

Advanced Analytics: A key Enabler for the Energy Transition

CORE Energy Day
Louvain-la-Neuve, April 16 2018

Philippe Chevalier
CORE and N-SIDE President

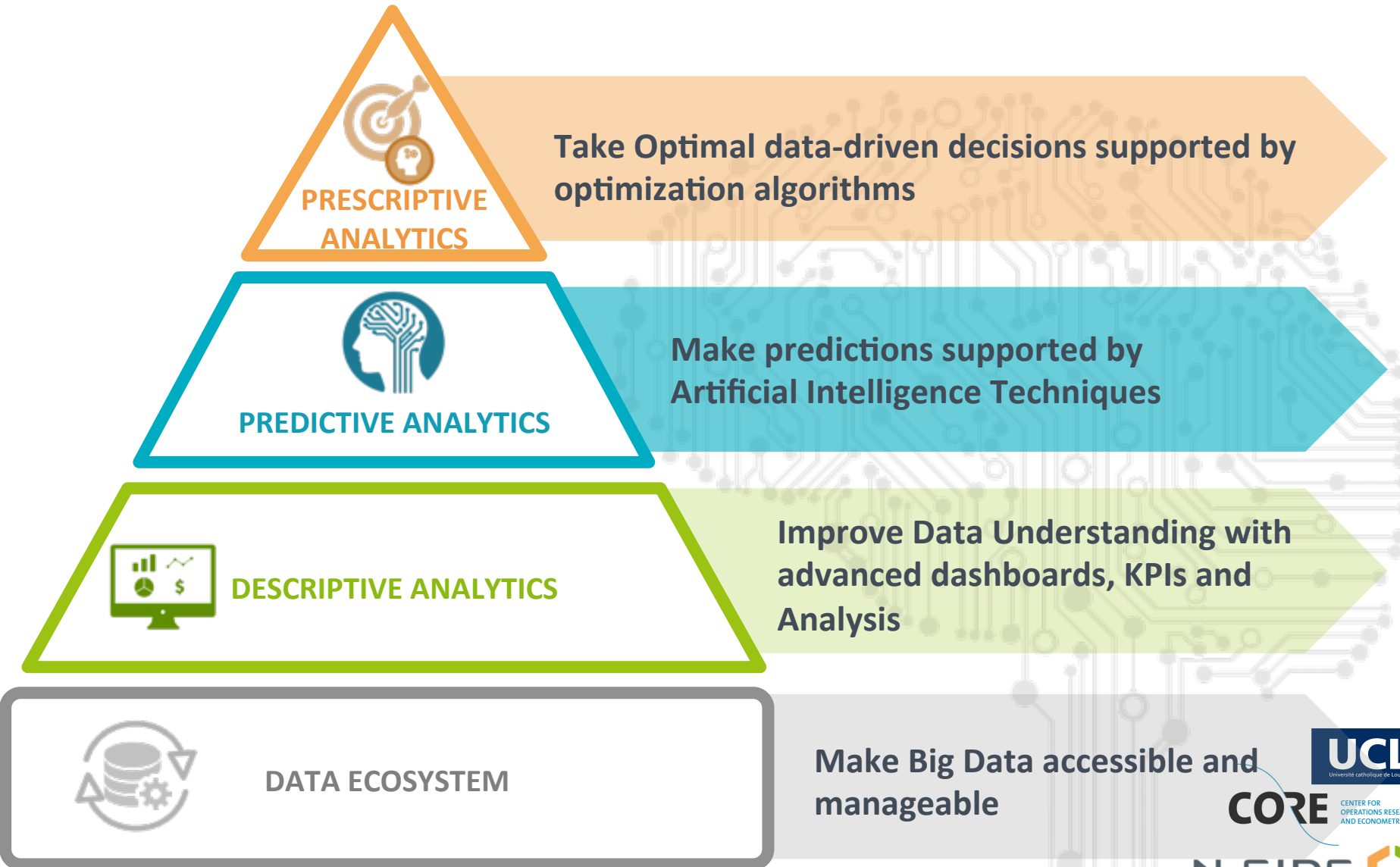
Olivier Devolder
Head of Energy Group @ N-SIDE



Analytics : a wide gap between academia and industry

- Academic research:
 - Development of advanced algorithms
 - Benchmarking based on earlier academic results
- Industrial practice
 - Vast majority of data driven decisions taken based spreadsheet models
 - Lots of buzzwords with no clear implementation path

Advanced Analytics in action

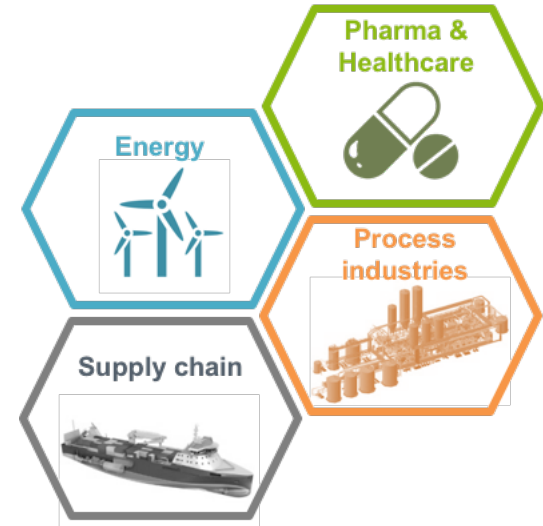


The N-SIDE project

- Observation:
 - Many companies do not use state of the art techniques in analytics
 - There is no partner to efficiently transfer academic knowledge in this area to industry
- Goal:
 - Make state of the art in analytics easily available to industry
 - Once industrial partners are using state of the art technology, create a direct link with academia to foster advanced research projects for further progress

N-SIDE currently

- 75 employees
 - 30% hold a PhD
 - 10 nationalities
- Strong local academic ties
 - Spin-off company of both UCL&Ulg
 - Active in 4 research project of the Wallon region together with university labs (funding of 10 researchers in 3 universities)
- Broad international reach
 - 85% of turnover outside Belgium (>50% outside EU)
 - Active in 3 H2020 research projects



Three of the key challenges for a successful Energy Transition



Active Electricity Consumers

How to make the demand more flexible and to adapt it based on available RES production ?



Electricity Markets Integration

How to integrate efficiently the european electricity markets and foster import/export between countries ?



Dynamic Imbalance Risk Management

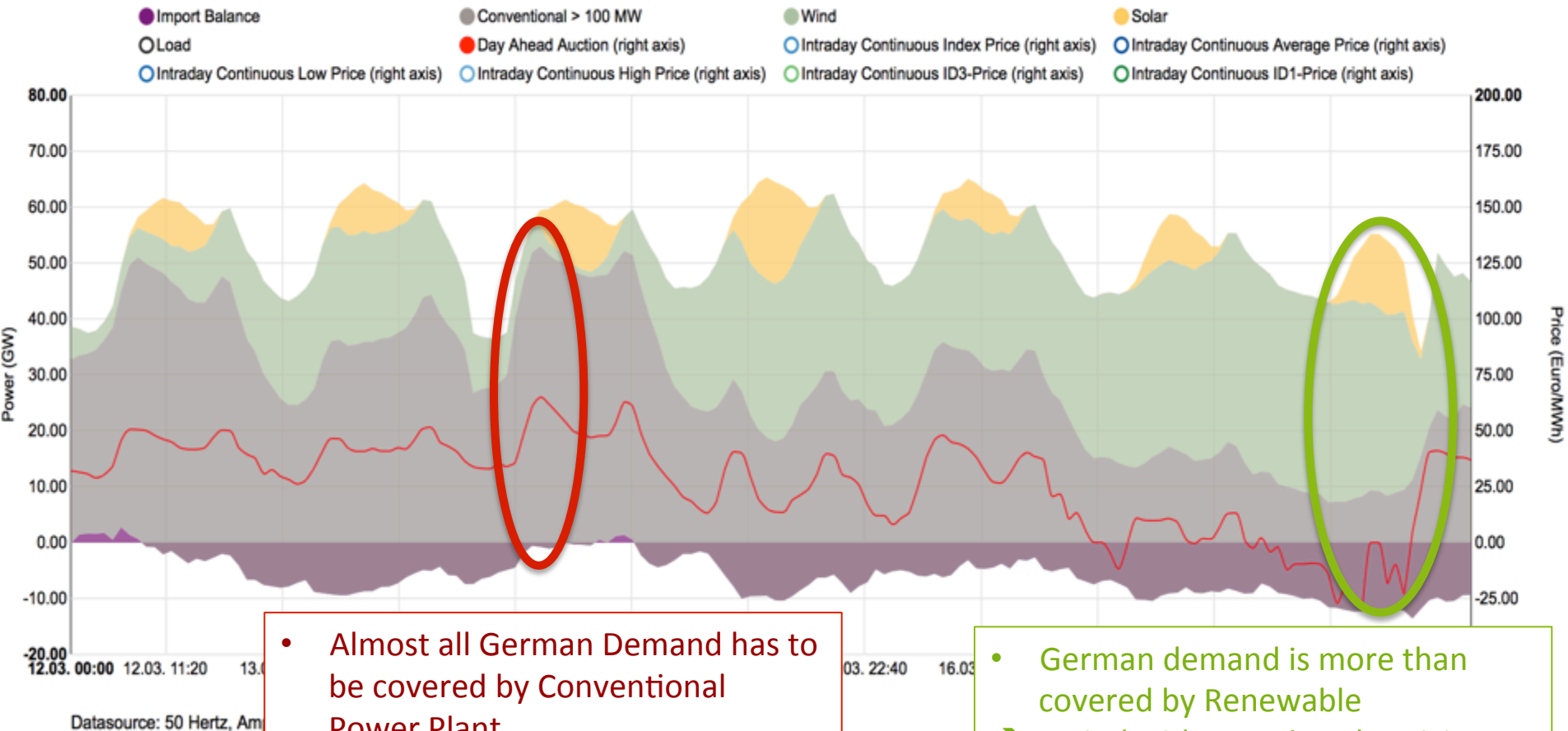
How to manage the risk in a dynamic way and secure the balance of the system at any time ?



Active Electricity Consumers

Electricity sector is facing a revolution where flexibility becomes a key asset...

Electricity Production in Germany March 12-March 18 2018



- Almost all German Demand has to be covered by Conventional Power Plant
- ➔ Higher Electricity Price

- German demand is more than covered by Renewable
- ➔ Period with negative electricity price and strong export

Electricity sector is facing a revolution where flexibility becomes a key asset...



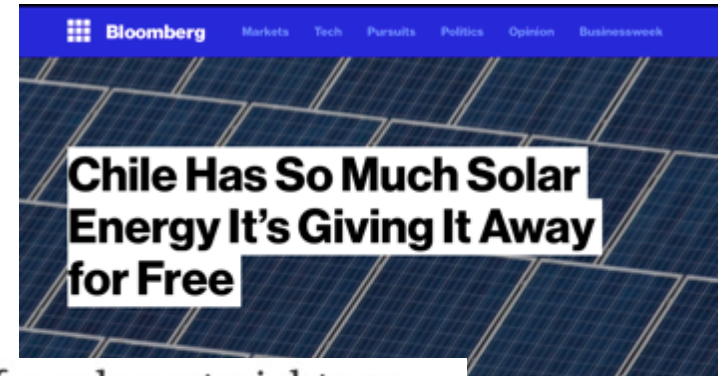
People in Germany are now being paid to consume electricity

The price of power in Germany briefly dropped to -€130 per MWh on 8 May

Doug Bolton | @DougieBolton | Wednesday 11 May 2016 | 3 comments



Wind turbines near a solar power plant in Werder, Germany Sean Gallup/Getty Images



Portugal runs for four days straight on renewable energy alone

Zero emission milestone reached as country is powered by just wind, solar and hydro-generated electricity for 107 hours

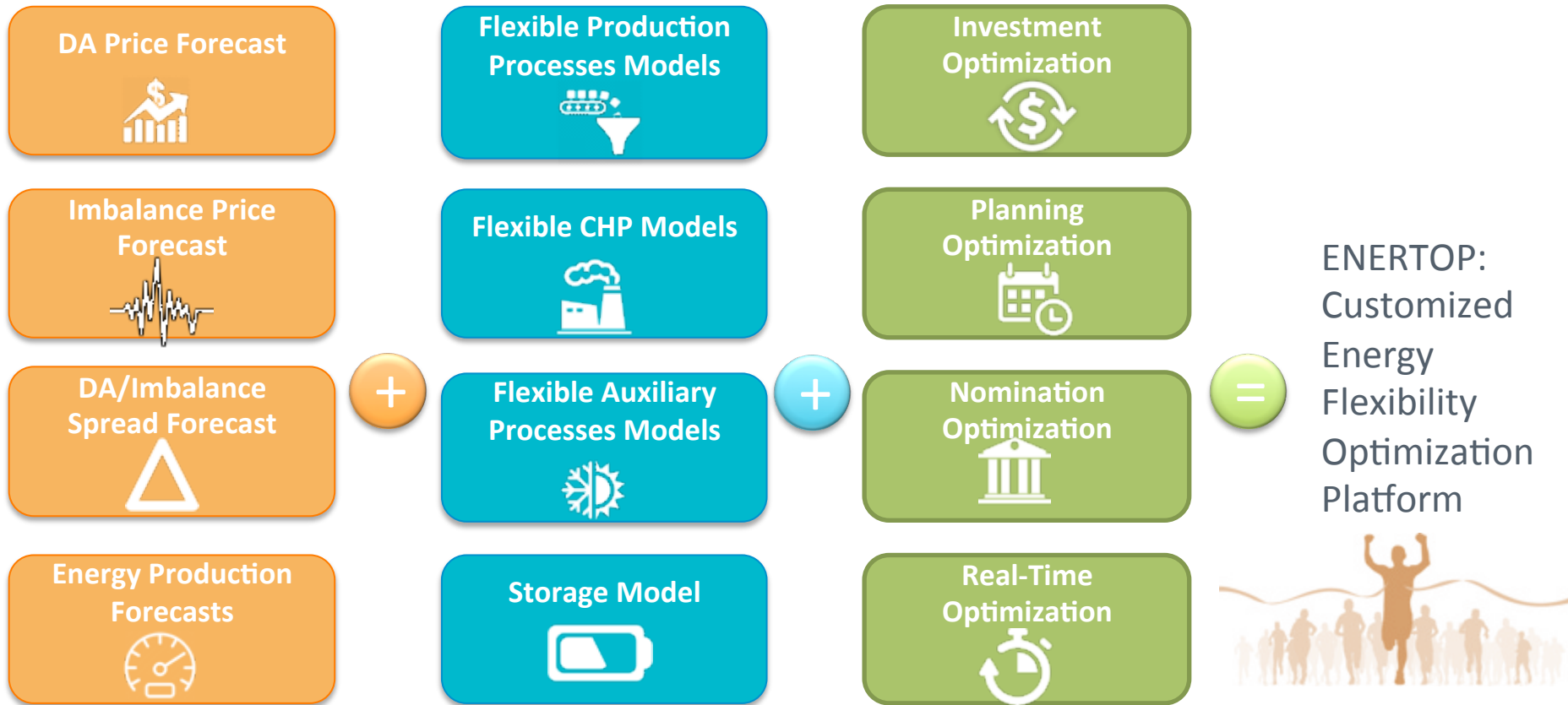


As recently as 2013, renewables provided only about 23% of Portugal's electricity. By 2015 that figure had risen to 48%. Photograph: Pete Titmuss/Alamy Stock Photo



it's giving electricity away for

Combining different layers of Advanced Analytics to enable flexibility in industrial sites

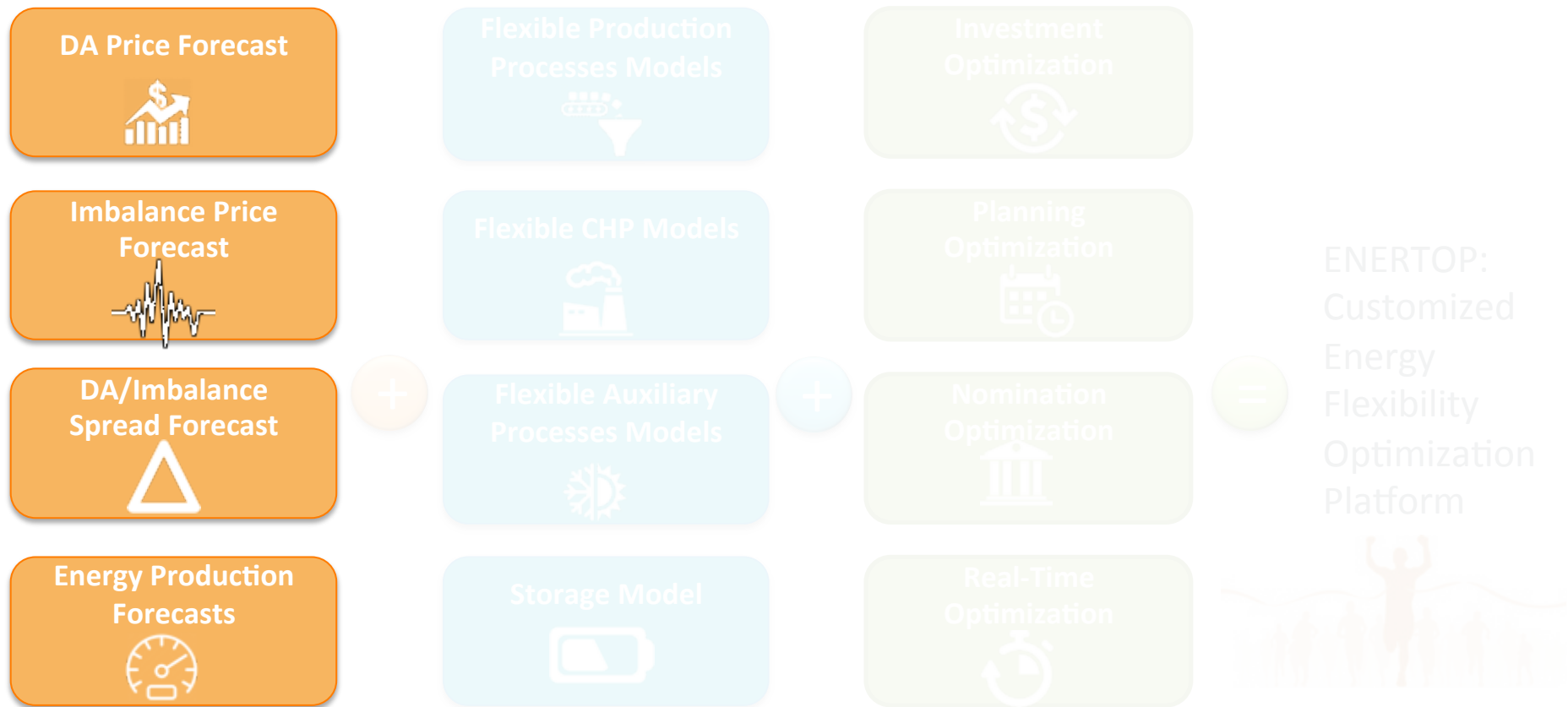


Accurate forecasts

Efficient mathematical
modelling

Advanced optimization
algorithms

Combining different layers of Advanced Analytics to enable flexibility in industrial sites



Accurate forecasts

Efficient mathematical modelling

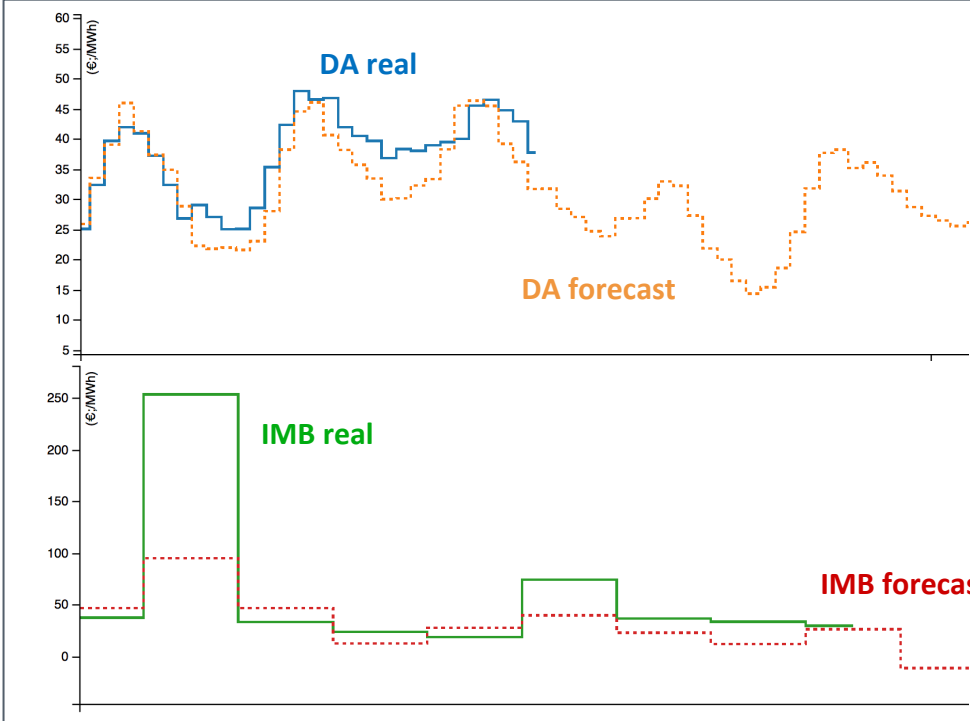
Advanced optimization algorithms

ENERTOP:
Customized
Energy
Flexibility
Optimization
Platform



Predicting electricity market prices: three machine learning challenges

REGRESSION PROBLEM



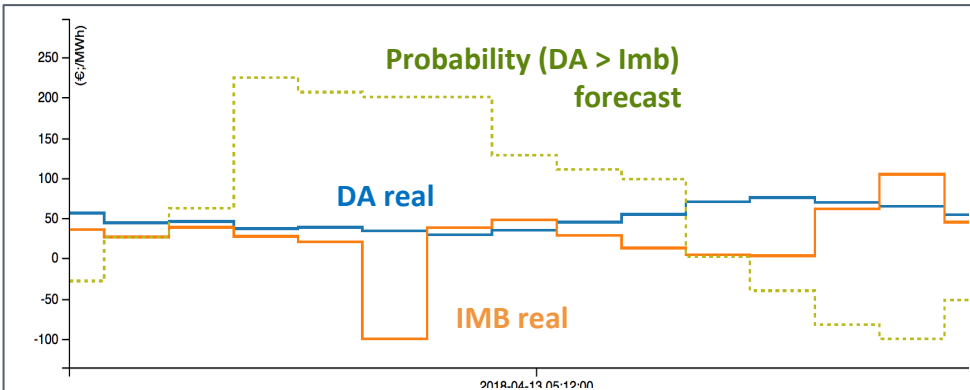
1. Day-Ahead prices

resolution : one price per hour
target : 1 day to 7 day in advance
N-SIDE precision : +- 10% error

2. Imbalance prices

resolution : one price per quarter
target : 1 quarter to 4 quarter in advance
N-SIDE precision : +- 25% error

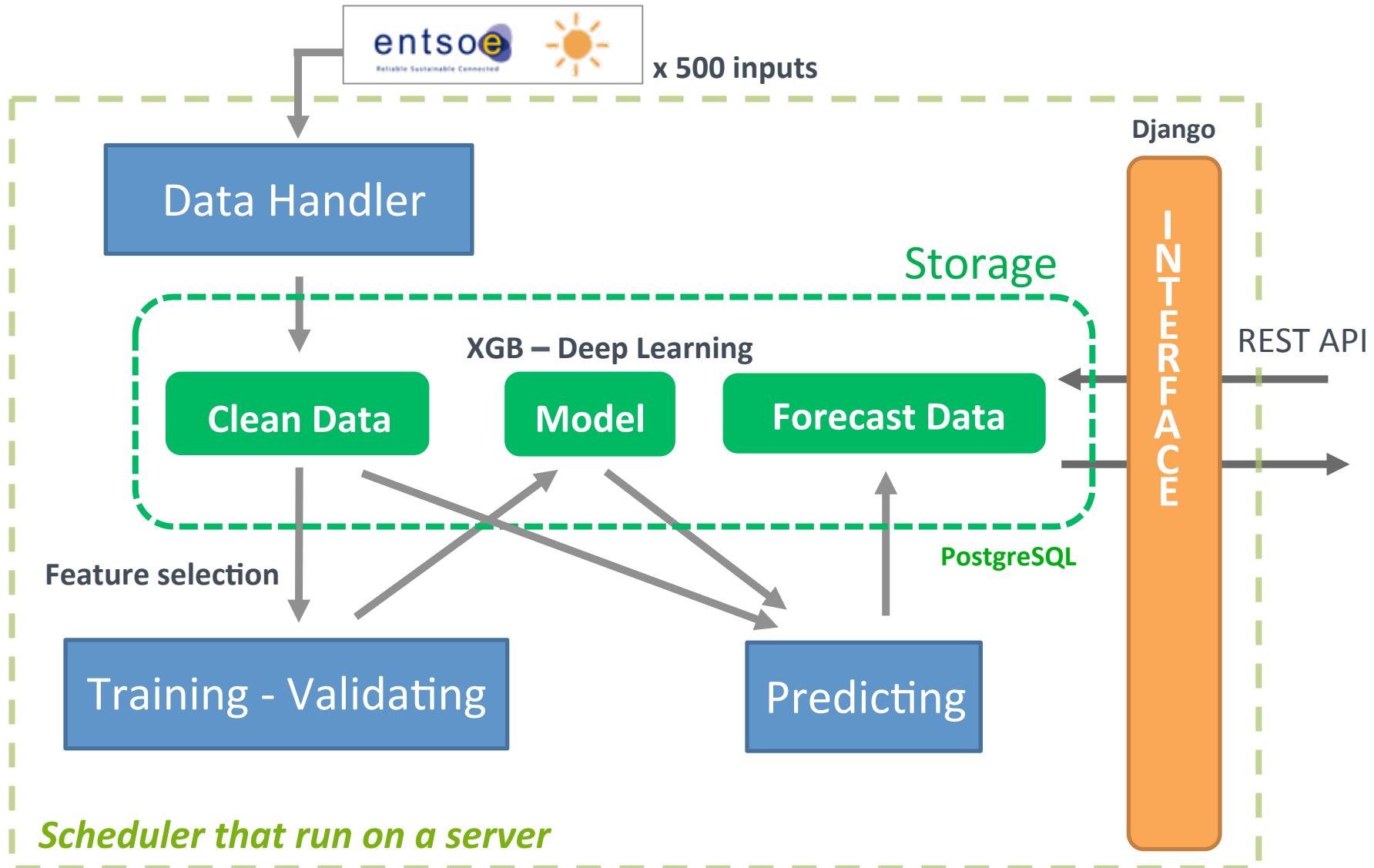
CLASSIFICATION PROBLEM



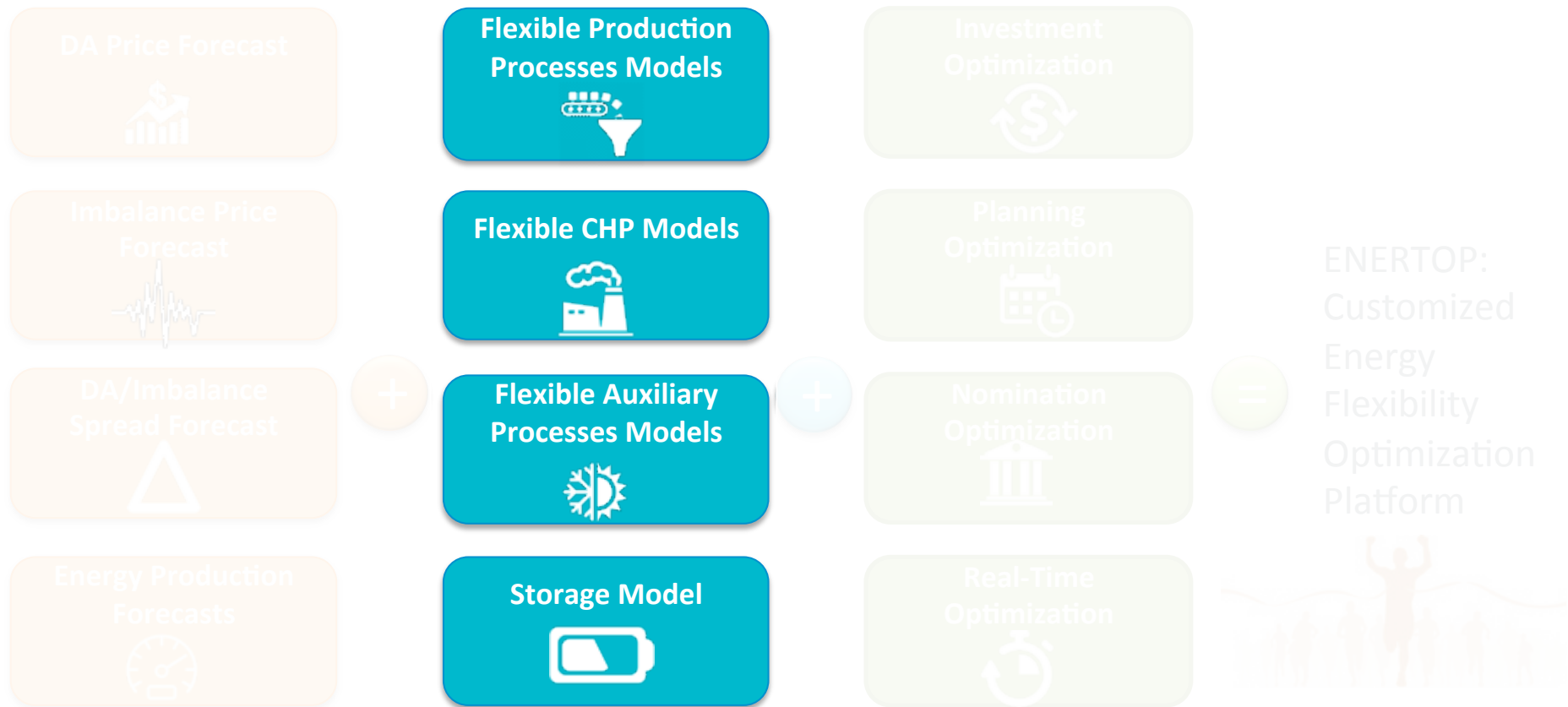
3. Imbalance versus Day-Ahead

resolution : one probability per hour
target : 1 day in advance
N-SIDE precision : +- 40% error

Structuring the “intelligence” behind the platform



Combining different layers of Advanced Analytics to enable flexibility in industrial sites



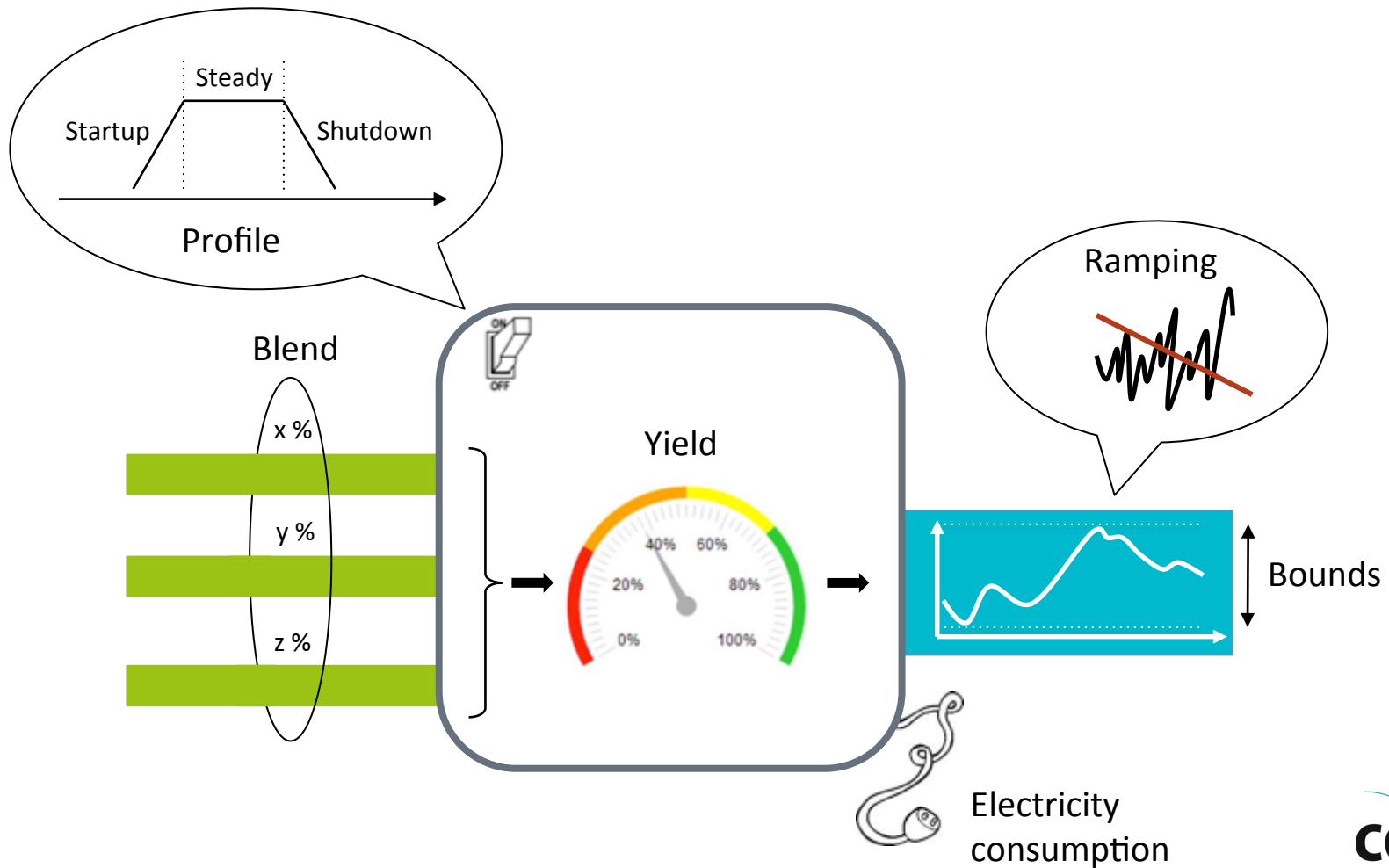
Accurate forecasts

Efficient mathematical modelling

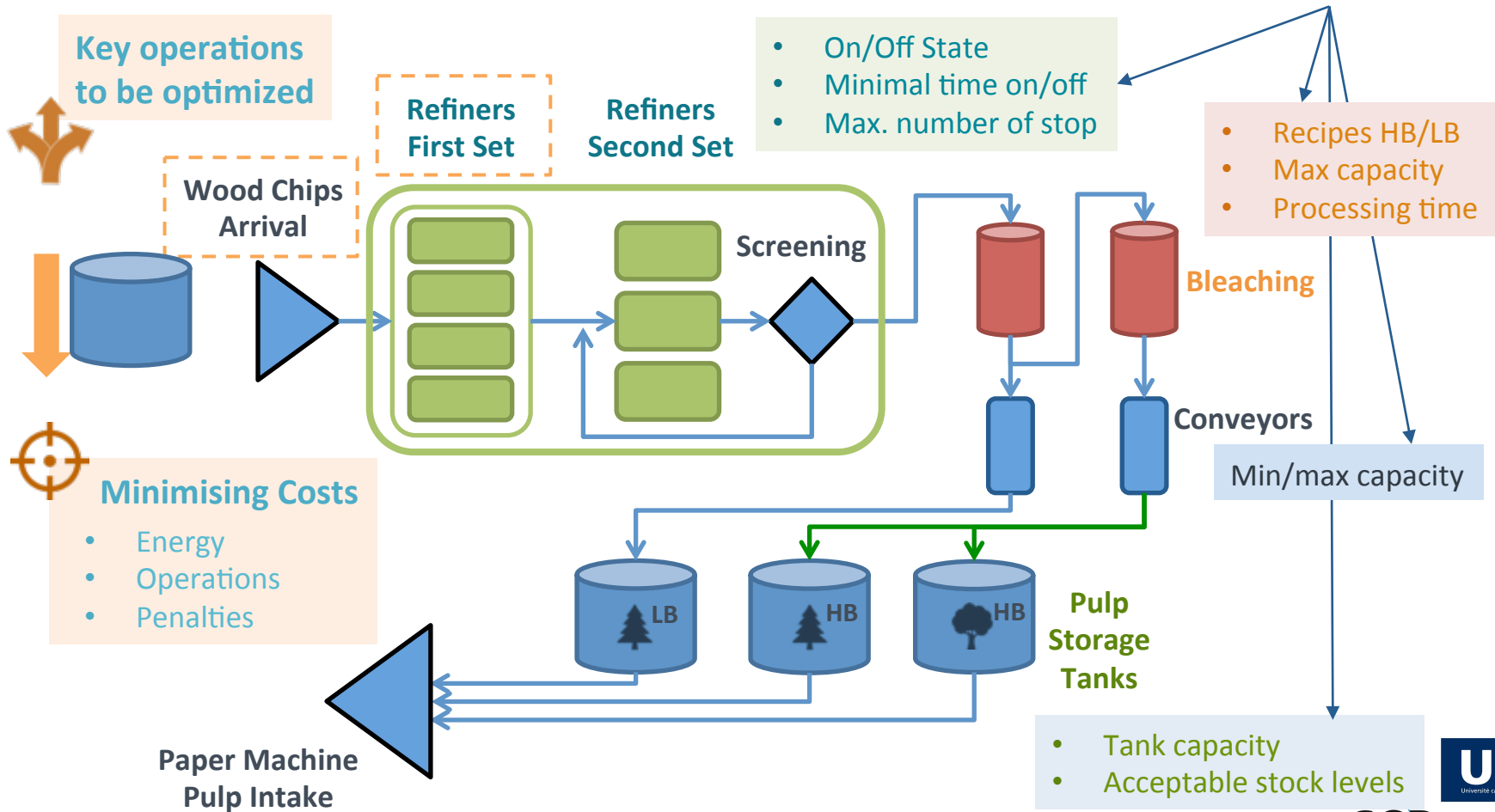
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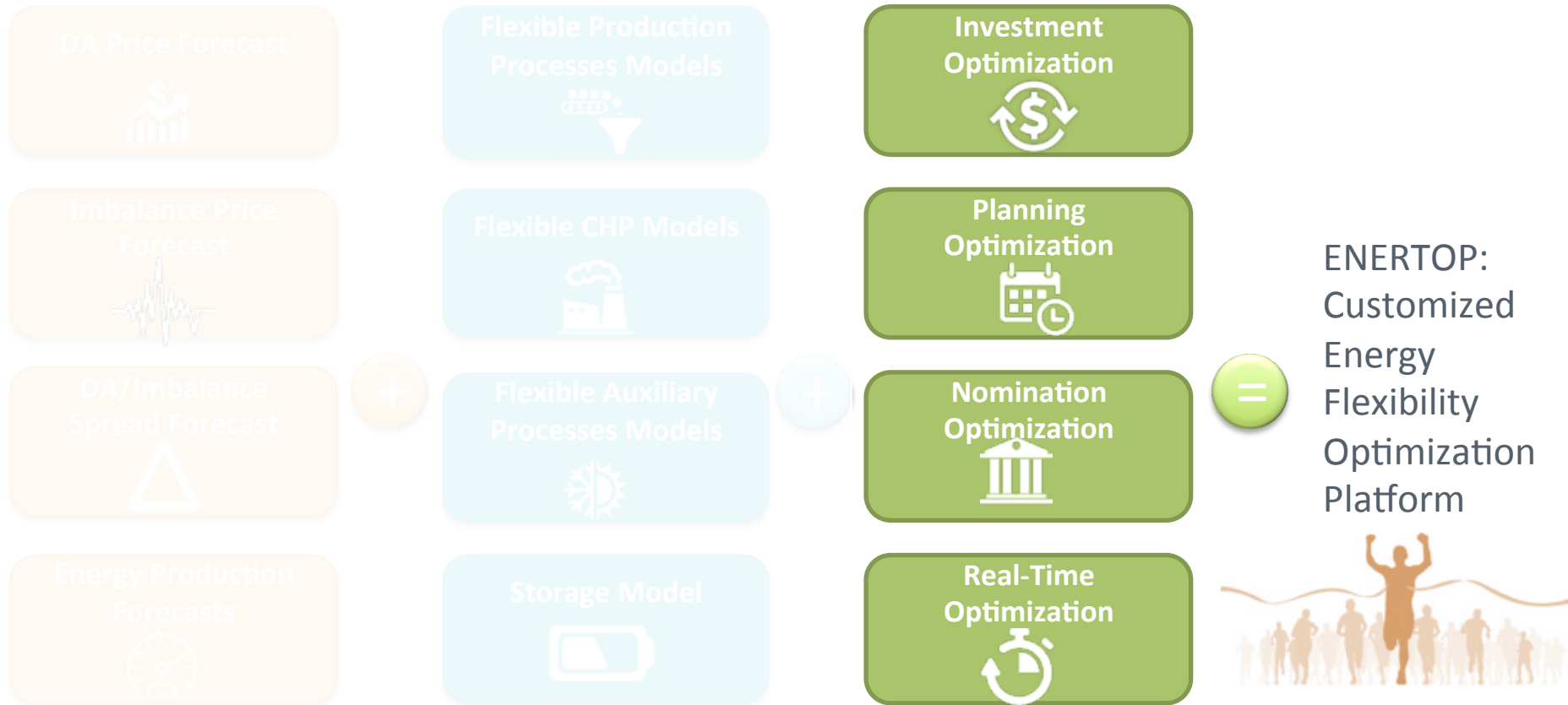
Mathematical Models to represent industrial processes complexity and flexibility ...



... in an integrated way



Combining different layers of Advanced Analytics to enable flexibility in industrial sites

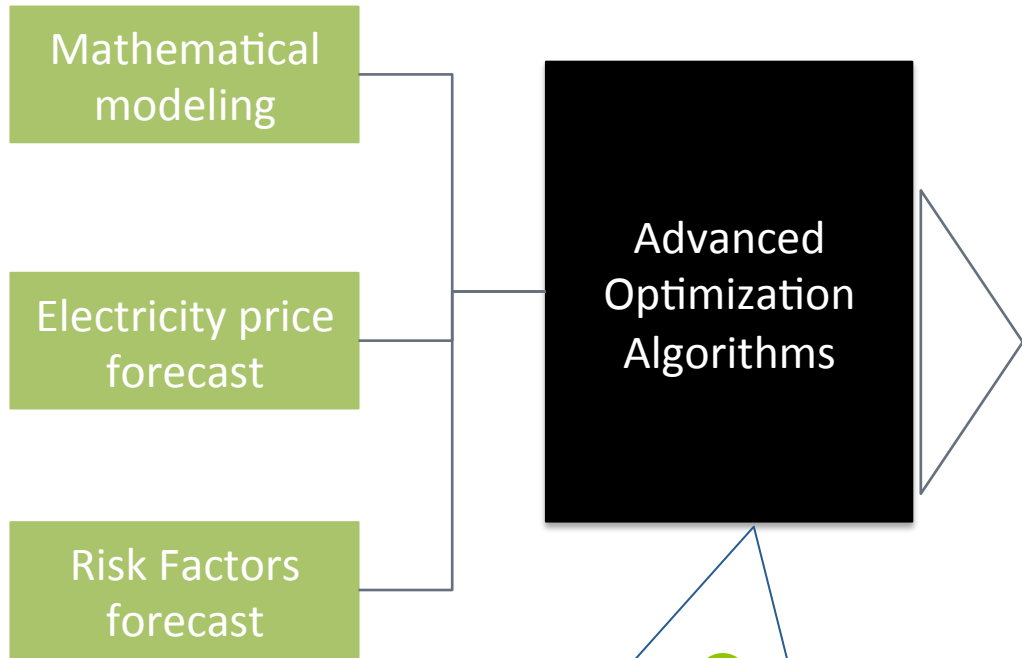


Accurate forecasts

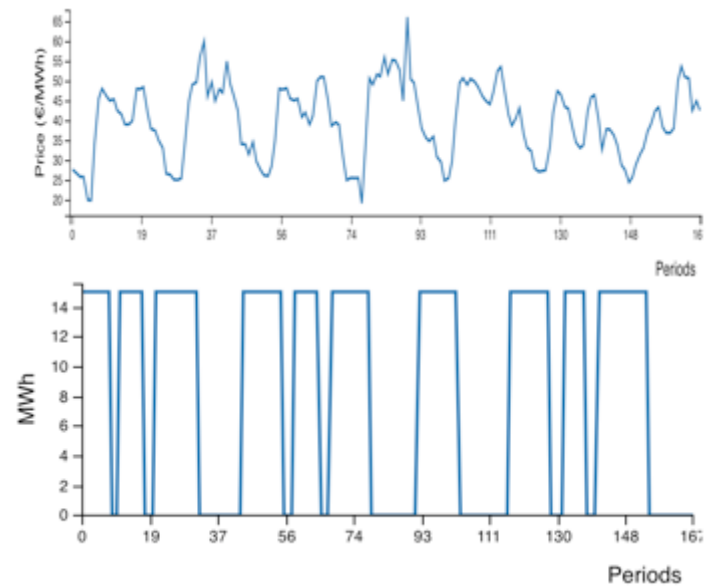
Efficient mathematical
modelling




Advanced optimization
algorithms

Efficient optimization algorithms to generate optimal flexibility decisions

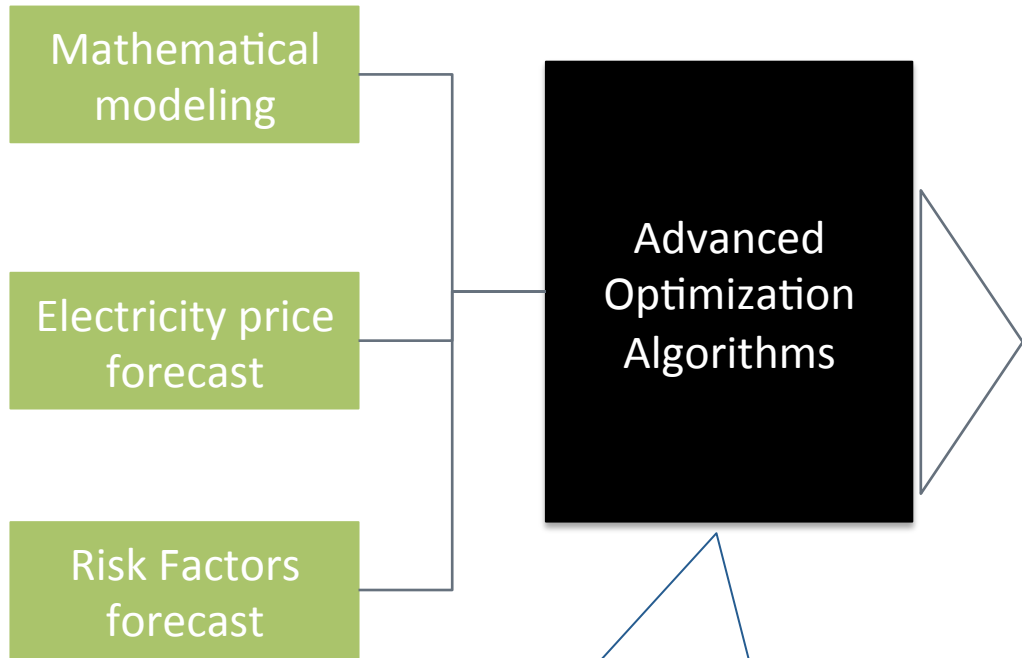


Optimized planning

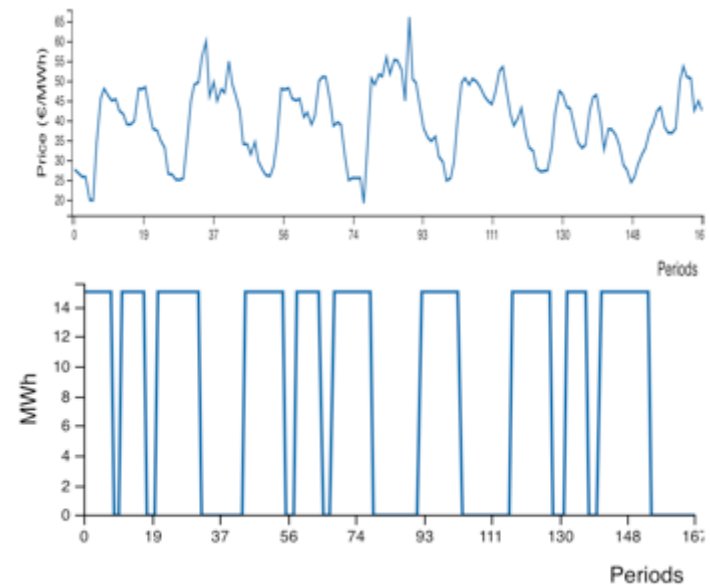


- ✓ Accurate results 
- ✓ Robust Solution 
- ✓ Fast running 
- ✓ Intuitive Planning 

Efficient optimization algorithms to generate optimal flexibility decisions



Optimized planning



- Mixed Integer Programming
- Constraint Programming
- Non-linear Optimization
- Stochastic Optimization

ENERTOP @ sappi

From flexibility potential to real savings



80% of flex opportunities captured with Machine Learning



540 k€ of savings on the DA Energy Bill



95% of recommendations Converted into actions

Frequent interactions with SAPPI

Training
Final user training

- Training for all End-User
- User guide documentation
- Dedicated training for demanding operators
- Frequent contact for answering questions
- Support ticket mechanism in case of problem

User friendly and efficient tool
implementation in the decision process and IT infrastructure

- Integrated user interface requirements
- Automated data importation
- Integrated decision process
- Integration to existing way of working

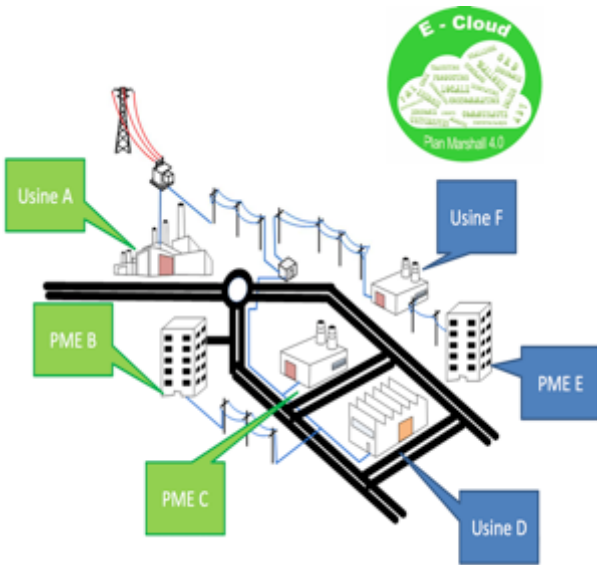
Realistic Modeling
Good match between software and CTMP Reality

- Collaboration Process Engineers/N-SIDE to define plant realities (Process set-up, constraints)
- Process modeling expertise of N-SIDE
- Calibration based on historical data

Alignment on Objectives
Leverage Energy flexibility in the CTMP Lines to reduce electricity cost

- Kick off meeting
- Project presentation
- Communication of SAPPI to employees

Flexibility beyond industrial sites



E-Cloud : Optimized microgrids for industrial parks



EV Fleet Optimizer: Optimal charging strategy for EV fleets based on Solar production, on-site constraints and market incentives



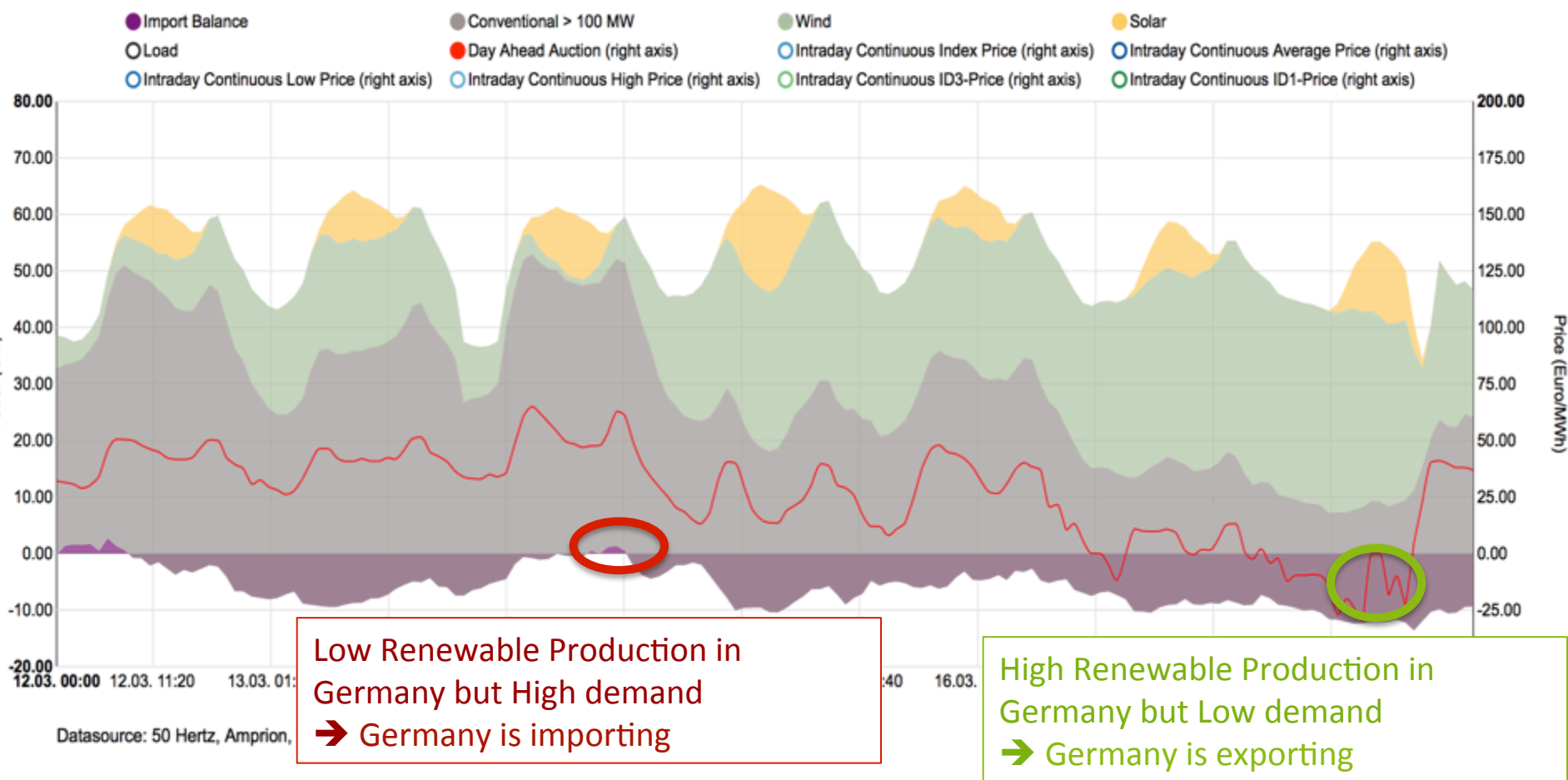
INTEREST: Optimized integrated renewable energy power stations including Hydrogen and green mobility

Electricity Markets Integration



Intermittent Renewable Electricity Production leads to a growing importance of import/export at EU level

Electricity Production in Germany March 12-March 18 2018



2500 days of European Market Coupling with Euphemia algorithm

EUPHEMIA
Market Coupling
Algorithm for
European DA markets

HORIZONTAL INTEGRATION



DESCRIPTIVE ANALYTICS

Accurate representation of Grid constraints (ATC, Flow-based, etc)

They trust us



PRESCRIPTIVE ANALYTICS

Market Cutting-edge Optimization algorithms to solve

- **Large-scale** (multi-countries)
 - **Non-linear** (complex network representation, complex market rules)
 - **Non-Convex** (complex market products)
- ...problems in **limited amount of time**



23 countries
All over Europe



10 min
to solve UE market coupling problem



200 M€
average daily value of matched trades

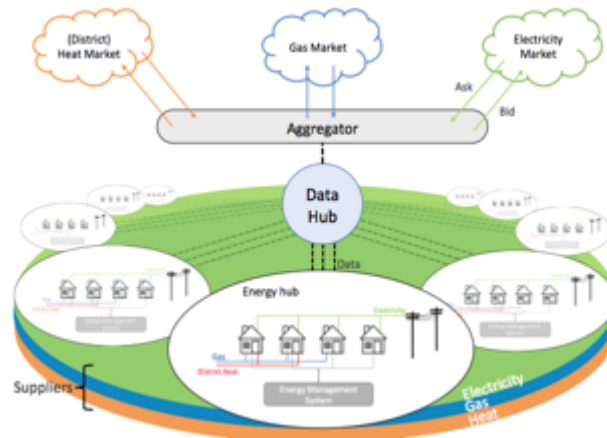


2500 days
Of successful coupling for DA markets

From European to Local Markets



SmartNet: TSO/DSO Coordination



Magnitude: Multi-energy Markets integration



P2P Local Electricity Markets

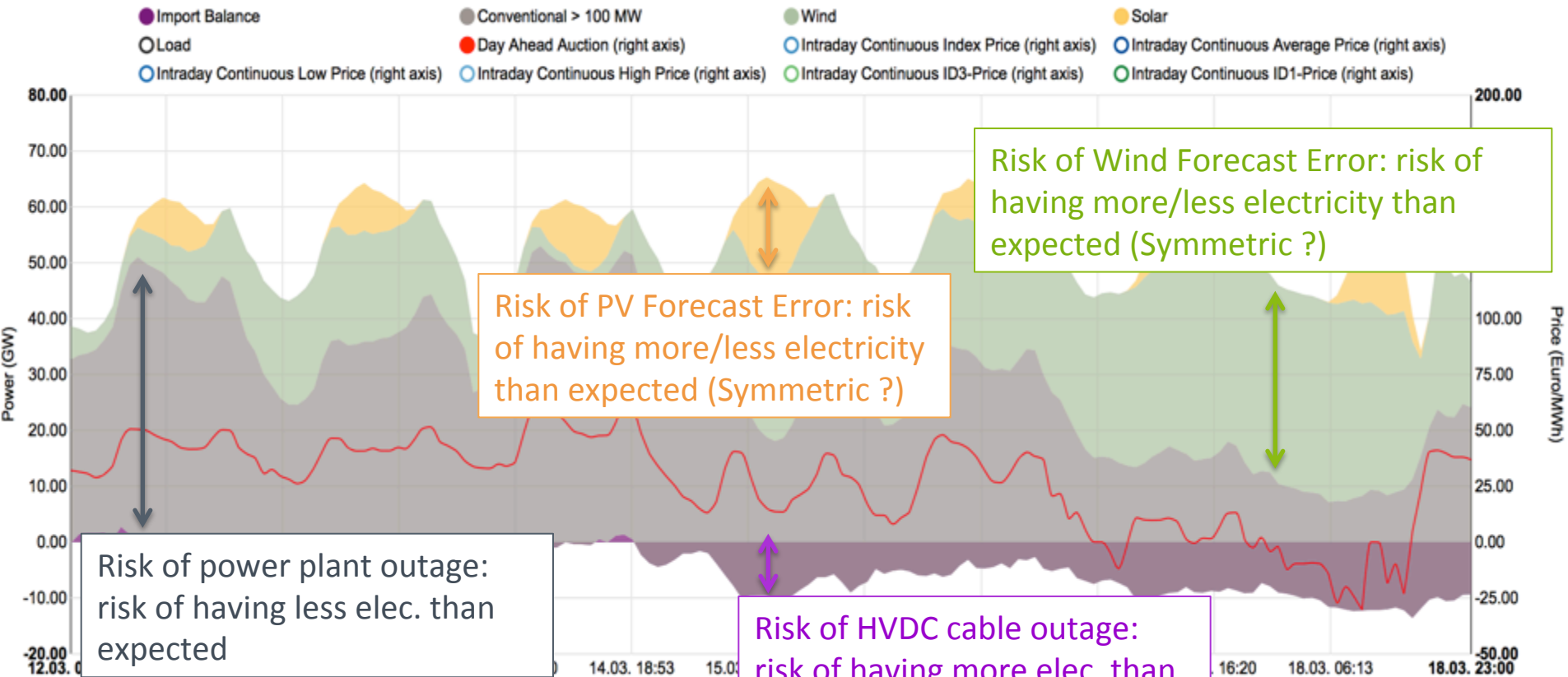




Dynamic Imbalance Risk Management

The risks in the systems becomes also more variables and needs to be covered by a « dynamic insurance »

Electricity Production in Germany March 12-March 18 2018



Datasource: 50 Hertz, Amprion, Tennet, TransnetBW, EEX, EPEX

Why Reserve Sizing ?

Forecast Uncertainty

- Uncertainty in PV and Wind Production
- Uncertainty in Load



Failure and Outage

- Forced **outage** of power plants
- **Failures** in the grid (e.g. storms)



What size of Reserve is required to cover the risk ?

Why Dynamic Reserve Sizing ?

Forecast Uncertainty

- Uncertainty in Renewable Production itself depends on D-1 Forecast level
- Uncertainty in Load can depend on D-1 expected system state



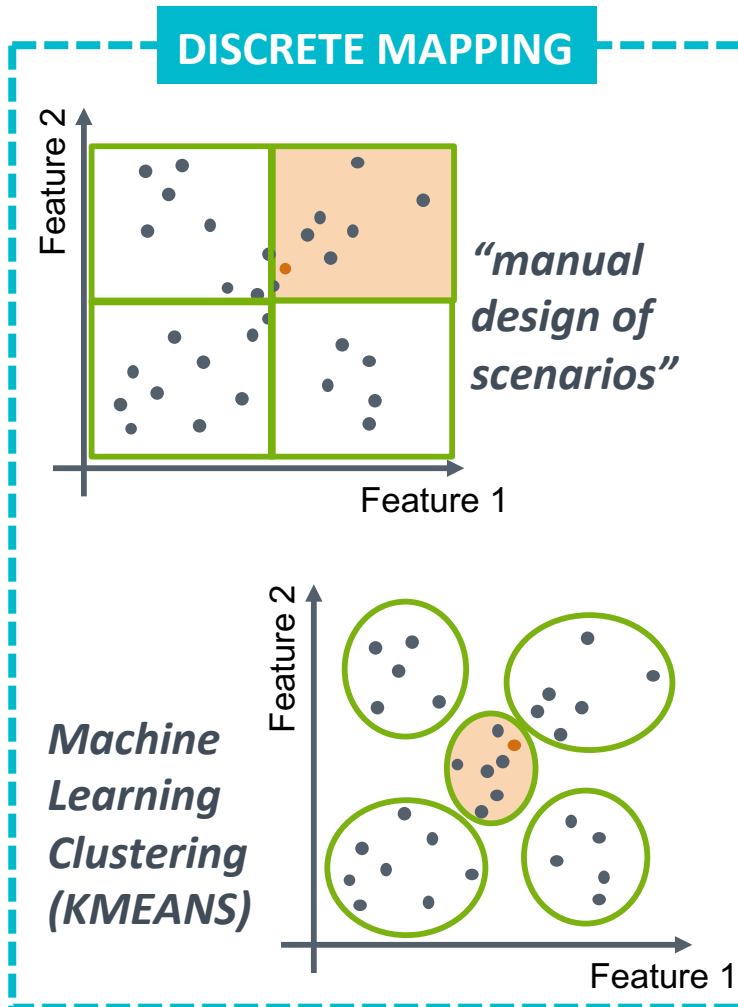
Failure and Outage

- Risk of forced outage of power plants depends on DAM dispatch
- Risk of HVDC failures depends on DAM dispatch

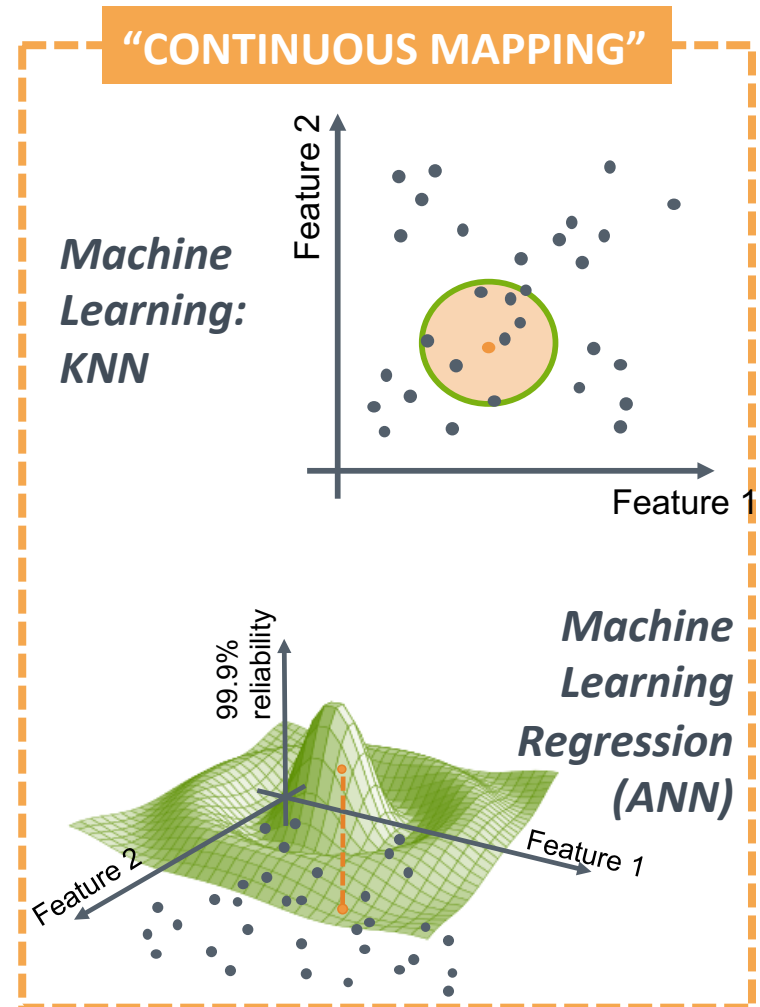


Incentive to size in a dynamic way instead of on a yearly basis

Dynamic Dimensioning supported by Machine Learning algorithms ...



COMPLEXITY



... to generate gains in reliability, volumes and robustness

Study conducted for Belgium by ELIA with N-SIDE support for Machine Learning aspects

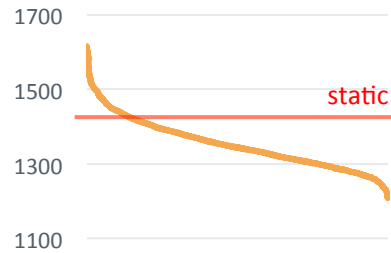


Gain in **RELIABILITY**

A better reliability management
Higher FRR during higher risk periods: proper reliability secured more constantly along the year



Savings of **VOLUMES**

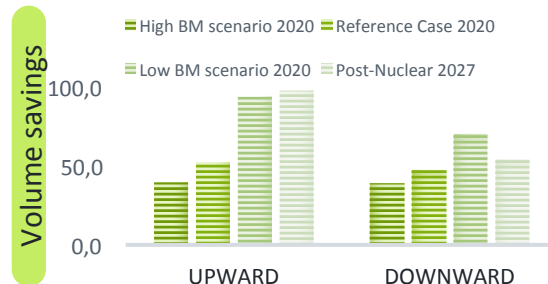


Positive business case:

- **Volume** reduction more **85%/time**
- **Financial** gains expected of **more 2M €/y** (outweighing the implementation costs)



Gain in **ROBUSTNESS**



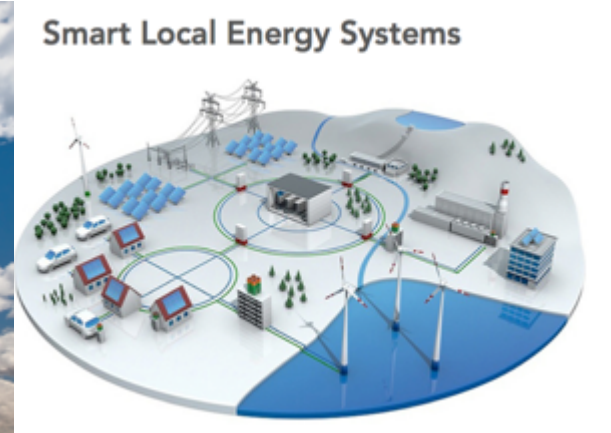
Robust methodology which remains **beneficial & feasible** towards the middle and long term system conditions:

- Toward 2020
- As well as towards 2027



Welcome To
The Future

Advanced Analytics as a key enabler of the energy transition ...

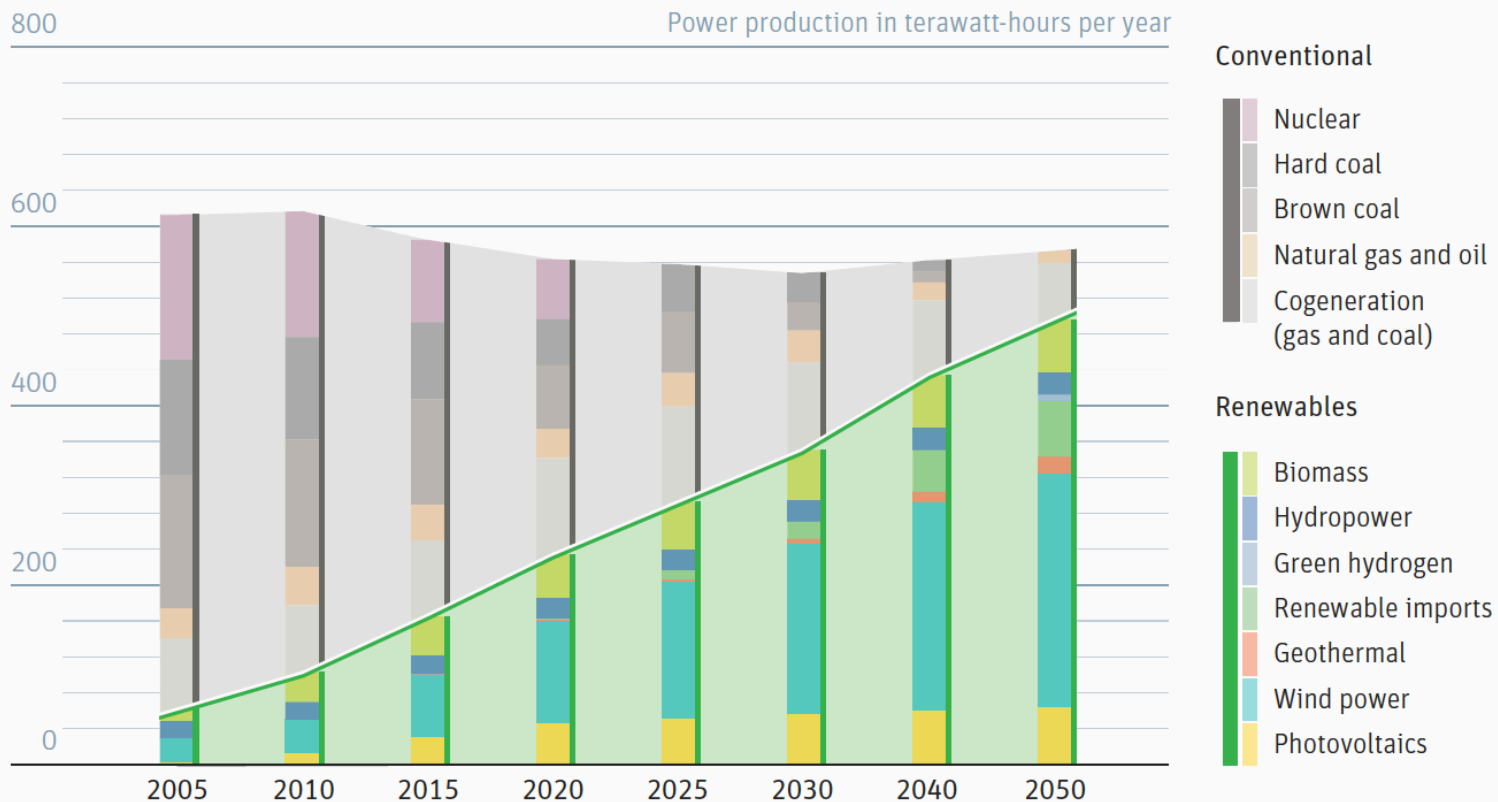


... and it is only the beginning !

Germany's plan: switch from coal and nuclear to renewables

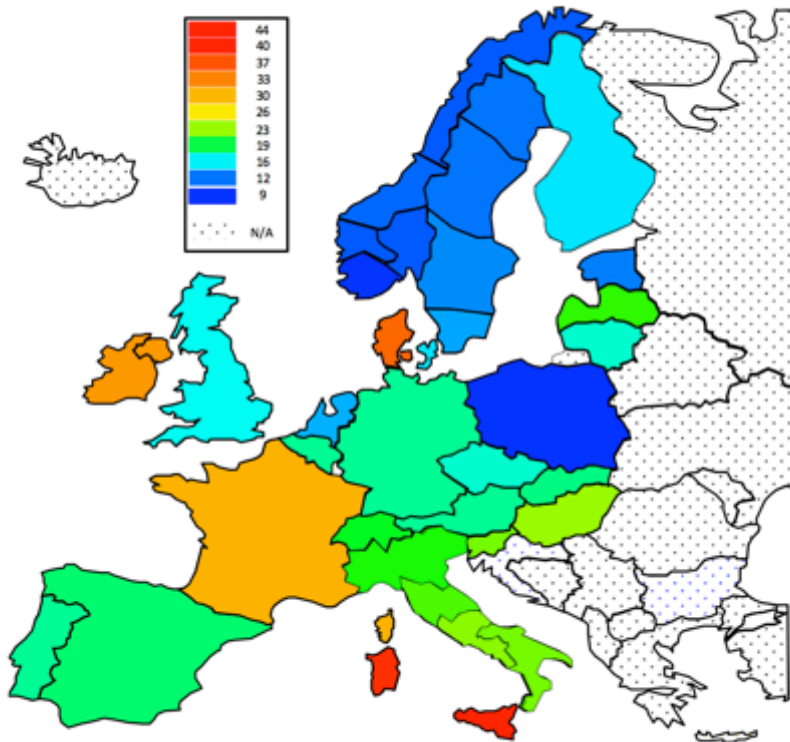
Electricity generation in Germany 2005-2050, scenario

Source: DLR and Fraunhofer IWES



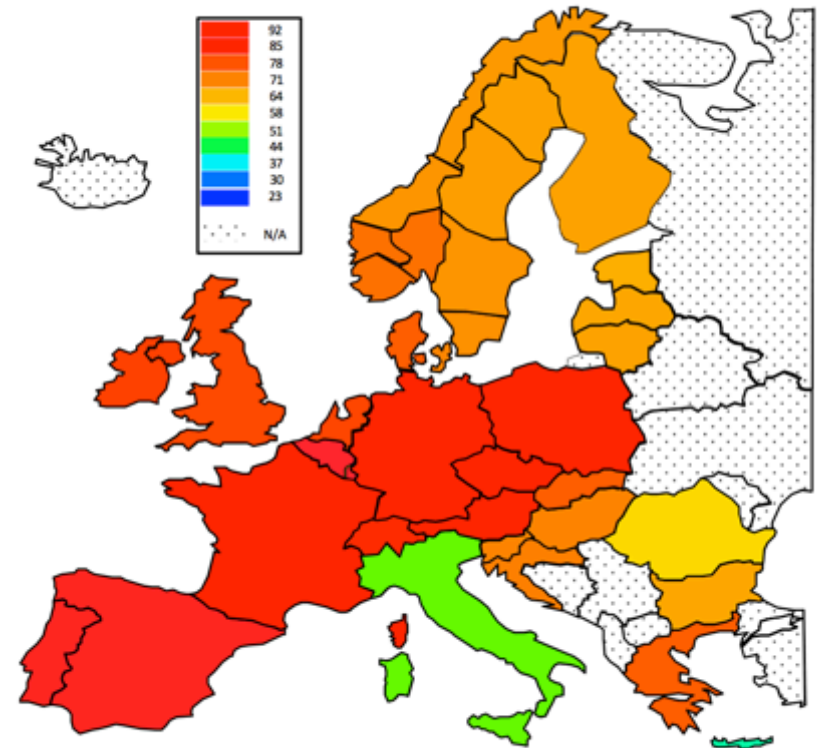
... and it is only the beginning !

Figure 18. Day-ahead market price volatility (standard deviation), 2012-2013



Source: Market data from European power exchanges, calculations by Sweco

Figure 22. Simulated future day-ahead market price volatility (standard deviation), 2030 – HIGH scenario



Source: Sweco Energy Markets, Apollo model simulations

The need for stronger ties between academia and industry is increasing

- Funding bodies are looking for impact
- Scientific journals ask for practical relevance
- Companies focus on core business
- Amount of data available is increasing exponentially

THANK YOU