



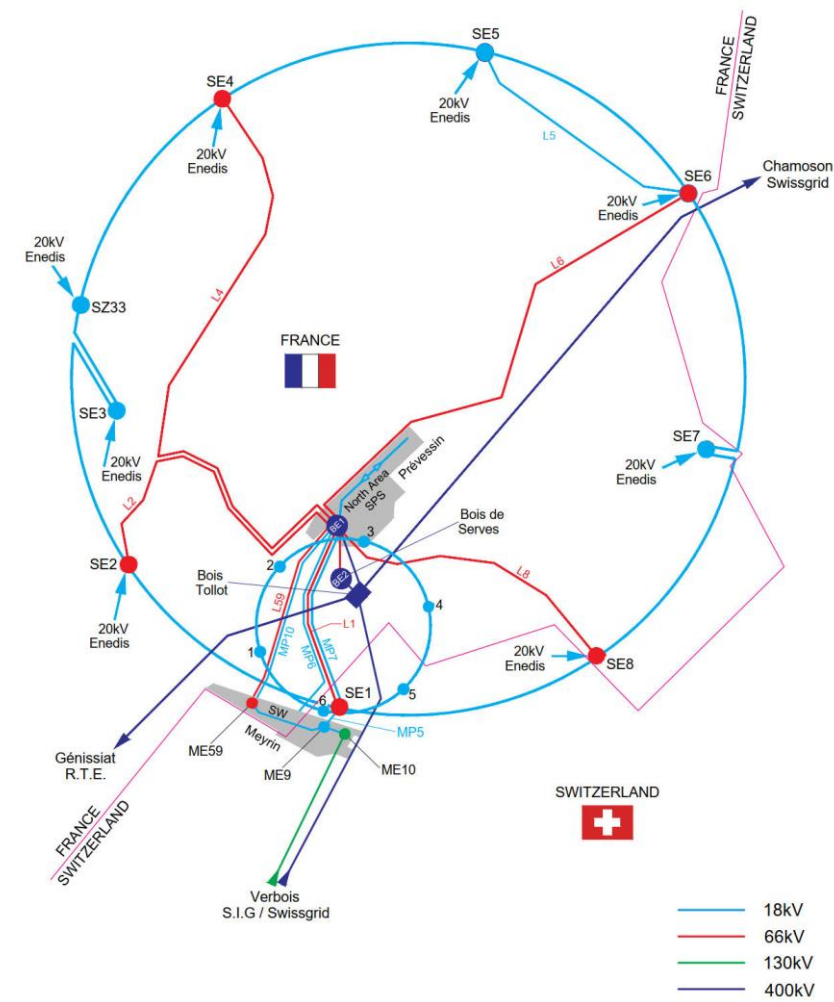
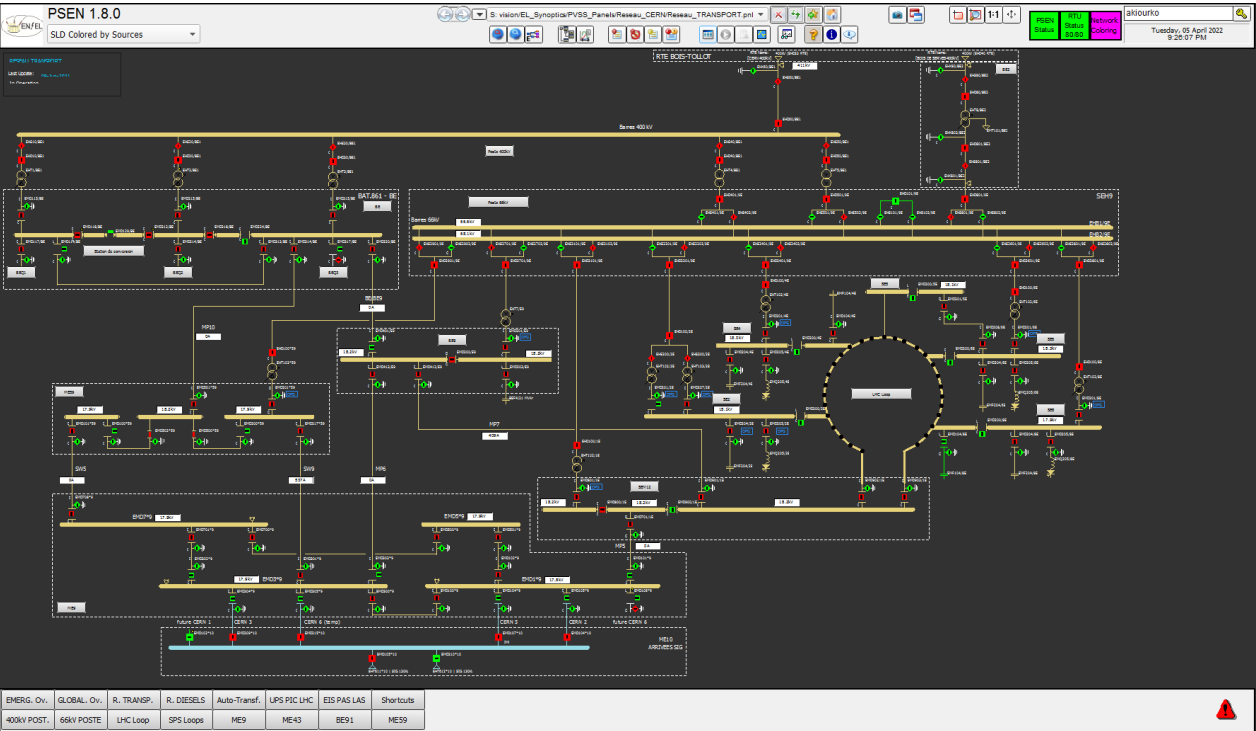
# ENS & Energy Management

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

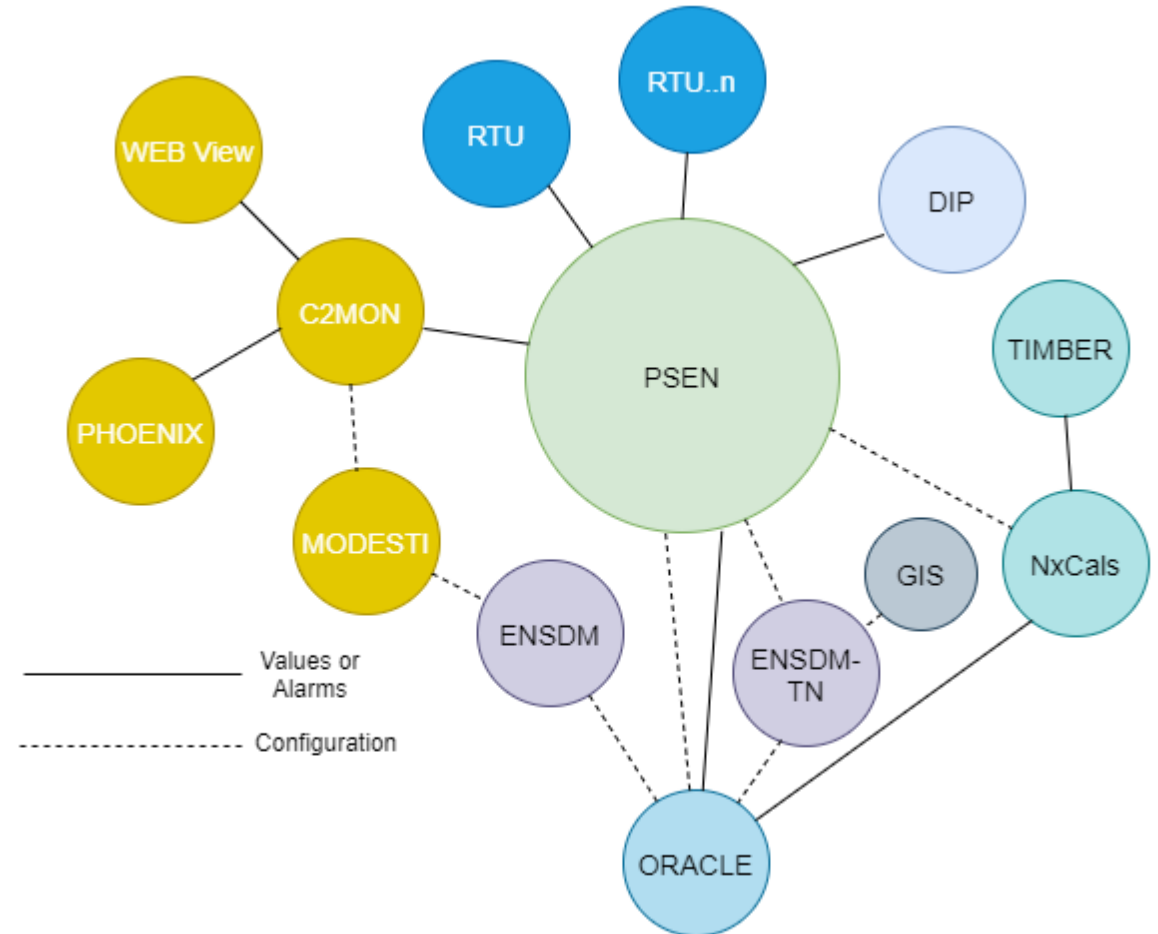
- **Comprehensive Supervision System**

- 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

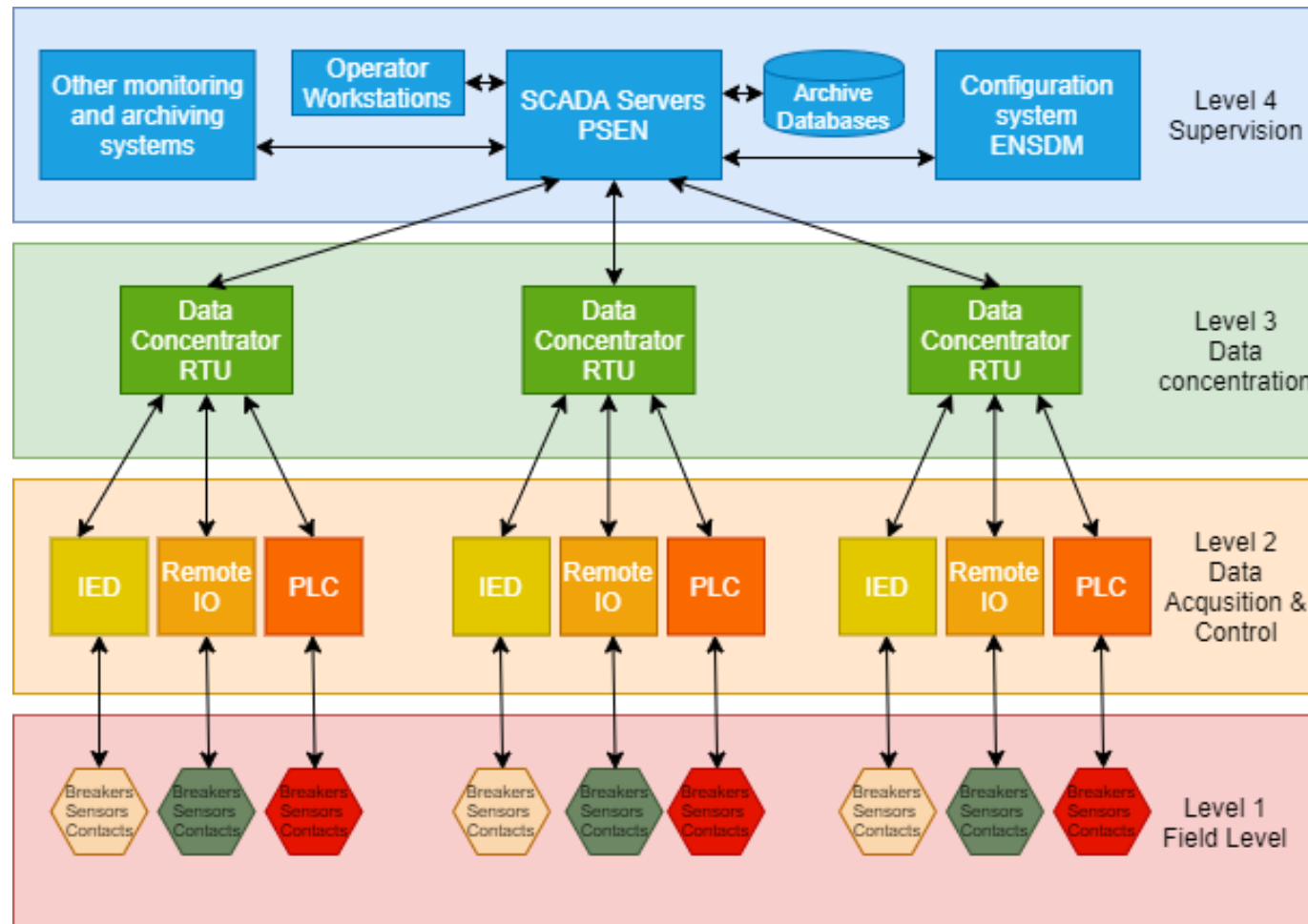
# Electrical Network Supervision - (ENS)

## 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

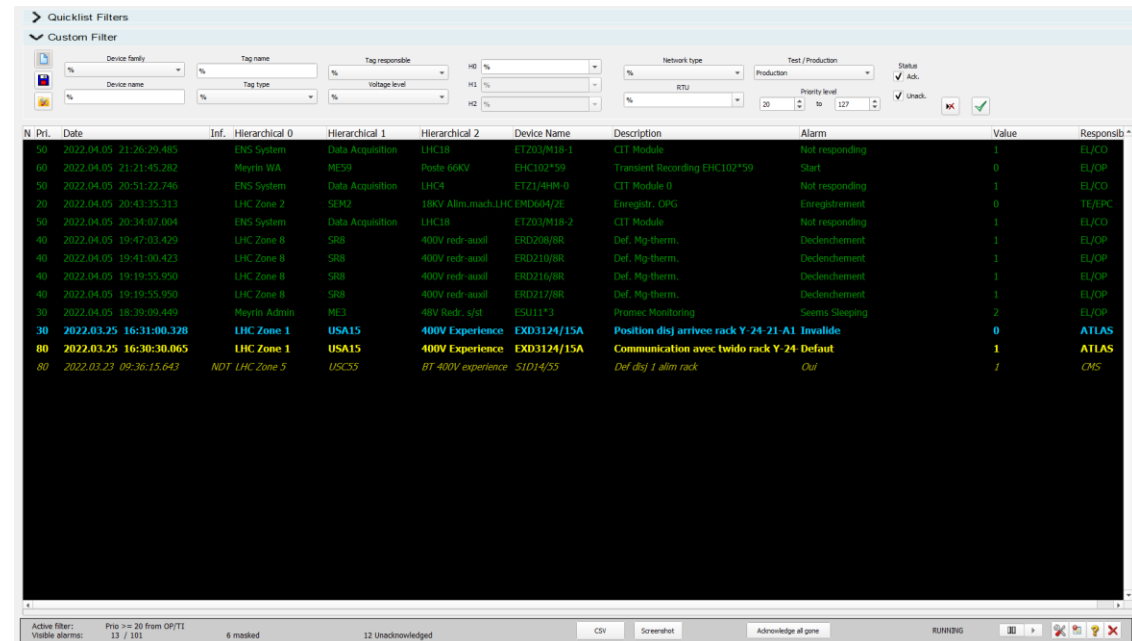


# Electrical Network Supervision - Layers



# SCADA - PSEN

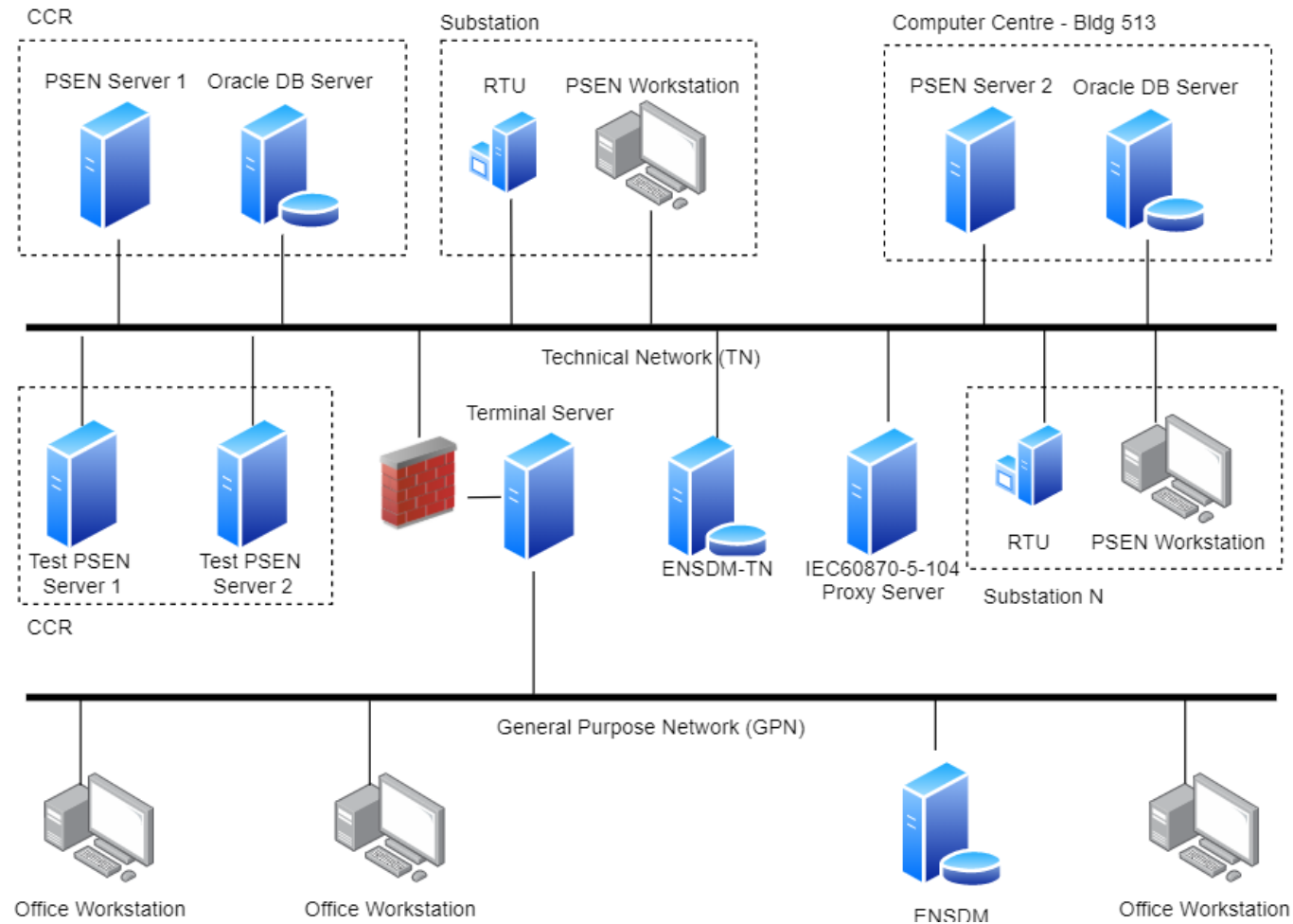
- WinCC OA based SCADA developed internally (BE/ICS)
- Monitoring CERN's Electrical Network
- 320,000 data points
- 24,500 devices
- 125,000 alarm states



The screenshot displays the WinCC OA SCADA interface. At the top, there are filter controls including 'Quicklist Filters' and 'Custom Filter' with various dropdown menus for device family, tag name, tag responsible, network type, and test/production status. Below the filters is a table with columns: N, Pri, Date, Inf, Hierarchical 0, Hierarchical 1, Hierarchical 2, Device Name, Description, Alarm, Value, and Response. The table contains multiple rows of data, including entries for 'ENS System', 'LHC Zone 2', 'LHC Zone 8', 'LHC Zone 1', and 'NDT LHC Zone 5'. The bottom status bar shows 'Active filter: Prio >= 20 from OP/TT', 'Visible alarms: 13 / 101', '6 masked', '12 Unacknowledged', and buttons for 'Clear', 'Screenshot', 'Acknowledge all gone', and 'RUNNING'.

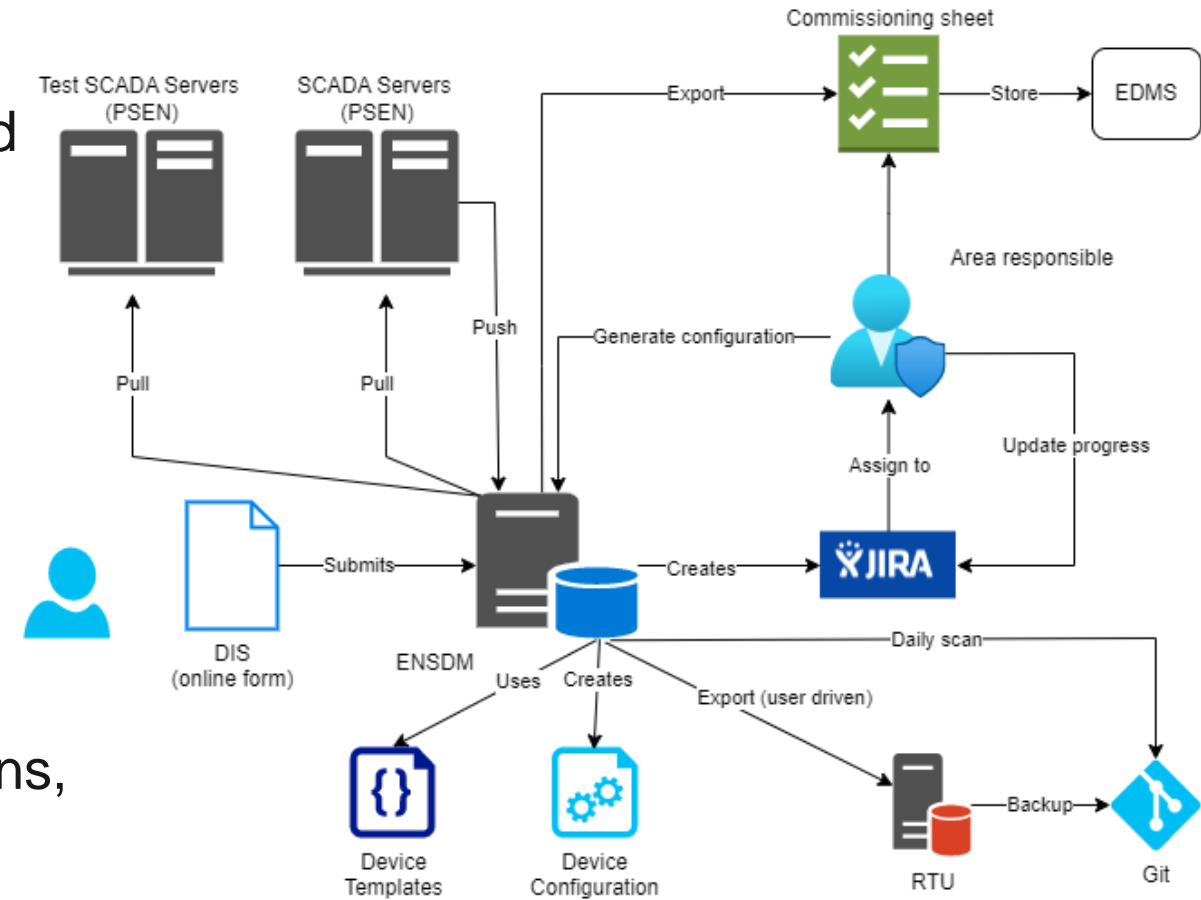
N	Pri	Date	Inf	Hierarchical 0	Hierarchical 1	Hierarchical 2	Device Name	Description	Alarm	Value	Response
50		2022.04.05 21:20:29.485	ENS System	Data Acquisition	LHC18	ET203/M18-1	CIT Module	Not responding	1		EL/CO
60		2022.04.05 21:21:45.282	Maylin WA	ME39	Poste 60KV	EHC102*59	Transient Recording EHC102*59	Start	0		EL/OP
50		2022.04.05 20:51:22.746	ENS System	Data Acquisition	LHC4	ET21/RRH-0	CIT Module 0	Not responding	1		EL/CO
20		2022.04.05 20:43:35.313	LHC Zone 2	SEM2	18KV Alim.mach.LHC	EMD604/26	Enregist. CPG	Enregistrement	0		TE/RPC
50		2022.04.05 20:34:07.004	ENS System	Data Acquisition	LHC18	ET203/M18-2	CIT Module	Not responding	1		EL/CO
40		2022.04.05 19:47:03.429	LHC Zone 8	SR8	400V redi-auxil	ERD208/RR	Def. Mq-therm.	Déclenchement	1		EL/OP
40		2022.04.05 19:41:00.423	LHC Zone 8	SR8	400V redi-auxil	ERD210/RR	Def. Mq-therm.	Déclenchement	1		EL/OP
40		2022.04.05 19:19:55.950	LHC Zone 8	SR8	400V redi-auxil	ERD216/RR	Def. Mq-therm.	Déclenchement	1		EL/OP
40		2022.04.05 19:19:55.950	LHC Zone 8	SR8	400V redi-auxil	ERD217/RR	Def. Mq-therm.	Déclenchement	1		EL/OP
30		2022.04.05 18:39:09.449	Maylin Admin	ME3	40V Redi. q/st.	ESU11*3	Promec Monitoring	Seems Sleeping	2		EL/OP
30		2022.03.25 16:31:00.328	LHC Zone 1	USA15	400V Experience	EXD3124/15A	Position disj arrivee rack Y-24-21-A1	Invalide	0		ATLAS
80		2022.03.25 16:30:30.065	LHC Zone 1	USA15	400V Experience	EXD3124/15A	Communication avec twido rack Y-24	Default	1		ATLAS
80		2022.03.23 09:36:15.643	NDT LHC Zone 5	USC35	BT 400V experience	SID14/55	Def disj 1 alim rack	Oui	1		CMS

# Supervision Layer – Network Layout



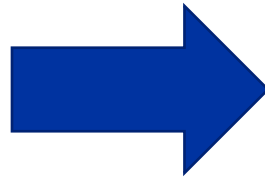
# Configuration workflow

- 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

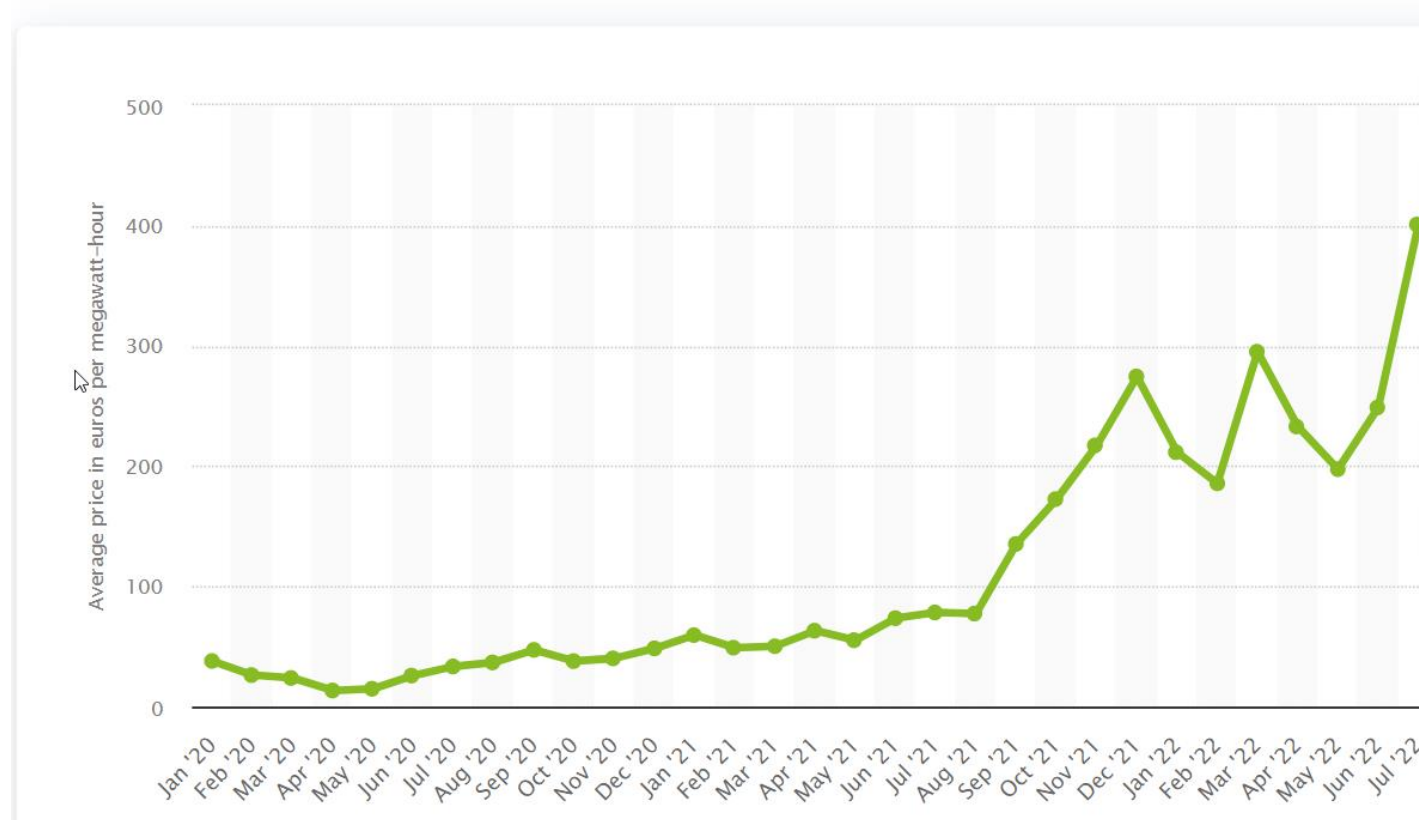


# Energy Management

# 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.**

English Edition ▾ | Print Edition | Video | Podcasts | Latest Headlines

◆ WSJ NEWS EXCLUSIVE | [WORLD](#)

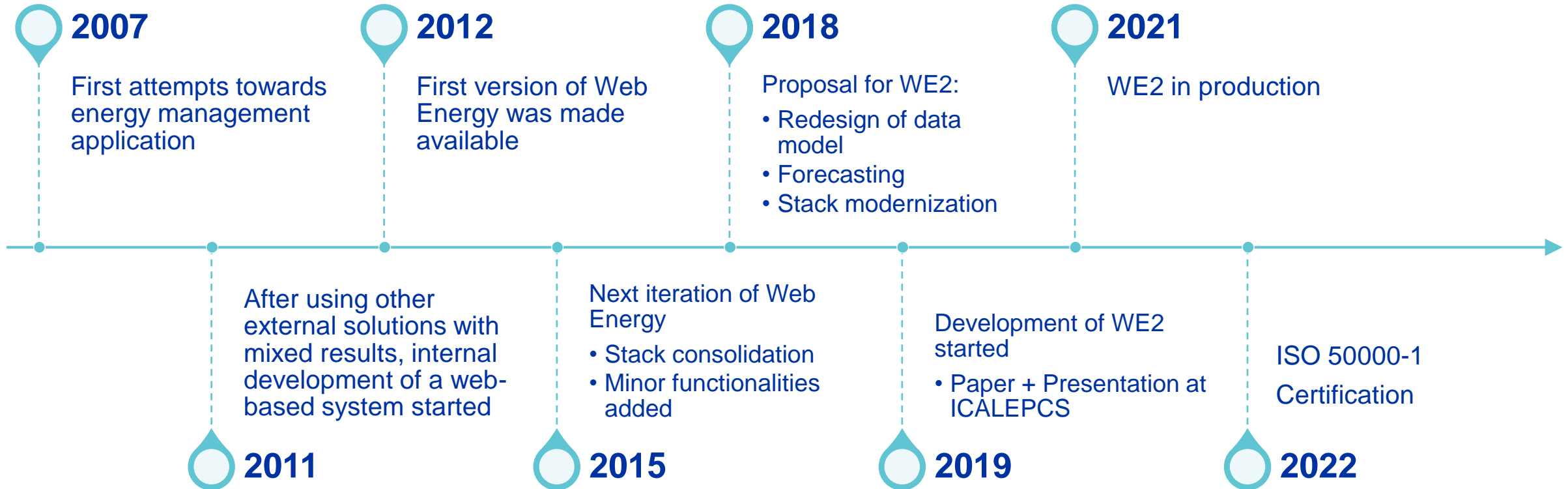
**Europe's Energy Crunch Squeezes World's Largest Particle Collider**

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

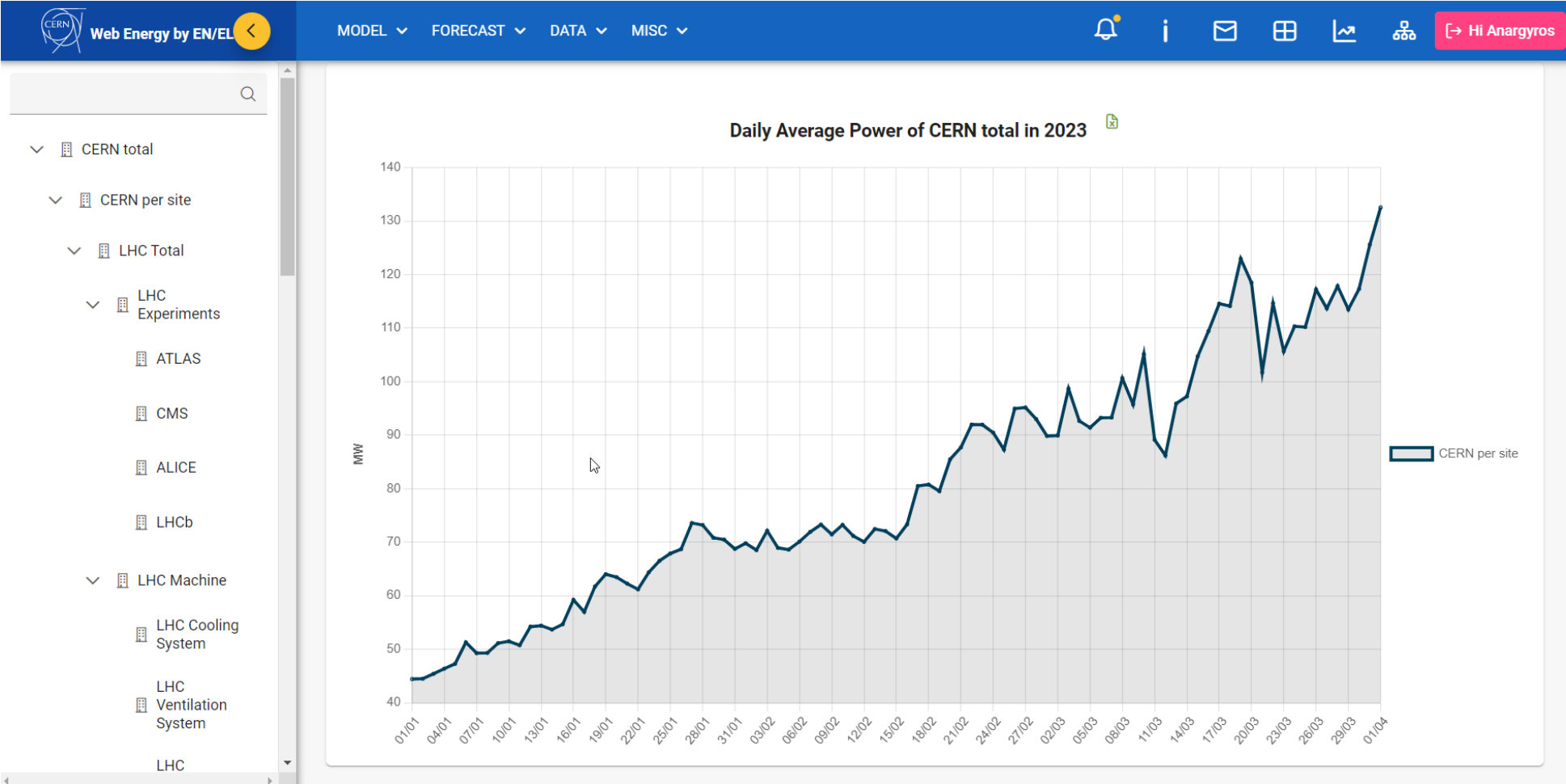
# Energy Management @ CERN - Web Energy

- 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

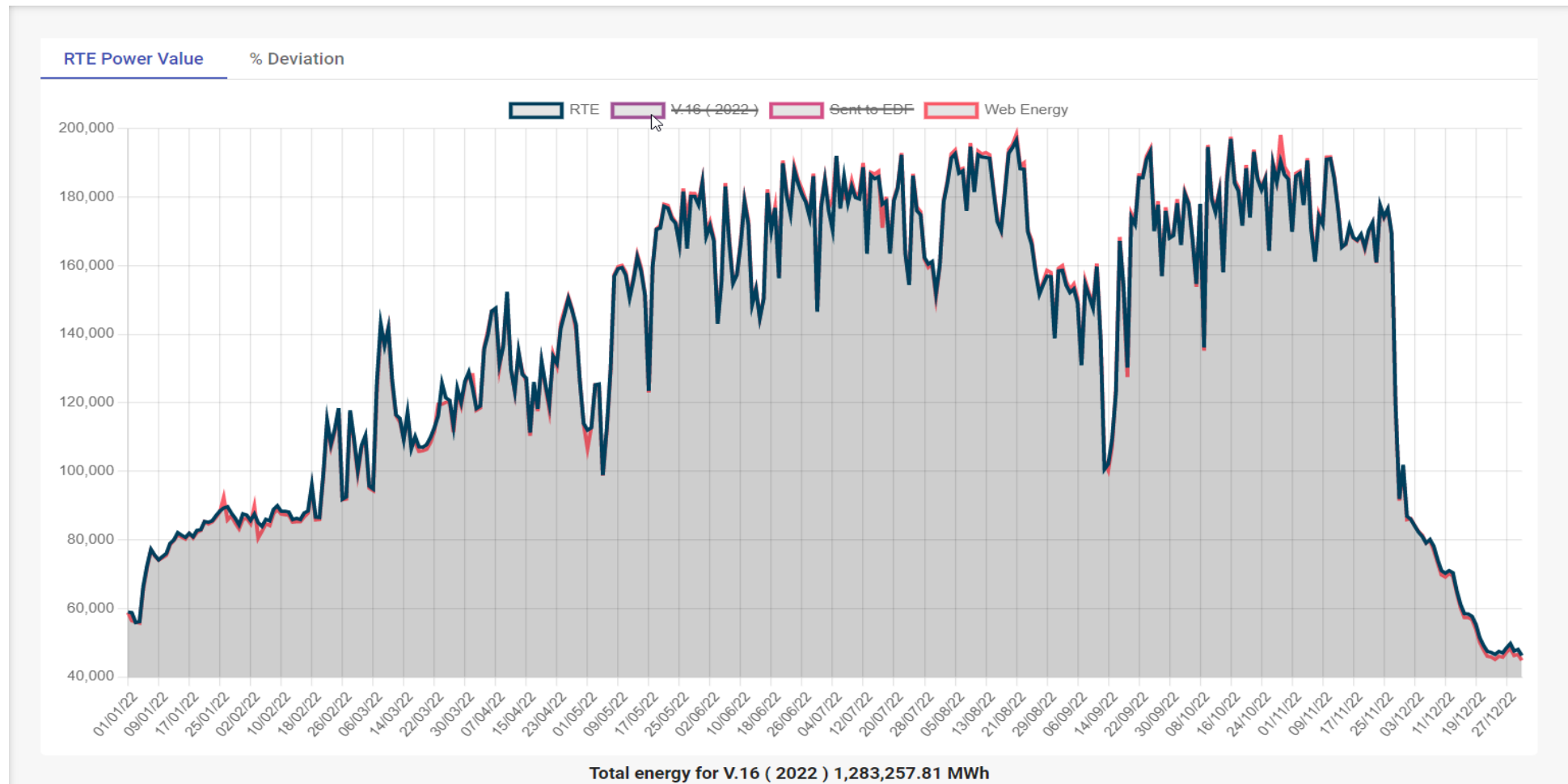
# Energy Management @ CERN - History



# 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



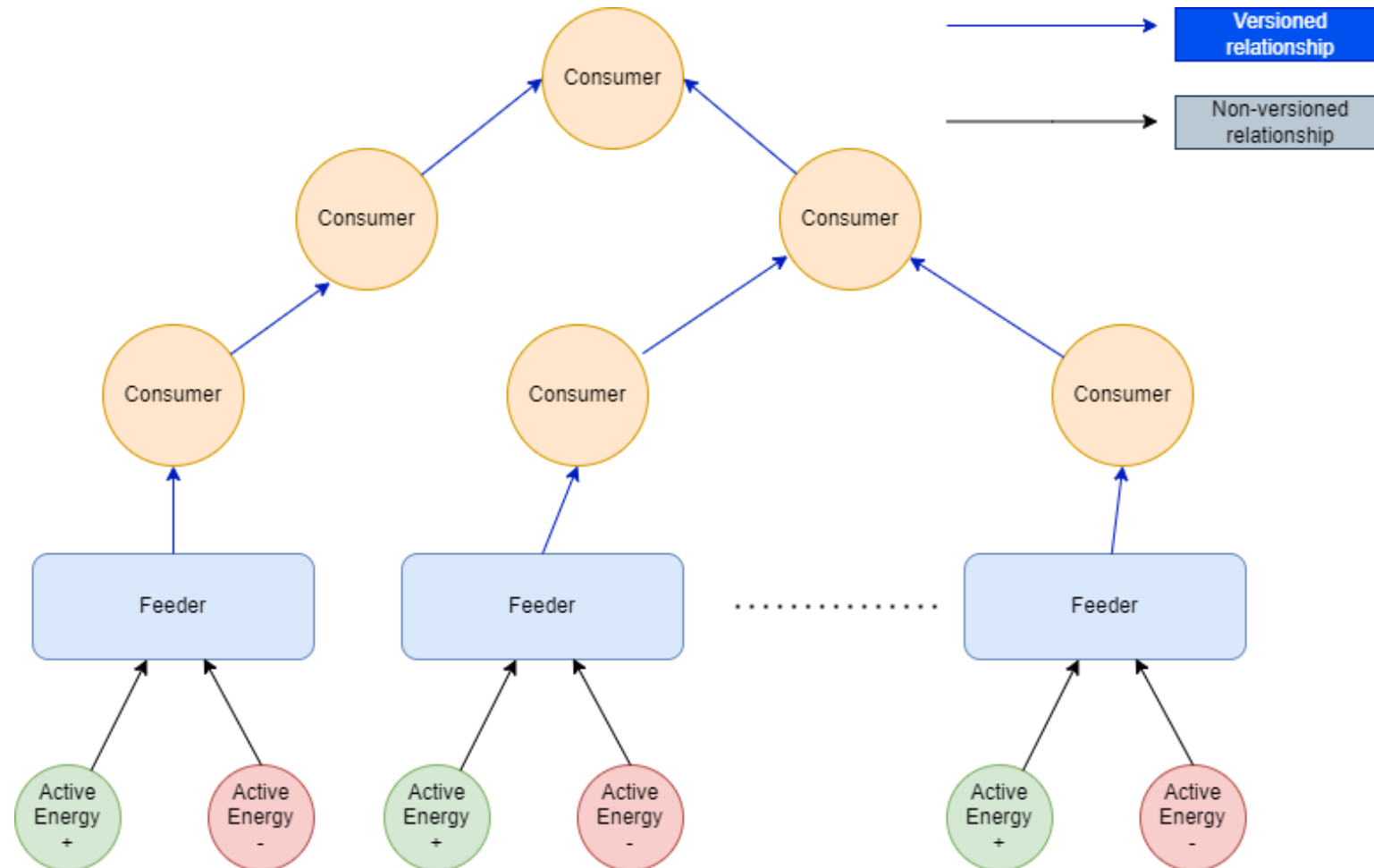


# Forecasting

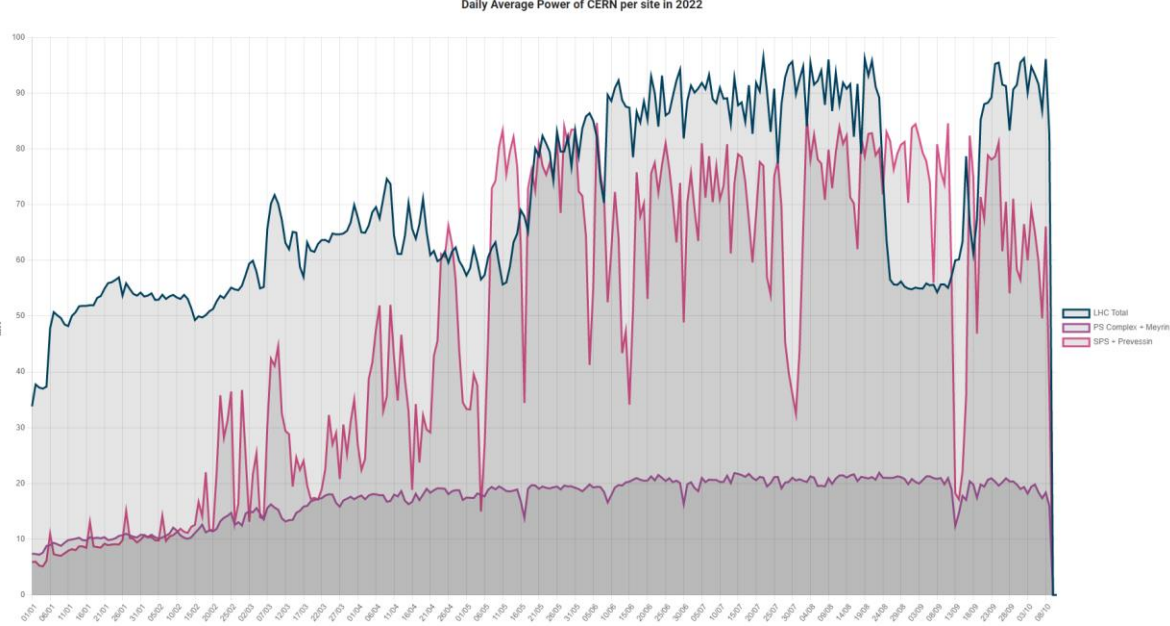
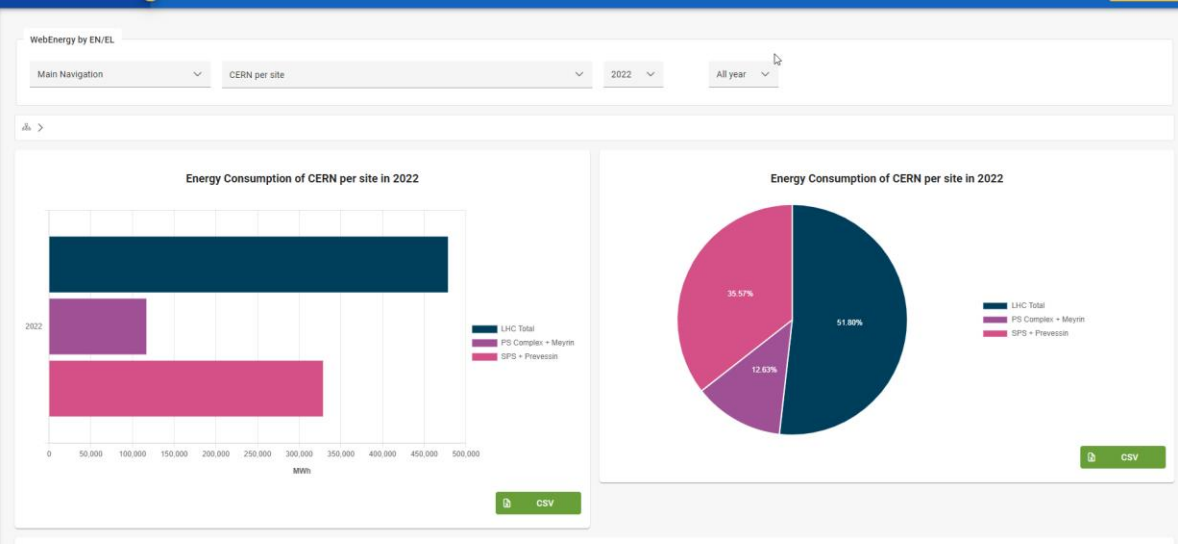
- Based on accelerator schedule
- Enables to generate different scenarios in short amount of time
- Important for strategy and decision making
- Continuously evolving and improving
- Indispensable tool for the management of the electricity contract



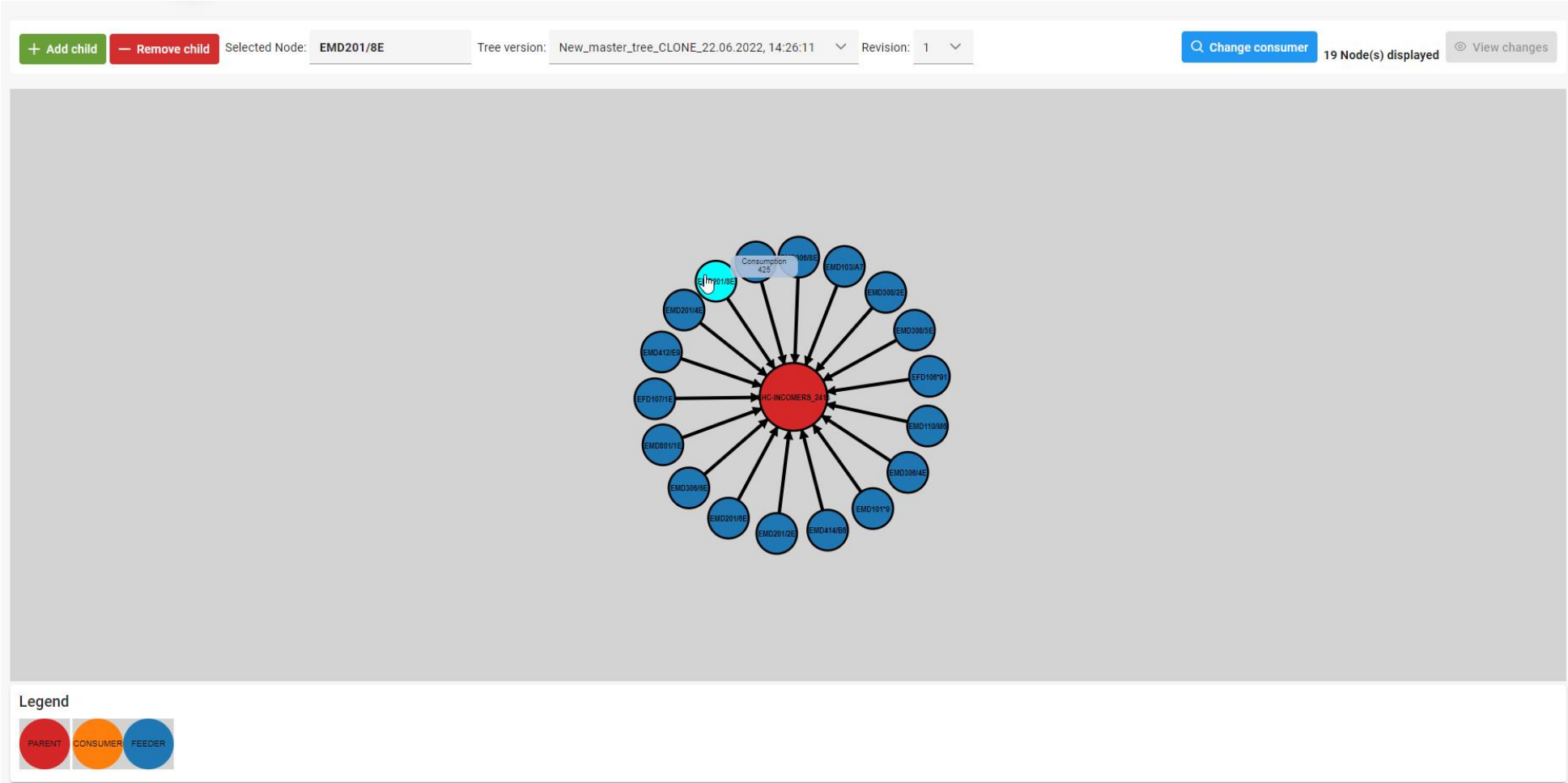
# Data model



# Dashboards

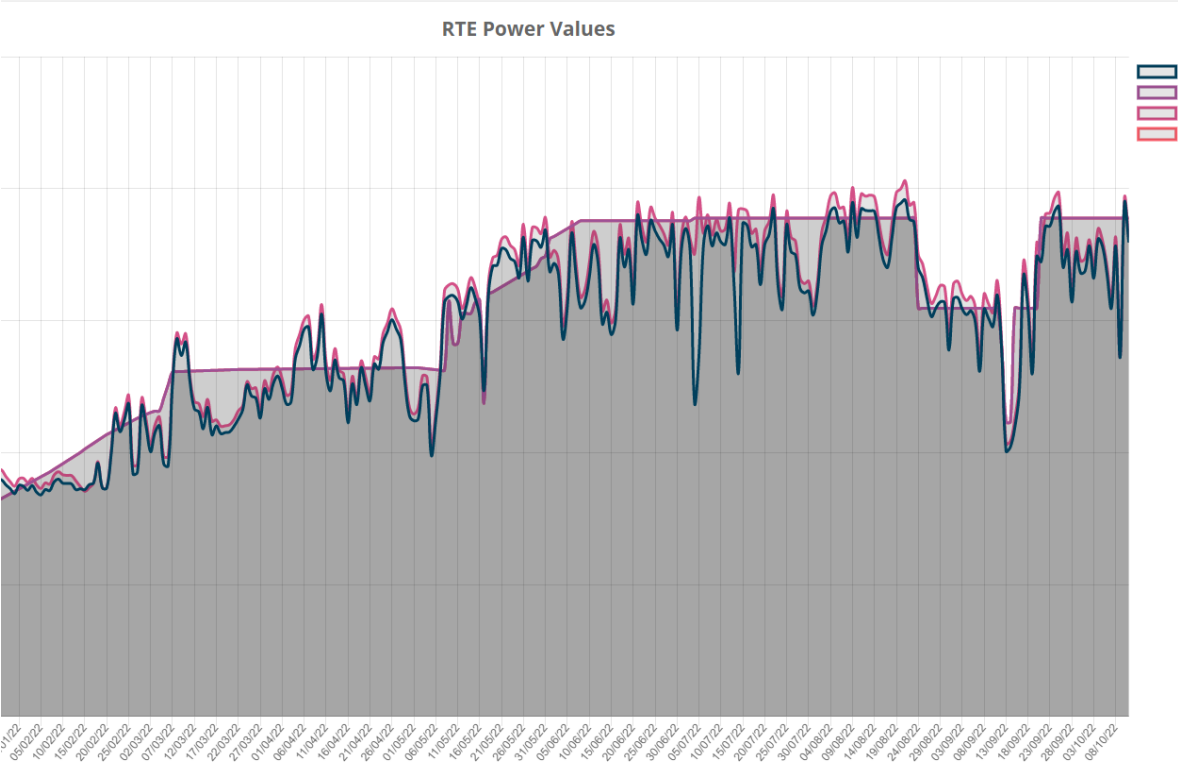


# Graphical tree editor

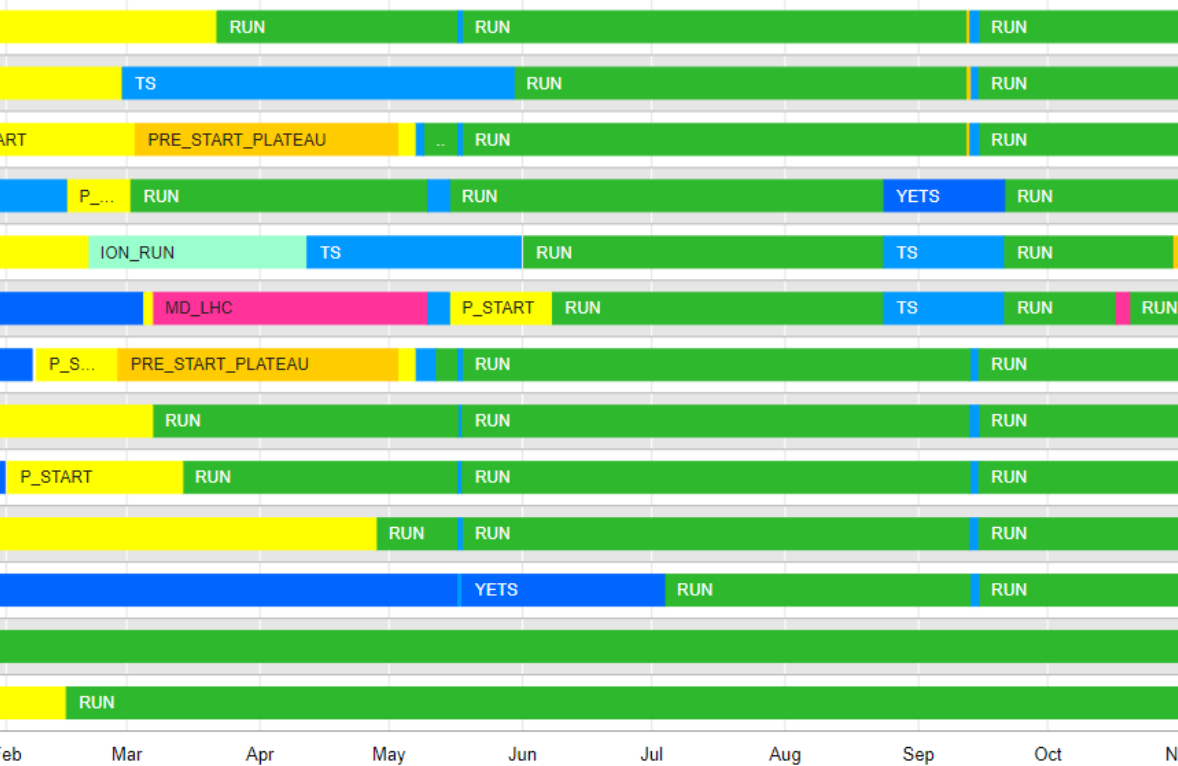


# Scenario comparison and planning

## Forecast vs Actual

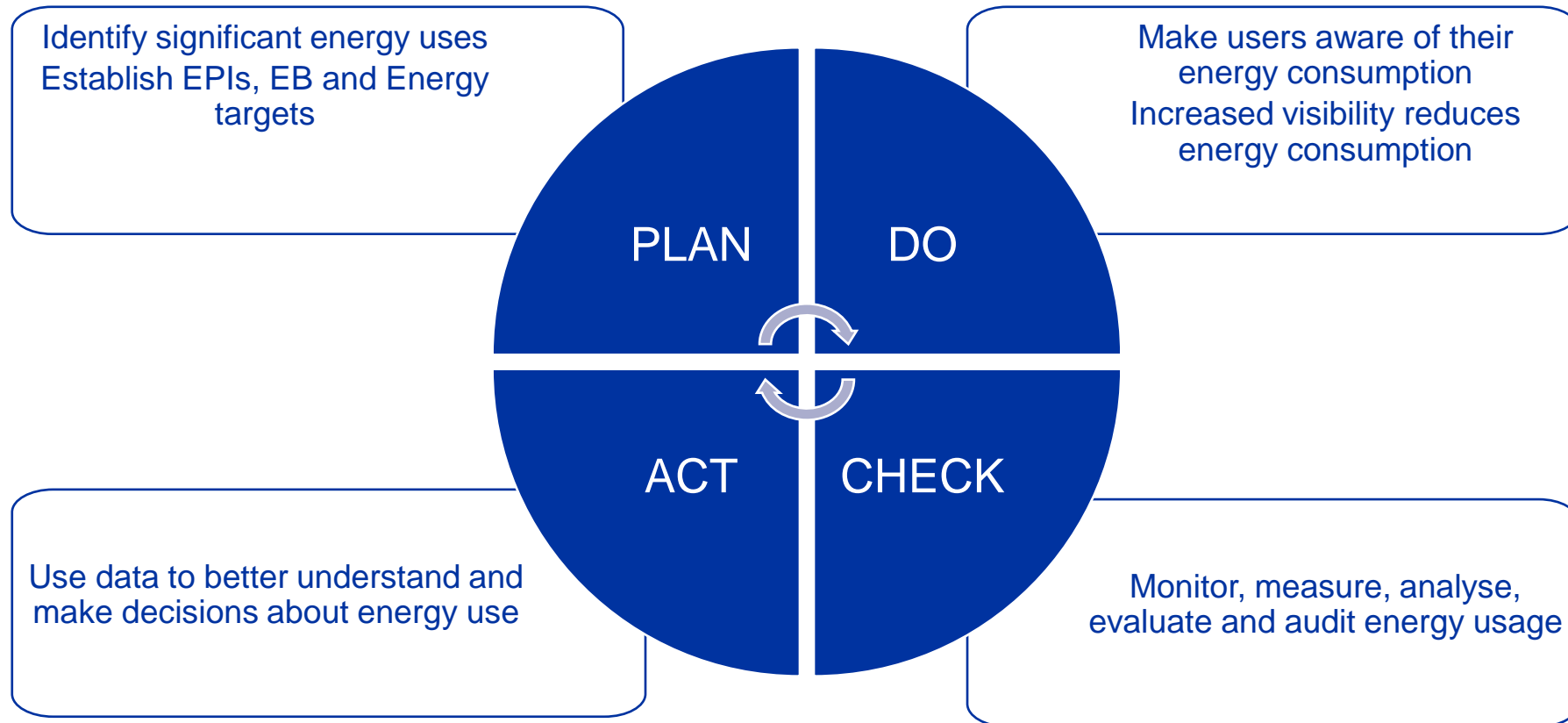


## Consumption Schedule



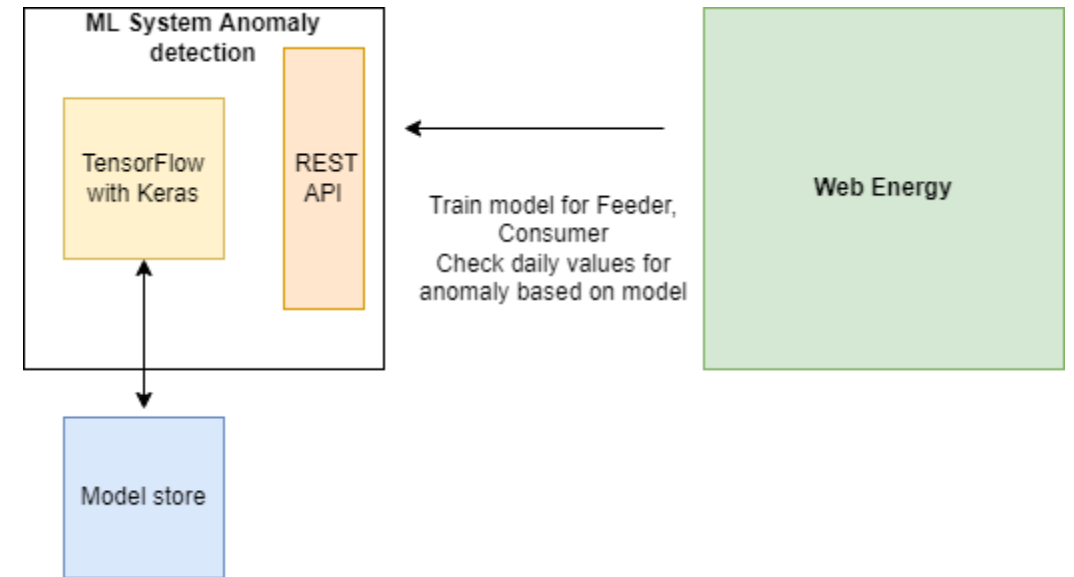
# ISO 50001

*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**

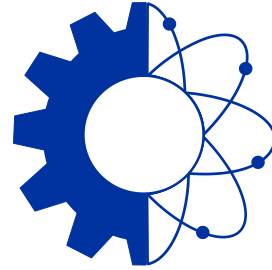
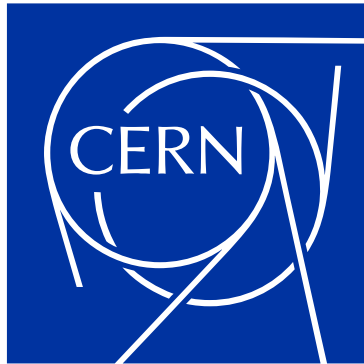


**Web Energy handles many  
aspects of the process**



**The system has been proven,  
is evolving and actively  
maintained**





**ENGINEERING  
DEPARTMENT**

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