TECHNISCHE UNIVERSITÄT CHEMNITZ

Institute of Joining and Assembly
Chair of Welding Engineering
Prof. Dr. Peter Mayr

PROFESSUR SCHWEISSTECHNIK

Challenges in Joining in the Energy Sector – Thermal Power

Peter Mayr

5th General Assembly Stakeholder Meeting

Joining Sub-Platform to MANUFUTURE

Brussels, 20.11.2015

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Introduction

About my person:

Mechanical Engineer and Welding Engineer graduated (Dipl.-Ing., Dr. techn.) from Graz University of Technology, Austria

Foreign Assignments:

Belgian Welding Institute, Gent
National Institute for Materials Science (NIMS), Japan
The University of Tokyo, Japan
Massachusetts Institute of Technology (MIT), USA

Since 2011 **Full Professor and Head of the Institute of Joining and Assembly**, Technische Universität Chemnitz, Germany

30 Researchers in 3 Workgroups: Materials and Joining, Joining Technology and Components Safety

Introduction

Selected Committees and Activities:

International Institute of Welding (IIW)
Chairman Commission IX-C, Behaviour of Materials subjected to Welding – Creep and Heat Resistant Steels

European Virtual Institute on Knowledge-based Multifunctional Materials AISBL (KMM-VIN),
Chairman WG2-WT3A Materials for Energy – Welding and Joining

European Commission – Research Fund for Coal and Steel (RFCS)
Expert STEEL Group

Introduction

Selected past and current projects related to the Energy Sector:

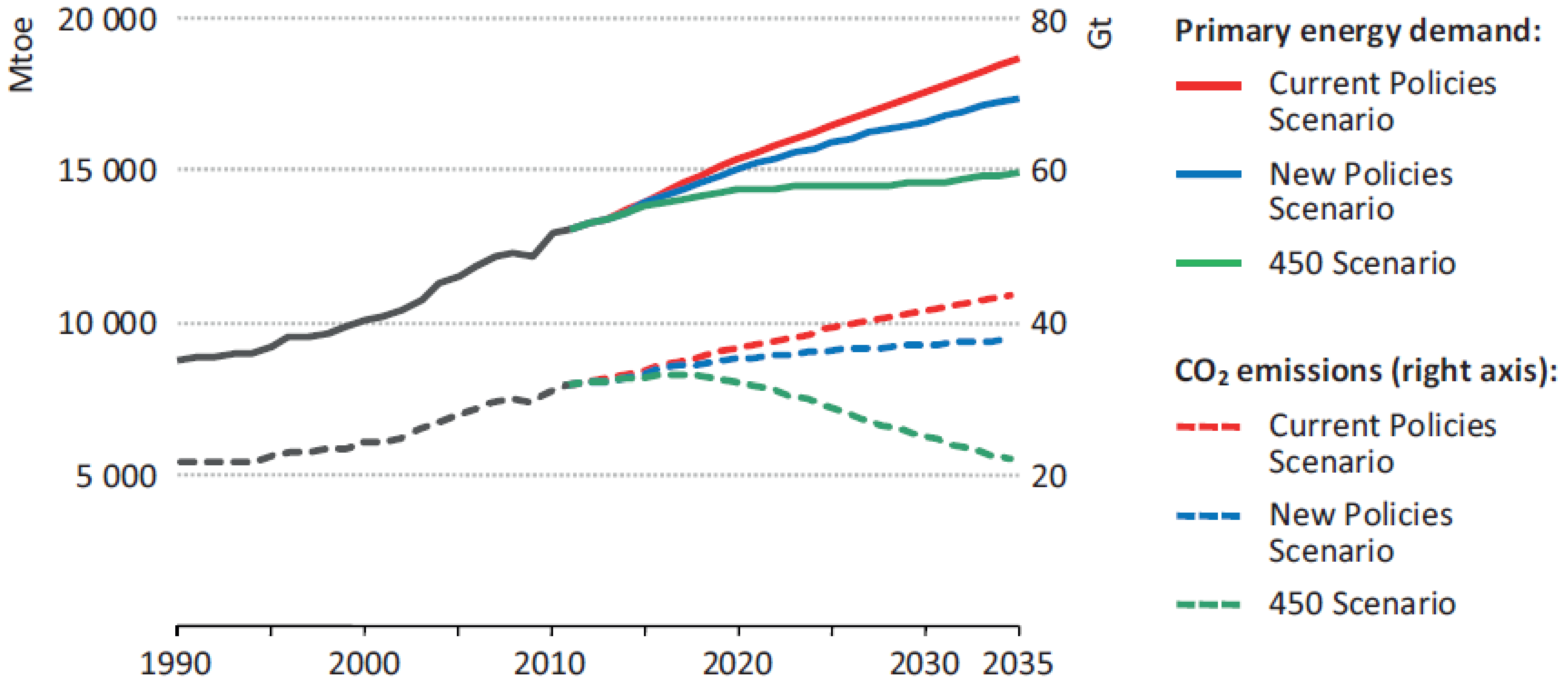
536 - Alloy development for Critical Components of Environmentally friendly Power planT (ACCEPT)

Material-Component Performance-driven Solutions for Long-Term Efficiency Increase in Ultra Supercritical Power Plants

Production of Coatings for New Efficient and Clean Coal Power Plant Materials

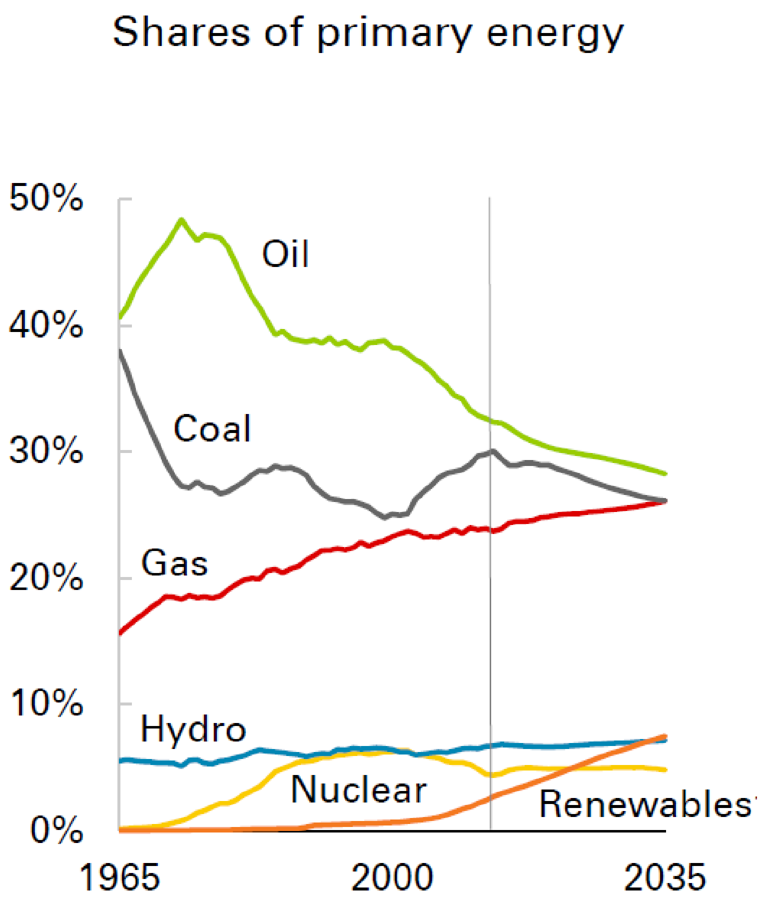
Motivation

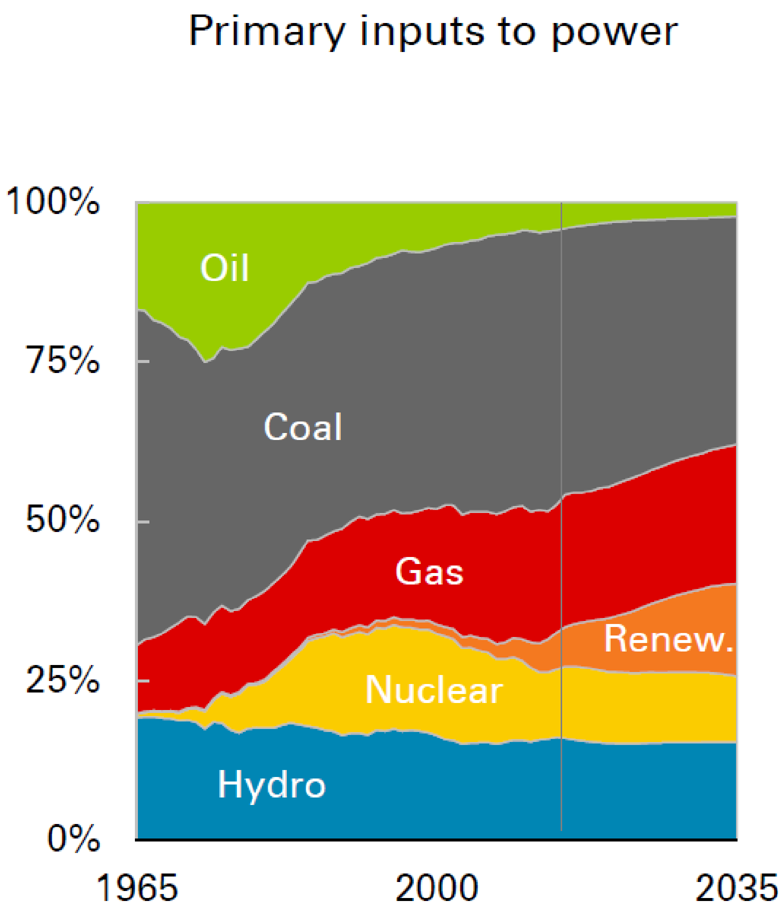
Predicted **Primary Energy Demand** and **CO2-Emissions** up to 2035 according to the scenarios of the WEO 2013



Note: Mtoe = Million tonnes of oil equivalent; Gt = gigatonnes.

Primary Energy Sources





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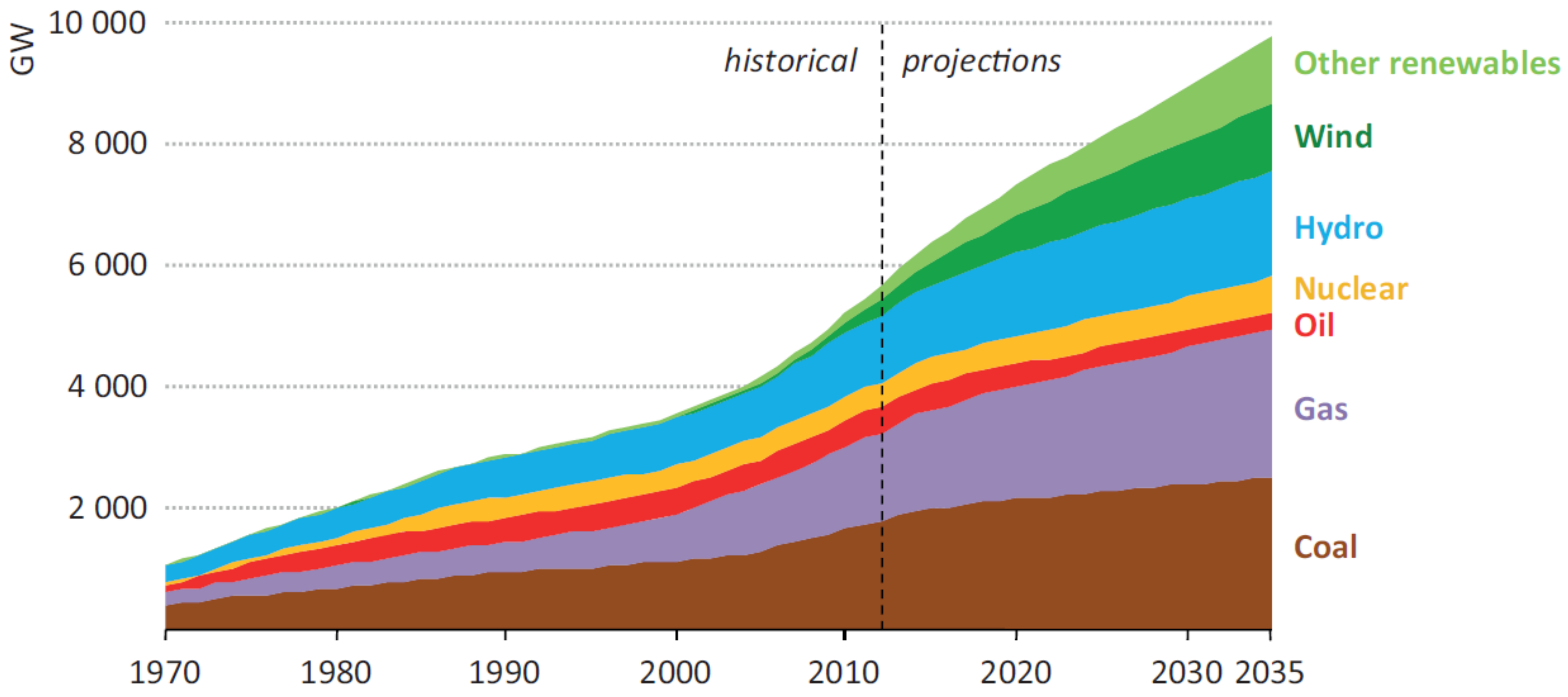
Electricity Generation – Today and Tomorrow

Installed Capacity by Source in the New Policies Scenario



There will be an increasing demand in installed capacity and also thermal power will increase its share

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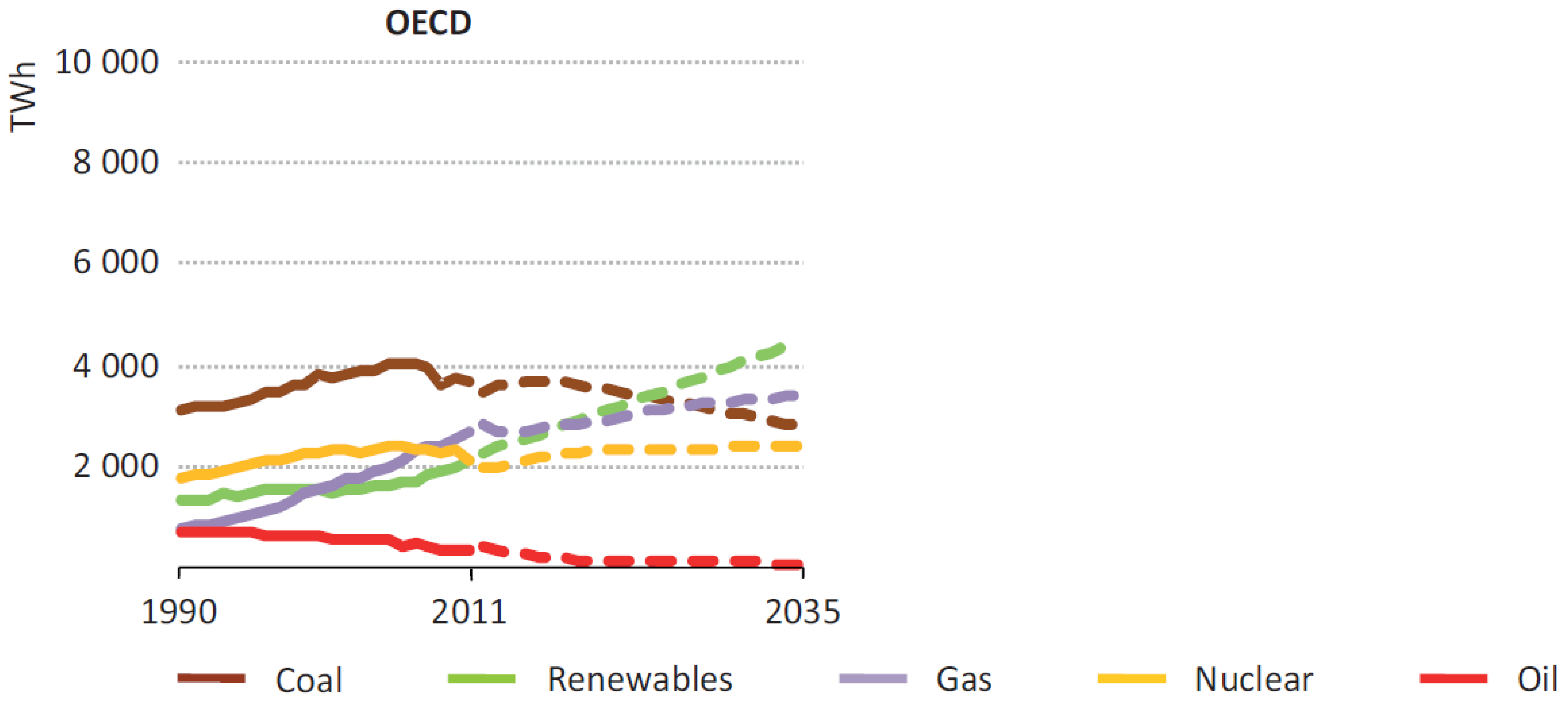
Electricity Generation – Today and Tomorrow

- Different development between **OECD**- und **Non-OECD**-Countries
- Opposing trend especially for **Coal and Nuclear**
- Clear increase of **Renewables**

Electricity Generation by Source in the New Policies Scenario



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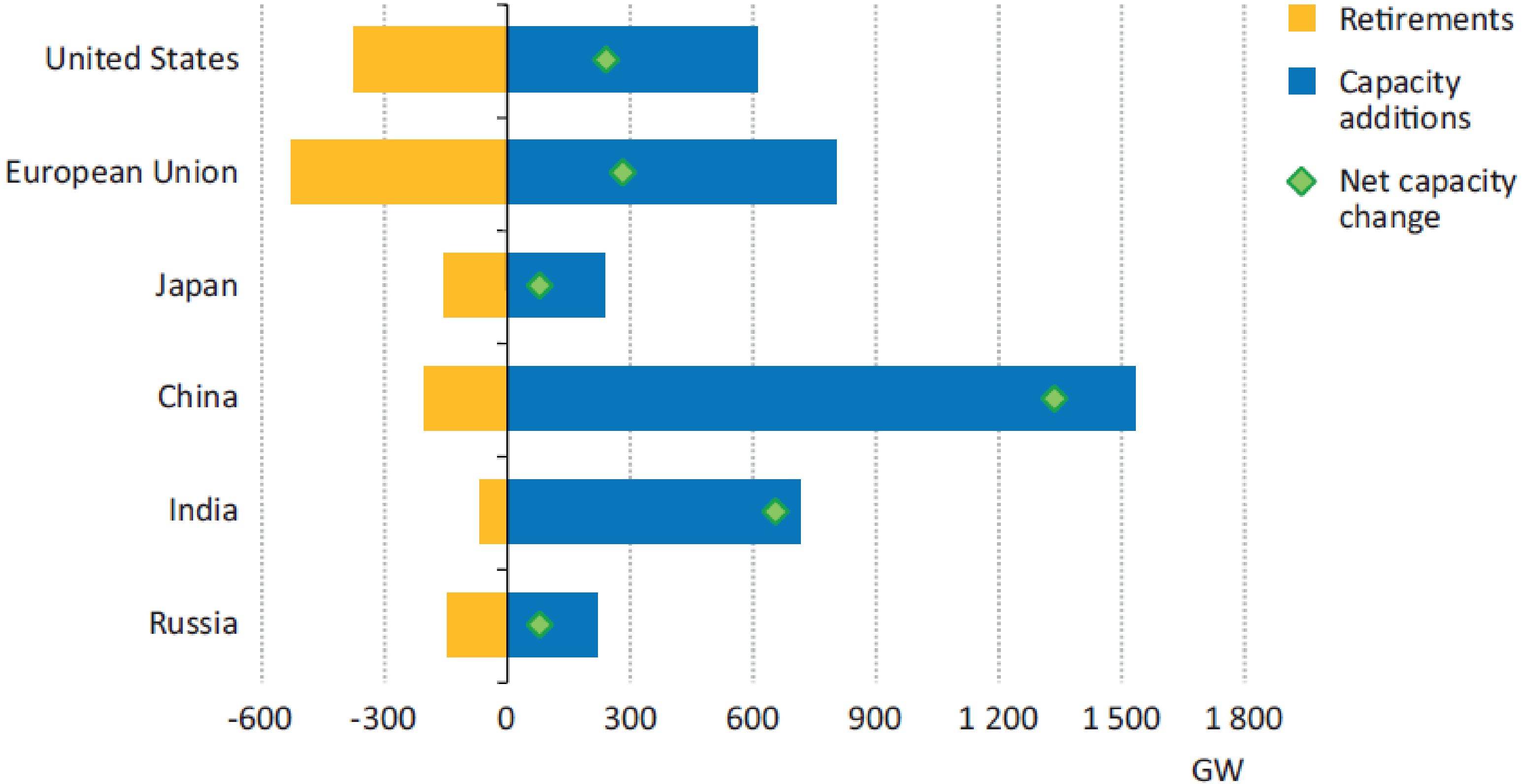
Capacity Retirements and Additions

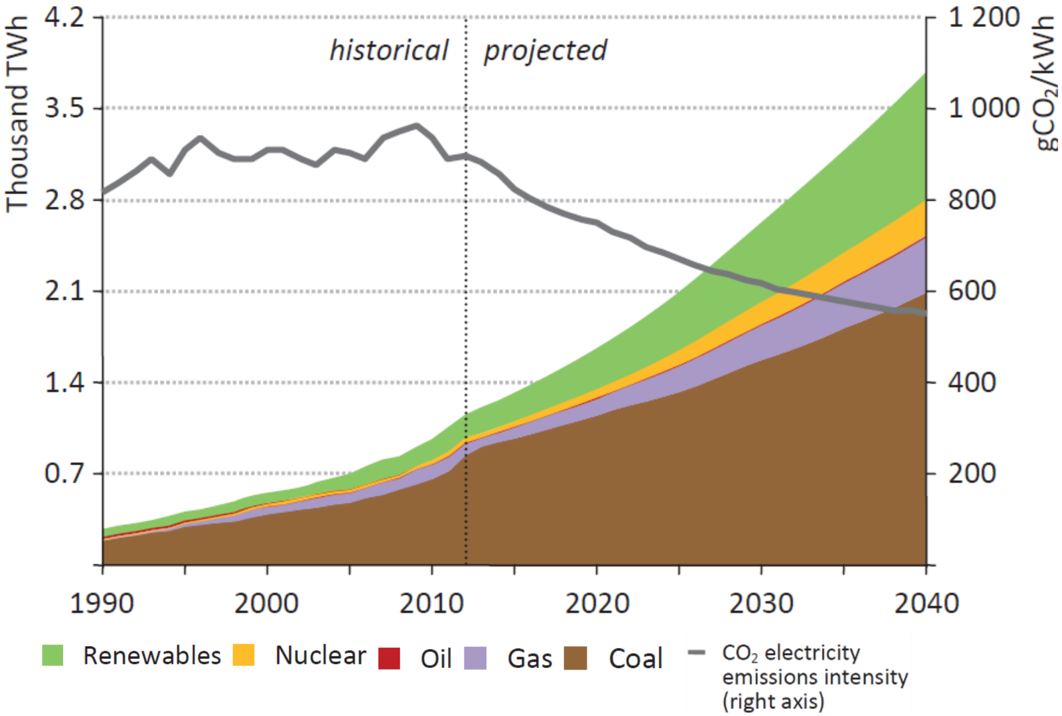
Power generation gross capacity additions and retirements by selected region in the new policies scenario, 2013 -2035



- In **EU, USA, e.g. OECD** mainly **replacement of aged fleet**
- In **Non-OECD-countries** new installations to **cover the increasing electricity demand**

Future Markets

India electricity generation by source and CO2 intensity in the New Policies Scenario



- Growth of electricity demand:
  4,4 % per year
- **Highest growth rate** worldwide
- **Coal** plays central role
- Installation of **SC** and first **USC** power plants
- Investments of **2 Trillion Dollar** required:
  21 % in new coal-fired plants

The main market for new installations is and will be outside Europe – huge potential for European companies

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Summary on demand for new installations

Worldwide increasing capacity **5.649 GW (2012) to 9.760 GW (2035)**

Biggest shares in **Gas** (1.370 GW), **Wind** (1.250 GW) und **Coal** (1.180 GW)

In total ca. **6.050 GW gross new capacity** until 2035, 1.940 GW as substitution for units taken out of service

CONSTRUCTION OF NEW THERMAL POWER PLANTS

ADVANCED-ULTRASUPERCRITICAL A-USC POWER PLANT CONCEPTS - 700°C

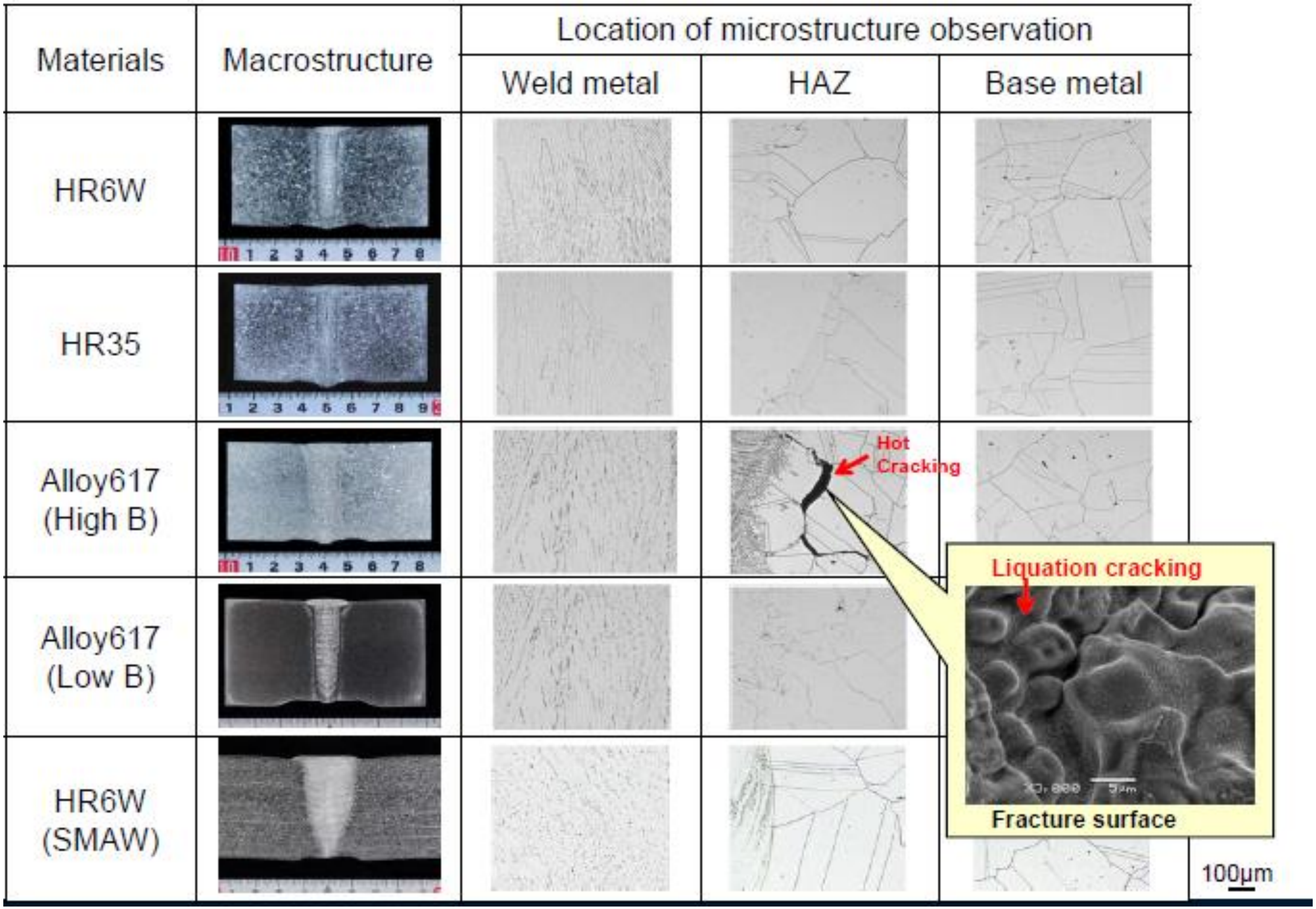
Thermal Power Plants with high efficiency

At present in several regions the development of advanced ultra supercritical power plant technology (700°C) is followed.

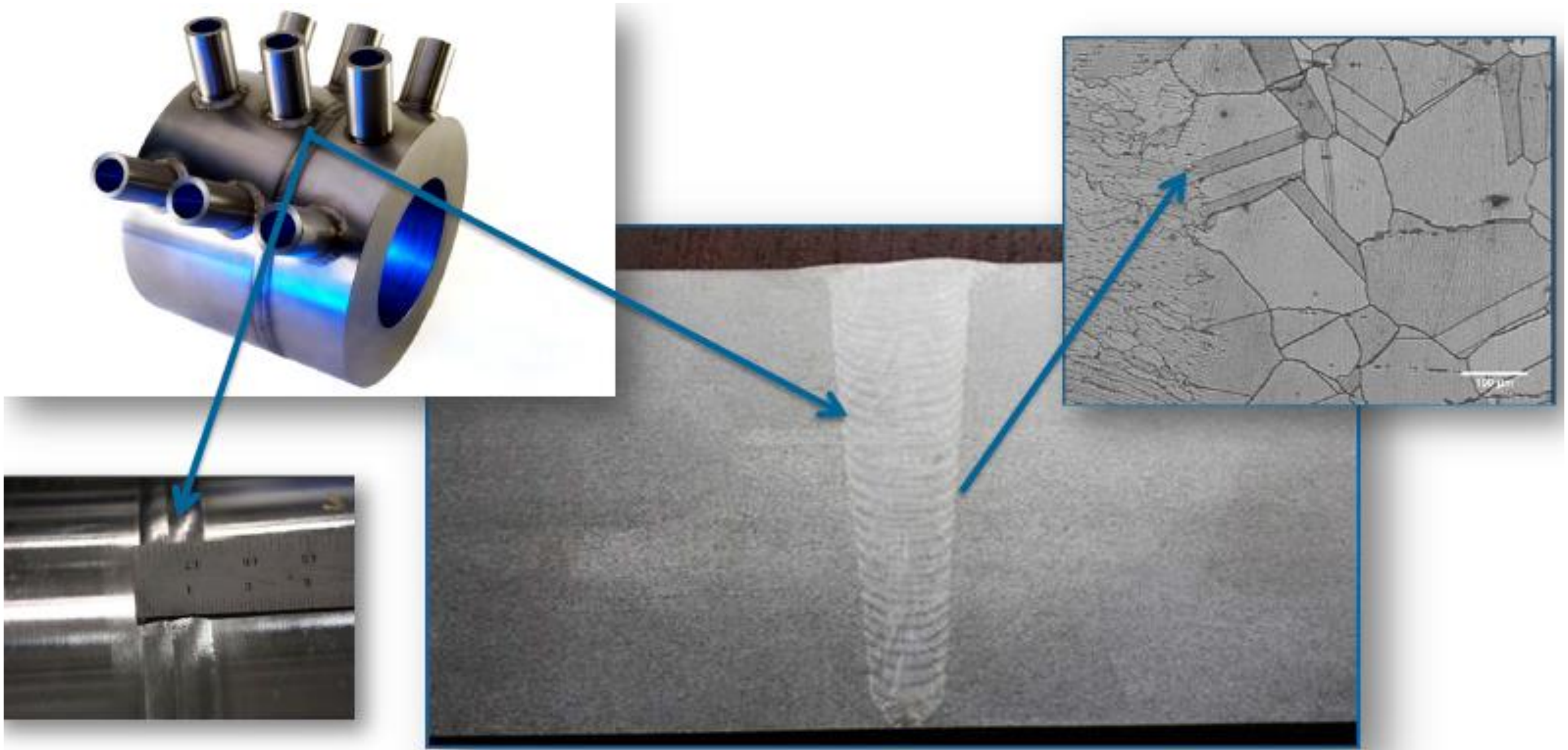
new materials – new technologies – new standards – new challenges

Region	Realisation	Materials	Status
Europe	Advanced concepts	known, EU F/A/Nibas	On hold – economic reason, technology leader (still)

Challenges – Materials - Weldability

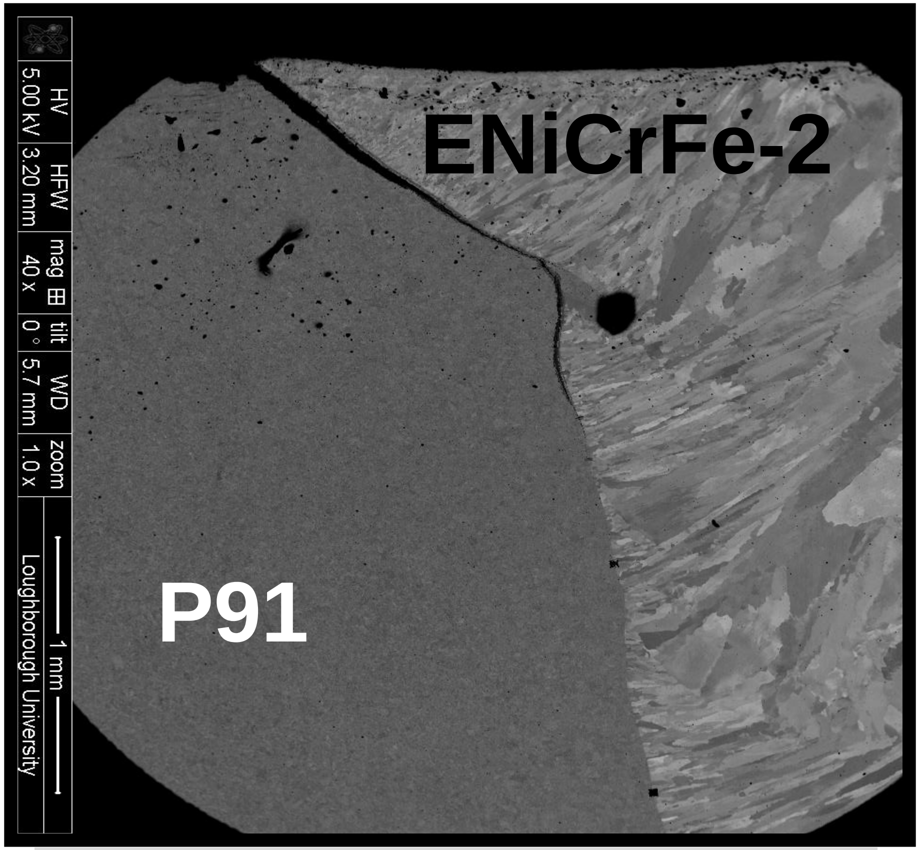


Nickel-based Alloys

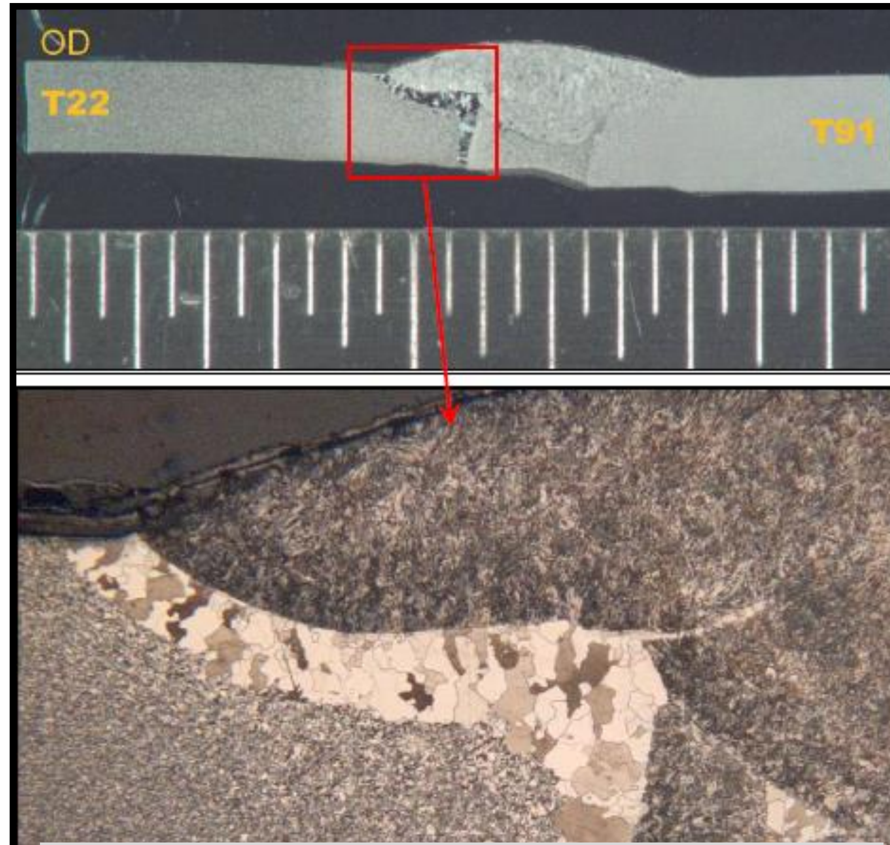


76mm (3”) wall thickness full circumferential pipe weld in Inconel 740H

Dissimilar Metal Welds



Ferritic to austenitic failures at fusion line due to phase formation



Ferritic to ferritic failures associated with carbon migration

Welding Processes

New Thermal Power Plants:

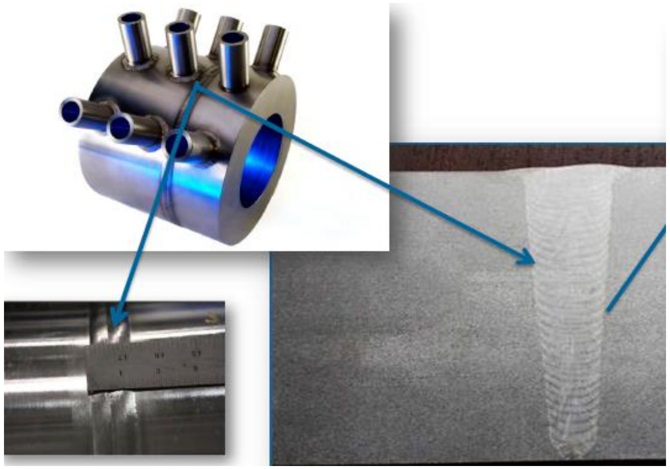
High economic feasibility

- Minimised weld cross-sections
- High welding speeds
- Fully automated welding solutions
- High system reliability
- Robust power sources
- Simple operability
- Easy maintenance

Excellent welds

- Defined heat input
- Adjustable deposition rates
- Processability of complex alloy systems
- Defect-free welding
- Highly tolerant welding strategies

Narrow-gap welding
Orbital-welding



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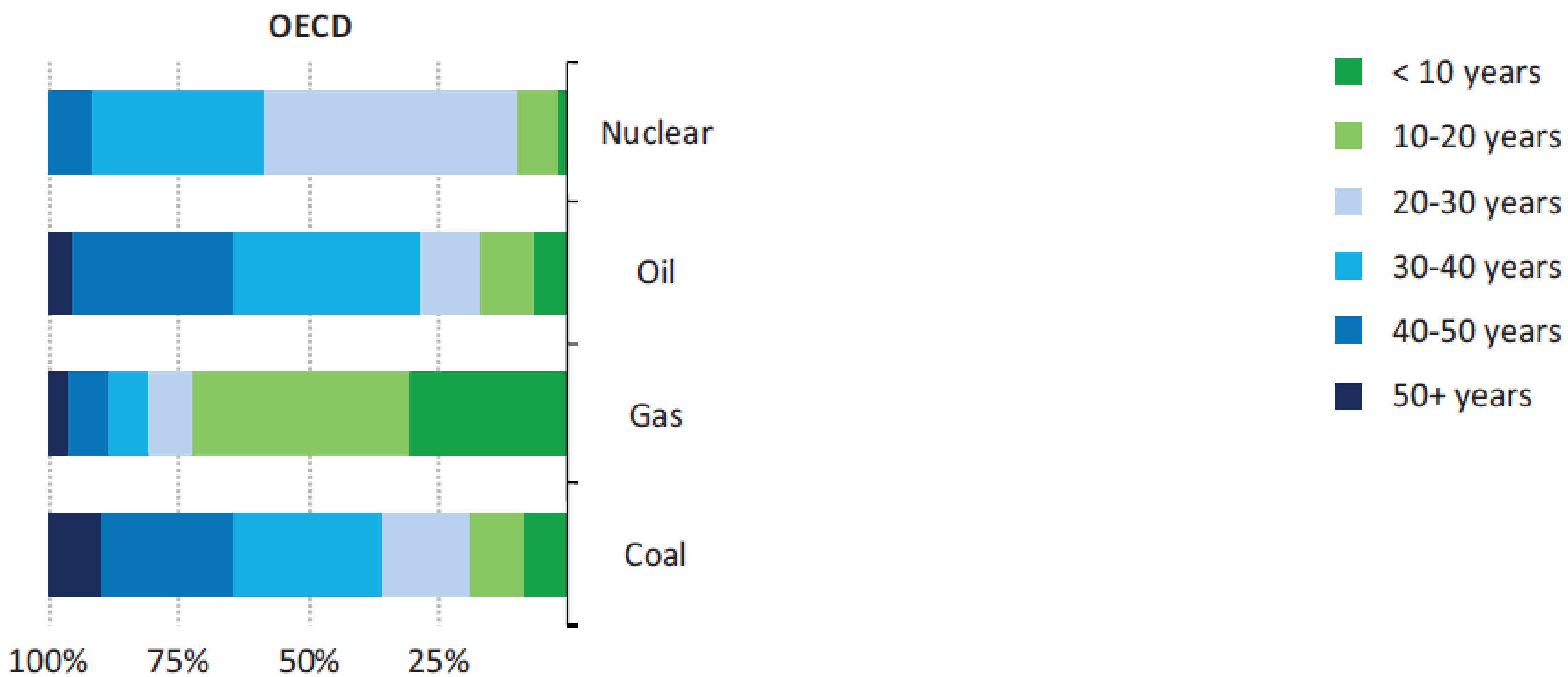
SAW, GTAW, GMAW, beam processes

- **Customised fully automised solutions**
- **Integrated quality control by sensing and online documentation**

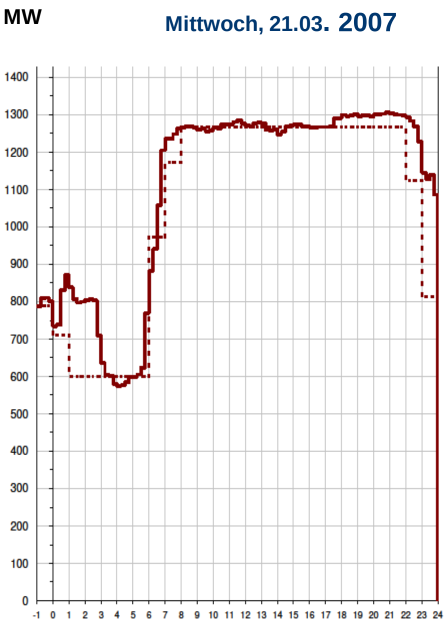
REPAIR AND MAINTENANCE OF EXISTING POWER PLANT FLEET

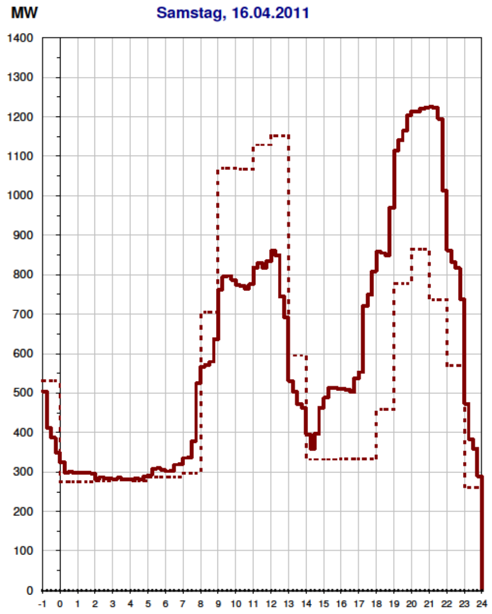
Age Structure of Power Plants

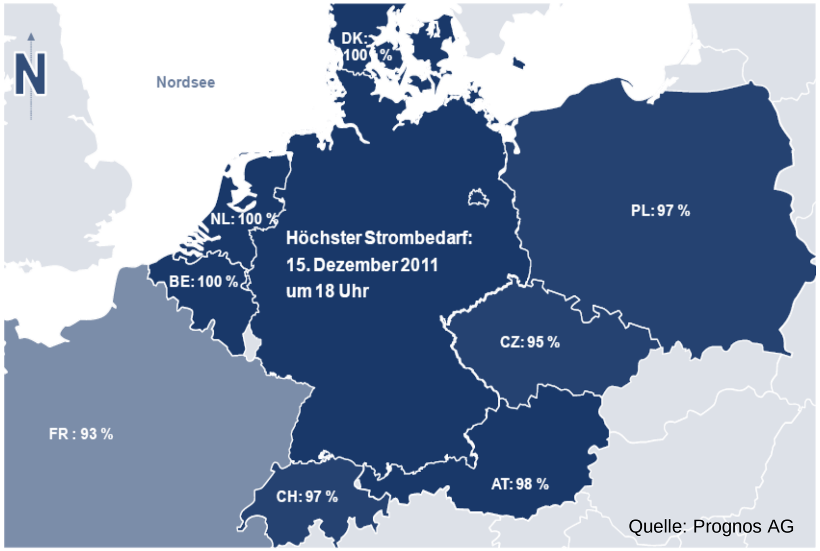
Comparison of the age structure of the existing power plant fleet



Thermal Power Plant Operation in the EU







Operation in the past (2007) and today (2011) … Acquisition of electricity in neighboring countries?

- Additional capacities with high flexibility also required in Europe
- Flexible operation results in higher loads for equipment and personnel
- Increased failure appearance in existing power stations

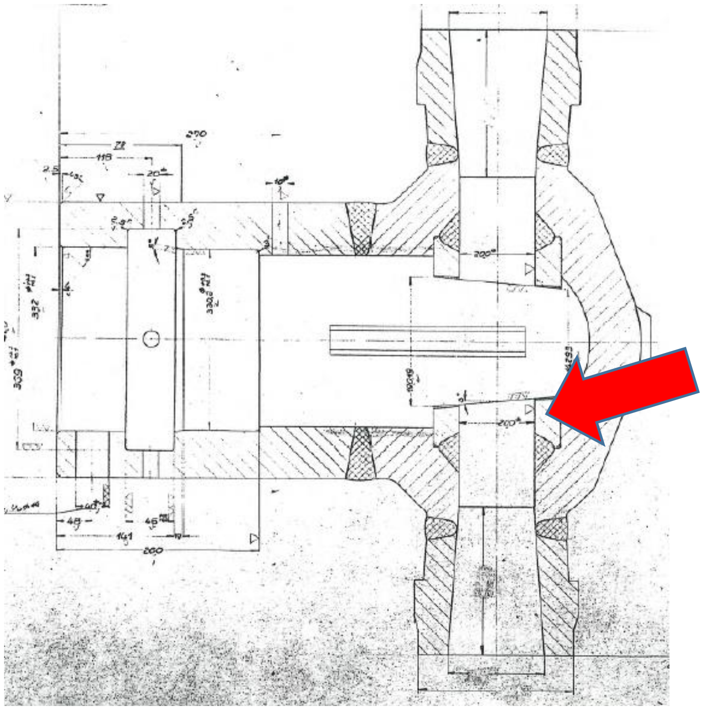
Operational Flexibility

Base materials, weld metal and welded joints have to be certified or new have to be developed to allow a save long-term operation of power plants.

Repair and Maintenance:

High profitability

- Similar strategies as for the erection of new power plants
- On-site Repair Concepts
- Complete solutions incl. machining and testing



Example: Repair of a Steam Valve

At present: Disassembly – external repair – assembly

Duration: ca. 3 – 5 months

New highly profitable on-site repair solutions are required.

Challenges: materials, consumables, NDT, documentation

Materials and Welding Consumables

Existing Fleet:

- Repair and Maintenance consumables
- In-situ repair
- Good weldability
- Heat treatment strategies
- Simple handling

Final Slide

In total a demand of ca. 6.050 GW Gross new installations to 2035

It is important to continue European research activities for new materials, welding consumables, joining processes, component safety, etc. even if the main prospective market is outside Europe.

Thank you very much for your kind attention!