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Recent and future needs on the operation of combined cycle power plants.

Kilian Link, Siemens, Energy Sector

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Agenda

- The basic principle of combined cycle power plants (CCPP)
- Transition of the energy system (e.g. Germany)
  - Market needs.
  - Demand on flexibility.
  - Integration of solar and wind power.
- Examples for challenging issues of control and decision making.

Sectors and Divisions as of October 1, 2011

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Energy

Divisions

- Fossil Power Generation
- Wind Power
- Solar & Hydro
- Oil & Gas
- Energy Service
- Power Transmission

Healthcare

Divisions

- Imaging & Therapy Systems
- Clinical Products
- Diagnostics
- Customer Solutions

Industry

Divisions

- Industry Automation
- Drive Technologies
- Customer Services

Infrastructure & Cities

Divisions

- Rail Systems
- Mobility and Logistics
- Low and Medium Voltage
- Smart Grid
- Building Technologies

- OSRAM [1)]

1) In fiscal 2011, Siemens announced its intention to publicly list OSRAM and, as an anchor shareholder, to hold a minority stake in OSRAM AG over the long term

Basic principle of a CCPP and why it is benficial

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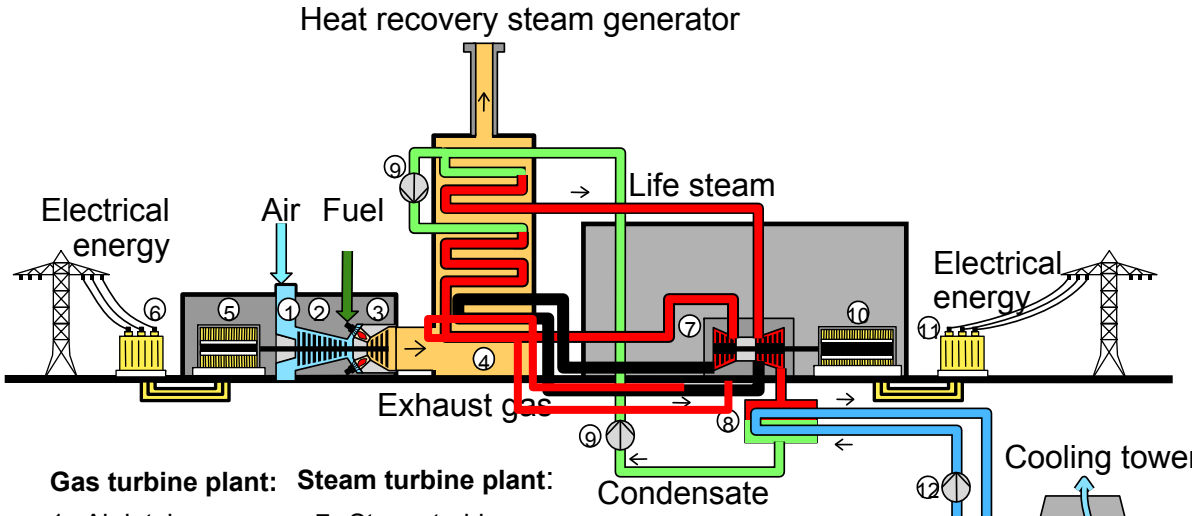


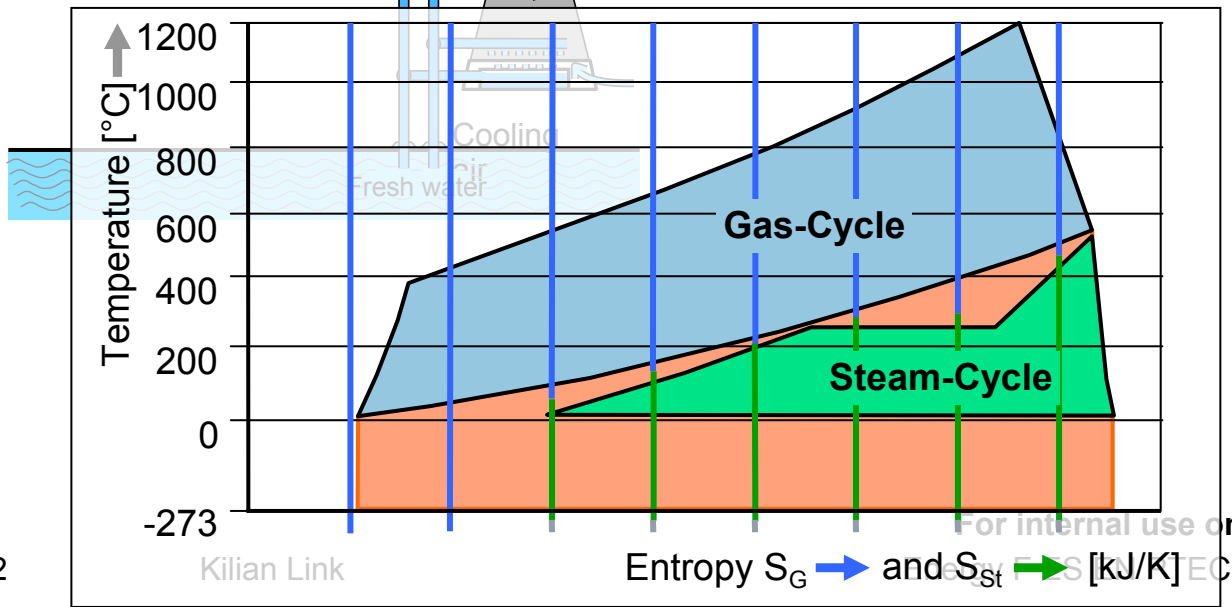
Gas turbine plant:

1 Air intake
2 Compressor
3 Gas turbine
4 Heat recovery steam generator
5 Generator
6 Transformer

Steam turbine plant:

7 Steam turbine
8 Condenser
9 Feeding pump
10 Generator
11 Transformer
12 Circulating pump

- High efficiency (world record over 60% efficiency, May 2011)
- Low invest.
- Flexible Operation.



Common single shaft configuration combined with a HRSG with 3 pressure stages plus reheat.

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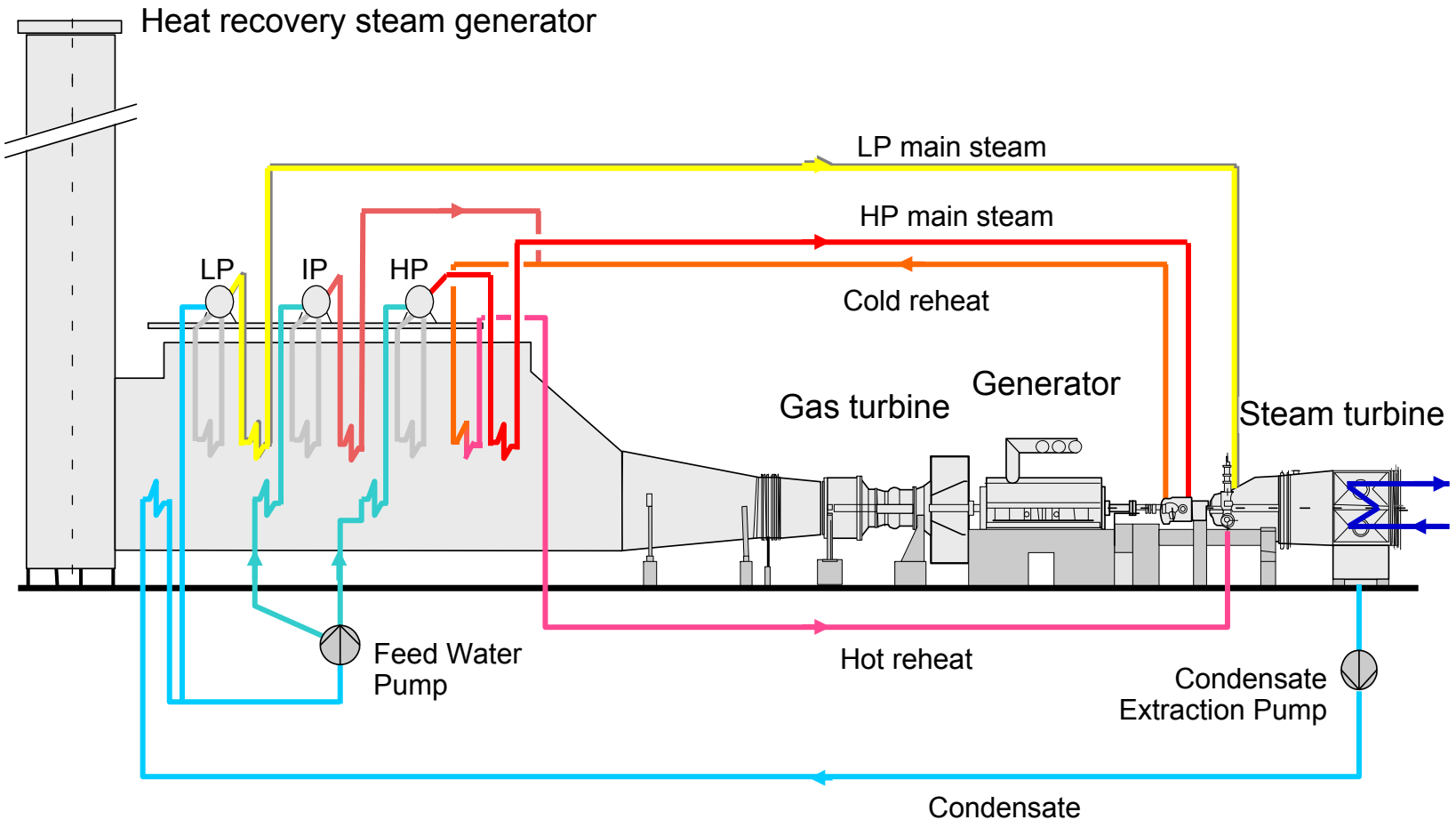

Future market needs

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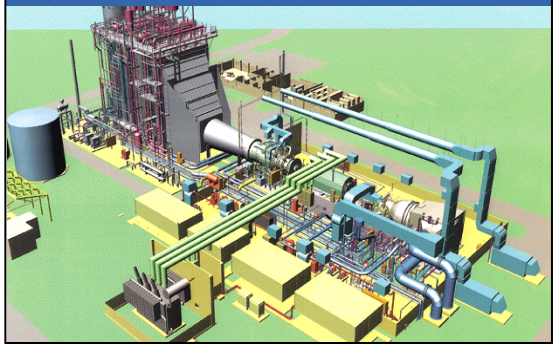
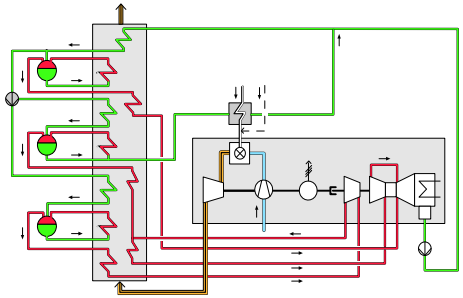
Wind Power

Solar Power

Lowest Investment



Highest Efficiency



Highest Flexibility

CO_2 emission reduction

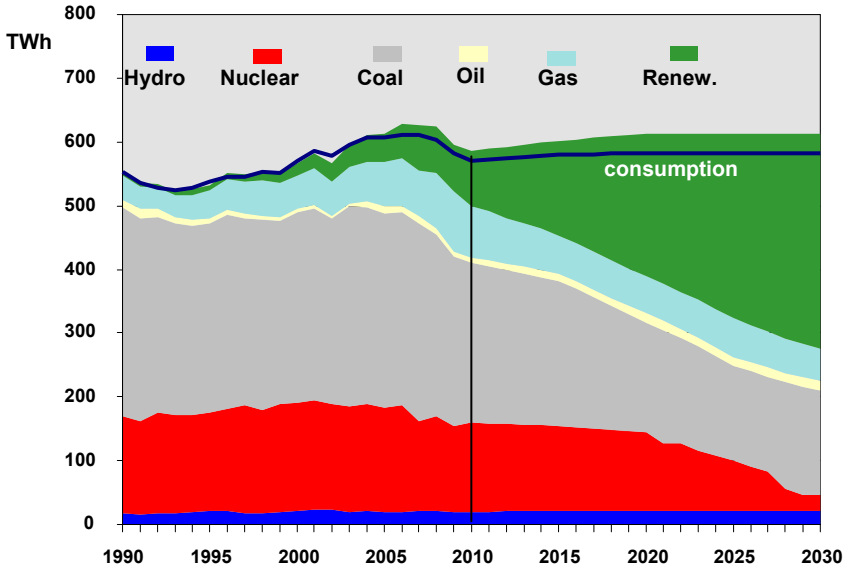
CO_2

increasing gas prices

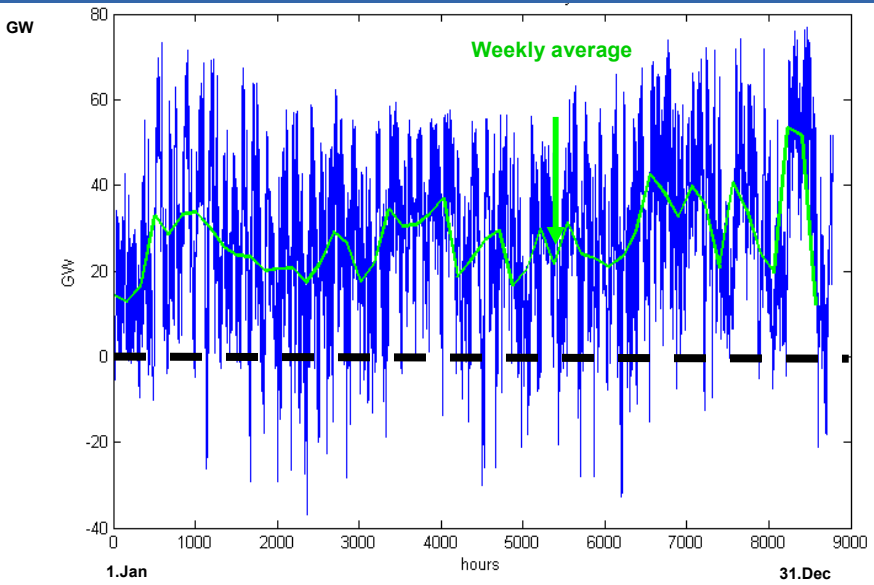
Operating flexibility

Power Generation in Germany: Challenges with a high share of renewable energy

Change in the generation structure



Residual load (load-renewable in feed) 2020



Increasing mismatch between generation and load to be compensated by backup and storage

Today’s power generation provided by renewables in Germany?

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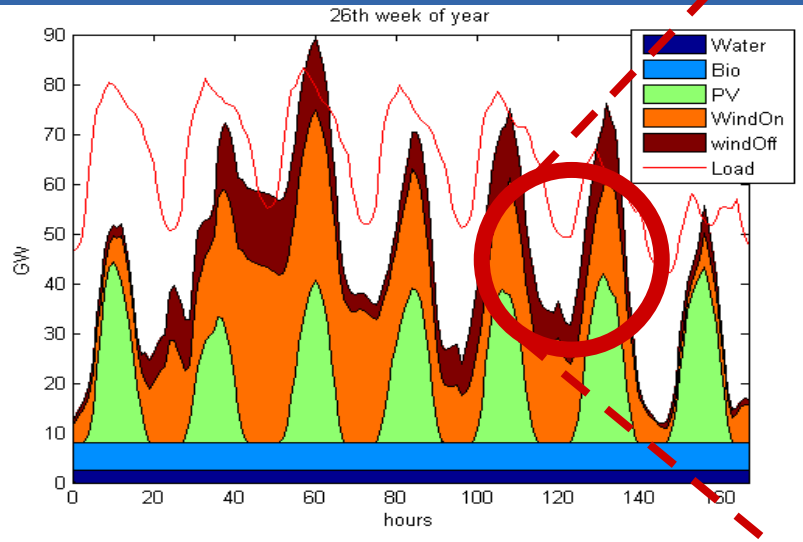
Today’s Power Mix in Germany

Today's Wind Power in Germany
Today's Solar Power in Germany

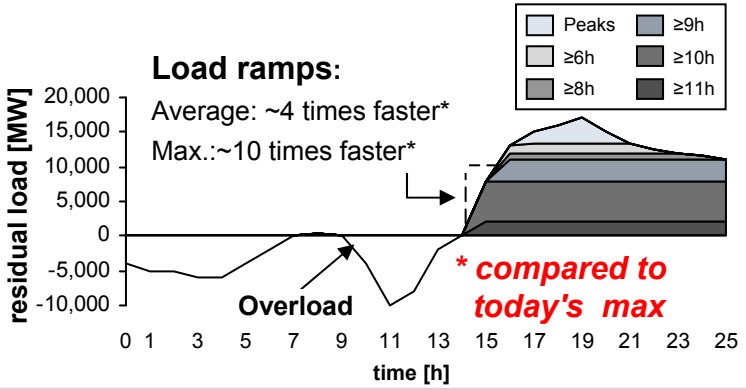
Operating flexibility forecast Germany

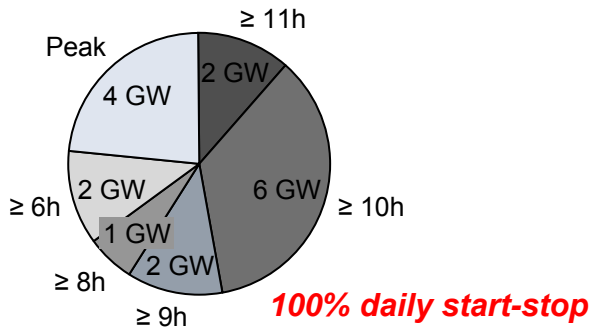
We need flexible plants in the future:
Power Generation Scenario 2020 (Germany)

Typical Summer Week (June 2020)



High wind day

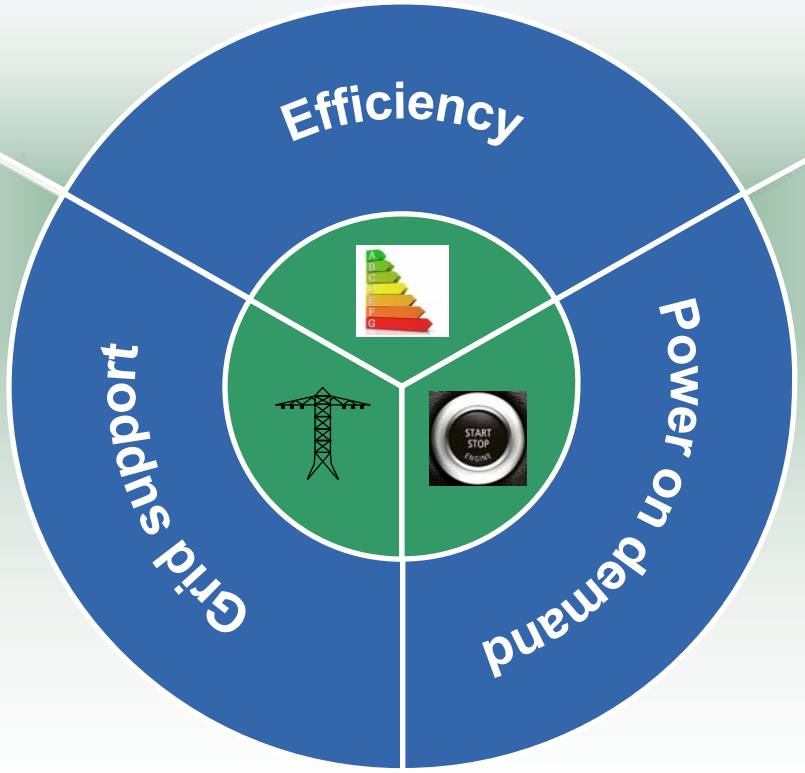




Germany 2020: Up to 100% of the non-renewable fleet requires daily start-stop operation, load ramps of about 200 MW/min to be covered

Operating flexibility – different aspects

- Highest efficiency throughout the whole load range
- Optimized start up and shutdown operation



- Load ramps
- Stable operation in case of grid incidents
- Backup power

- Fast starts
- Load ramps
- Park load

Siemens Application
How MODRIO adresses these requirements

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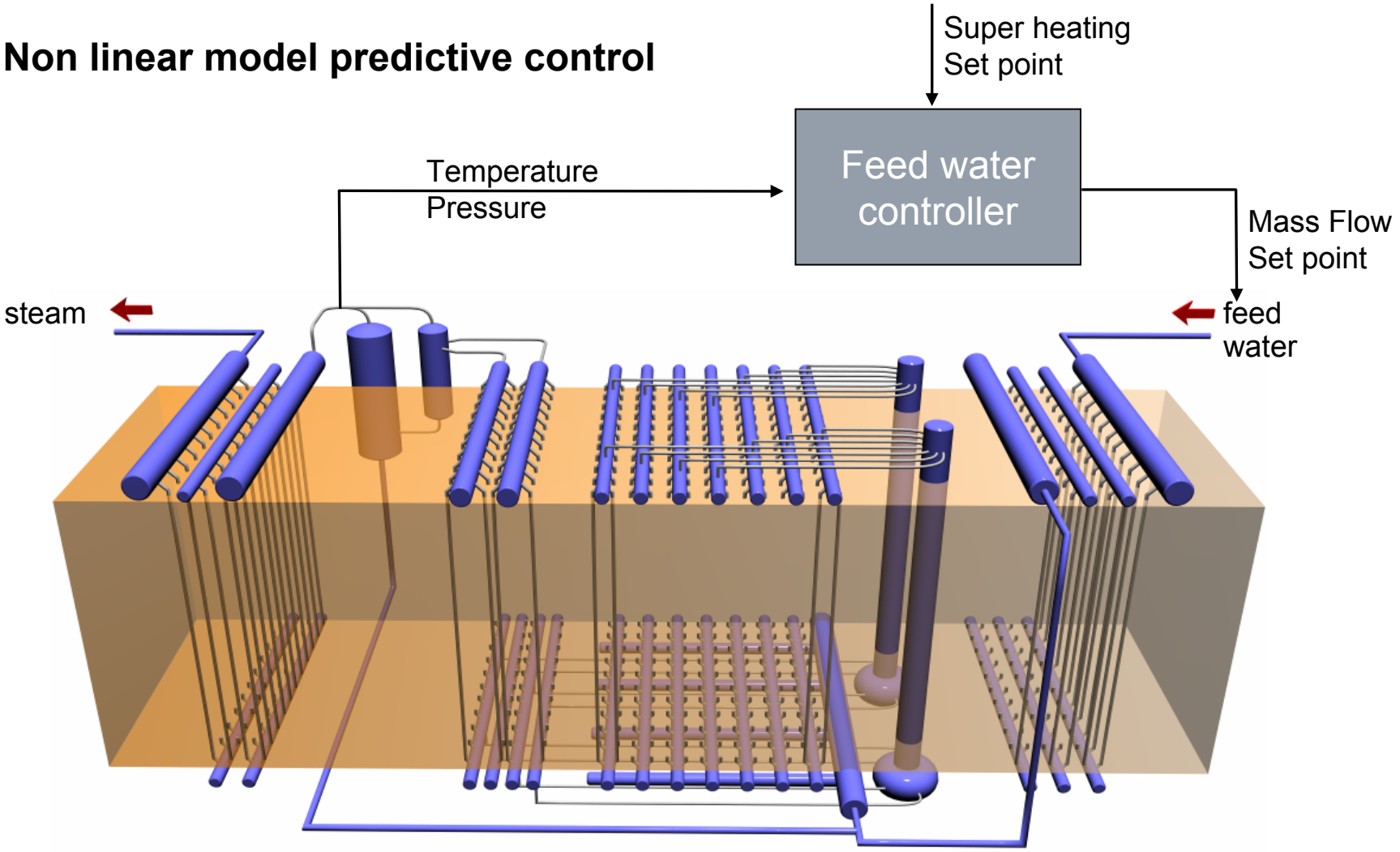
Non linear model predictive control



Siemens Application
How does MODRIO addresses these requirements

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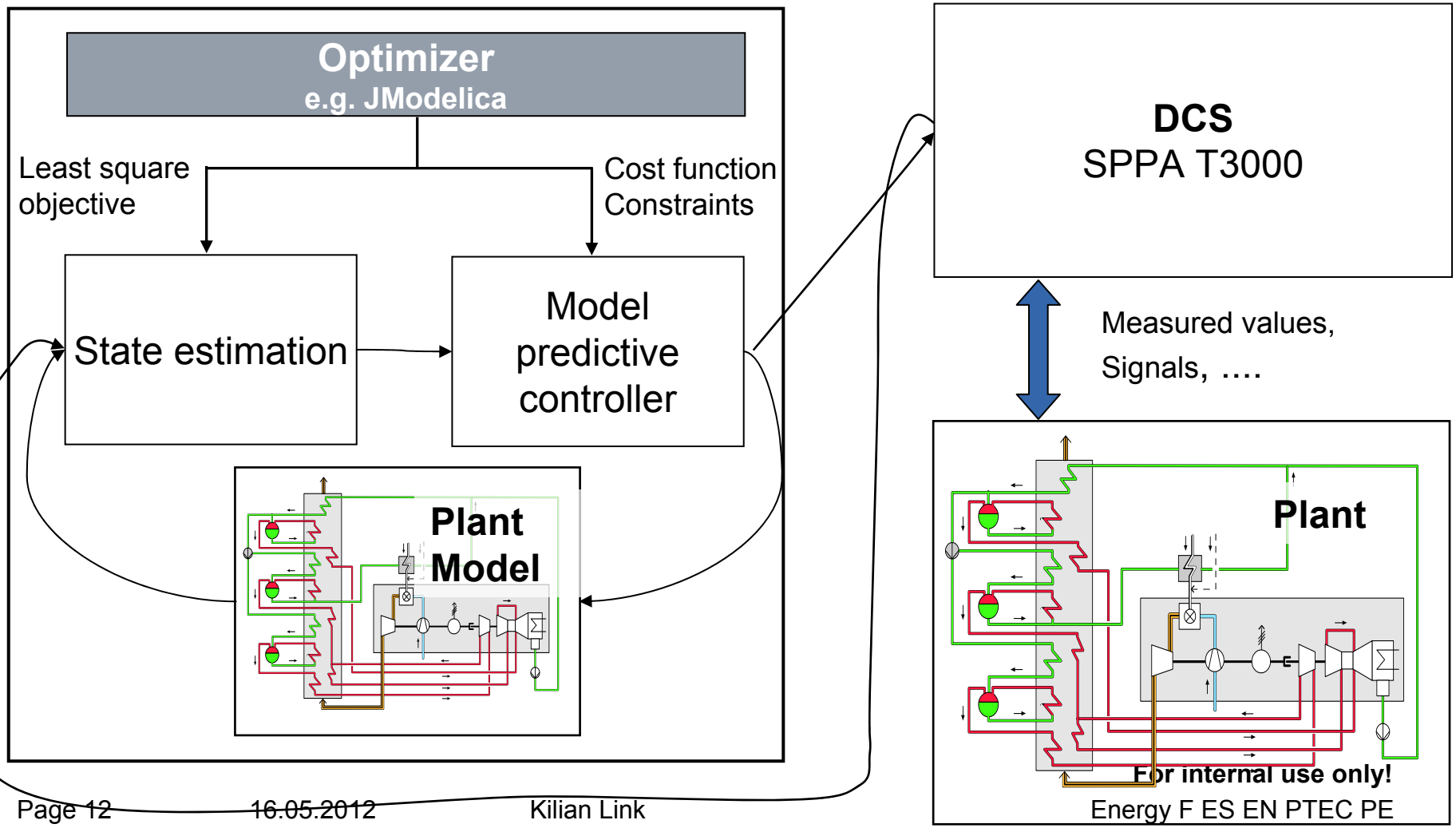
Non linear model predictive control



The operator will need some guidance in the future

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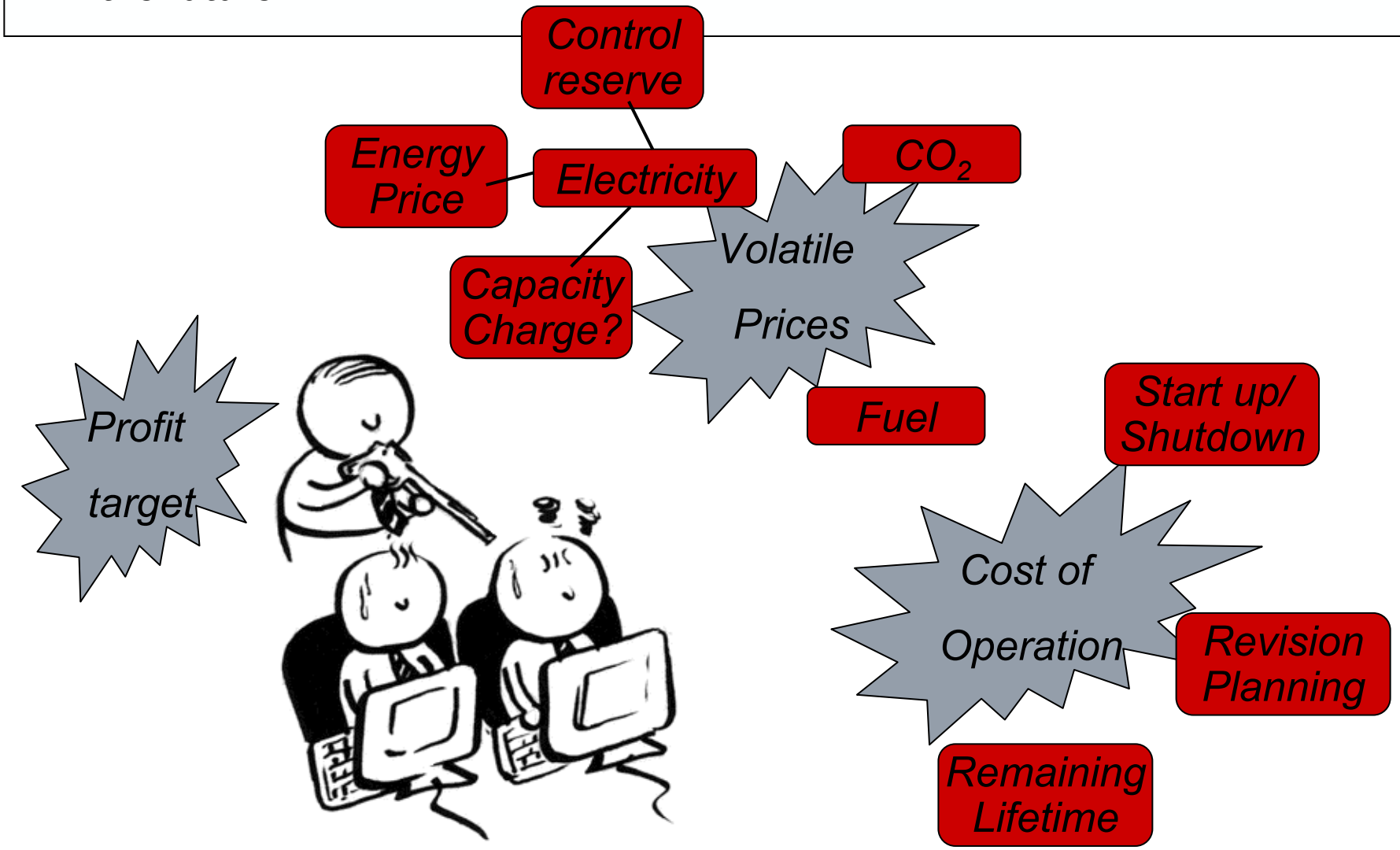

Plant control will evolve into high sophisticated software.

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The business model of controllable power plants will change focus form steady state operation of flexibility..

- Development processes of software will be applied to control design and implementation.
- Control guys will be bothered with real world's non linearity.
- Innovation will be boosted with respect to
  - modeling.
  - On- and offline Optimization.
  - Diagnosis.
  - Operator guidances.

Your Feedback

Thank you for your attention!