Adaptation of O&M procedures – new operating, maintenance and training requirements

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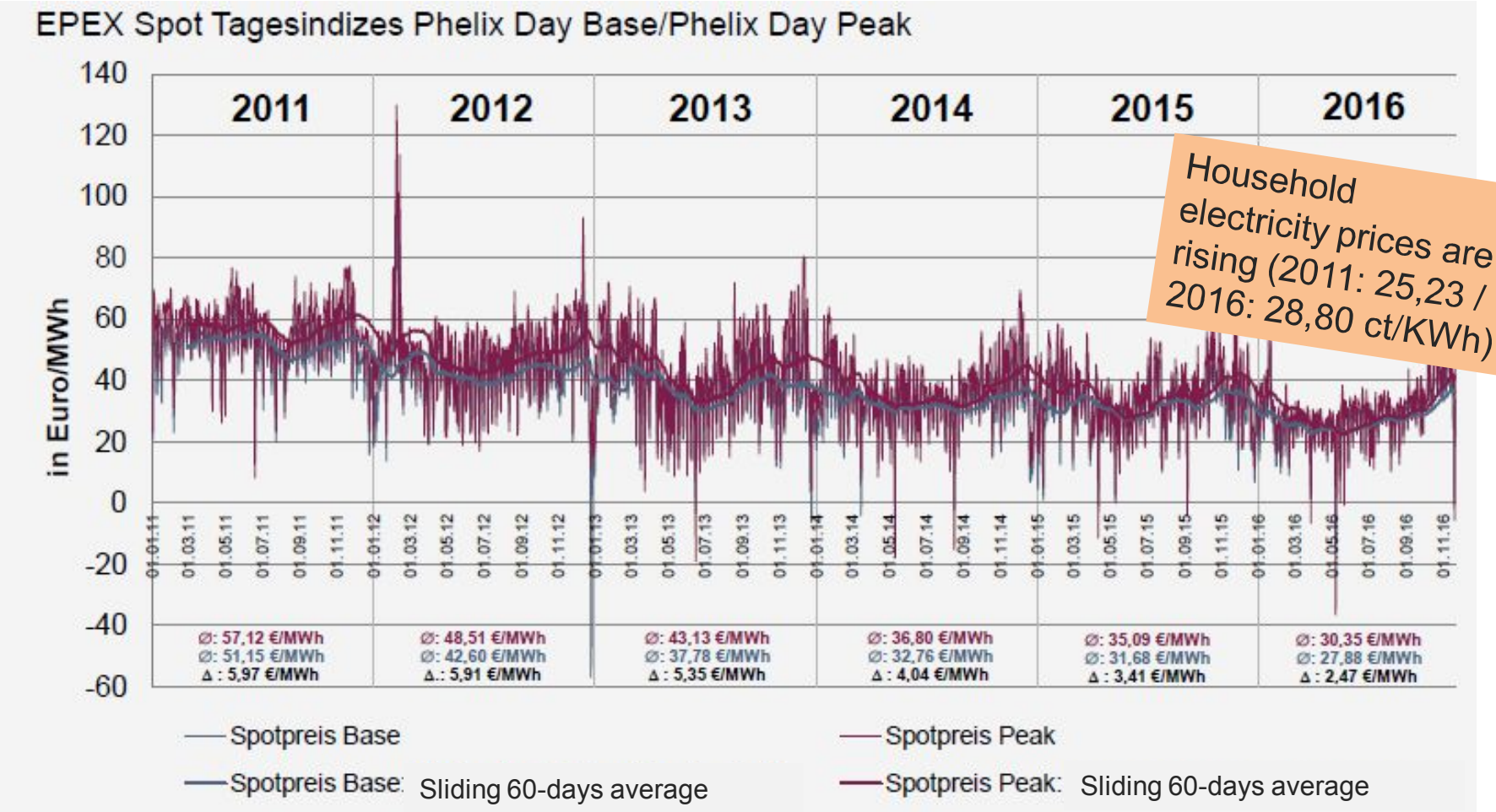
Agenda

1. Challenges
2. Aspects and consequences of flexible operation
3. Modern maintenance strategies
4. New requirements for the power plant personnel
5. Conclusions and outlook

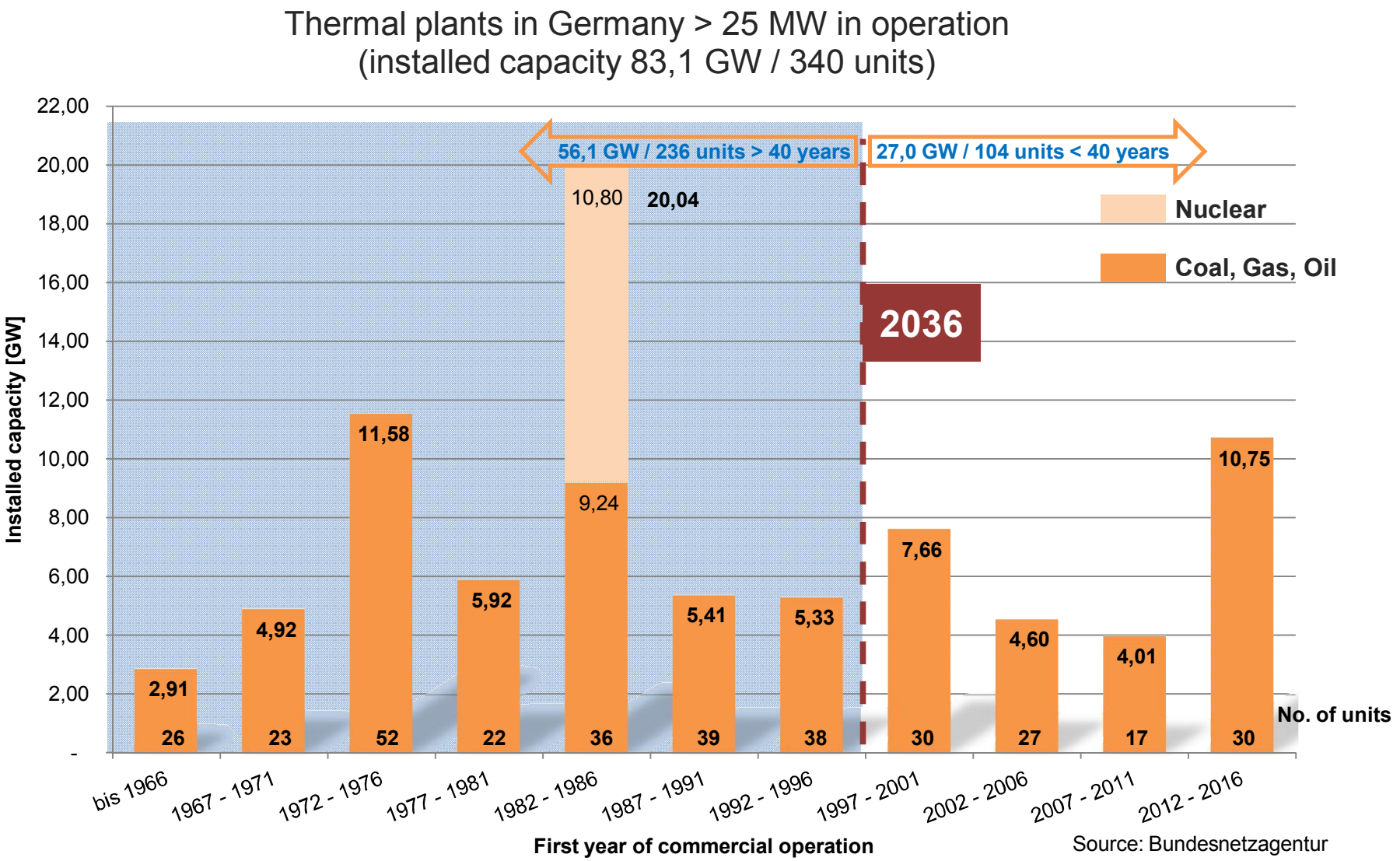
1. Challenges: declining energy prices



Source: EPEX Spot, BDEW

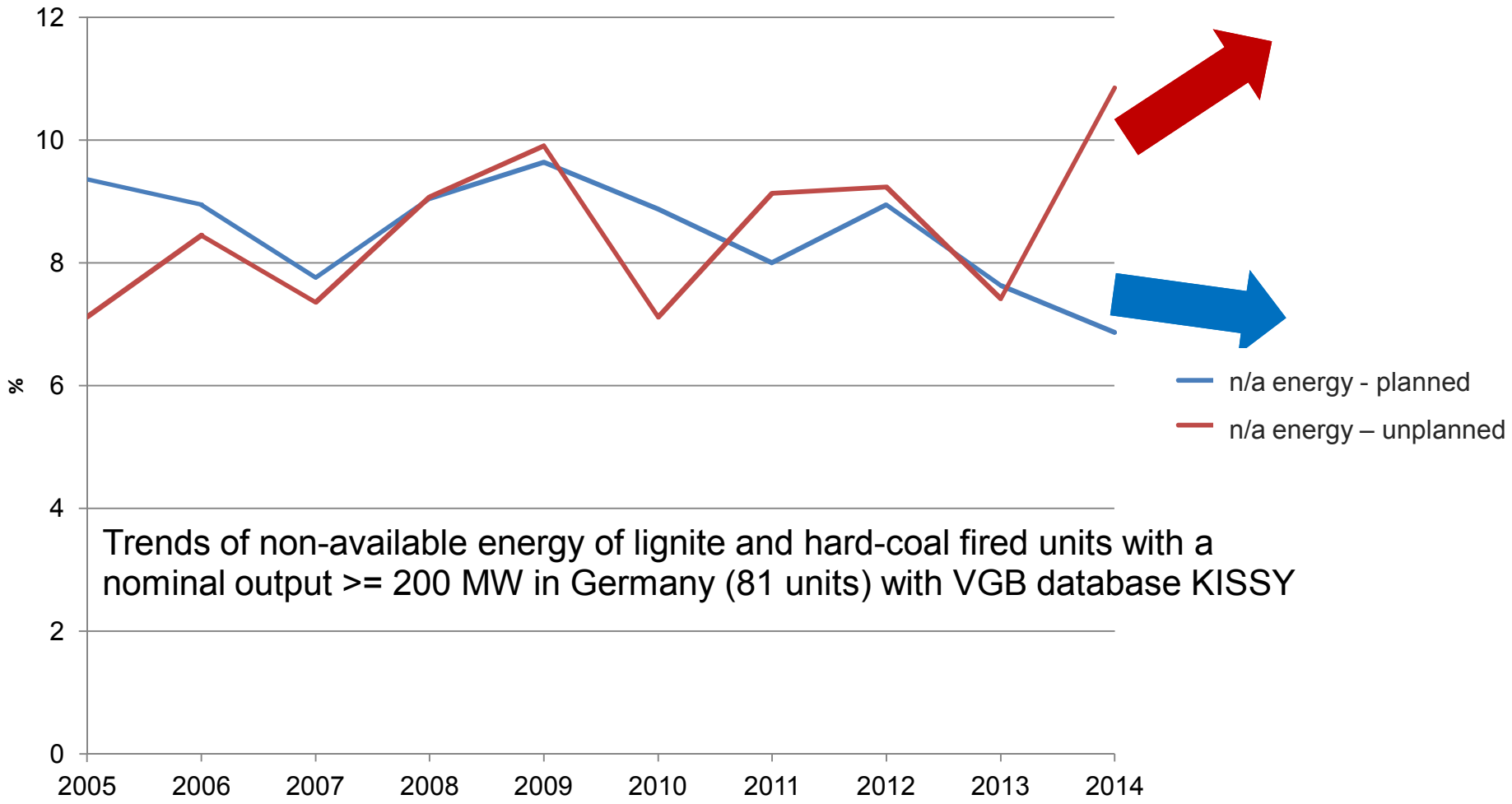
The spot market prices are continuously declining (even negative prices are possible) – the **budget for O&M is very small**.

1. Age structure of German thermal power plants



The ageing of the fleet is reducing the secured capacity significantly.

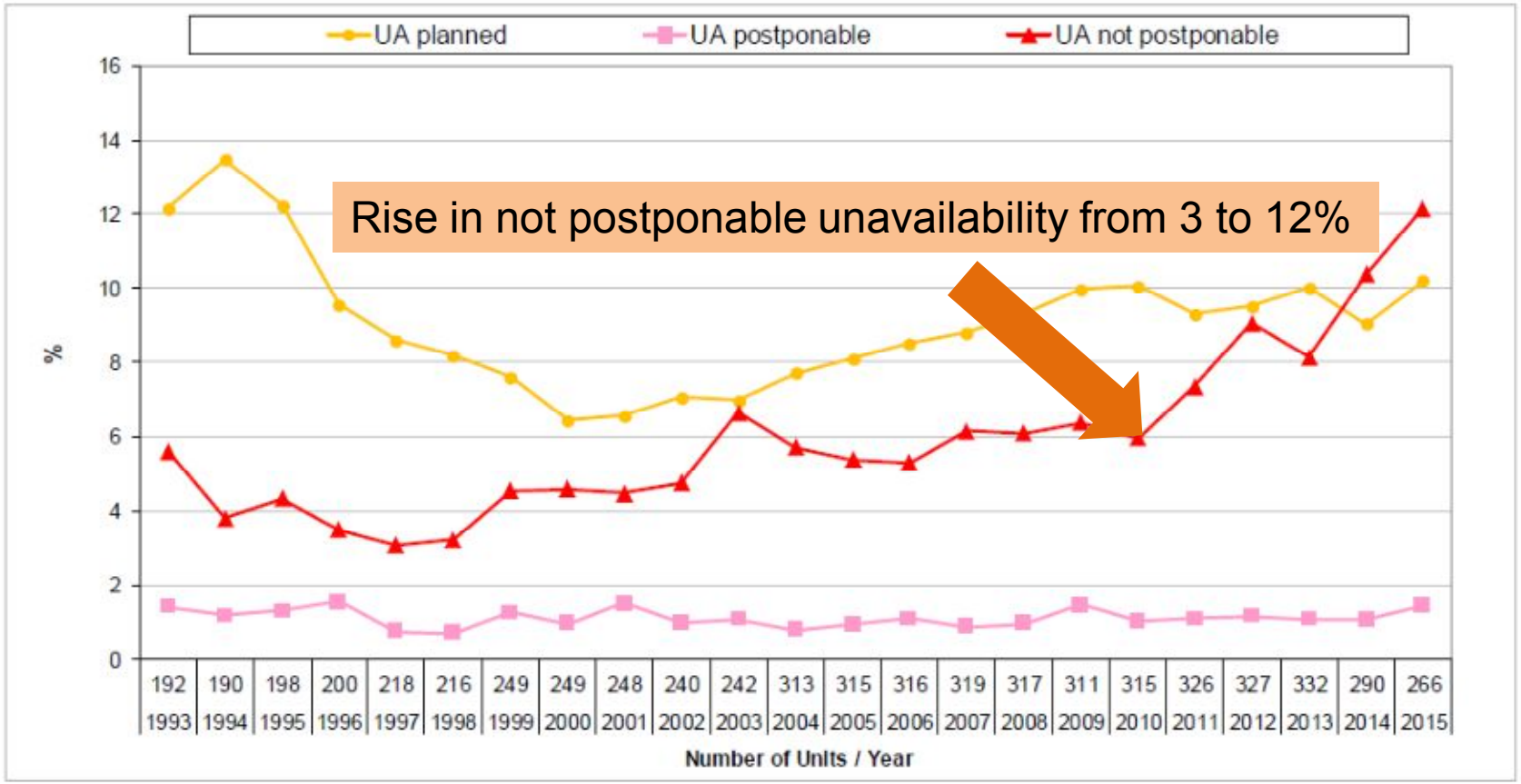
2. Consequences of the new O&M strategies



During the last ten years planned unavailabilities have decreased whereas un-planned unavailability has increased significantly.

2. Development of the plant unavailibilities

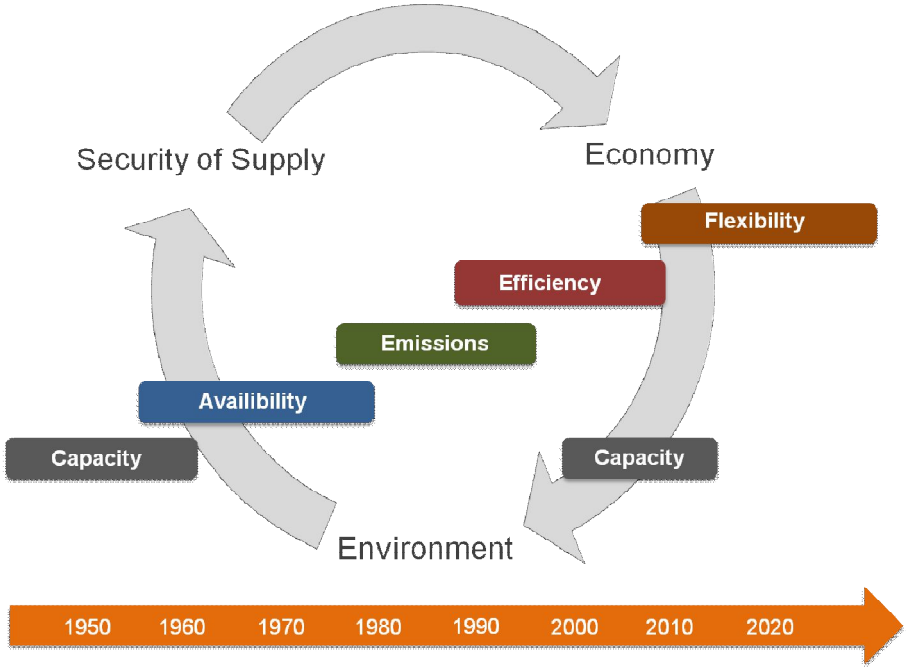
Time range: 1993 - 2015



Annex 5: TSR 'Availability', A.2.1.1 Trend of fossil fired units without CCGT's, total

Availibility has no value if market prices are below the electricity generation costs. This results in a paradigm shift for maintenance strategies.

3. Modern maintenance strategies



Priority in the past:

Increase availibility and reliability while keeping the maintenance costs stable

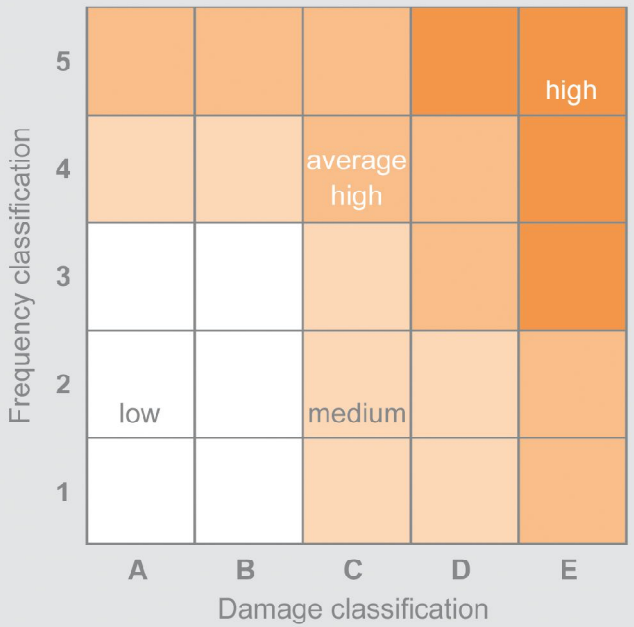
Priority today:

Reduce the maintenance costs while keeping sufficient availibility and reliability

Operators need to preserve the plant availability according to market requirements and increase flexibility of assets with a minimum maintenance budget.

3. Modern maintenance: Risk-based assessment

Risk Based Maintenance considers the risk of a potential failure. It is derived from the product of the damage potential and the probability of failure.



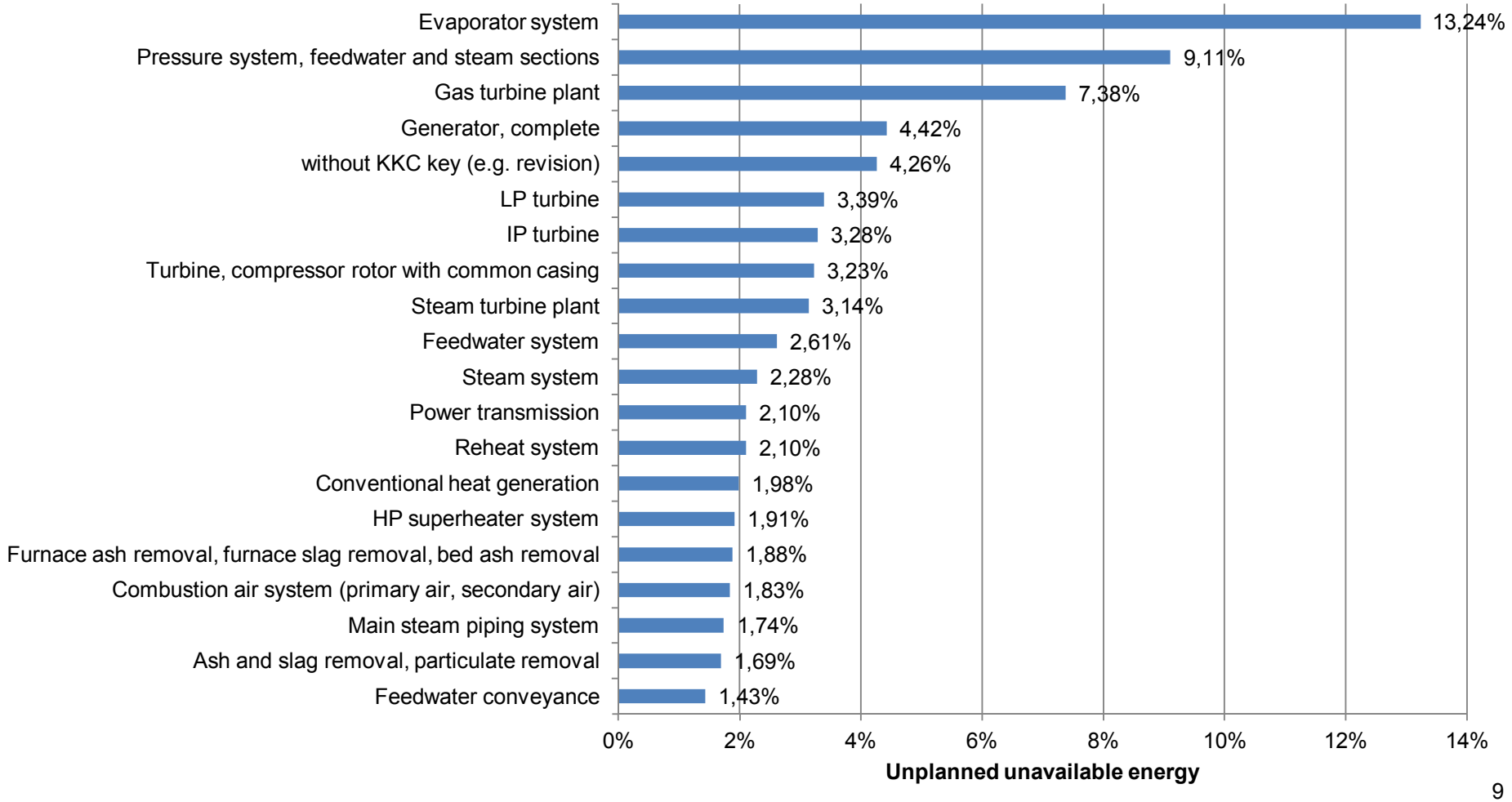
Class	Lifetime expectation in years
1	> = 10
2	> = 5
3	> = 1
4	> = 0.5
5	< 0.5

Class	€-costs caused by the damage
A	< = 500
B	< = 5,000
C	< =50,000
D	< = 500,000
E	> 500,000

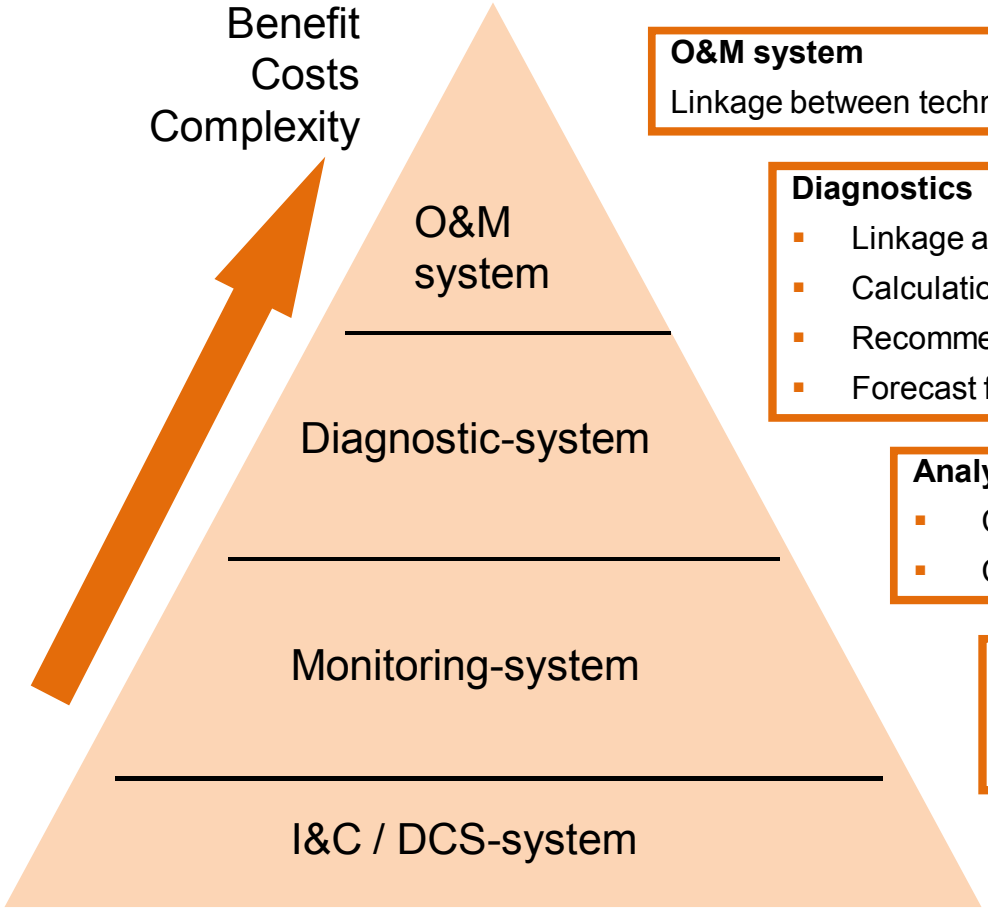
Risk-based methods have been proven efficient and cost-effective while keeping a high health & safety standard. They require a high transparency about the plant status.

TOP 20 components with highest unplanned unavailability

Evaluation of 3,633 incidents without external influence
Collective: fossil fired units; commis. date ≥ 2000; ≥ 200 MW gross capacity; all countries
Time Period 2000 to 2013



3. Enabler for modern maintenance: high level of automation



O&M system
Linkage between technical and commercial information (company-wide)

Diagnostics
- Linkage and interpretation of measured values and parameters
- Calculation and assessment of the actuial process condition
- Recommendation and automatic initiation of measures
- Forecast for further process

Analysis
- Calculation of paramenters and set values
- Comparison between set and actual values

Monitoring
- Collection and Storage of measured data
- Comparison with simple limit values

I&C and DSC
Measuring, operating, monitoring and protection

An optimized mixture of monitoring and diagnostics provides useful information for adapting the plant to flexible operation including modern maintenance strategies.

3. Fleet approach for maintenance

Fleet approach to realise synergies

Define power plant types

- **market driven** – must-run, reserve, etc.
- **technology driven** – similar equipment (e.g. turbine / boiler)

Assessment and **definition of maintenance strategies** for different power plant types

Overall fleet is equipped with a uniform automation technology ensuring data transparency and advanced data assessment as well as benchmarking

Standardization, harmonized working and reporting procedures and exchange of experiences and lessons learned are benefits of the fleet management approach.

3. Market driven fleet approach

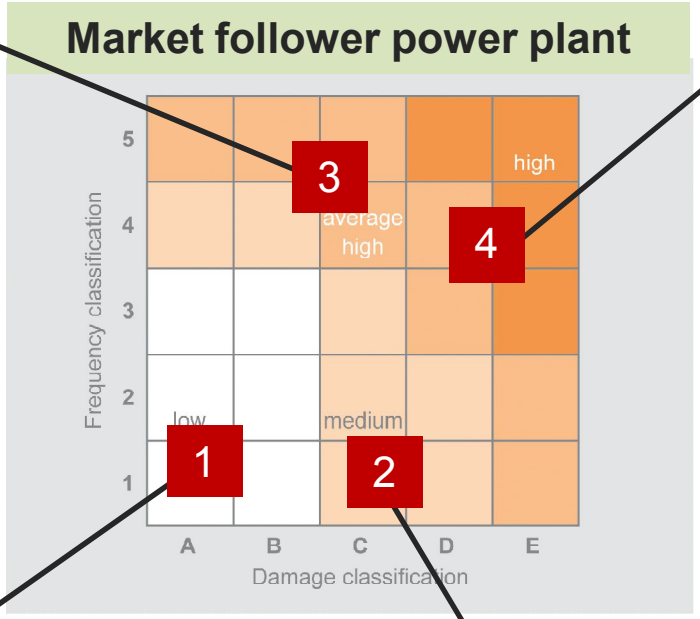
	Must-run (contractual)	Market follower	Reserve
Characteristics	operation according customers' needs for electricity and/or heat	market prices rule the power operation	operation on demand of the TSO
Availibility	> 90 %	< 80 %	not important
Utilisation	70 – 80 %	35 – 50 %	1 – 5 %
Maintenance approach	▪ preventive maintenance in wear-intensive areas (mills, boiler, FG-cleaning) ▪ condition based maintenance ▪ overhaul cycles and durations are time-dependent	▪ risk-based maintenance ▪ advanced condition monitoring ▪ overhaul cycles are cost-optimised and based on equivalent operating hours ▪ longer stand-stills	▪ condition based maintenance ▪ frequent plant tests and start-ups to secure reliable operation if requested ▪ long stand-stills ▪ need for a concept to maintain know-how

Source: VGB based on Uniper

The operational regime remains stable over the contractual period for must-run and reserve power plants. Market followers suffer from increased lifetime consumption.

3. Risk-based selection of maintenance measures

Reduction of failure's consequences by predictive (condition based) maintenance including repair and replacement



Continuous improvement by advanced I&C tools, life time assessment, frequent inspections and solid repair strategy

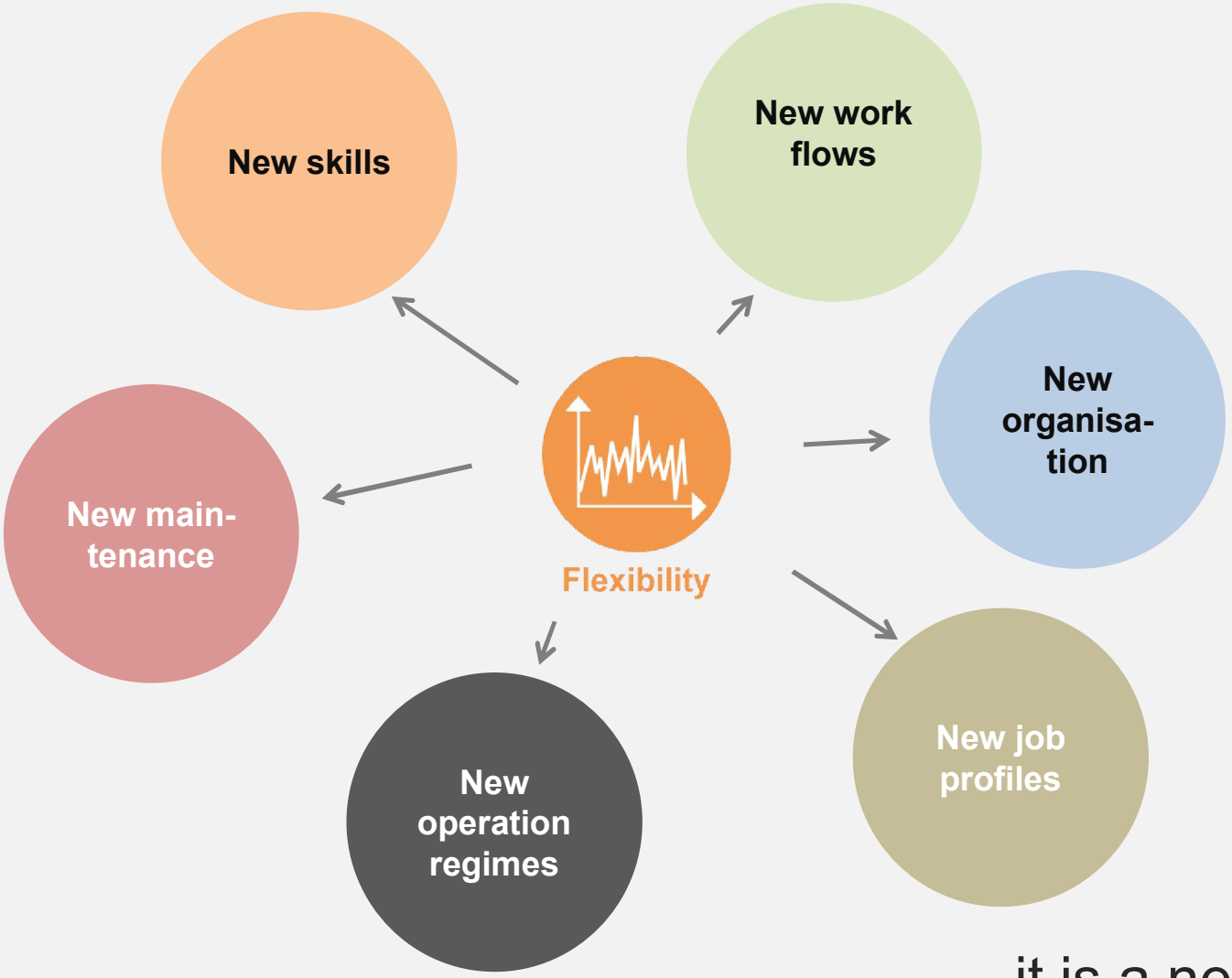
Run-to-failure strategy with minimised maintenance efforts based on reactive and corrective measures

Reduction of failures and degradation by preventive (time-based) maintenance measures (e.g. optimised spare part mgt)

Source: EnBW and VGB

The higher the risk the higher the inspection efforts. An optimum needs to be found – based on a reliability-versus-(maintenance)costs-evaluation.

4. New requirements for power plant personnel



…it is a new culture

4. How to deploy the cultural change?

Deriving a fleet approach:

- Installing *Flexibility Cells* to sustain and to transfer know-how and to implement train-the-trainer-concepts

Training for power plant personnel:

- New operating regimes – simulator training modules to familiarise with new processes and features
- New maintenance routines – specific training to familiarise with new inspection, repair and spare part management
- Specific for different types of personnel but aiming at a intensive co-operation across departments (operation, maintenance and controlling)

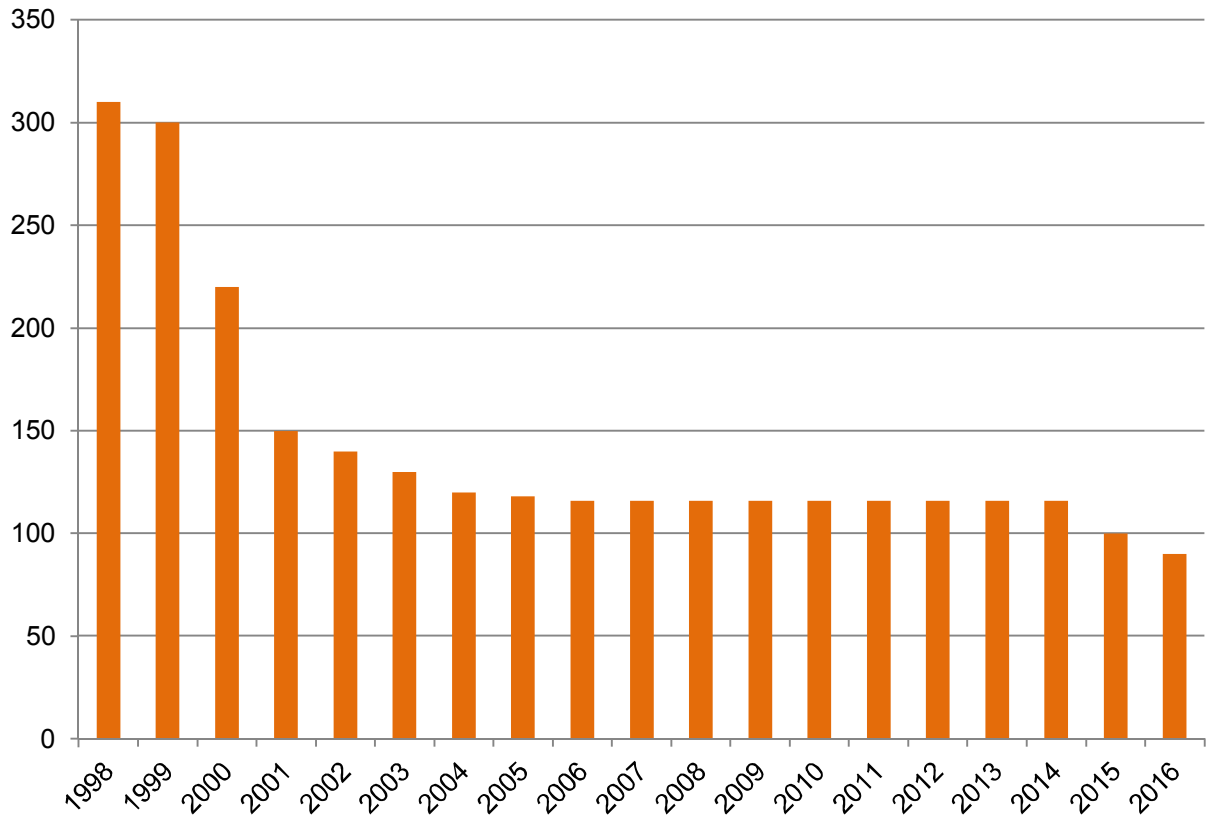
Motivation:

- Raise awareness for flexibility and the need for a change

The planning and implementation of flexibility measures in the power plants should go hand in hand with a profound training concept taking the staff aboard for the change.

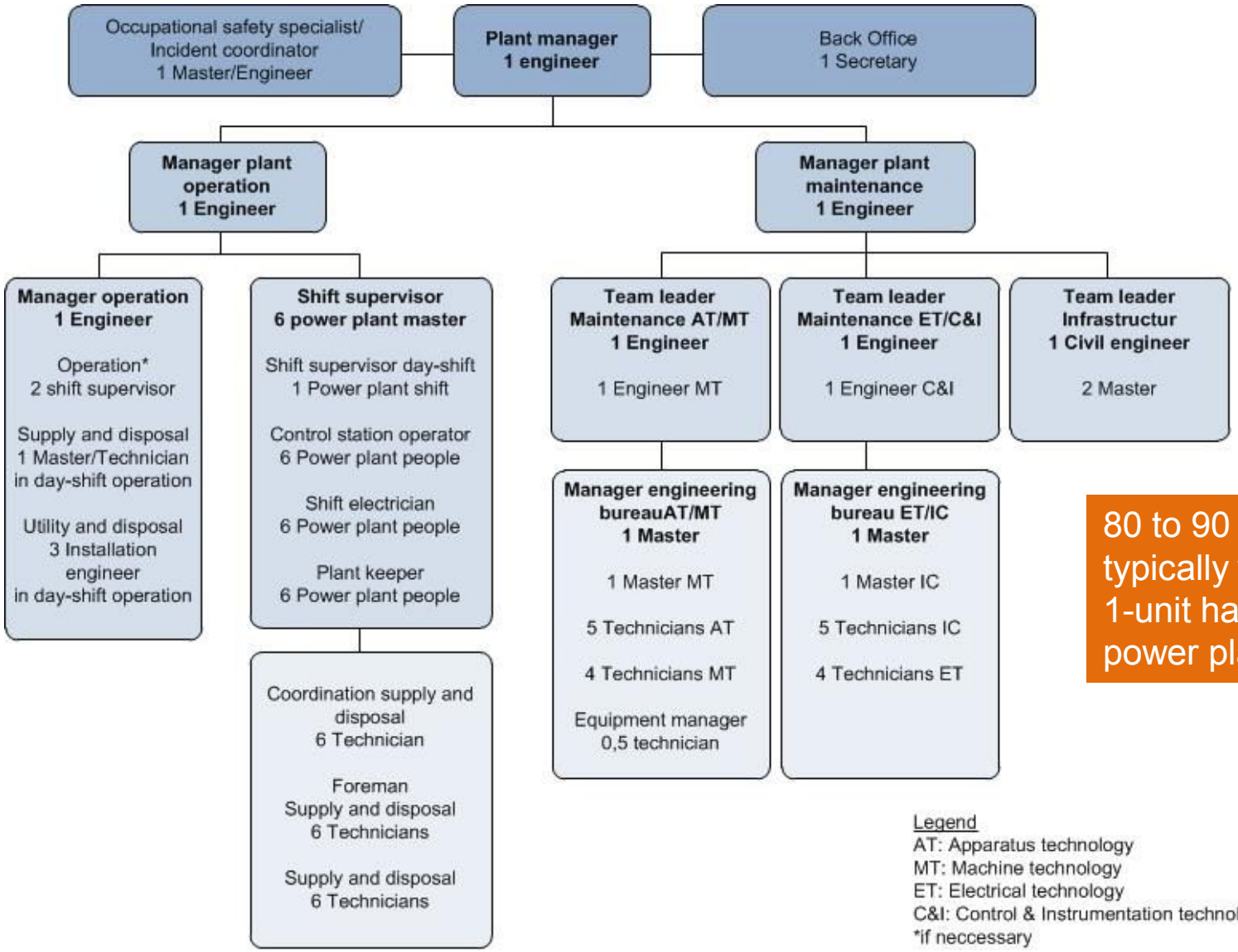
4. Staff count in German power plants

Development of staff numbers in a reference hard coal power plant with one unit



Due to liberalisation and tight market conditions the average staff count has decreased by 70 percent over the last 18 years – there is limited potential for further reduction.

4. Organisational structure of a German power plant



80 to 90 employees typically work in a 1-unit hard-coal power plant

Legend
AT: Apparatus technology
MT: Machine technology
ET: Electrical technology
C&I: Control & Instrumentation technology
*if neccessary

5. Conclusions and outlook

→ **High-level of automation** is required for flexible plant operation and modern maintenance strategies.

→ A **techno-economically assessment** is vital for O&M looking at the trade-off between lost margin due to unavailability and the disposable maintenance budget

→ **Training and skill development** is an inherent part of the change process

→ Intense **co-operation across departments** is necessary

→ Power plants need to become a **permanently learning institution**

Flexible power plant operation implies many challenges: technically and organisationally. A holistic approach is needed to address the complex tasks and requirements.

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Thank you
for your interest!

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