AI for power grid development studies
and other AI applications in the electricity sector

Juin 2023

Vincent Lefieux

RTE: French Transmission System Operator

105,817 km
of power lines, the biggest grid in Europe

99.9994 %
power supply continuity

9,586
employees including 470 apprenticeships

4,926 M€
of revenue in 2022

40 M€
worth of investment committed to R&D

92 %
customer satisfaction rate in 2022

RTE: French Transmission System Operator

- Is a public utility and provides access to electricity 24/7

- Accelerates the energy transition by adapting the grid

- Enlightens the public authorities by publishing schedules and forecasts

Context

4 million

households will be self-consumers by 2035

+60 %

players have come onto the market within the space of 4 years

x 1 000

increase in the number of solar panels installed within the space of 10 years

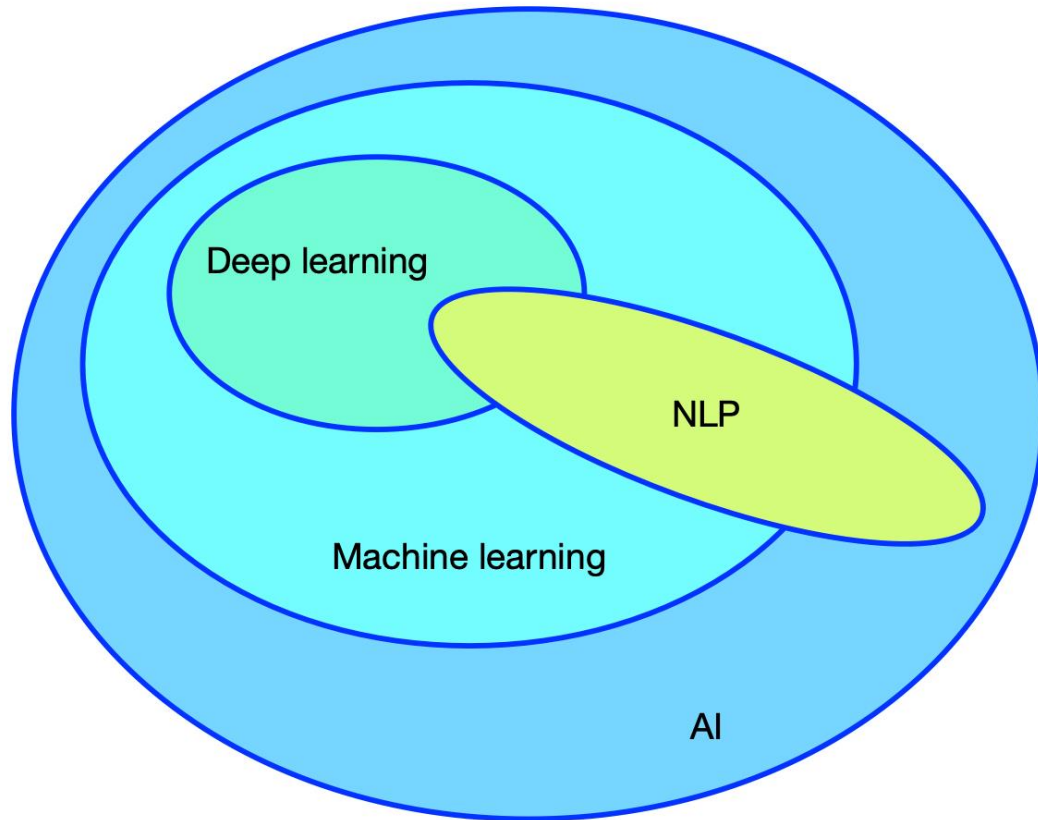(installed generation capacity).

x7

increase in the number of wind turbines erected within the space of 10 years

(installed generation capacity).

300 000

data items processed by RTE every day

This number will soon rise to 3 million.

Some (5) AI applications:

- From real time to long term
- Challenges, R&D experimentations or IT developments

AI complements, but does not replace, electrical engineering, automatic control, optimization…

Consumption and renewable energy short-term forecasts

Open Short Term Energy Forecasting (OpenSTEF)

- Develop automatic machine learning pipelines to provide accurate and automatic consumption and renewable generation forecasts

- Use a common environment allowing archiving, rapid and robust deployment of new functionalities, and monitoring of their performance
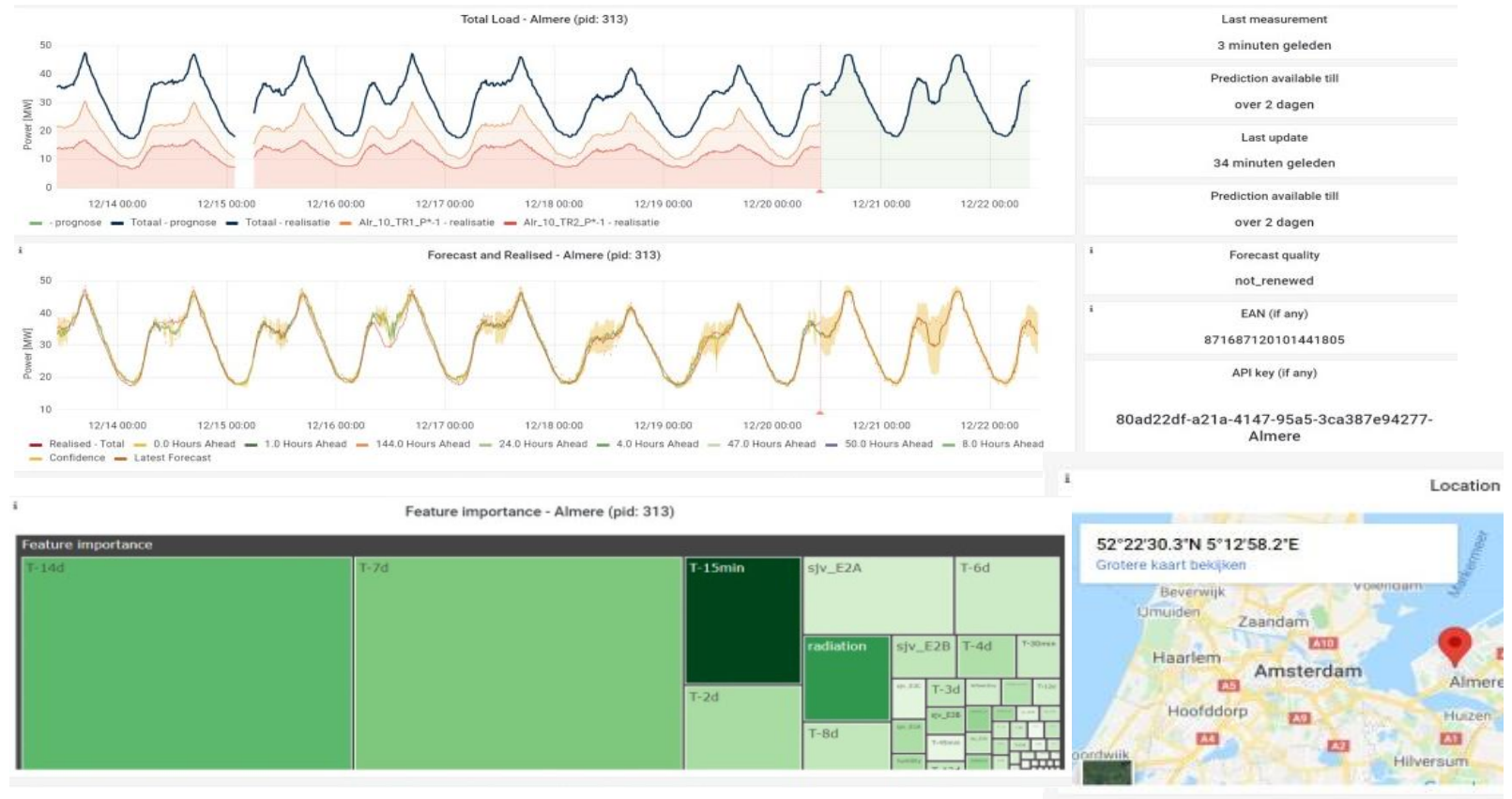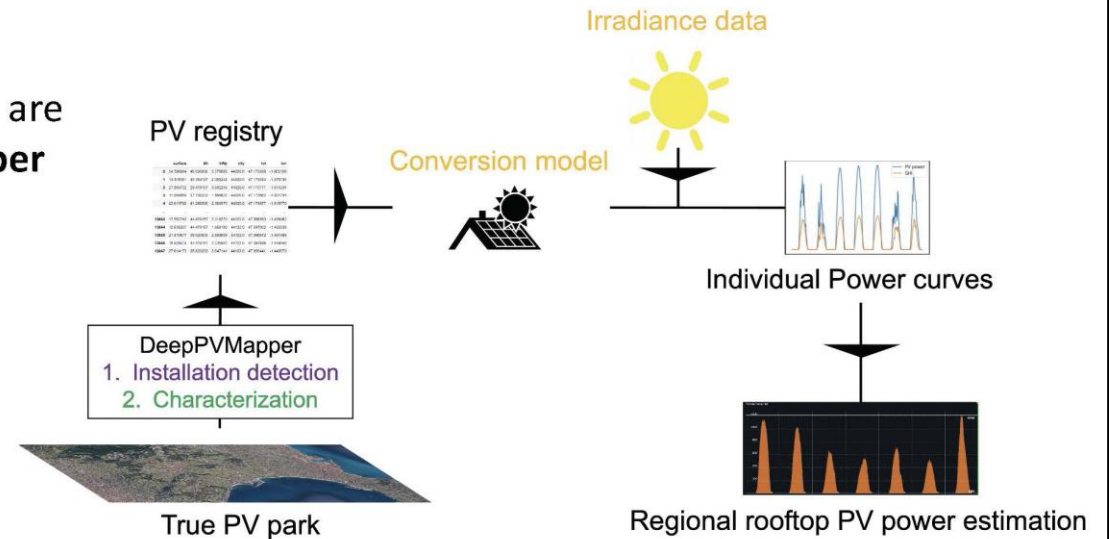
Enhancing regional PV power estimation using physics-based models, solar irradiance data and deep learning

Gabriel KASMI

A new model for estimating rooftop PV power production

- Rooftop PV characteristics are collected by **DeepPVMapper** (Kasmi et al, 2022)

- Four sources of errors:
  1. Detection
  2. Characterization
  3. Conversion model
  4. Irradiance data

Flowchart of the proposed approach

AI-based assistant for human operators (real time)

New actors & scales

Evolving grid

AC + DC

No New Lines

Digitalisation

Operators will need increasingly better assistance …

AI-based assistant for human operators (real time)
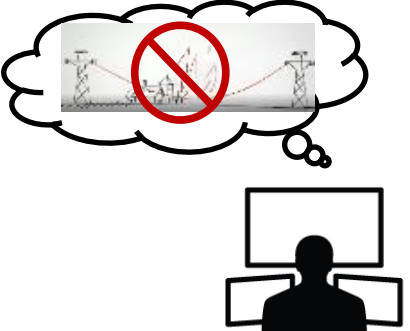
Line overload to redispatch urgently

Make trusted remedial action recommandations

AI-based assistant for human operators (real time)
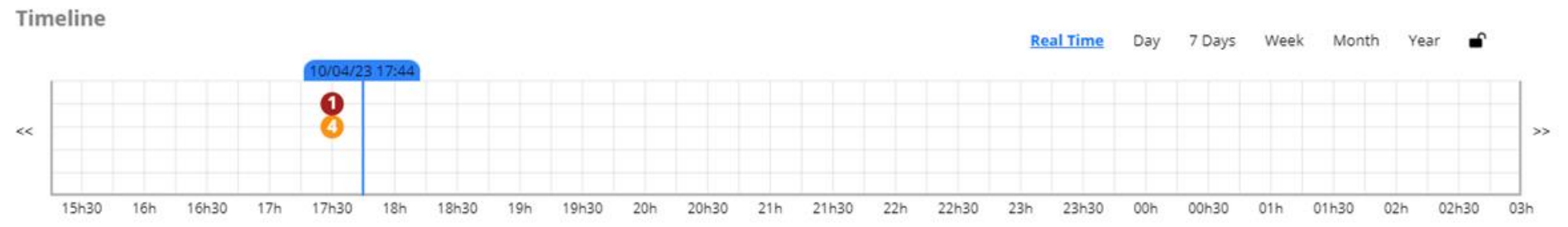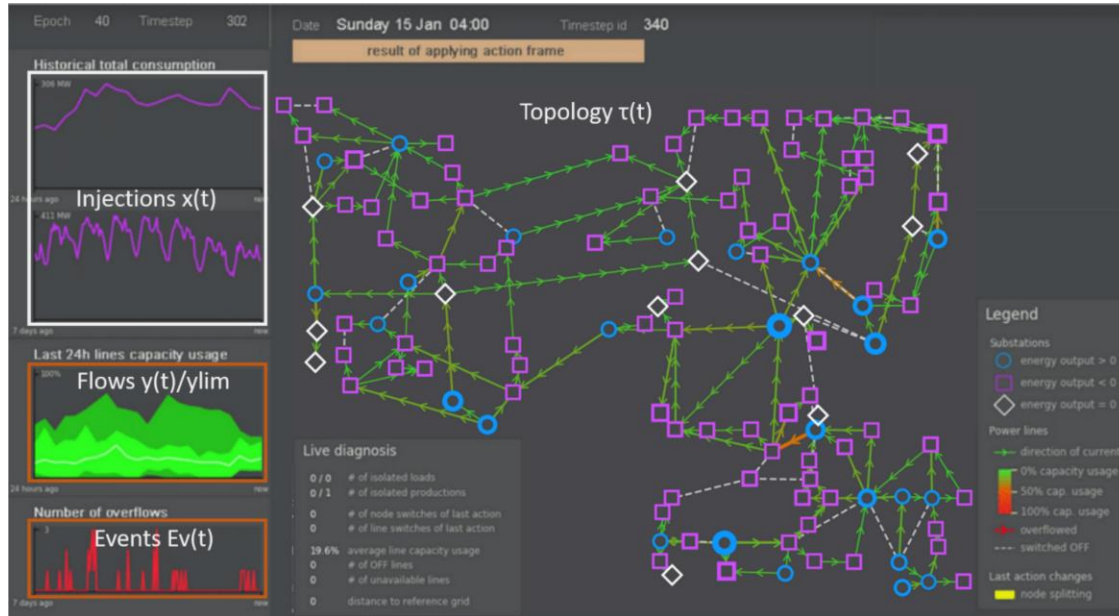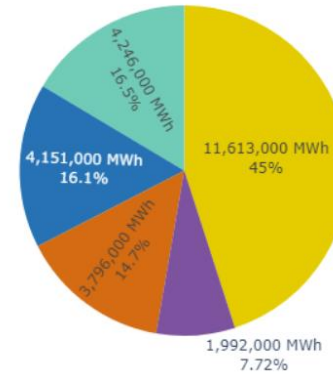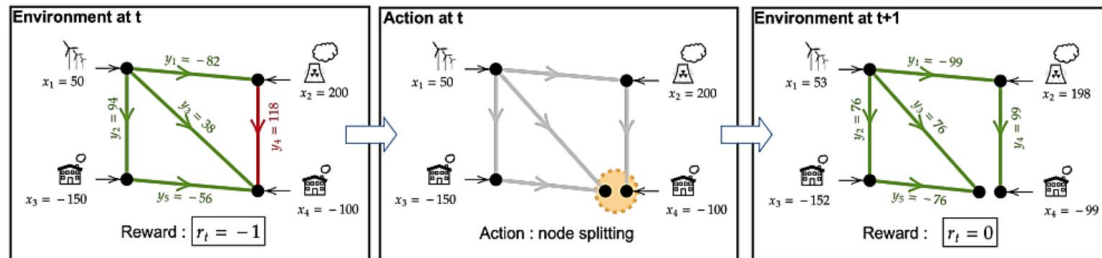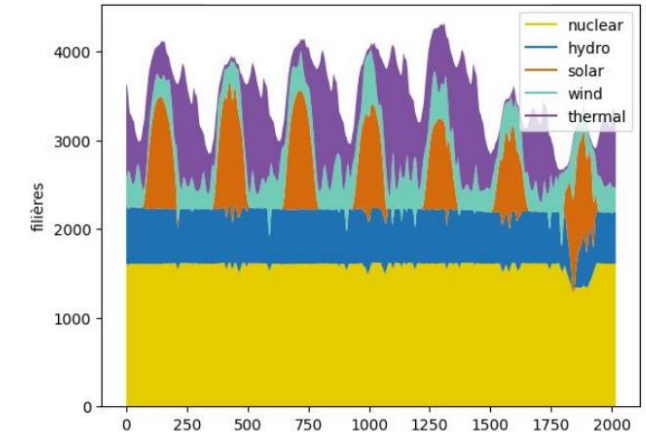
The aim of the challenge is to develop and train an agent to solve this critical sequential decision-making problem to:
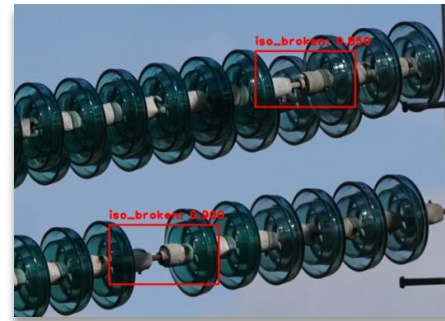• Manage overloads and avoid blackouts
• Send alerts when closer supervision is needed

https://www.iledefrance.fr/challenge-ia-pour-la-transition-energetique

Detection of transmission line defects

- Over 100,000 km of overhead lines inspected every year by helicopter

- Visual inspection

Broken insulator

Paint on insulator
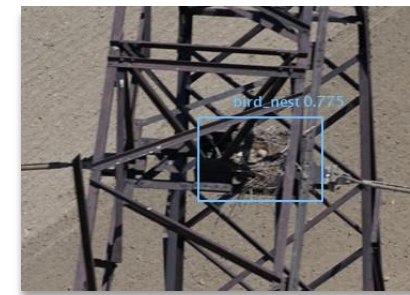

Cut cable strand
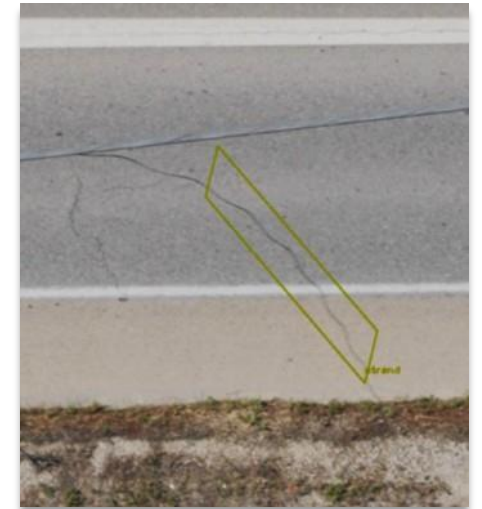
Broken spacer

Bird's nest on pylon

Detection of transmission line defects

The inspection vector (drone)
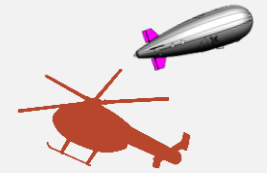
The data capture system
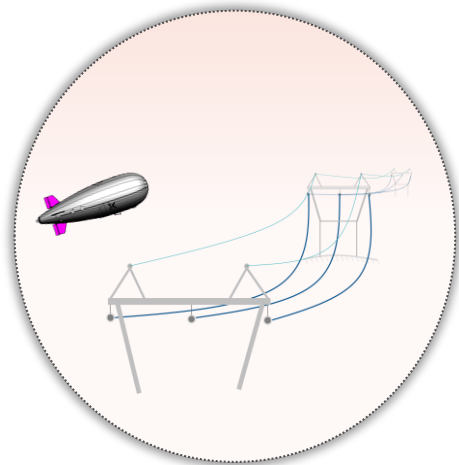
The automatic detection algorithm (AI)

Fleet : 100% helicopter

Data collected and processed by on-board RTE operators

Fleet : mixed helicopter-drone

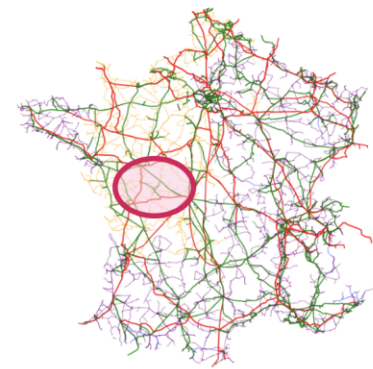Data captured automatically and processed by an AI algorithm (1,300 TB annually)

Support for electric power grid modernization studies

ORIented Grid Analysis by Machine Intelligence (ORIGAMI)

Background | Assumptions | Simulations | Contraints & Valuation
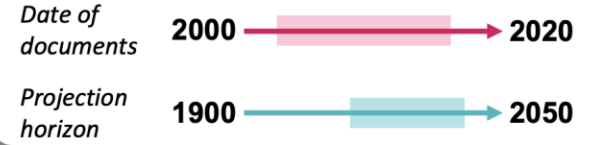
1 Bibliographic survey prior to the studies

Module 1

Spatial contextualisation

Temporal contextualisation

Date of documents: 2000 — 2020
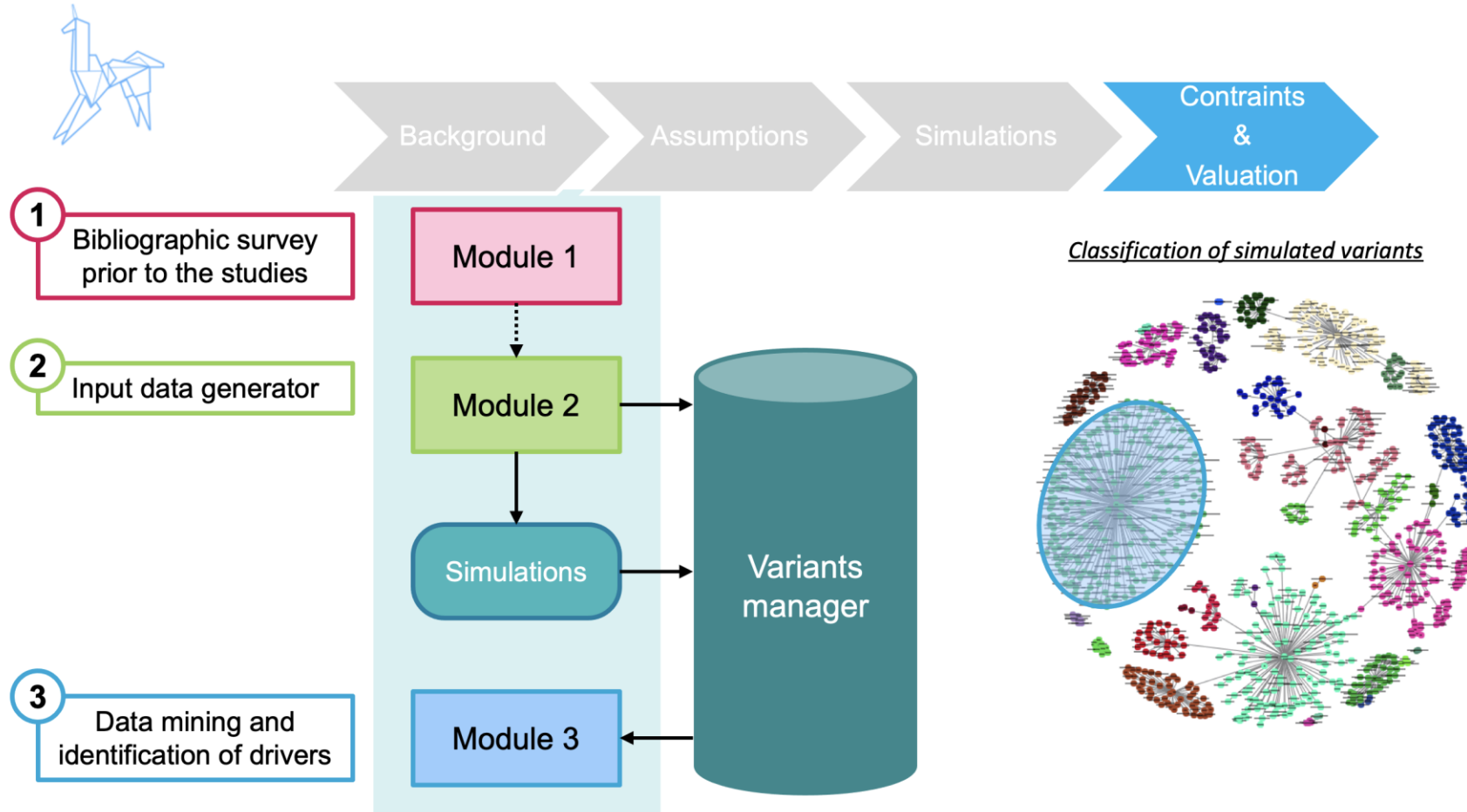
Projection horizon: 1900 — 2050

Support for electric power grid modernization studies

Support for electric power grid modernization studies

Background → Assumptions → Simulations → **Contraints & Valuation**

1. Bibliographic survey prior to the studies

2. Input data generator

3. Data mining and identification of drivers

Module 1

Module 2

Simulations

Module 3

Variants manager

Classification of simulated variants
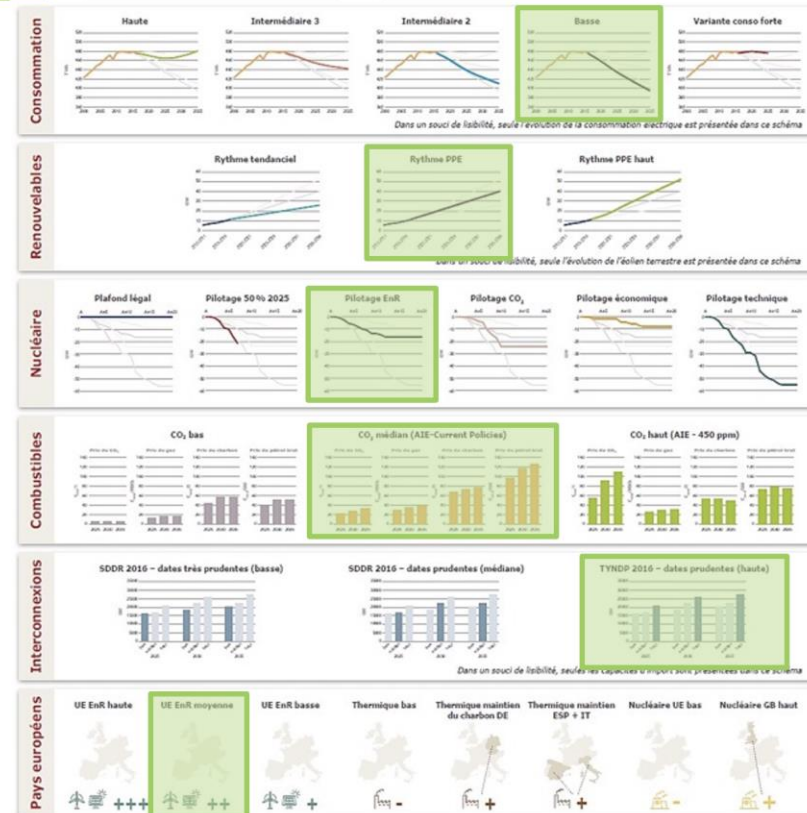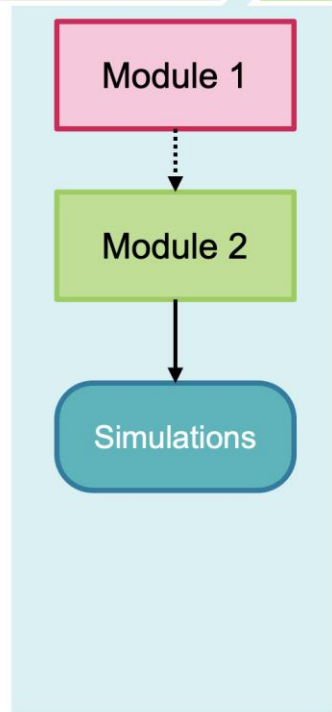
- Facilitating access to (high-quality) data and IT capabilities

- Fighting algorithmic bias

- Improving interpretability

- Combining techniques and implementing multidisciplinary strategies

- Facilitating acceptability

- Ensuring the final responsibility is human

- Aiming for frugality