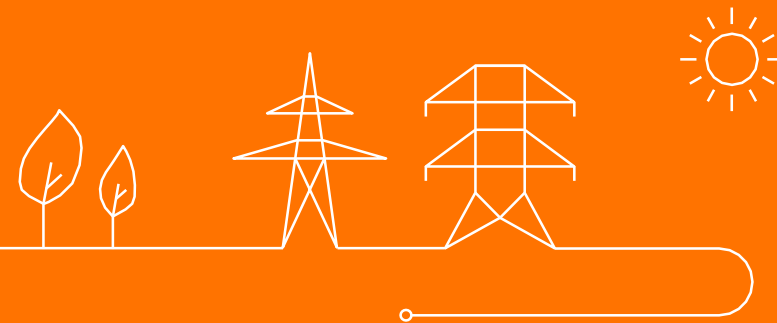# AI Monday – AI in Energy

Advancing AI at a Major Energy Player

Rachel Berryman & Oskar Grabarczyk
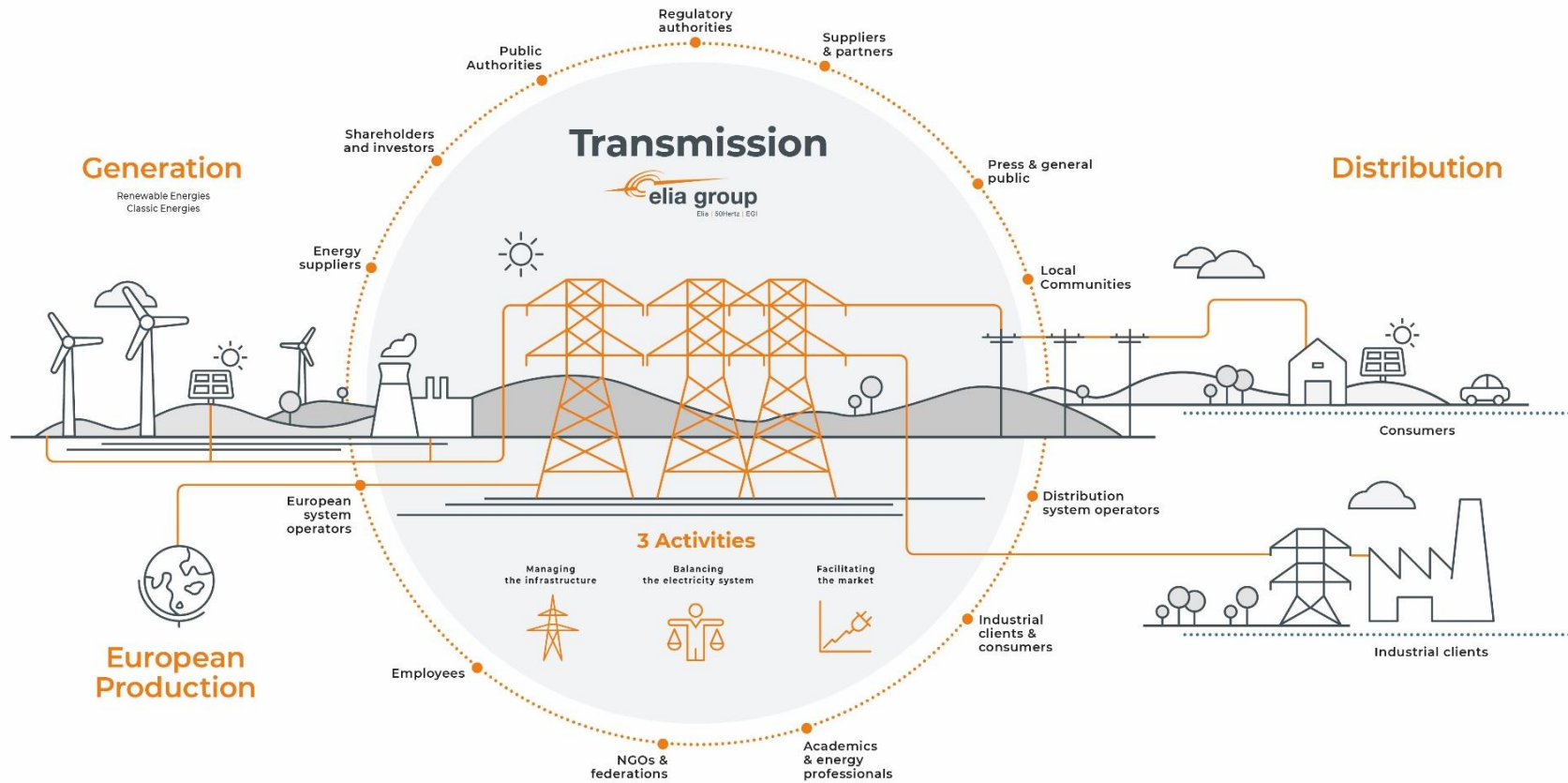
Elia Group

Agenda

Intro to Elia Group

- Energy system in flux
- Need for AI in the Group

AI Center of Excellence
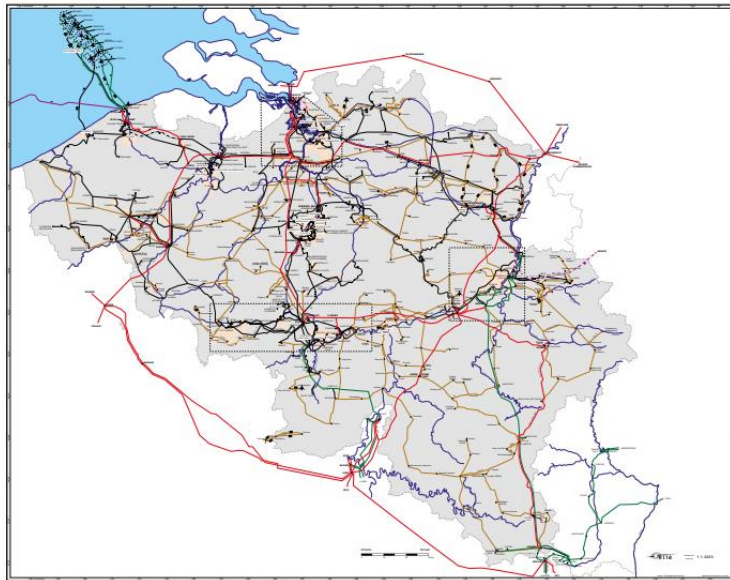
Intro to System Operations

Reinforcement Learning project in the Group – Grid Topology Optimization
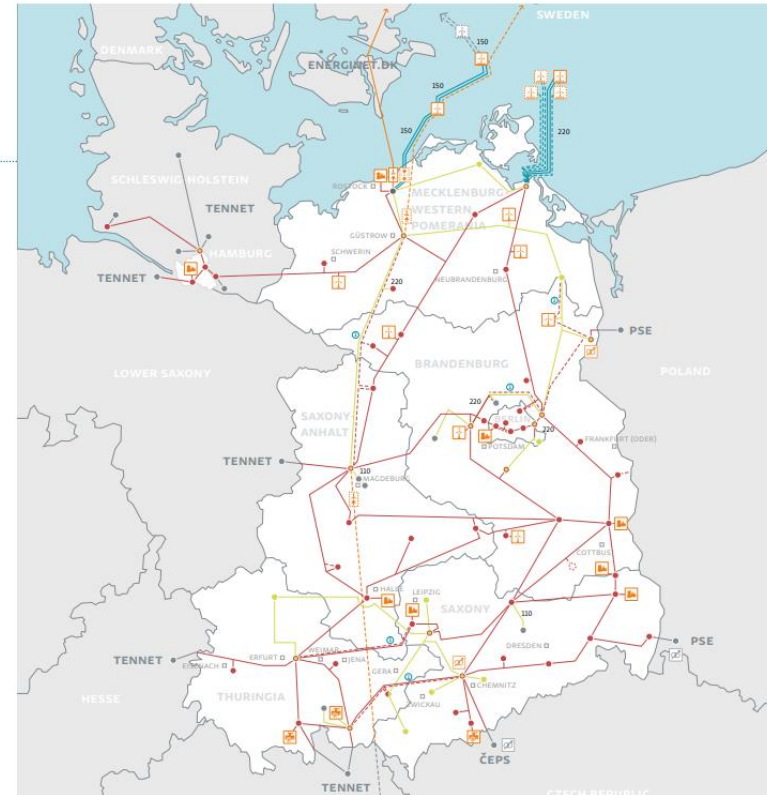
Introduction to the Elia Group

Introduction to the Elia Group

Grid Map Elia

Grid Map 50Hertz

Energy transition is characterized by a high penetration of renewables and a fundamental paradigm shift towards "demand follows generation"

Epicenter of energy today

Generation follows consumption

Future epicenter of energy

Prosumer centric

Demand will follow generation
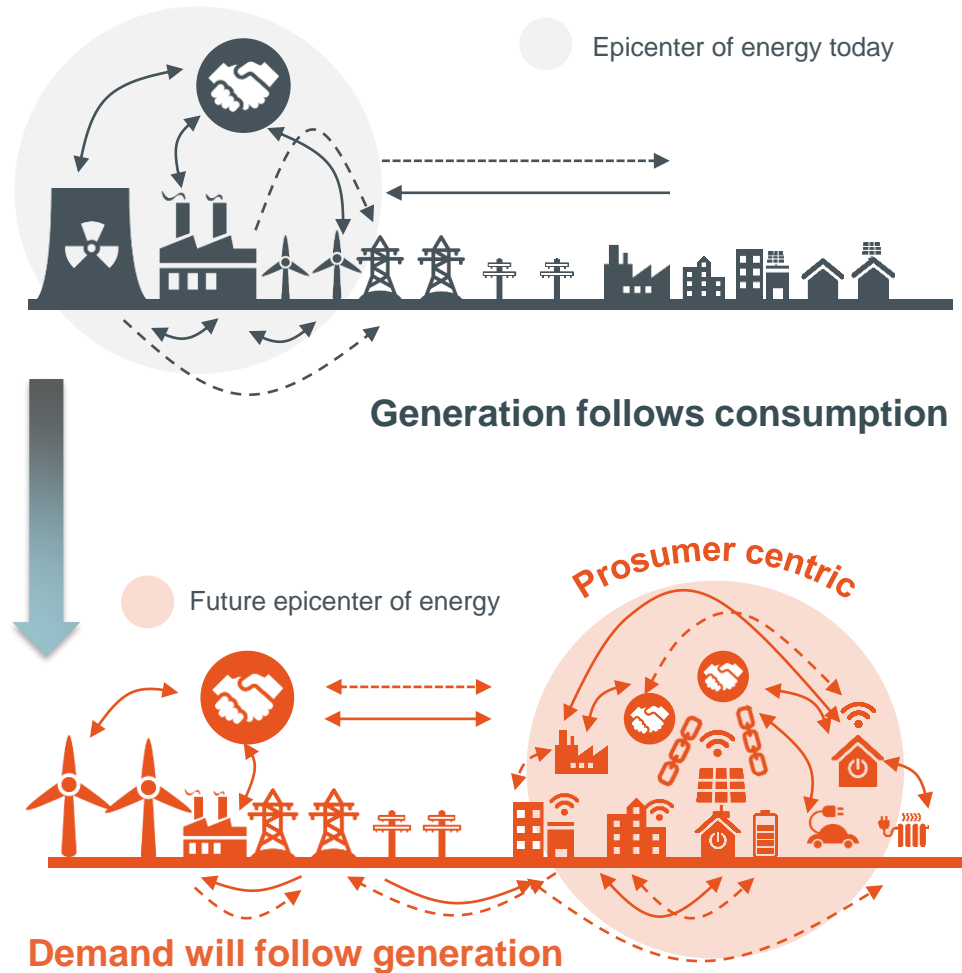
Increasing scalability needs

Increasing intermittency and uncertainty

Increasing complexity of grid planning

Affordable

Secure   **Sustainable**

In the context of the increase complexity of RES, Digital TSO is a pre-requisite to stay relevant … and AI a mandatory tool!

The digital TSO

Use of artificial intelligence for forecasting (load, generation, flexibility) decision automation, image analysis…

Big data from huge amount of sources: smart meters, IOT from smart homes, connected workers and assets, real-time market…

Drones and robots for inspections and first remedial actions

Virtual reality for training and planning

Connected generation asset

Automated dispatching managing millions of flexibility means with increased real-time needs and cross-border activities

Connected workforce

Connected and automated transmission asset

Smart homes with smart meters, electrified heating and cars providing flexibility

Real time market connected to decentralized players, notably using blockchain

What is a center of Excellence? Definition!

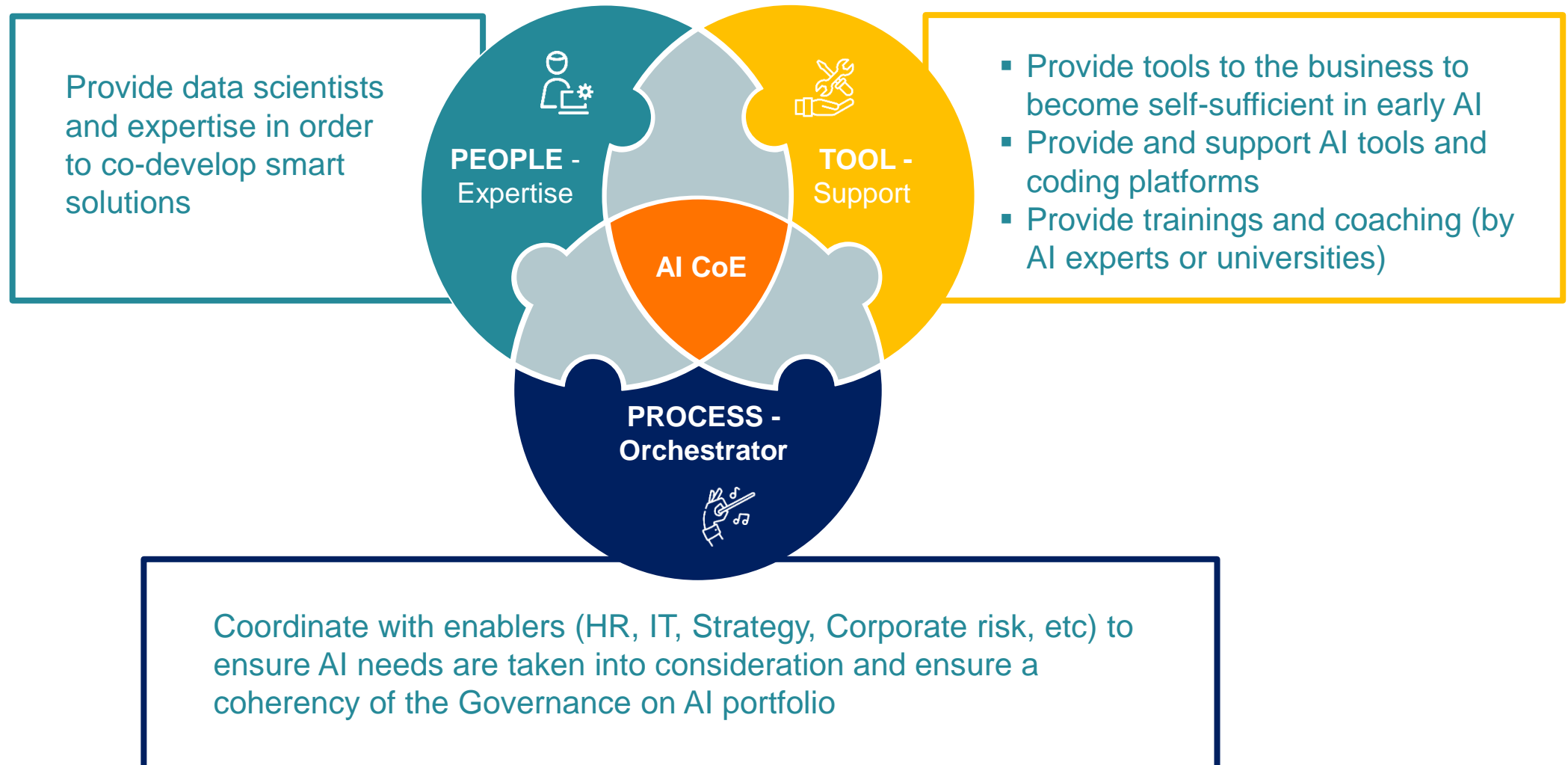"A team, a shared facility or an entity

that provides

leadership, best practices, research, support and training for a focus area."

Artificial Intelligence

The AI CoE focuses on enabling AI to the business bringing expertise, tools and orchestration

Provide data scientists and expertise in order to co-develop smart solutions

PEOPLE - Expertise

TOOL - Support

AI CoE

PROCESS - Orchestrator

- Provide tools to the business to become self-sufficient in early AI
- Provide and support AI tools and coding platforms
- Provide trainings and coaching (by AI experts or universities)

Coordinate with enablers (HR, IT, Strategy, Corporate risk, etc) to ensure AI needs are taken into consideration and ensure a coherency of the Governance on AI portfolio

AI CoE Offerings - Trainings

AI Demystification Workshop

AI Project Management Track

1. Use Case Development Workshop

Together with the Innovation team, we use design thinking methods to help you prepare a detailed proposal of an AI project.

Online Trainings
Online training for all EG employees available anytime, anywhere

Hands-OnTrack

1. Intro to Data Wrangling with Python

Leave this 2-day training with the tools you need to explore and discover in Python

2. In-Depth Python Training at Partner Coding School

At our partner coding schools in Belgium and Germany, you will increase your skills and bring value to your team.

3. Machine Learning Training

In this training, you'll move from data analyst to data scientist and learn how to implement Machine Learning algorithms on your own.

Motivation and Driver: Target for the expansion of renewables

**65 %
by 2030**

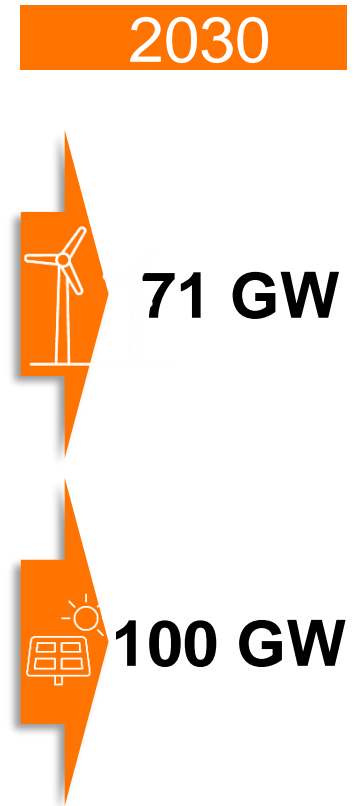The expansion of renewables is driving the need for transportation. We are therefore building lines, optimizing existing networks and **operation**.
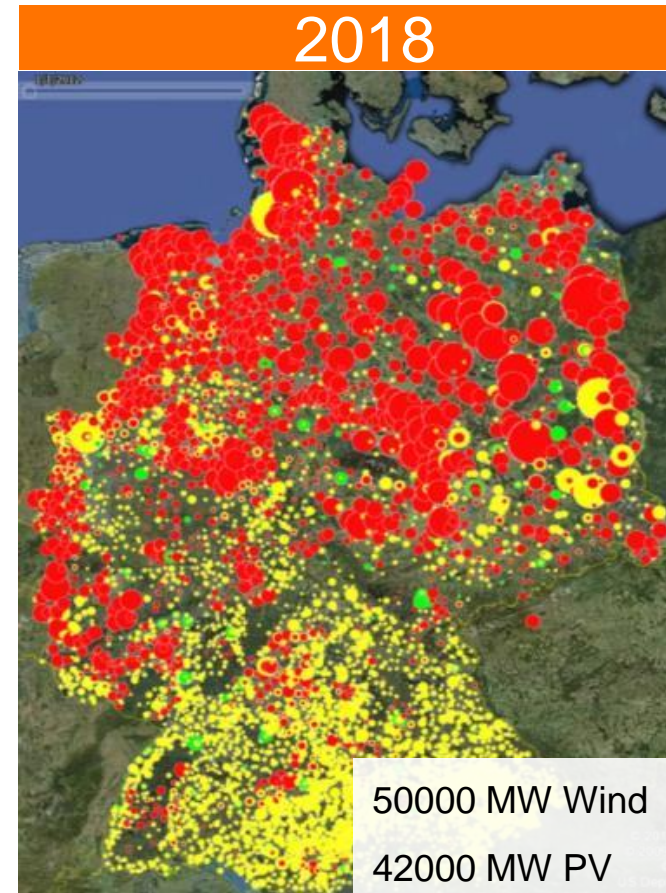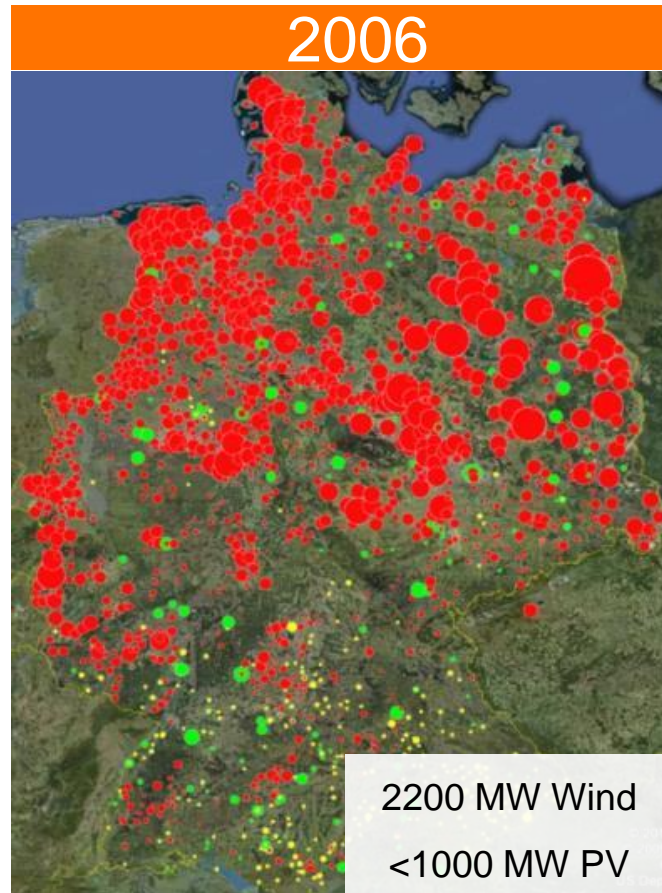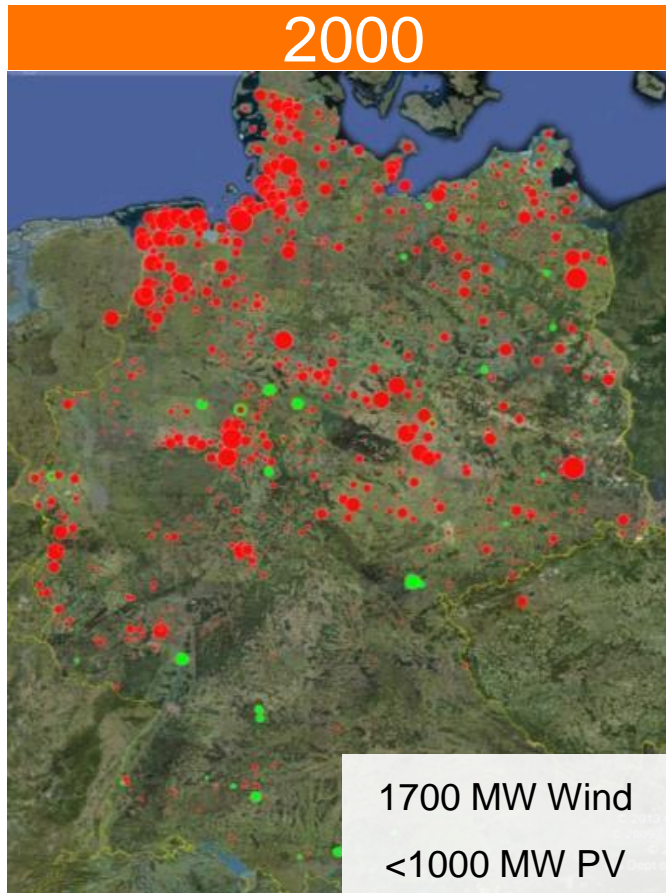
→ Carbon neutral before 2050

RES Development in Germany

| 2000 | 2006 | 2018 | 2030 |

Area proportional to the installed capacities

2000
1700 MW Wind
<1000 MW PV

2006
2200 MW Wind
<1000 MW PV

2018
50000 MW Wind
42000 MW PV

2030
71 GW
100 GW

PV   Wind   Biomass

Systemoperation
50Hertz Control Center
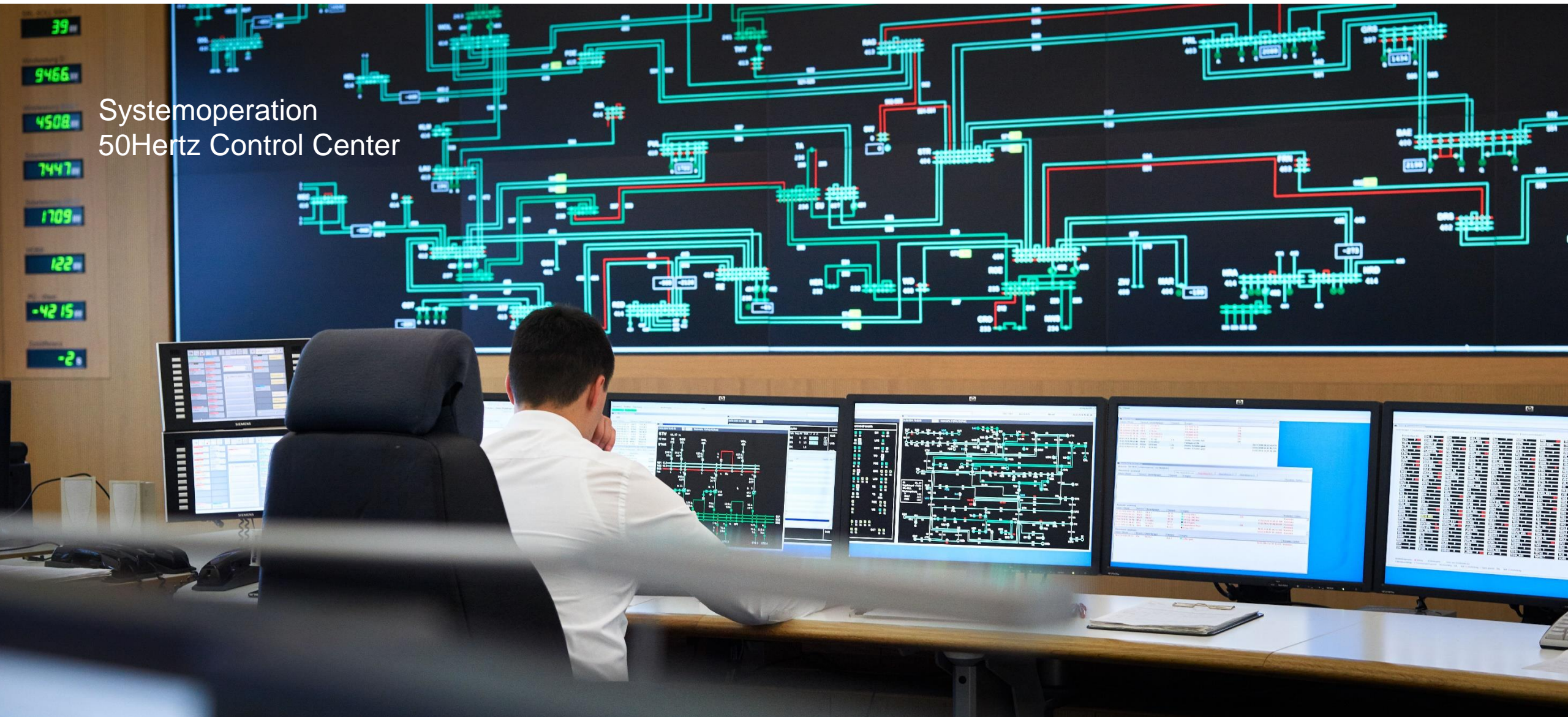
50Hertz it is in the name

Can we support system operators with help of AI?

50 times per second

Reinforcement Learning applied to 50 Hz

Environment

50 times per second

Observation (state / reward)

- What`s the position of my bike?

- What`s the position of the road?

- Did I fall?

Action

- Speed up

- Brake

Agent

Training of AI model
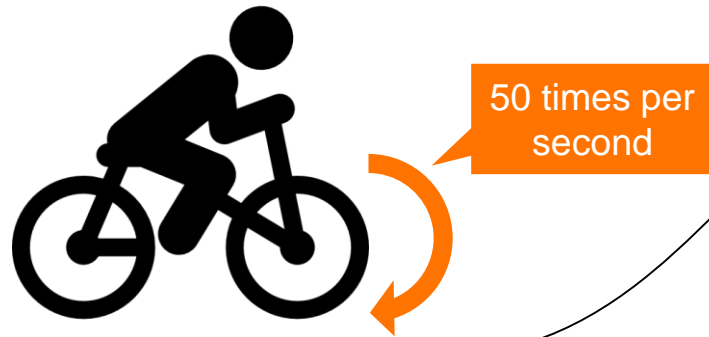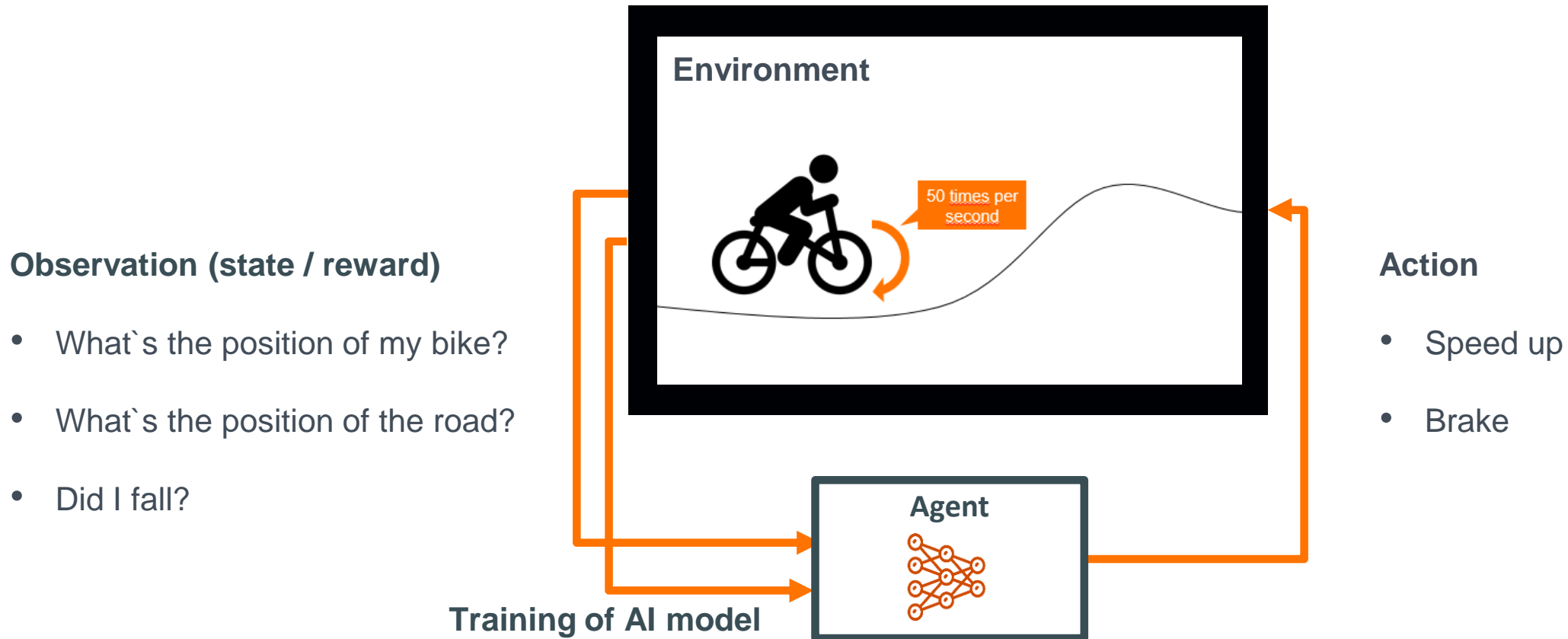
- Learns from failing and accidently winning

- The higher the final score the better the trained actions behaviour

Reinforcement Learning applied to a power system
The five fundamental elements for agent training

Environment: Power system model with lines, generation, …

State: Resulting power flow simulation

Reward: Gain or loss from taking an action in a given state

Agent: Reinforcement Learning algorithm

Learns how to act to increase the reward

Takes the state into account

Action: Actions that the agent can perform to influence the environment for example node splitting or line (de-) activation

Environment

State   **Reward**   **Action**

Agent

![elia group logo — Elia | 50Hertz | EGI]

Reinforcement Learning applied to a power system
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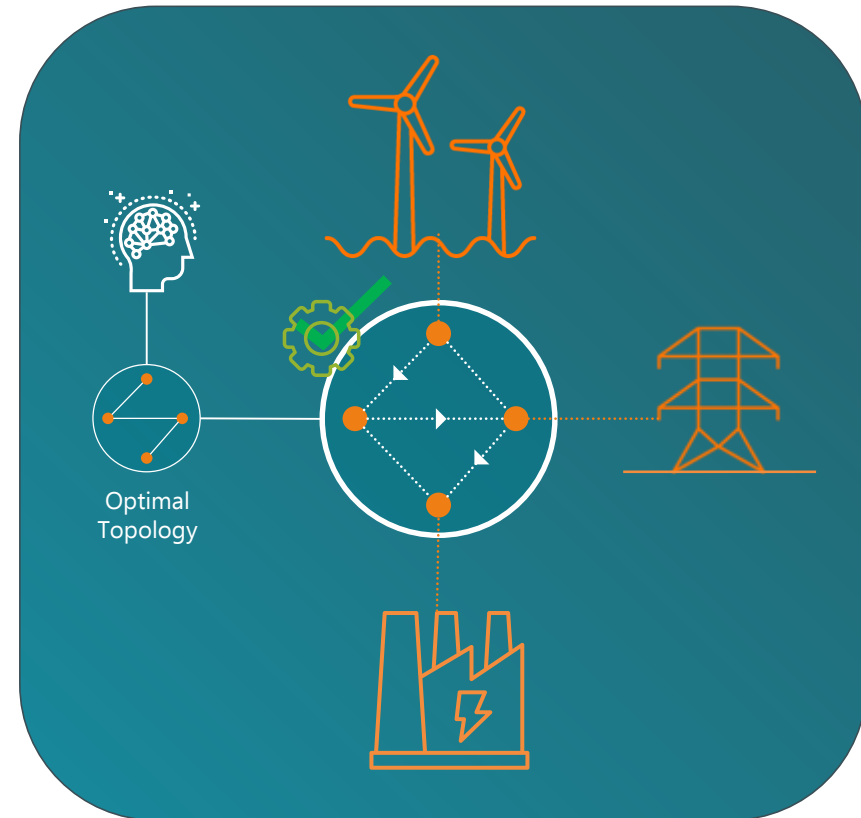**Reward:** Gain or loss from taking an action in a given state

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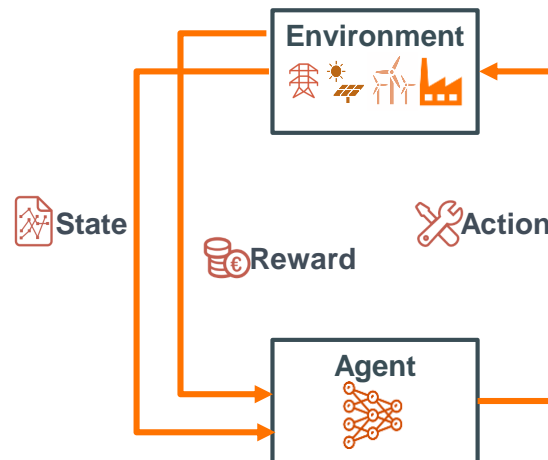
Optimal
Topology

Migration from training to operation
Reinforcement learning has two phases and a big advantage

TRAINING PHASE

- Environment is a digital representation
  - Scenario's with loads & generation
- Agent learns first through Trial & Error
- Time consuming phase

OPERATING PHASE

- Environment is the real grid state + load and generation forecast
- Agent gives an action or new grid state as an outcome, based on what he learned during training
- Very fast

Environment

State

Reward

Action

Agent

EMS
- current grid state
- forecasted load & generation

Trained Agent

Action

Proposed grid state

Questions for applying Reinforcement Learning
Early stage research on the application of AI in our business

What are the possible applications of reinforcement learning (RL) in the business ?

Is RL mature enough to optimise system operation problems ?

What would be the right AI agent ?

How applicable are the suggestions by an AI to the real operation ?

What is the right reward that we give our agent in each iteration ?

How time consuming is the training phase ? What would be the right hardware ?

RTE Research Actions and the L2RPN Challange

- **Gamification of Electricity Transmission Operations (Cha Learn)**

- **Objectives**

  - se of AI for power grid operations automation

  - First: demonstrate feasibility of applying RL

  - Next: Use realistically-sized grid environment

- **Grid2Op is …** (before Pypownet)

  - a python module making it easier to research on decision making applied to the power system

  - "… [an] easy to use framework, to be able to develop, train or evaluate performances of "agent" or "controller" that acts on a powergrid in different ways."*

  - Modular, opensource and uses reinforcement learning

* https://grid2op.readthedocs.io/   https://l2rpn.chalearn.org/

Opensource AI-PowerSystem framework

- **4 of 5 elements** are handled by an open-source framework **Grid2Op*** by RTE

- The **Environment** is a powerflow simulation, done by a AC/DC **solver** called **pandapower**

- **State, reward** are looking at the total line loading (n-0)

- **Agent**: Using Keras machine learning library & Tensorflow back-end to train a neural net

*This framework allows to perform most kind of powergrid operations, from modifying the setpoint of generators, to load shedding, performing maintenance operations or modifying the *topology* of a powergrid to solve security issues.

(powerflow solver)

pandapower

Grid2Op framework

Environment

State   Reward   Action

Agent

TensorFlow   K Keras
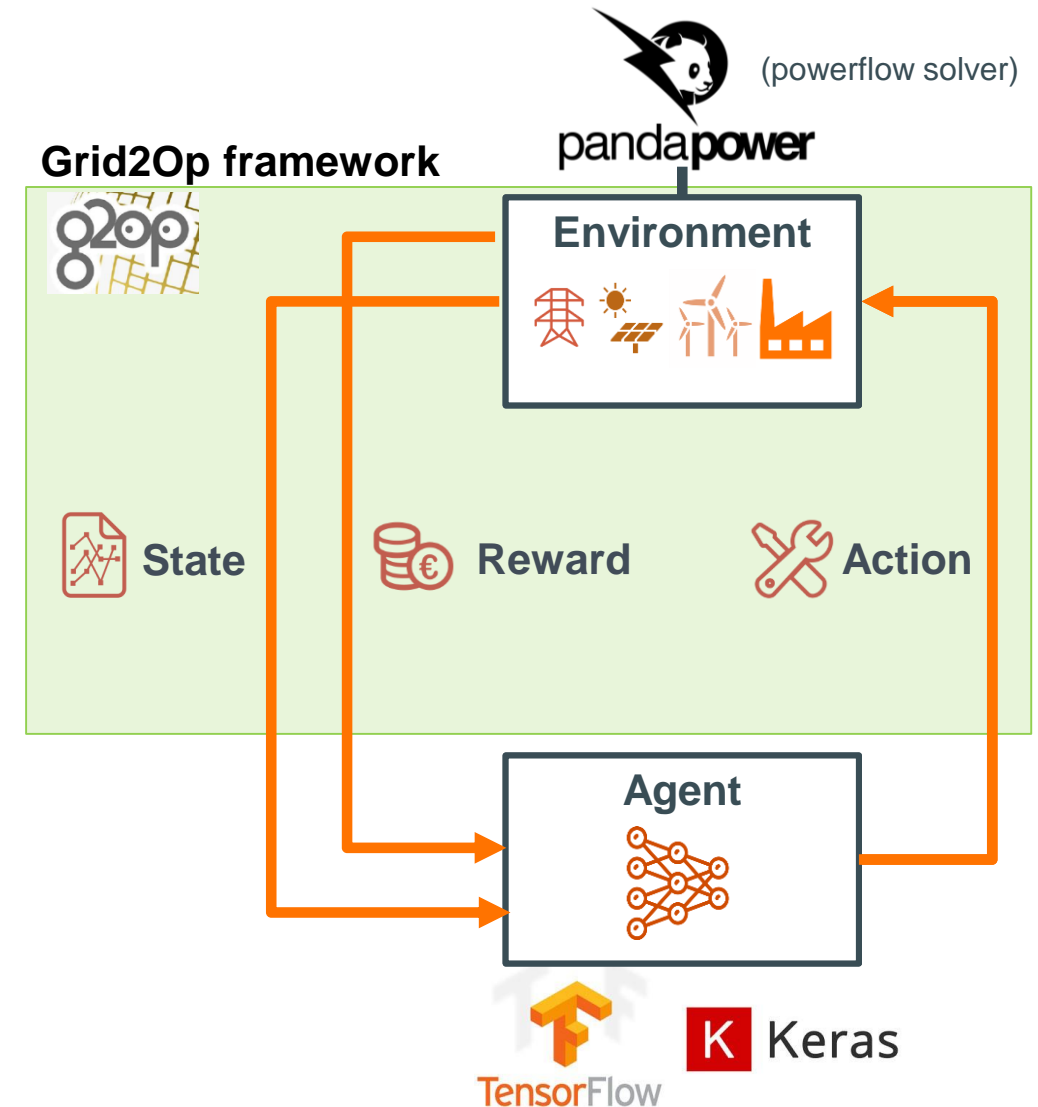
Thank you.
Stay healthy.

AI@eliagroup.eu