From Energy Data to useful information for Analysis

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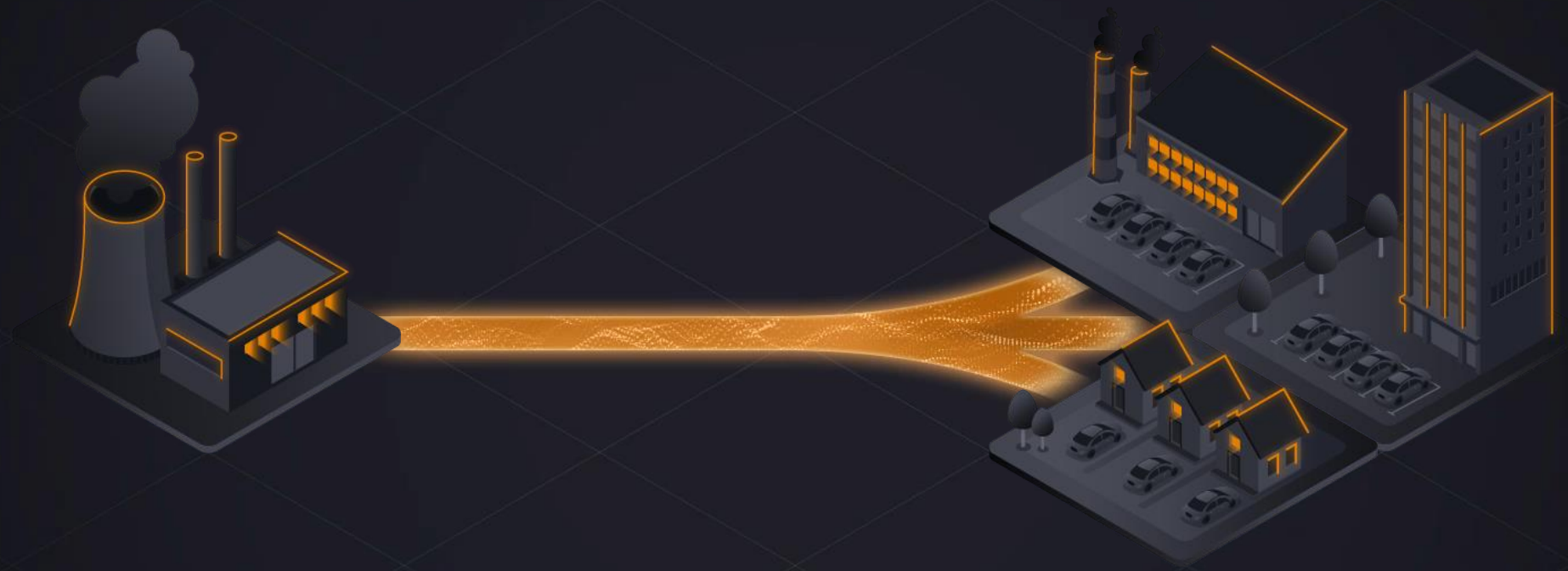
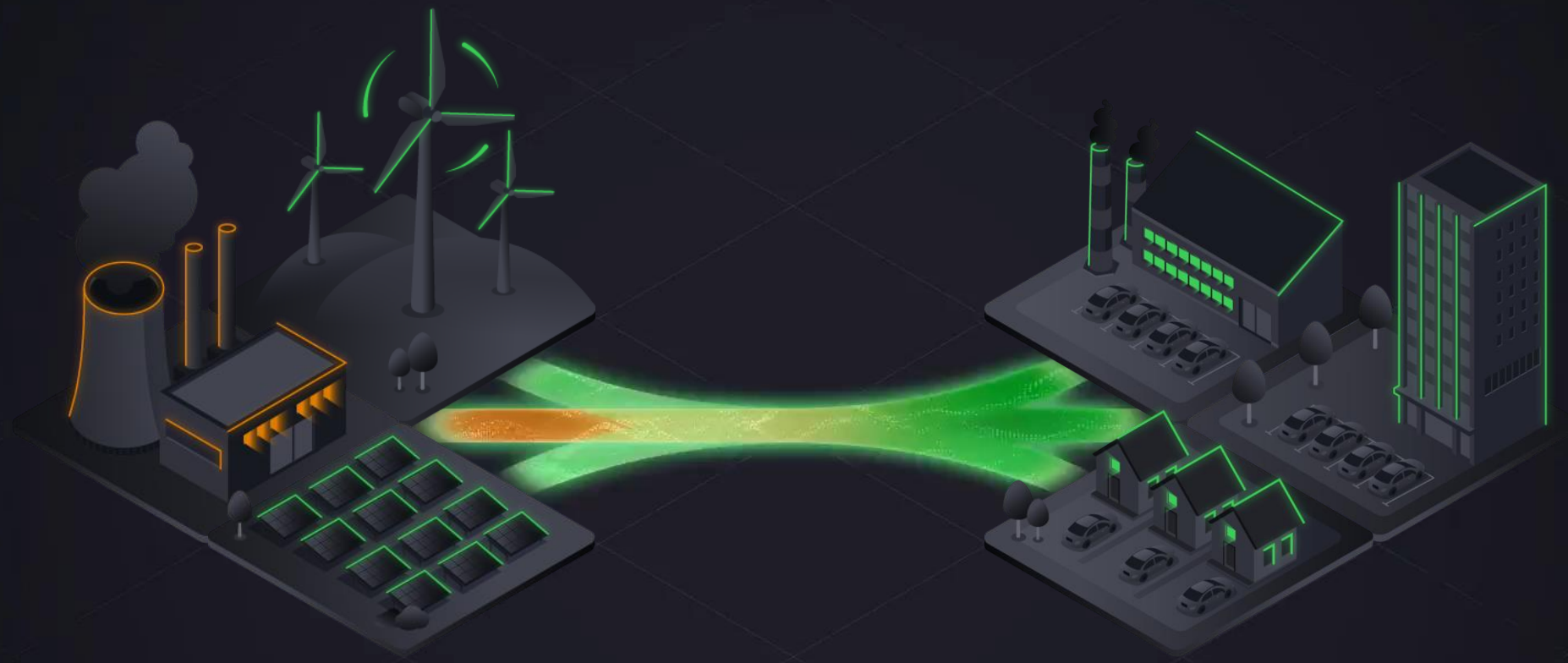
Energy Transition is a historical opportunity to reconsider the way we **produce**, **distribute** and **use energy**

Schneider Electric

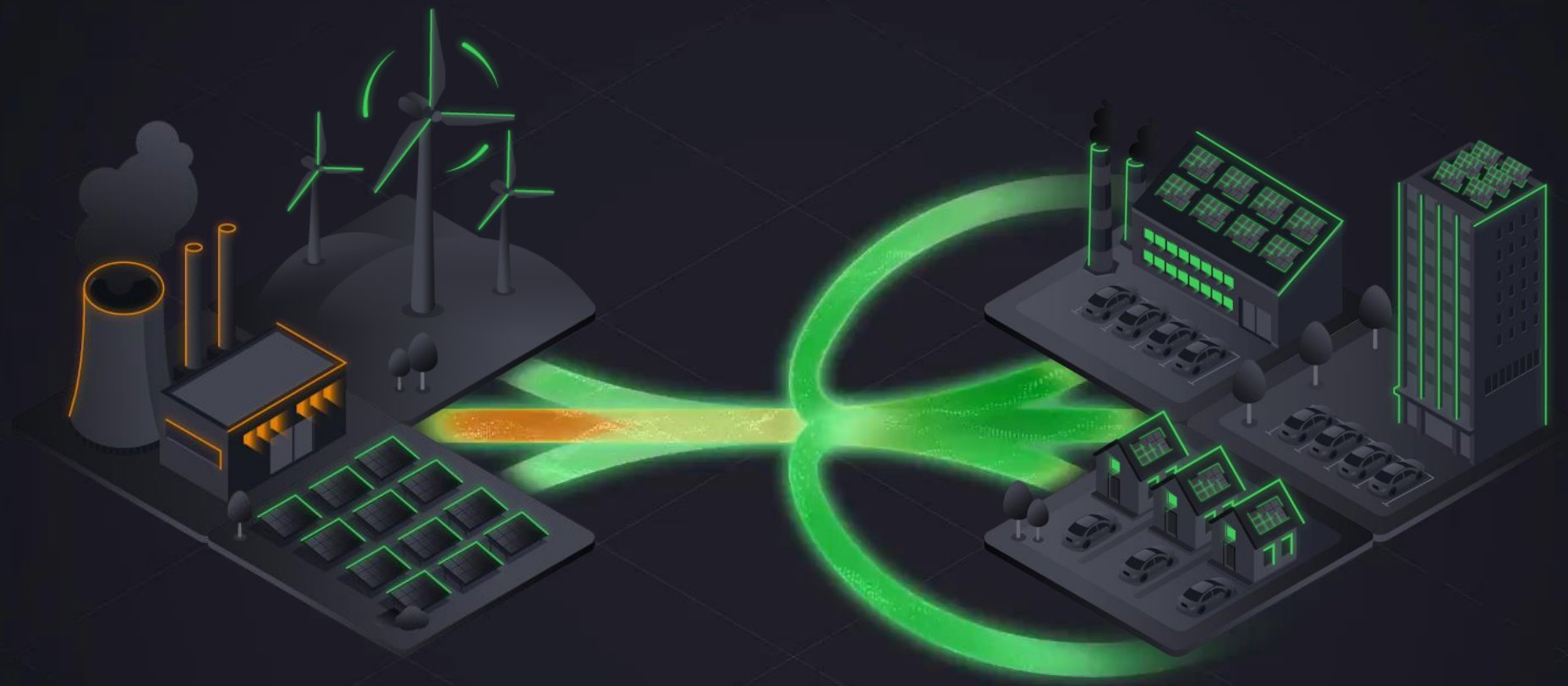
From fossil fuel generation and centralized usage



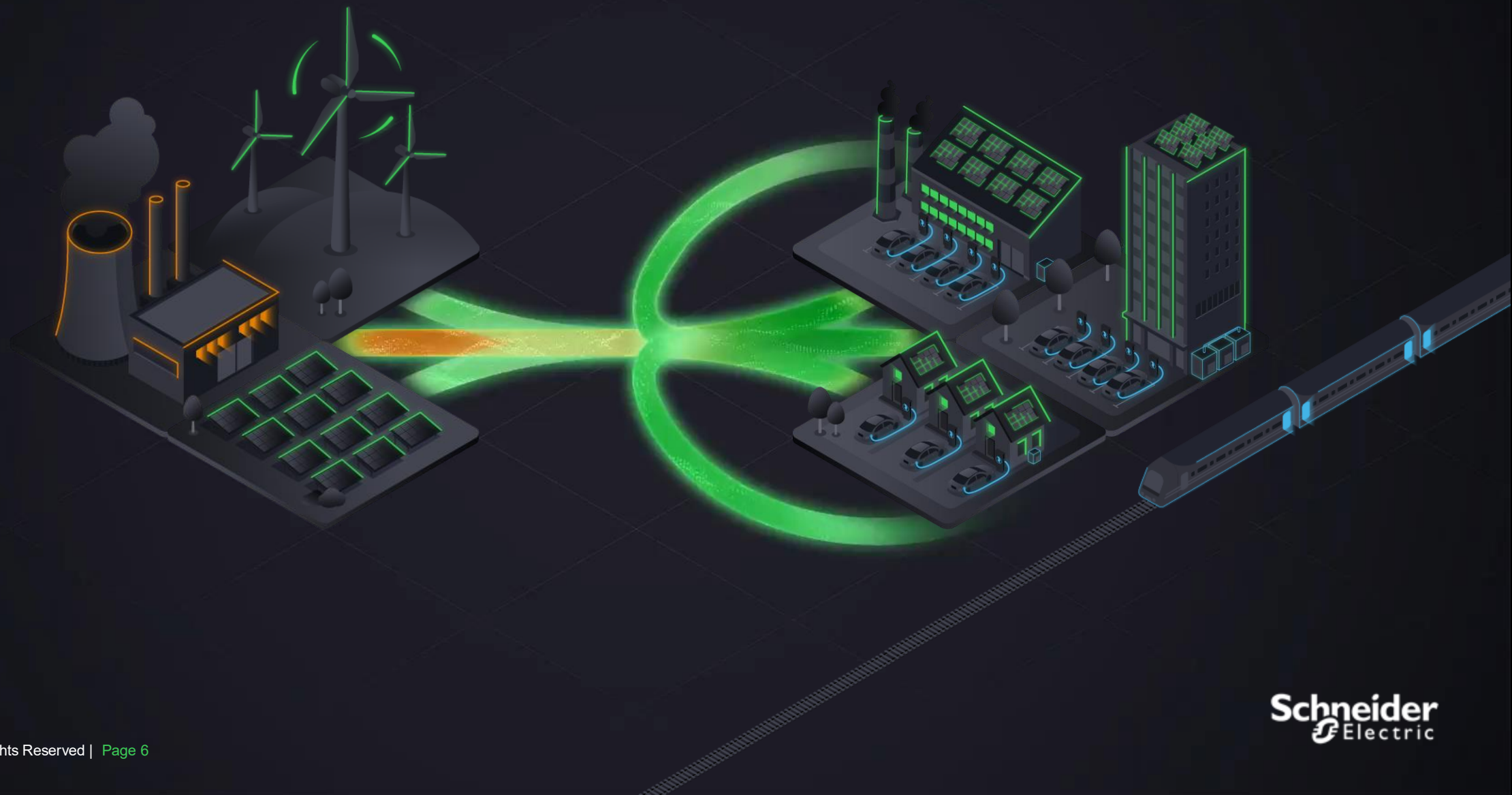
To a production of mixed energy due to renewable sources...



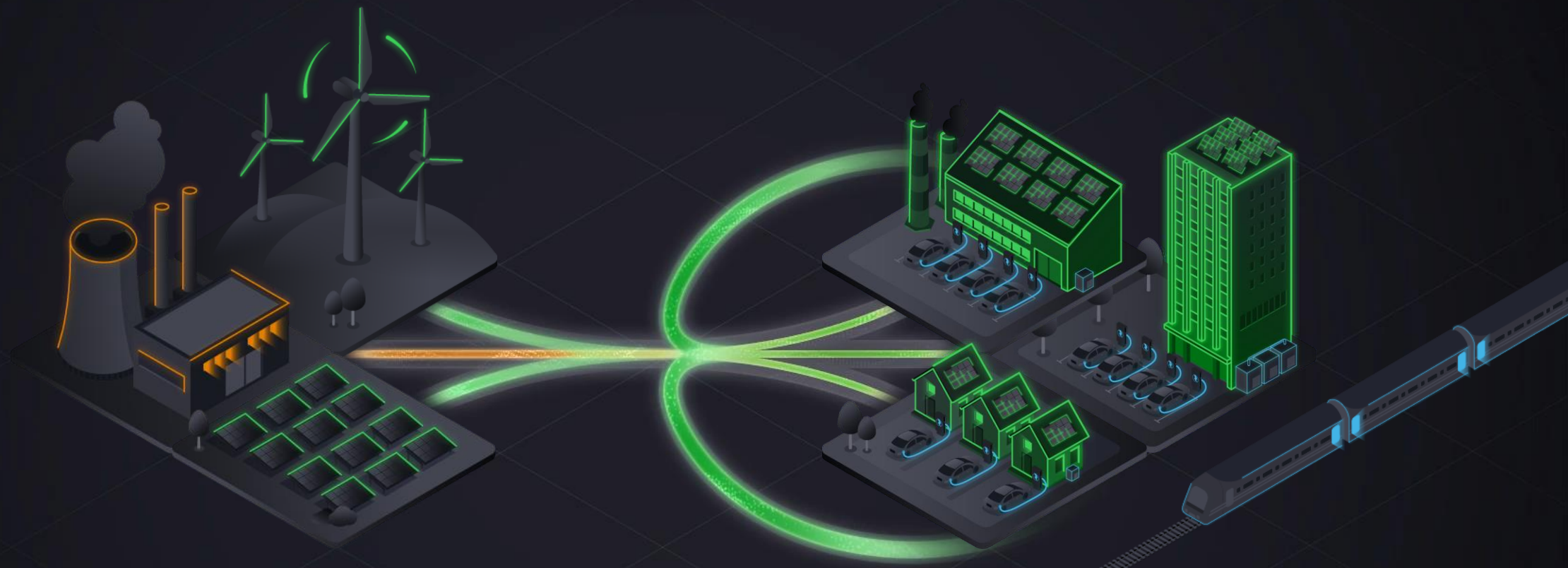
… and to prosumers, making the network bi-directional and flexible



Increasing electrification also allows us to quickly untie from fossil fuels



And thanks to digital technologies, we can reach the optimal point in demand management



Decarbonization is just a side of the coin

Renewables

Purchase of energy produced from renewables
PPA (Power Purchase Agreement)

Distributed Renewable Generation
Solar, microgrid, storage

We should look at both faces… and focus on Demand

Low Carbon Building Design
Design BIM 3D-6D to optimize choises

Measure, Monitor and Save
Interconnected systems and software for data acquisition, analysis and automation

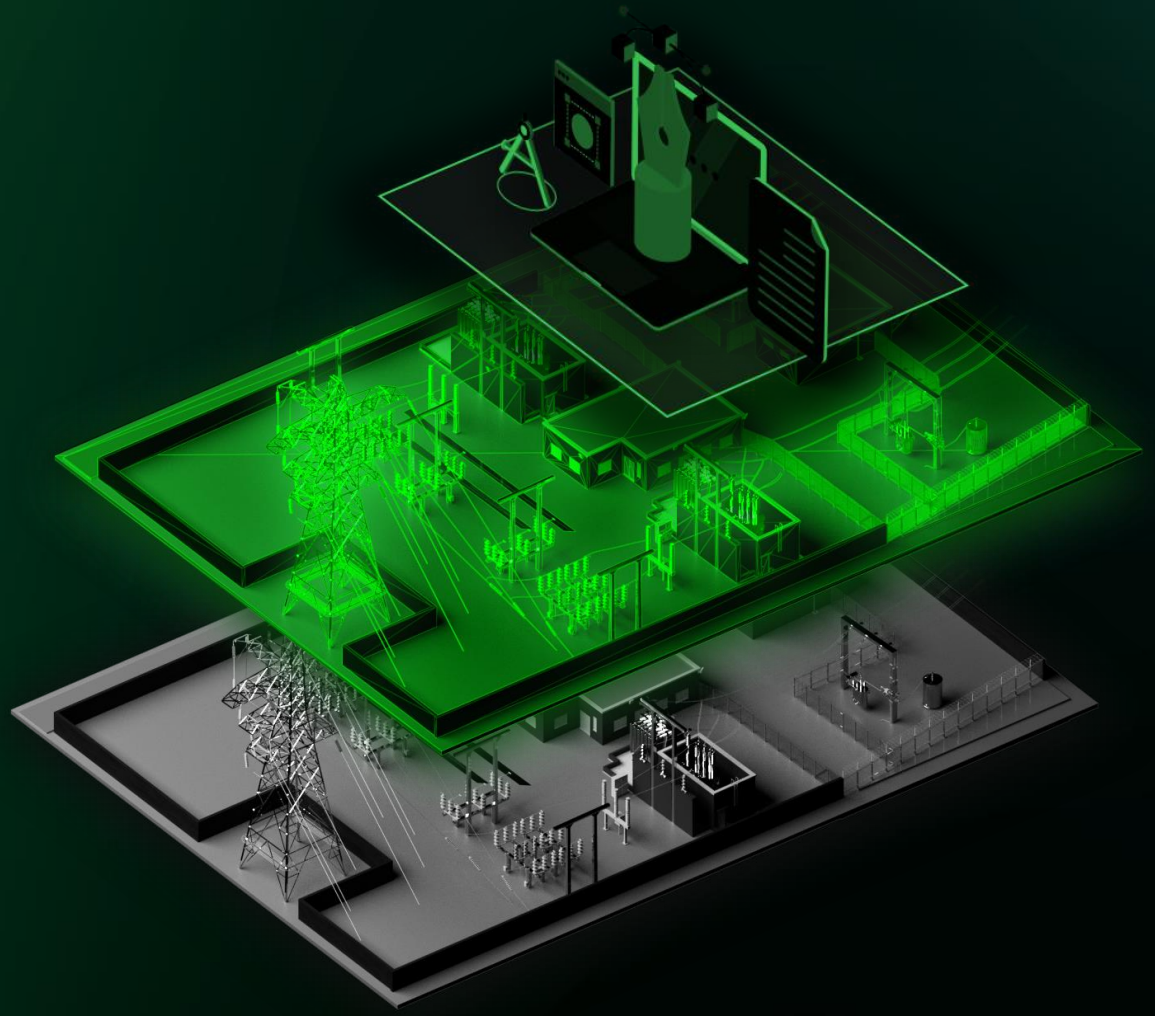
Circularity for sustainability
Green choices by design, with extended useful life, efficient use, and clear end-of-life process

Electrification
From transportation to heating to industrial processes...Reducing fossil fuels through electric transition

Reduction
Due to Energy and Operational Efficiency

Electrification
Processes

The importance of starting from good quality Data



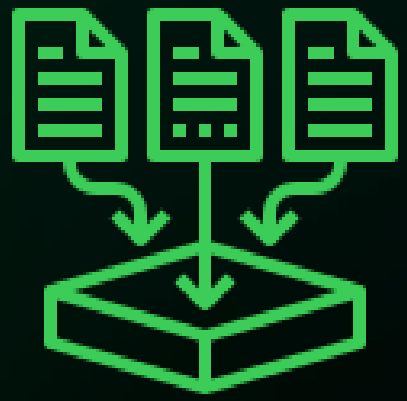
Why is starting from good quality data important for any analysis?

Scan Me

Why we need data?

Data describe the reality
Data is the only way to observe, measure, comprehend the reality

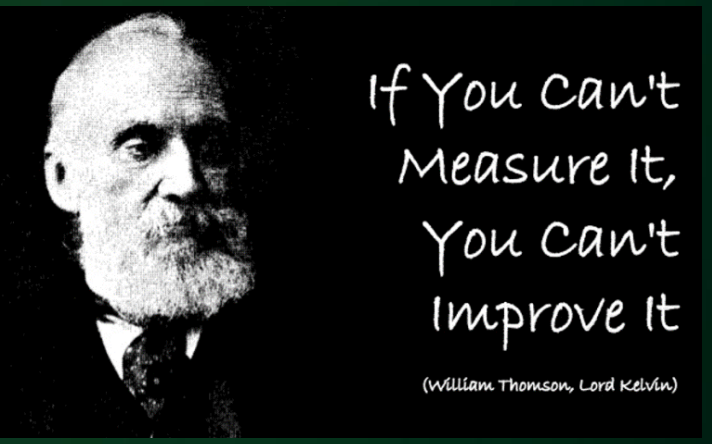
Data transforms perceptions into evidences
Everyone has different opinions, only data can provide certainties

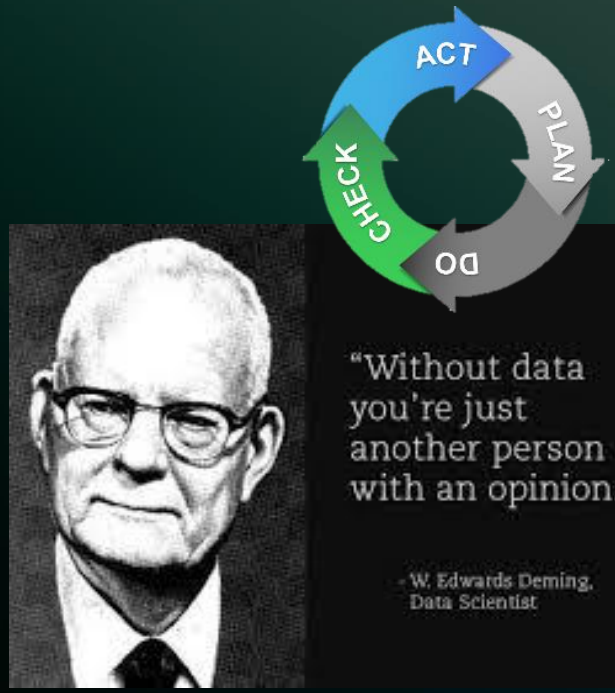


Data gives control
Without data you're reactive. Thanks to data you act in advance

Data reduces costs and improve performance
Data helps to take the best choices

Where to start?





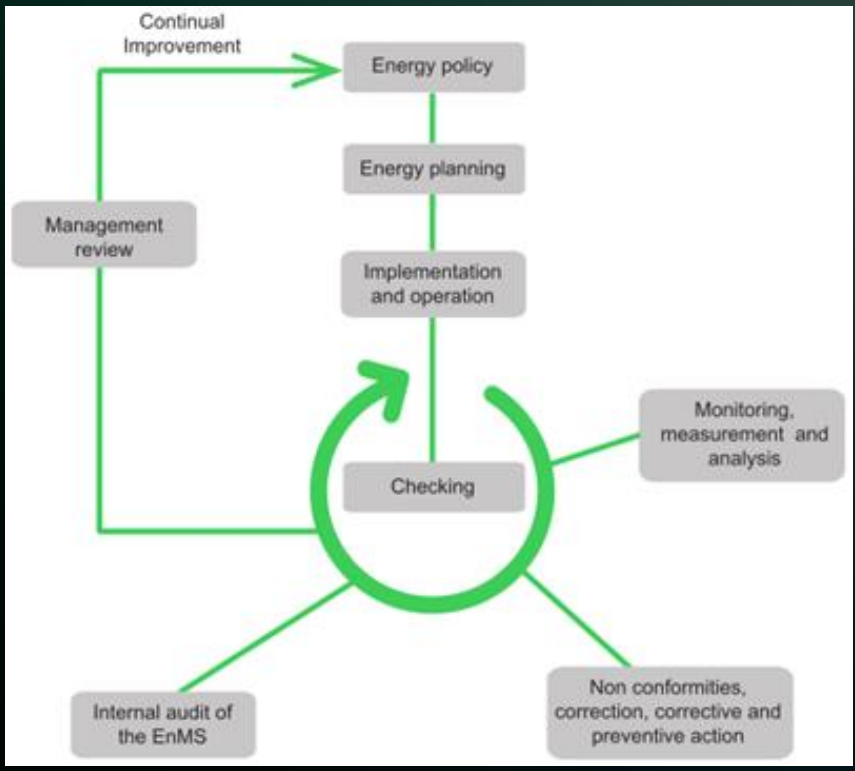
Deming Cycle or PDCA

The basis of ISO50001

Why is ISO50001 so important?

An energy management system allows you to:

- Take a systematic approach geared toward continuous improvement
- Identify opportunities for improvement in energy use
- Reduce energy consumption costs
- Obtain tax breaks and comply with regulatory requirements



ISO 50001 ENERGY MANAGEMENT

TÜVRheinland CERTIFIED
Energy Data Management System
Regular Surveillance
www.tuv.com
ID 0000043069

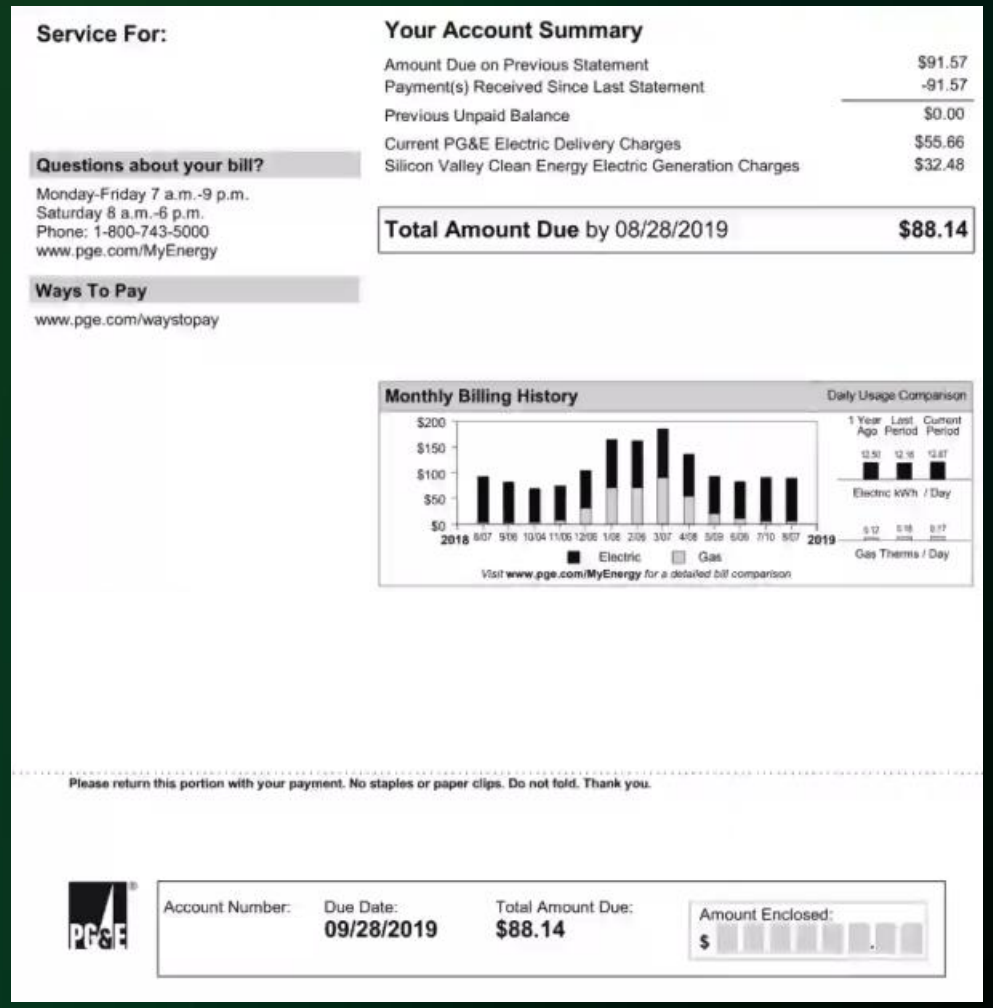
Examples of requirements to be met for ISO 50001 certification

- 6.3 a), b), c) Energy review
- 6.4 Energy performance indicators
- 6.5 Energy baseline
- 9.1.1 Monitoring, measurement, analysis and evaluation of energy performance and the EnMS
- 9.3.2 c) Management review

Schneider Electric

Data is important in every situation

Energy billing data



Service For:

Your Account Summary

Amount Due on Previous Statement	$91.57
Payment(s) Received Since Last Statement	-91.57
Previous Unpaid Balance	$0.00
Current PG&E Electric Delivery Charges	$55.66
Silicon Valley Clean Energy Electric Generation Charges	$32.48

Total Amount Due by 08/28/2019 **$88.14**

Questions about your bill?

Monday-Friday 7 a.m.-9 p.m.
Saturday 8 a.m.-6 p.m.
Phone: 1-800-743-5000
www.pge.com/MyEnergy

Ways To Pay

www.pge.com/waystopay

Monthly Billing History

Daily Usage Comparison

$200
$150
$100
$50
$0

2018 8/07 9/06 10/04 11/06 12/06 1/08 2/06 3/07 4/08 5/09 6/09 7/10 8/07 2019

Electric Gas

1 Year Ago | Last Period | Current Period

Electric kWh / Day

Gas Therms / Day

Visit www.pge.com/MyEnergy for a detailed bill comparison

Please return this portion with your payment. No staples or paper clips. Do not fold. Thank you.

PG&E

Account Number:

Due Date: 09/28/2019

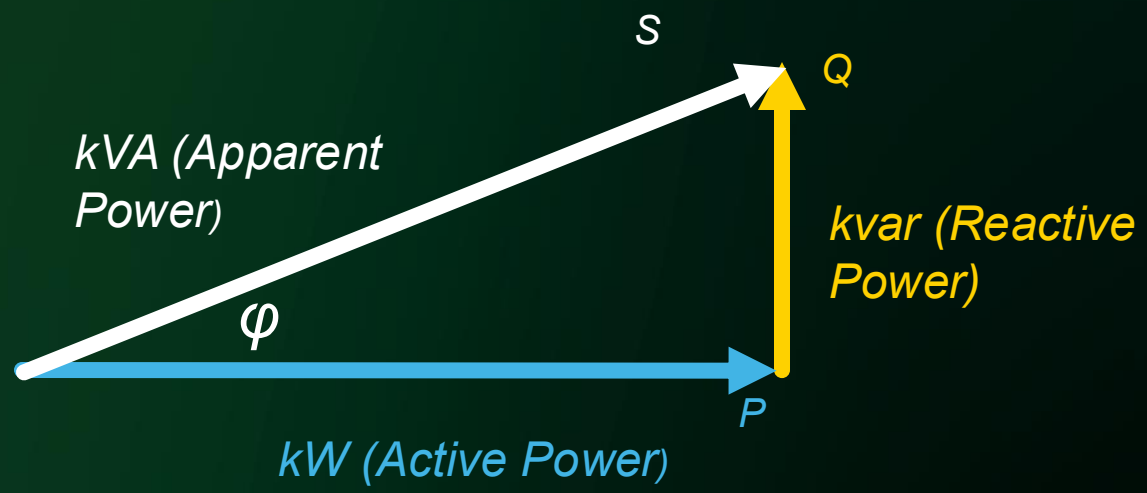
Total Amount Due: $88.14

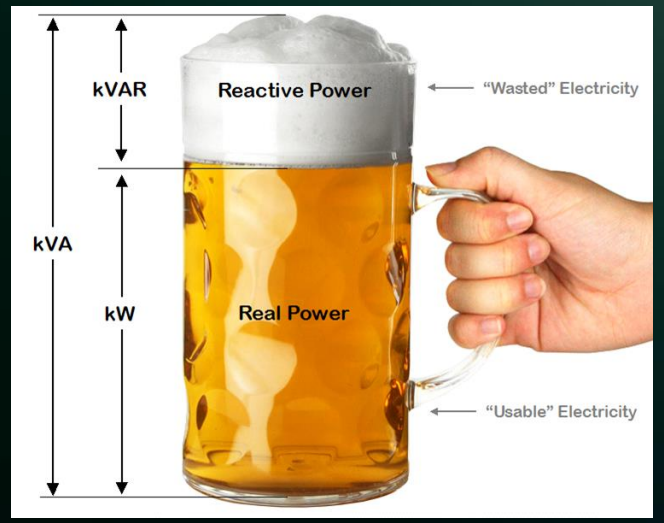
Amount Enclosed: $

1. Electrical Energy consumption (kWh)
2. Natural Gas consumption (m^3)
3. Water consumption (m^3)
4. Power Factor

Power Factor

Power Triangle





POWER FACTOR (PF): $\cos\varphi = \frac{P}{S} = \frac{kW}{kVA}$

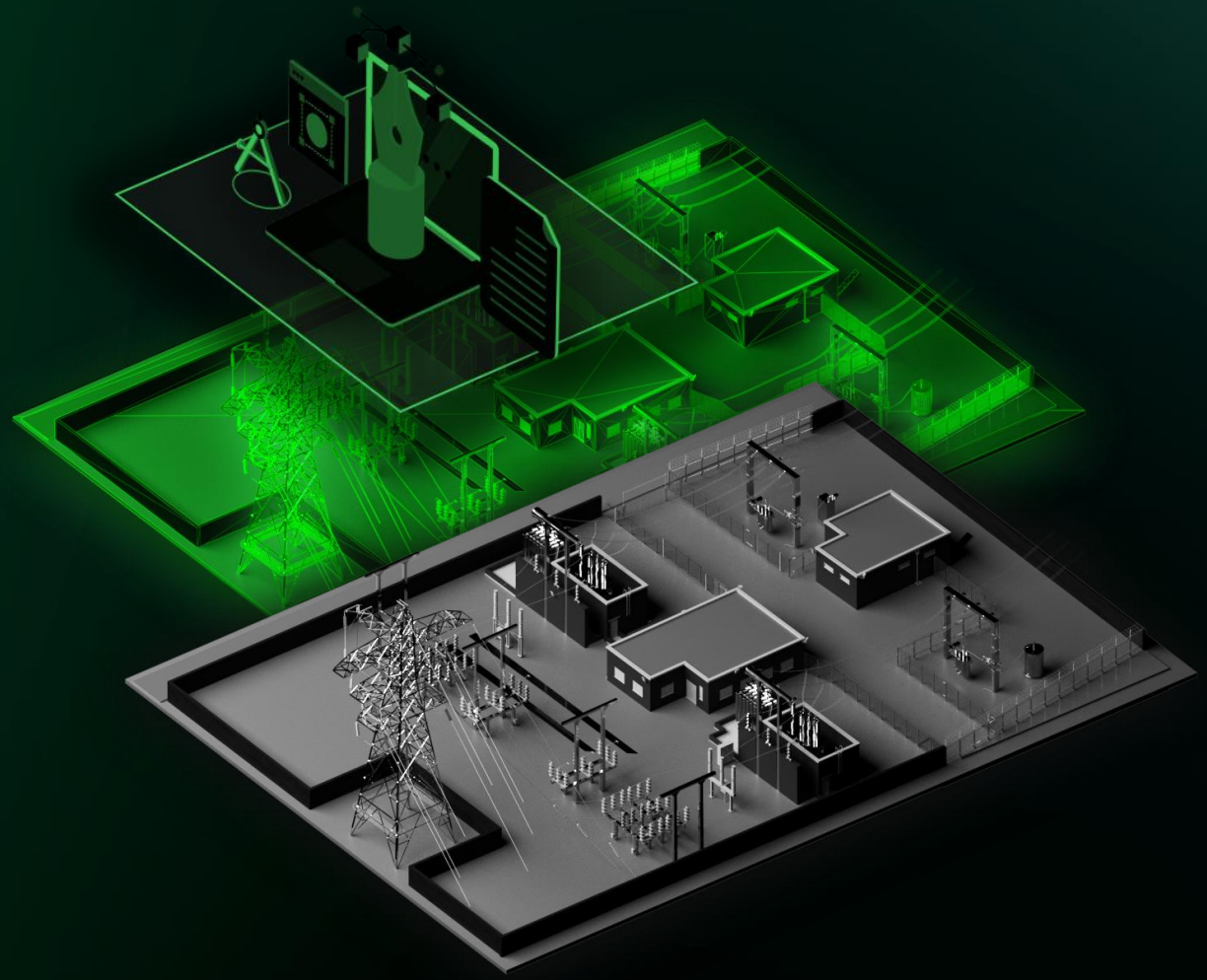
In Italy, electric utilities apply financial penalties when customers operate with a power factor below the regulatory threshold (0,95), as low power factor increases losses and reduces the overall efficiency of the distribution network

Energy Manager

The Energy Manager is the professional responsible for monitoring, managing and optimizing an organization's energy consumption. It supports the company in reducing costs, waste and environmental impacts, contributing to sustainability goals.

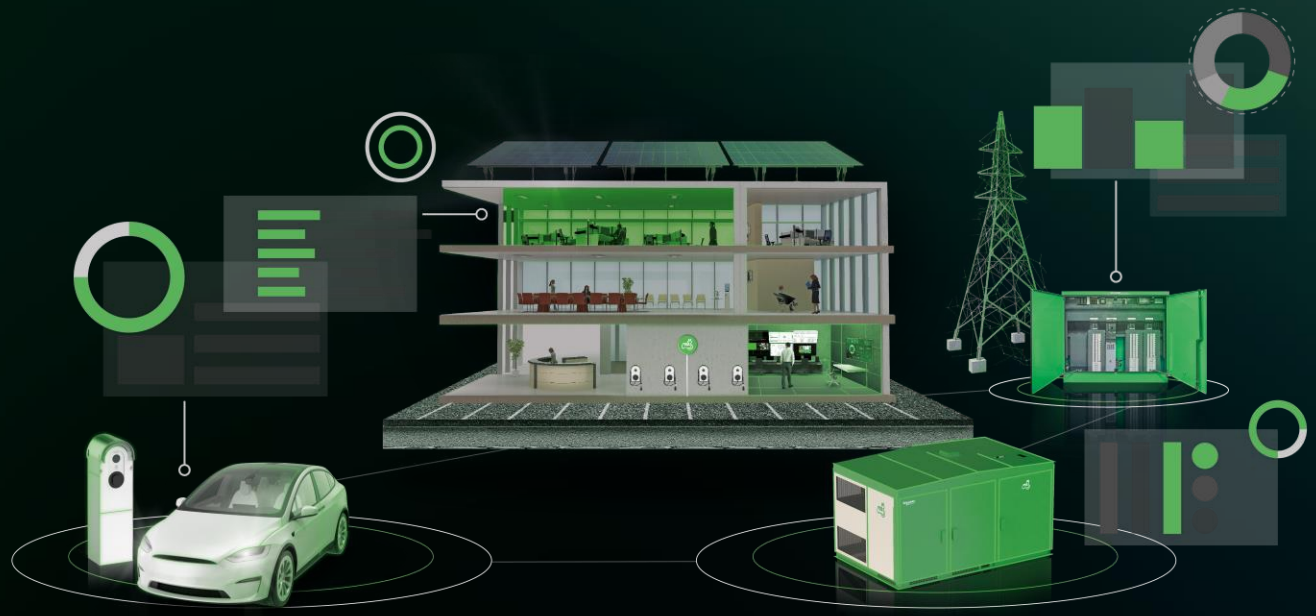
1. **Consumption monitoring:** analyzes energy data, inefficiences and controls consumption trends
2. **Energy efficiency plans:** proposes and implements interventions to reduce waste and improve energy performance
3. **Cost optimization:** Identify opportunities to lower energy expenditure through targeted strategies
4. **Corporate sustainability support**: contributes to the definition and achievement of decarbonization goals

Basic Principles of Energy Management

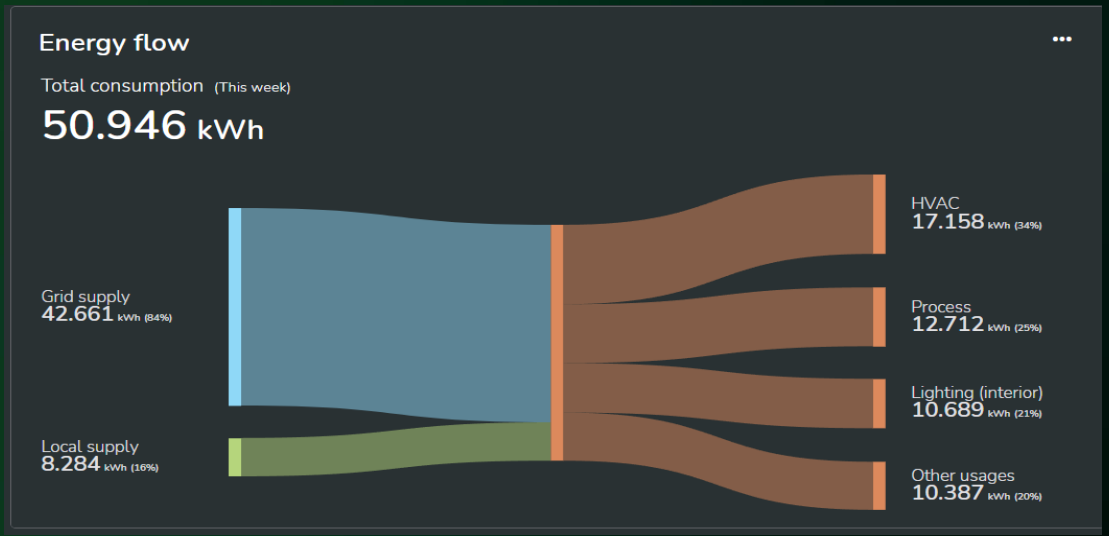


Basic Principles of Energy Monitoring

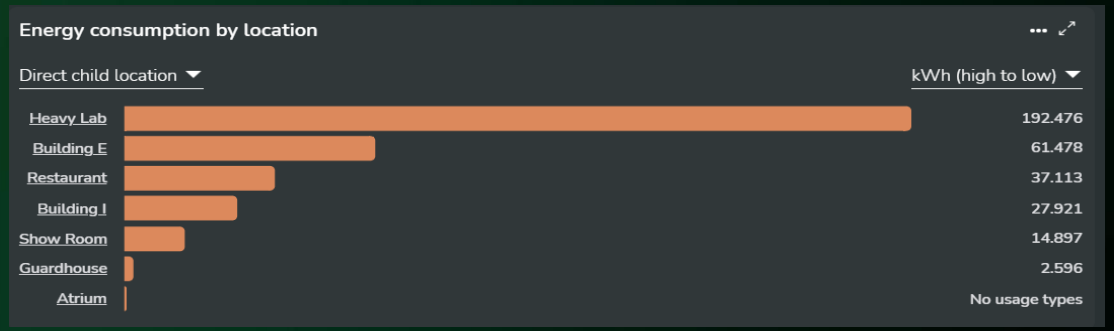
- Allocation of Energy Consumption
- Data relation
- Period–by-Period Analysis
- Normalization & KPIs
- Benchmark
- Load Profile Analysis

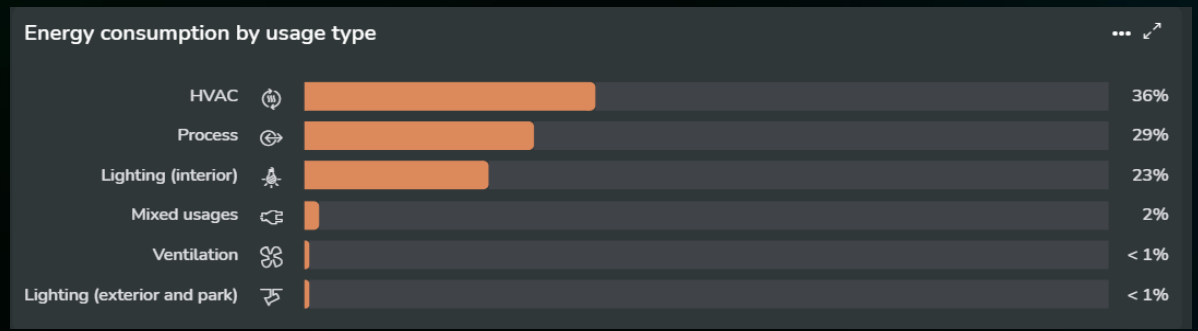


Allocation of Energy Consumption

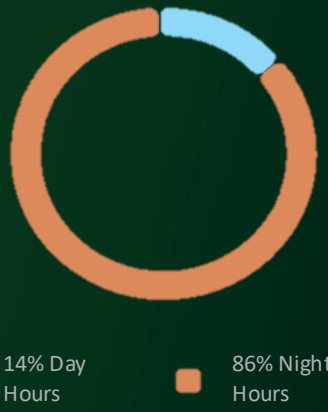


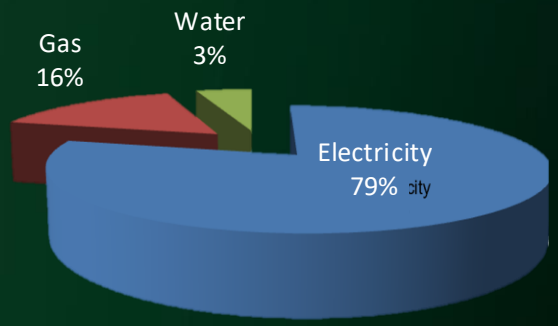
The allocation of energy consumption is crucial in energy monitoring as it enables organizations to **identify inefficiencies, optimize resource usage, and reduce costs while promoting sustainable practices**



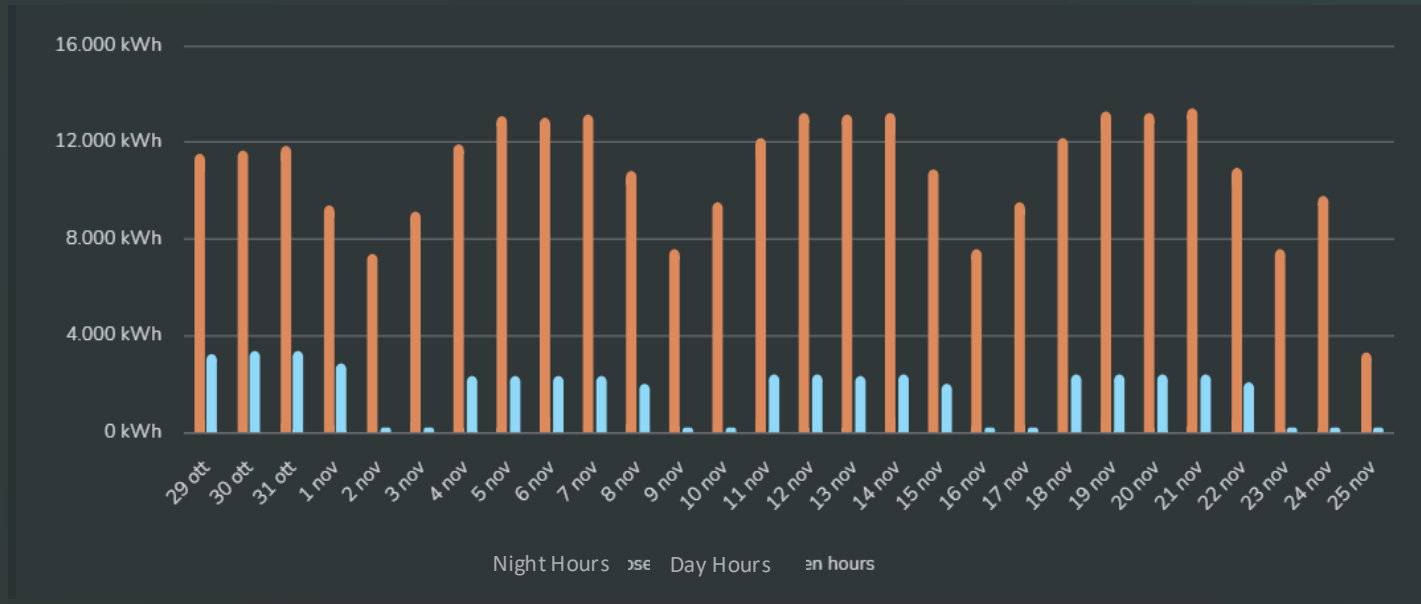


Allocation of Energy Consumption



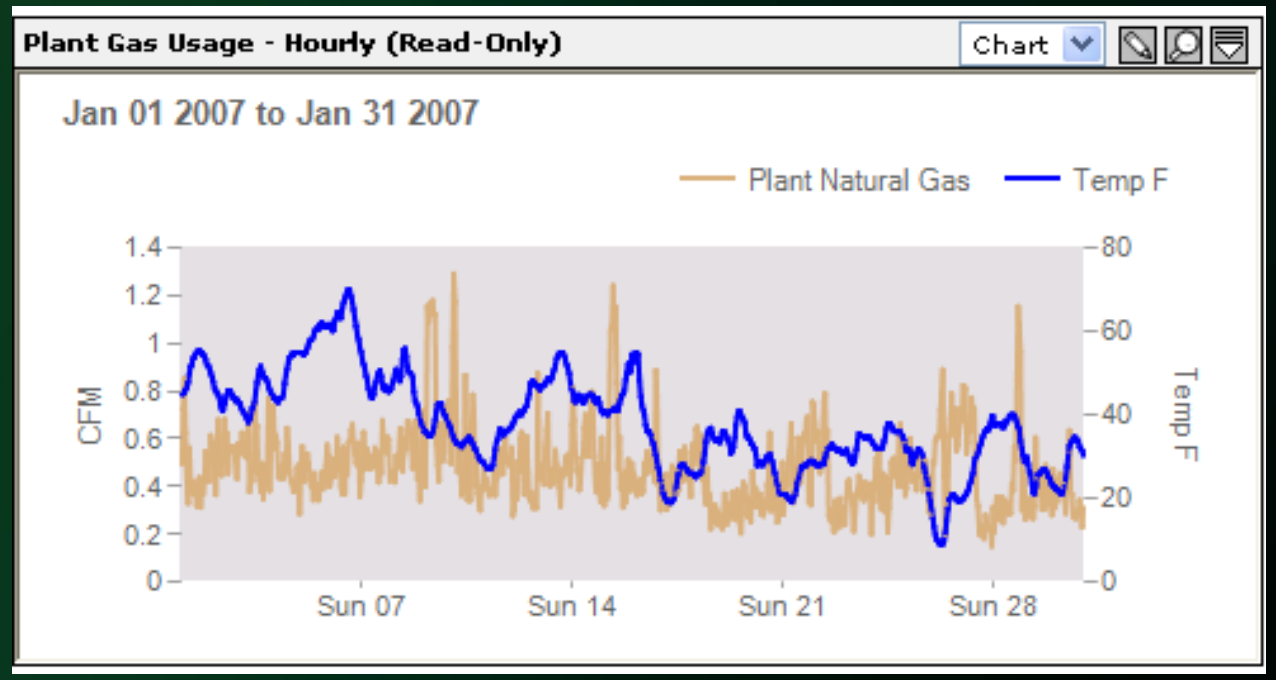


Allocating consumption **by type, hours** etc gives us information to be able to identify consumption spikes, due to operational inefficiencies or improvable through the introduction of best practices



Data Relation

Trends of 2 measurements can be compared related to a timeline



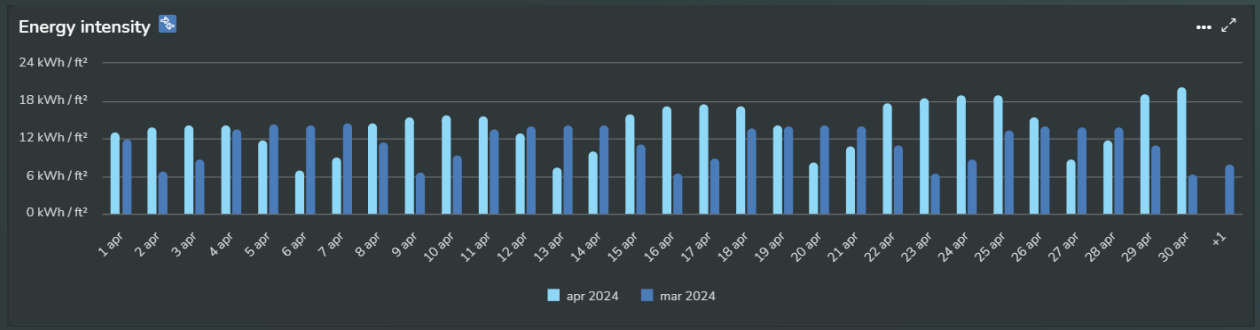
Relation between gas consumption and external temperature

→ Identify **Relation between Quantities**

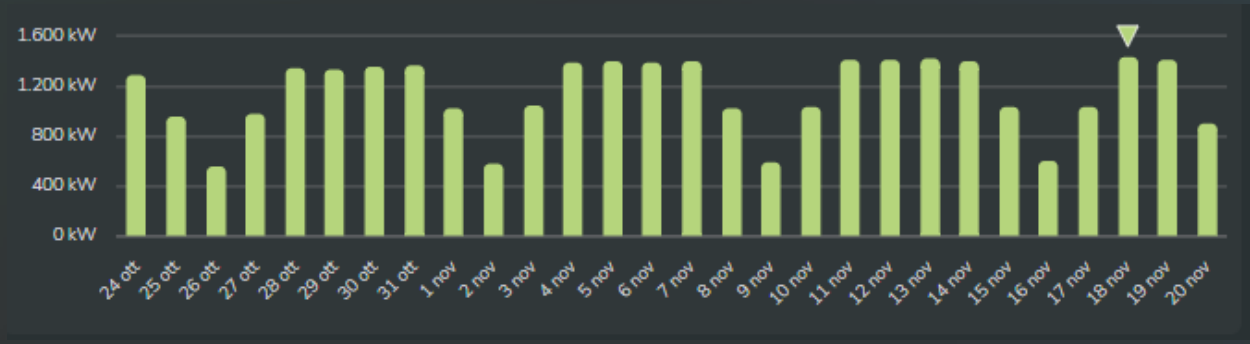
→ Understand **Cause and Effect**: can highlight the relationships between events, helping to determine how one event may influence another.

Period-by-Period Analysis

Period-by-Period Analysis allows identification of also temporary inefficiencies



Analyzing Absorption Peaks, in relation to those of previous periods, also makes it possible to **identify patterns** and consequently go on to study their origin in order to **implement efficiency plans**



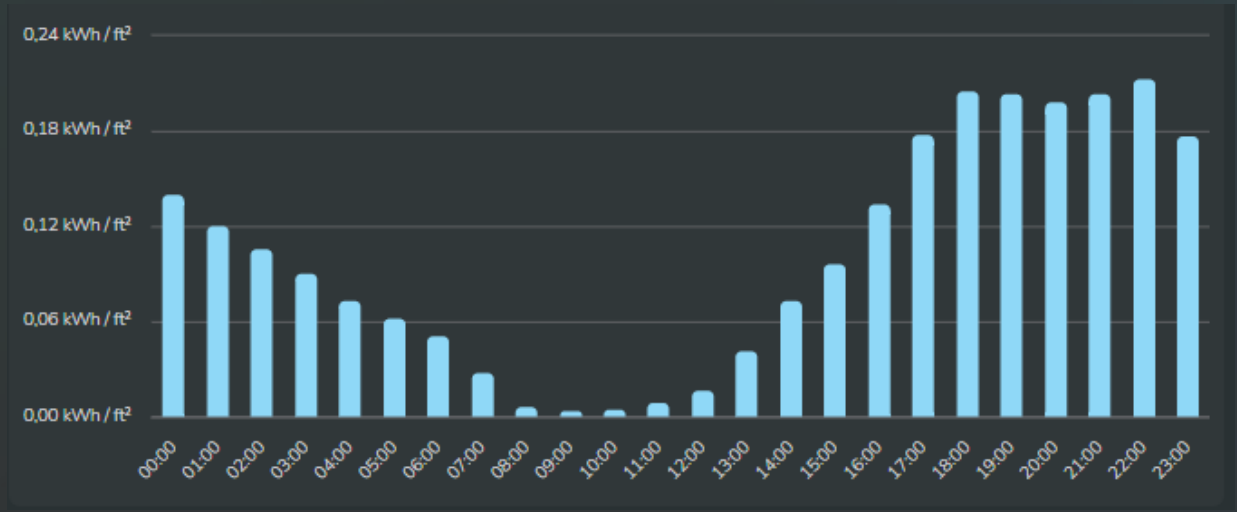
Normalization & KPIs

KPIs are used to monitor and quantify energy-saving actions and evaluate their success.

$$KPI = \frac{Energy\ Consumption}{Variable\ of\ greatest\ influence}$$

Energy Use Intensity

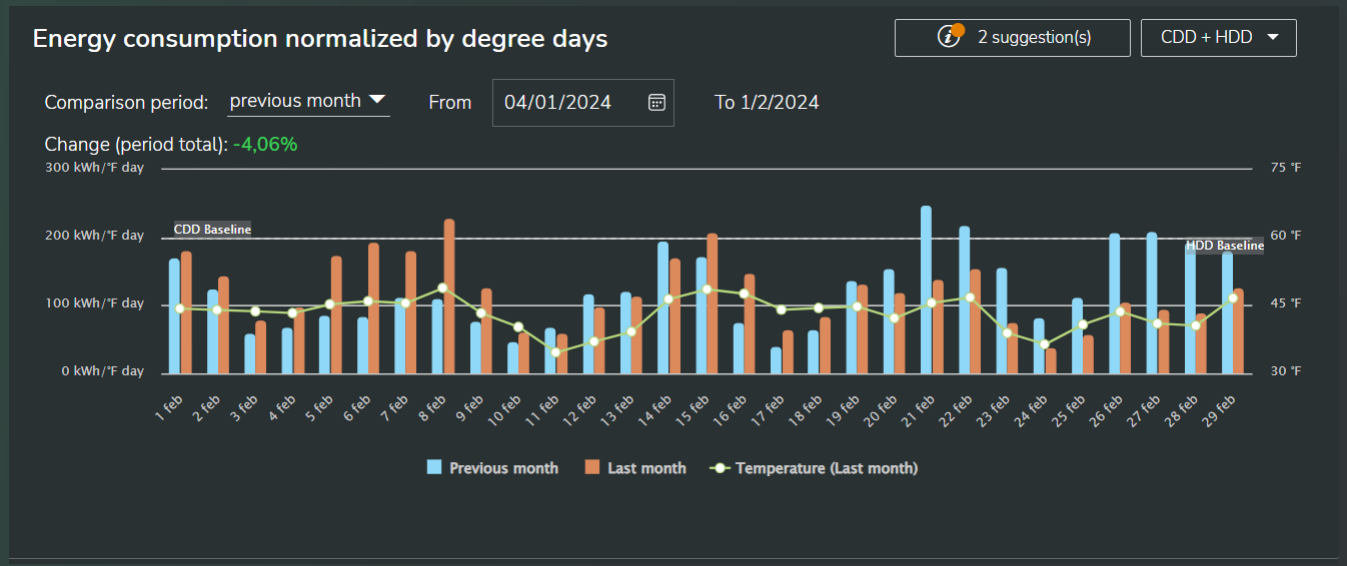
ratio between consumption and air-conditioned square footage. Typically expressed in kilowatt hours (kWh) per square foot (per year or month).



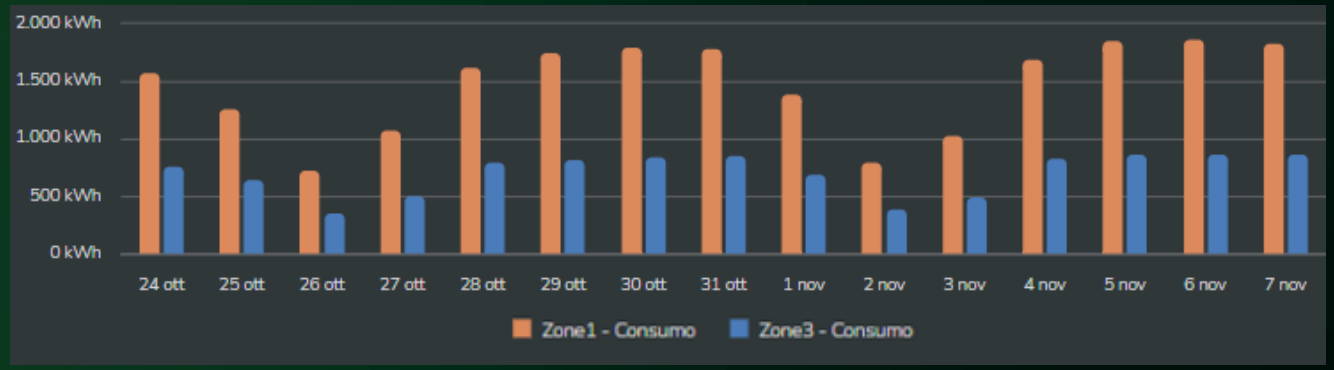
Normalization & KPIs

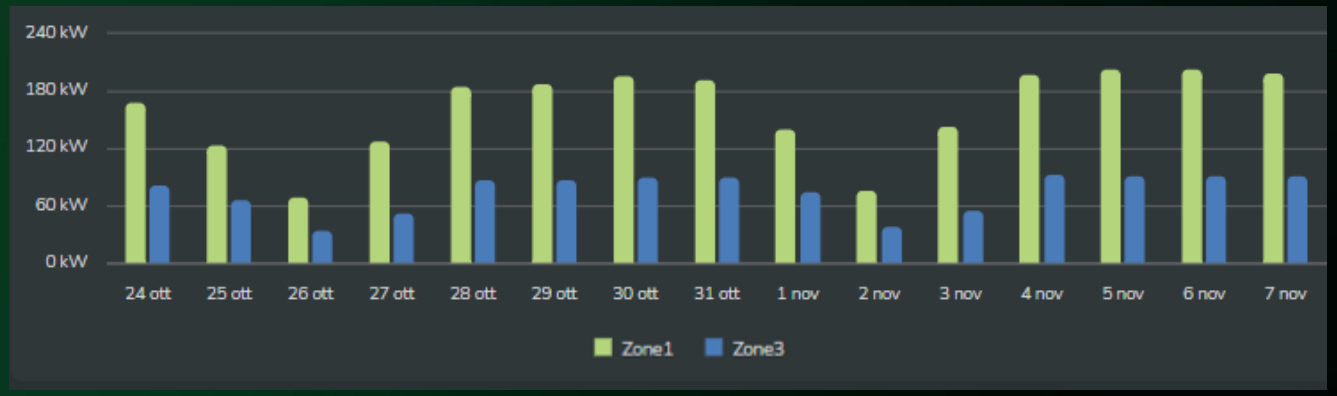
Normalization vs. degree days

The simplest way to normalize energy-consumption is to calculate the kWh per degree day. Simply divide each kWh figure by the number of degree days in the period over which that energy was used.



Benchmark





→ **Identify the best performers**: and set Performance Standards

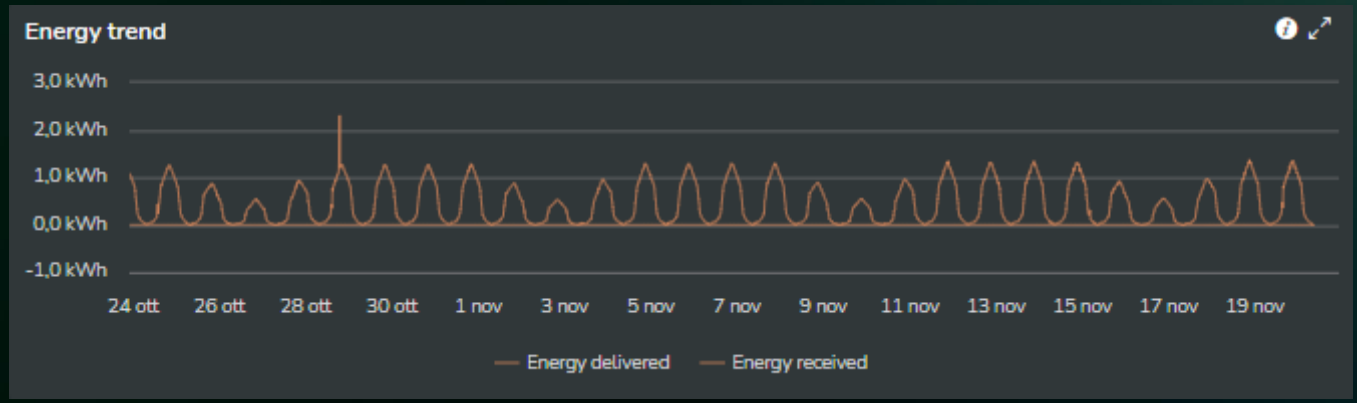
→ **Identify relations** between consumption and factors like equipment, operational practices, ext conditions..

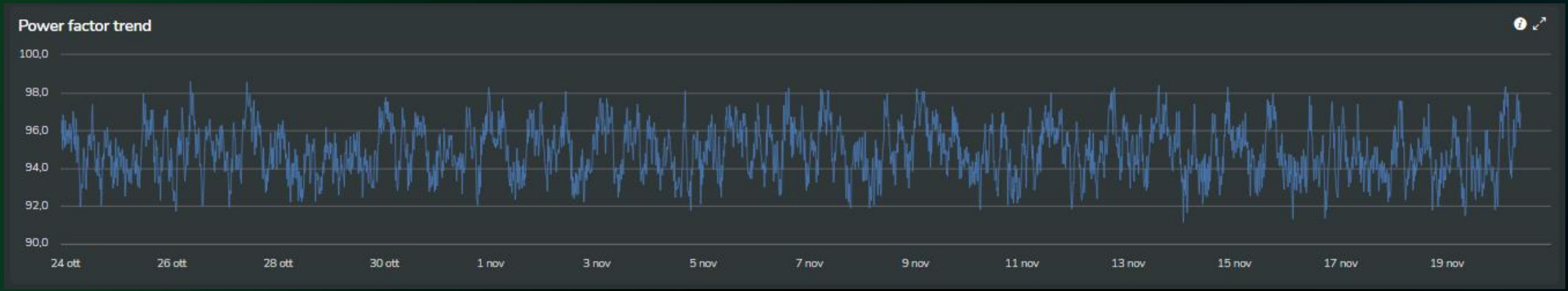
→ **Optimizing investments**: By identifying underperforming sites, it is possible to allocate resources and support where they are most needed, in energy efficiency

Load Profile Analysis

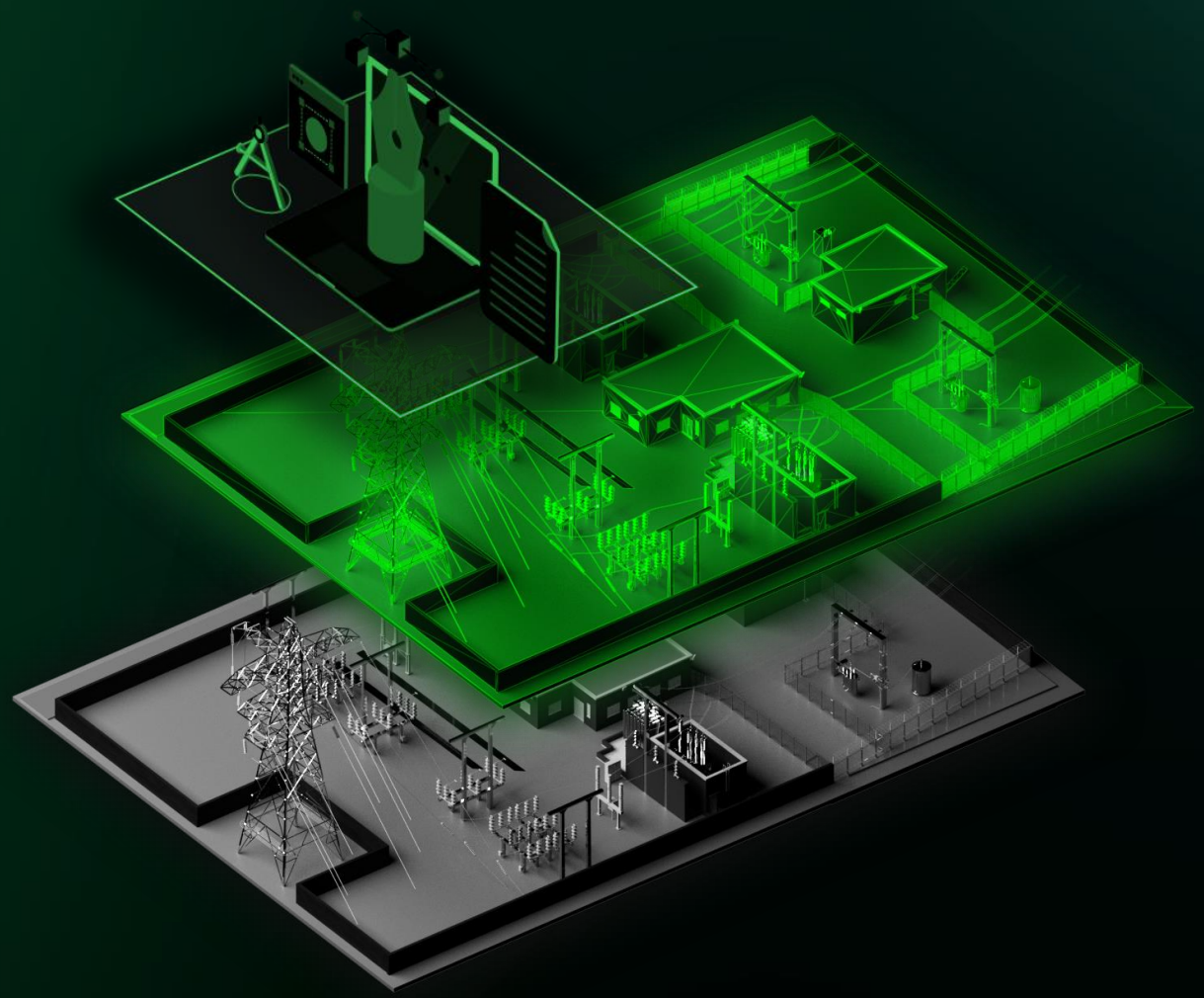
Load Profile Analysis enables to go deeper into the nature of malfunctions.

From aggregated data to the level of the individual meter.





Energy Analysis

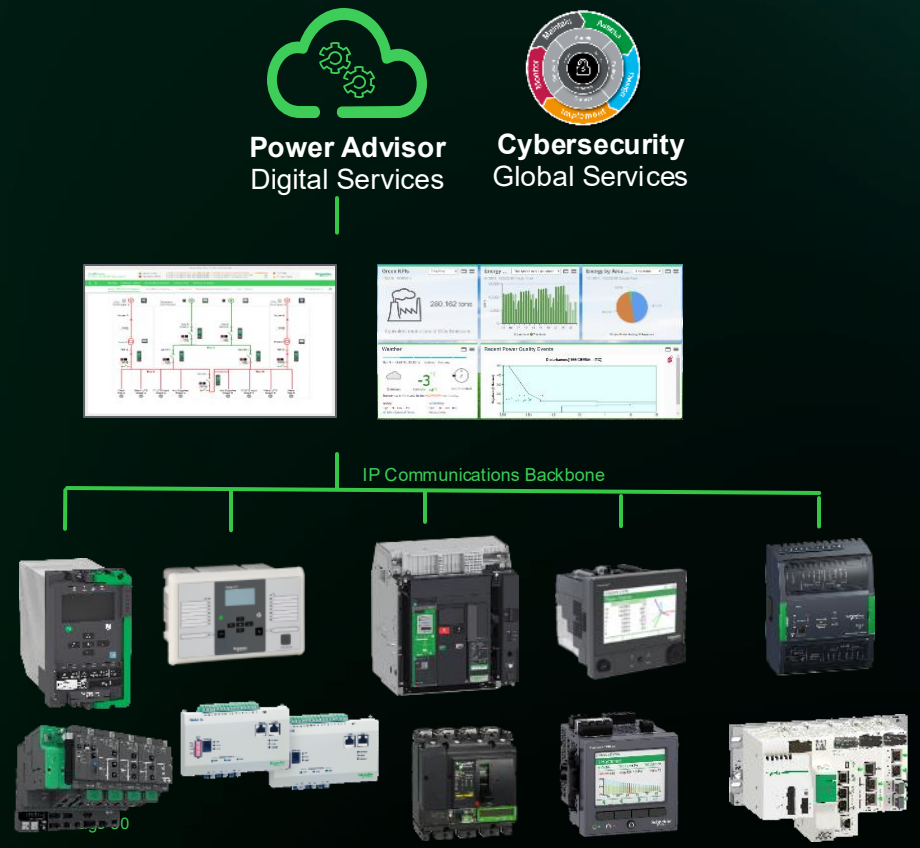


Power Management System

Apps, Analytics & Services

Edge Control

Connected Products



Where does energy data come from?

Integrated Measurement

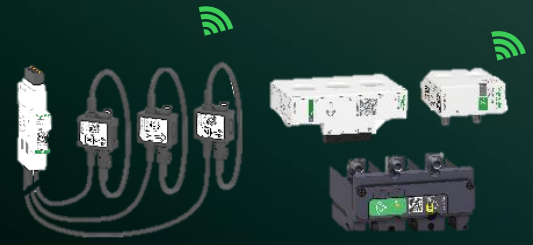
➢ **Where?**
Green field
Critical loads

➢ **Why?**
- Breaker status, diagnostics, and maintenance
- Measurement of basic electrical parameters (Class 1/2)
- Less reliable measurement below 20% In

Traditional Measurement

➢ **Where?**
Green field and Brown field
General + critical loads

➢ **Why?**
MID-approved fiscal measurement
Active energy Class 0.5S
Basic Power Quality



Wireless Measurement

➢ **Where?**
Green field and Brown Field
Secondary lines / terminal loads

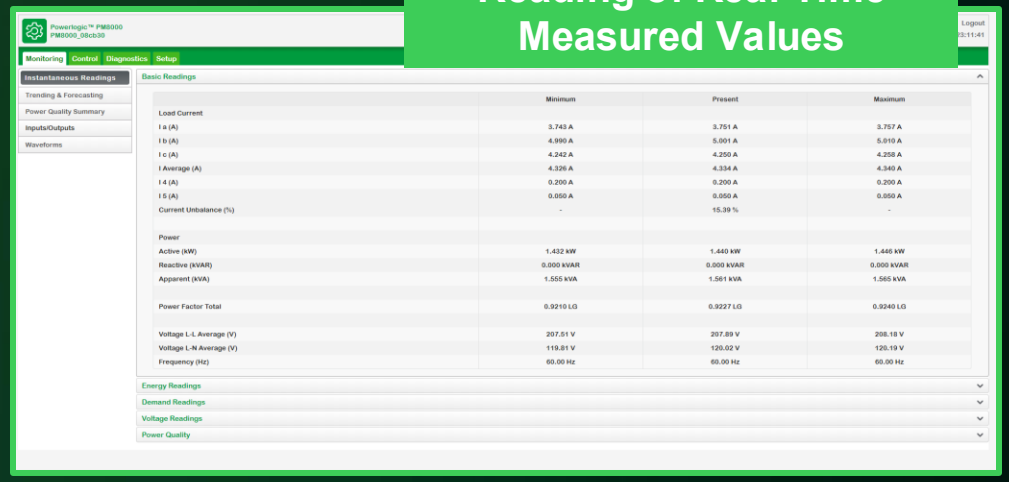
➢ **Why?**
No wiring needed → Ideal for retrofit
Active Energy Class 1
Voltage loss alarm

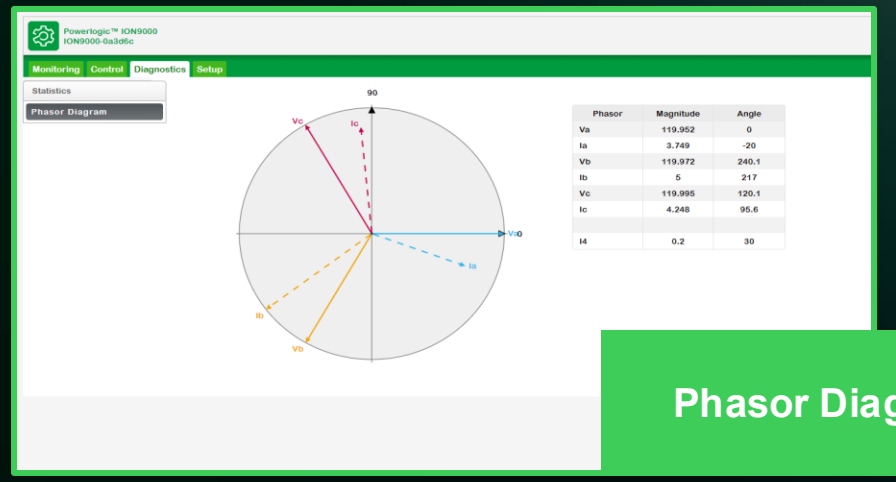
Key characteristics of energy meters

Technical Features	Advanced	Intermediate	Energy Meters	PowerTag	Integrate Measurement
Accuracy Class	Up to 0,1S	Up to 0,2S	Up to 0,5S	Class 1	Class 1 MTZ Class 2 NSX
Electrical Measurements (I, U, F, P, Q, S, PF, E)	✓	✓	✓	✓	✓
4-quadrant Measurement	✓	✓	✓	✓ (from 63 A)	✓
Data Logging	✓	✓	✗	✗	✗
Harmonic Distortion (THDi, THDu, TPF)	✓	✓	✓	✗	✓
Single Harmonics Measurement	✓	✓	✗	✗	✗
Unbalance Measurement	✓	✓	✗	✗	✗
Power Quality (EN50160 & IEC61000-4-30) (Voltage dips, swells, flicker, trans)	✓	✗	✗	✗	✗
MID Certification	✓	✓	✓	✗	✗

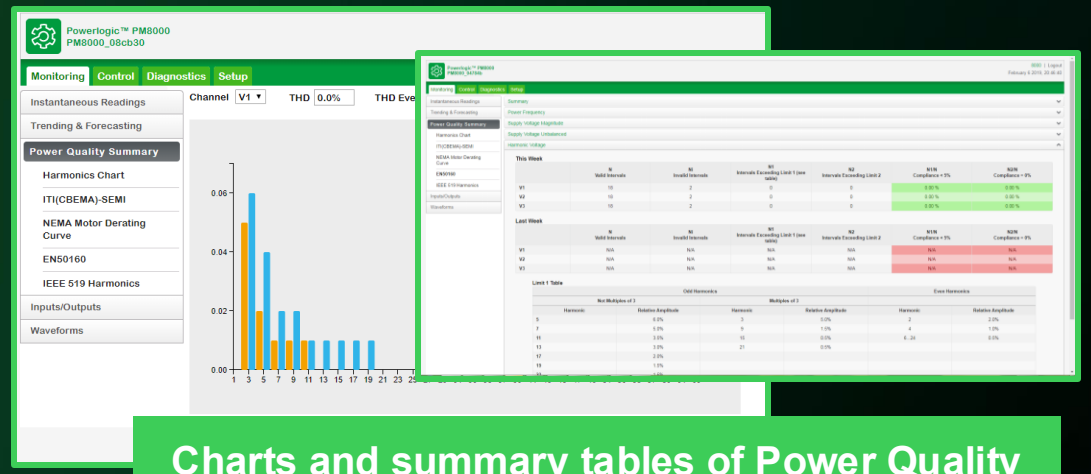
Web Page Detail – Power Analyzers

Reading of Real-Time Measured Values

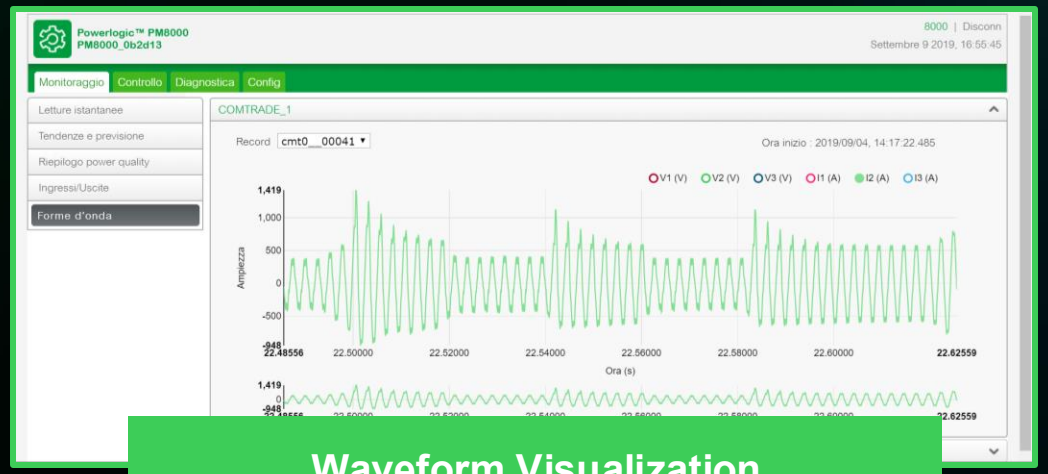




Phasor Diagram



Charts and summary tables of Power Quality events according to the main international standards



Waveform Visualization

Meters accuracy class

0,2S

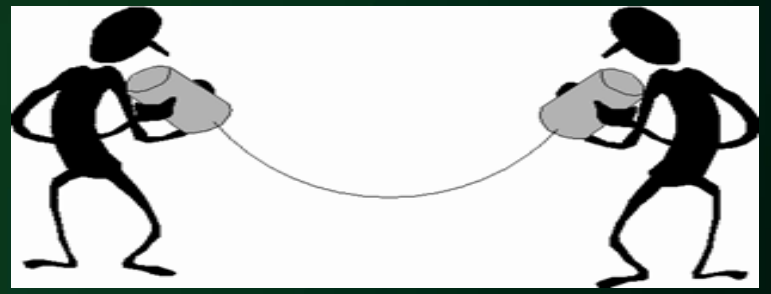
- **Maximum error 0,2%**
- **Precision guaranteed from 5% to 120% of the nominal current**

Accuracy class	Class 0.2S active energy conforming to IEC 62053-22 Class 0.2 active energy conforming to ANSI C12.20 Class 0.2 active power conforming to IEC 61557-12 Class 0.5S reactive energy conforming to IEC 62053-24 Class 0.5 power factor conforming to IEC 61557-12 Class 0.2 voltage conforming to IEC 61557-12 Class 0.2 current conforming to IEC 61557-12 Class 0.2 frequency conforming to IEC 61557-12 Class 0.2 active energy conforming to IEC 61557-12

Industrial communication protocols

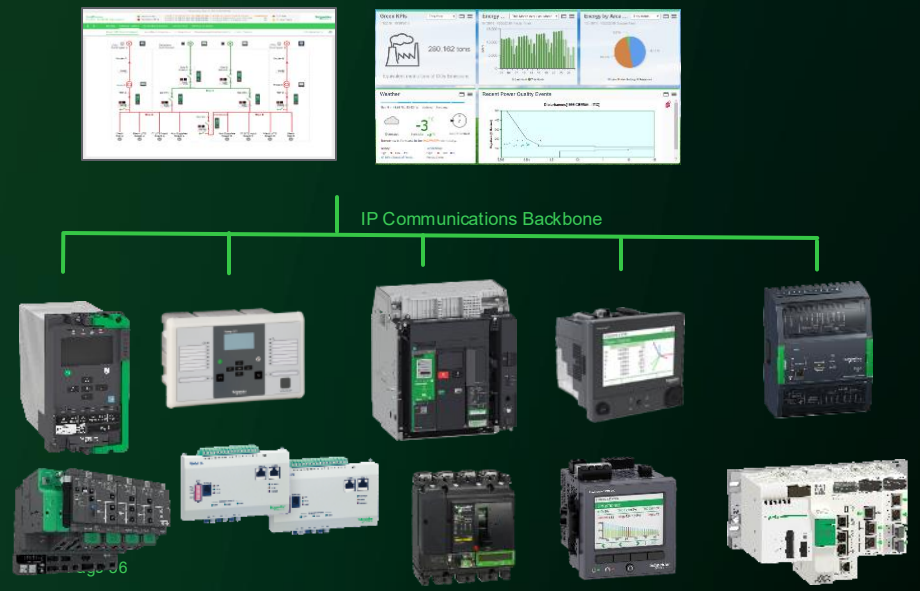
A monitoring software requires **real-time and historical data** from devices in the field to create a complete power management system

This is possible if both software and devices communicate through the **same protocol.**



Example:
A protocol for two devices is like the (spoken) language for one person. Two people can understand each other only if they speak the same language, such as Italian

Industrial communication protocols



IEC 61850

DNP3 Distributed Network Protocol

ION

KNX

OPC®

BACnet

SNMPv2

IEC 60870-5-104

Schneider Electric

Gateway, Data Loggers

Gateway

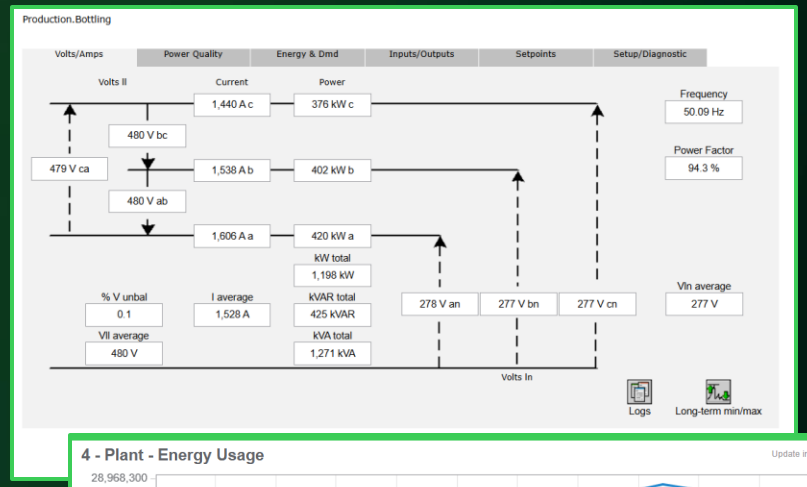
- Simple, easy and reliable connectivity between meters and systems
- Bridge between connected devices and power management software in real-time

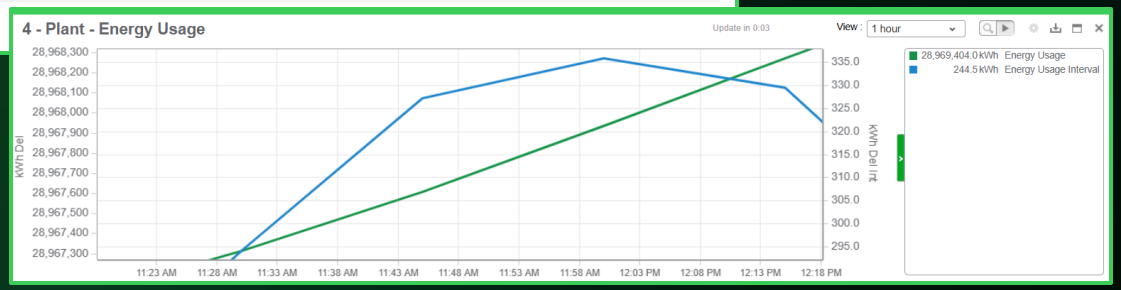
Data Logger

Gateway +

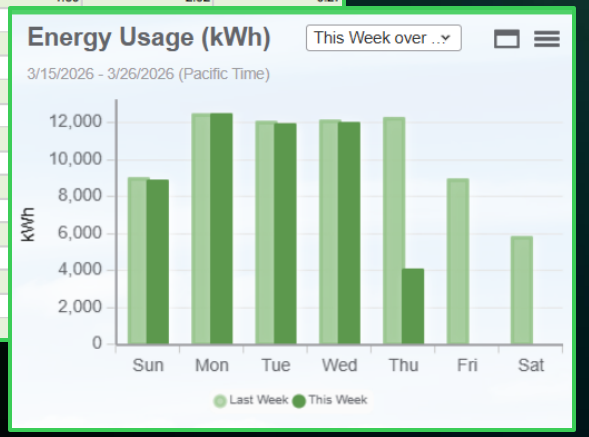
- Logs to collect and transmit energy data periodically
- Essential for remote services

Real-time vs Historical Data





Timestamp	Zone5.HVAC1 Current Avg (A)	Zone5.HVAC2 Current Avg (A)	Zone5.HVAC3 Current Avg (A)	Zone5.HVAC4 Current Avg (A)	Zone5.HVAC5 Current Avg (A)
12/14/2024 12:15:00 AM	0.13	0.10	0.58	0.93	0.20
12/14/2024 12:30:00 AM	0.07	0.06	0.32	1.04	0.11
12/14/2024 12:45:00 AM	0.12	0.09	0.52	0.95	0.18
12/14/2024 1:00:00 AM	0.10	0.07	0.44	0.99	0.15
12/14/2024 1:15:00 AM	0.08	0.06	0.01	1.19	0.13
12/14/2024 1:30:00 AM	0.09	0.07	0.78	1.59	0.14
12/14/2024 1:45:00 AM	0.13	0.10	1.41	1.91	0.20
12/14/2024 2:00:00 AM	0.18	0.14	1.60	2.02	0.27
12/14/2024 2:15:00 AM	0.81	0.63			
12/14/2024 2:30:00 AM	2.65	2.05			
12/14/2024 2:45:00 AM	4.51	3.48			
12/14/2024 3:00:00 AM	5.32	4.10			
12/14/2024 3:15:00 AM	5.30	4.09			
12/14/2024 3:30:00 AM	5.41	4.18			
12/14/2024 3:45:00 AM	5.37	4.14			
12/14/2024 4:00:00 AM	5.28	4.08			
12/14/2024 4:15:00 AM	5.26	4.06			
12/14/2024 4:30:00 AM	5.23	4.04			
12/14/2024 4:45:00 AM	5.24	4.05			
12/14/2024 5:00:00 AM	5.15	3.97			
12/14/2024 5:15:00 AM	5.18	4.00			
12/14/2024 5:30:00 AM	5.23	4.04			



Real-Time Data

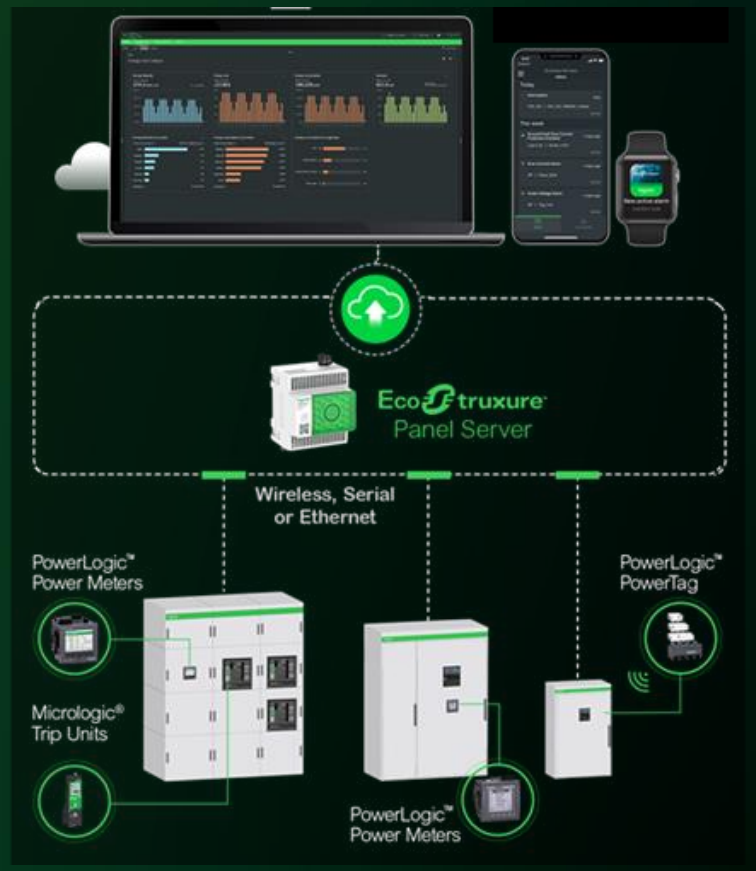
Voltages, currents, power, breakers status monitoring during maintenance/operations activities

Historical Data

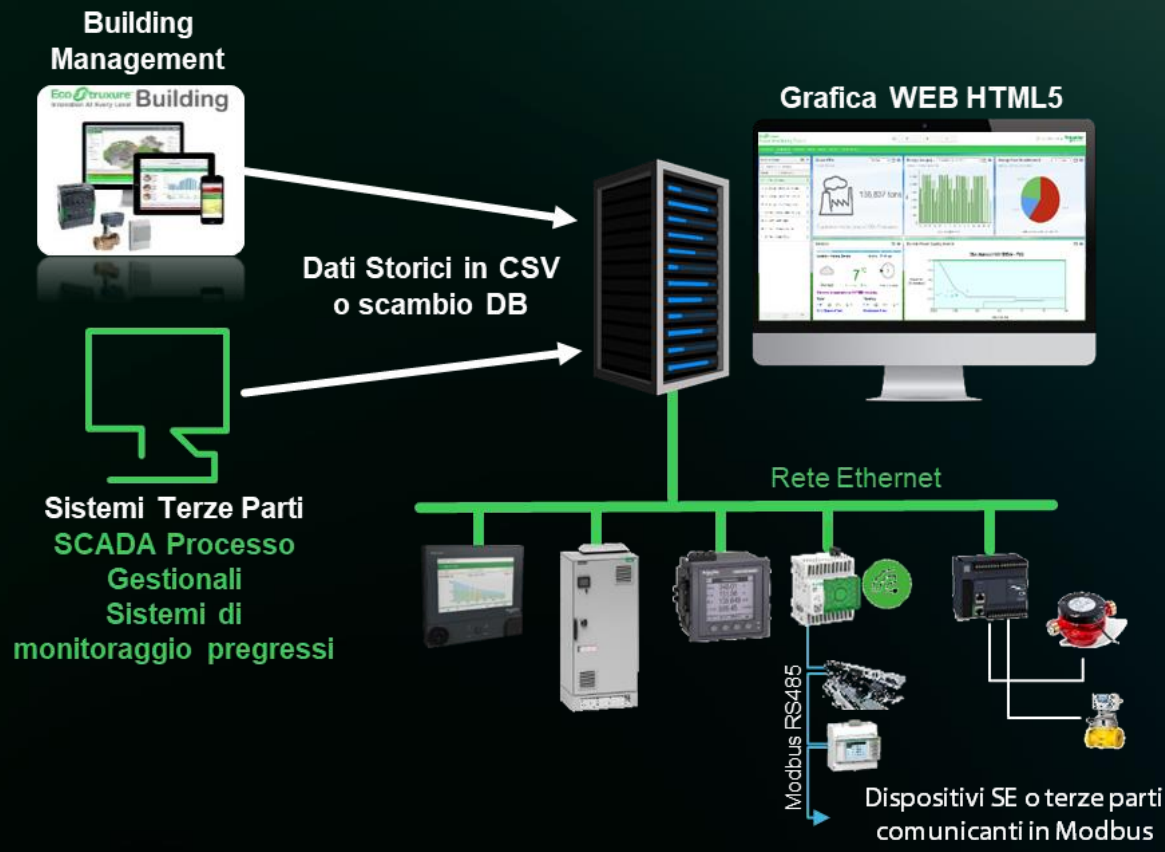
Energy management analysis are based on this data type

Energy Monitoring Software - SaaS vs On-Premise

SaaS



On-Premise



Local Energy Monitoring Software

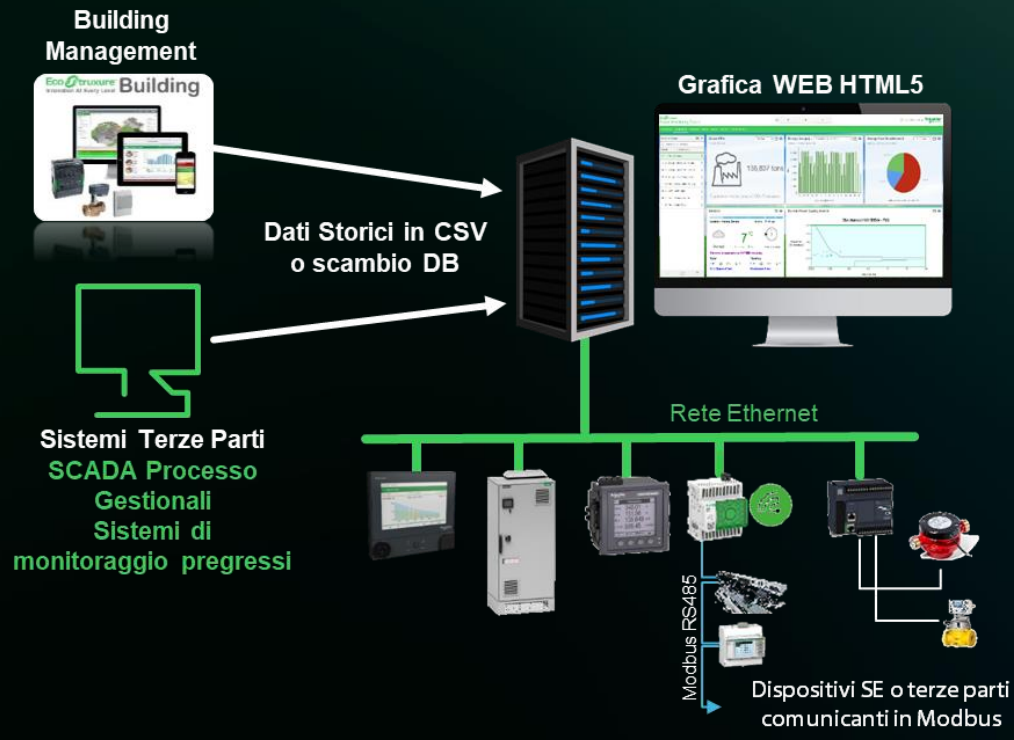
EcoStruxure Power Monitoring Expert (PME)

Energy monitoring for facilities of any size and for all **energy vectors (WAGES).**

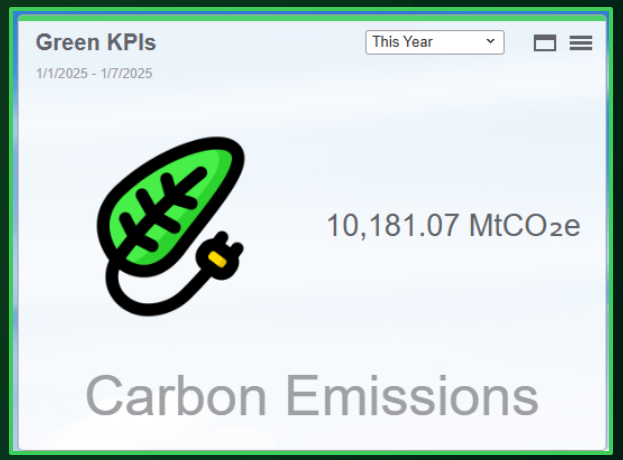
Data collection from the network and visualization of useful and meaningful information through a **simple and intuitive interface.**

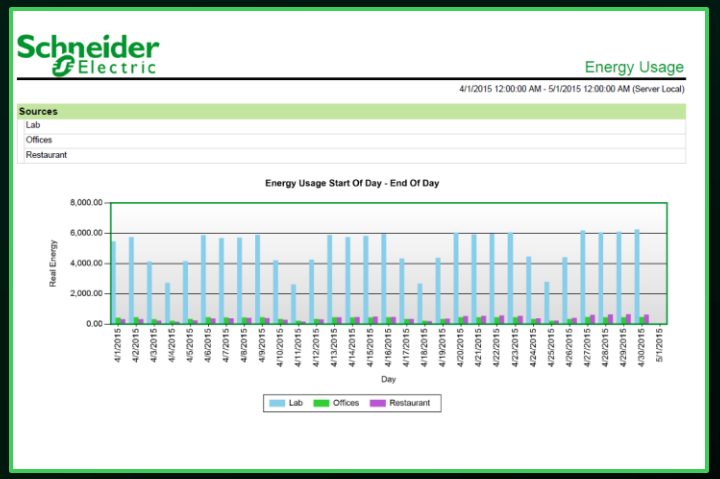
Analysis of energy performance with the support of **ISO 50001 certification.**

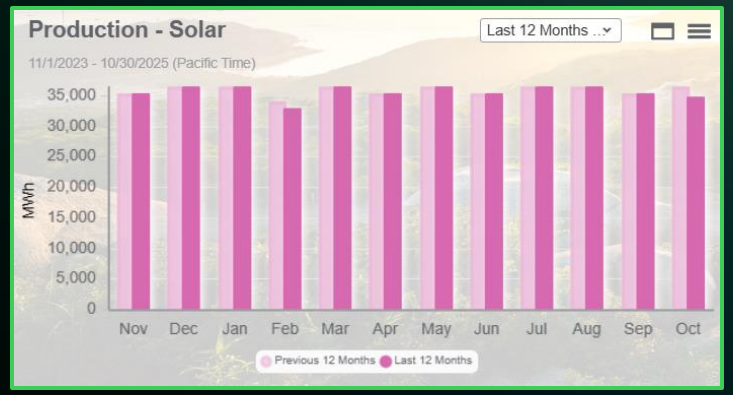
How does it integrate into the network architecture?



PME for Energy Audits





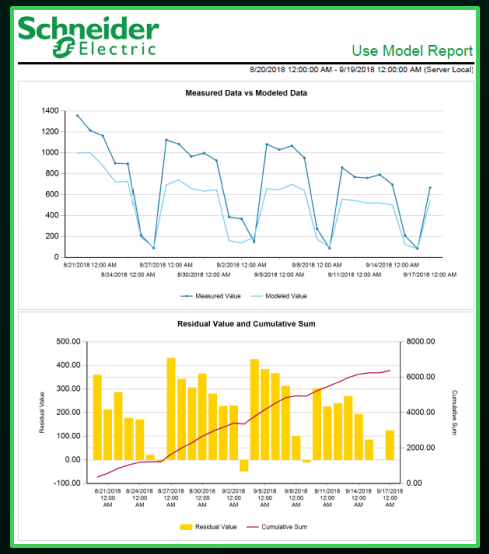


Energy equivalences to understand carbon emissions

Advanced reporting for the allocation of energy consumption

Monitoring of renewable Energy sources

PME for Energy Audits

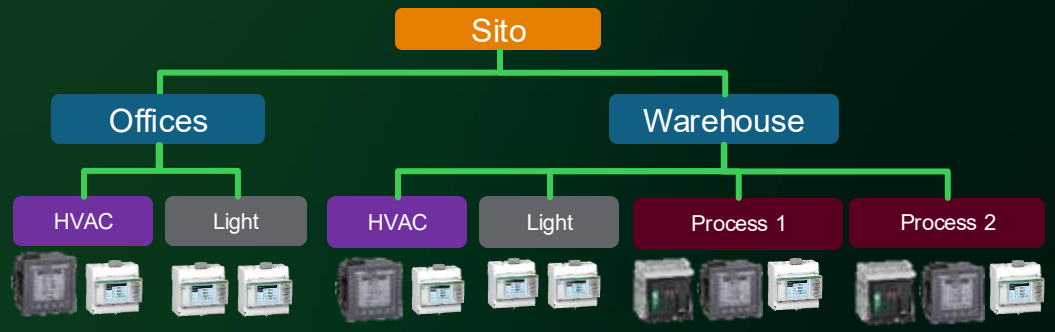


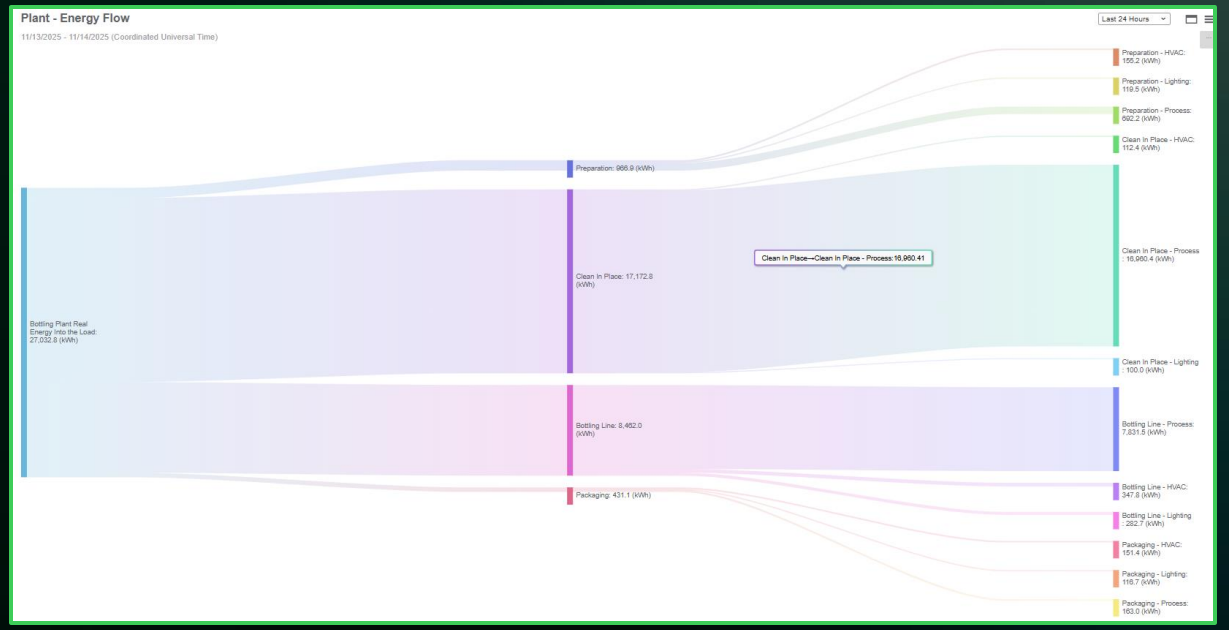
Instant identification of load peaks with trends or thereshold **alarms**

Energy consumption modeling

Multi-site/multi-user management

PME for hierarchical breakdown





Recommended **energy-consumption tree structure** for different energy vectors and functional areas

Creation **of customized hierarchies** (up to 7 levels) for load types and consumption centers

Identification of the most energy-intensive areas thanks to the **Sankey diagram**

PME for KPIs Analysis

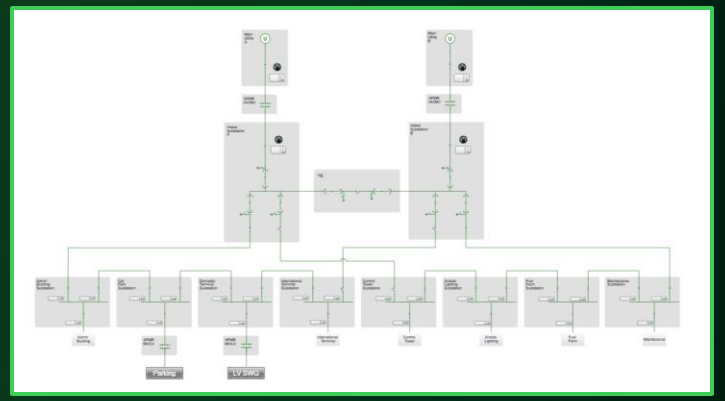
$$KPI = \frac{Consumo\ di\ energia}{Destinazione\ d'uso}$$

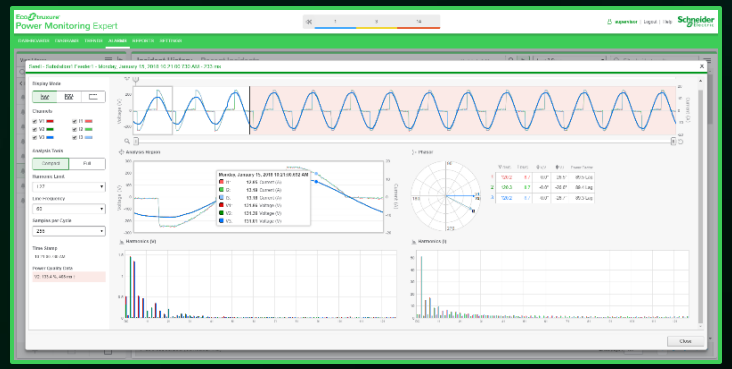
KPI necessari per il benchmarking: confronto delle prestazioni con quelle di un sito/impianto simile o target

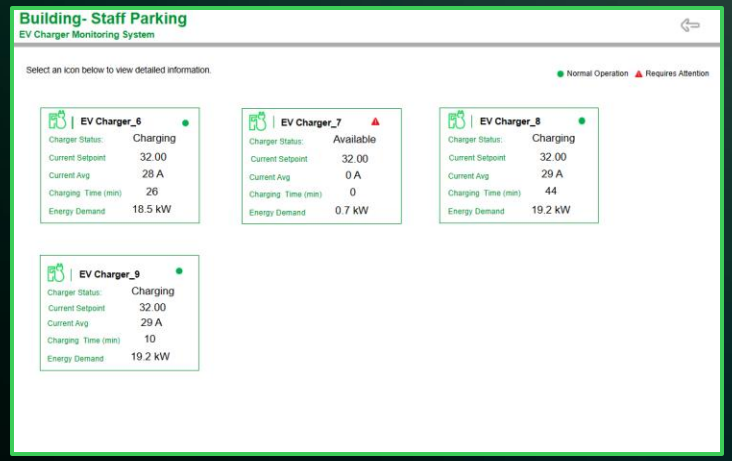
Calcolo KPI con formule completamente personalizzate e salvataggio dei valori nel Database

Utilizzo e visualizzazione dei KPI in dashboards, reports, trends, allarmi

PME for site reliability and operational efficiency







Native Integration with EcoStruxure Power Operation electrical SCADA for single-line parameter supervision

Understanding the **impact of power Quality events**, temporal analysis and reports compliant with EN50160 and IEC61000-4-30 regulations

Connected Asset Monitoring: UPS, Power Factor Correction, EV Charging

Thanks to the digitalization of electrical energy, a smart grid can guarantee

Sustainability	Resilience	Efficiency	Flexibility
Reduce the carbon footprint	Mitigate outages	Optimize resources and operations	Maximize grid adaptability

Trends and Italian Regulatory Context

Decreto elettrivori

Up to 80% reduction of system charges

Conto Termico 3.0

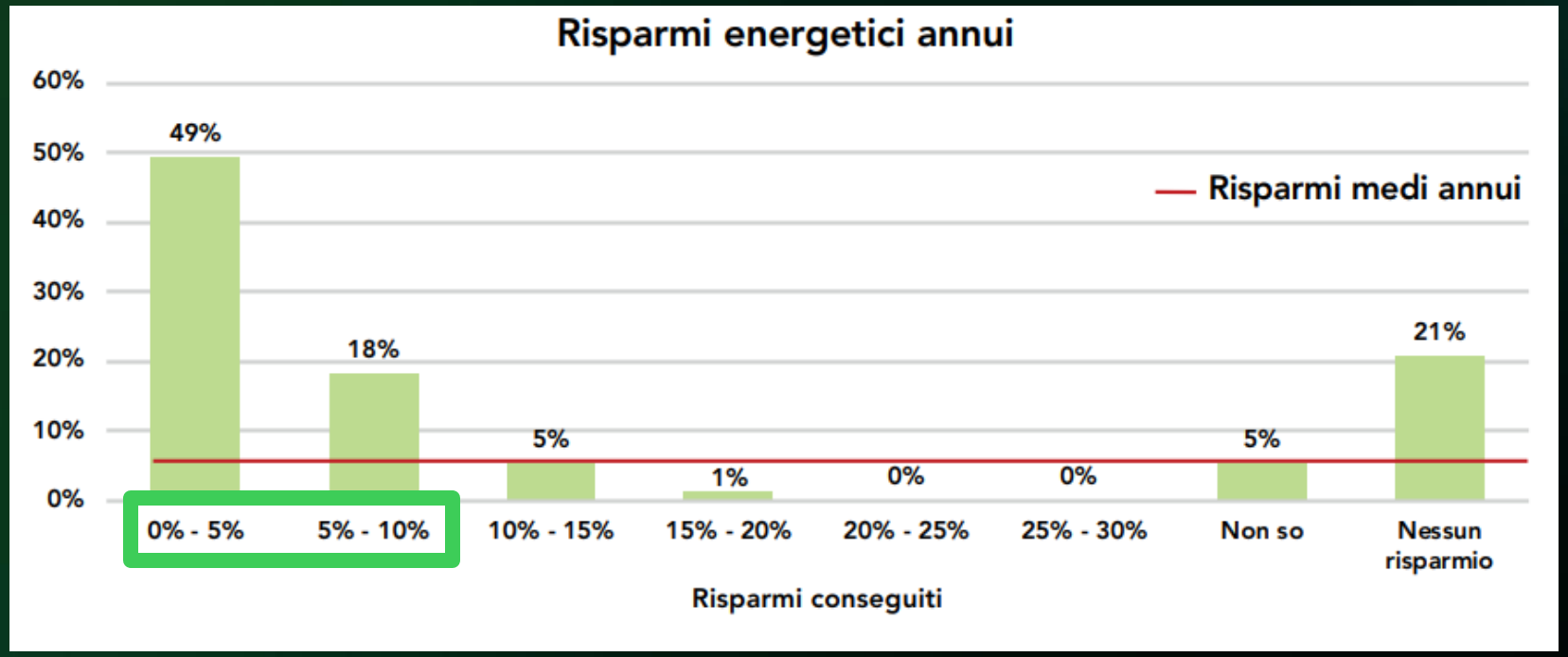
Reduce energy costs and accelerate the green transition

CSRD

Sustainability reporting

Growing awareness of **energy monitoring** and **CO_2 emissions control**, also at a regulatory level→ Strong push toward Energy Monitoring Software

What results can we achieve?



Practical case

- **Energy expense:** €100.000/year
- **Average software cost:** €10.000

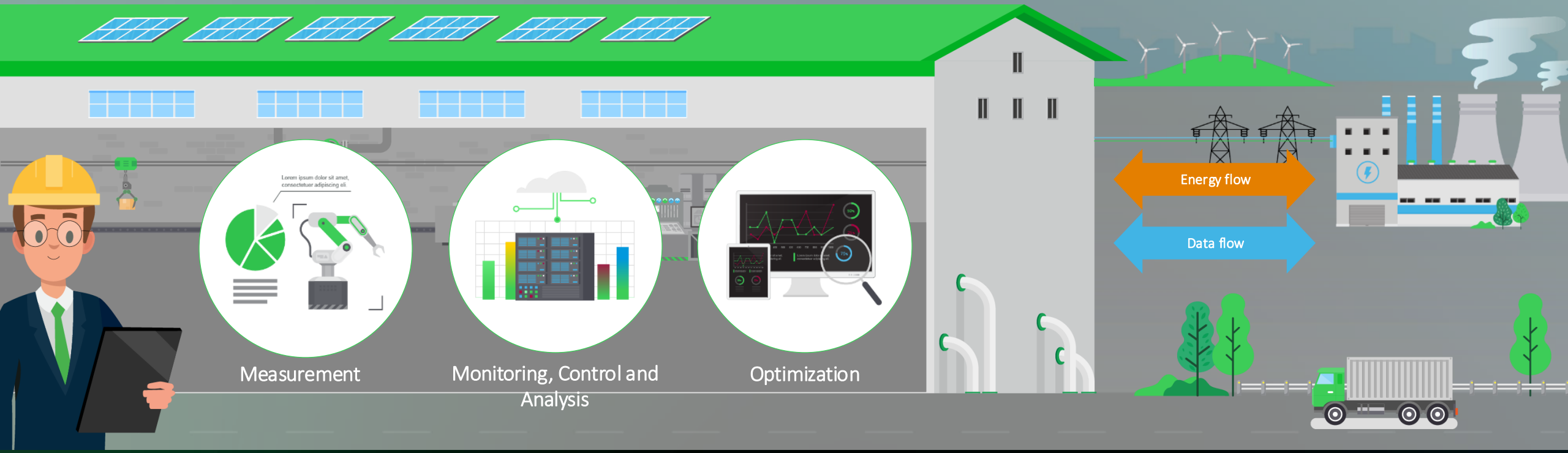
→ €5,000/year savings
→ Payback period: 2 years

A study conducted by the Politecnico di Milano found that the average annual energy savings achieved by companies using software solutions for energy data monitoring is around 5%*.

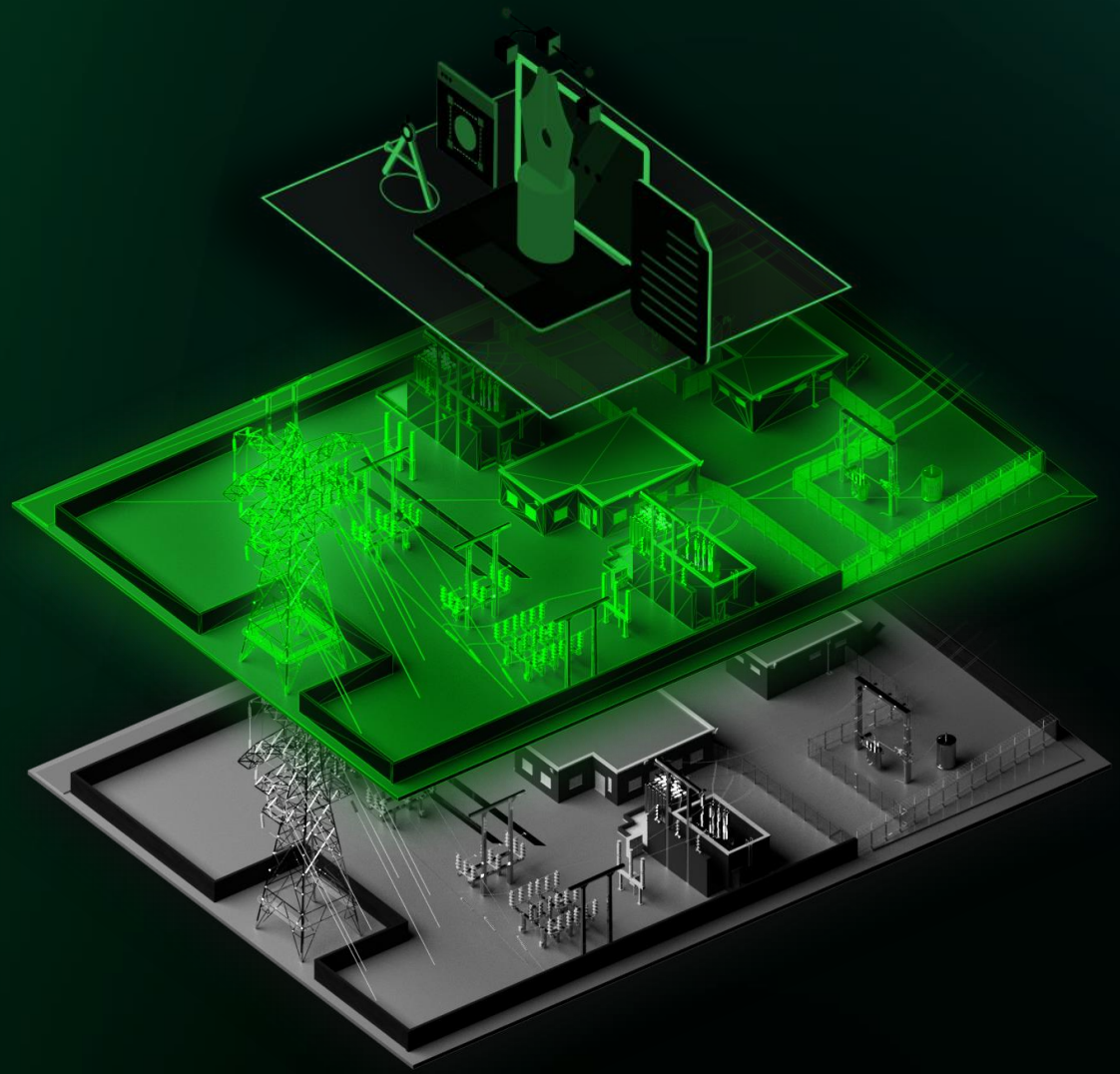
**DIGITAL ENERGY EFFICIENCY REPORT, Politecnico di Milano, luglio 2020*

Scalable and Interoperable Approach

Ensuring site reliability and efficiency through an active process of supervision and optimization



Power Quality Issues: unwanted effects and benefits of mitigation



PQ issues may occur inside a user facility, creating multiple service disruption

Up to €1M for 8-hour outage in a critical site
80% of events are linked to internal site issues

High electricity bills

Faults or operational inefficiency

Transformers

Unexpected trips

Circuit breakers

Circuit breakers

Start-up problems and overloads

Generators

Conductor faults, overheating and reduced capacity

Capacitors banks

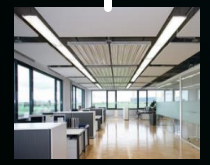
Data loss or lack of accuracy

Motors and drivers' issues

Specialized equipment faults

Disconnection or failures

Reverse power flows



Lighting

Flicker

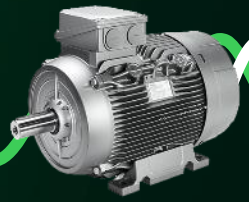
Schneider Electric

*Leonardo Power Quality Initiative

Power Quality events

Distribution Grid

Inductive load (motor)



Reactive currents and phase shift

Capacitor banks or active compensators

Distributor Grid

Electronic load (Inverter)

Waveform distorsion

Active harmonic filters

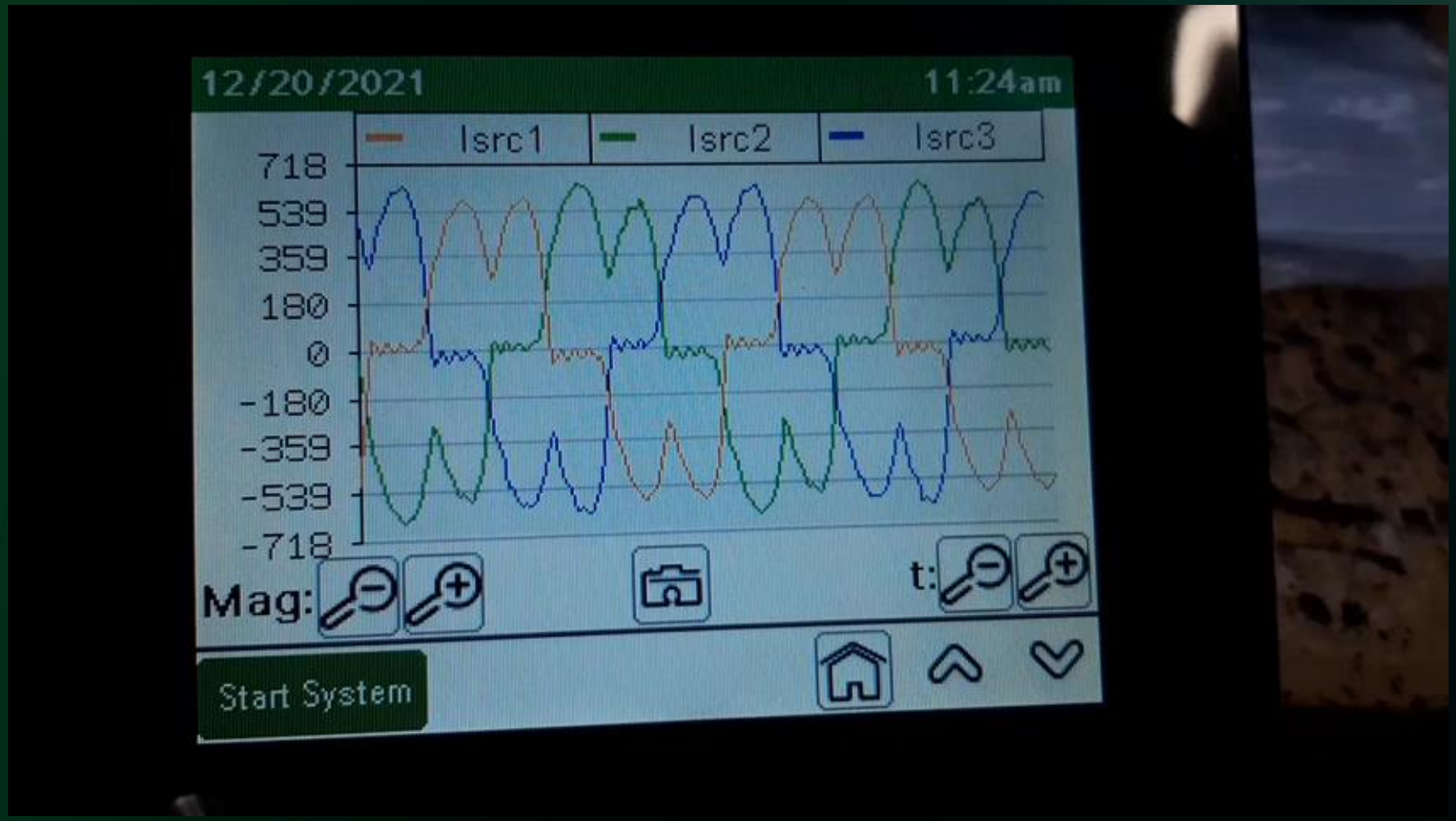
Distributor Grid

Voltage sags and interruptions

UPS (for sags and/or interruptions) or DVR

Active Harmonic Filter to compensate chiller harmonics

Functional demonstration – video youtube



To wrap things up

Action – Mitigation thanks to Data

Measurement – Data source

Analysis – Data processing