Reference Power Plant India

Delhi, February 11, 2015

Dr. Oliver Then

Agenda

Goals of the initiative

The VGB managed study „Reference Power Plant NRW“

Study „Reference Power Plant India“

Summary and next steps

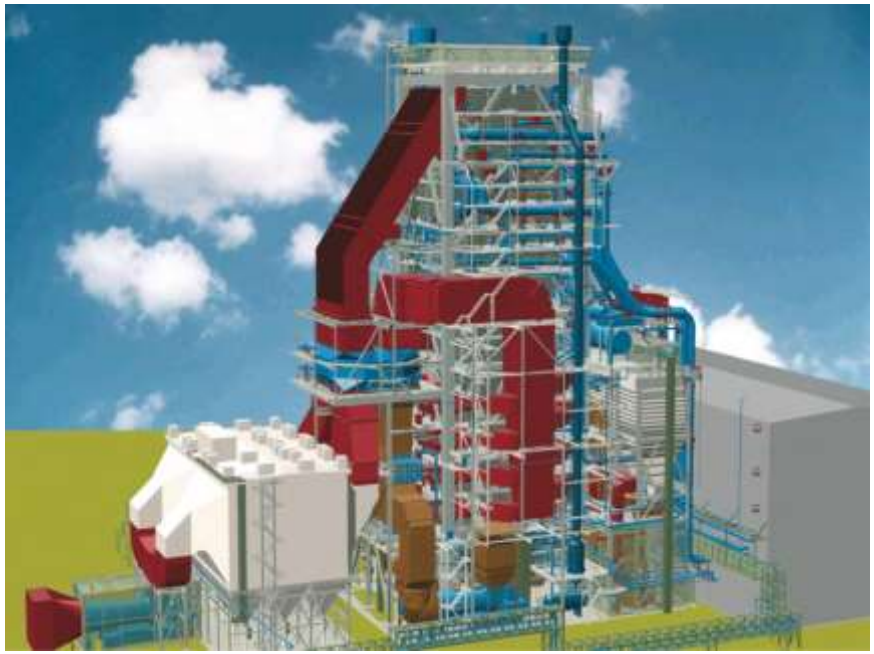
Goals of the initiative “Reference Power Plant India”

- Development of an optimized general concept for a hard-coal fired power plant based on pre-determined boundary conditions for India (e.g. economical & markets development, grid, industry aspects…)
- Evaluation of state-of-the-art technologies and innovations to optimize
  - Output and fleet composition
  - efficiency
  - Environmental impacts
  - Life-cycle costs (investment and O&M)
  - Political and industrial aspects
- Establish an exchange platform for all relevant stakeholders from government, universities, generators, grid operators, industry…

The VGB managed study “Reference Power Plant NRW”

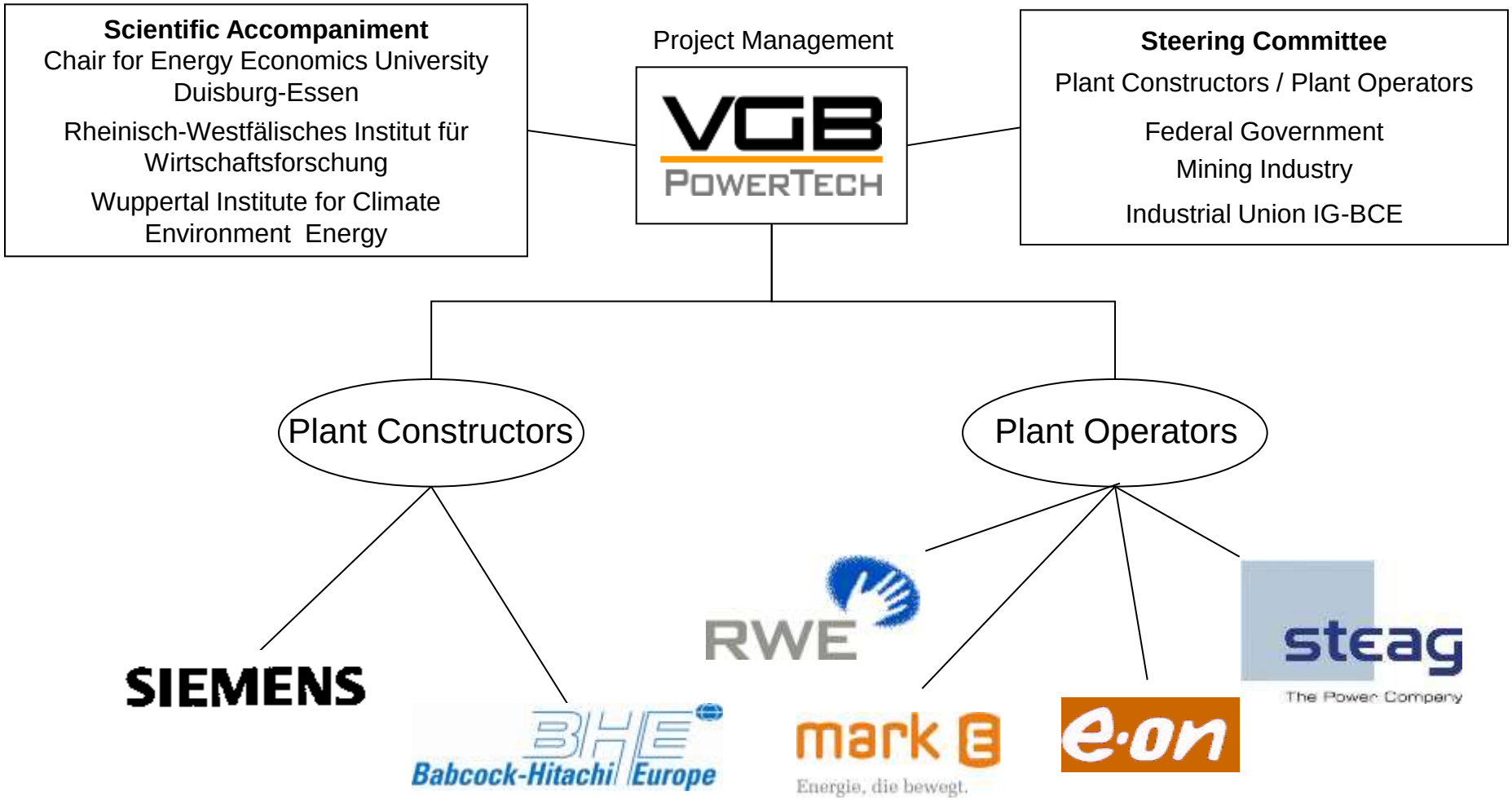
The VGB managed study “Reference Power Plant NRW”

- reduction of full-load hours
- increased number of start-ups and load changes
- potential of reduced economic viability due to reduced life time
- technical development is focussed to ensure:
  - → more flexibility (load changes)
  - → reduction of minimal load
  - → high availibilty and reliability
  - → possibility of island operation and fast cold start



Reference Power Plant NRW

The VGB managed study “Reference Power Plant NRW”



The VGB managed study “Reference Power Plant NRW”

Define boundary conditions

- Market
- Commercials
- Politics
- Industry
- Environment
- Infrastructure

Develop technological options

- Size
- Location
- Basic design
- Technical options
- O&M concepts

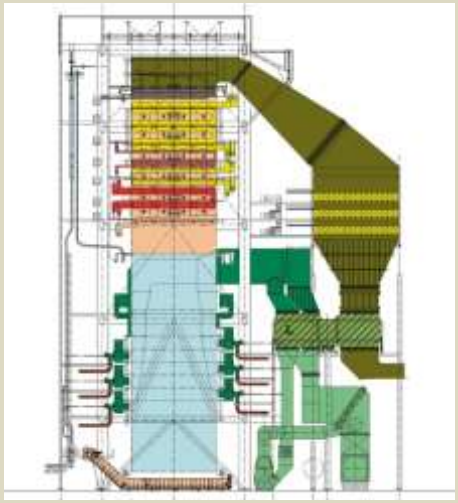
Technical-commercial evaluation

- Setup evaluation criteria
- Define variants
- Calculate life-cycle-costs

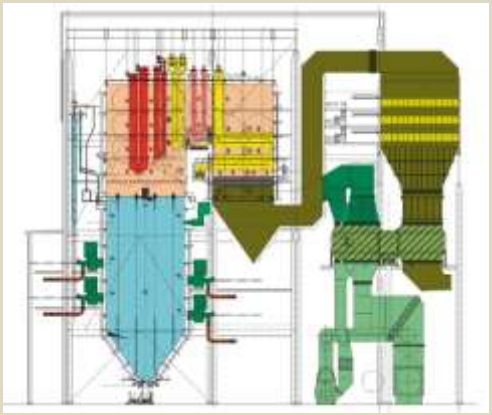
Identify preferred option

- Comparison of options
- Identify preferred solution
- Communication & discussion
- Start realization

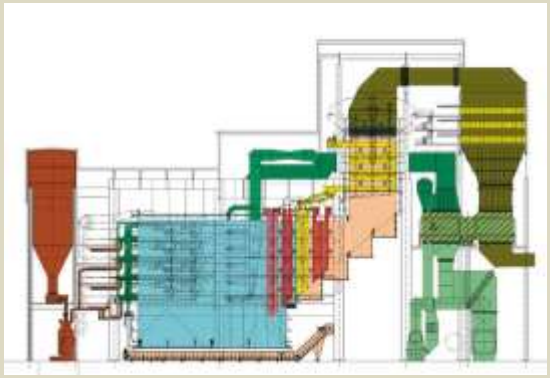
Comparison of different Boiler Concepts



Floor space: 2 975 m²
Volume: 166 000 m³
Efficiency: 95%



Floor space: 4 164 m²
Volume: 197 000 m³
Efficiency: 95%



Floor space: 4 600 m²
Volume: 209 000 m³
Efficiency: 95%

Measures for Efficiency Enhancement

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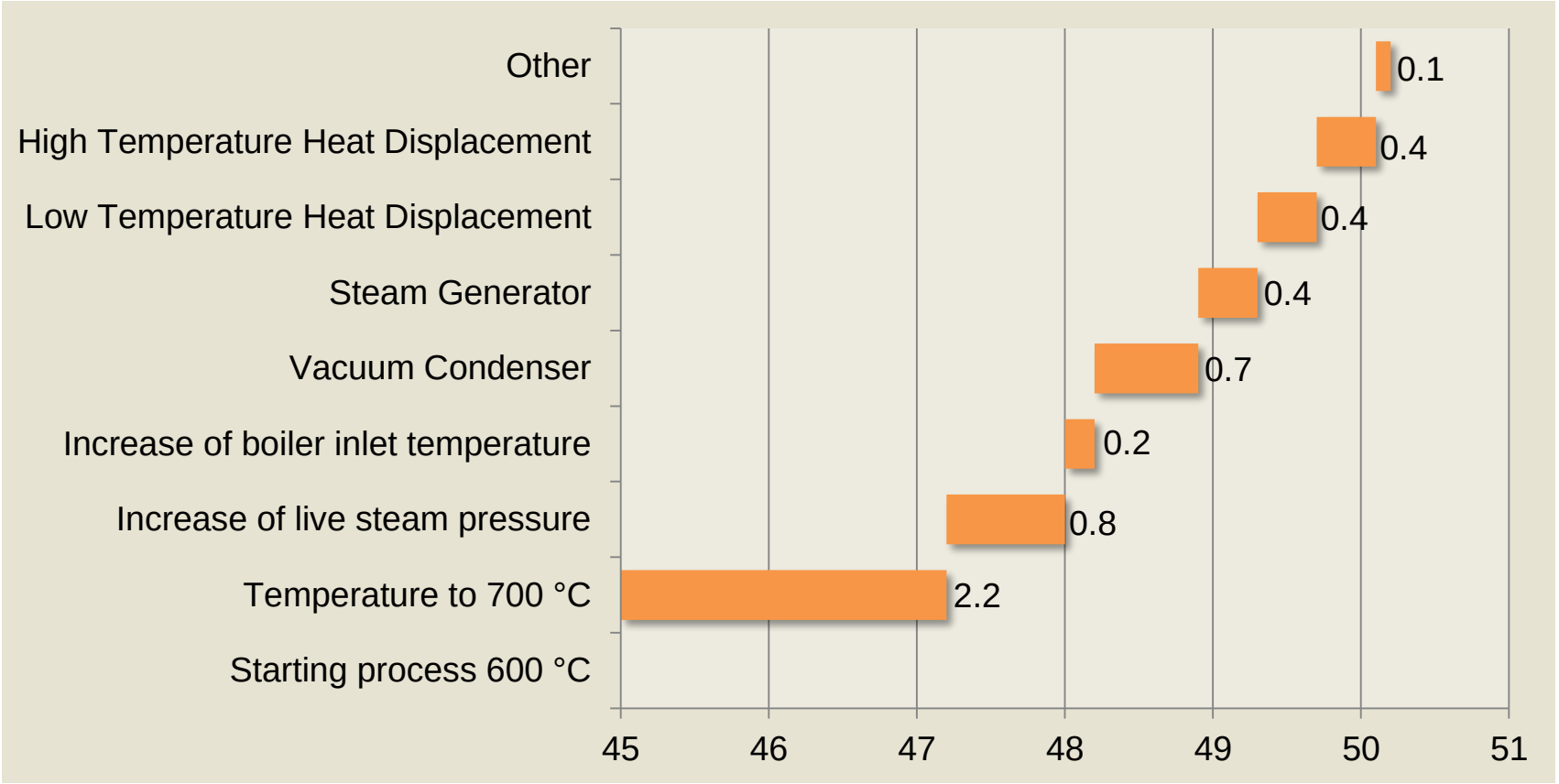
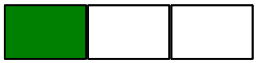
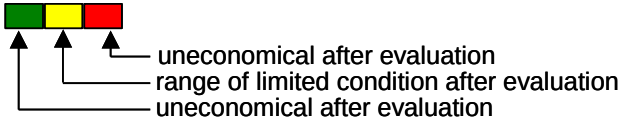
Expected values, partially estimated



Design of the feed water heating system

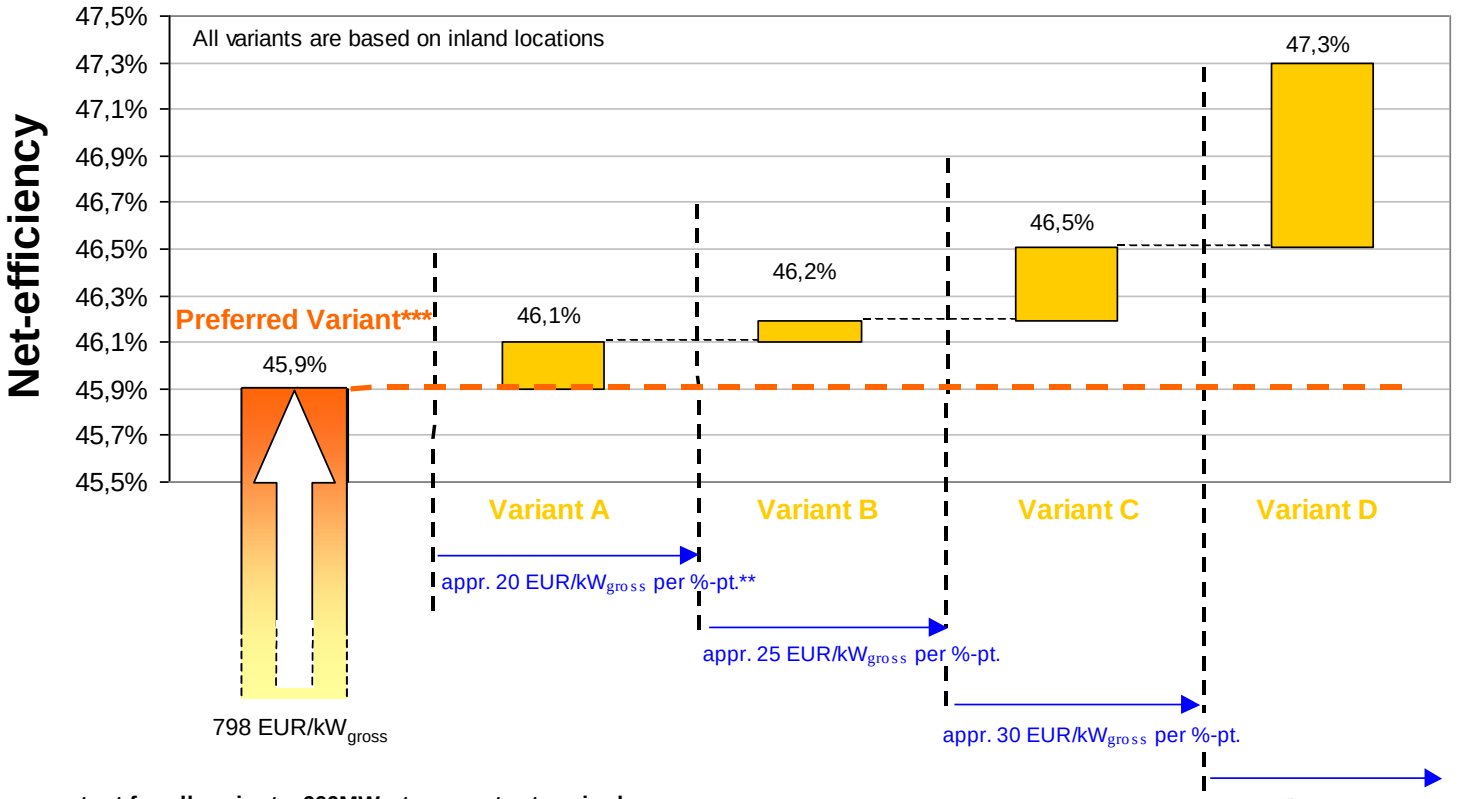
Number of idea: 6

Variant	external desuperheater feedwater-temperature at boiler inlet 303,4°C	external desuperheater feedwater-temperature at boiler inlet 320°C	thermo-compression	9-stage feedwater heating
Turbine-heat rate	appr. -9 kJ/kWh	appr. -24 kJ/kWh	appr. -12 kJ/kWh (supplier information)	appr. -11 kJ/kWh
Disadvantage			no preheaters located in condenser neck (A1/A2) possible	
Additional charge	appr. 400TEUR	appr. 2.100TEUR	appr. 840TEUR*	appr. 710TEUR
Results				
Recommendation			consideration only for A3 / A4	



* expenditures for turbine building not considered

Efficiency vs. Evaluation Factor*



Power output for all variants: 600MW at generator terminals

*** Increase of efficiency in EUR/kW$_{gross}$/%-pt.**

**** The increase of efficiency in Variant A considers also a reduced auxiliary power consumption, which requires an additional capital investment with an amount of appr. 8 EUR/kW$_{gross}$.**

***** In the concept study the Preferred Variant was investigated in detail; the Variants A-D have been derived.**

VGB Study "*Reference Power Plant North Rhine-Westphalia*"

Plant capacity:	600.0 MW
Net capacity:	555.5 MW
Net efficiency:	45.9 %
Specific costs (2003 price):	800 Euro/kW_{gross}
Cost of electricity:	3.3 - 3.5 ct/kWh
Type of boiler:	Benson
Live steam condition:	285bar/600°C/620°C
Condenser pressure:	45 mbar
Preheater:	8 preheater + external cooler

Year 2012
about 1,100 €/kW

New 600/620°C coal fired power plants in Europe based on RPP NRW study

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Anlage	Betreiber	Standort	Anzahl Blöcke	MW
Datteln 4	E.ON	Datteln	1	1100
Walsum 10	STEAG	Walsum	1	750
Moorburg 3-4	Vattenfall	Moorburg	2	820
Westfalen D-E	RWE Power	Hamm	2	800
Rheinhafen RDK 8	EnBW	Karlsruhe	1	912
GKM 9	GKM	Mannheim	1	912
Wilhelmshaven	Electrabel	Wilhelmshaven	1	800
Boxberg Block R	Vattenfall	Boxberg	1	675
Neurath G-F	RWE Power	Neurath	2	1100
Eemshaven A-B	RWE Power	Eemshaven	2	800
Maasvlakte	Electrabel	Rotterdam	1	800
Maasvlakte 3	E.ON	Rotterdam	1	1100
Ledvice	CEZ	Bilina	1	660

Draft content of the study “Reference Power Plant India”

1. Introduction and project implementation
2. Market Trends in India and Economic Feasibility
3. Environmental aspects and climate protection
4. Industrial Policy Aspects
5. Technical Plant Design
    a) Basic Design, BoP
    b) Steam Turbine Island
    c) Boiler Island
    d) Flue Gas Cleaning
    e) Electrical Systems and C&I
    f) Process Engineering
6. Operation & Maintenance Concept
7. Technical-commercial evaluation
8. Preferred solution
9. Summary

Next steps to set-up the study “Reference Power Plant India”

1. Discuss technical and financial feasibility
2. Determine project sponsor (IGEF SG1?)
3. Determine project management (EEC?)
4. Identify potential stakeholders and project partners
5. Setup project plan, structure, schedule, budget by PM
6. Financial close

7. WORK!

8. Publish study

Today?

Q2-2015
Q4-2015

…2016…

IGEF 2017

धन्यवाद

Thank you

for your interest!

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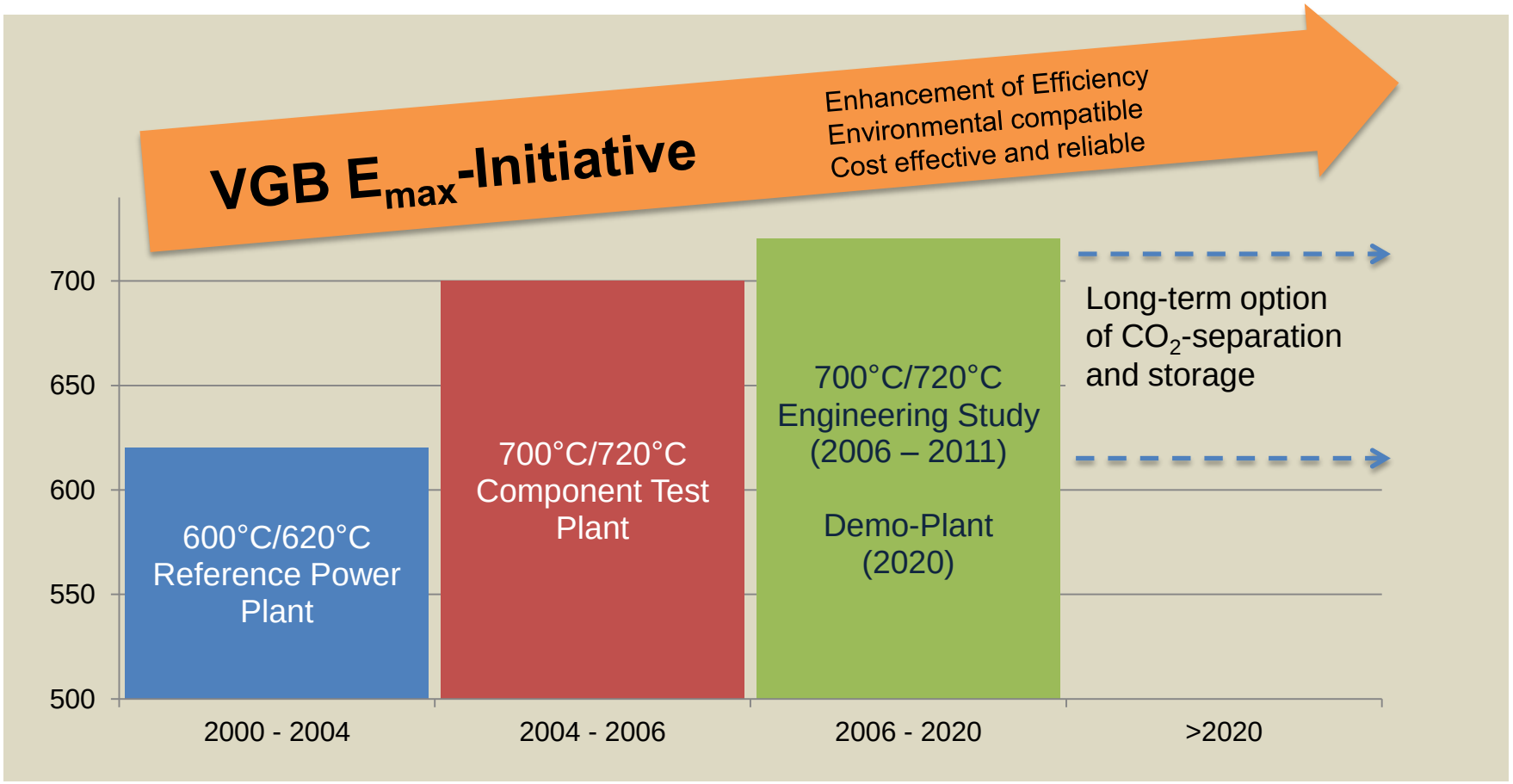
German evaluation criteria 2004

RPP NRW - Reference Case		**FDK: 3.37 ct/kWh**
Number of power station units	[Unit]	1
Gross installed capacity	[MW]	600
Auxiliary station power requirement	[%]	7.4%
Investment sum (IS)		
Price of plant (PP)	[Euros/kW (gross)]	798
Distribution over construction period	[% p.a.]	25, 40, 35%
In advance/arrears	[1..0]	0.5
Escalation until and after construction period	[% p.a.]	1.0%
Project owner's own contribution		
In total, proportional to PP	[%]	5.0%
Distribution over construction period	[% p.a.]	25, 40, 35%
In advance/in arrears	[1..0]	0.5
Contingencies, proportional to PP	[%]	3%
Service life	[a]	35
Hours under full load		
From period 1 to end of period 17	[h/a]	7500
From period 18 to end period 35	[h/a]	5500
Rate of interest used in costings	[% p.a.]	10.0%
Period to start of construction	[Months]	15
Construction time	[Months]	36
Maintenance costs		
Total, proportional to IS	[% p.a.]	1.5%
Escalation over operating time	[% p.a.]	1.0%
Insurance/overhead, proportional to sum invested		
Total, proportional to IS	[% p.a.]	0.5%

German evaluation criteria 2004

Operational efficiency		
From period 1 to end of period 17	[%]	44.9%
From period 18 to end period 35	[%]	43.9%
Fuel costs		
Base price (free power plant)	(Euro/t]	41
Escalation over the term	[% p.a.]	0.0%
Heating value	[kJ/kg	25,000
Personnel costs		
Personnel requirement	[Men]	70
Basic wage (incl. ancillary payroll costs)	[1000 euros/man/a]	70
Escalation over the term	[% p.a.]	0.5%
Auxiliary/operating supplies (including desulphurisation/denitrification/ disposal)		
Base price, proportional to power generation	[€/kWh]	0.001
Escalation over the term	[% p.a.]	1.0%
Decommissioning costs	[Euro]	2,000,000
Exchange rate	[Euro/$]	1
CO_2 cost impact		
Price at start of operation	[Euro/t]	0
Price at end of operation	[Euro/t]	0

VGB E_{max}- Initiative for efficiency improvements



600/620°C Power Plant Concepts

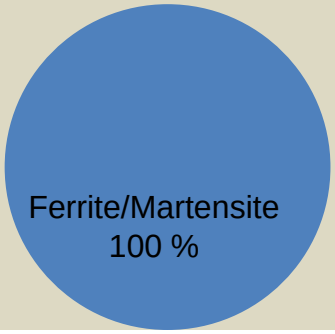
- Reference efficiency > 45%
- Material concept realized
- High production requirements especially on site
- Intensive quality checks
- Investment ~ 1.300 €/kW

700/720° C Power Plant Concepts

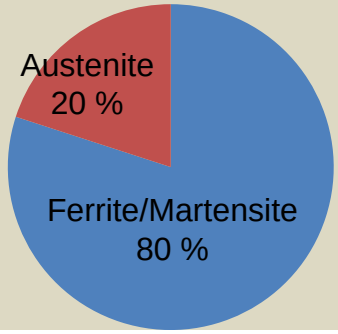
- Reference efficiency > 50%
- Material concept under development
- High specific costs for Ni-Ba-Mat.
- High machining time and effort
- Further material development and component tests necessary
- Investment > 2.000 €/kW

Material mix in modern power plants

250 bar / 540 °C / 560 °C



280 bar / 600 °C / 620 °C



360 bar / 700 °C / 720 °C