESYSTEEM VERANDERT TE SNEEL



Warmtevraag stedelijk gebied

Terugleveren aan het elektriciteitsnet niet mogelijk

Terugleveren aan het elektriciteitsnet niet mogelijk

Lange wachttijd voor bedrijfsterrain op aansluiting elektriciteitsnet

Gas- en warmtevraag voor industrie

De juiste infrastructuur op de juiste plek

We hebben jullie nodig!

OVERGANGSSITUATIE

Samen nieuwe energiesystemen ontwerpen

Terugleveren aan het elektriciteitsnet niet mogelijk

Groen gas kan niet overal worden ingevuld

Eenzijdige afhankelijkheid restwarmte

Samen afspraken maken

Vroegtijdige en concrete plannen nodig

Flexibele contracten

Datadeling

Aanleg nieuwe infrastructuur

RANDVOORWAARDEN

TOEKOMSTSITUATIE

Iedereen toegang tot het energiesysteem

ELEKTRICITEIT UIT DUURZAME ENERGIEBRONNEN

Direct leveren aan het elektriciteitsnet

Conversie naar waterstof

Conversie naar warmte

Kortetermijnopslag

Seizoensopslag

Waterstof

Batterijen

Groen gas

Invoering van groen gas in het gasnet

Opwaardering van bestaand naar groen gas

Waterstof voor mobiliteit

Waterstofnetwerk gebouwd

Opwaardering van bestaand naar groen gas

Waterstof voor mobiliteit



DUURZAME ELEKTRICITEIT



DUURZAME MOLECULEN



DUURZAME WARMTE

Maakt waterstof



Veilig en klimaatneutraal



Betrouwbaar en betaalbaar



Een flexibel energiesysteem



Vraag en aanbod effectief aan elkaar gekoppeld

- The actual situation of the grid makes focus on the short term essential
- What we build should be ready for the expected future demand
- On the short term, flexibility can help to prevent congestion, but expanding the grid is essential.
- Too much focus on the electricity as the key energy carrier. The end-use is almost never electricity. It's only a low energy density carrier, however flexible and known.
- Beside of expanding the AC network, we need to investigate the role of DC.



UNIVERSITY OF TWENTE.



Alliander, TU/e

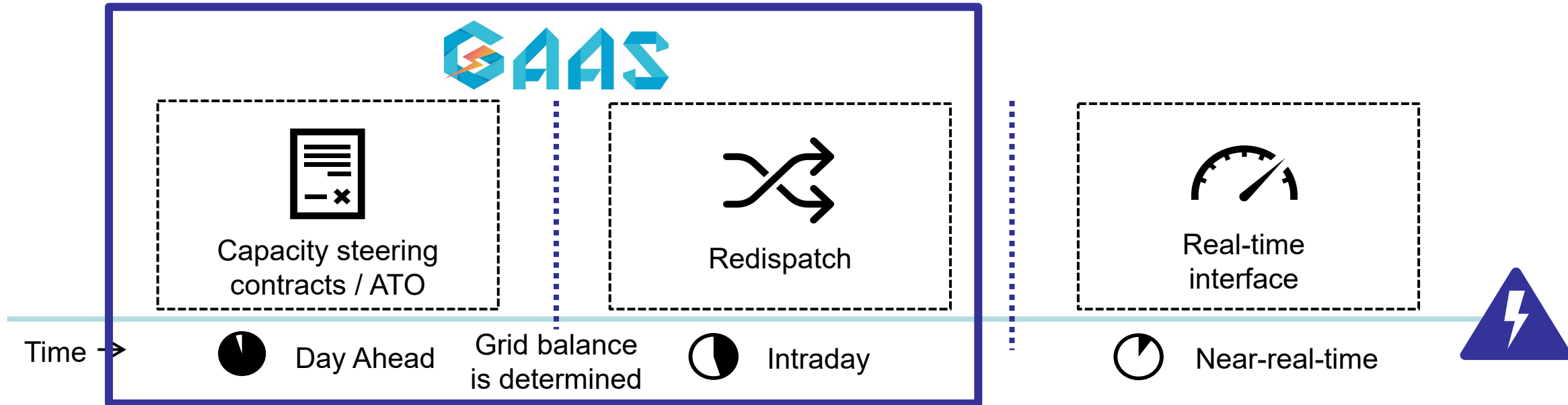
IRENA DUKOVSKA

Grid calculations in Congestion Management

dr. Irena Dukovska
Alliander | TU Eindhoven



System Operations Alliander



2500 contingencies

250 steerable customers

4000 MWh requested flex power

Grid as a service

Process/progress assistance & UI (dashboard)



Core functionalities

1. Creating an integral view

Creating forecasts



Determine topology



2. Determine problem & limit

Find limits



Check for overload



3. Solution & communication

Determine solution

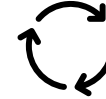


Communicate solution



4. Verify solution

Update overload information



Verify customer behavior



Virtual grid

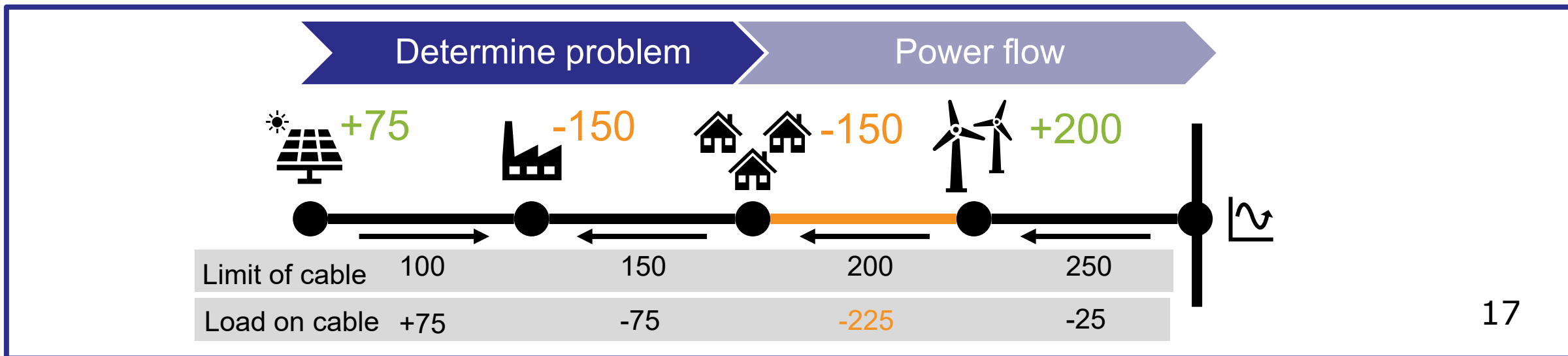
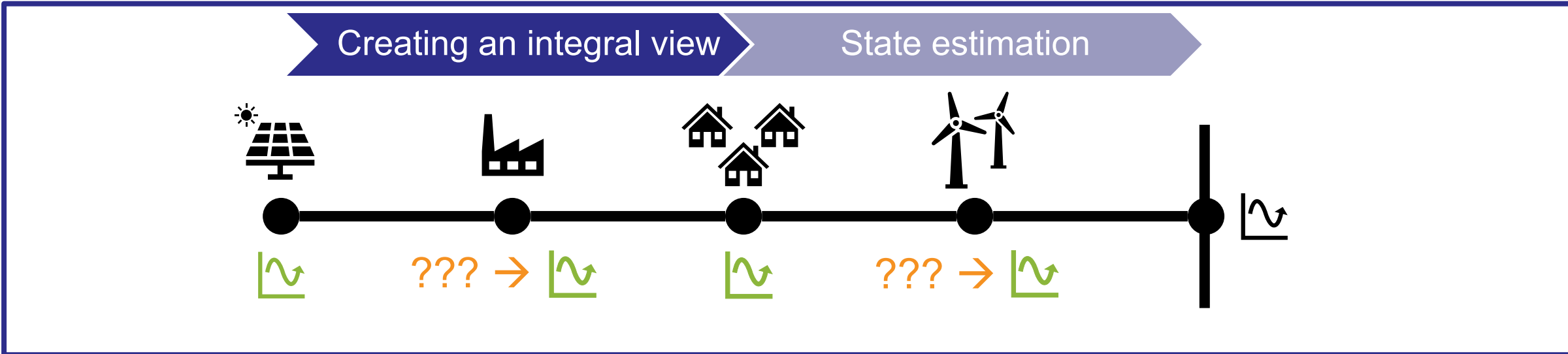
Measurements

Equipment and topology

Operational limits

Customers and contracts

Grid calculations for CM



Challenges & Opportunities

Data-driven grid calculations

Current use of classical calculations in with incomplete data/data with poor quality?

How to use data-driven calculations that can handle imperfect data and/or clean up and impute data to a sufficient completeness?

Forecasting in the blind

Less measurement data and more diversity for the customers in the MV grid.

How to represent uncertainty in the forecasts so that it is used in the problem and solution determination?

Customers in MV grid

Steering customers in the MV-grid requires more advanced uncertainty and risk management.

How to deal with complex interdependencies between inputs and uncertainty?

Beyond active power management

Rising need for voltage and reactive power management in MV grids.

How to manage different variables and balance assumptions and calculations for accuracy?

Kwetta

CONOR RICHARDS

EV charging that unlocks the grid.

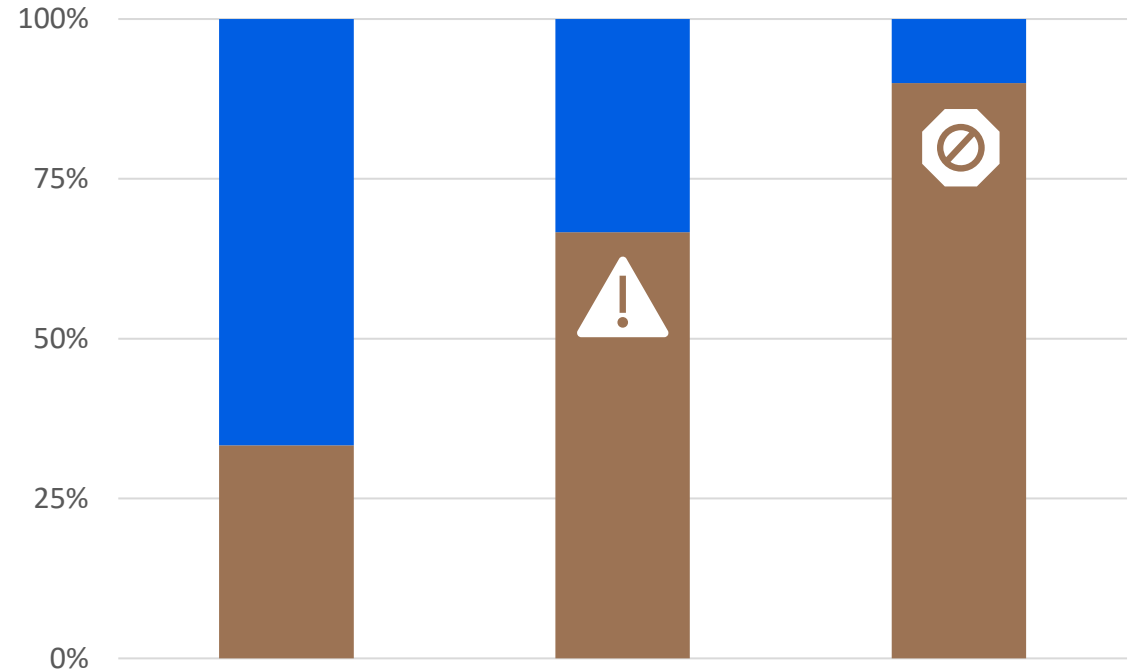
Conor Richards
Director of Growth and Tech



Grid Congestion: *Electrification is outpacing the grid*

- Traditional power grid design has led to an investment paradox; **Grids everywhere are overloaded whilst utilisation can be less than 10%**
- Grid connection queues exploding (**>10,000s long**) delaying connections for **10+ years** in many EU Countries
- Grid Congestion is costing the Dutch economy **€40Bn** annually (**4% of GDP**)

% Grid Feeders Constrained



- Aus/NZ
- UK
- Germany
- Norway
- Spain
- Netherlands

The growing constraints challenging Distribution Networks

To enable transport electrification, net architects must consider the following challenges:



1

Thermal Overload

High-current loads exceed asset thermal limits, risking overheating, accelerated aging, and forced derating of infrastructure. Organic Load Growth must also be accounted for within thermal limits.



2

Voltage & Power Quality

Unmanaged loads create voltage deviations, harmonics, and power factor issues, violating EN 50160/IEEE 519 and threatening grid stability.



3

Security Planning

N-1 redundancy, and extreme weather demand robust planning to prevent outages and ensure grid resilience.



“What if Power Grids could approve more capacity, but without taking on more risk?”

Advanced Grid Forming Inverters + Extreme Power Conditioning = Kwetta's Grid Unlock

Kwetta provides grid-forming power electronics and control systems that enable EV charging sites to operate as controllable, grid supporting and stabilising resources rather than unmanaged loads.



Prime Grid Gateway™

Connects at 6.6 to 22 kV, delivering up to 1.2 MW per unit. Multiple units can be connected in an HV ring with single or dual supply to deliver up to 12 MW per site with 99.99% reliability.



Grid Power Modules

Grid Power Modules actively regulate voltage, current and load sharing in real time, responding to charger demand and site constraints to deliver high availability and reliable charging.



Sky Hook

Flexible DC-fed dispensers from 200kW to MCS, designed for reliable operation in robust environments with industry-leading cable management.

Full Stack Grid Unlock in Action

Ampol – Wyong, NSW, Australia

Problem

Busiest Highway EV Charging Station in Australia (North & South Bound)

Insufficient network capacity to support required EV Charging

Sites fed off 2x panels, with differing levels of security & future capacity availability

Solution

Autonomous & real time dynamic operating envelope

North & South resiliency – shared flex capacity envelope
Min 1,000 – max 2,500

Voltage support trial under development

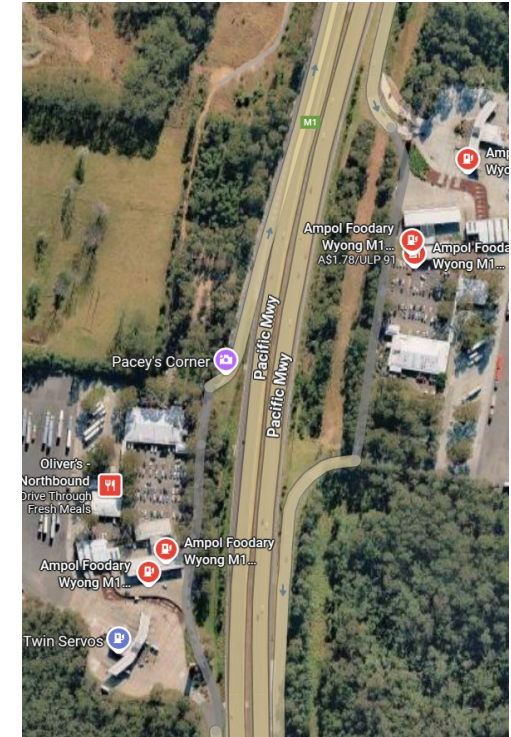
Outcome

Unlock >100% more power

Deferral of CAPEX for DSO

OPEX benefit for customer – dynamic trial tariff implemented

Increased network utilization



Create a genuine win-win: for customers and the power grids



>60% grid headroom unlocked at Wyong,

[Australia's Busiest Fuel Site for Australia's leading Fuel Company \(AMPOL\)](#)



>50% grid headroom unlocked at Ngātea,

[Strategic Location for NZ's Largest Fuel Company \(Z Energy\)](#)



>50% grid headroom unlocked at Tūrangi,

[Strategic Location for NZ's Largest Fuel Company \(Z Energy\)](#)



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ELI SHIRAZI

Congestion Observability in Distribution Networks Under Sparse Sensing

Elham (Eli) Shirazi, e.shirazi@utwente.nl

Assistant Professor, Faculty of Engineering Technology,
University of Twente



Observability

EDSO: "Observability in the grid means the ability to observe how conditions are in different places in the grid."

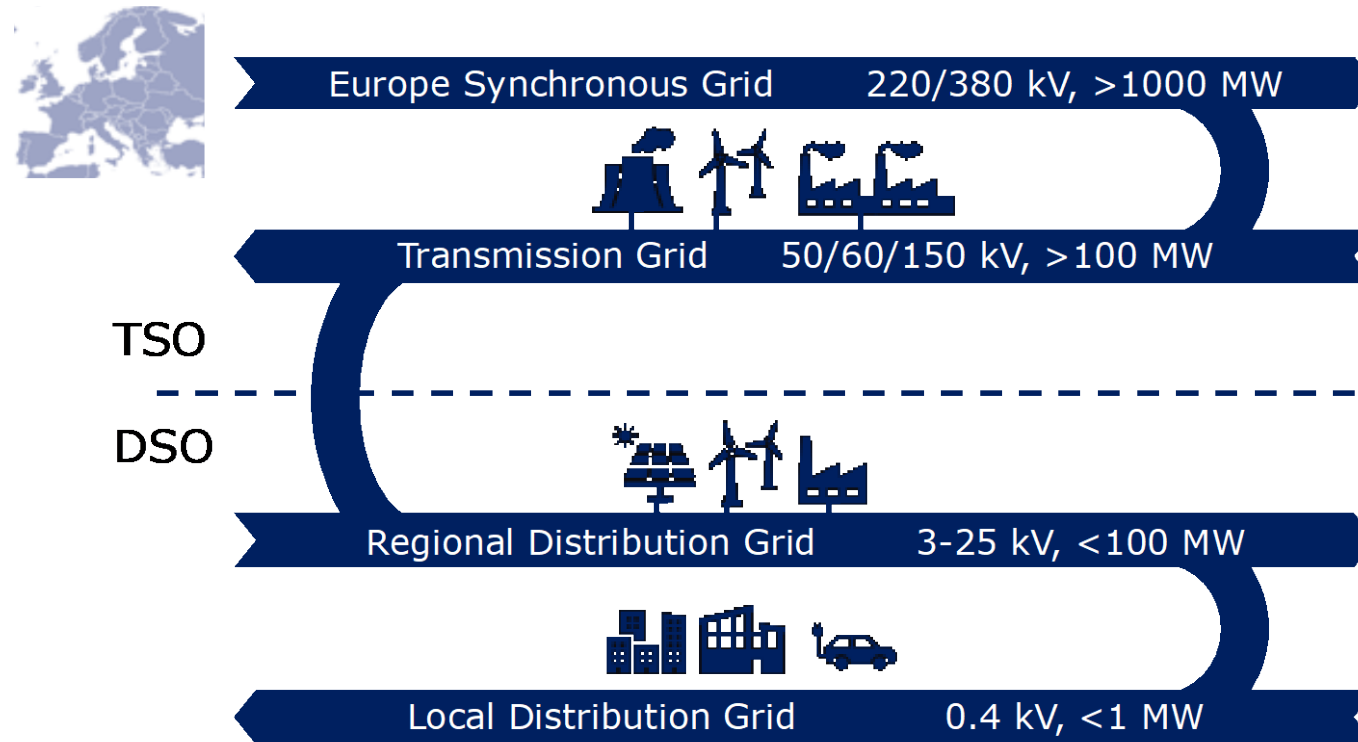


Mainly through V and I
measurements



Increased observability, better
knowledge of grid

Observability in various voltage levels



But LV is different



"as-built" topology



dynamic topology



Sparse measurements



High uncertainty in pseudo-measurements



Privacy and regulatory constraints



Scalability



Latent nodes



Localization

Double wammy!



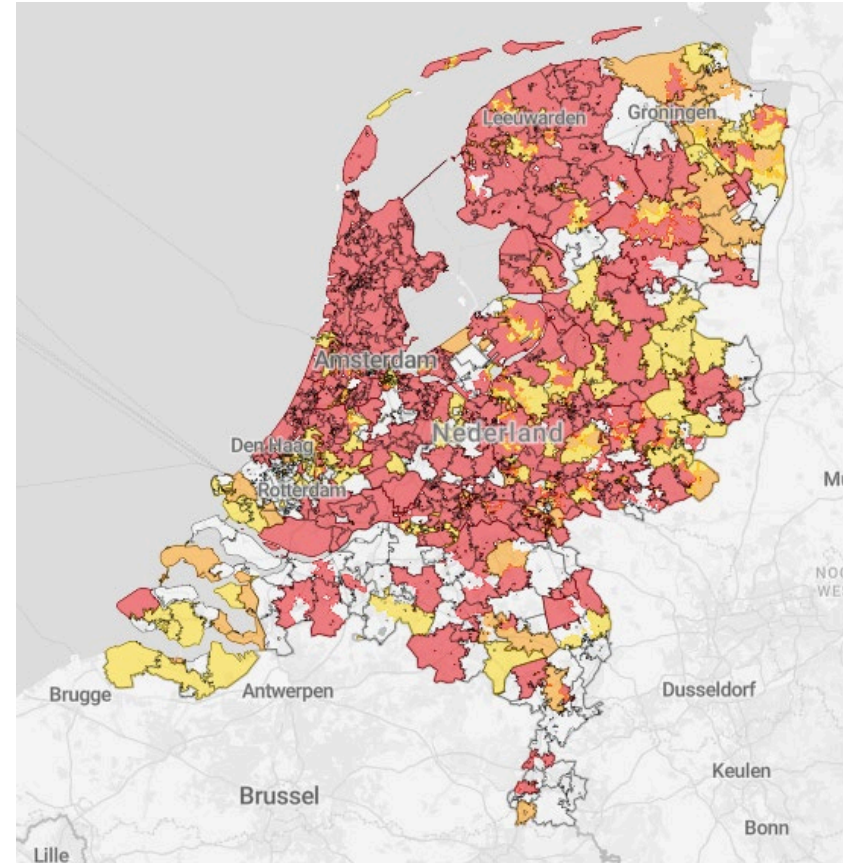
Rapid electrification
is intensifying both demand
and feed-in congestion



Distribution systems remain
only **partially observable**

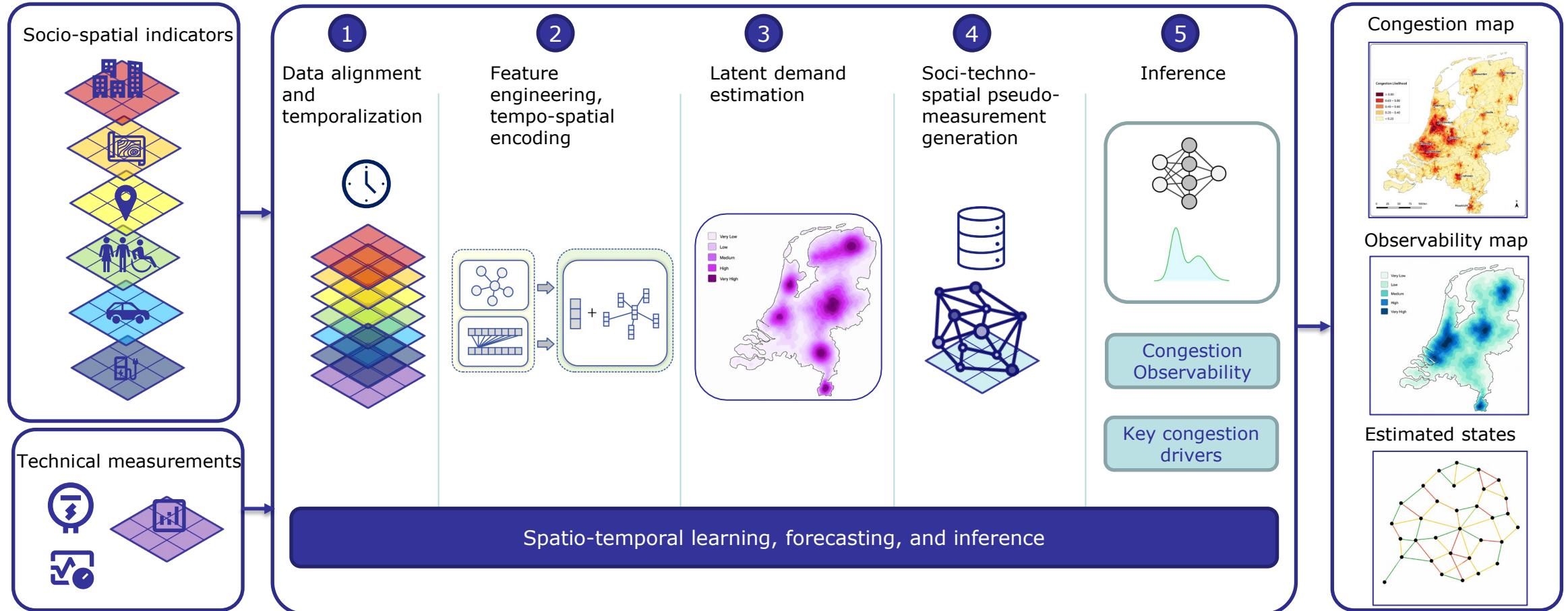


Existing pseudo-measurements
largely neglect **socio-spatial
dynamics**



congestion map at the regional grid operators, 26-05-2026

Socio-Technical Congestion Observability Framework



Questions

1. What/where are the main observability blind spots for DSOs?
2. What measurements are available today for congestion detection, and what are the main struggles?
3. Which operational decisions would improve most if congestion were observable with higher confidence?
4. How much observability is needed for reliable operation?
5. and outside this box of questions ...



UTwente

NATALY BAÑOL ARIAS

Power Electronics for Congestion Mitigation in MV/LV Grids

Dr. Nataly Bañol Arias

m.n.banolarias@utwente.nl

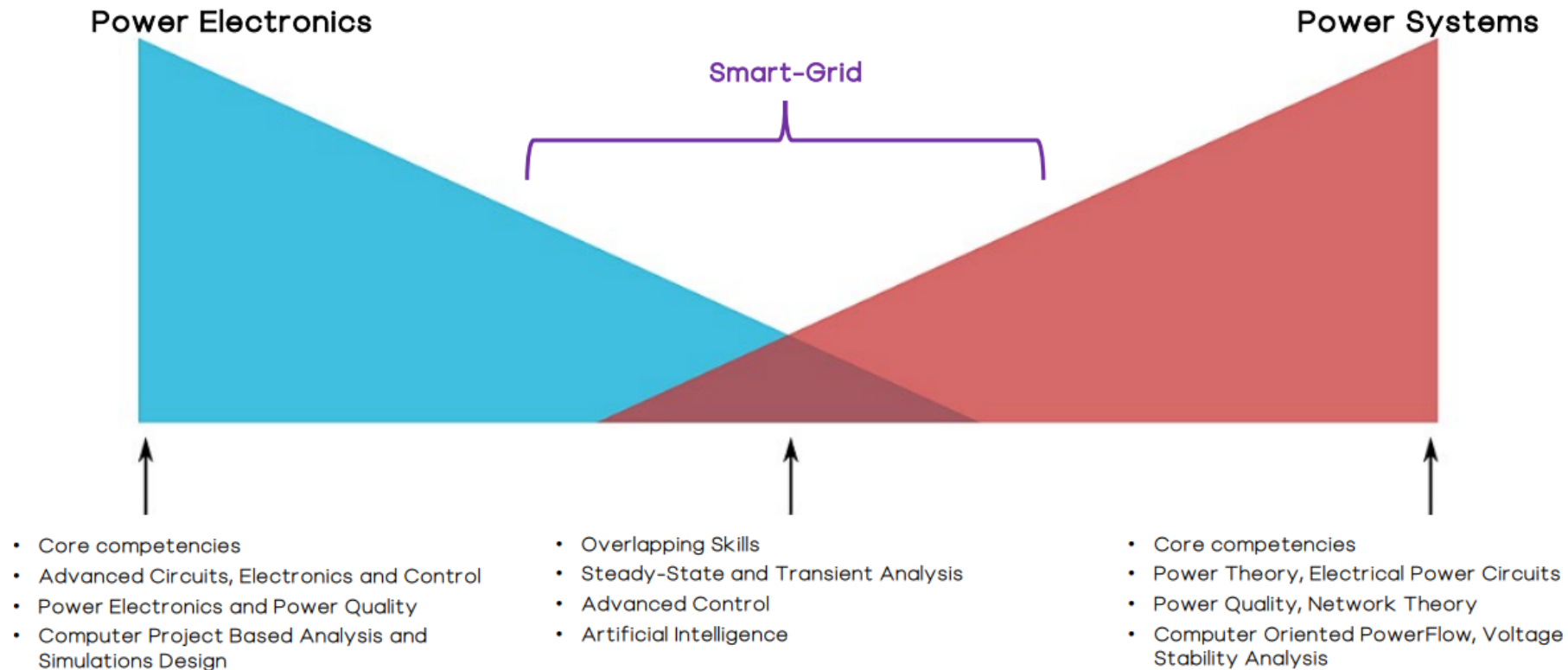
Assistant Prof. Power electronics group

University of Twente, The Netherlands



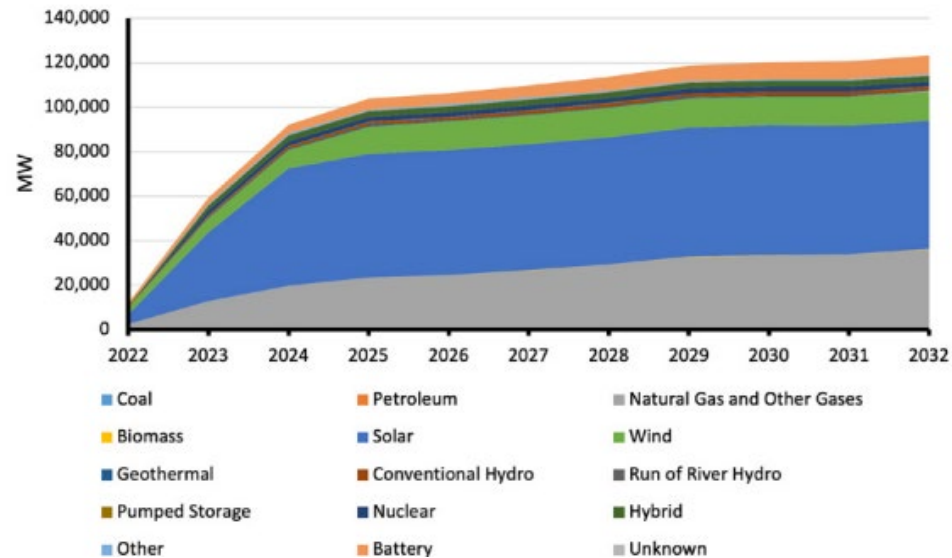
SMART GRIDS

“Research, development, and optimal integration/control of **power electronics-based** devices into **smart distribution grids** to make them more cost-effective, reliable, and sustainable”

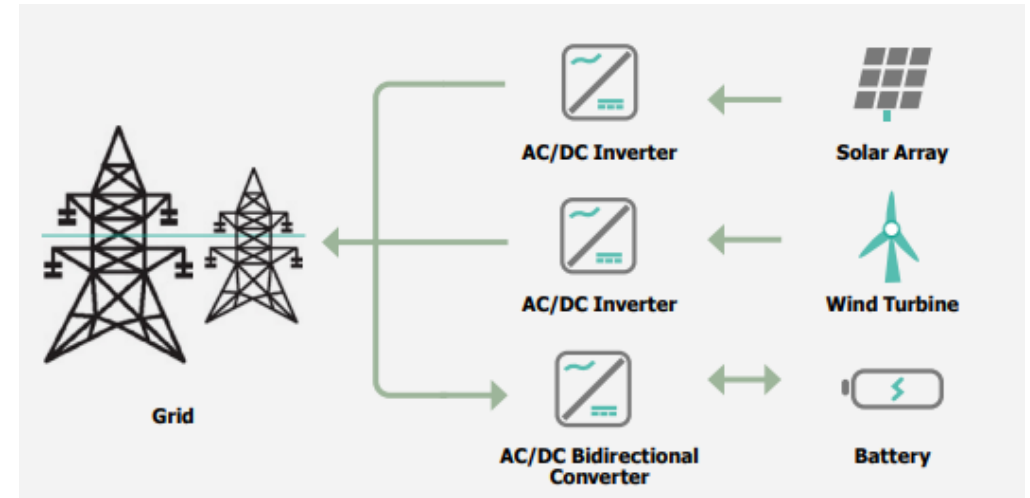


WHY?

“Research, development, and optimal integration/control of **power electronics-based** devices into **smart distribution grids** to make them more cost-effective, reliable, and sustainable”



Wind, solar, and batteries directly translates into the demand for power electronics!



NERC (2023) An introduction to inverter-based Resources on the bulk power system

WHY?

Problem

- Power electronics (**PE**) interfaces
 - Inverter-based resources (**IBRs**)
- Increasing number of electric loads **supplied** and **controlled** via **PE**
- **Transformation** of the Power System
- Transforming the way we **design** and **operate** them

Challenges

- **Decentralized** system
- More **dynamic** and complex
- Difficult to ensure **balance** between supply and demand
- Congestion (higher risk of power **outages/blackouts**)
- More points of **failures**/maintenance
- PE increases **vulnerability** (cybersecurity)
- Less **inertia**

MITIGATION STRATEGIES

Traditional

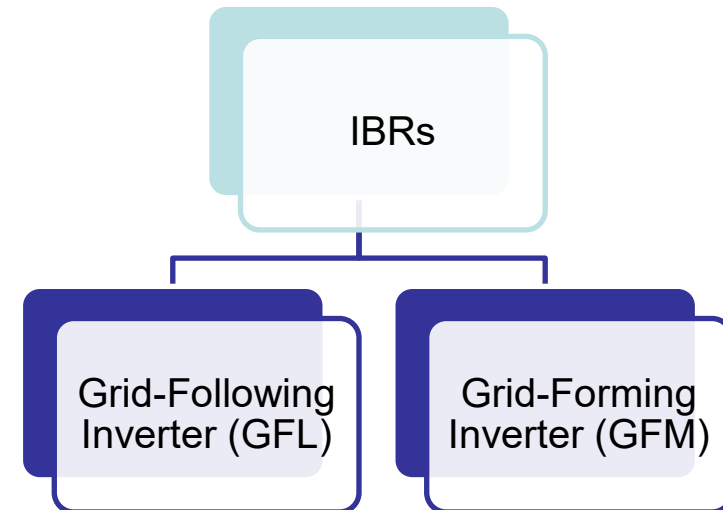
- Grid reinforcement expansion
- Flexibility Markets

Innovative?

- **D-FACTS** → Flexible AC Distribution systems
- D-STATCOM, SVC, DSSC, PST, VRT, ...
- Can be controlled by DSOs
- Very expensive for DSOs

Inverter-based resources (IBRs)

- Key enabler technology
- Sensor data for low observability grids
- Local control → device level



Power electronics interfaces

IBRs OPPORTUNITIES

GFM Technologies

- Prevent localized blackouts and grid instability
- Control local voltage
- Allow islanding (microgrids)
- Black start capability

They don't work well together (yet)
(Interoperability issues)

But...

- IBRs are not owned by DSOs, they are private
- No controllability from DSOs
- Users lose potential/capability (reduce active power)

TECHNICAL CHALLENGES

- Interoperability of IBRs in LV grids
- Different IBR brands
- Inverters are black boxes!
- Grid codes

- Different **power** control (droop, VSG)
- Symmetrical/asymmetrical faults (outage)
- Different Fault-ride-through methods
- Appropriate designs for MV/LV grids?
 - Different types of control simultaneously is problematic!

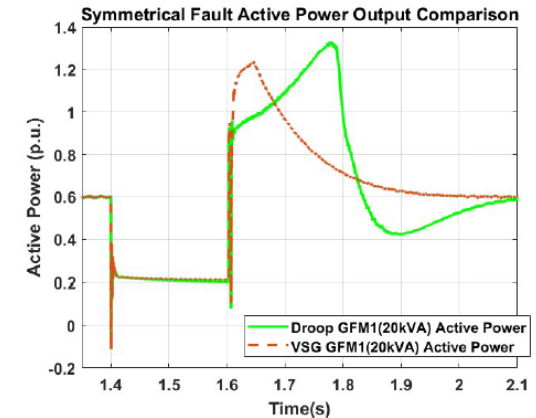
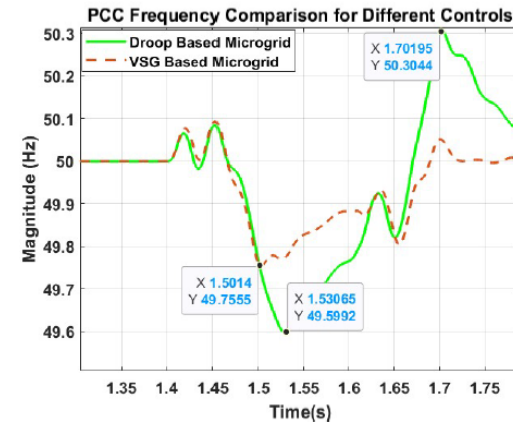
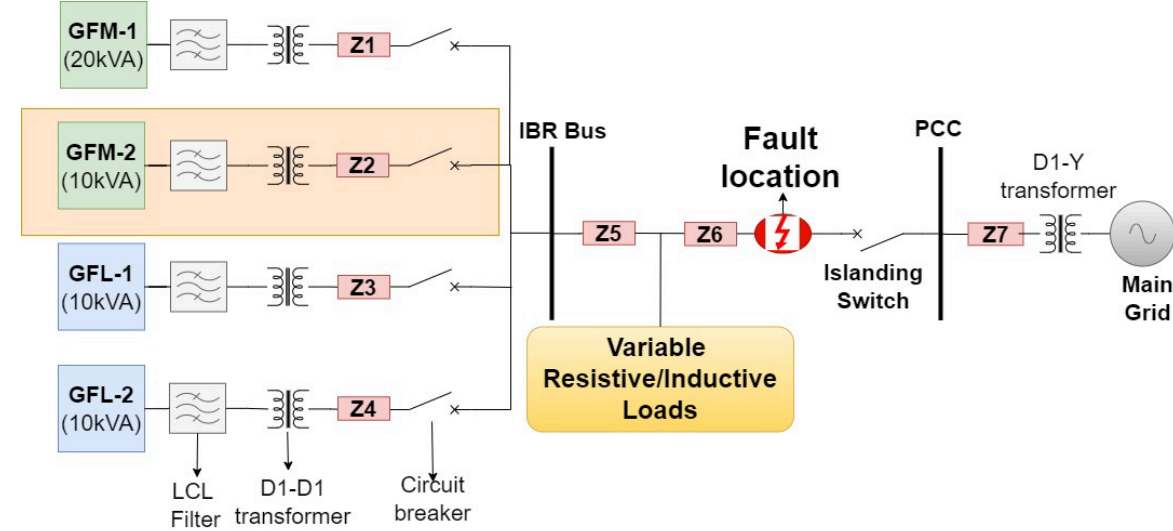


Figure 5.5: Frequency Change of GFMs

(a) Active Power Output

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ADITYA PAPPU

Robust coordination in local energy systems

Aditya Pappu, University of Twente



Guidelines

1. “Conceptual integrity is the most important consideration in systems design.”

-Fred Brooks in The Mythical Man-month

2. “Everything fails, all the time.”

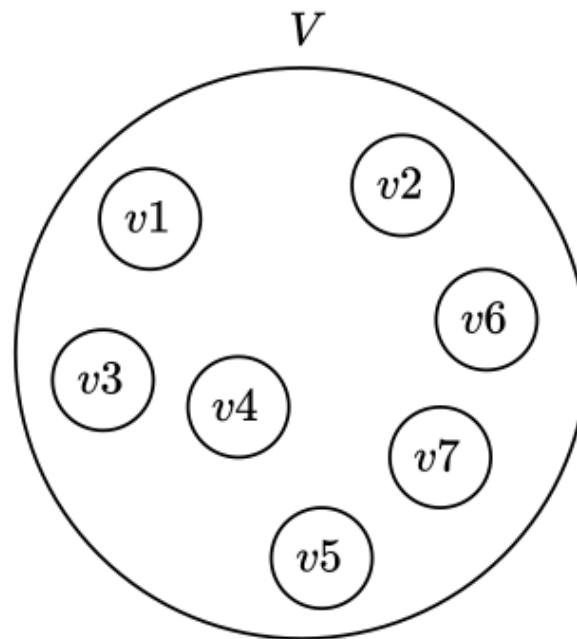
-Werner Vogel, AWS CTO

Context



Aardehuizen, Olst

The problem



e.g. group objective:
 $\min \|X - P\|_2$

X is group aggregate
 P is group desired

Sure, why not...



Nothing is ever on time.

There is traffic during rush hour.

Yet, things get done well enough and life goes on.

Two aspects

1. Synchronous coordination > Asynchronous / Event-driven [1].
2. Making aggregation privacy-secure [2].

[1] – Asynchronous Distributed Energy Management with Co-Operative Agents, 10.1109/ENERGYCON58629.2024.10488799.
Asynchronous Coordination in Local Energy Systems, 10.1145/3765611.3815594.

[2] – Privacy Preserving Aggregation using Noise in Large-scale Energy Networks, 10.1109/PowerTech59965.2025.11180527

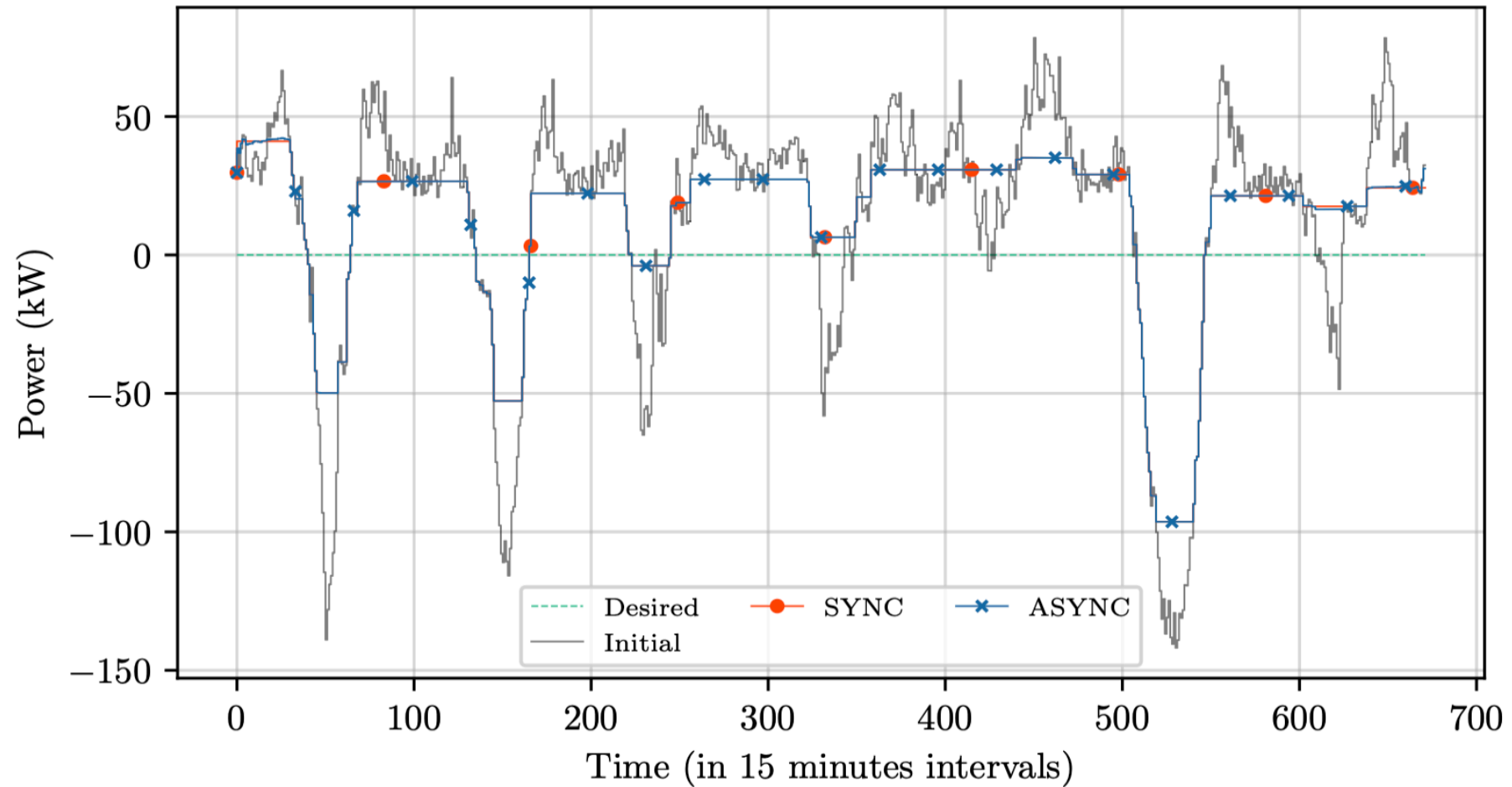
1. Synchronous > Asynchronous

sync

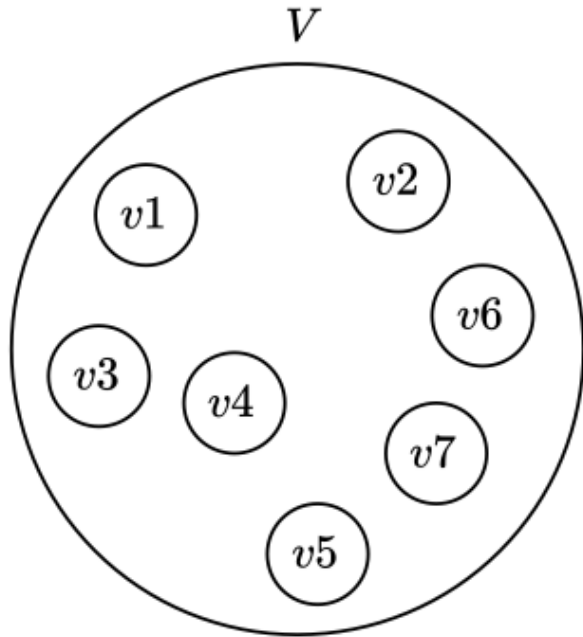
async

1. Synchronous > Asynchronous

- Over a 2-week simulation,
- SYNC achieves 27.32% improvement
 - ASYNC achieves 27.30% improvement



2. Privacy-secure computation



e.g. group objective:
 $\min \|X - P\|_2$

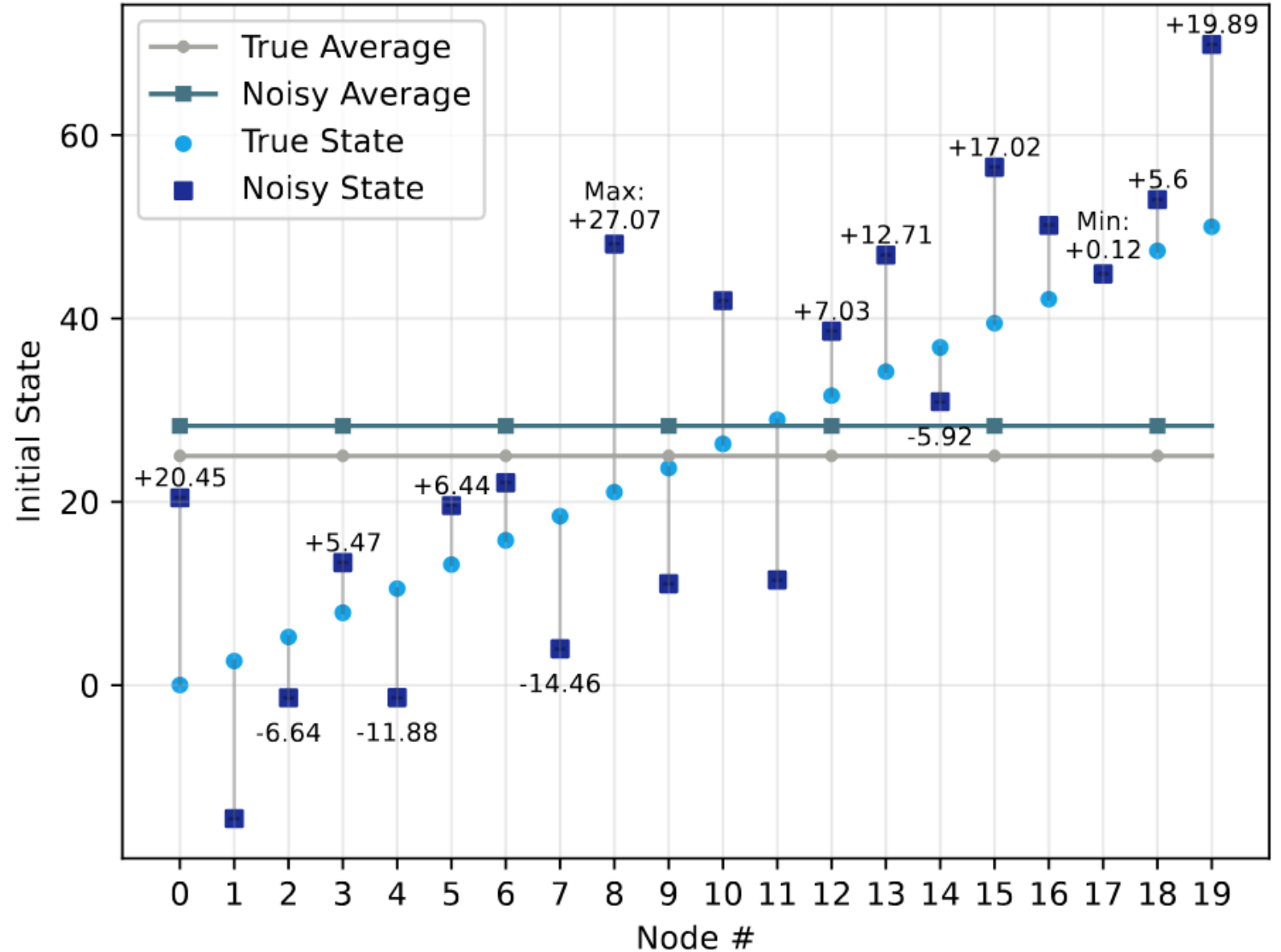
X is group aggregate
 P is group desired

How can each energy agent
get aggregate $X = \sum_{v \in V} x_v$

But agent v should not know
 $x_j \mid \forall j \neq v$

2. Privacy-secure computation

Adding noise to individual states...

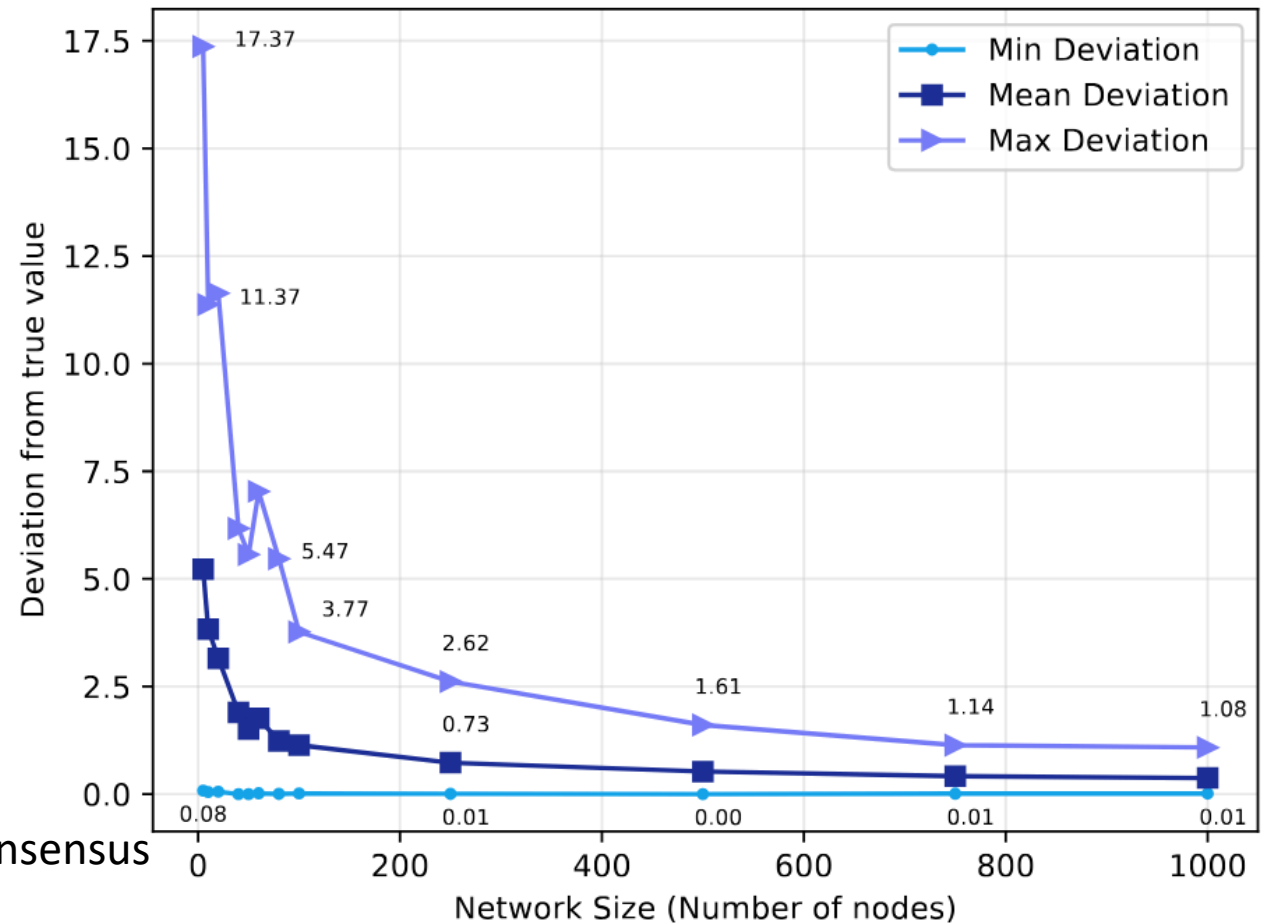


2. Privacy-secure computation

Deviation in the aggregate power after convergence...

Distributed Load-balancing algorithm by Olshevsky and Tsitsitklis [3]

Observation: More agents in an group, more accurate is the noisy estimate. Favors large-scale groups.



Two future things...

1. Resilience as group's ability to handle imprecision.
 - Think tolerance /*conits*/ 'age of information'
2. Privacy with homomorphic encryption.

Robust coordination in local energy systems

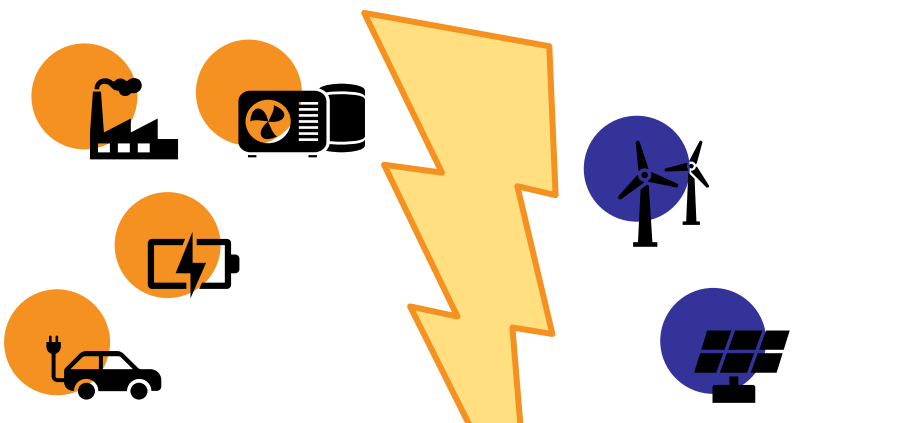
Aditya Pappu, University of Twente



Energy Group @UT

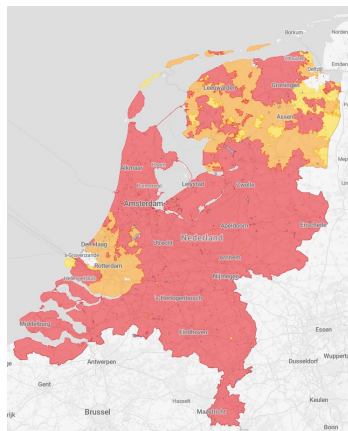
<https://www.utwente.nl/en/eemcs/energy/>

Grid Congestion & Infrastructure

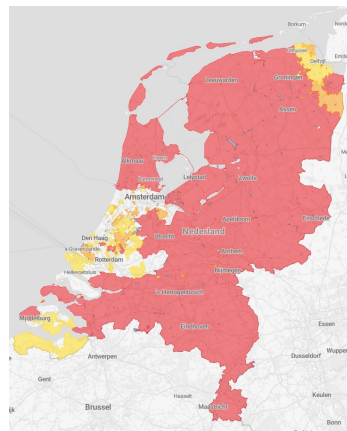


Capacity shortage

Demand



Supply



[NBNL Landelijke capaciteitskaart](#)

PRESENTERS



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Enexis, TU/e



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Stedin, TUDelft



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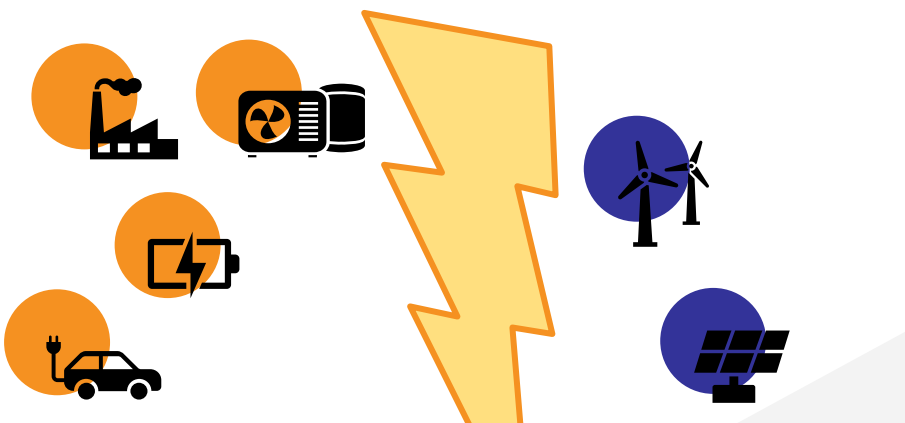


Dr. Nataly Bañol Arias
UTwente



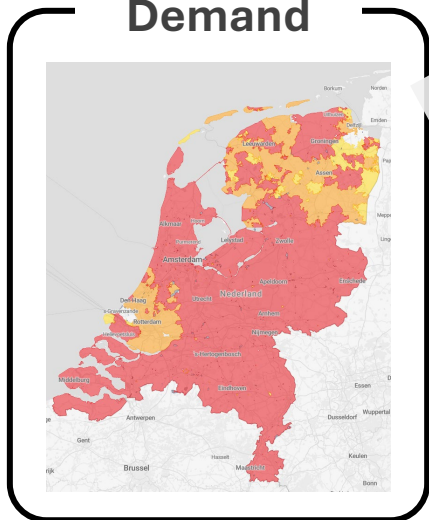
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Grid Congestion & Infrastructure



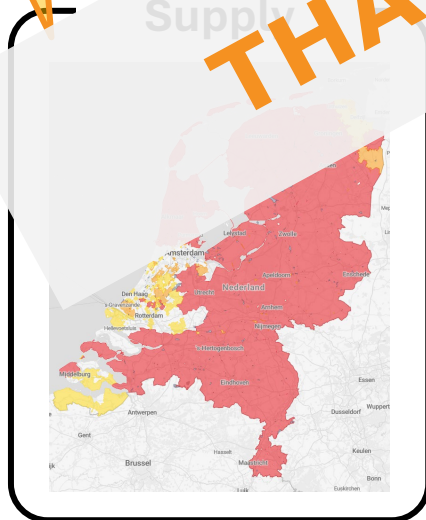
Capacity shortage

Demand



[NBNL Landelijke capaciteitskaart](#)

Supply



THANK YOU!

PRESENTORS



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Energy Systems TU/e



Dr. Arjan van Voorden
Stedin, TUDelft



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