HELLENIC CABLES
Member of CENERGY HOLDINGS

The Role of Data Analytics in Industrial Energy Management

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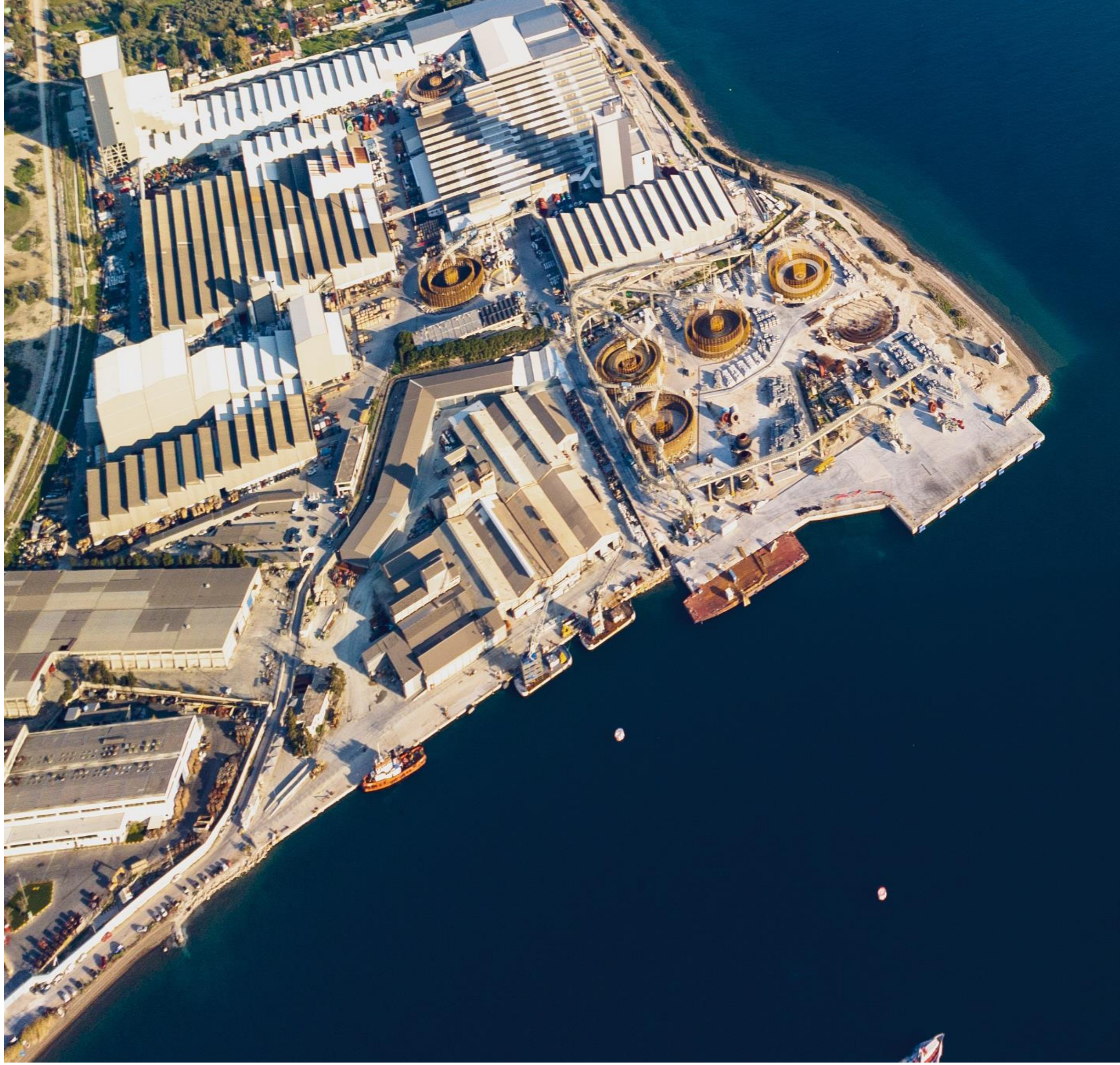
Agenda

- Measuring and Collecting Data
- Energy Efficiency
- Use Cases
  - Optimization of Production under maximum provided Power Constraint
  - Monitoring energy infrastructure performance
  - Measuring results of energy conservation actions
  - Identifying energy efficiency opportunities
  - Digital Shadow Design

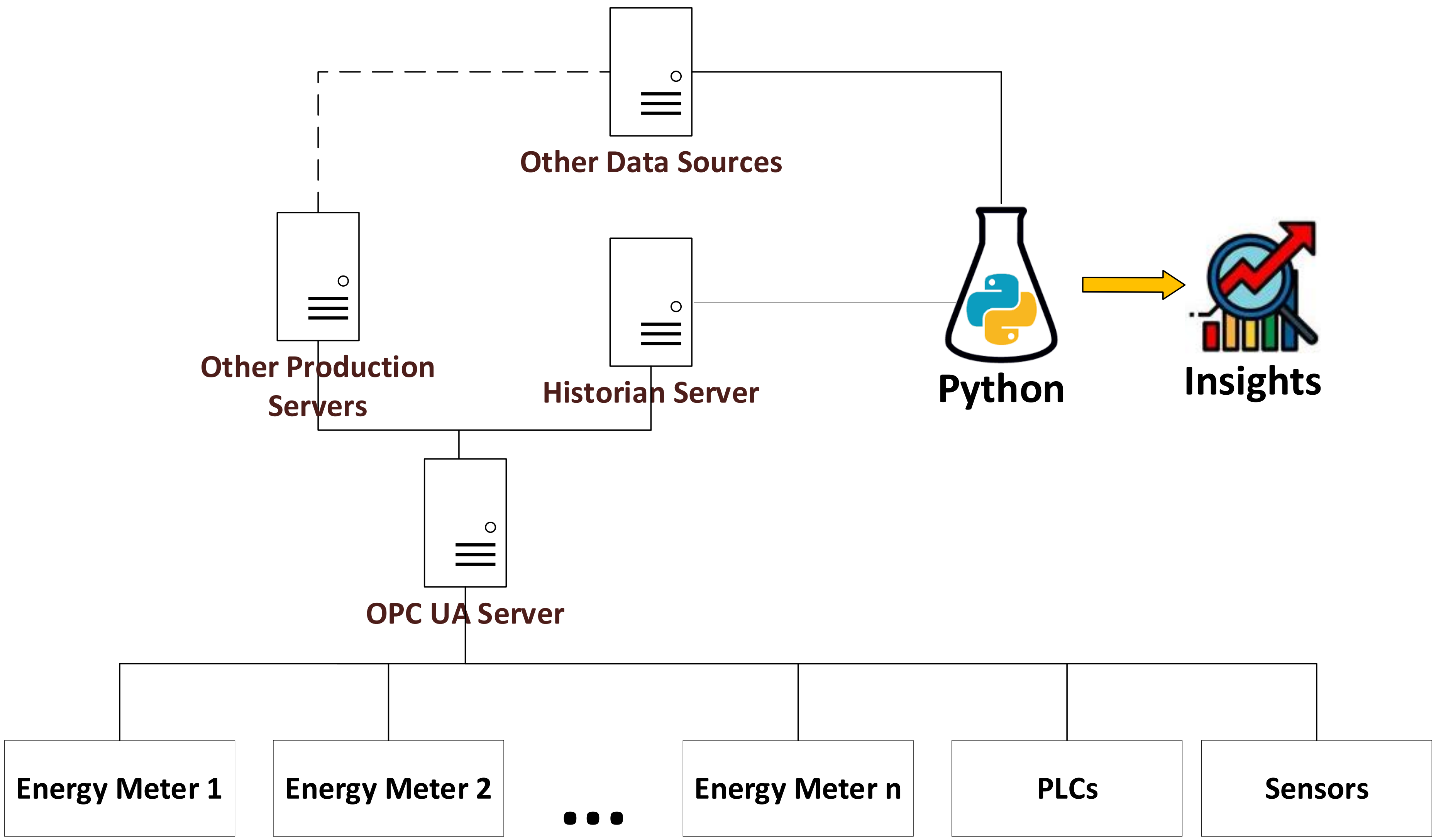


Measurements

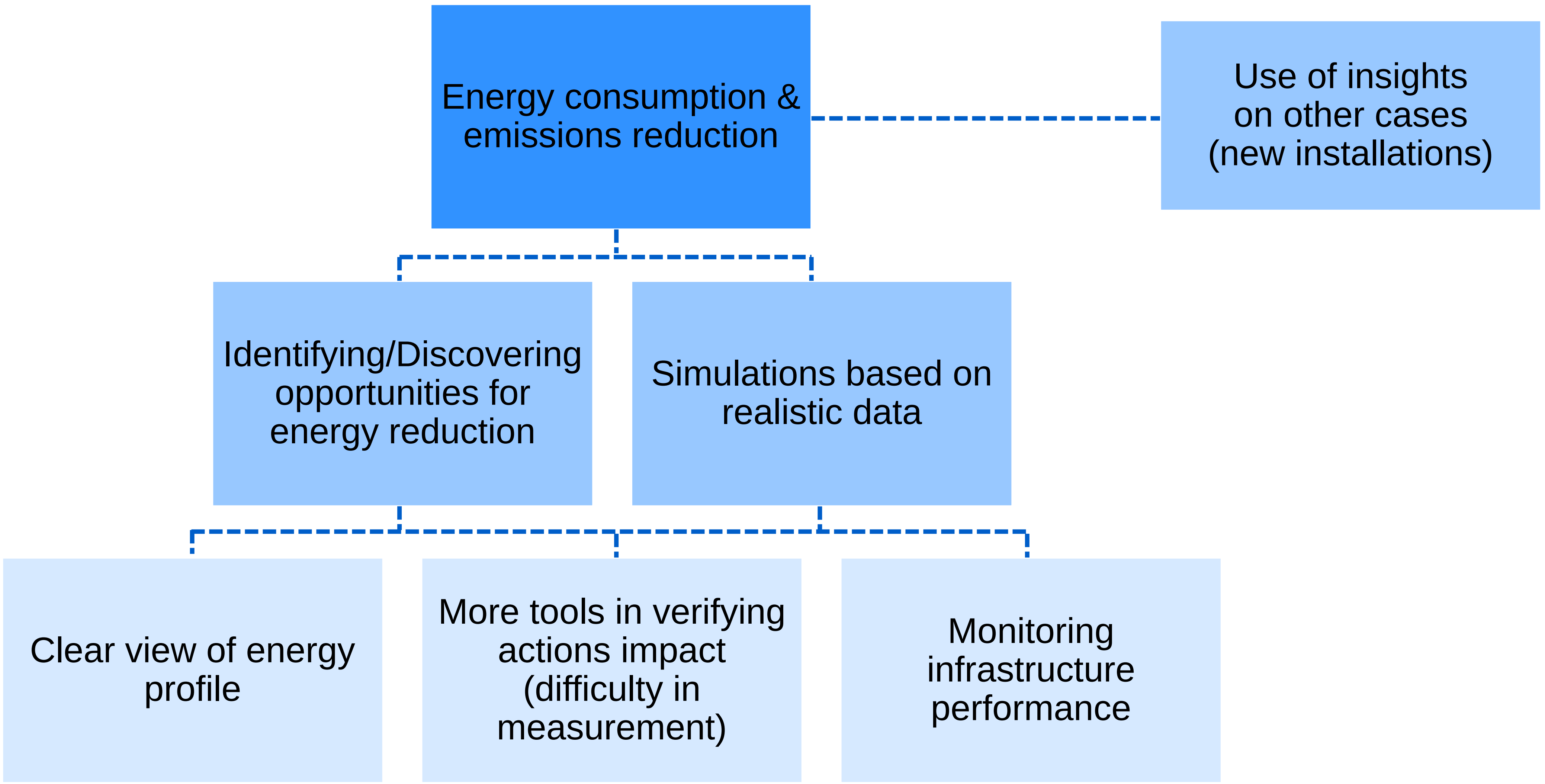
If you can't measure it, you can't manage it.

- How dense;
  As dense as possible (at least at production line level)
- To what extent;
  As much as possible (not under 75%-80% of total energy consumption)
- How many variables;
  At least the most significant (for example for electrical phase currents, phase voltage, active and reactive power, power factor, active and reactive energy, harmonics)
- How often;
  Sampling even per second, using the compression algorithms the volume is easily manageable.
  Bigger problem is processing the data.
  In practice 10-20 samples per minute are good enough depending on the variable

Infrastructure, extracting value out of data



Benefits of Measuring and analyzing data



Ways to improve Energy Efficiency

Energy Efficiency

Power Quality (Losses)

Typical 1-4%*****
Examples
- PF correction capacitors
- Harmonic filters
- Negative sequence current reduction
- Neutral blocking filter
- Soft starters
- Zig-zag reactors
- Harmonic mitigating transformers (HMT)

Innovation & Equipment

Depends. From 1% to 30%
Examples
- LED Lights
- High Efficiency Pumps
- High Efficiency motors (IE3,IE4)
- High Efficiency Fans
- Direct Motion
- Innovative Design

Process Optimization

Usually up to 10%
Examples
- Well tuned (PID) controllers
- Close loop to control cooling equipment
- Use of Variable speed drives

Procedures

Not easy to quantify – Not large but usually without cost
Examples
- Shutdown unnecessary equipment
- Optimize procedures
- Adaptive/Predictive/Descriptive Maintenance

***** Eaton Whitepaper: Power Quality Solutions and Energy Savings – What is Real?

Use Case
Optimizing Production Output under Maximum Power constraint

The problem

❑ The plant may be asked to limit the maximum required power to a given value

Target

✓ We need to develop a tool that will check whether a given combination of production lines will be able to run under the above constraint

Assumptions

i. The required power of the combination of the production lines should be as close as possible to the given constraint
ii. The maximum required power will not exceed the constraint to a given confidence level
iii. Critical infrastructure will always be used

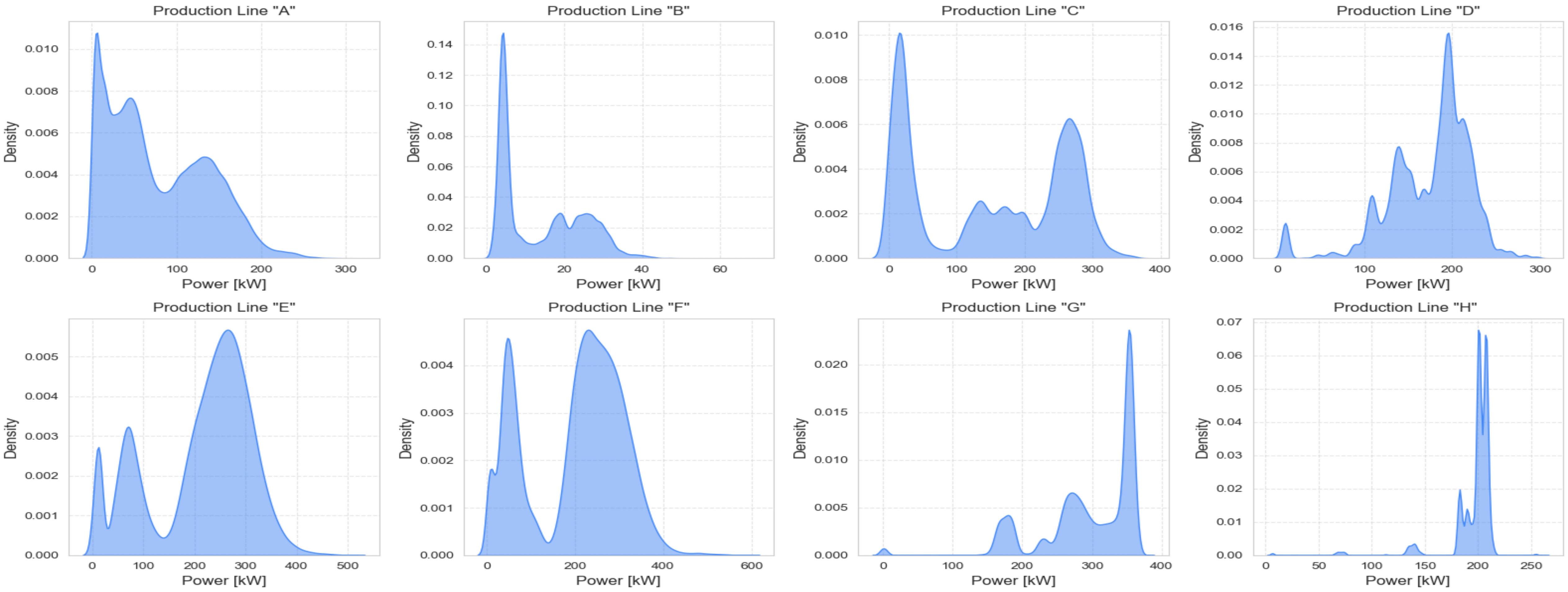
Monte Carlo Simulation

❑ A Monte Carlo simulation is a mathematical technique that simulates the range of possible outcomes for an uncertain event. These predictions are based on an estimated range of values instead of a fixed set of values and evolve randomly.

Monte Carlo Simulation – Define PDF for independent variables

Monte Carlo Simulation :

i. Derive probability density functions of Active Power of production lines from historical data (1 year ≈ 250 x10^6 samples)



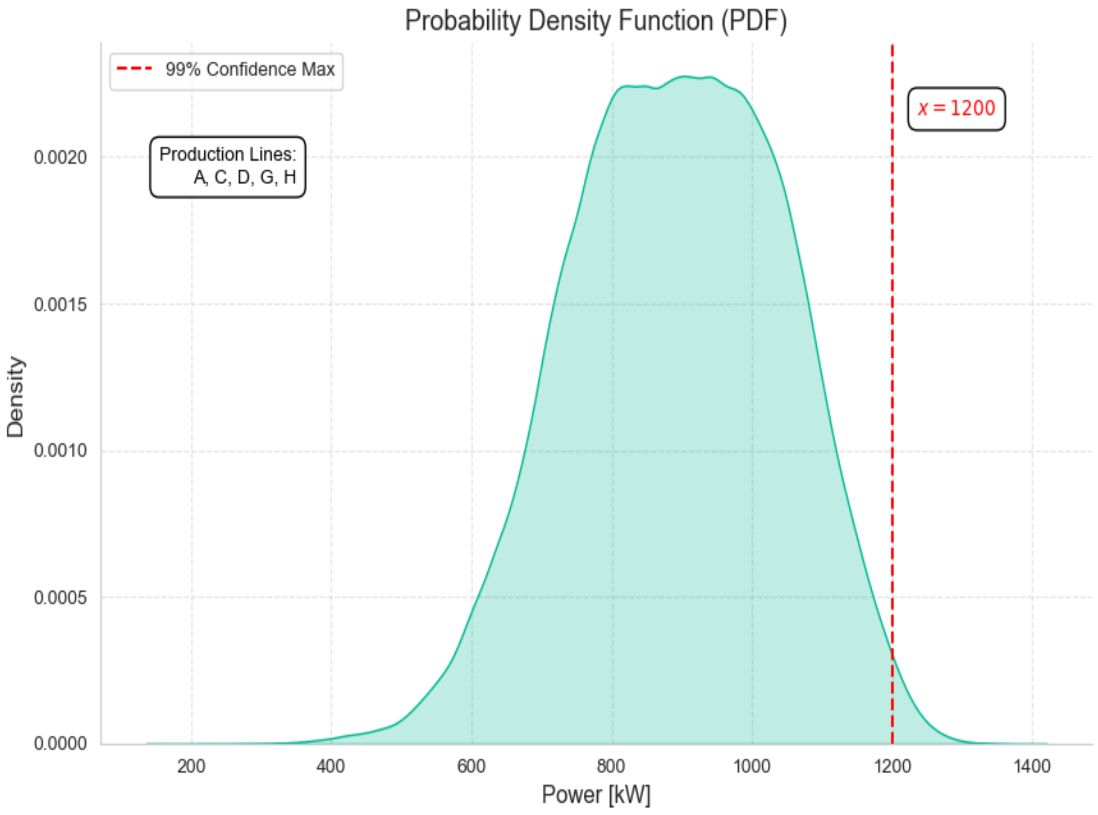
Monte Carlo Simulation

Application of Monte Carlo Simulation :

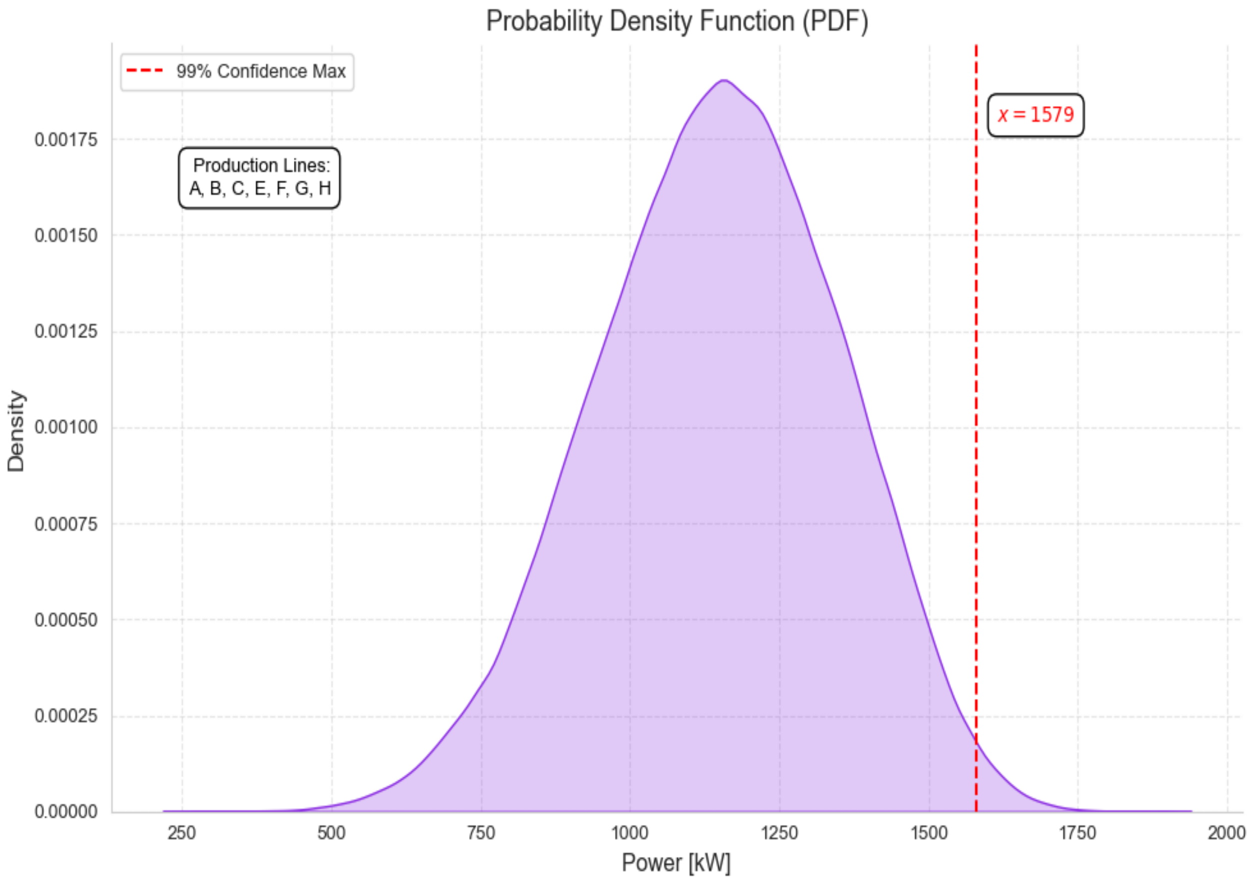
ii. Simulate ($n = 1 \times 10^6$) based on the probability density functions derived from previous step

iii. Process and analyze results

1st Combination (5 lines)

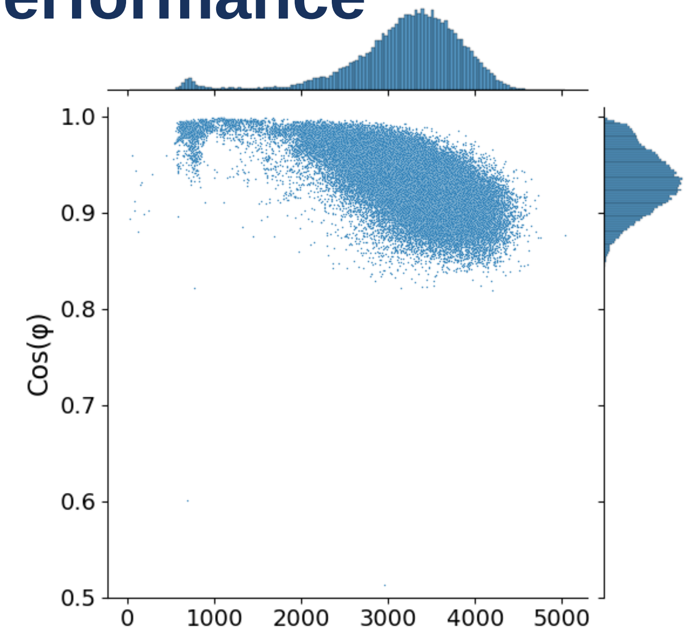


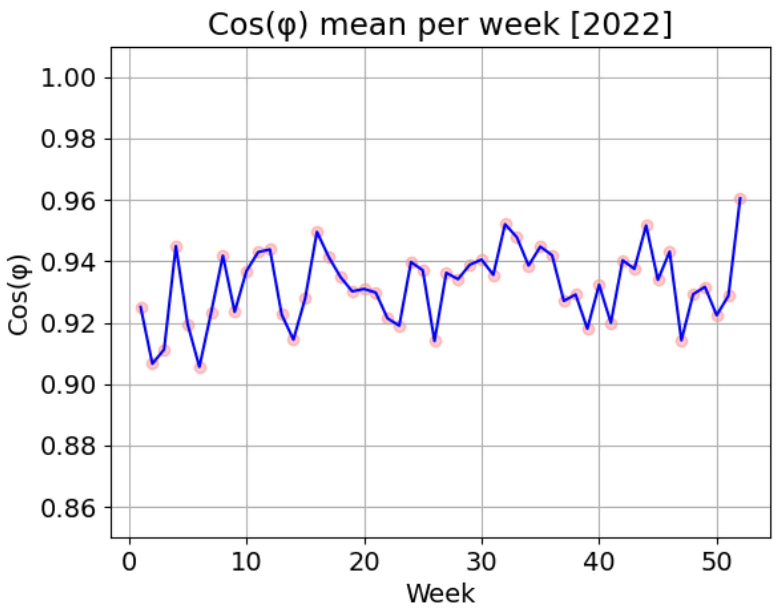
2nd Combination (7 lines)



Use Case: Monitoring energy infrastructure performance

- Plant cos(φ) vs Real Power
- Effects of central compensation
- Depict deviation from original design
- Estimate if actions should take place to redesign central compensation infrastructure or apply local compensation on energy intensive production lines with low power factor

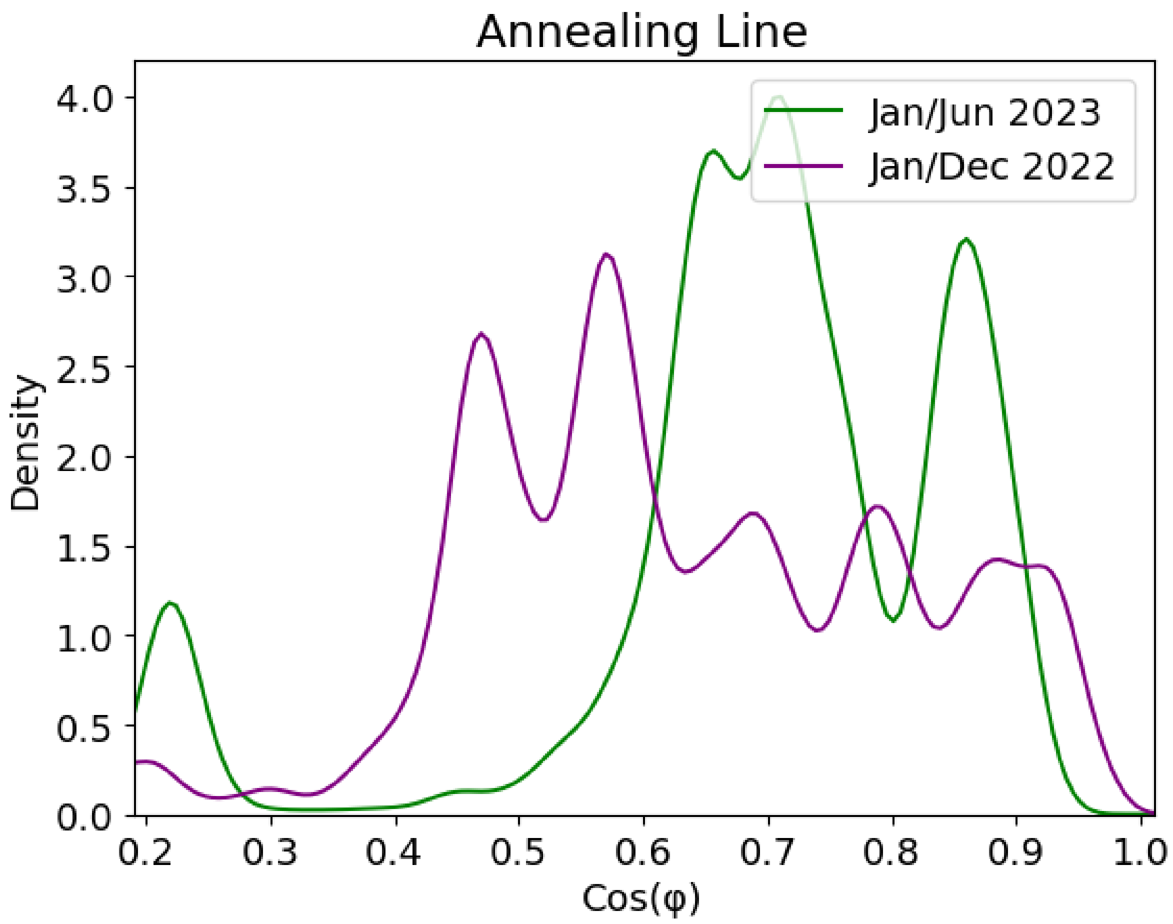




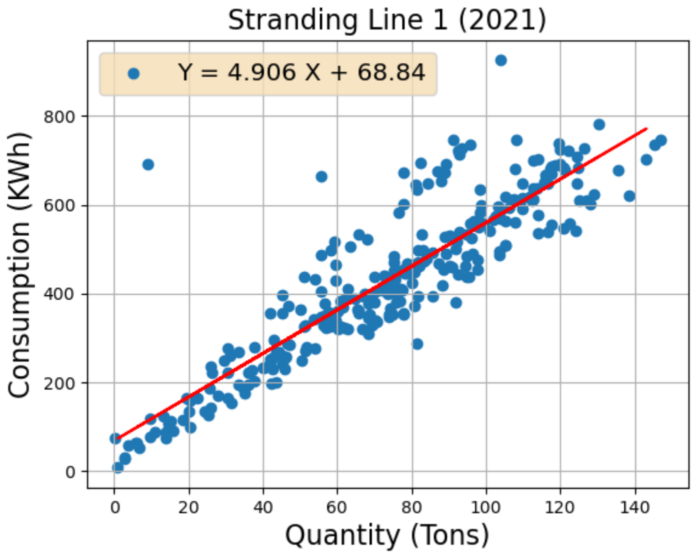
Use Case: Evaluate Local Compensation action (pilot)

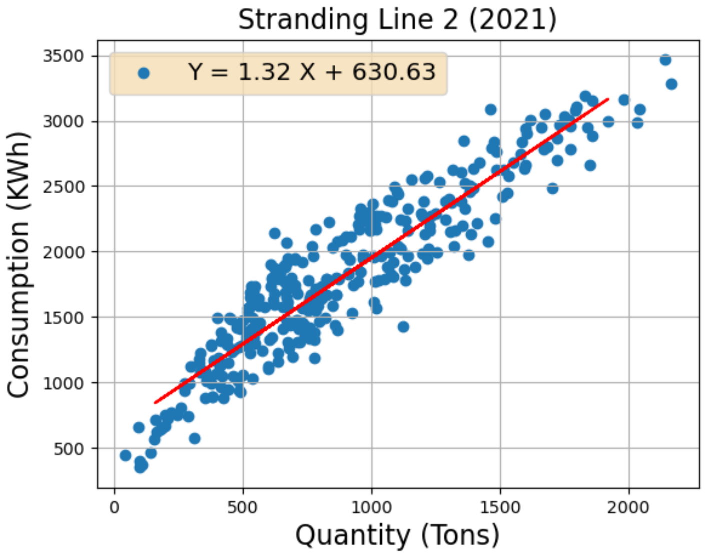
Target: Evaluate action for local compensation of an energy intensive production line with a problematic cos(φ)

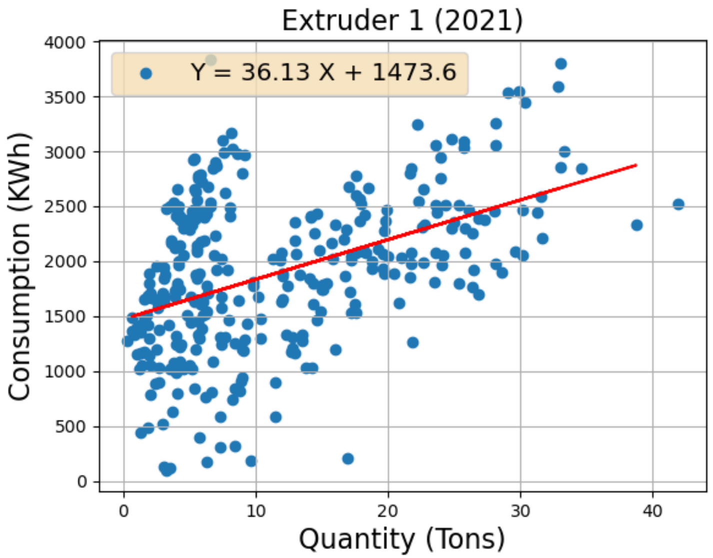
- Calculate impendence based on recorded data (current and Voltage drop)
- Estimate Transformer efficiency
- Based on the above calculate the reduction in losses
- Estimated from 0.7% to 1% reduction

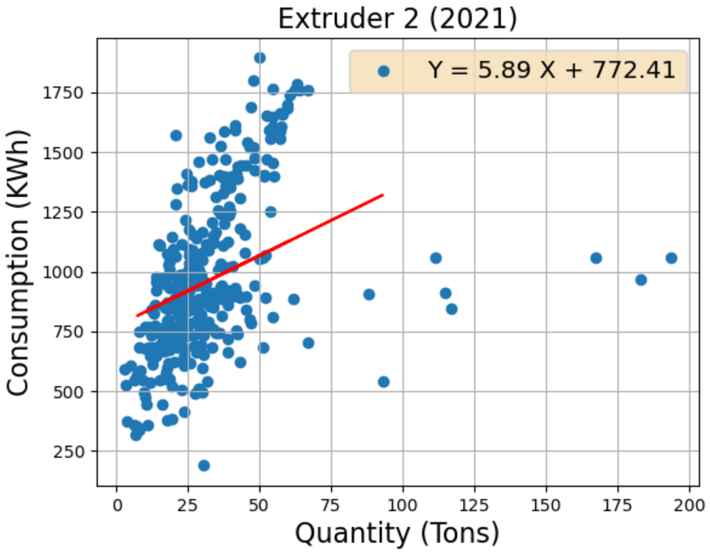


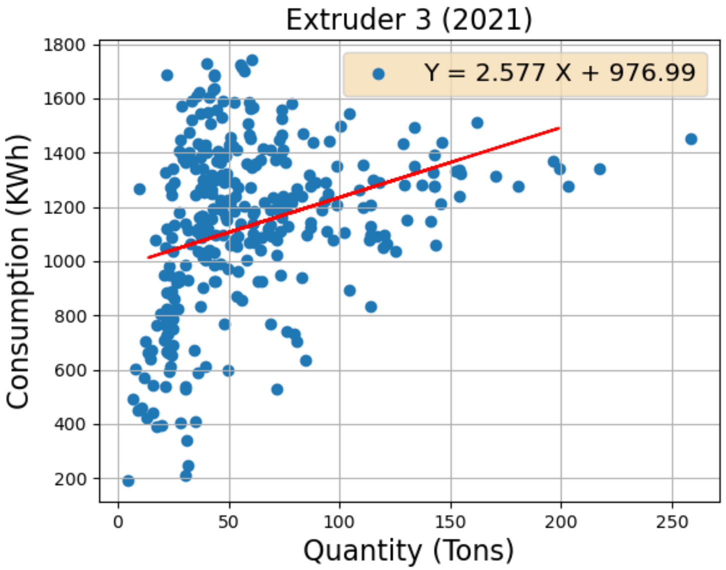
Create Base line models per production line for a Digital Shadow implementation

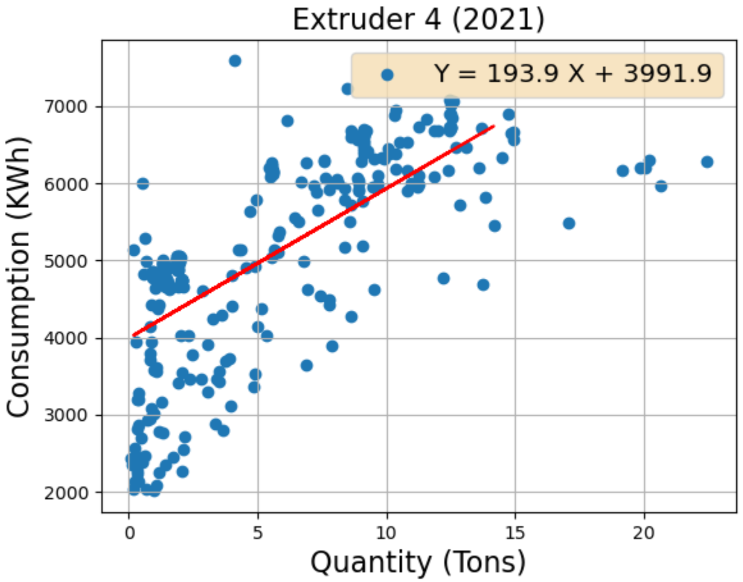






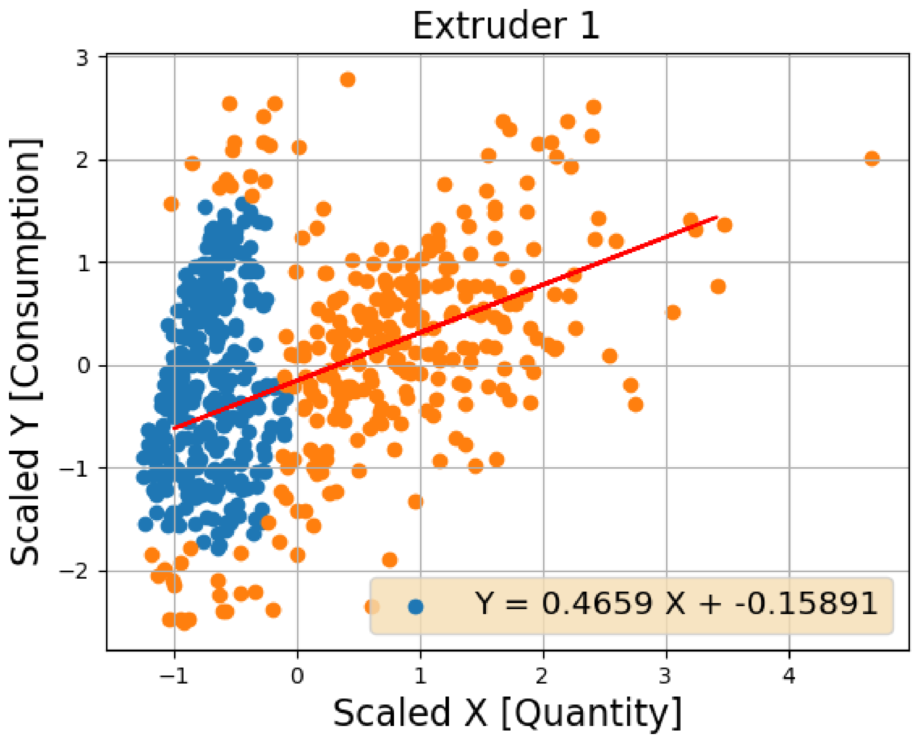




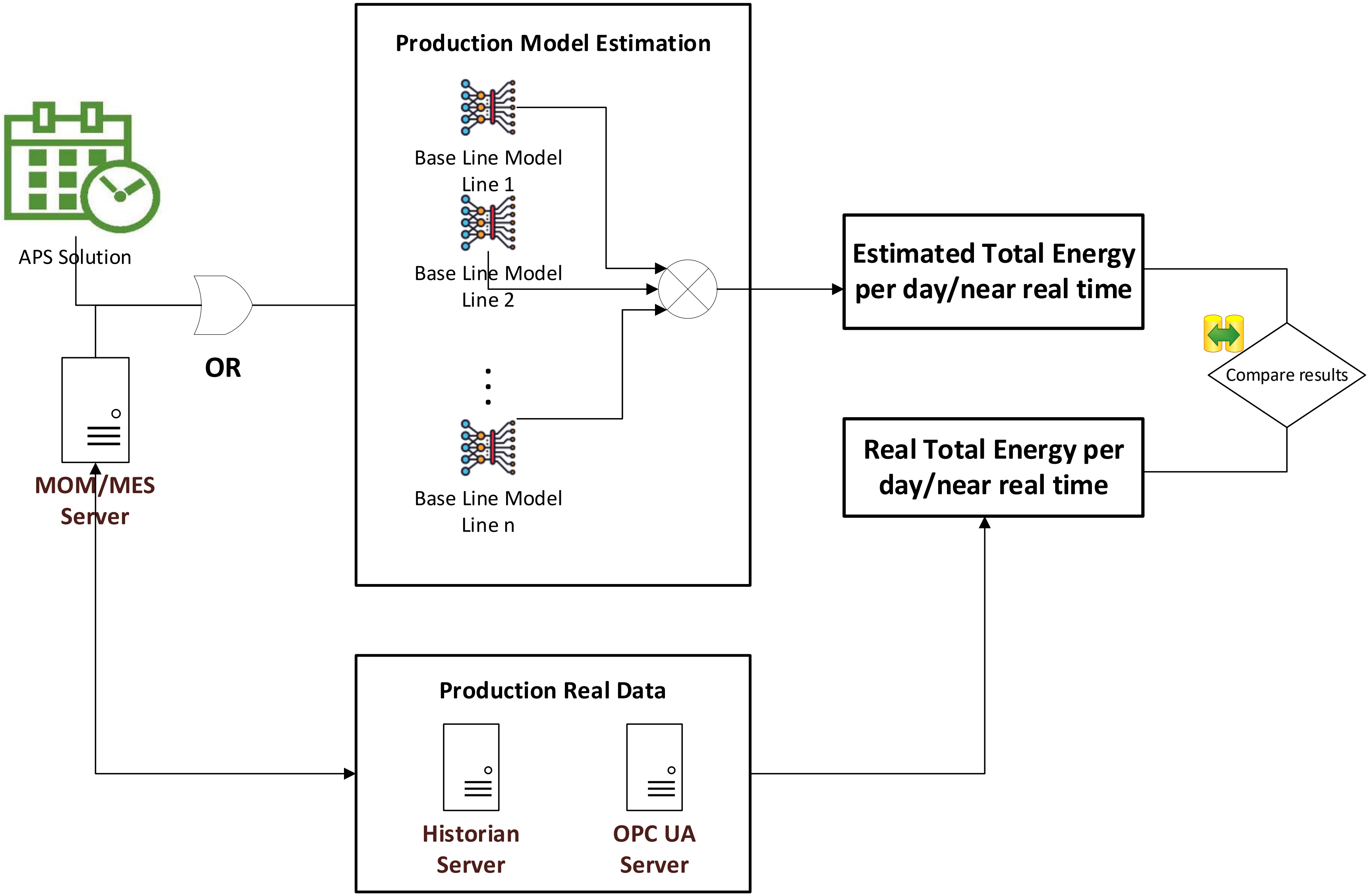


Explore contradictory cases

- Points with low production but high energy consumption
- Repeated behavior in certain type of production lines (extruders)
- More in depth analysis per case based on production data and other historical data showed various reasons but there was a common one for all extruders
- During idle times (e.g. setup, breakdown) extruder heating was left on
- Based on production and other data we estimated (conservatively) that annually for the extruders there is a potential for saving about 60.000 kWh (0,2 % of total Plant consumption)
- Rule of thumb: If the line remains idle for more than 1 hour we can switch it off and reheat before we start production



Digital Shadow Approach



Main messages

- Measure and Store
- Explore and use your data systematically
- Acquire Knowledge and understand from your data (Data➡Information➡Knowledge)

Thank you!

Q&A