Internet of Energy (IoE) in practice

Energy ADVICE

Topics

1. About and why IoE?
2. Electricity generation, transmission, distribution and consumption. Which part should be smarter?
3. What is Consumers behaviour and why digitalization is needed?
4. What is the role of IoE in Demand respond?
5. How can we impact electricity market?
6. Industry approach and benefits. Industry 5.0.

About IoE

- Internet of Energy is a technological term that refers to the upgrading and automating of electricity infrastructures for energy producers and manufacturers (Consumers).
- IoE allows energy production to move forward more efficiently and cleanly with the least amount of waste.
- Benefits of using IoE include increased efficiencies, significant cost savings, and a reduction in the wastage of energy.
- The Internet of Things refers to the idea of connecting devices to the internet. This includes anything from smartphones, tablets, and television sets to major appliances, headphones, and automobiles.

www.investopedia.com

Why IoE

- By using IoE technology, manufacturers and producers can reduce inefficiencies in existing energy infrastructure by **de**increasing generation, transmission, and use of electricity.
- Making updates to electric infrastructures allows an ease in flow of energy which can maximize its potential, therefore cutting down on any wastage of energy.
- Without any critical updates, a lot of that energy is lost along the line because they can't transmit it efficiently. Put simply, the lines simply don't have the capacity to carry all the energy being sent.

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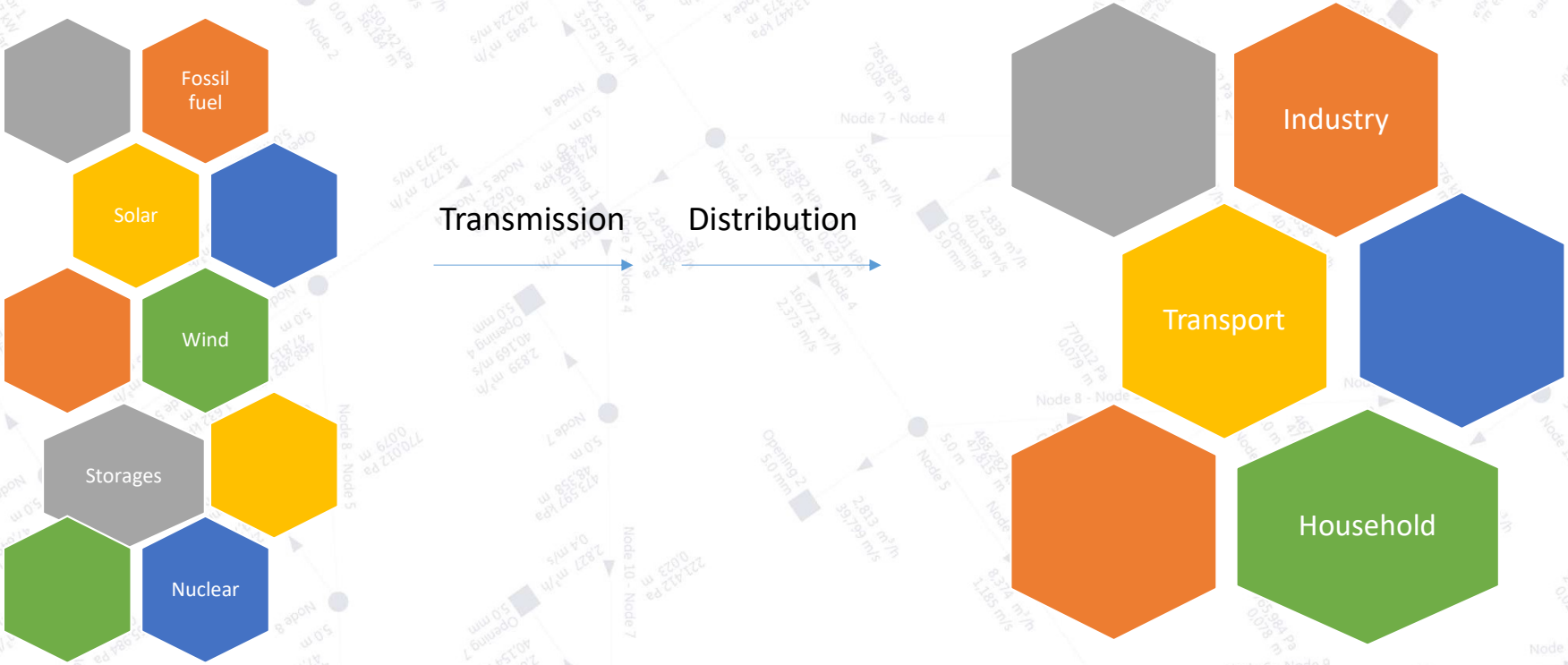
- In other words, grid capacity limitation limits Renewable integration.

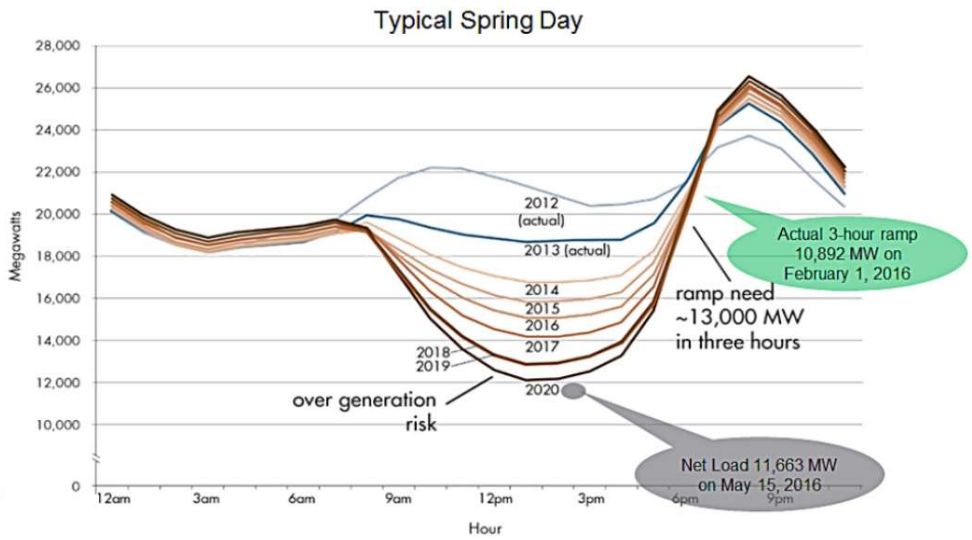
Smart Infrastructure

- Electricity generation, transmission, distribution and consumption. Which part should be smarter?



Consumer behavior

- Real time electricity generation and consumption balance;
- The main problem, solved by TSO is reliability, however very good forecast is required;
- 5% of forecast error requires huge capacity of generation;
- Target is to involve Consumer to the balancing;
- On other had, imbalance creates costs, and costs are covered by Consumer;
- Consumer is willing to reduce Costs;
- Understanding of consumption profile allow to reduce Consumer Costs (electricity price);

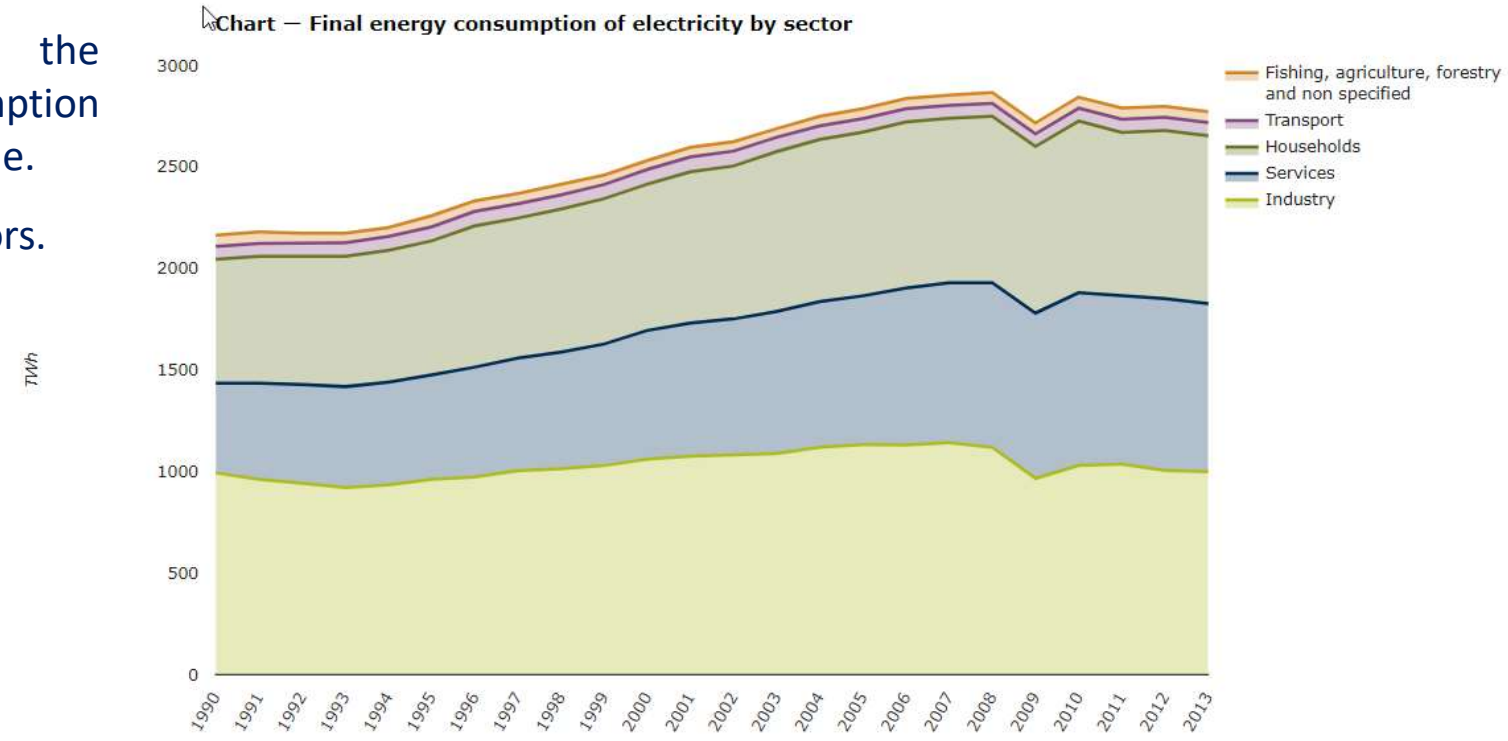


https://energywatch-inc.com/reverse-demand-response/

- PV generation impact seen in consumption profile;

Consumer behavior

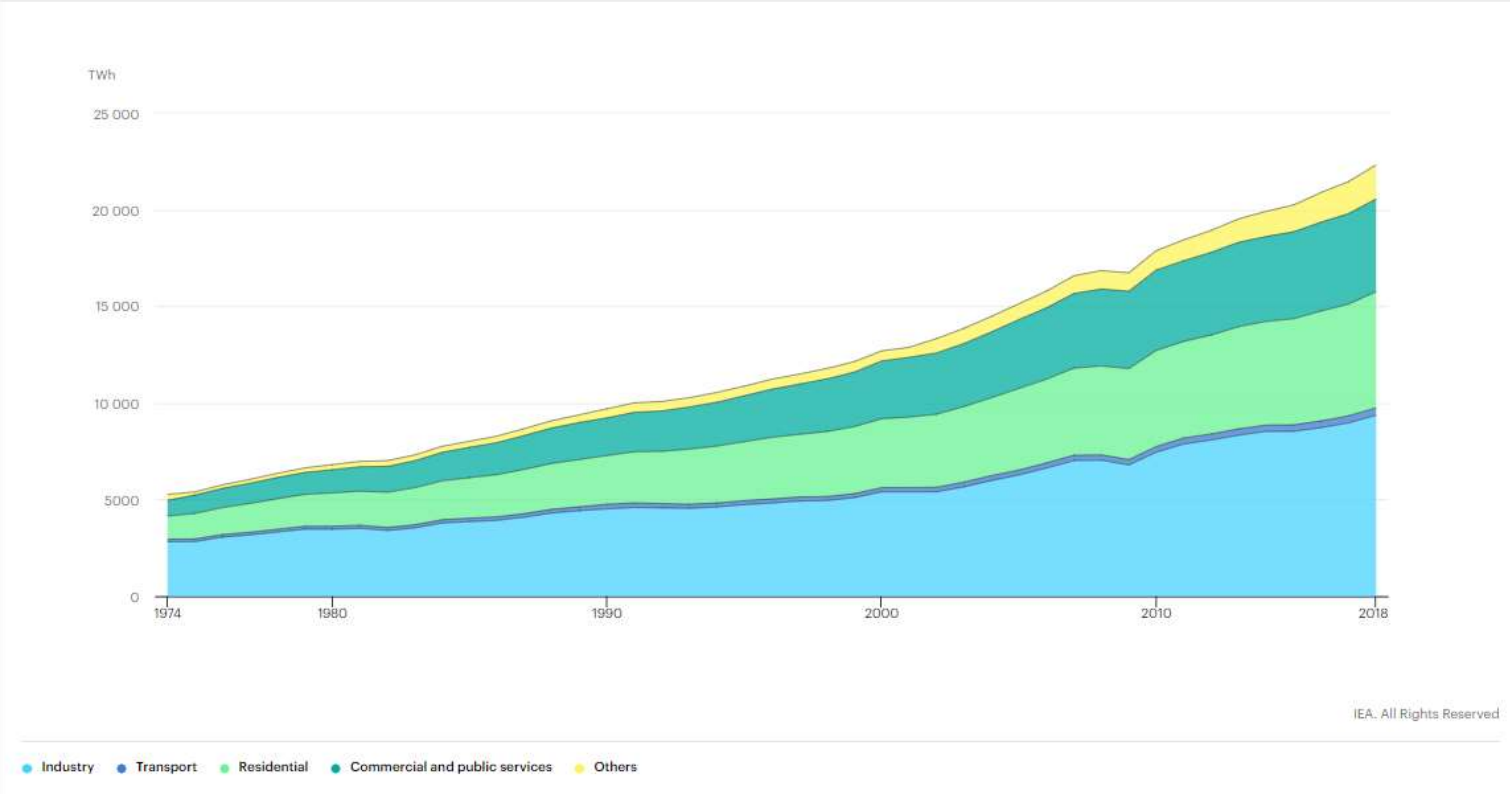
- After 2009 crisis, the electricity consumption curve in Europe decline.
- Decline cover all sectors.



https://www.eea.europa.eu/themes/data-and-maps/indicators/final-energy-consumption-by-sector-9/assessment

Consumer behavior

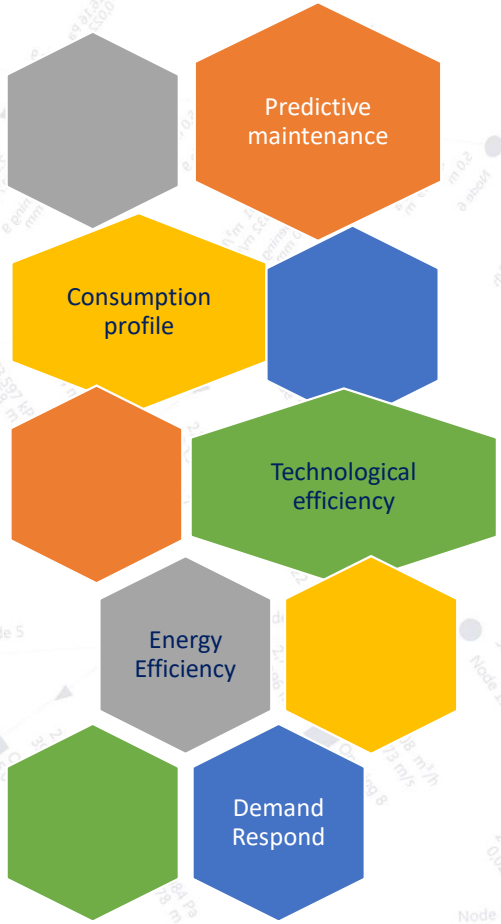
- However electricity consumption worldwide constantly increase.



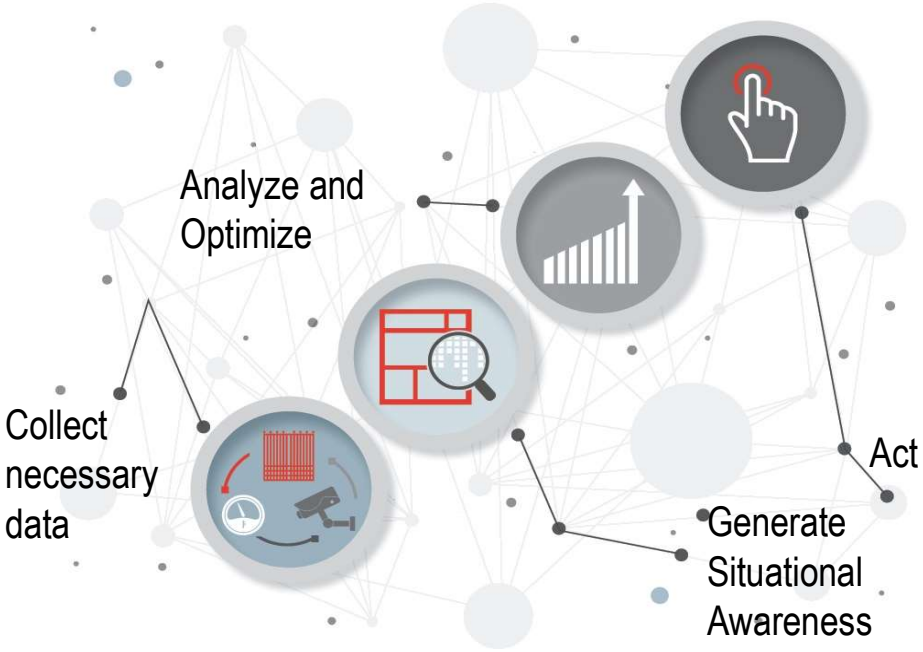
https://www.iea.org/data-and-statistics/charts/world-electricity-final-consumption-by-sector-1974-2018

Consumer digitalization, inventory

- Consumer digitalization means full mathematical model of all process in the Company;
- Consumer digitalization (Industry) provide:
  - Predictive maintenance. Reduce maintenance costs. Industry 5.0.
  - Consumption profile – reduction of electricity price, due to Increase forecast precision;
  - Technological efficiency;
  - Energy Efficiency;
  - Opportunity to participate in Demand Respond scheme.



Data Management Concept



While utilities already possess huge amounts of data, this situation is going to be even more severe due to smart meters roll-out.

However, data is only as good as useful knowledge extracted from it.

Therefore, the important question is how utilities are going to benefit from all this data?

Energy Advice team is ready to apply classical and AI based big data analysis solutions to answer this question to your company.

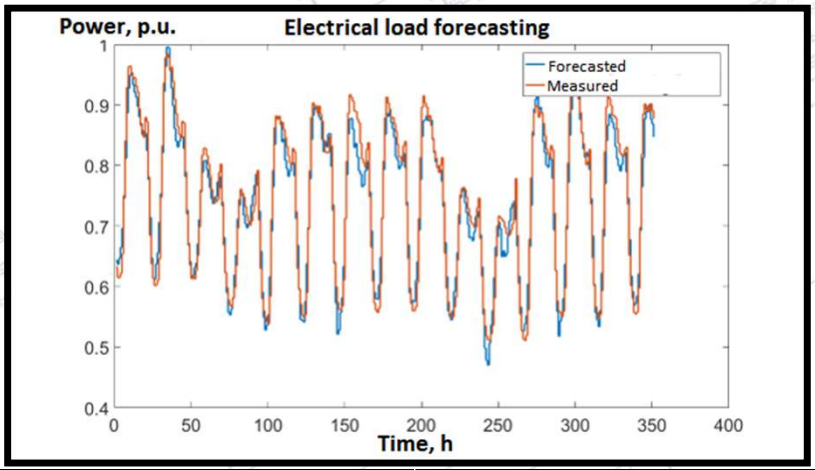
Data Driven Solutions

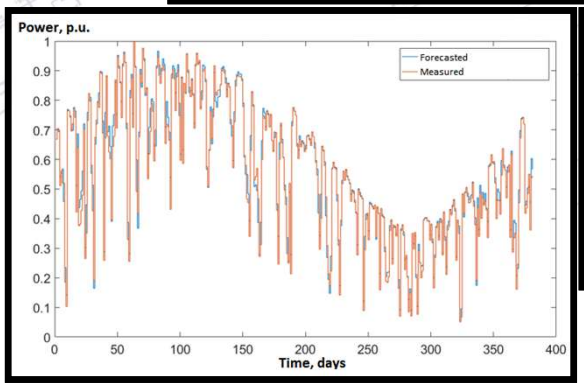
Optimize assets planning
Optimize CAPEX to defer capital investments where possible. Base these decisions on advanced data analytics.

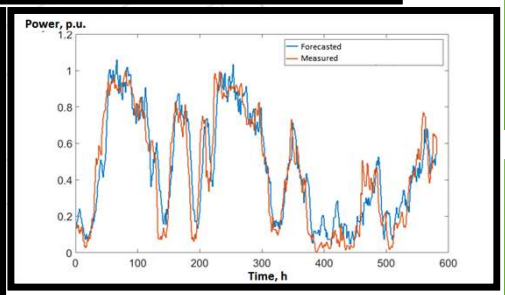
Improve operational performance
Control system according to consumers behaviors and ensure maximum energy efficiency.

Increase system reliability
Avoid unplanned outages and revenue loss. Compare optimal system reliability measures with your current situation.

Short-Time Demand Forecasting







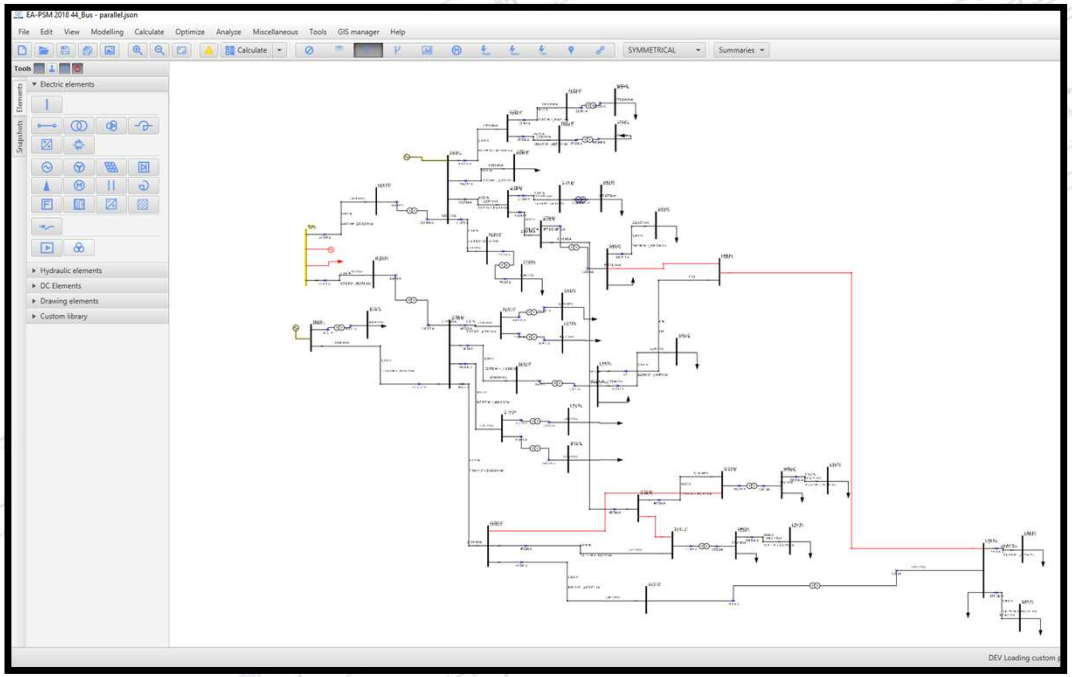
Advanced data analysis algorithms allow to forecast water, electricity, gas and heat consumption as well as renewable power plants generation.

Increase operations efficiency
Control water pressure, system configuration, heat carrier temperature and fluid flow according to the expected demand. As a result, minimize system power consumption and avoid unfavorable conditions like water stagnation.

Forecast your business expenditures and revenues
According to the expected demand get accurate information about company‘ energy and fuel consumption.

Plan electricity, gas and biomass future contracts
Make well – reasoned decisions on your future contracts in electricity, gas or biomass markets.

Reliability Analysis



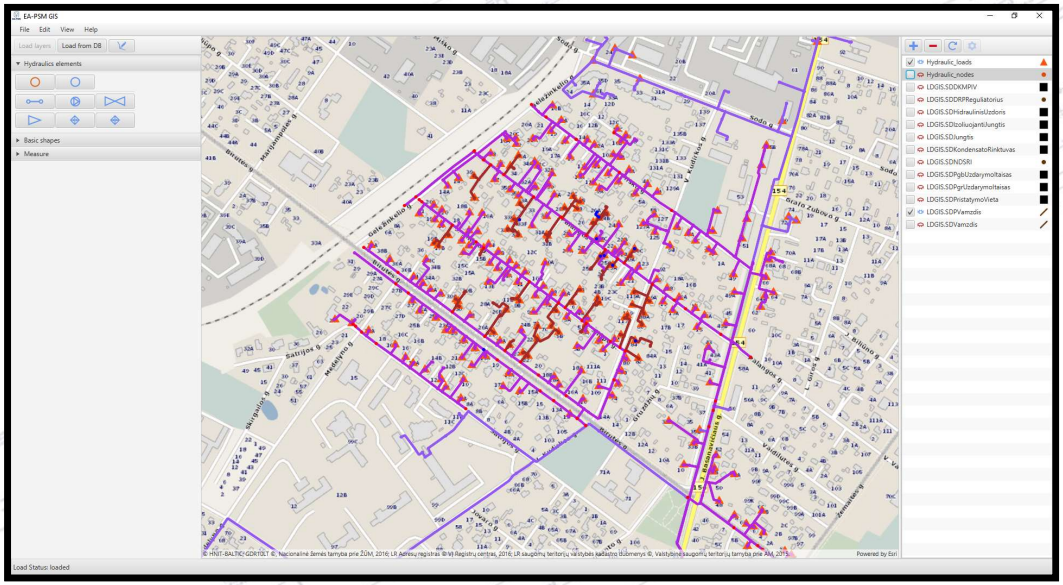
Proposed algorithms allow to calculate electric and hydraulic networks reliability.

Reduce losses by ensuring reliability
Get information about bottleneck system parts that significantly affect system reliability or efficiency.

Optimize CAPEX
Redirect investments to critical system parts and ensure cost-effectiveness of expenditures.

Benchmark outage processes
Collect necessary data and calculate measures like SAIDI, SAIFI, CAIDI and etc. Compare optimal system reliability measures with your current situation.

Faults Detection



Energy Advice products allow to calculate electric and hydraulic networks. According to measurements and calculation results algorithms will suggest expected fault location.

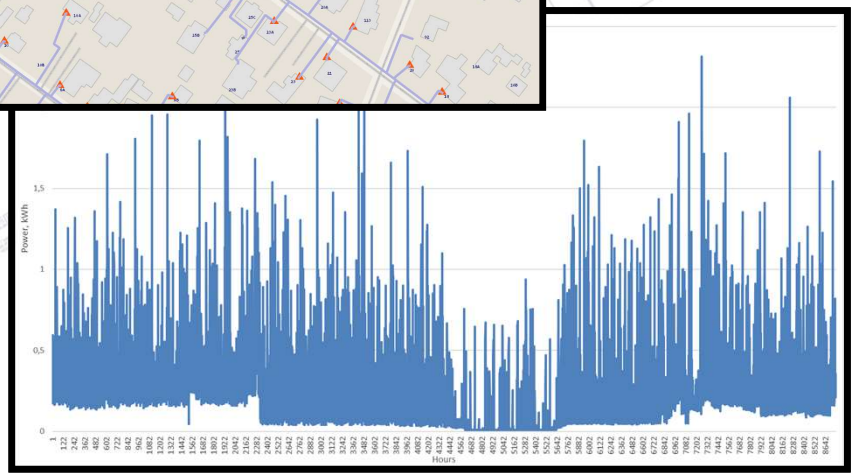
Reduce faults elimination time

Faster fault elimination minimizes revenue losses and improves system reliability measures.

Find not only the fault but also its cause

Cause is not always obvious. Network modeling algorithms allow to find it and take actions to avoid it in the future.

Resource Theft Detection



Get the most out of your data

Algorithms analyze energy usage patterns, payment history, other customers data and notify accordingly about any abnormal changes.

Reduce expenditures on inspections

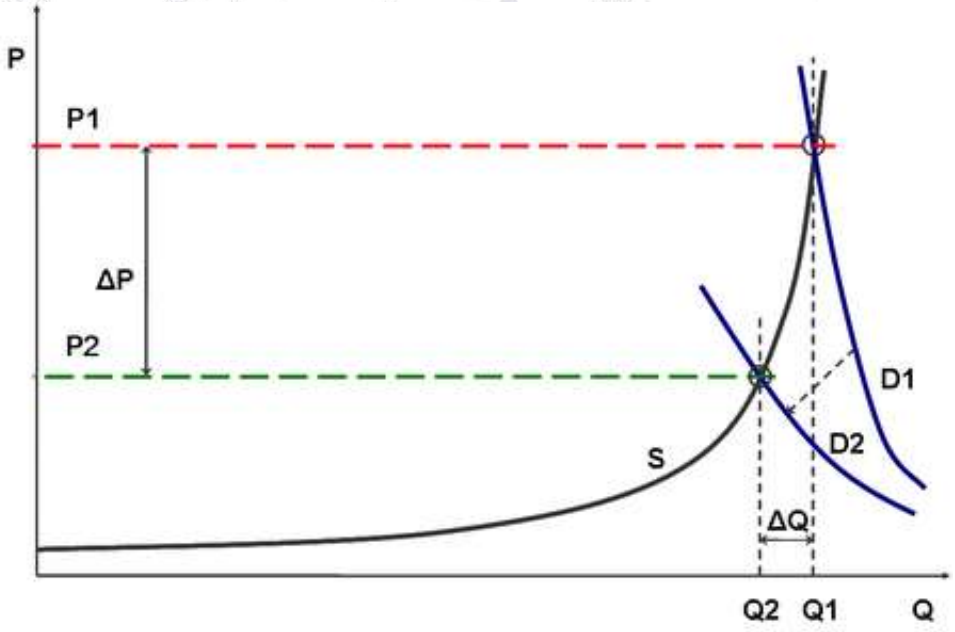
In vast systems expenditures on inspections can be significant and, in most cases, economically infeasible. Therefore, it is necessary to employ automatic solutions.

Mitigate revenue losses

In some utilities illegal consumption accounts for up to 40% of distributed energy or material. What is more, majority of utilities do not know even the approximate scale of illegal consumption.

IoE and Demand Response

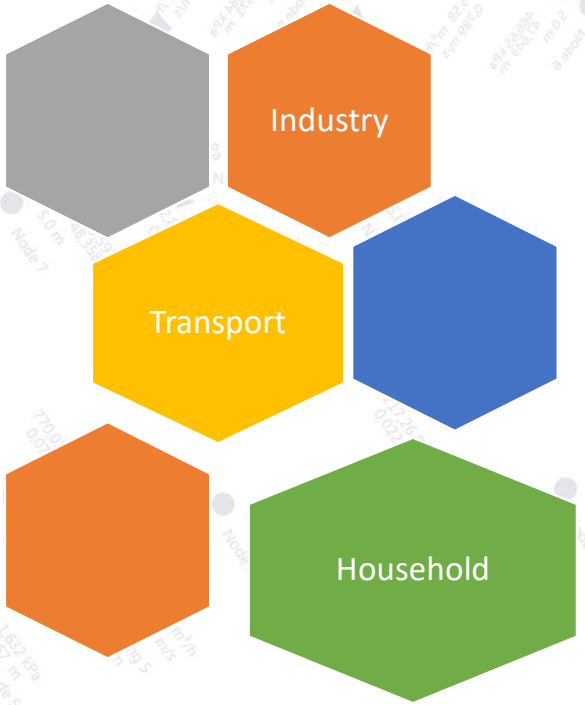
- Demand response is a change in the power consumption of an electric utility customer to better match the demand for power with the supply.
- Under inelastic demand (D1) extremely high price (P1) may result on a strained electricity market.
- If demand response measures are employed the demand becomes more elastic (D2). A much lower price will result in the market (P2).
- How Consumer could achieve results with Demand respond philosophy?
- Can Consumer shift load during peak hours?



https://en.wikipedia.org/wiki/Demand_response

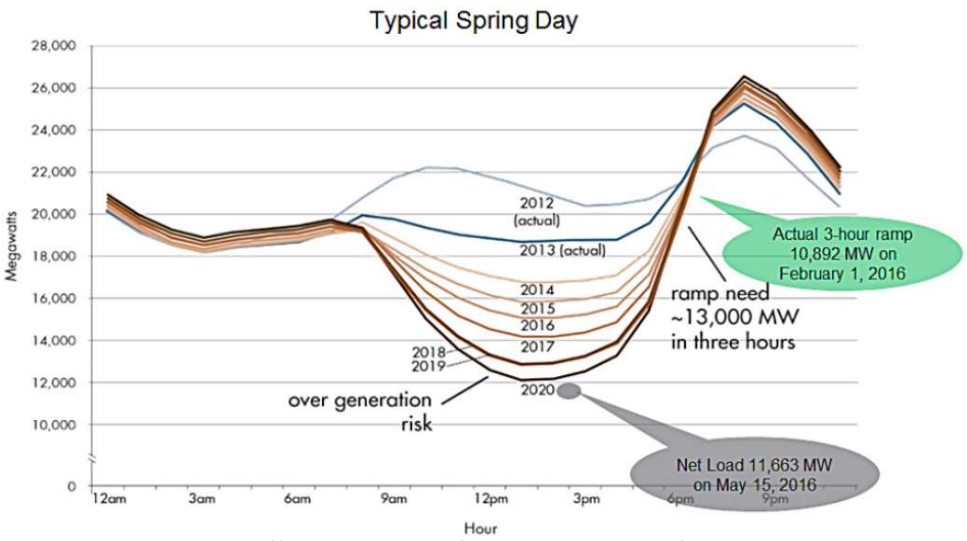
IoE and Demand Response

- Household could reach target only with household appliances connected to Internet;
  - Run/stop washing machine, refrigerator?, other equipment…
- Transport could charge/discharge batteries, however IoE infrastructure required;
- Industry could shift load with doubts, however, temporally turn off/on ancillary equipment;
- *In general, Consumer - human hardly would change behavior, however IoE could automate process and help TSO better control grid operation.*



Impact on Electricity market

- Solar, Wind generation provides high uncertainties to the market and Grid Control;
- Solar generation at Distribution level reduce Consumption peak, seen from TSO;
- IoE by it self creates value for Consumer indirectly, ie due to reduce Costs for Grid Operation;
- Seems, that Houshold Consumer could not be motivated adopt consumption according to electricity price. So, the EU Directives could solve motivation issue;
- Industry by itself could be motivated for Technological and energy efficiency so, reduction of energy consumption is on the way;



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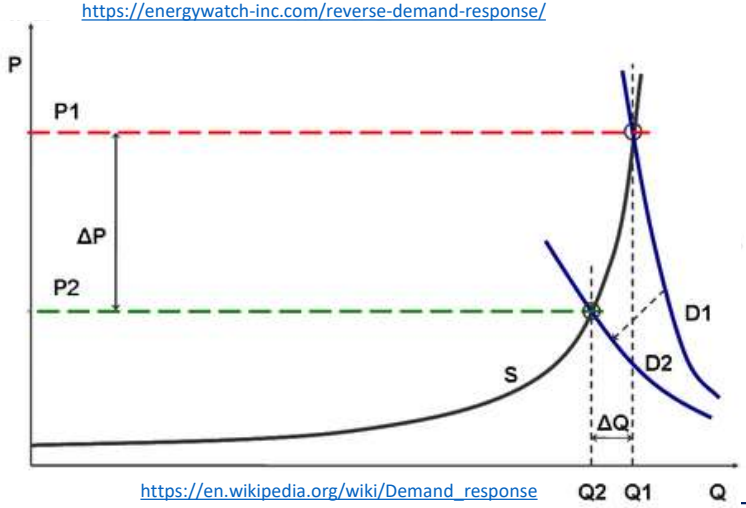

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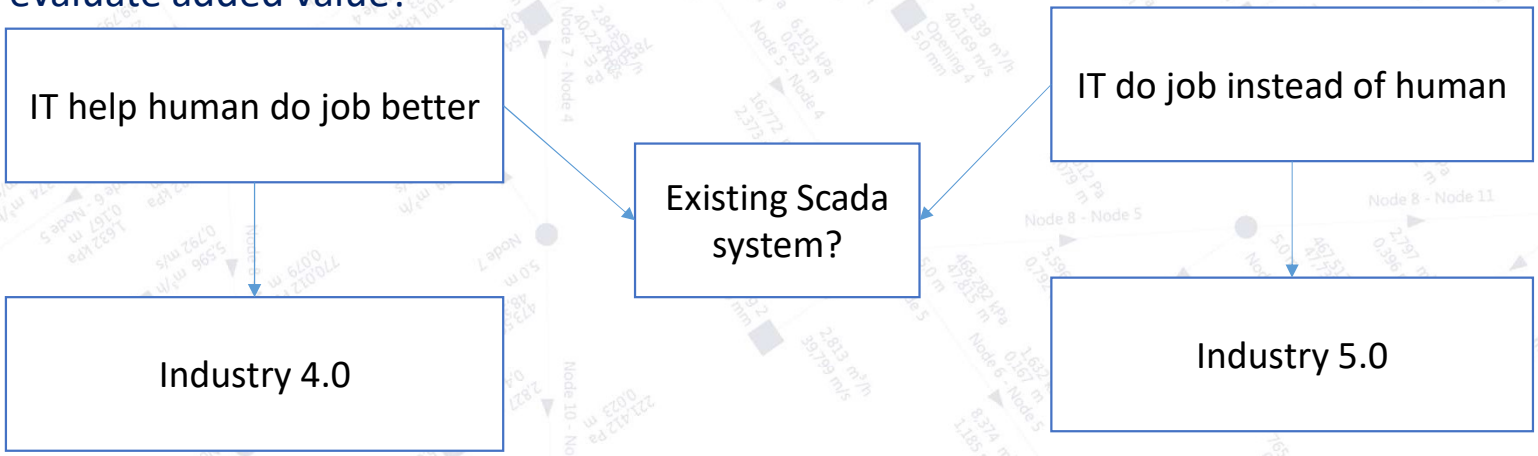
Impact on Electricity market

- IoE is tool/concept which allow automated data exchange and optimize overall behavior between Consumer and Producer;
- IoE should be evaluated as CO2 emission reduction concept, due to allow decrease Electricity Consumption, increase energy efficiency;

Industry 5.0

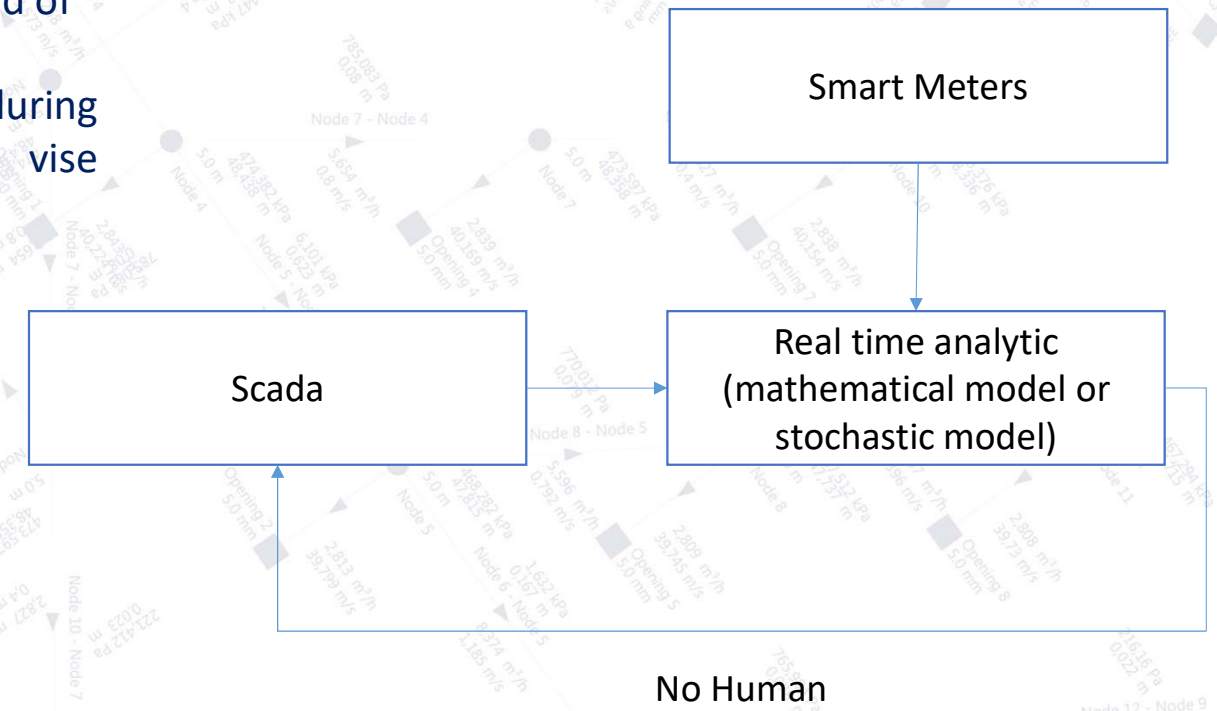
- Industry 4.0 involves methods for interconnecting new technologies to improve efficiency and productivity.
- Industry 5.0 robots (software as a service) helping humans work better and faster by leveraging advanced technologies like the Internet of Things (IoT) and big data.
- How to evaluate added value?



Industry 5.0

- Added value:
  - Business variable costs instead of fixed costs;
  - Reduction of energy usage during reduced production and vise versa;
  - Up to 5% of costs reduction.

- Functional diagram:



Industry 5.0

- What about examples:
  - Transportation company deliver only bear. How to optimize route and cargo? Human receive optimized route.
  - Food Industry consume “cold energy”. Consumption is dynamic, means production is dynamic. Industry is wiling increase energy efficiency by understanding consumption profile. “Cold energy” consumption profile is created using a lot of data. Waste of energy is cached and limited.
  - Wood chip boiler due to dynamic load change suffer from extra losses due to imperfect control and system nonlinearity. Boiler mathematical model, which involve burning reaction mathematics and includes real time measurement, provide optimum boiler operation setpoints.
  - Office building consumes energy for Heating, ventilation, conditioning (HVAC). Energy supply could be monitored, however, what is added value? Smart HVAC control. Feed Back for personnel.

Industry 5.0

- What about examples:
  - Malt (for bear) production is highly related to malt quality, however human or scada system can not analyze data and forecast results. Real time data analytic provide set point for scada system.
  - PV generation forecast and comparison with real electricity generation allow understand the generation deviation from maximum possible generation. Reduction of electricity generation could be registered, and value added due to predictive maintenance.
  - Real time district heating network control and thermal losses minimization.
  - However bad examples exist. Bad only, because bad ROI.
  - Sometimes bad ROI for person, however, have good impact globally. All examples, related to Household.
  - …..

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