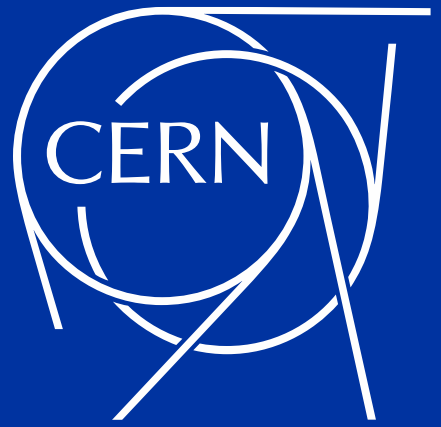


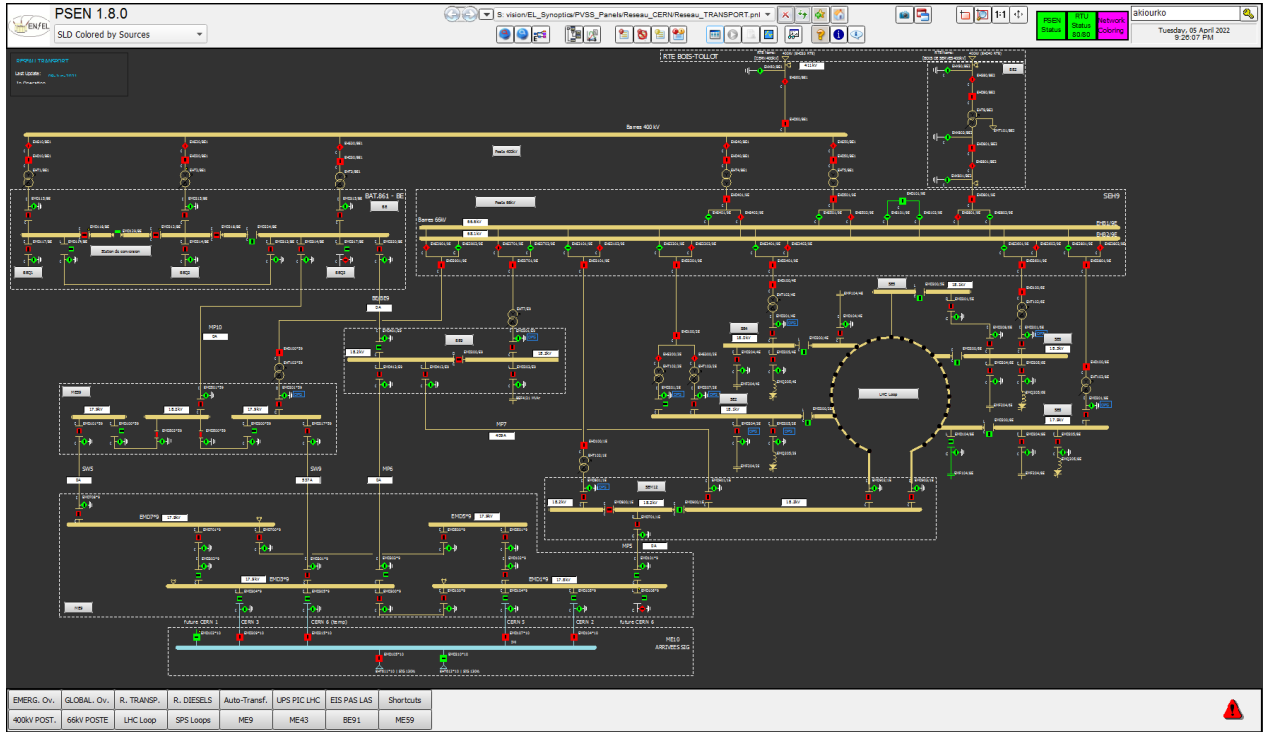
ENS & Energy Management

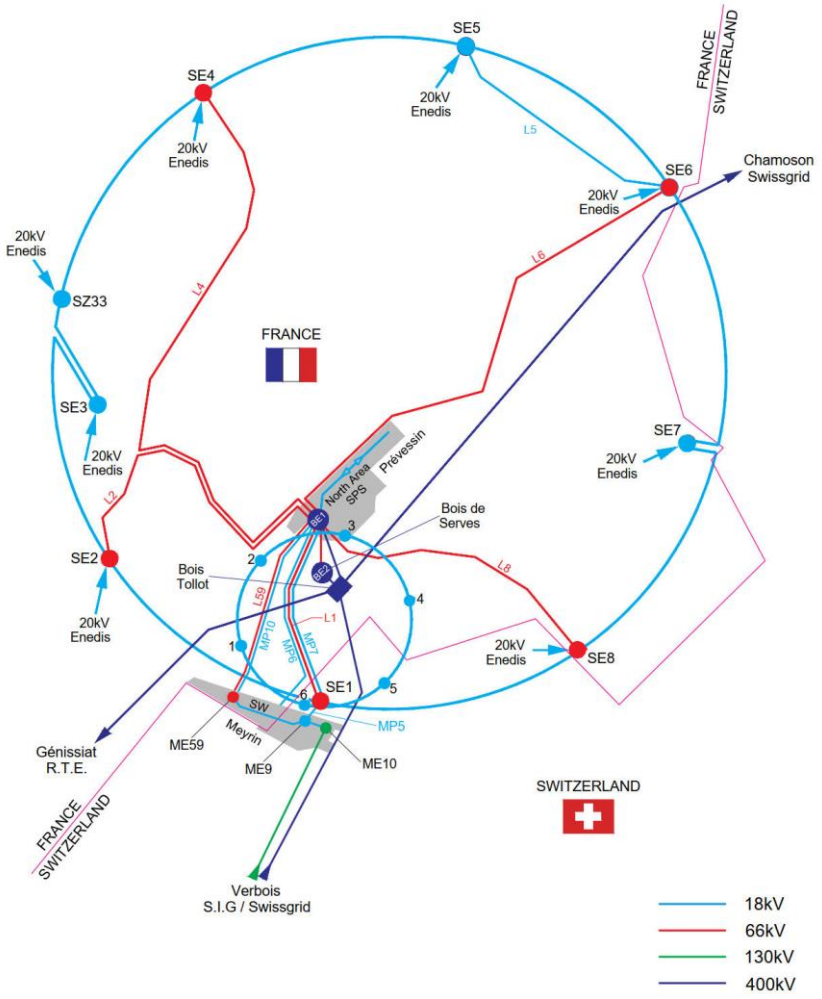
A.Kiourkos – EN/EL

2023-04-04

https://indico.cern.ch/event/1260288/

CERNs Electrical Network





Geographical overview of the CERN power supply network

15/07/21
EDMS: 2560654

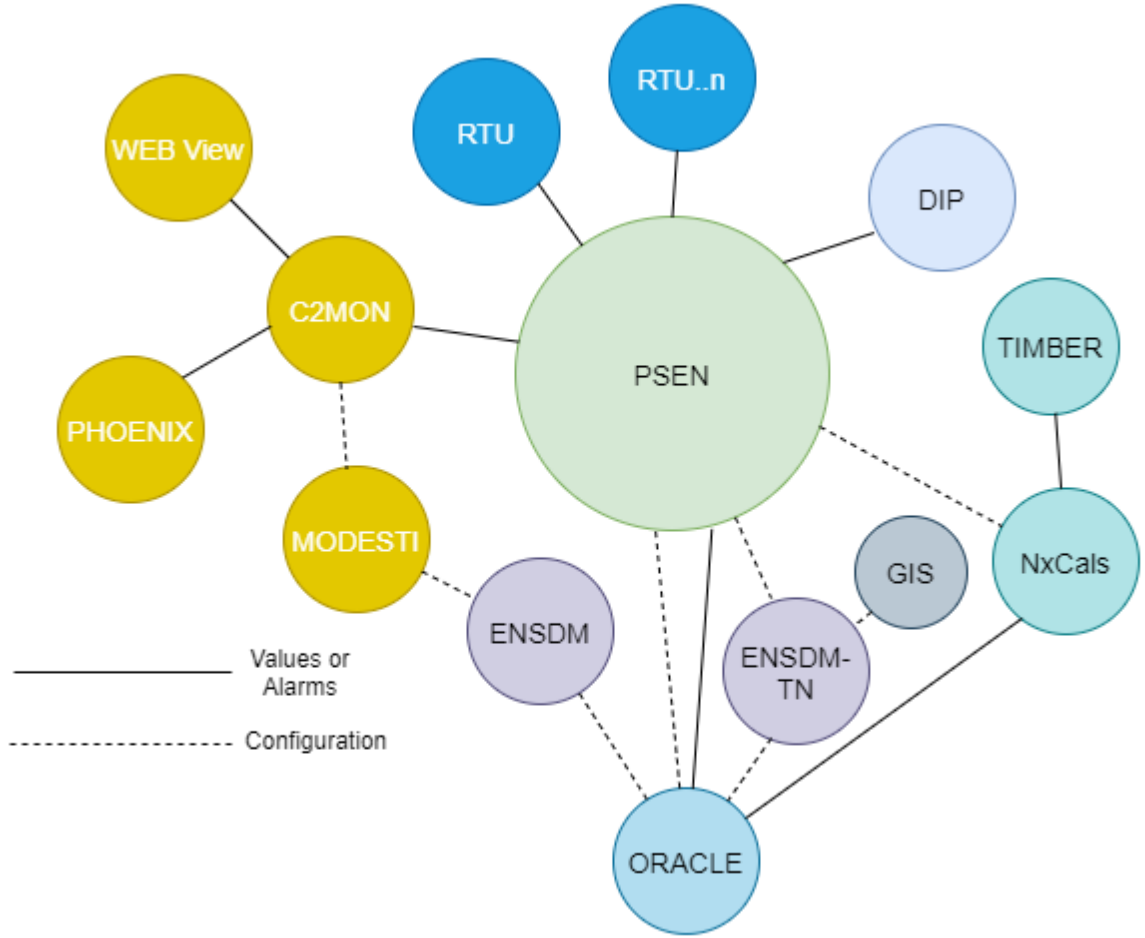
CERNs Electrical Network

- **Heterogeneous Electrical Network**
  - Diverse Voltage Levels and Loads: 400kV, 130kV, 66kV, 18kV, 3.3kV, and others. Reactive loads.
  - Varied Devices & Equipment
  - IEDs, PLCs, Serial Devices, UPS, Diesel Generators, Battery Chargers, etc.
  - Multiple Communication Protocols
  - IEC 61850, IEC 60870-5-104, MODBUS, JBUS, and other proprietary serial protocols
- **Organic Growth**
  - Developing with the laboratory and evolving to meet the requirements of its machines and systems
- **Comprehensive Supervision System**
  - Multilevel Monitoring: Supervision at all voltage levels, from high voltage to low voltage equipment
  - End-to-End Oversight: Ensures robust performance, reliability, and safety across the entire electrical network

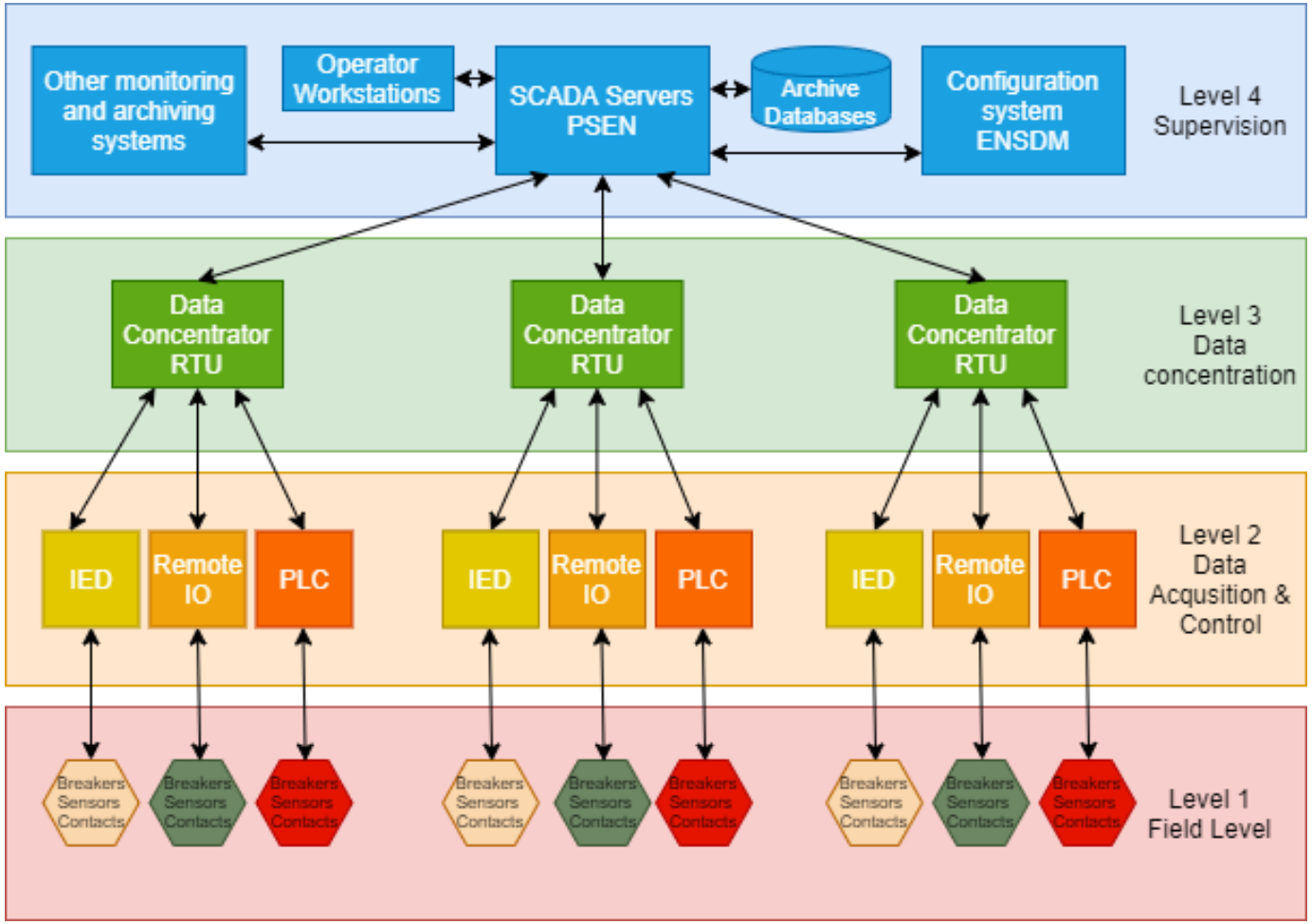
Electrical Network Supervision - (ENS)

A constellation of systems and services:

- Typical 4 level SCADA (PSEN – RTUs – IEDs)
- Online configuration system (ENSDM)
- Energy Management System (Web Energy)
- Connections to other CERN services

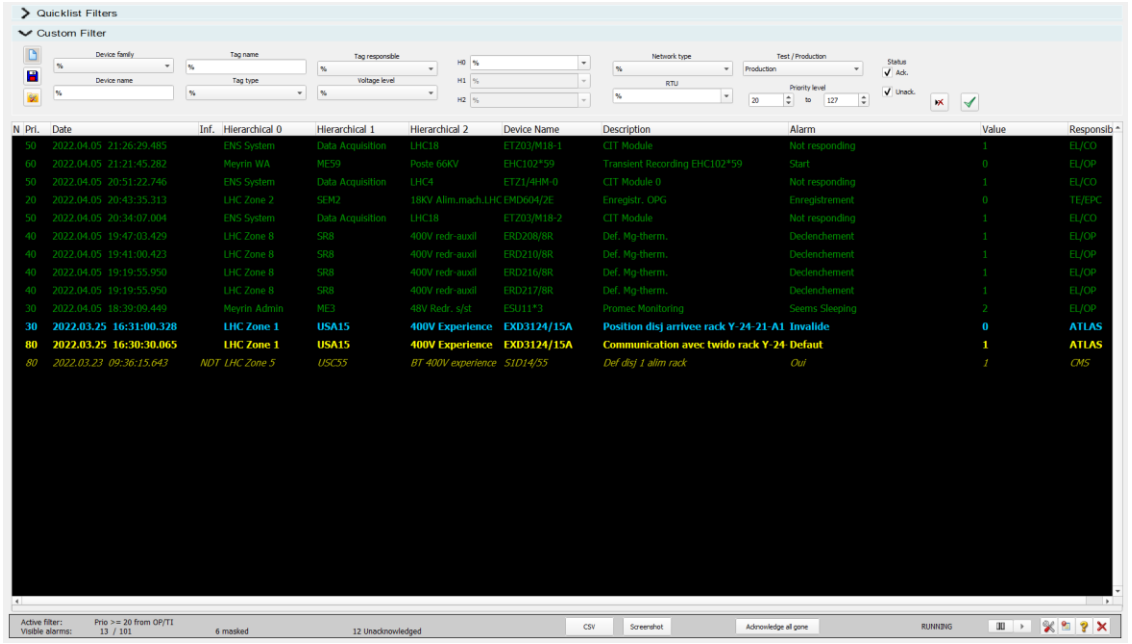


Electrical Network Supervision - Layers

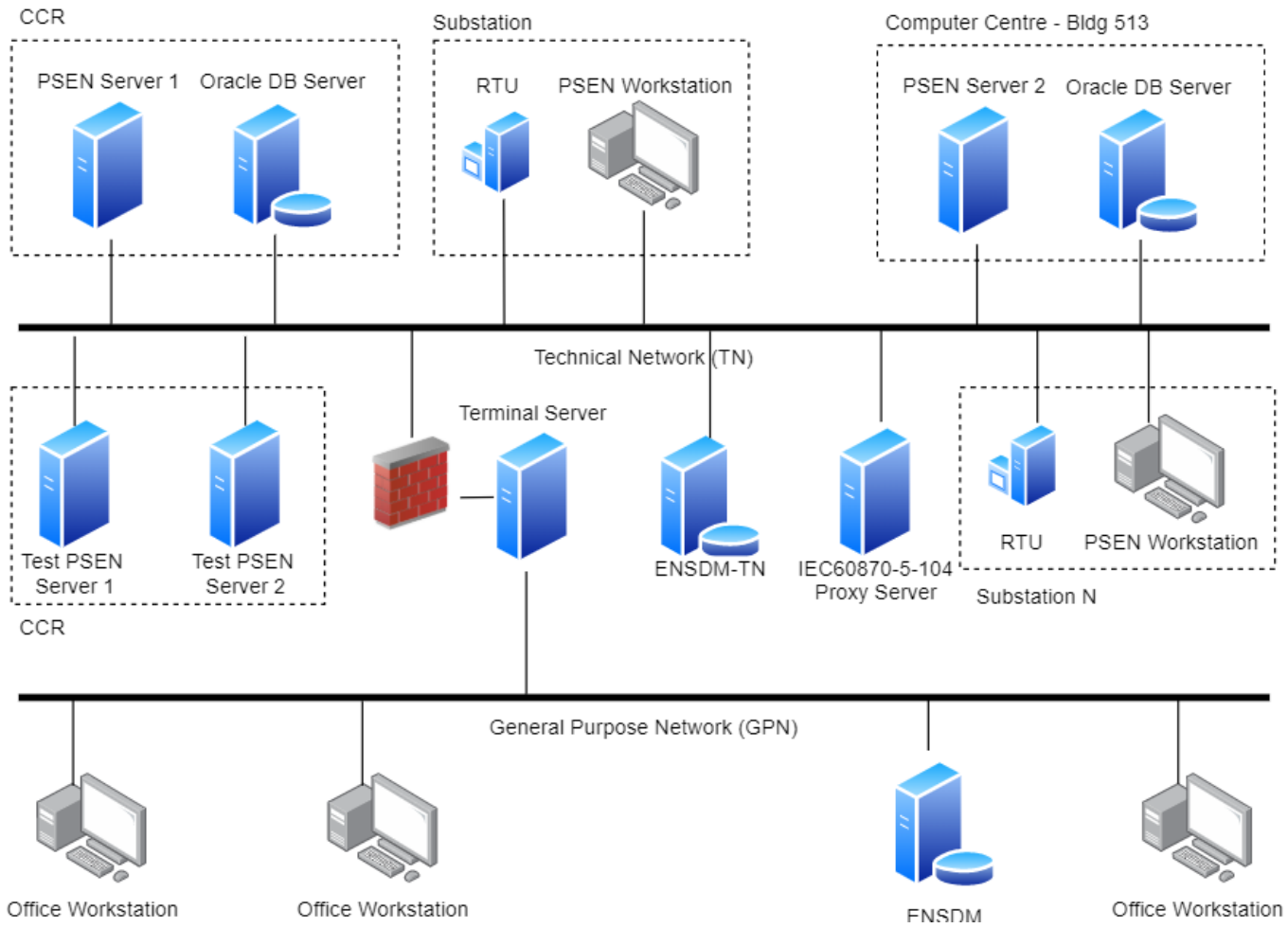


SCADA - PSEN

- WinCC OA based SCADA developed internally (BE/ICS)
- Monitoring CERN's Electrical Network
- 320,000 data points
- 24,500 devices
- 125,000 alarm states

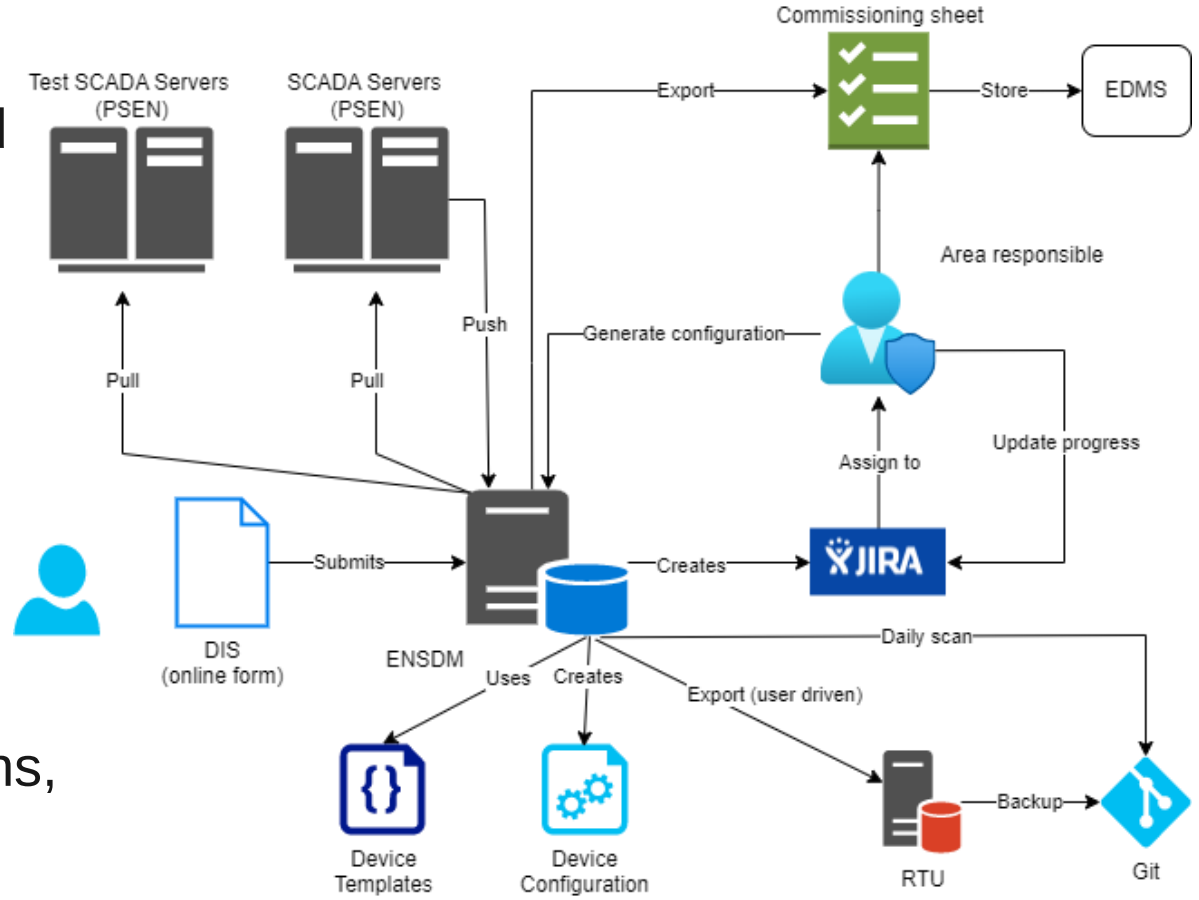


Supervision Layer – Network Layout

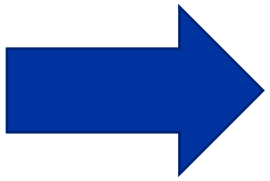


Configuration workflow

- Automate as much as possible
- Achieve uniformity through standardization and harmonization
- Boost efficiency and minimize effort
- Reduce errors for dependable and accurate configuration
- Avoid duplication
- Balance reusable services with custom solutions, depending on needs



Substation operation – Evolution

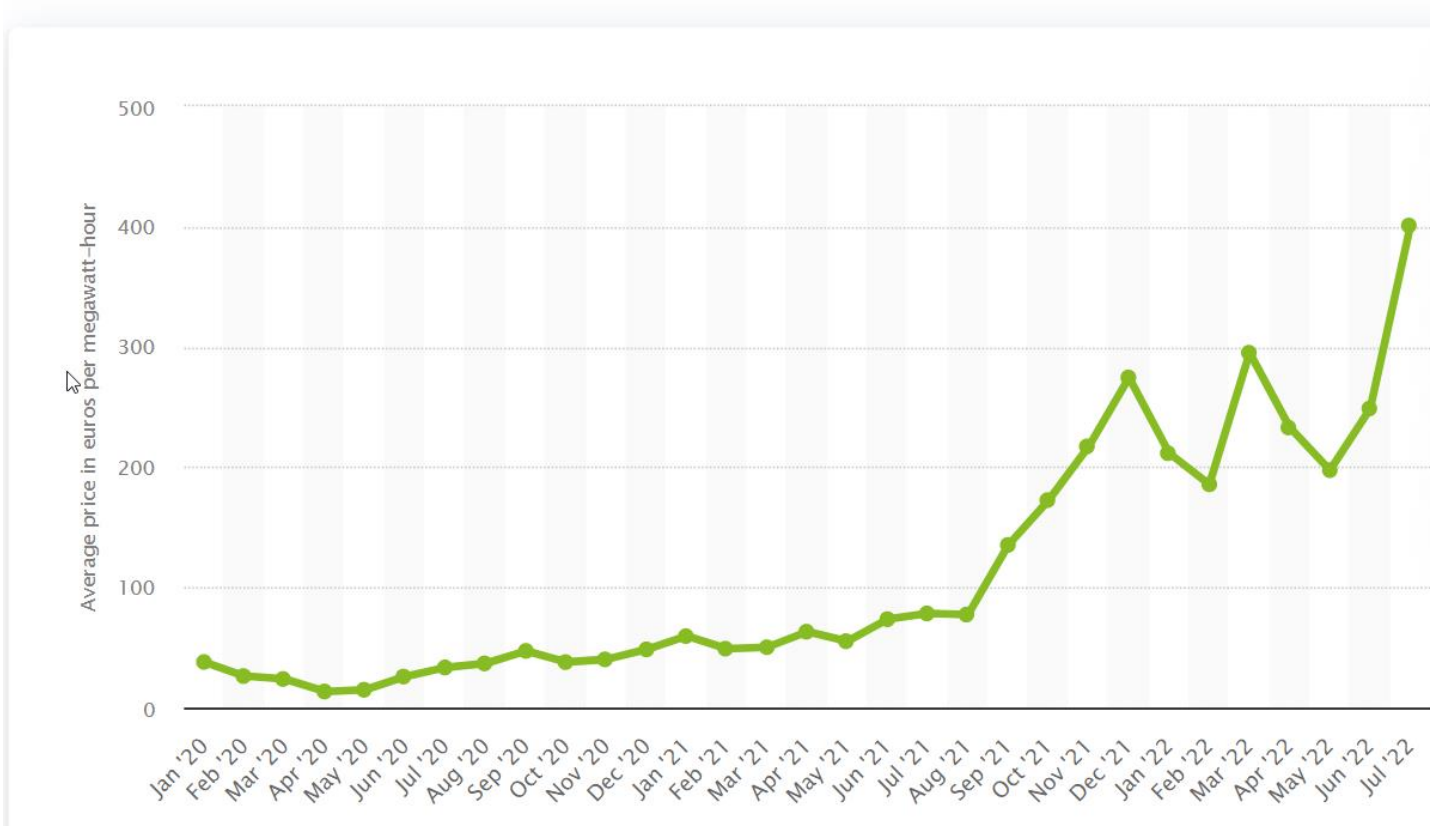


Energy Management

The challenge

(EU) from January 2020 to July 2022

(in euros per megawatt-hour)



Bloomberg
Europe Edition

France Aims to Cut Energy Consumption 10% This Winter to Avoid Outages

EU Ministers Call For 10% Cut In Energy Consumption

THE WALL STREET JOURNAL.
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WSJ NEWS EXCLUSIVE | WORLD

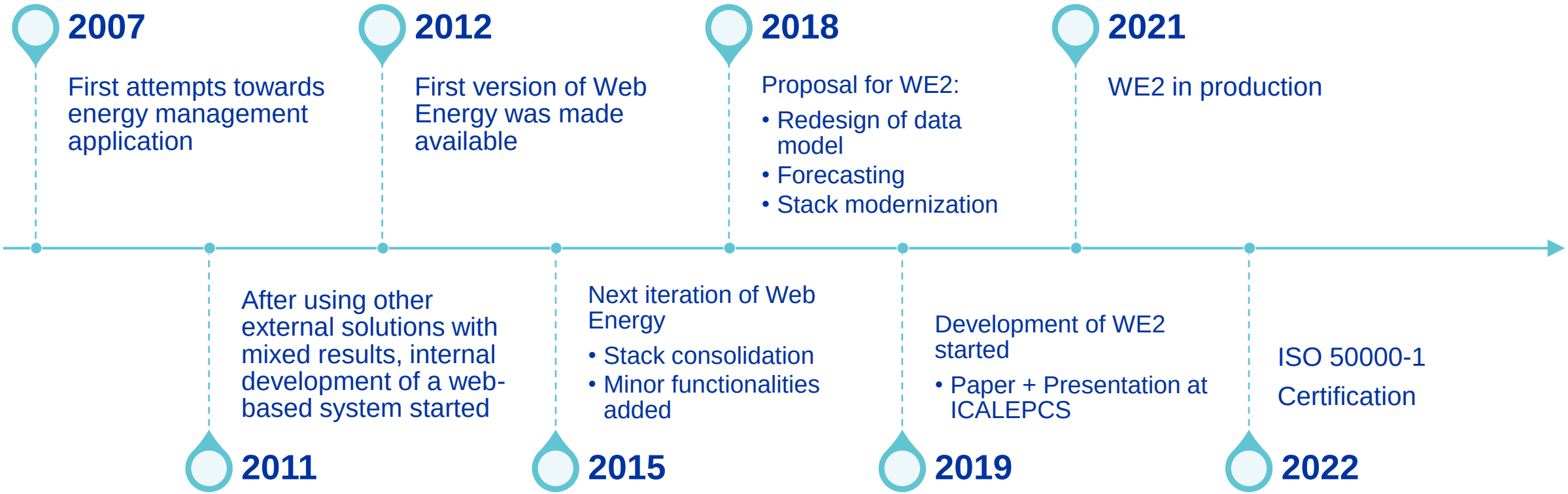
Europe's Energy Crunch Squeezes World's Largest Particle Collider

CERN is drafting plans to idle its particle accelerators, including the Large Hadron Collider, if France runs short of electricity

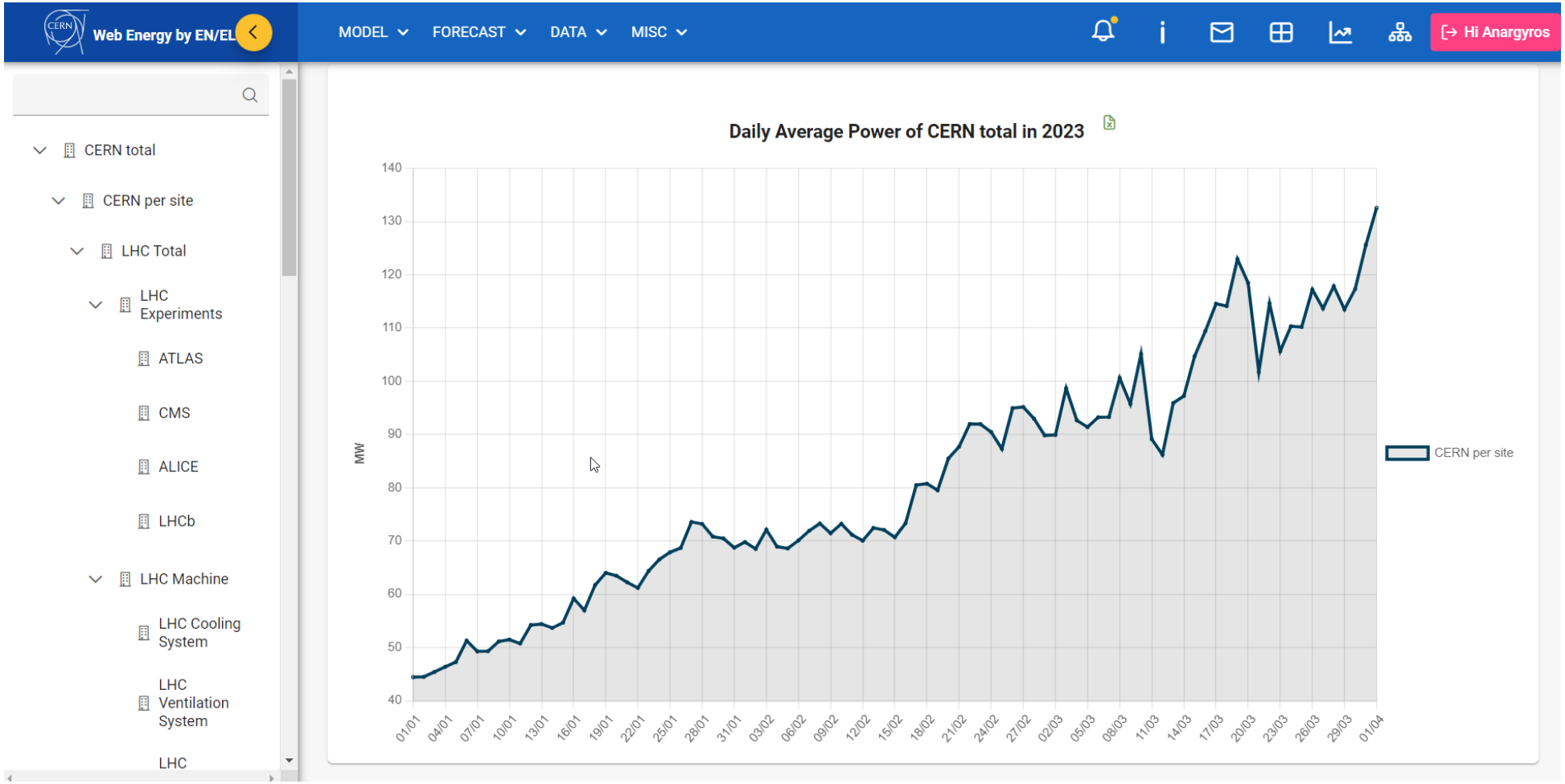
Energy Management @ CERN - Web Energy

- Used to manage the energy consumption at CERN
- Generates energy consumption forecast
- Enables to identify **early**, deviations from forecasted consumption
- Assists with the management of the electricity contract
- Allows to evaluate assumptions
- Findings discussed at a dedicated panel – Energy Management Panel (EMP)
- Gives visibility of the energy consumption to the users

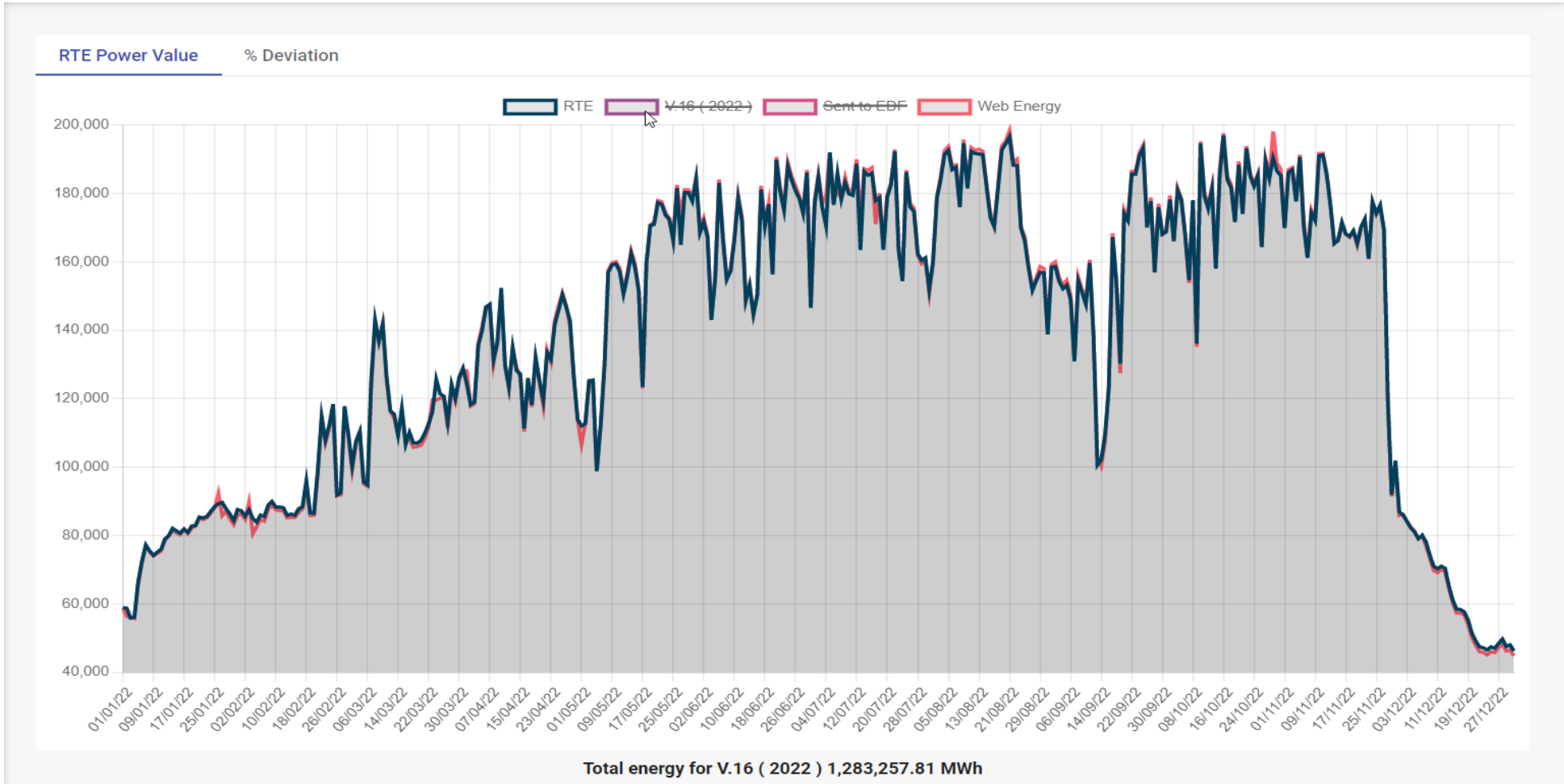
Energy Management @ CERN - History



Energy Management @ CERN – Web Energy



Energy Management @ CERN – Web Energy



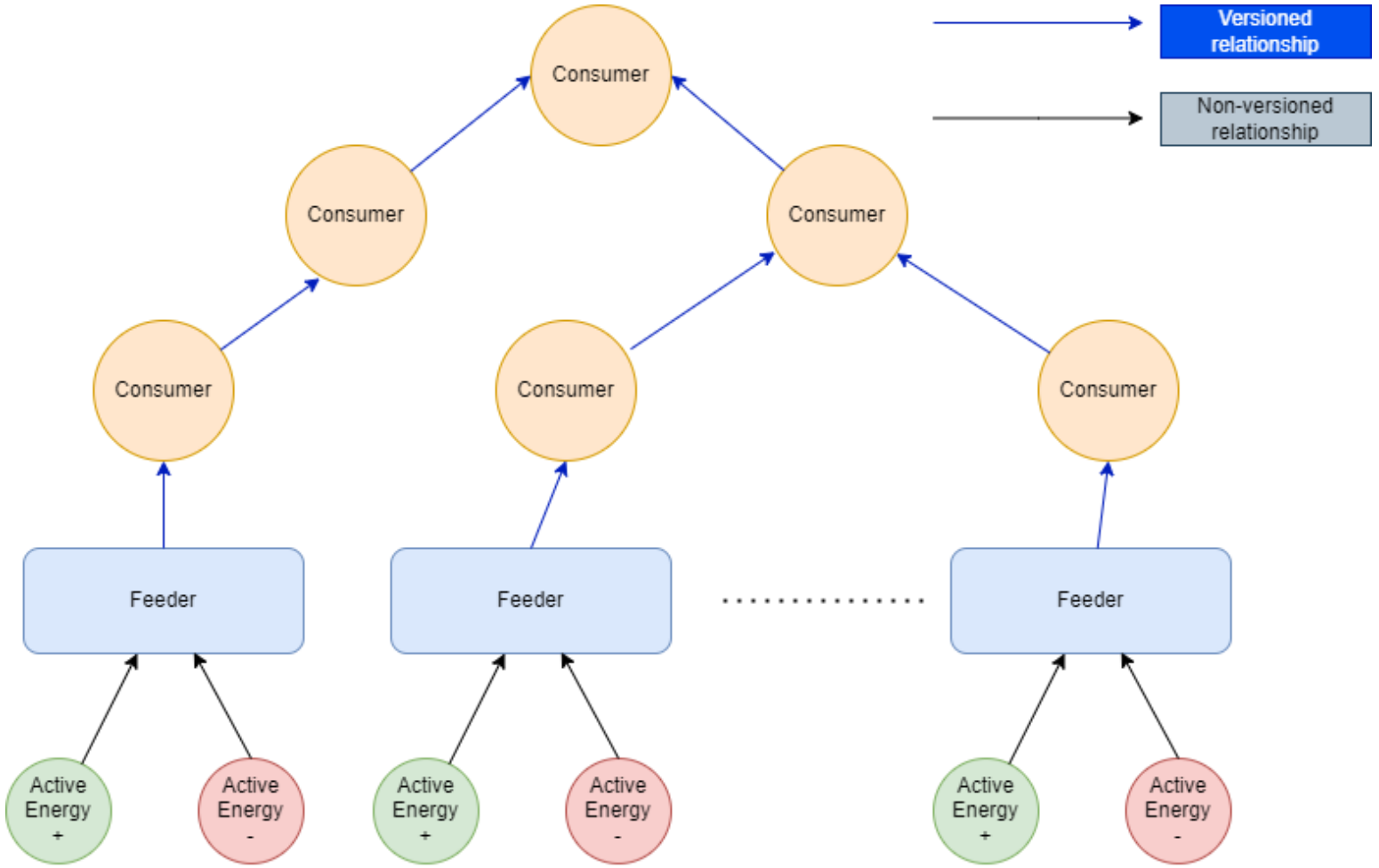
Capabilities

- Flexible Energy tree:
  - Allows versioning
  - Incorporates revisions
- Graphical editor for the tree:
  - Ergonomic & intuitive
- Spike detection, logging & tracing:
  - Enables to find abnormalities in the configuration or data, quickly and efficiently
- Flexible file exports
- Responsive design

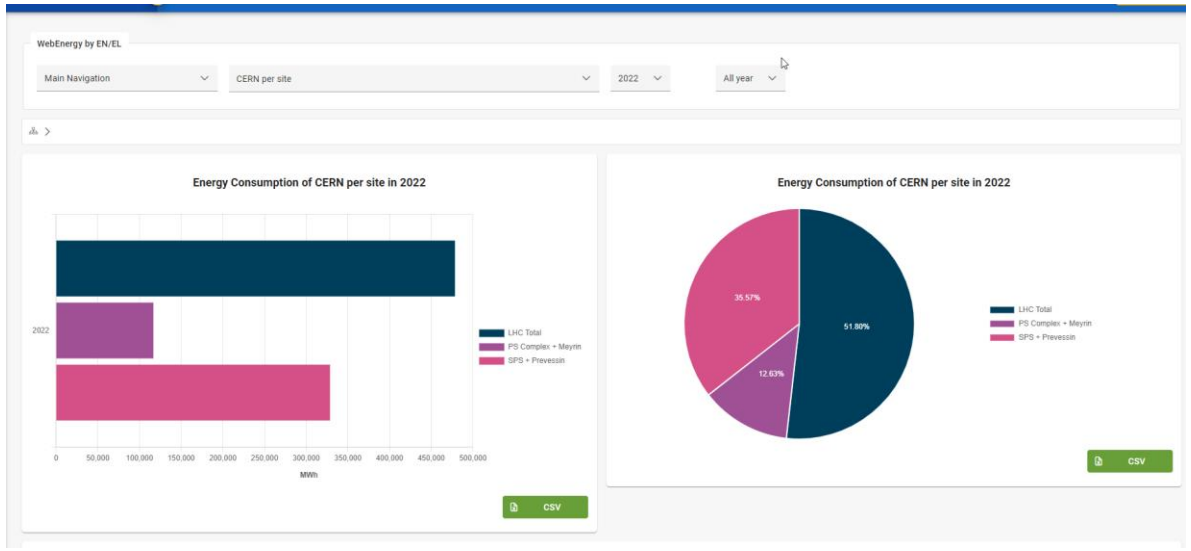
Forecasting

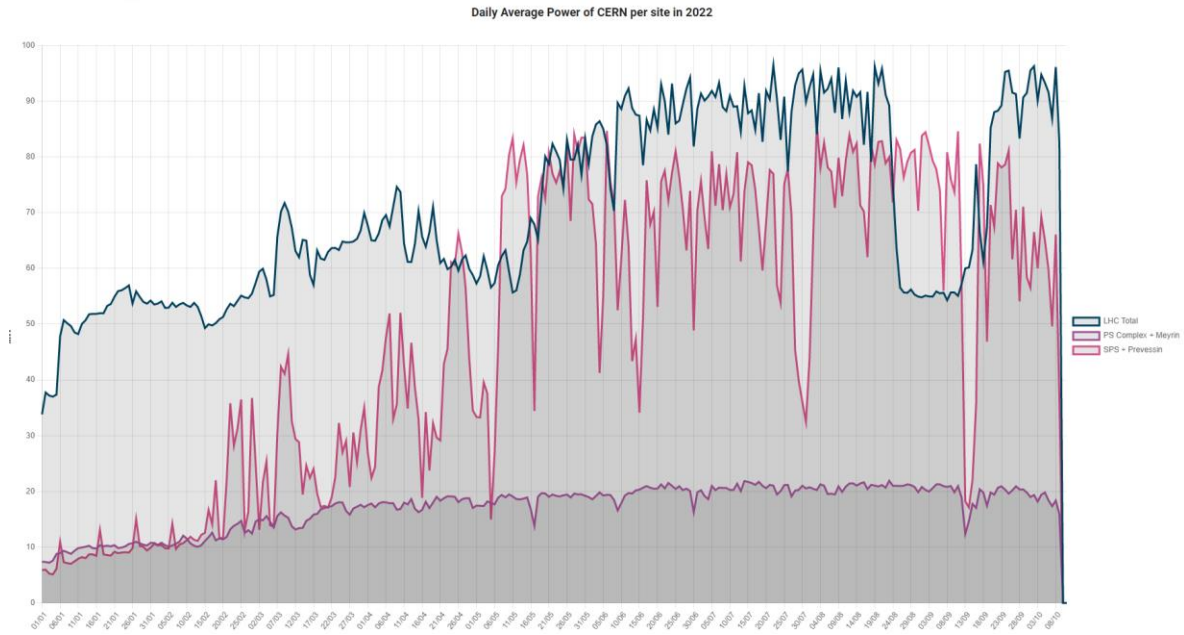
- Based on accelerator schedule
- Enables to generate different scenarios in short amount of time
- Important for strategy and decision making
- Continuously evolving and improving
- Indispensable tool for the management of the electricity contract

Data model

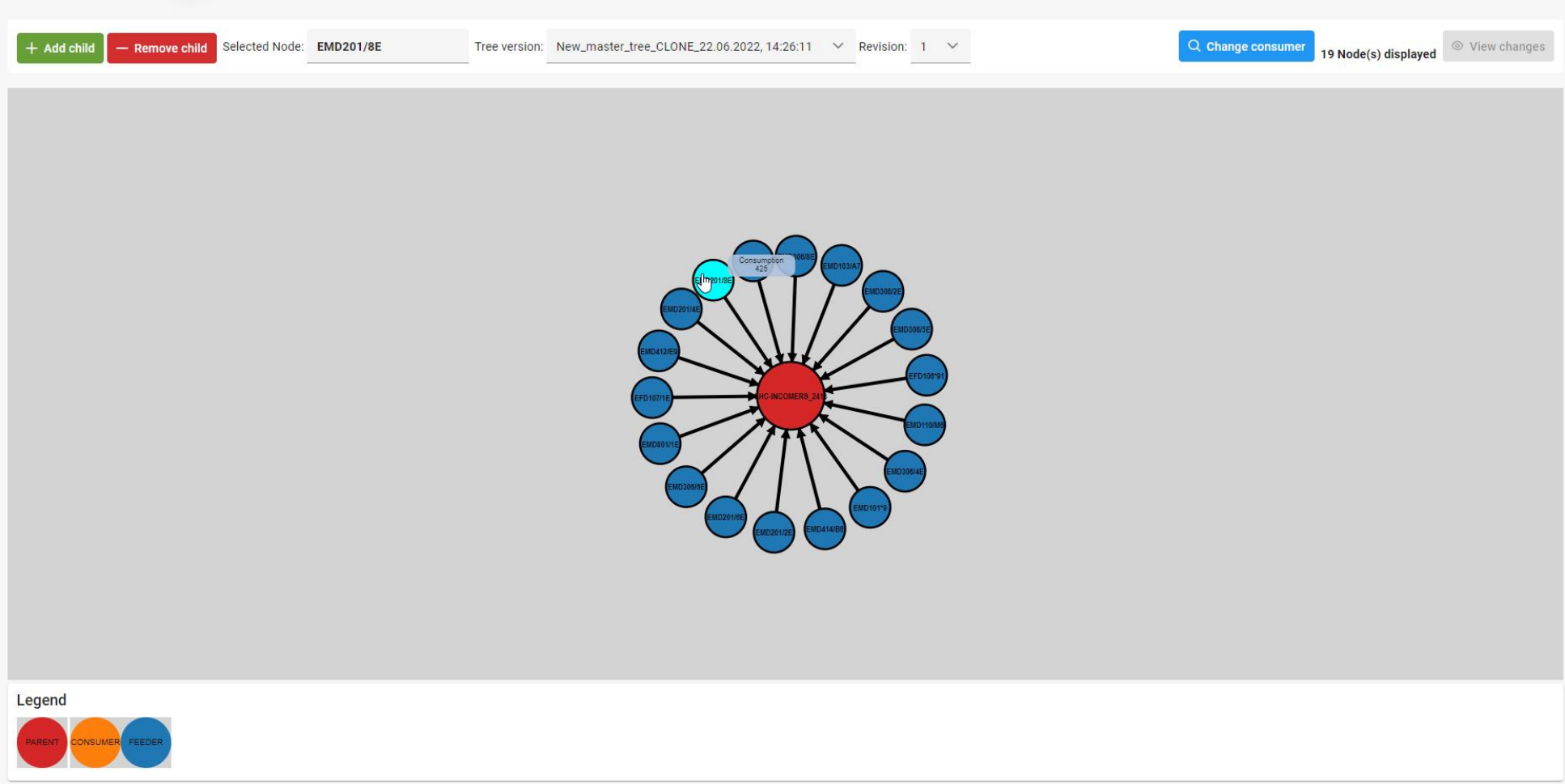

Versioned relationship
Non-versioned relationship
Consumer
Consumer
Consumer
Consumer
Consumer
Consumer
Feeder
Feeder
Feeder
Active Energy +
Active Energy -
Active Energy +
Active Energy -
Active Energy +
Active Energy -

Dashboards


WebEnergy by EN/EL
Main Navigation
CERN per site
2022
All year
Energy Consumption of CERN per site in 2022
2022
LHC Total
PS Complex + Meyrin
SPS + Prevessin
0
50.000
100.000
150.000
200.000
250.000
300.000
350.000
400.000
450.000
500.000
MWh
CSV
Energy Consumption of CERN per site in 2022
35.57%
51.80%
12.63%
LHC Total
PS Complex + Meyrin
SPS + Prevessin
CSV

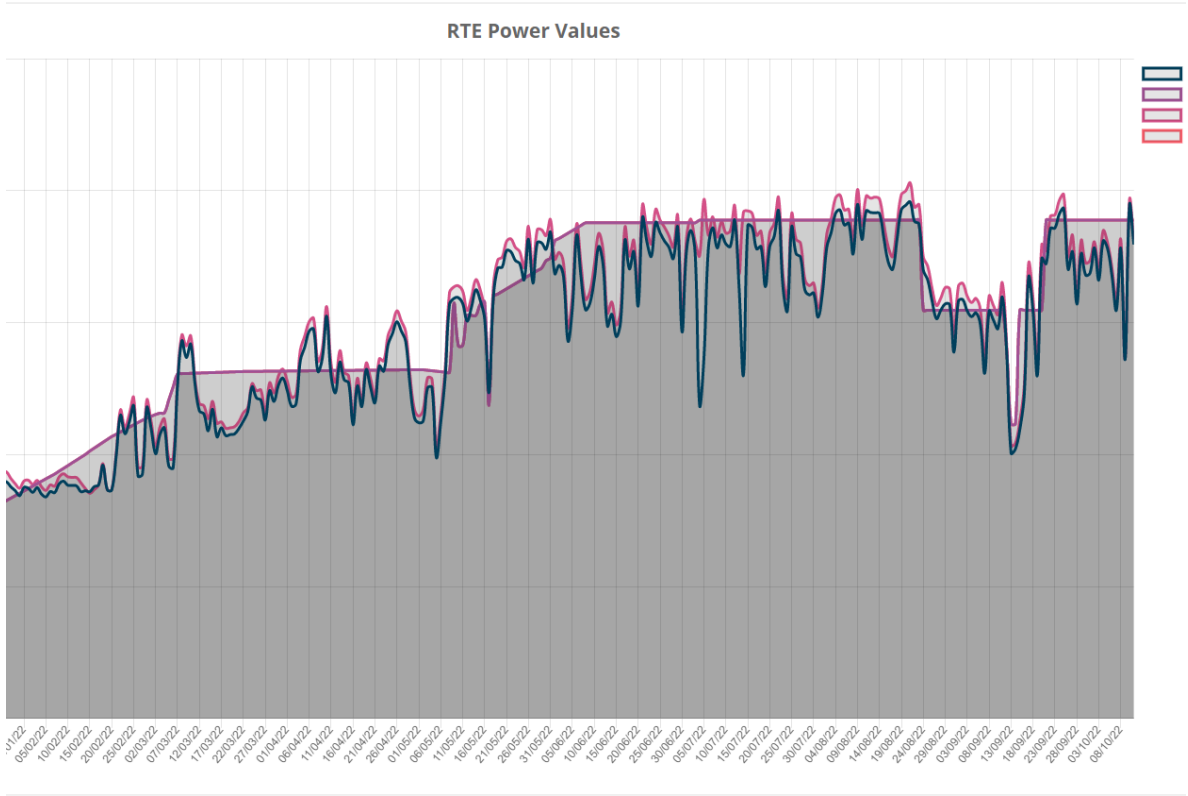

Daily Average Power of CERN per site in 2022
100
90
80
70
60
50
40
30
20
10
0
LHC Total
PS Complex + Meyrin
SPS + Prevessin

Graphical tree editor

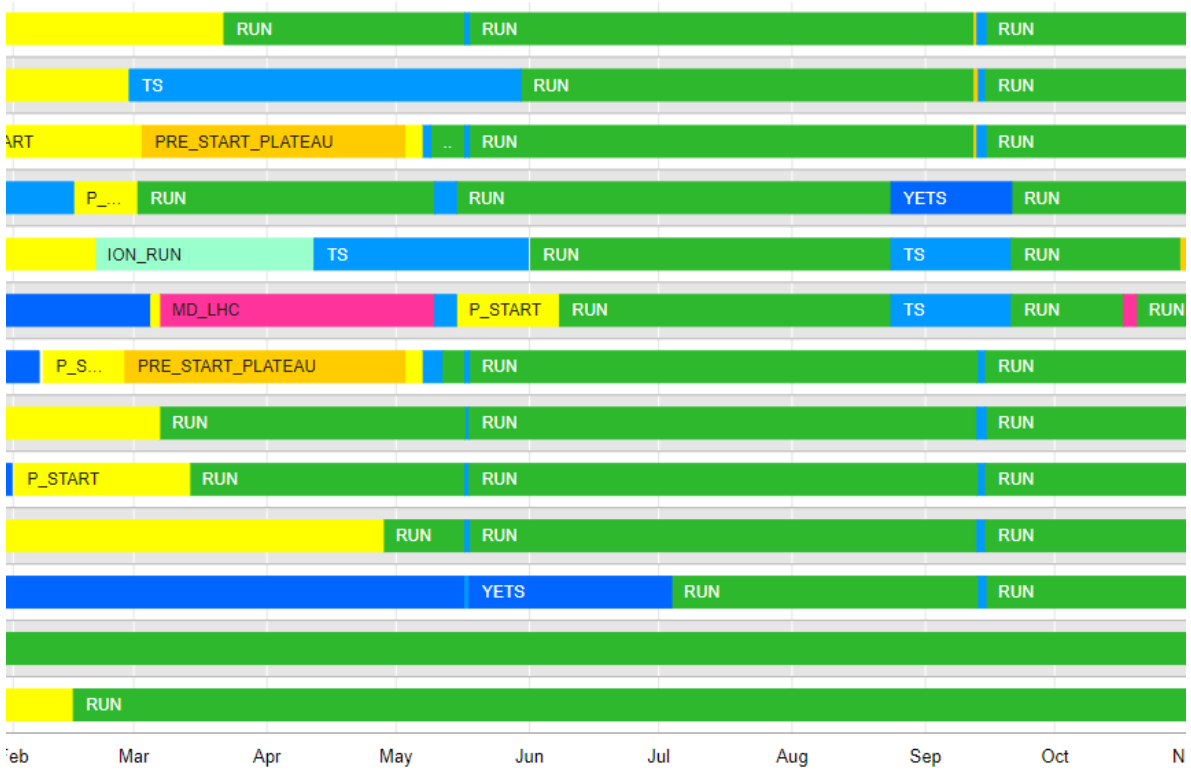


Scenario comparison and planning

Forecast vs Actual

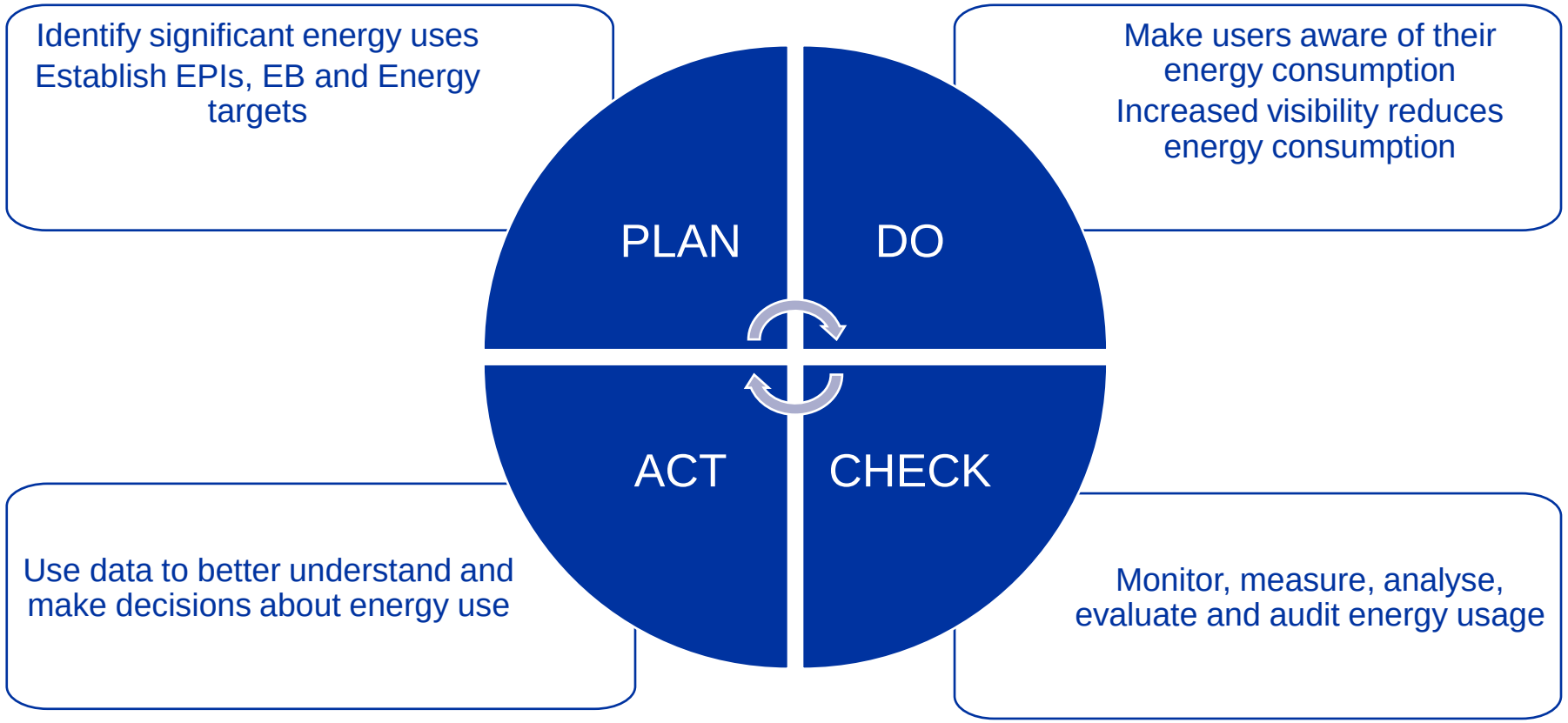


Consumption Schedule



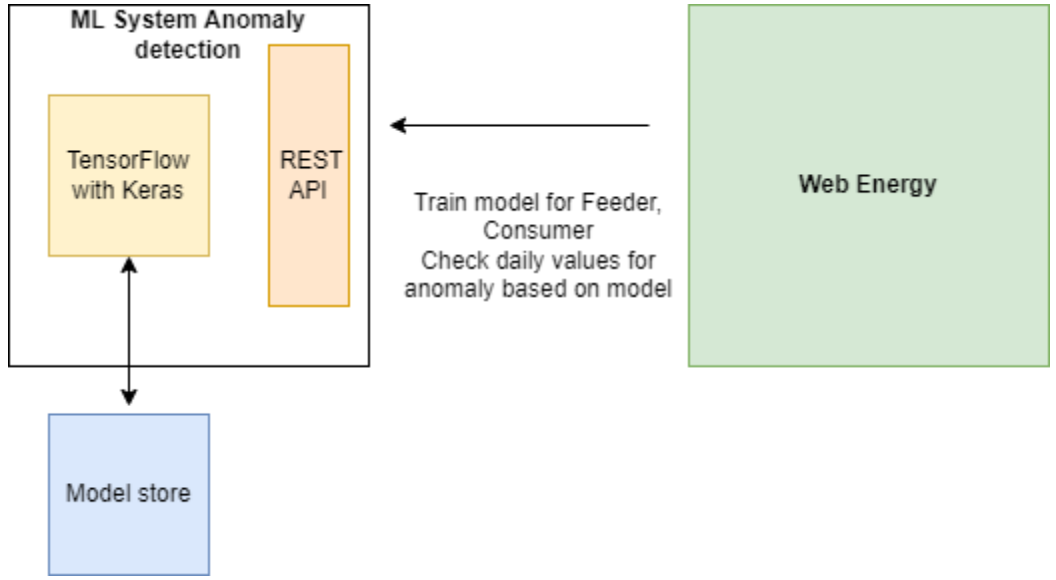
ISO 50001

Web Energy enables continuous improvement via assisting in the all steps of the PDCA Cycle (ISO50001)



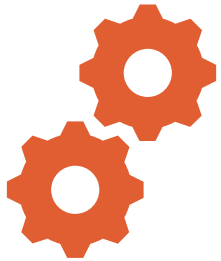
Roadmap

- Add support for Gas and Water
- Advanced reporting & analytics
- Support for additional data sources
- Anomaly detection using AI
  - Anomaly detection using a reconstruction convolutional autoencoder model



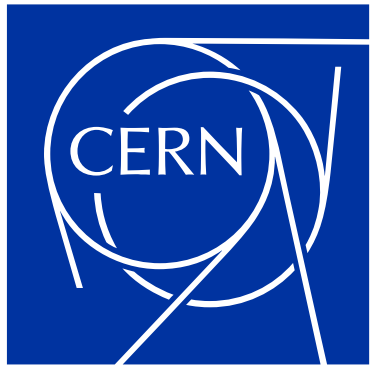
Conclusion

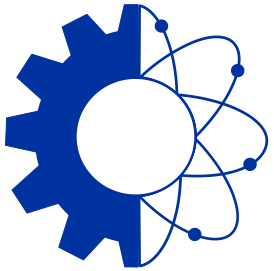
Energy management is important for CERN



Web Energy handles many aspects of the process

The system has been proven, is evolving and actively maintained





ENGINEERING
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