Learning to Run a Power Network Delft 2023

27 September 2023

TU Delft DAIE ENERGY

PowerWeb L2RPN Session
September 27, 14:00-15:15 CET, Delft X, Theater Hall

Talk	Speakers
Introduction and history of L2RPN	Jochen Cremer (TU Delft)
From L2PRN to the real grid – challenges we face as a TSO	Christian Merz (Elia Group)
Practical Challenges in AI Development for Real-World Congestion Management at TenneT	Davide Barbieri (TenneT)
Overview of winners of L2RPN 2023	Ali Rajaei (TU Delft)
Winner's pitch and Industrial panel discussion (RTE, Elia, and TenneT) (zoom link)	Jochen Cremer (TU Delft)
• 3rd team HybridAgent pitch (video link) • Q&A with panel	Anandsingh Chauhan (TCS)
• 2nd team ACT SMART pitch (video link) • Q&A with panel	Pusen Dong (Beihang Uni)
• 1st team BYZ-UCSC pitch (video link) • Q&A with panel	Shourya Bose (UC Santa Cruz)

Organizer team

Ali Rajaei
PhD student
TU Delft

Geert Jan Meppelink
MSc student
TU Delft

Jochen Cremer
Assistant Professor
TU Delft

Benjamin Donnot
Data Scientist
RTE

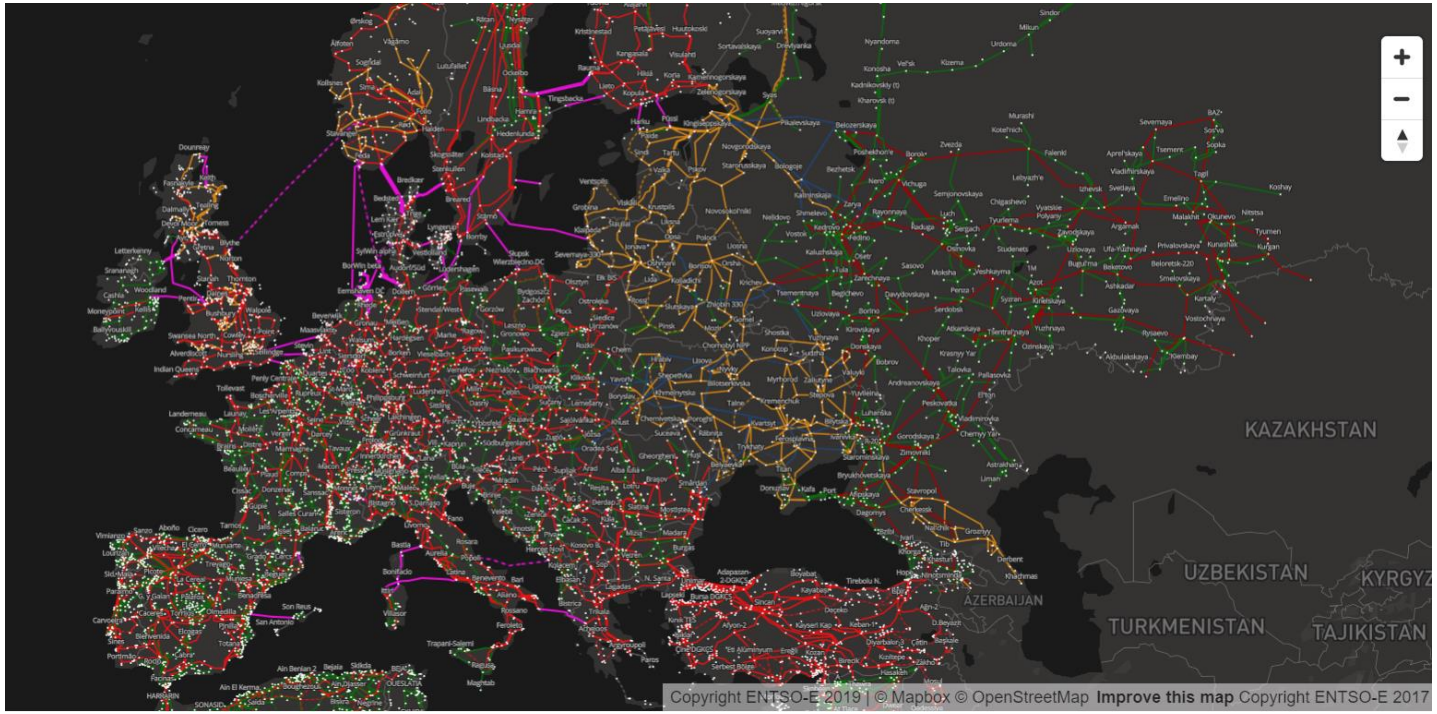
TU Delft | AI Initiative

DAIE ENER ERGY

Rte

10 POWERWEB

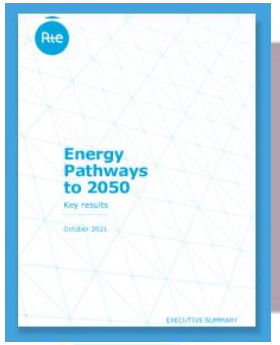
Energy Transition

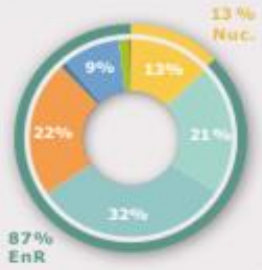


TU Delft

DAIE
ENER
ERGY

Energy Transition



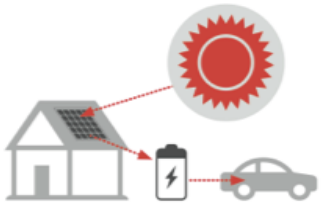
	NARRATIF	RÉPARTITION DE LA PRODUCTION EN 2050	CAPACITÉS INSTALLÉES EN 2050 (EN GW)*					BOUQUET DE FLEXI-BILITÉS EN 2050
			Solaire	Éolien terrestre	Éolien en mer	Nucléaire historique	Nouveau nucléaire	
M23 EnR grands parcs	Développement très important de toutes les filières renouvelables, porté notamment par l'installation de grands parcs éoliens sur terre et en mer. Logique d'optimisation économique et ciblage sur les technologies et les zones bénéficiant des meilleurs rendements et permettant des économies d'échelle.		~ 125 GW (soit x12)	~ 72 GW (soit x4)	~ 60 GW	16 GW	/	15 GW 1,7 GW (1,1 MVE) 20 GW 13 GW
N2 EnR + nouveau nucléaire 2	Lancement d'un programme plus rapide de construction de nouveaux réacteurs (une paire tous les 3 ans) à partir de 2035 avec montée en charge progressive. Le développement des énergies renouvelables se poursuit mais moins rapidement que dans les scénarios N1 et M.		~ 90 GW (soit x8,5)	~ 52 GW (soit x2,9)	~ 36 GW	16 GW	23 GW (soit 14 EPR)	15 GW 1,7 GW (1,1 MVE) 5 GW 2 GW

2020 ~ 10% solar+wind **2050 > 50% solar + wind**

To meet the net-zero carbon emission target and tackle Climate change

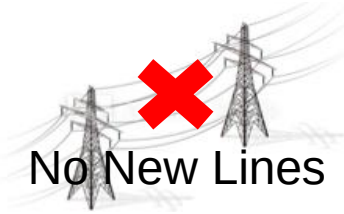
Operational Complexity

New actors & scales



Operators will need to get assisted !

Evolving grid

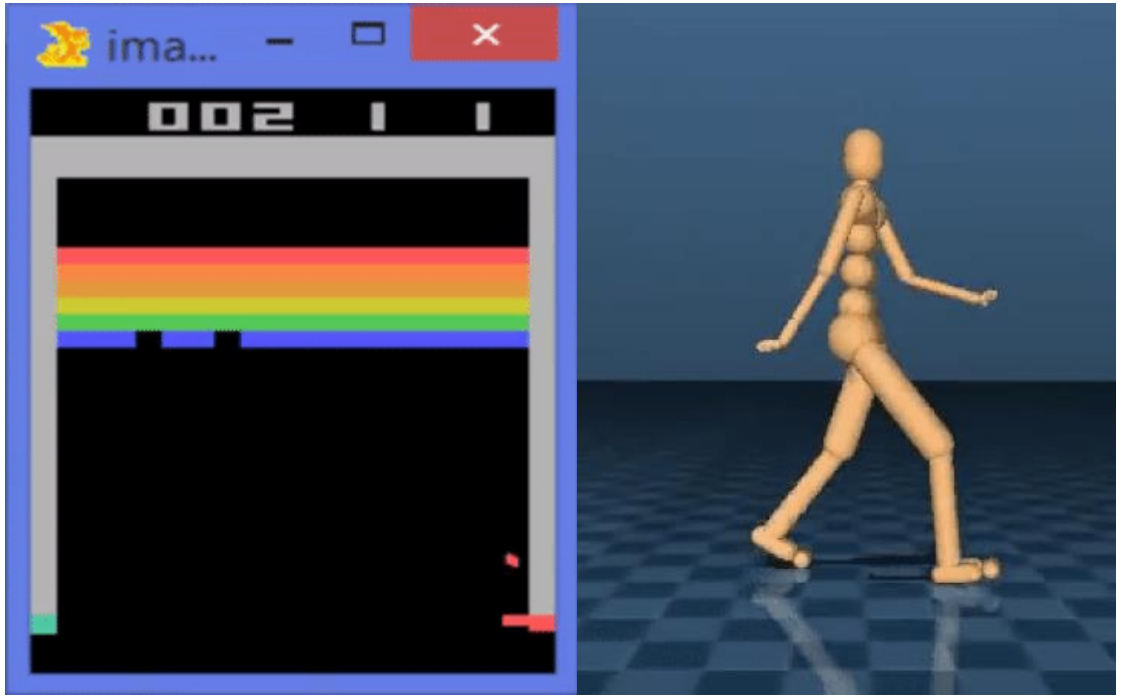


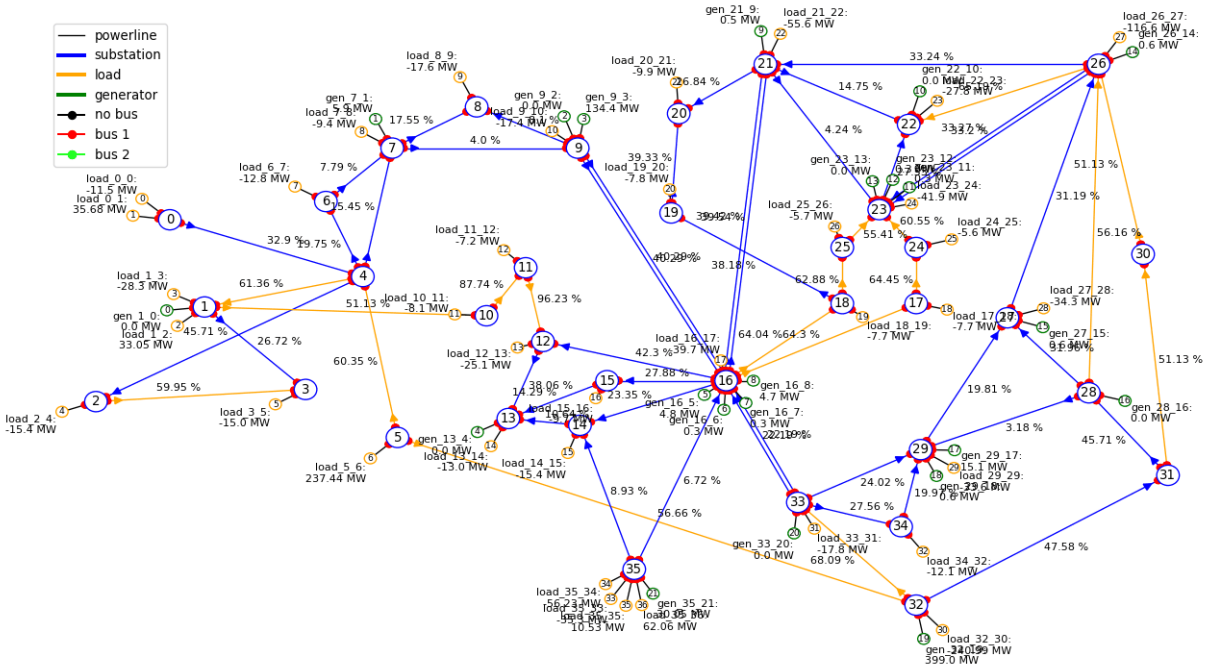
Digitalisation

Automates distribués

TUDelft DAIE ENER ERGY Rte

Artificial Intelligence (AI)

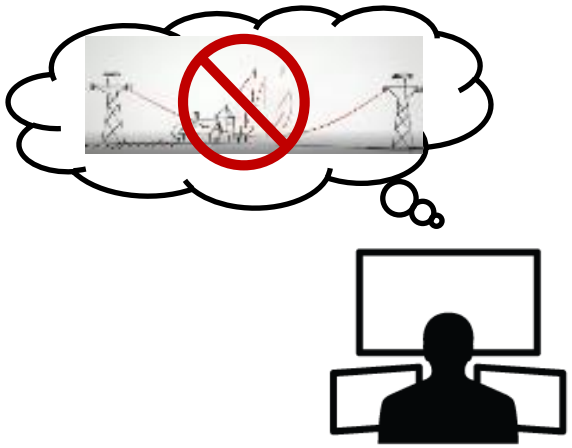




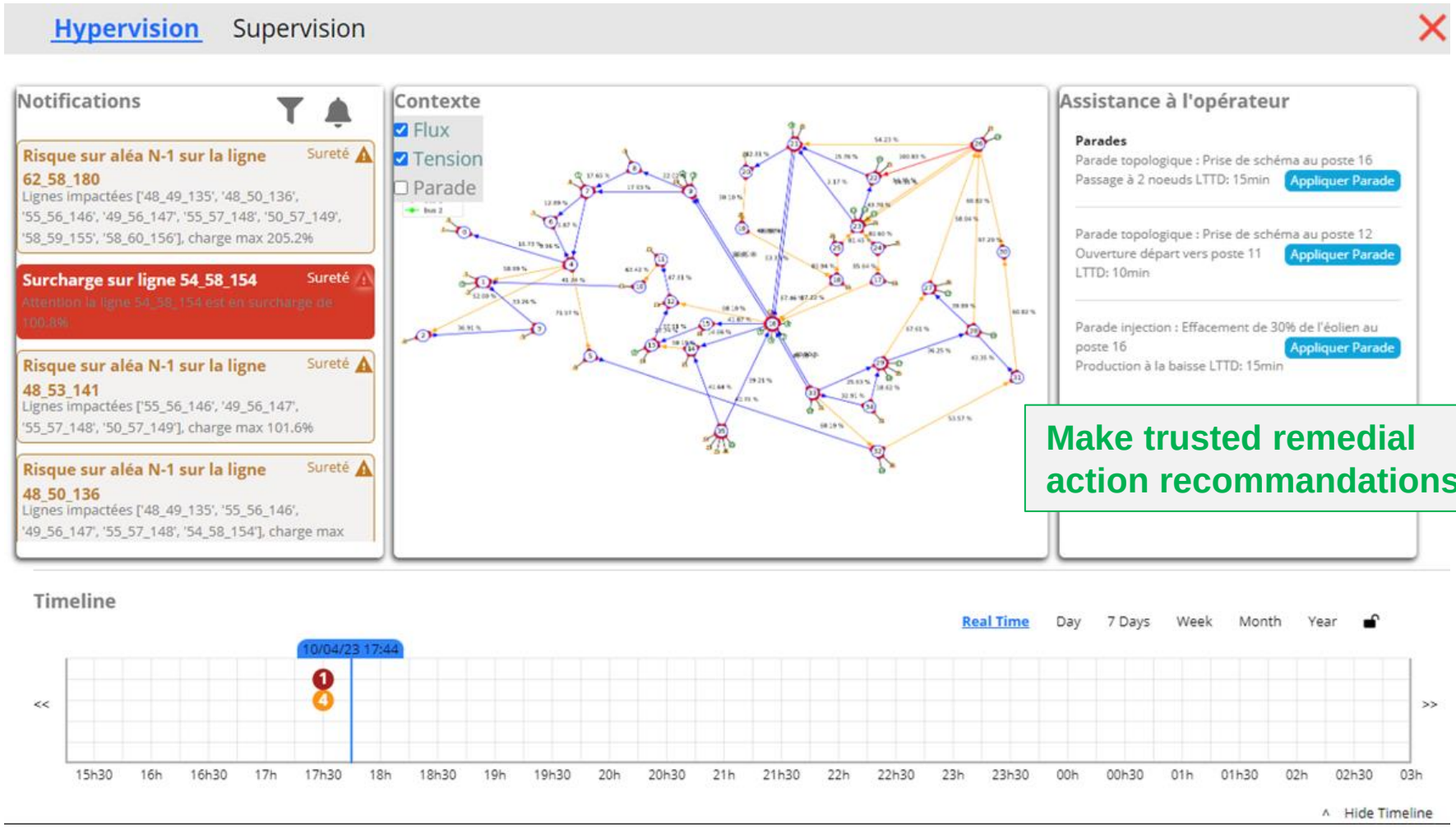
2013 2017 Soon?

TU Delft DAIE ENER ERGY

Develop an AI-based Assistant for human operators

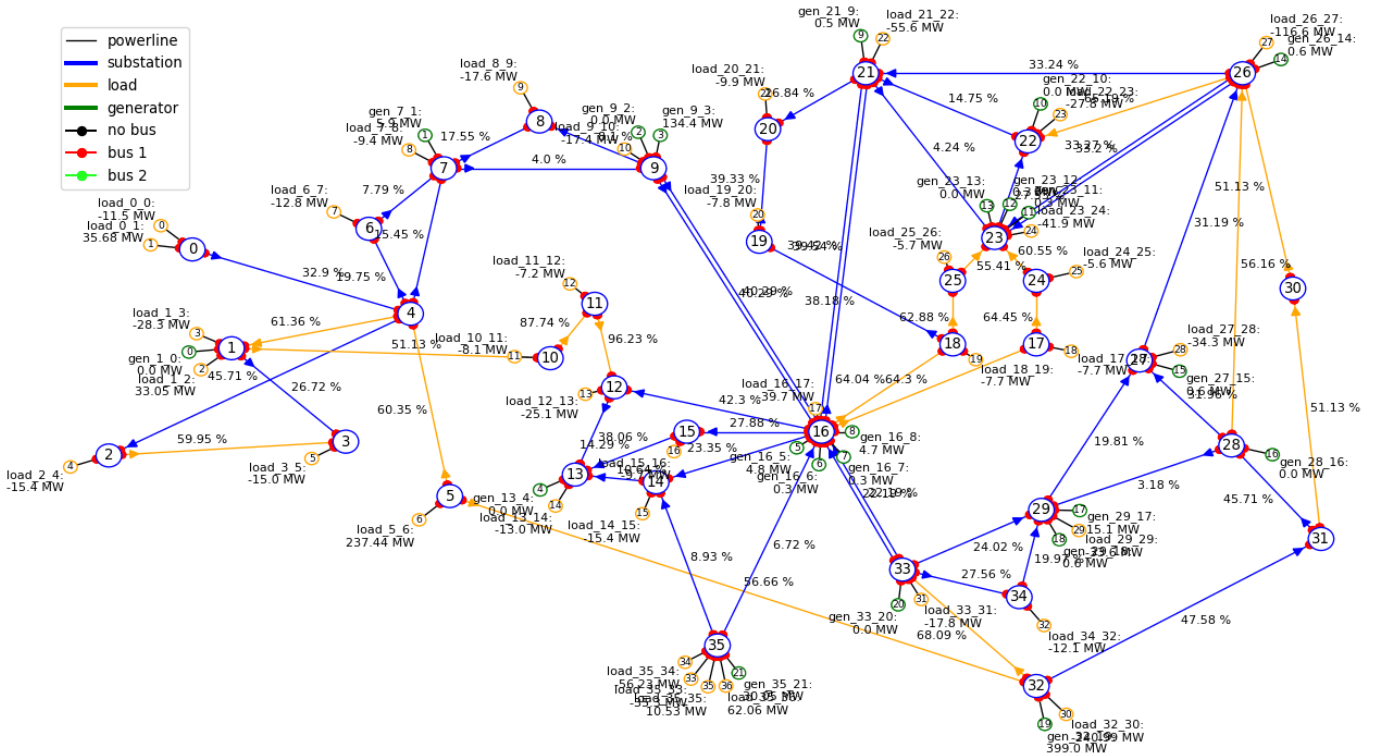


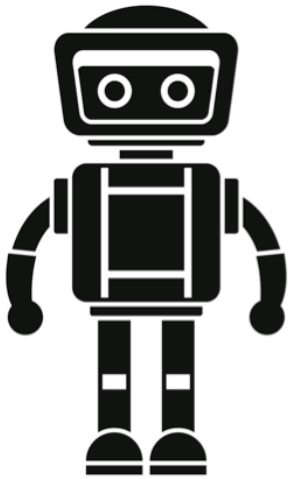
Line Overload to redispatch urgently



Make trusted remedial action recommandations

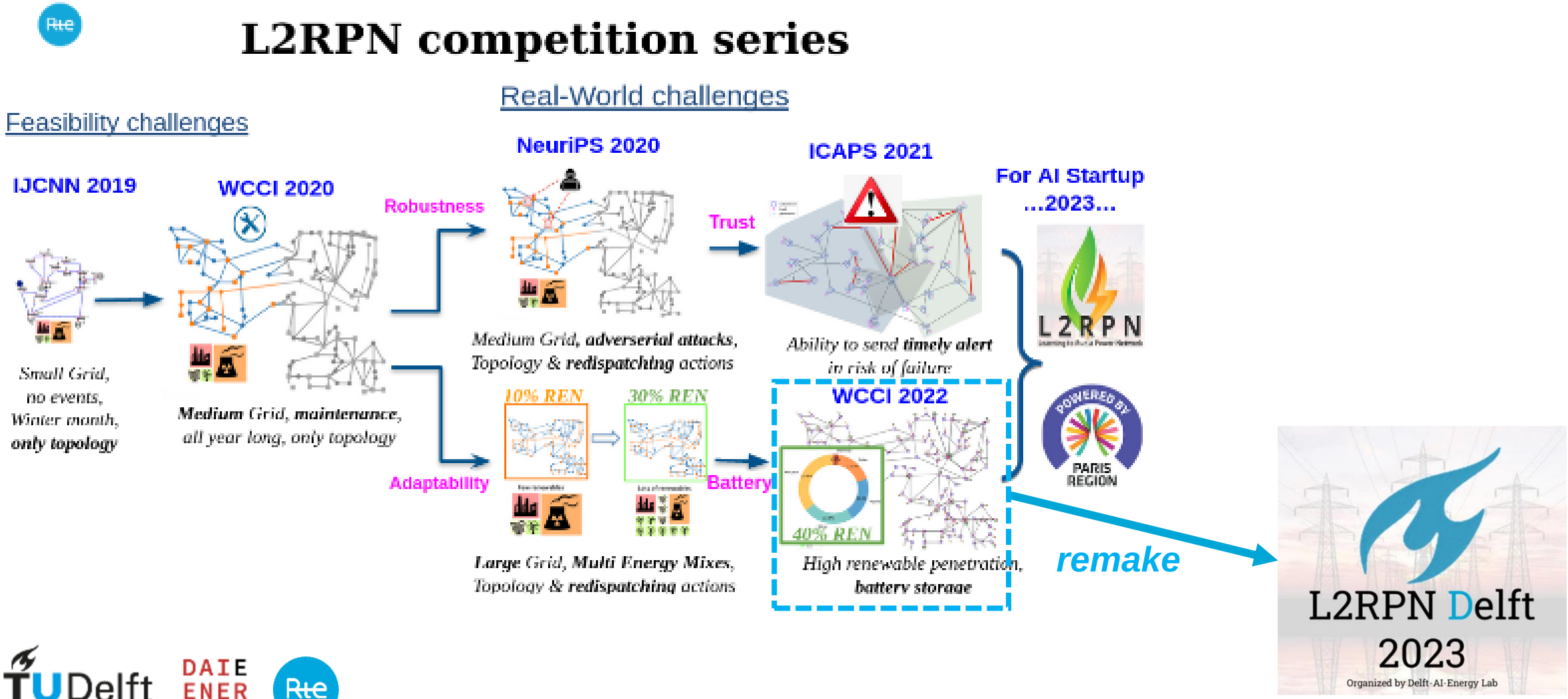
Learning to Run a Power Network (L2RPN) Competition





Test the potential of AI to robustly operate a power grid in real-time given operational constraints.

Learning to Run a Power Network (L2RPN) Competition



TUDelft DAIE ENER ERGY

Thank you for your attention!

TU Delft DAIE ENER ERGY

PowerWeb L2RPN Session
September 27, 14:00-15:15 CET, Delft X, Theater Hall

Talk	Speakers
Introduction and history of L2RPN	Jochen Cremer (TU Delft)
From L2PRN to the real grid – challenges we face as a TSO	Christian Merz (Elia Group)
Practical Challenges in AI Development for Real-World Congestion Management at TenneT	Davide Barbieri (TenneT)
Overview of winners of L2RPN 2023	Ali Rajaei (TU Delft)
Winner's pitch and Industrial panel discussion (RTE, Elia, and TenneT) (zoom link)	Jochen Cremer (TU Delft)
• 3rd team HybridAgent pitch (video link) • Q&A with panel	Anandsingh Chauhan (TCS)
• 2nd team ACT SMART pitch (video link) • Q&A with panel	Pusen Dong (Beihang Uni)
• 1st team BYZ-UCSC pitch (video link) • Q&A with panel	Shourya Bose (UC Santa Cruz)

Learning to Run a Power Network Delft 2023

27 September 2023

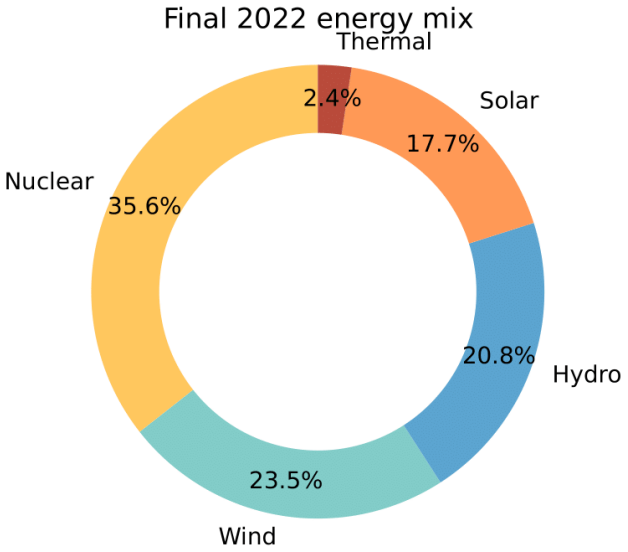
TU Delft DAIE ENERGY

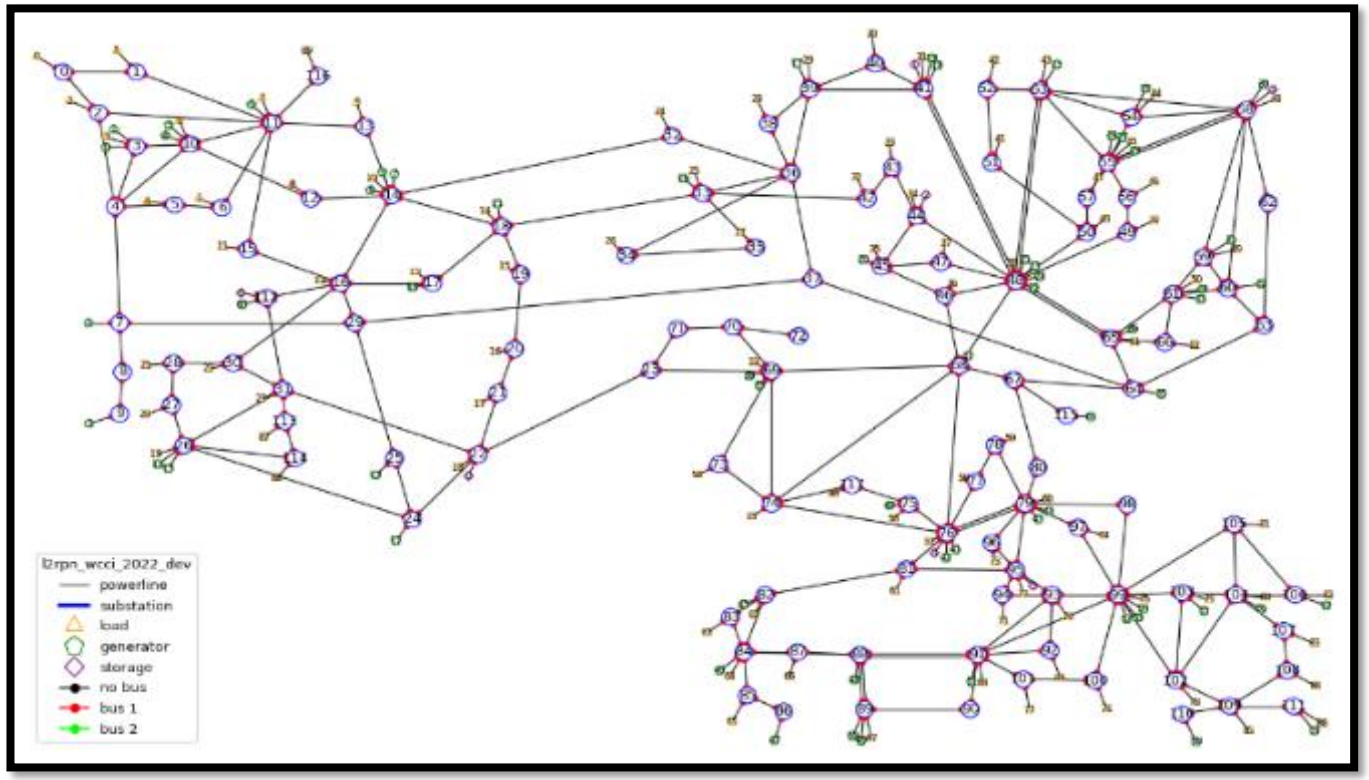
PowerWeb L2RPN Session
September 27, 14:00-15:15 CET, Delft X, Theater Hall

Talk	Speakers
Introduction and history of L2RPN	Jochen Cremer (TU Delft)
From L2PRN to the real grid – challenges we face as a TSO	Christian Merz (Elia Group)
Practical Challenges in AI Development for Real-World Congestion Management at TenneT	Davide Barbieri (TenneT)
Overview of winners of L2RPN 2023	Ali Rajaei (TU Delft)
Winner's pitch and Industrial panel discussion (RTE, Elia, and TenneT) (zoom link)	Jochen Cremer (TU Delft)
• 3rd team HybridAgent pitch (video link) • Q&A with panel	Anandsingh Chauhan (TCS)
• 2nd team ACT SMART pitch (video link) • Q&A with panel	Pusen Dong (Beihang Uni)
• 1st team BYZ-UCSC pitch (video link) • Q&A with panel	Shourya Bose (UC Santa Cruz)

L2RPN Delft 2023 Environment

- IEEE 118-bus system.
- Observation space: more than 4,000
- Action space: more than 70,000

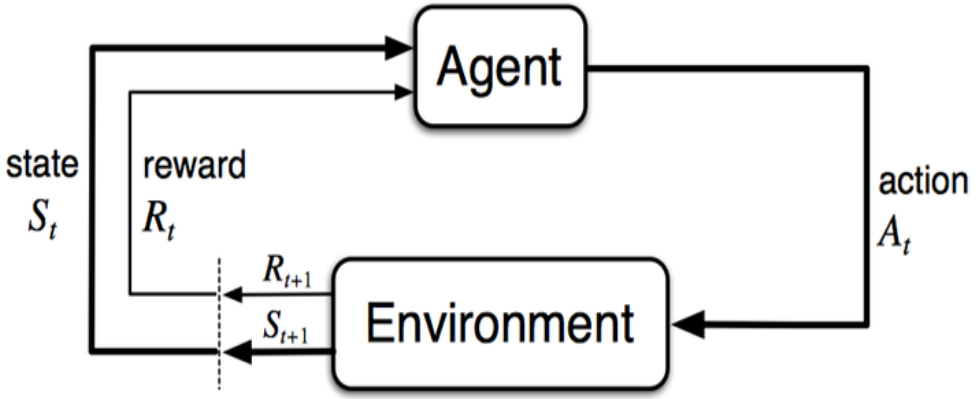




"l2rpn_wcci_2022" environment

TU Delft DAIE ENER ERGY Rte

Modeling of real-time operation decision making



State: flows, generations, demands, grid topology, etc

Action: re-dispatch or topology change

Reward/cost function: number of overflowed lines, cost, … **Participant design choice**

Score: scaled to 100.

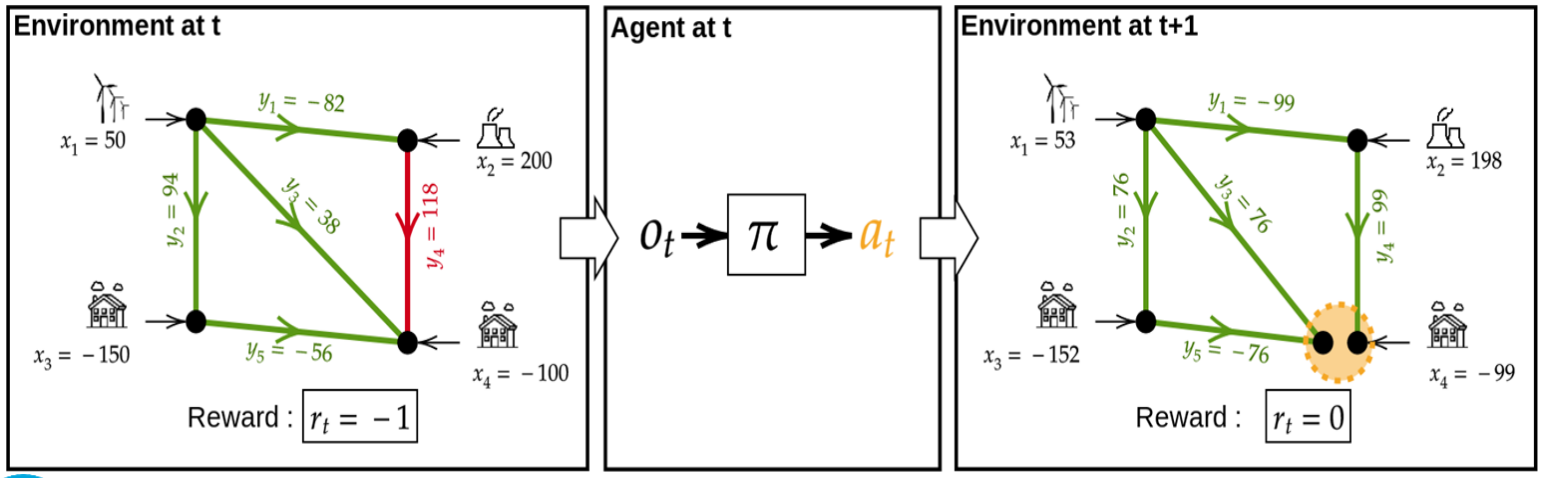
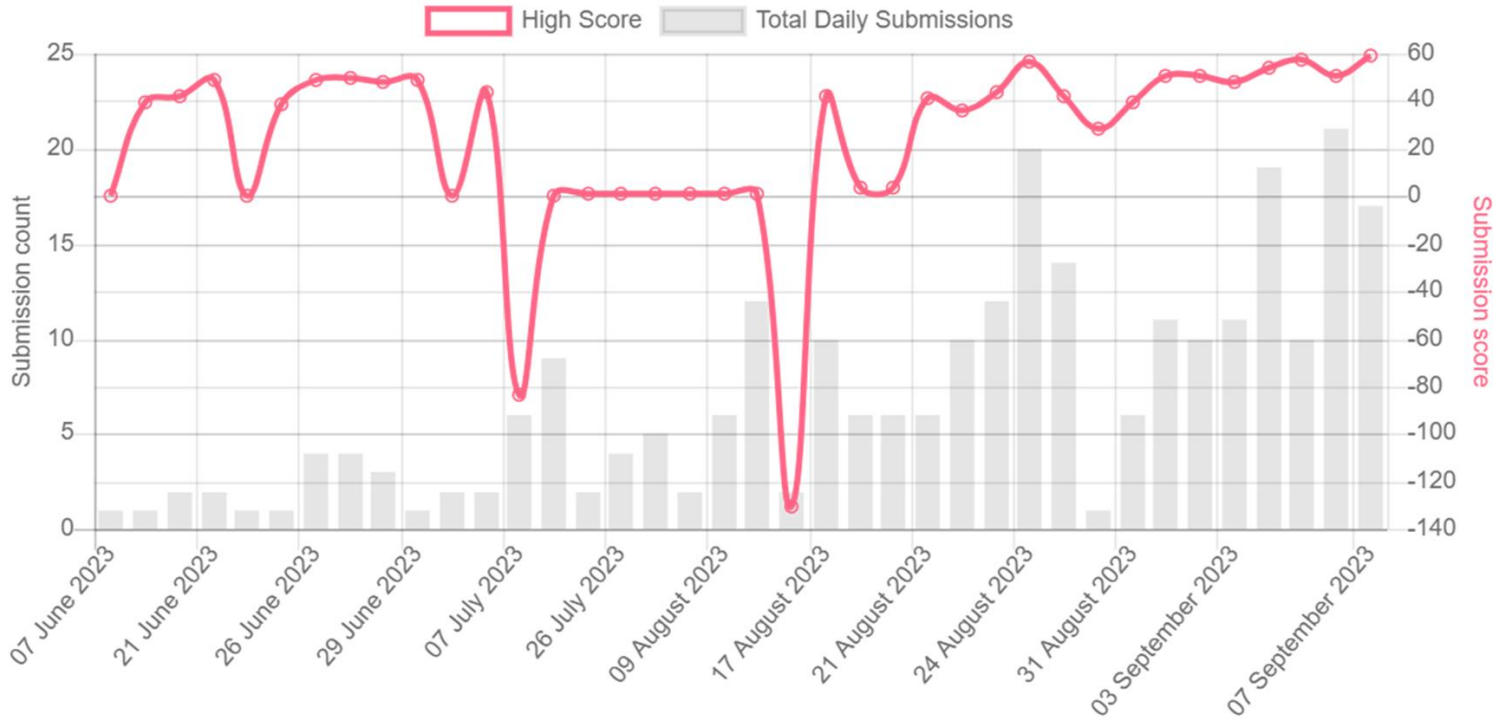


Fig. 2 - *Step-by-step evolution of the RL environment*

Time resolution considered: 5 minutes (human operators work with snapshots every 5 minutes)

L2RPN Delft 2023

- 90 registrations from around the world.
- 12 teams.
- 410 submissions.



codalab.lisn.upsaclay.fr/competitions/12420

TU Delft DAIE ENER ERGY Rte

Winner teams!

- 1st place: €1500
  - 2nd place: €1000
    - 3rd place: €500

TU Delft DAIE ENER ERGY Rte

3rd Team: Hybrid Agent

- Members:
  - Anandsingh Chauhan
  - Dr. Mayank Baranwal

- Score: 42.44

2nd Team: ACT SMART

- Members:
  - Pusen Dong
  - Tianchen Zhu
  - Chang Liu
  - Yue Qiu
  - Haoyi Zhou
  - Yingying Zhao

- Score: 54.44 and 52.01

TUDelft DAIE ENER ERGY Rte

1st Team: BYZ-UCSC

- Members:
  - Shourya Bose
  - Qiuling Yang
  - Yu Zhang
- Score: 58.98

Zoom meeting

Thank you for your attention!

TU Delft DAIE ENER ERGY

PowerWeb L2RPN Session
September 27, 14:00-15:15 CET, Delft X, Theater Hall

Talk	Speakers
Introduction and history of L2RPN	Jochen Cremer (TU Delft)
From L2PRN to the real grid – challenges we face as a TSO	Christian Merz (Elia Group)
Practical Challenges in AI Development for Real-World Congestion Management at TenneT	Davide Barbieri (TenneT)
Overview of winners of L2RPN 2023	Ali Rajaei (TU Delft)
Winner's pitch and Industrial panel discussion (RTE, Elia, and TenneT) (zoom link)	Jochen Cremer (TU Delft)
• 3rd team HybridAgent pitch (video link) • Q&A with panel	Anandsingh Chauhan (TCS)
• 2nd team ACT SMART pitch (video link) • Q&A with panel	Pusen Dong (Beihang Uni)
• 1st team BYZ-UCSC pitch (video link) • Q&A with panel	Shourya Bose (UC Santa Cruz)

From L2RPN to the real grid

Challenges we face as a TSO

27.09.2023 | Christian Merz

Agenda

1. Why do we need to optimize for grid topology?
2. Our approach
3. The challenges
4. Next steps

Elia Group: one of Europe's top 5 TSOs

Elia Group is active in electricity transmission.
It encompasses two leading TSOs strategically located in two European regions:

- Elia in Belgium
- 50Hertz in Germany

International consulting services

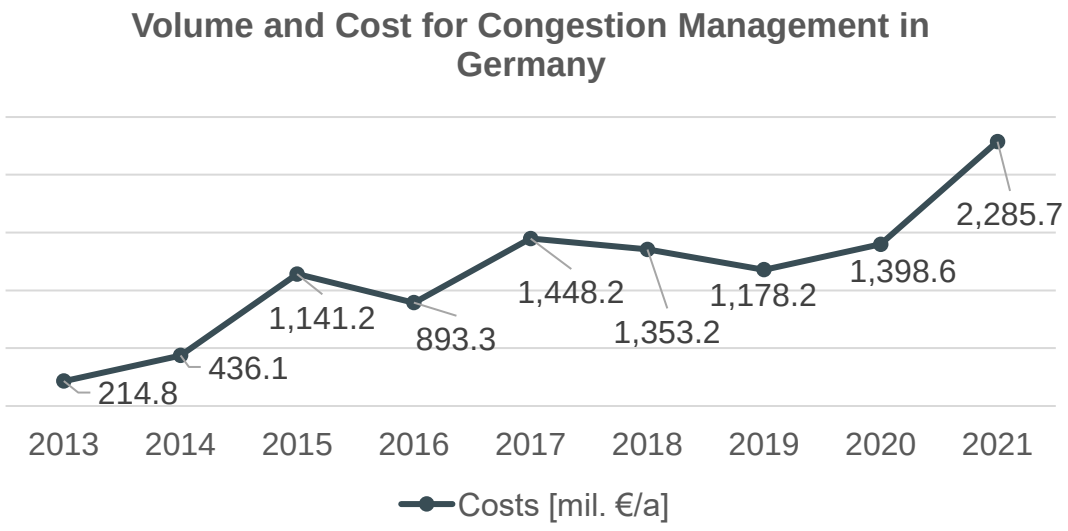
Connect to energy data and digital products via APIs

Accelerate development of offshore energy

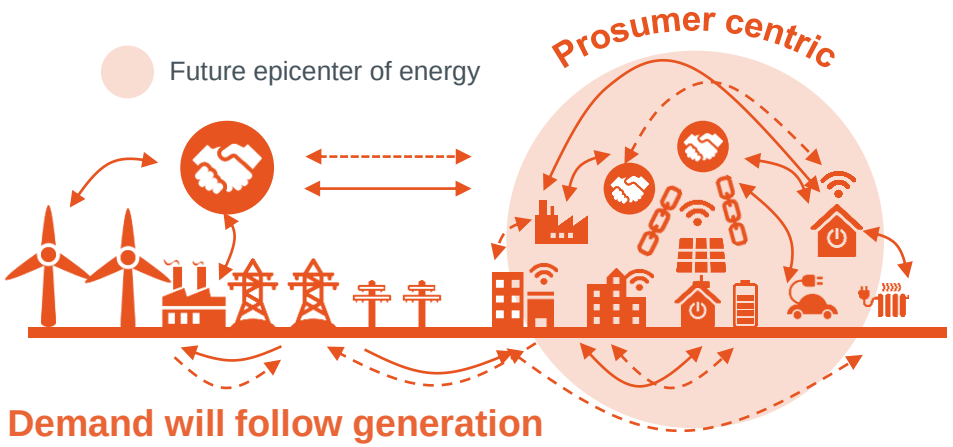
1. Why do we need to optimize for grid topology ?

Why do we need to optimize for grid topology ?

Increasing redispatch costs



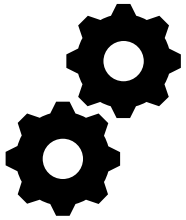
Increasing grid complexity



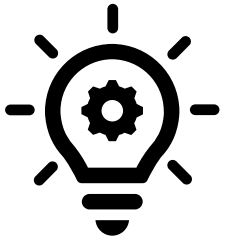
In **2022** redispatch costs nearly doubled **to 4,2 billion €.**

2. Our Approach

There is a strong **need to find topological grid actions** to resolve congestion in the grid and to lower redispatch costs



Can we optimize for topological actions in the grid?



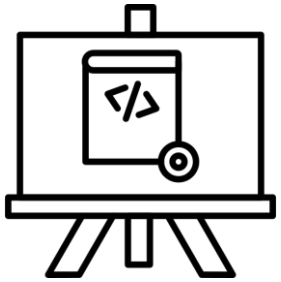
1. Proof of Concept
„Advanced Analytics for Topology Optimization“
2020-2022

2. Proof of Concept
RL & optimized load flow solver approach
(Q2 2023)

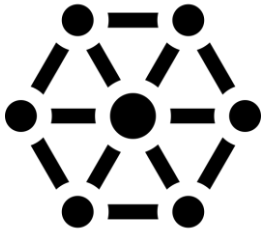
Together with InstaDeep™

Icons: Idea Icon - Noun Project

Our goal is to work on the challenges that have been discovered during the first proof of concept phase.



RL Demonstration
of a test grid



Requirements to implement
RL for **Congestion Management to Elia‘s grid + first steps**

Analysis of potential use-cases for RL
in Elia Group

From a topology optimizer different departments would benefit. In addition,

Elia Group

Grid development

Operational Planning

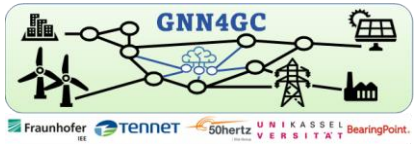
(Close-to)-Realtime

European level / TSO / academia

coreso

TenneT

Rte



InnOptem

IAEW | RWTH AACHEN UNIVERSITY

GUROBI OPTIMIZATION

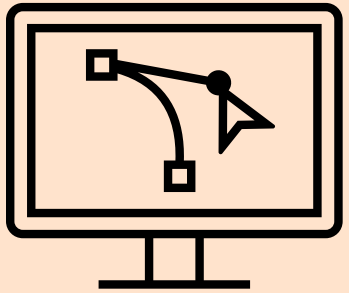
FGH

amprion verbindet

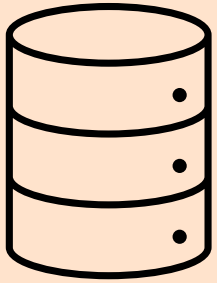
and probably many more.

3. The challenges

From L2RPN to the real grid – three main challenges need to be tackled



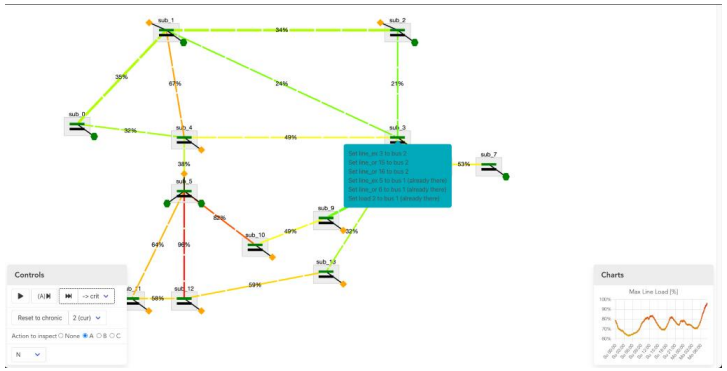
1. Show the potential of RL to the business

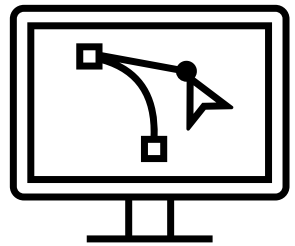


2. Get the real grid into the environment

3. Speed up load flow calculations

Grid2op / L2RPN – great starting point to demonstrate RL to the business but currently difficult to adapt to the Elia Group grids.





Grid2Elia Version

Data articfacts and inconsistent data make it difficult to set-up a RL environment

Requirements

- Load and generation data with sufficient critical situations
- A consistent number of elements between the timesteps
- Loaded into Pandapower

Data sources

- Elia Group tools: Integral (50 Hertz), PowerFactory (Elia), Pandapower
- The benm_gridmodel_importer used to do the conversion to pandapower

CGMES Files

- Grid operation (DACF (50Hertz & Elia) (PowerFactory & AMICA exports)
- Test files

Pandapower

- VoltControl project files (Belgium)

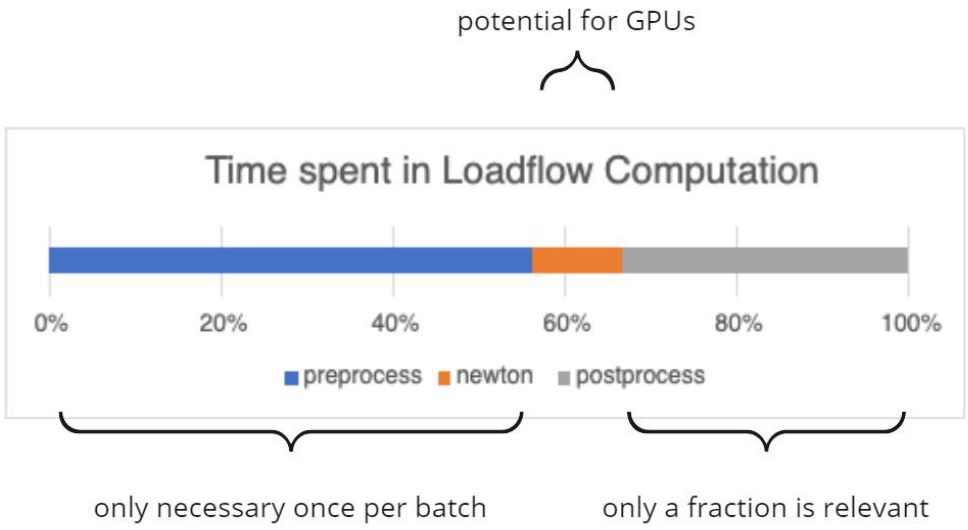
Integral .dat files

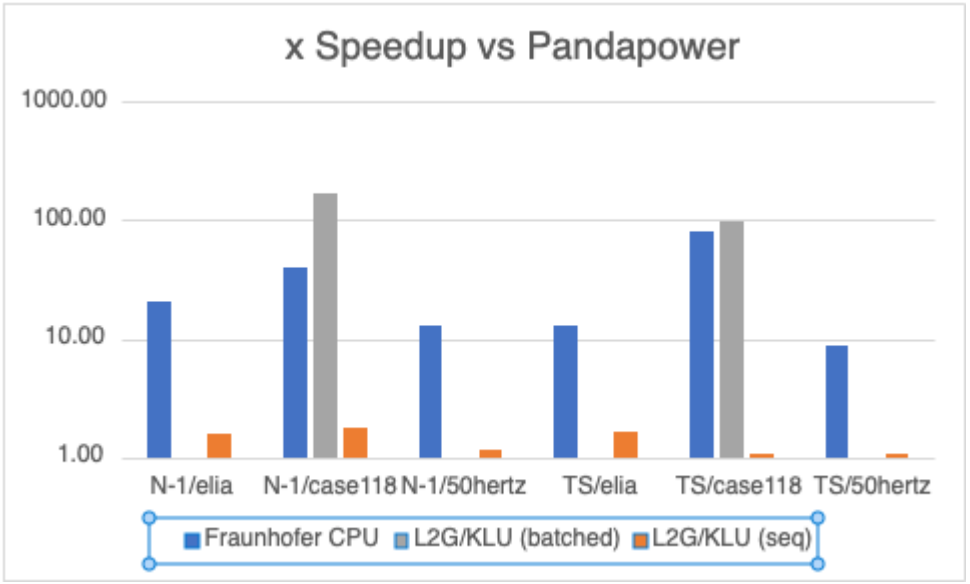
- Grid Planning (50Hertz) Integral exports

challenges

- Inconsistent numbers of elements
- AC load flow would not converge
- Converter would introduce artifacts
- Discovering new bugs in the converter
- Some elements not modelled in Pandapower

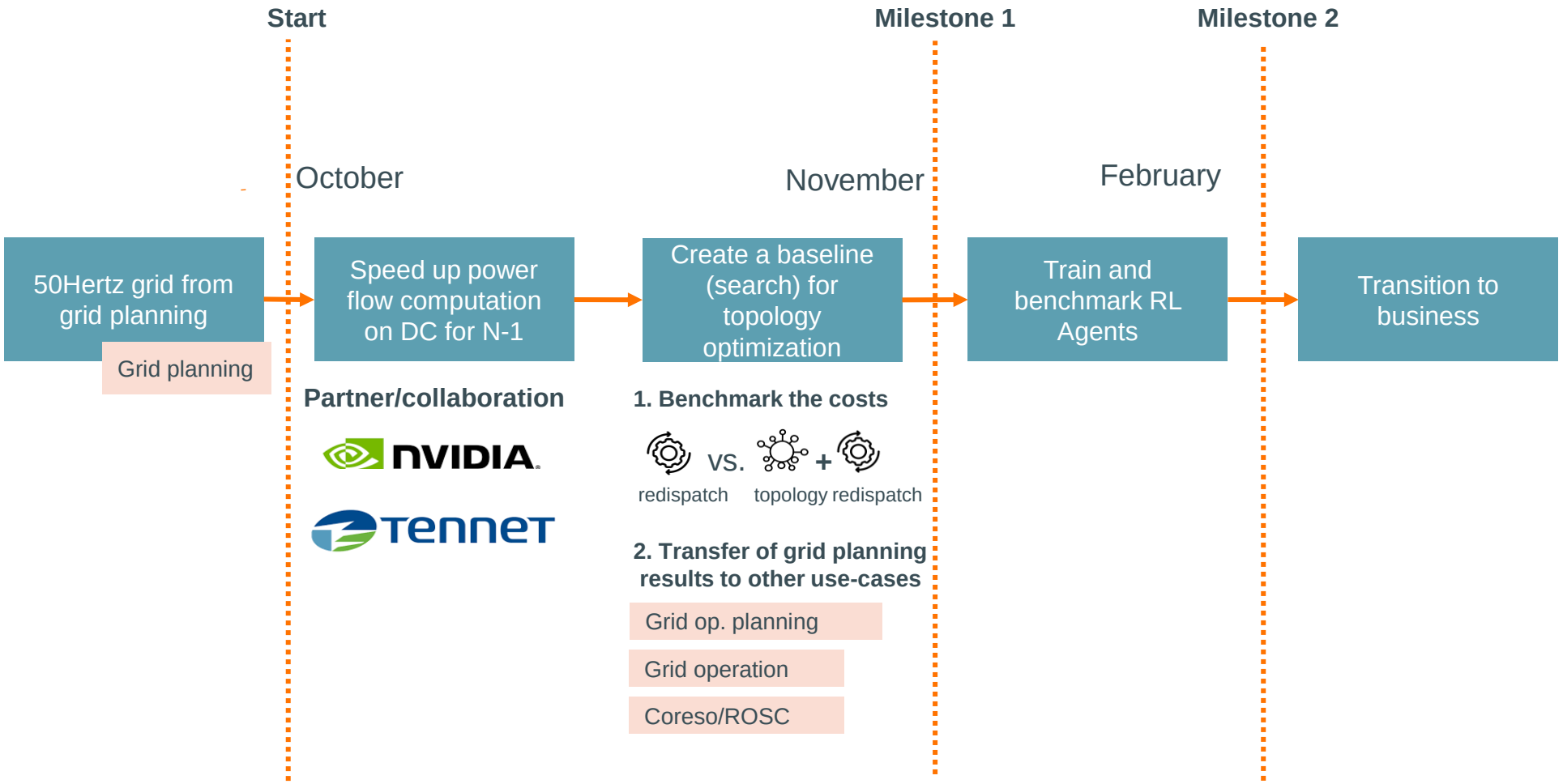
Speed up the load flow calculations to handle the big grid and enable various solving methodologies.





4. Next steps

Next steps


Start
Milestone 1
Milestone 2
October
November
February
50Hertz grid from grid planning
Grid planning
Speed up power flow computation on DC for N-1
Create a baseline (search) for topology optimization
Train and benchmark RL Agents
Transition to business
Partner/collaboration
NVIDIA
TenneT
1. Benchmark the costs
vs.
+
redispatch
topology redispatch
2. Transfer of grid planning results to other use-cases
Grid op. planning
Grid operation
Coreso/ROSC

Summary

1. Why do we need to optimize for grid topology?
2. Our approach
3. The challenges
4. Next steps

Let‘s get in touch and exchange !

Community of Practice

Christian Merz
Data Scientist
Christian.merz@eliagrou.eu

Practical Challenges in AI Development for Real-World Congestion Management at TenneT

PowerWeb L2RPN Session
Davide Barbieri (TenneT)

Control Room of the Future (CROF) Programme
Overview

- Established in Summer 2020

Control Room of the Future (CROF) Programme Overview

- Established in Summer 2020
- Why?
  - Develop new (smart) functionalities to mitigate future risk
  - **Congestion management** given high priority

#	System Issue
1	Increase in Transmission System Congestion in Known Areas
2	Increase in Transmission System Congestion in Unpredictable or Unknown Areas
3	Increased ROCOF & Reduced Nadirs
4	Faster Ramping
5	Increased Frequency Volatility
6	Larger Propagation of Low Voltages During Disturbances
7	Larger Voltage Dips
8	Inadequate Observability of RES
9	Lack of Operator Situational Awareness for New Issues
10	Reduction of Transient Stability Margins
11	Decreased Damping of Existing Power Oscillations
12	Inaccurate Load Model Data/Information
13	Harmonic Instability
14	Reduced Dynamic Reactive Power Reserves
15	Resonances Due to Power Electronics
16	Inadequate Controllability of RES
17	Reactive Power Fluctuations
18	Cyber Attack on Entities Connected to the Grid
19	Misoperation of Protection Relays
20	LCC Commutation Failure due to Reducing System Strength

Control Room of the Future (CROF) Programme
Overview

- Established in Summer 2020
- Why?
  - Develop new (smart) functionalities to mitigate future risk
  - **Congestion management** given high priority
- Main tracks
  - Congestion management project (**GridOptions tool**)
  - Forecasting project
  - Dynamic line rating
  - Etc…

Control Room of the Future (CROF) Programme
Overview

- Established in Summer 2020
- Why?
  - Develop new (smart) functionalities to mitigate future risk
  - **Congestion management** given high priority
- Main tracks
  - Congestion management project (**GridOptions tool**)
  - Forecasting project
  - Dynamic line rating
  - Etc…
- Goal
  - Embed available **SOTA** tools and technologies **within TenneT**

Control Room of the Future (CROF) Programme
Overview

- Established in Summer 2020
- Why?
  - Develop new (smart) functionalities to mitigate future risk
  - **Congestion management** given high priority
- Main tracks
  - Congestion management project (**GridOptions tool**)
  - Forecasting project
  - Dynamic line rating
  - Etc…
- Goal
  - Embed available **SOTA** tools and technologies **within TenneT**
  - Develop/maintain some (smart) **functionalities in-house**

Control Room of the Future (CROF) Programme
Overview

- Established in Summer 2020
- Why?
  - Develop new (smart) functionalities to mitigate future risk
  - **Congestion management** given high priority
- Main tracks
  - Congestion management project (**GridOptions tool**)
  - Forecasting project
  - Dynamic line rating
  - Etc…
- Goal
  - Embed available **SOTA** tools and technologies **within TenneT**
  - Develop/maintain some (smart) **functionalities in-house**
  - Build **R&D environment** to tailor solutions to TenneT's needs

GridOptions Tool

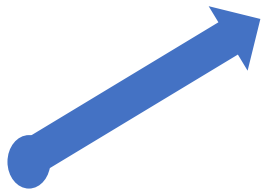
Problem Setting

- TenneT uses loadflow simulations to
  - Asses congestion related risks
  - Determine possible remedial actions

GridOptions Tool

Problem Setting

- TenneT uses loadflow simulations to
  - Asses congestion related risks
  - Determine possible remedial actions



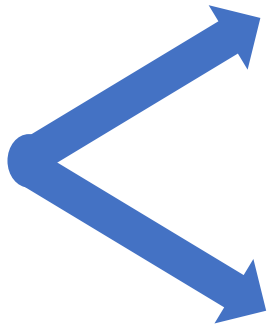
Redispatch

- Baseline optimization tooling available
- Costly

GridOptions Tool

Problem Setting

- TenneT uses loadflow simulations to
  - Asses congestion related risks
  - Determine possible remedial actions



Redispatch

- Baseline optimization tooling available
- Costly

Topological actions

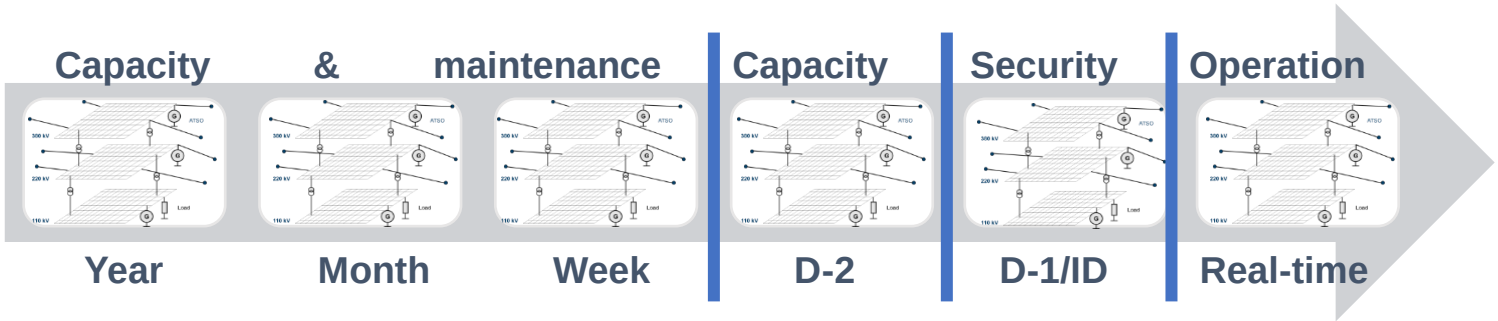
- Solutions are thought of and evaluated by humans
- Currently not fully exploited
- Support tooling only for running simulations

GridOptions Tool

Problem Setting

- TenneT uses loadflow simulations to
  - Asses congestion related risks
  - Determine possible remedial actions

- Several stages for each given day
  - Currently GridOptions is focusing on start of ID

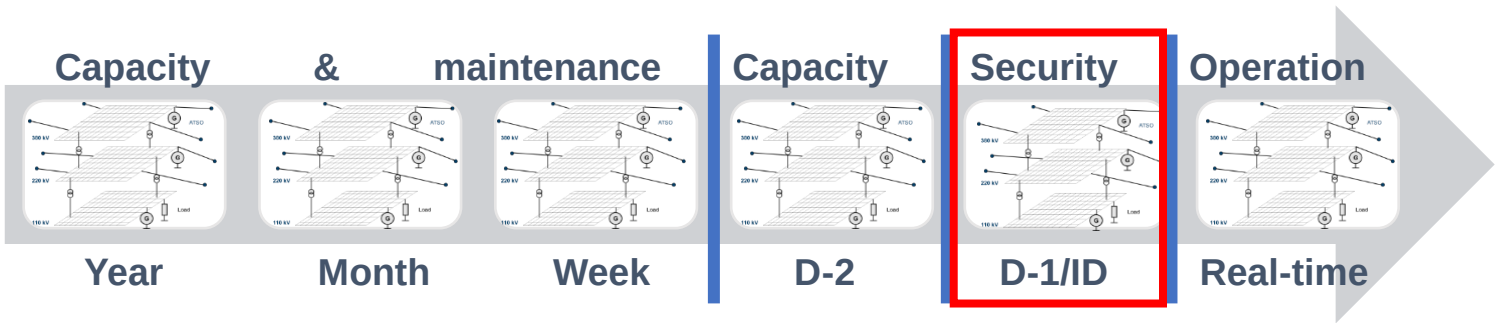


GridOptions Tool

Problem Setting

- TenneT uses loadflow simulations to
  - Asses congestion related risks
  - Determine possible remedial actions

- Several stages for each given day
  - Currently GridOptions is focusing on start of ID

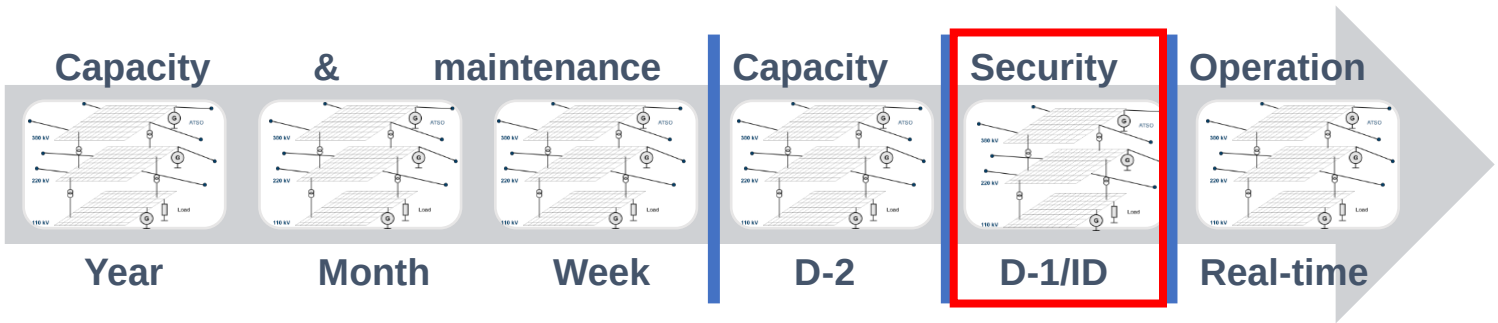


GridOptions Tool

Problem Setting

- TenneT uses loadflow simulations to
  - Asses congestion related risks
  - Determine possible remedial actions

- Several stages for each given day
  - Currently GridOptions is focusing on start of ID
  - Goal is to move expand in other time-frames



GridOptions Tool
Overview

- Developing on sub-net (Groningen-Drenthe)

Viebahn J. et al, GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions, 2024

GridOptions Tool

Overview

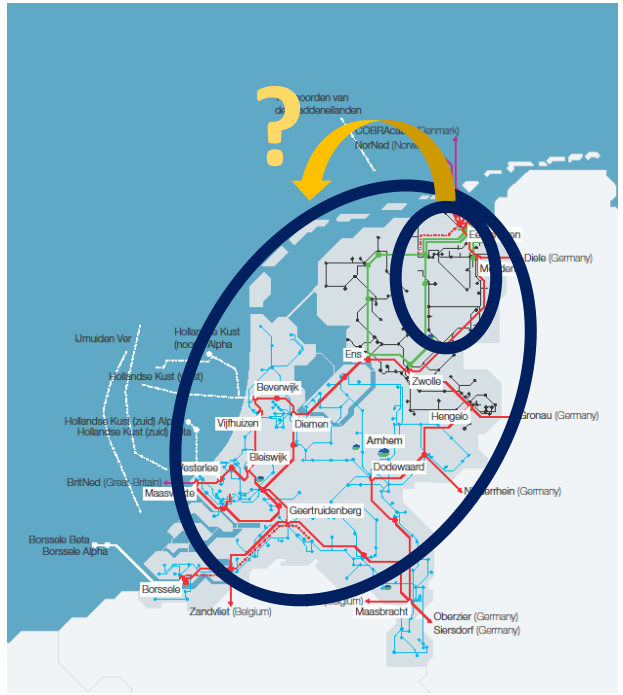
- Developing on sub-net (Groningen-Drenthe)
  - Challenging region due to shortages
  - Increasing requested connections
  - More generation of renewable energy resources
  - Dynamic flow patterns

Viebahn J. et al, GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions, 2024

GridOptions Tool

Overview

- Developing on sub-net (Groningen-Drenthe)
  - Challenging region due to shortages
  - Increasing requested connections
  - More generation of renewable energy resources
  - Dynamic flow patterns



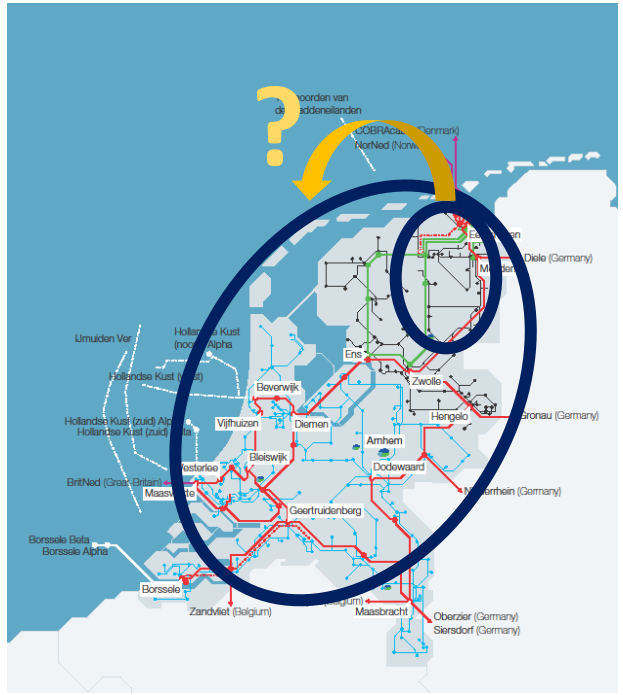
Viebahn J. et al, GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions, 2024

GridOptions Tool

Overview

- Developing on sub-net (Groningen-Drenthe)
  - Challenging region due to shortages
  - Increasing requested connections
  - More generation of renewable energy resources
  - Dynamic flow patterns

- Meant to aid not automate
  - Need trust
  - Need to be understandable
  - Contrast between users and business case



Viebahn J. et al, GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions, 2024

GridOptions Tool

Comparison to L2RPN problem

- Fully **rolled-out** solutions for entire day
  - Provide topology for **each time-step** of the day
  - (Currently) **lower time resolution**

GridOptions Tool

Comparison to L2RPN problem

- Fully **rolled-out** solutions for entire day
  - Provide topology for **each time-step** of the day
  - (Currently) **lower time resolution**

- Dynamic environment
  - Grid model constantly changing

GridOptions Tool

Comparison to L2RPN problem

- Fully **rolled-out** solutions for entire day
  - Provide topology for **each time-step** of the day
  - (Currently) **lower time resolution**

- Dynamic environment
  - Grid model constantly changing

- Multi-Objective
  - **Safety** of the network is important
  - **Reduce** the number of **topological changes**
  - Ideally switch only bus-bar couplers (remote)

Viebahn J. et al, GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions, 2024

GridOptions Tool

Comparison to L2RPN problem

- Fully **rolled-out** solutions for entire day
  - Provide topology for **each time-step** of the day
  - (Currently) **lower time resolution**

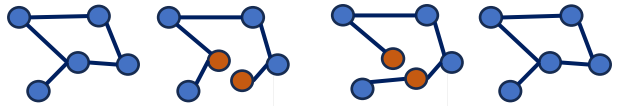
- Dynamic environment
  - Grid model constantly changing

- Multi-Objective
  - **Safety** of the network is important
  - **Reduce** the number of **topological changes**
  - Ideally switch only bus-bar couplers (remote)
  - Solutions must be **trusted/understood** by operators
  - Set of solutions
    - Allowing operators to have options

Viebahn J. et al, GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions, 2024

GridOptions Tool

Comparison to L2RPN problem



80	90	82	85	Max loading
t=1	t=2	t=3	t=4	

- Fully **rolled-out** solutions for entire day
  - Provide topology for **each time-step** of the day
  - (Currently) **lower time resolution**

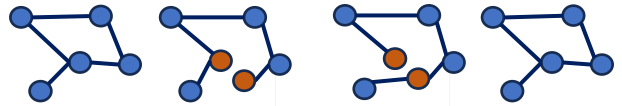
- Dynamic environment
  - Grid model constantly changing

- Multi-Objective
  - **Safety** of the network is important
  - **Reduce** the number of **topological changes**
  - Ideally switch only bus-bar couplers (remote)
  - Solutions must be **trusted/understood** by operators
  - Set of solutions
    - Allowing operators to have options

Viebahn J. et al, GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions, 2024

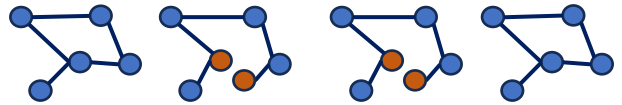
GridOptions Tool

Comparison to L2RPN problem



80	90	82	85
t=1	t=2	t=3	t=4

Max loading



80	90	92	85
t=1	t=2	t=3	t=4

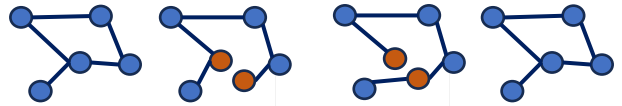
Max loading

- Fully **rolled-out** solutions for entire day
  - Provide topology for **each time-step** of the day
  - (Currently) **lower time resolution**
- Dynamic environment
  - Grid model constantly changing
- Multi-Objective
  - **Safety** of the network is important
  - **Reduce** the number of **topological changes**
  - Ideally switch only bus-bar couplers (remote)
  - Solutions must be **trusted/understood** by operators
  - Set of solutions
    - Allowing operators to have options

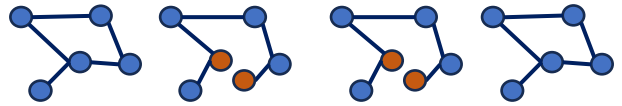
Viebahn J. et al, GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions, 2024

GridOptions Tool

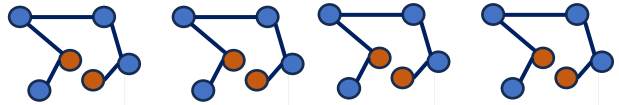
Comparison to L2RPN problem



80	90	82	85	Max loading
t=1	t=2	t=3	t=4	



80	90	92	85	Max loading
t=1	t=2	t=3	t=4	



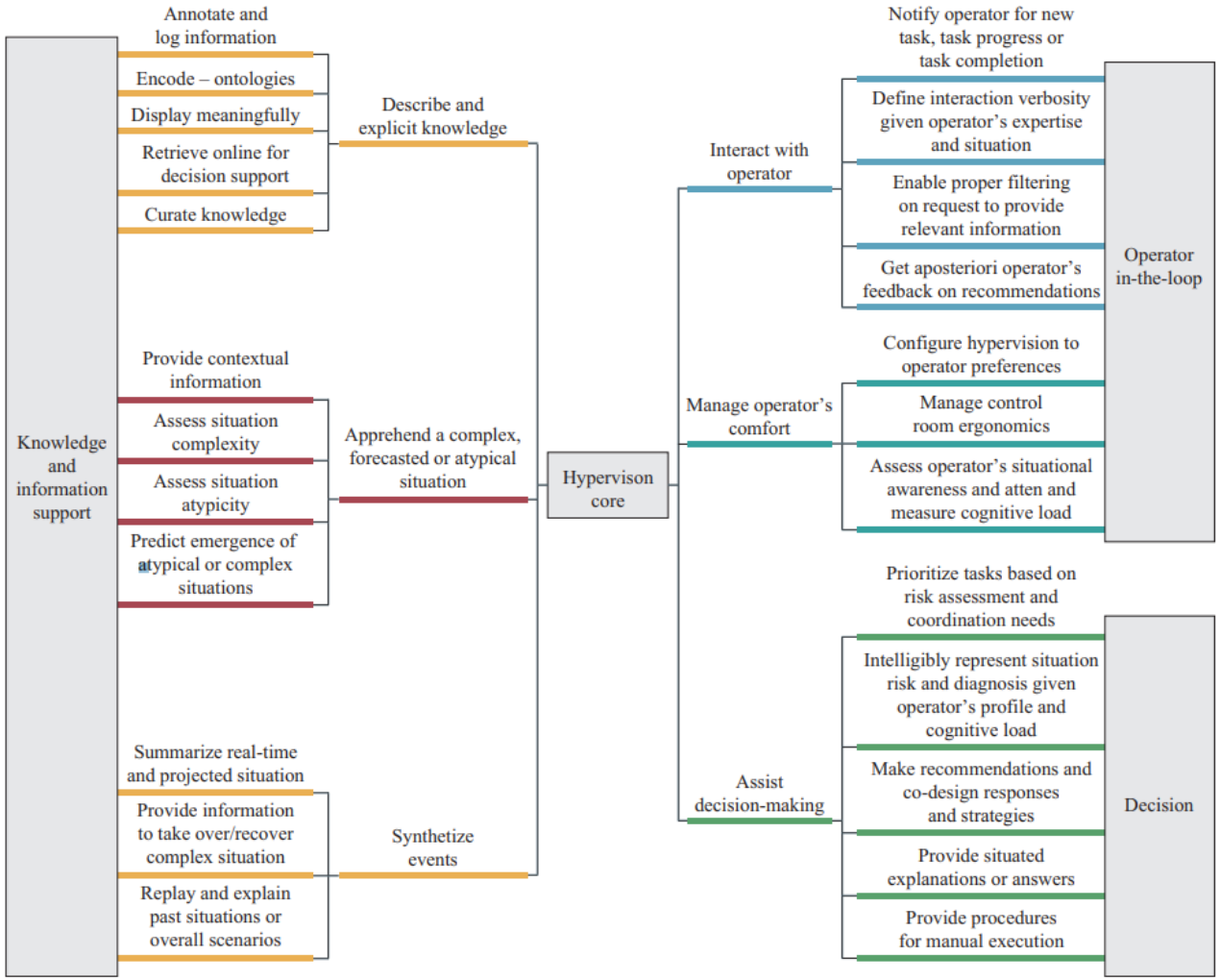
91	90	92	93	Max loading
t=1	t=2	t=3	t=4	

- Fully **rolled-out** solutions for entire day
  - Provide topology for **each time-step** of the day
  - (Currently) **lower time resolution**
- Dynamic environment
  - Grid model constantly changing
- Multi-Objective
  - **Safety** of the network is important
  - **Reduce** the number of **topological changes**
  - Ideally switch only bus-bar couplers (remote)
  - Solutions must be **trusted/understood** by operators
  - Set of solutions
    - Allowing operators to have options

Viebahn J. et al, GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions, 2024

Where do we want to go?

Dot in the Horizon

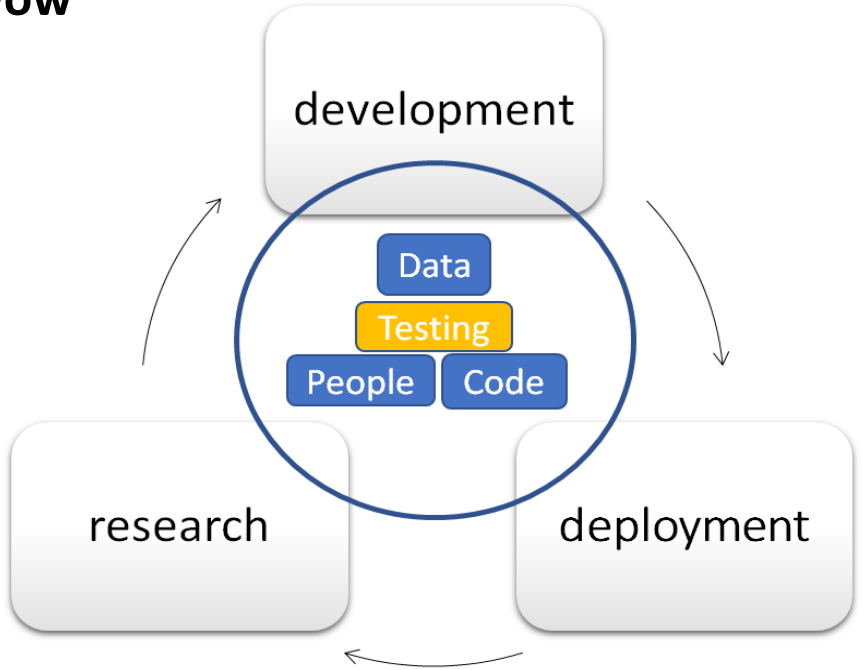


Marot A. et al, Perspectives on Future Power System Control Centers for Energy Transition , 2022

TenneT R&D (at Digital & Data department)

Establishing a R&D environment

- CROF development **requires** a well-defined **environment and wow**

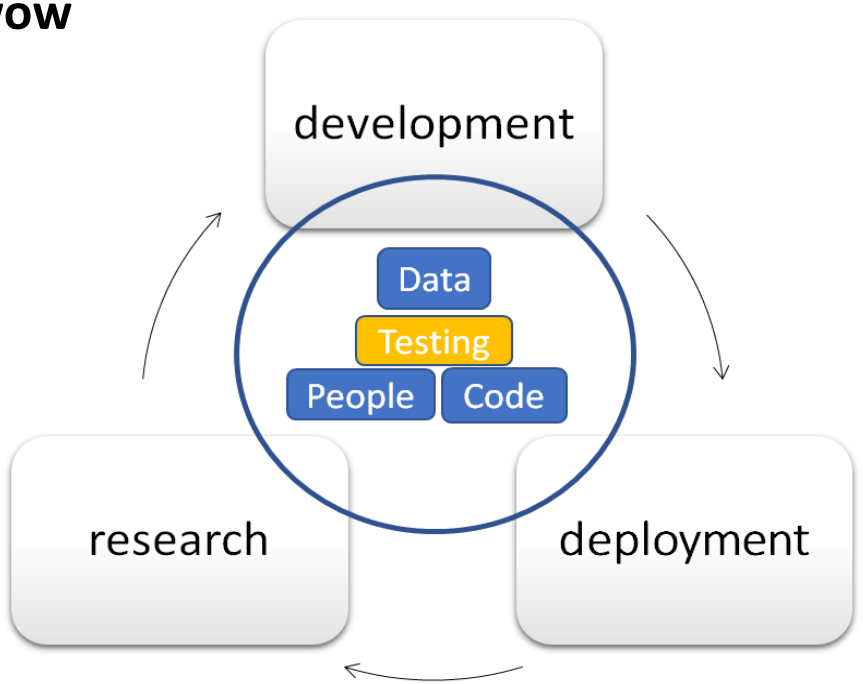


Viebahn J. et al, Potential and challenges of AI-powered decision support for short-term system operations, 2022

TenneT R&D (at Digital & Data department)

Establishing a R&D environment

- CROF development **requires** a well-defined **environment and wow**
- Bring research and development closer



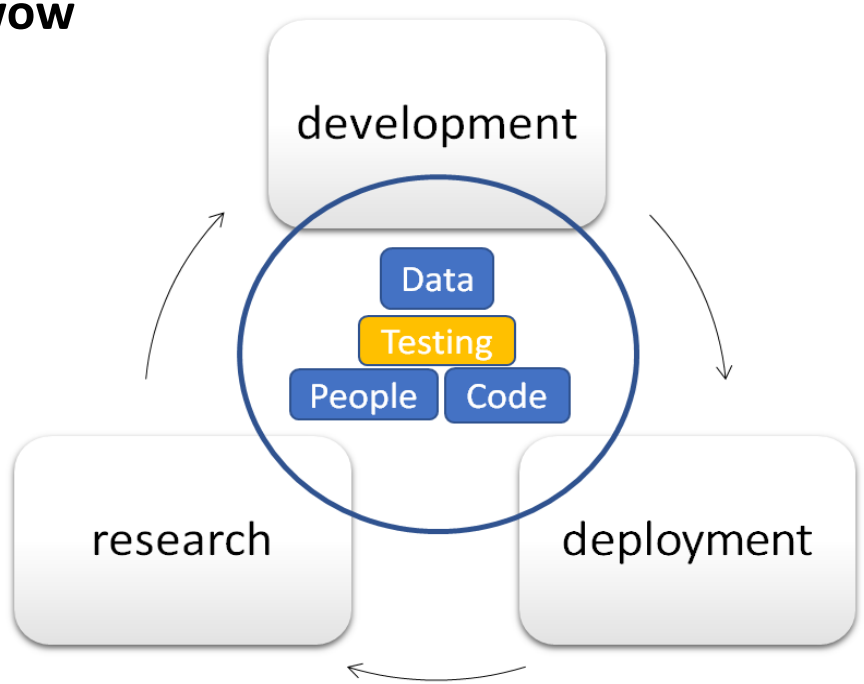
Viebahn J. et al, Potential and challenges of AI-powered decision support for short-term system operations, 2022

TenneT R&D (at Digital & Data department)

Establishing a R&D environment

- CROF development **requires** a well-defined **environment and wow**

- Bring research and development closer
  - Research focused on real world data
    - Close the gap between idealistic and realistic problem constraints



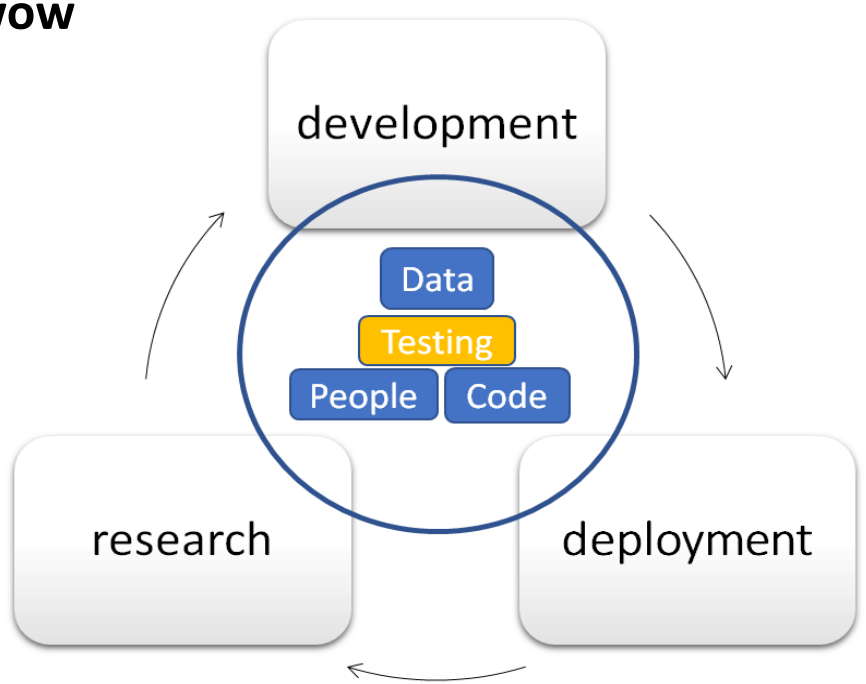
Viebahn J. et al, Potential and challenges of AI-powered decision support for short-term system operations, 2022

TenneT R&D (at Digital & Data department)

Establishing a R&D environment

- CROF development **requires** a well-defined **environment and wow**

- Bring research and development closer
  - Research focused on real world data
    - Close the gap between idealistic and realistic problem constraints
  - Development with flexibility and modularity in mind
    - Keep track of SOTA
    - Reuse solutions



Viebahn J. et al, Potential and challenges of AI-powered decision support for short-term system operations, 2022

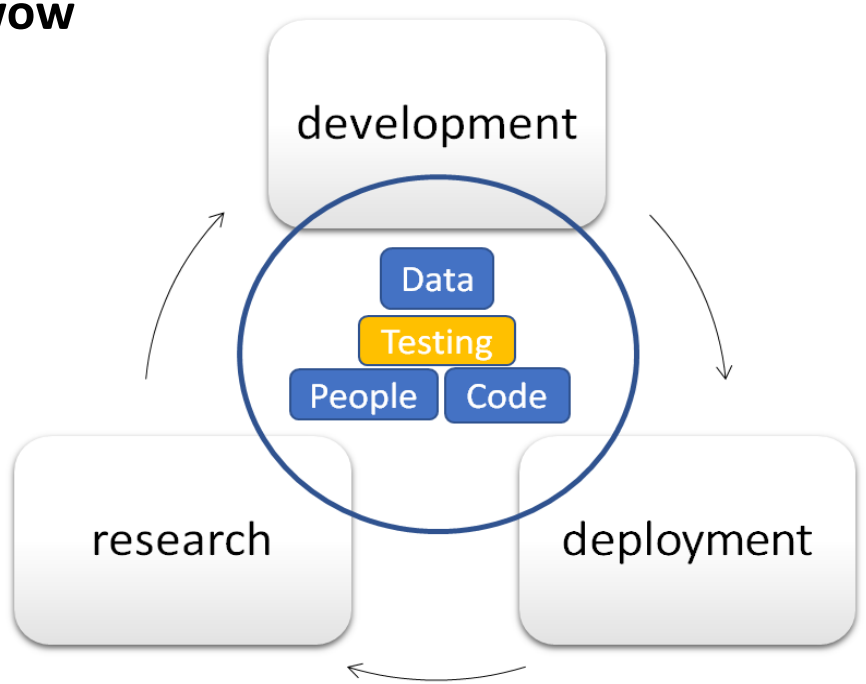
TenneT R&D (at Digital & Data department)

Establishing a R&D environment

- CROF development **requires** a well-defined **environment and wow**

- Bring research and development closer
  - Research focused on real world data
    - Close the gap between idealistic and realistic problem constraints
  - Development with flexibility and modularity in mind
    - Keep track of SOTA
    - Reuse solutions

- Data at the center
  - Want to test/deploy on **real world data** as much as possible
  - Difficult to **share data**



Viebahn J. et al, Potential and challenges of AI-powered decision support for short-term system operations, 2022

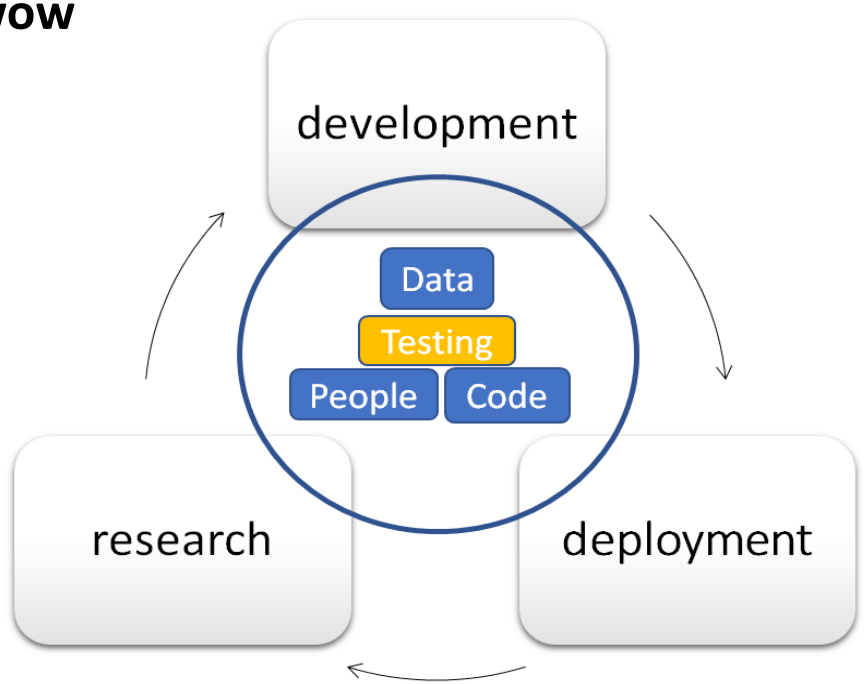
TenneT R&D (at Digital & Data department)

Establishing a R&D environment

- CROF development **requires** a well-defined **environment and wow**

- Bring research and development closer
  - Research focused on real world data
    - Close the gap between idealistic and realistic problem constraints
  - Development with flexibility and modularity in mind
    - Keep track of SOTA
    - Reuse solutions

- Data at the center
  - Want to test/deploy on **real world data** as much as possible
  - Difficult to **share data**
  - SOLUTION: **data** (format) **agnostic platform**
    - Easy to share on open-source data
    - Easy to test/tailor on TenneT data



Viebahn J. et al, Potential and challenges of AI-powered decision support for short-term system operations, 2022

Research Track
Overview

- Ongoing research collaborations

Research Track
Overview

- Ongoing research collaborations
  - GNN for Grid Control (German Funded Project)

Research Track
Overview

- Ongoing research collaborations
  - GNN for Grid Control (German Funded Project)
  - AI4RealNet (Horizon Europe Project)

Research Track
Overview

- Ongoing research collaborations
  - GNN for Grid Control (German Funded Project)
  - AI4RealNet (Horizon Europe Project)
  - Several MSc/PhD students @ TenneT focusing on
    - GNNs
    - MARL
    - MORL

Research Track
Overview

- Ongoing research collaborations
  - GNN for Grid Control (German Funded Project)
  - AI4RealNet (Horizon Europe Project)
  - Several MSc/PhD students @ TenneT focusing on
    - GNNs
    - MARL
    - MORL

- Literature
  - **Marot A. et al 2022**: Perspectives on Future Power System Control Centers for Energy Transition, Journal of Modern Power Systems and Clean Energy
  - **Viebahn J. et al 2022**: Potential and challenges of AI-powered decision support for short-term system operations, CIGRE Paris session
  - **Viebahm J. et al 2024:** GridOptions Tool: Real-World Day-Ahead Congestion Management using Topological Remedial Actions, CIGRE Paris session

Thank you for you attention