TECHNICAL INNOVATIONS IN NEW 500.000 T/YR WTE FACILITY IN THE CITY CENTER OF COPENHAGEN (AMAGER), DENMARK

Ole Poulsen, Ramboll

RAMBØLL

Beacon, Malmö, November 4, 2011

RAMBØLL

- Established i 1945
- Ramboll consulting group: approx. 9,000 employees
- Leading waste-to-energy consultant with >50 specialists within WtE
- Long track record of waste-to-energy plant projects – on-going > 30 WtE projects.
- Independent consulting services

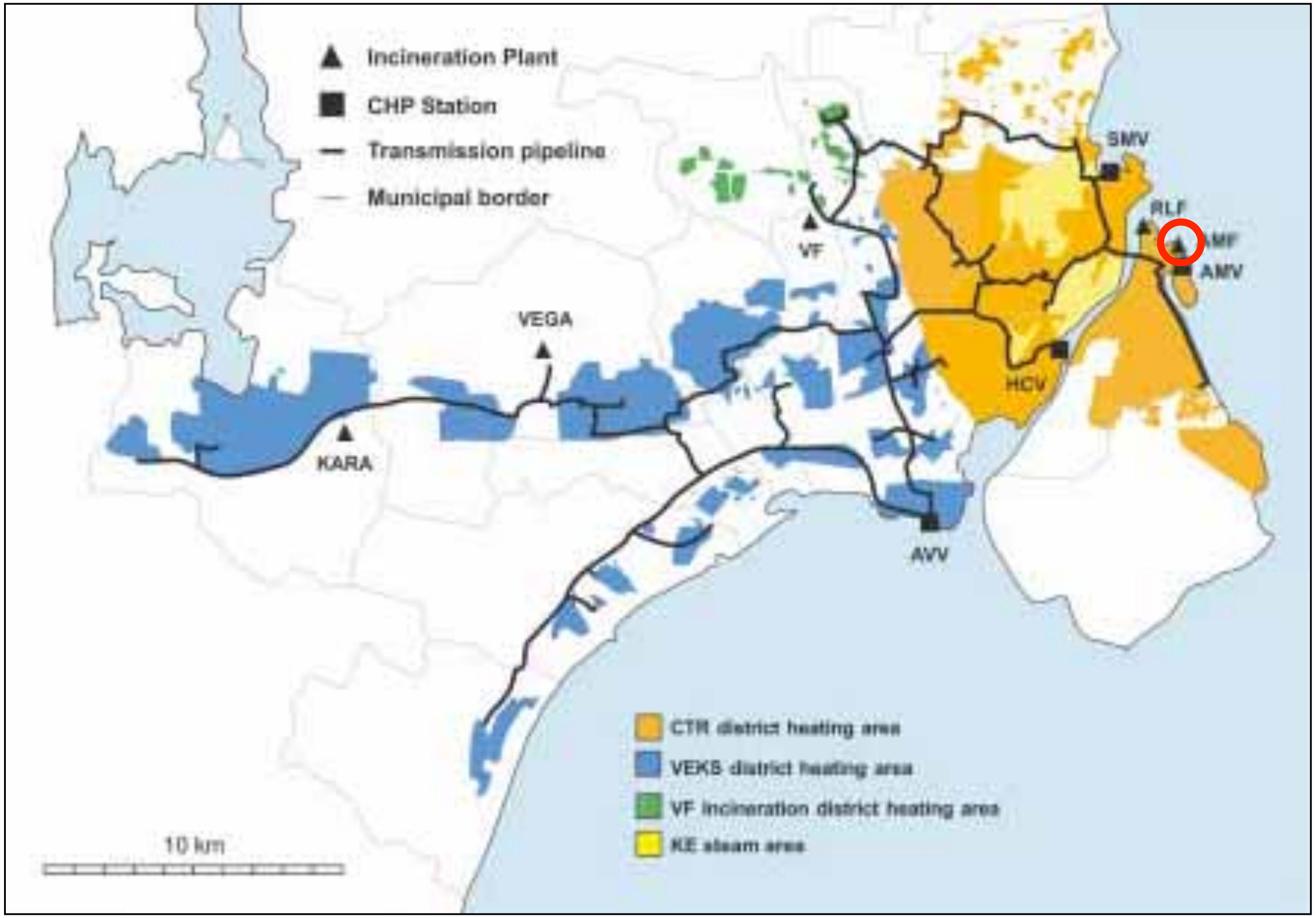
WASTE-TO-ENERGY PLANT REFERENCES

COPENHAGEN-AMAGER WTE PLANT

Capacity:

2 x 35 ton/h

COPENHAGEN-AMAGER WTE PLANT



PERFORMANCE GOALS

- World Class Architecture
- High Energy Efficiency
- Best Possible Environmental Standard
- High Level of Community Integration
- High Level of Public Acceptance

World Class Architecture

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VISUALISATION COPENHAGEN WTE

VISUALISATION COPENHAGEN WTE

VISUALISATION COPENHAGEN WTE

VISUALISATION BOILER HALL

High Energy Efficiency

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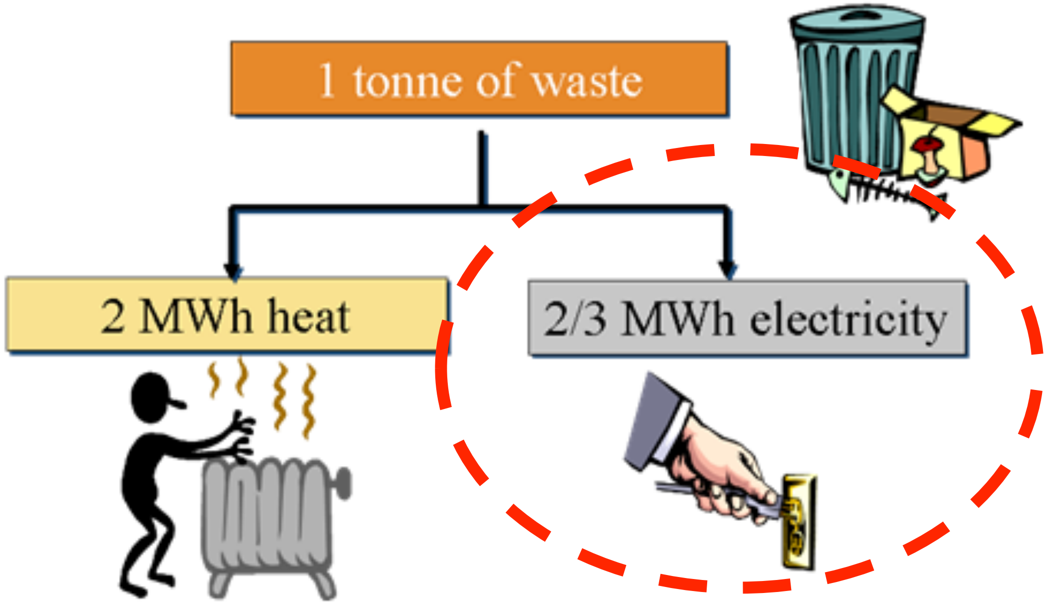
MEASSURES TO INCREASE ENERGY EFFICIENCY

- Optimizing of boiler steam parameters
- Optimizing of district heating couplings
  - 2 water based DH networks
  - 1 steam based DH network
- Heat pumps
- Optimizing of technical concept and internal energy consumers



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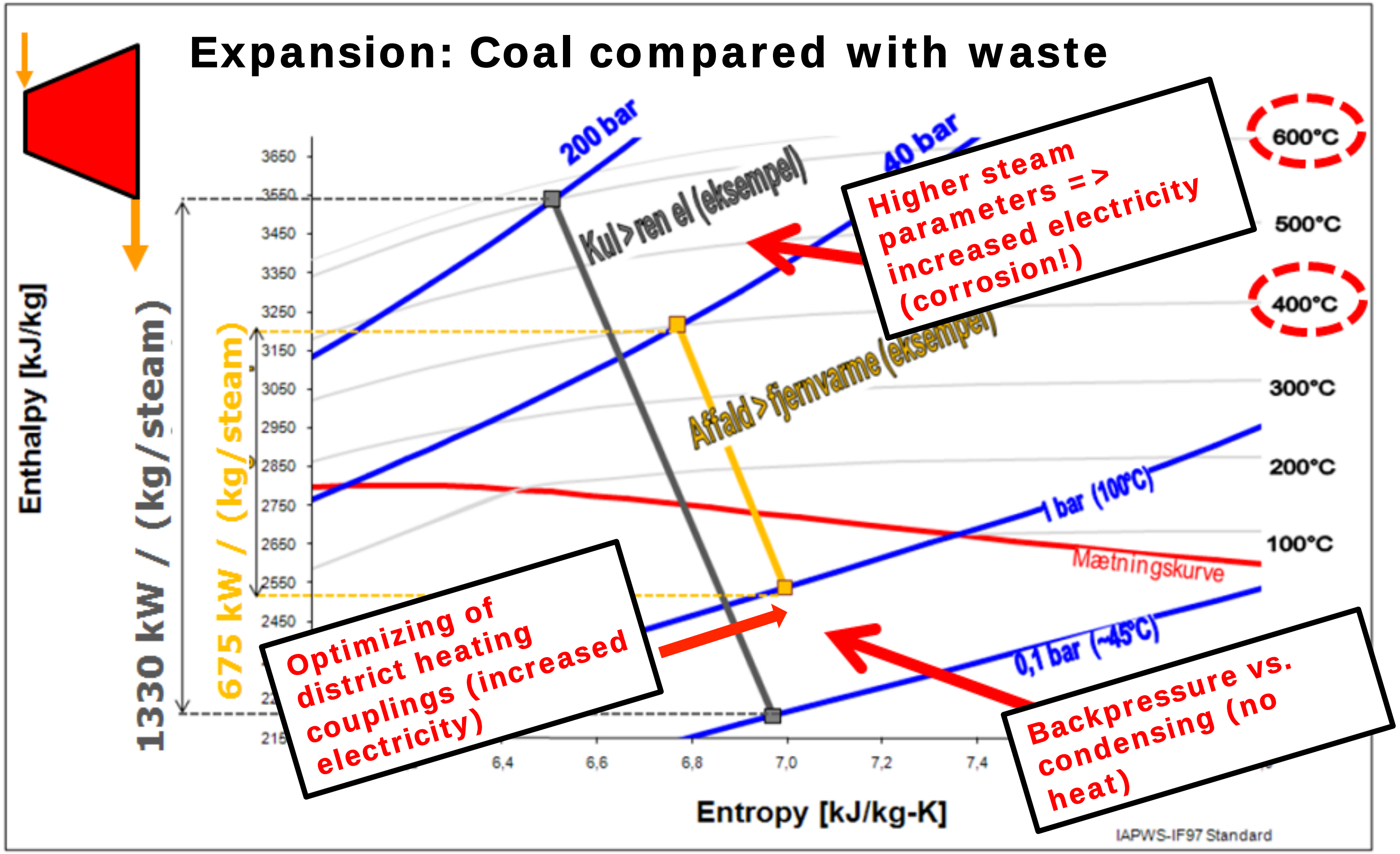
OPTIMIZING STEAM PARAMETERS



Expansion diagram

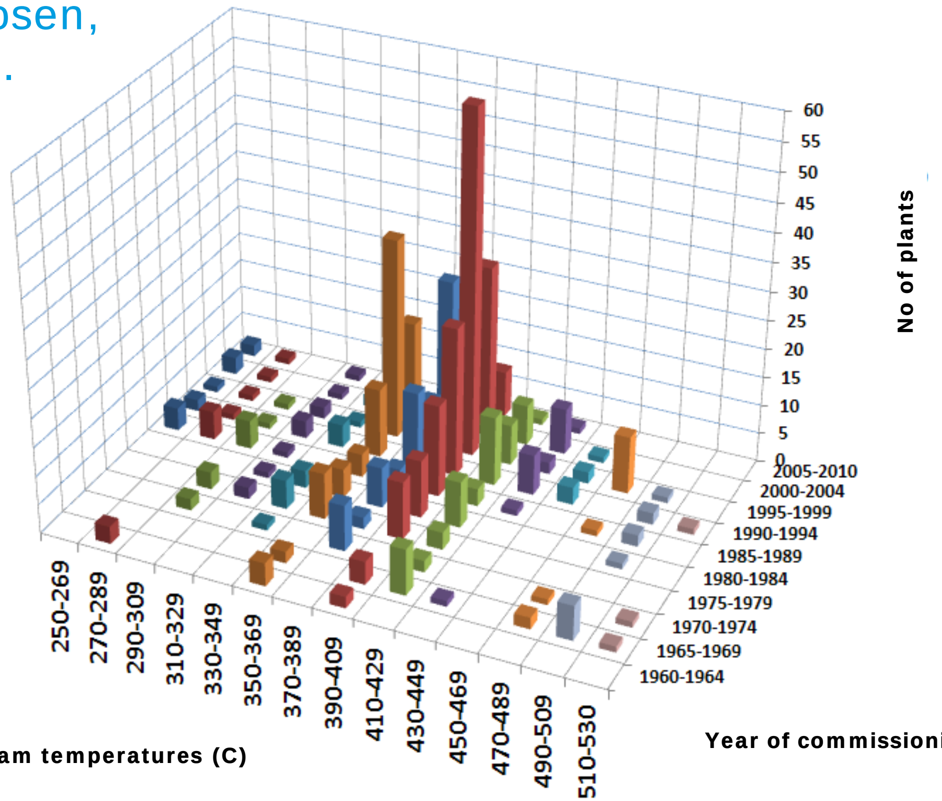
STEAM PARAMETERS: EU TRENDS

No strong tendency towards higher steam parameters…

~ 400 degreeC is often chosen, even for condensing plants.

WtE Plants
(data from 2006)

Steam temperatures, grate fired plants in Europe



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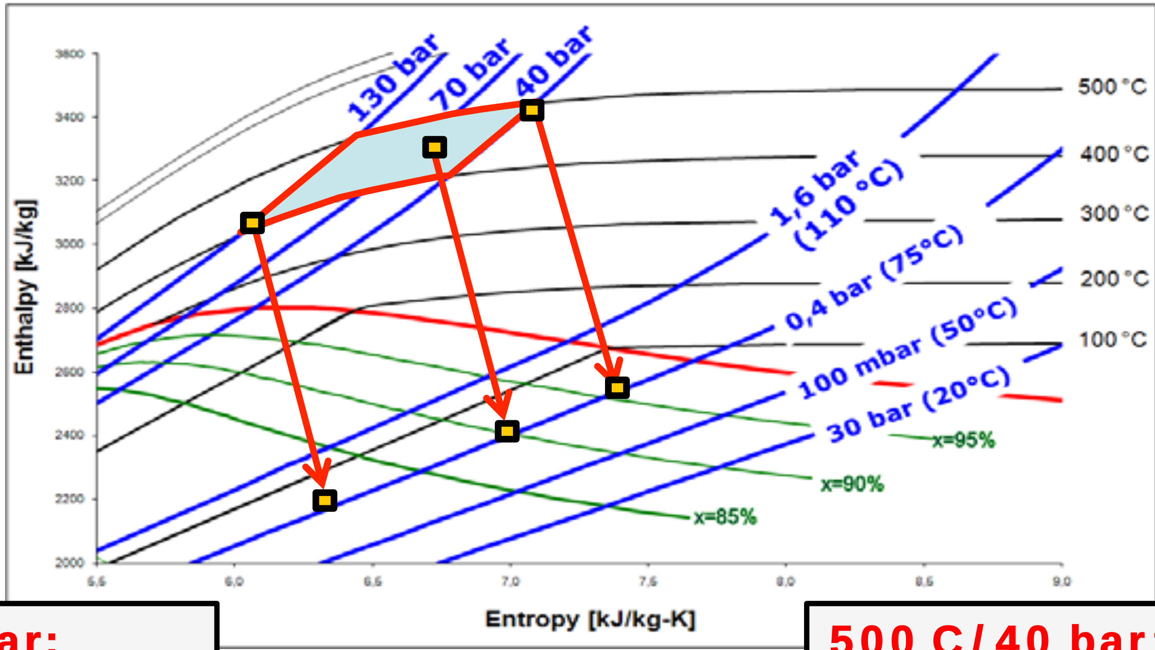
WtE plants in EU15 countries, ISWA 2006 (inklusive condensing plants)

STEAM PARAMETERS EVALUATED

Limits:
400-500C
40-130 bar



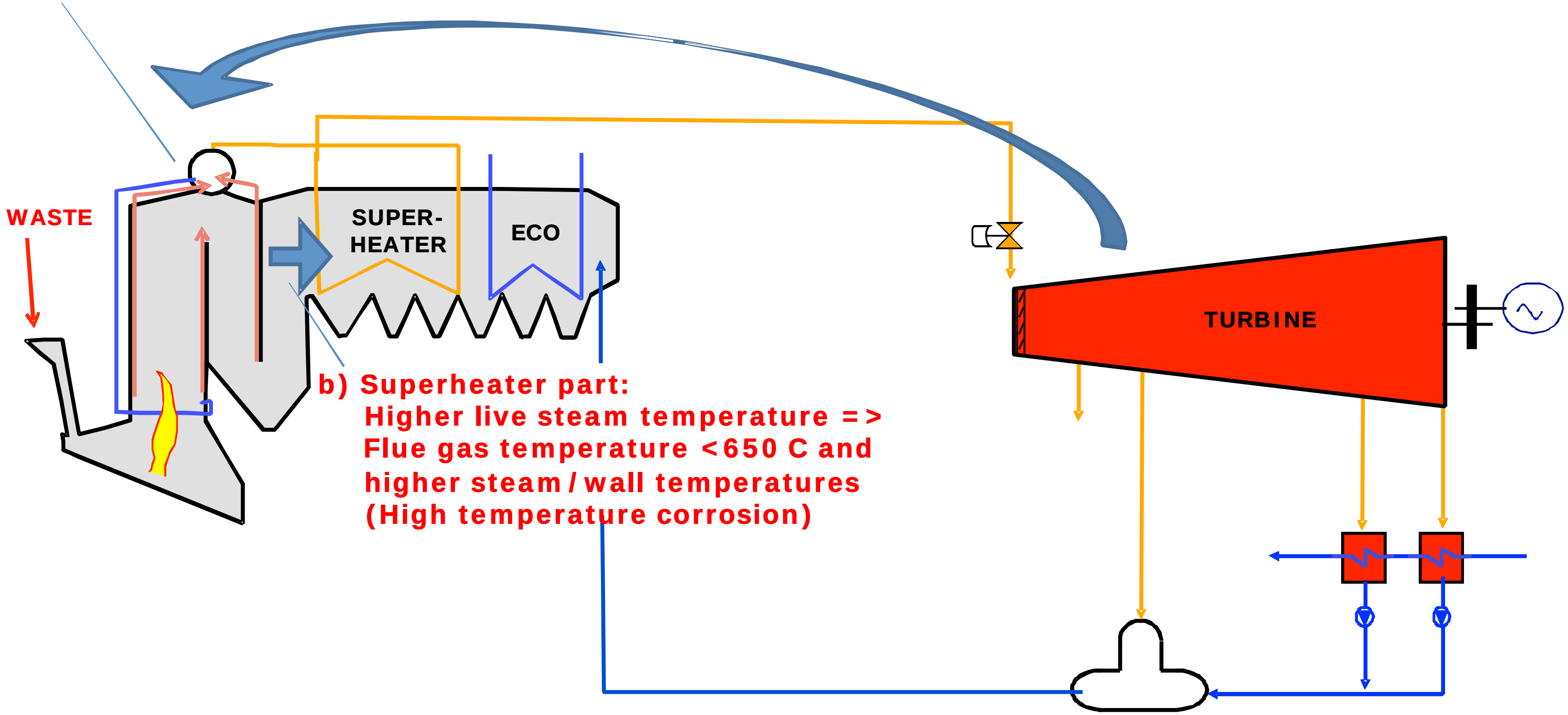
400 C/130 bar:
Erosion of turbine blades due to moisture in turbine exaust

500 C/40 bar:
Very high corrosion rates on superheaters

Optimal choice:
“somewhere” in between

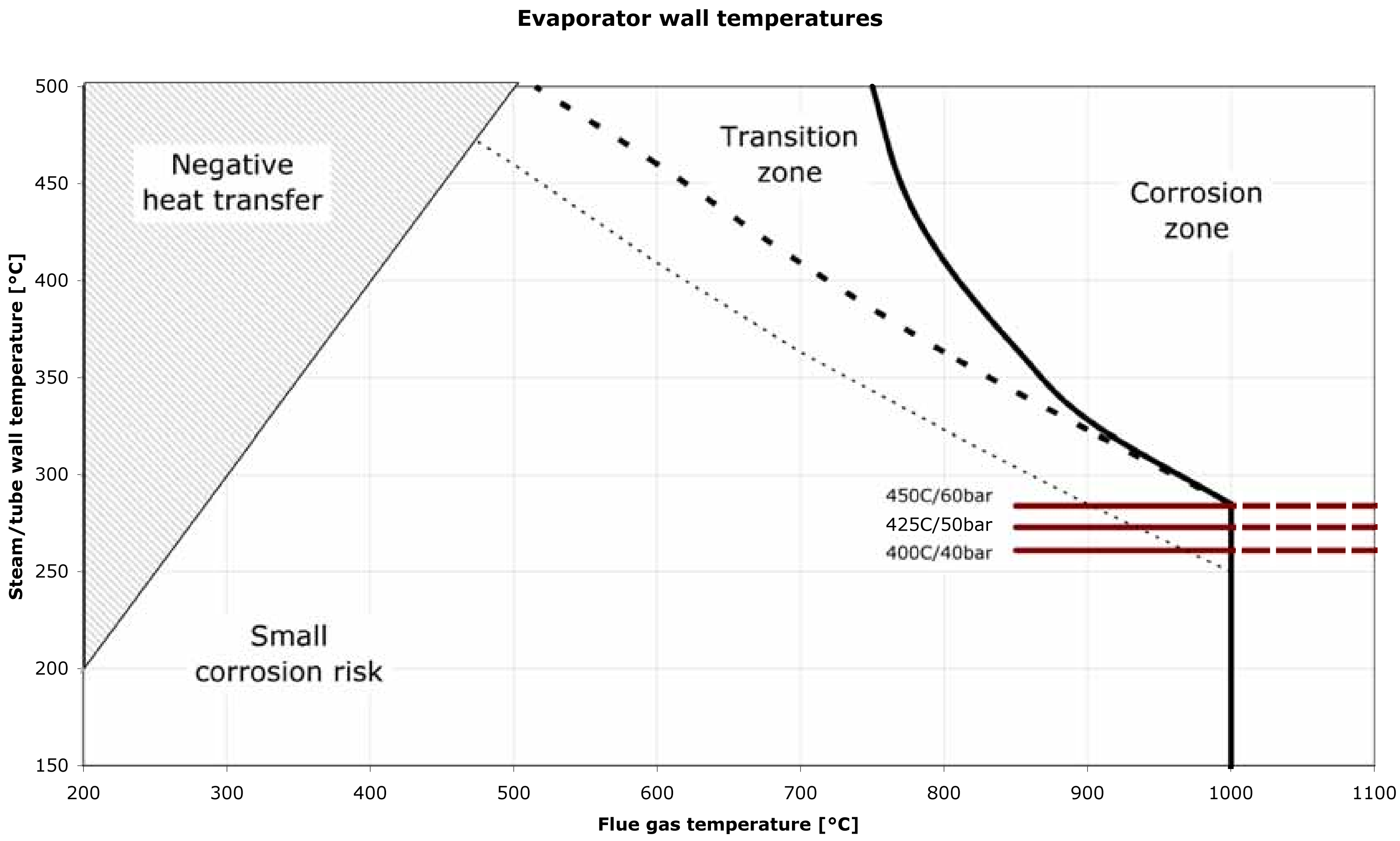
RISK FOR CORROSION

a) Evaporator part:
Higher live steam pressure =>
High flue gas temperature and higher steam/wall temperatures

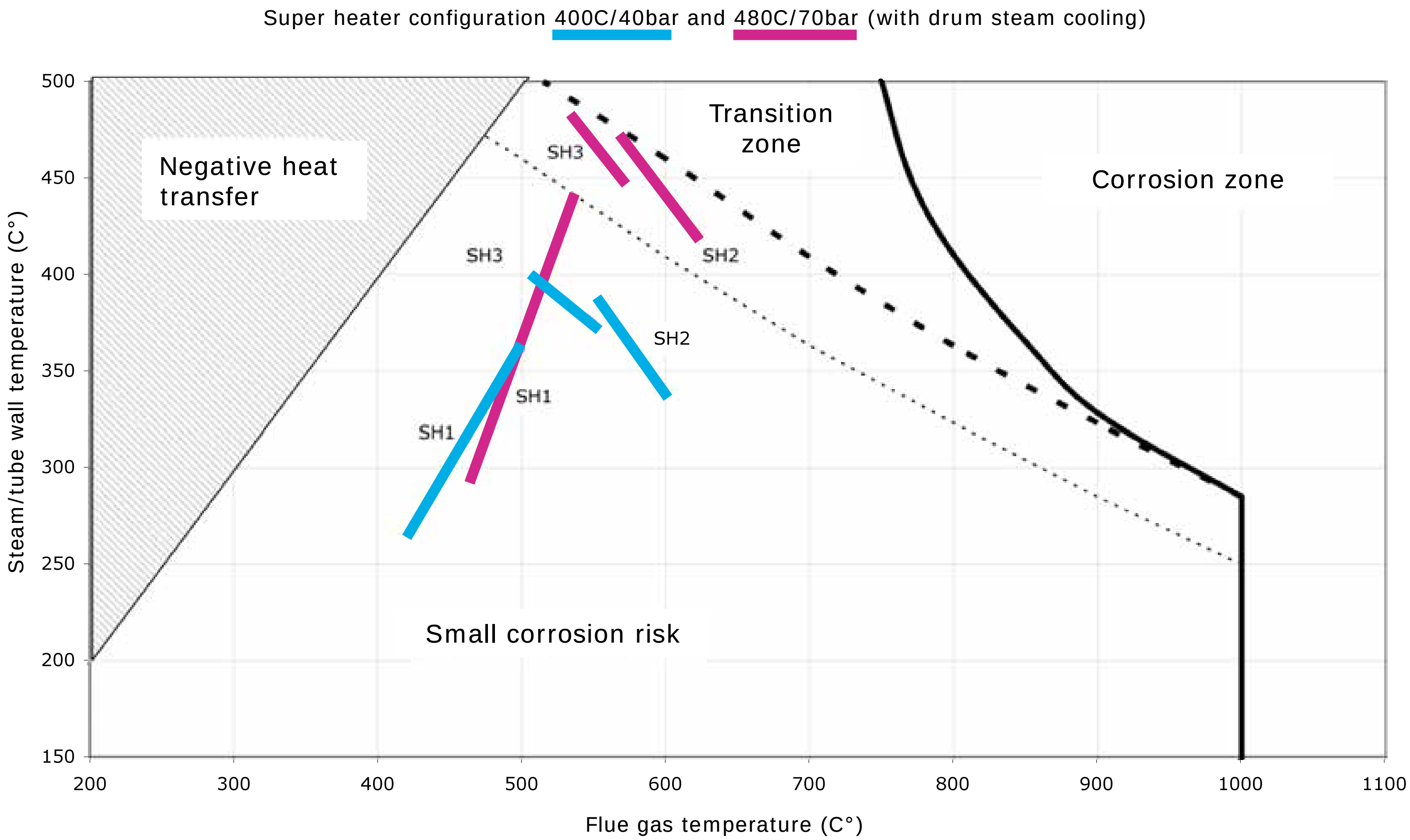


b) Superheater part:
Higher live steam temperature =>
Flue gas temperature <650 C and
higher steam/wall temperatures
(High temperature corrosion)

CORROSION DIAGRAM – EVAPORATOR PART

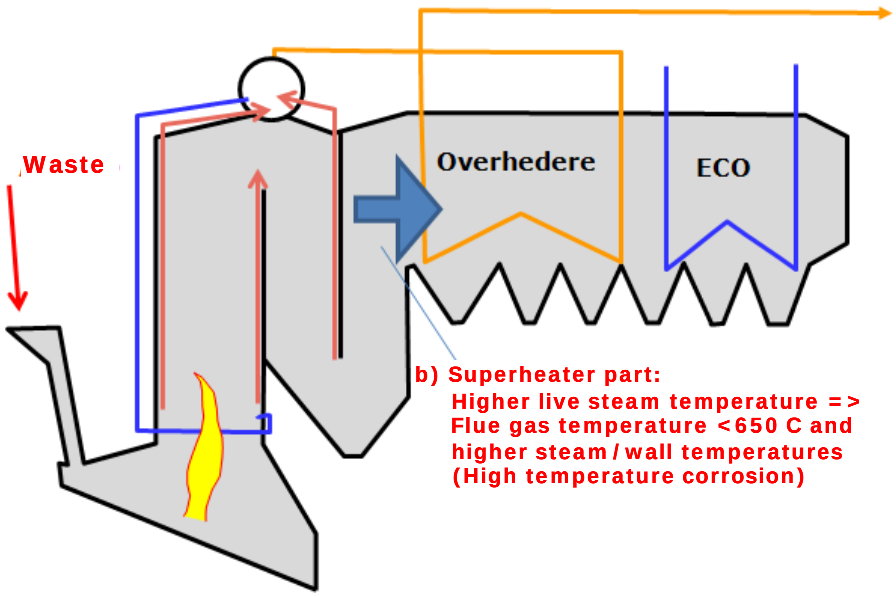


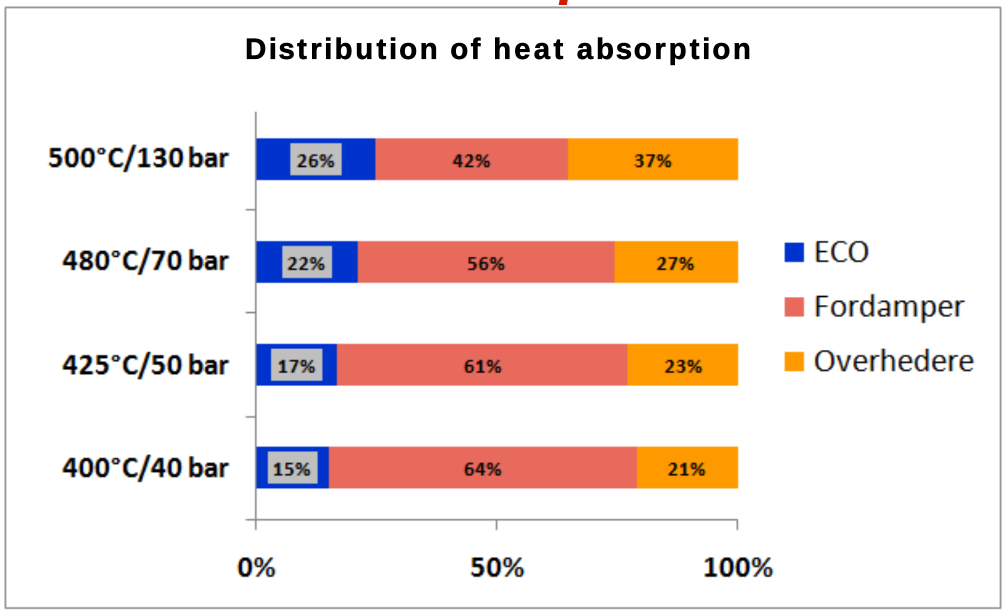
CORROSION – DIAGRAM SUPERHEATER PART



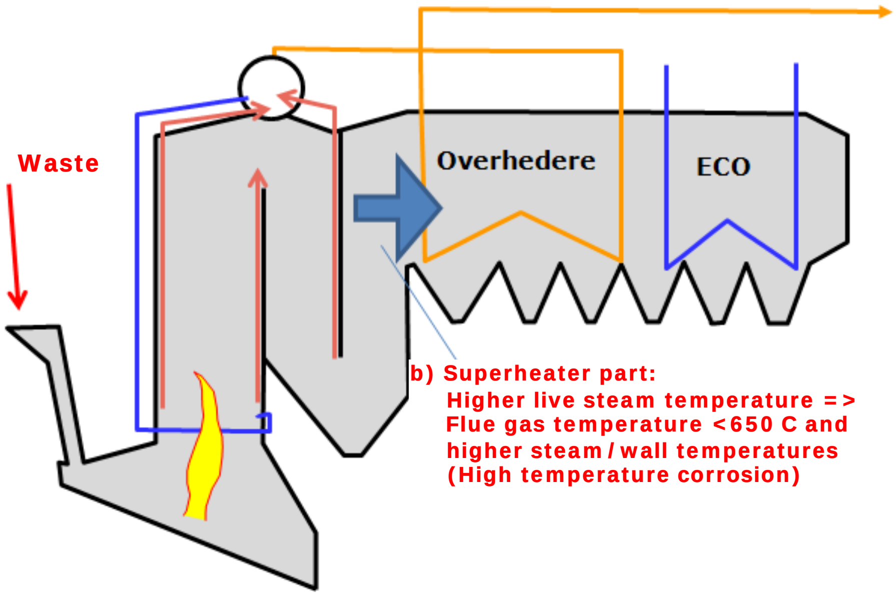
CORROSION – SUPERHEATER PART

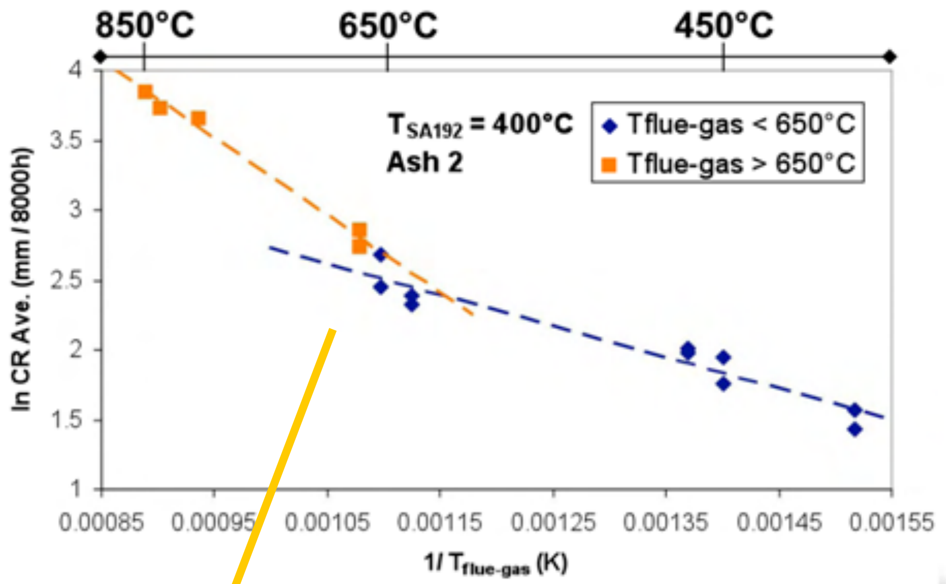
Furthermore there is a thermodynamic tendency to that the flue gas temperature before superheaters will increase with increasing steam parameters !





CORROSION – SUPERHEATER PART





Source: Beacon conference, Malmø 2009

Higher flue gas temperatures in front of superheaters results in a higher corrosion rate

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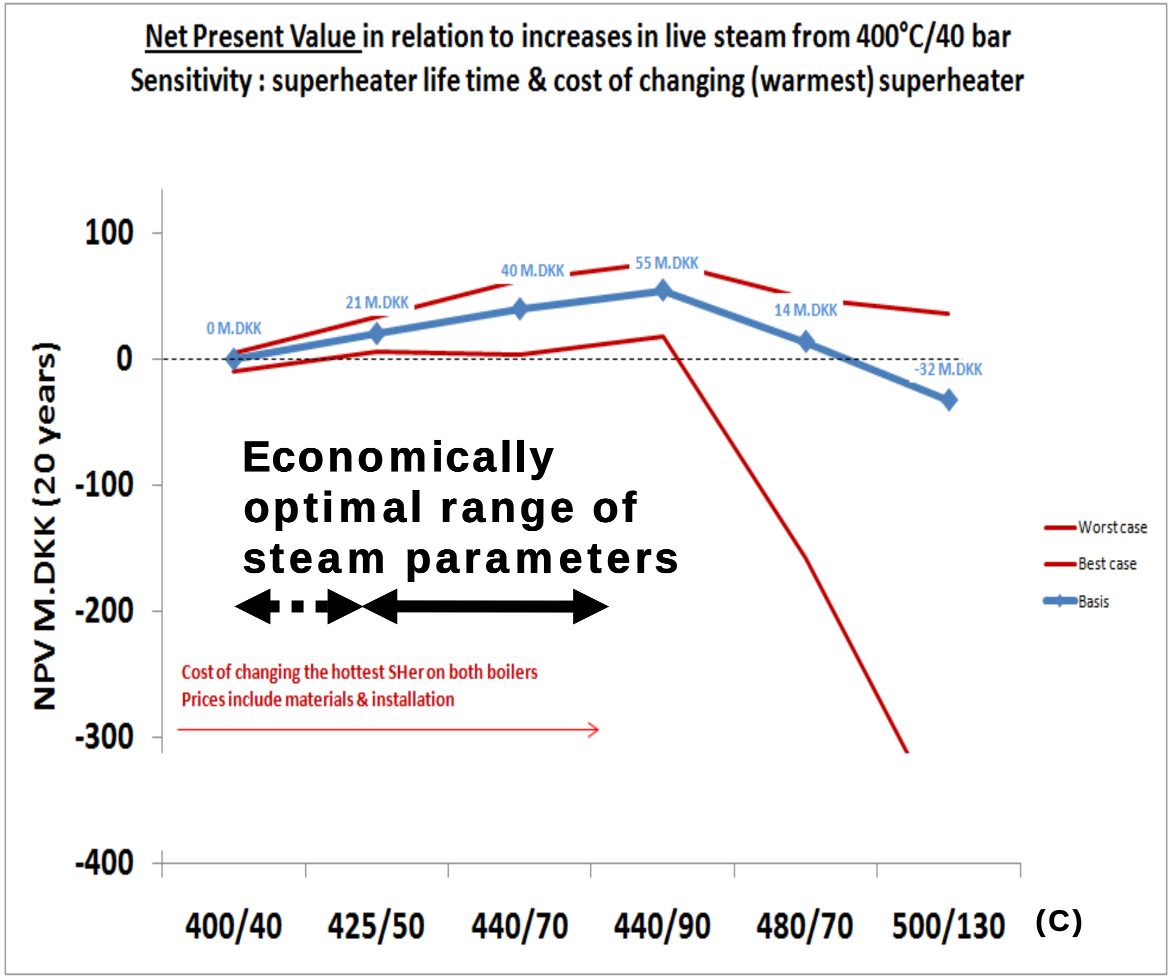
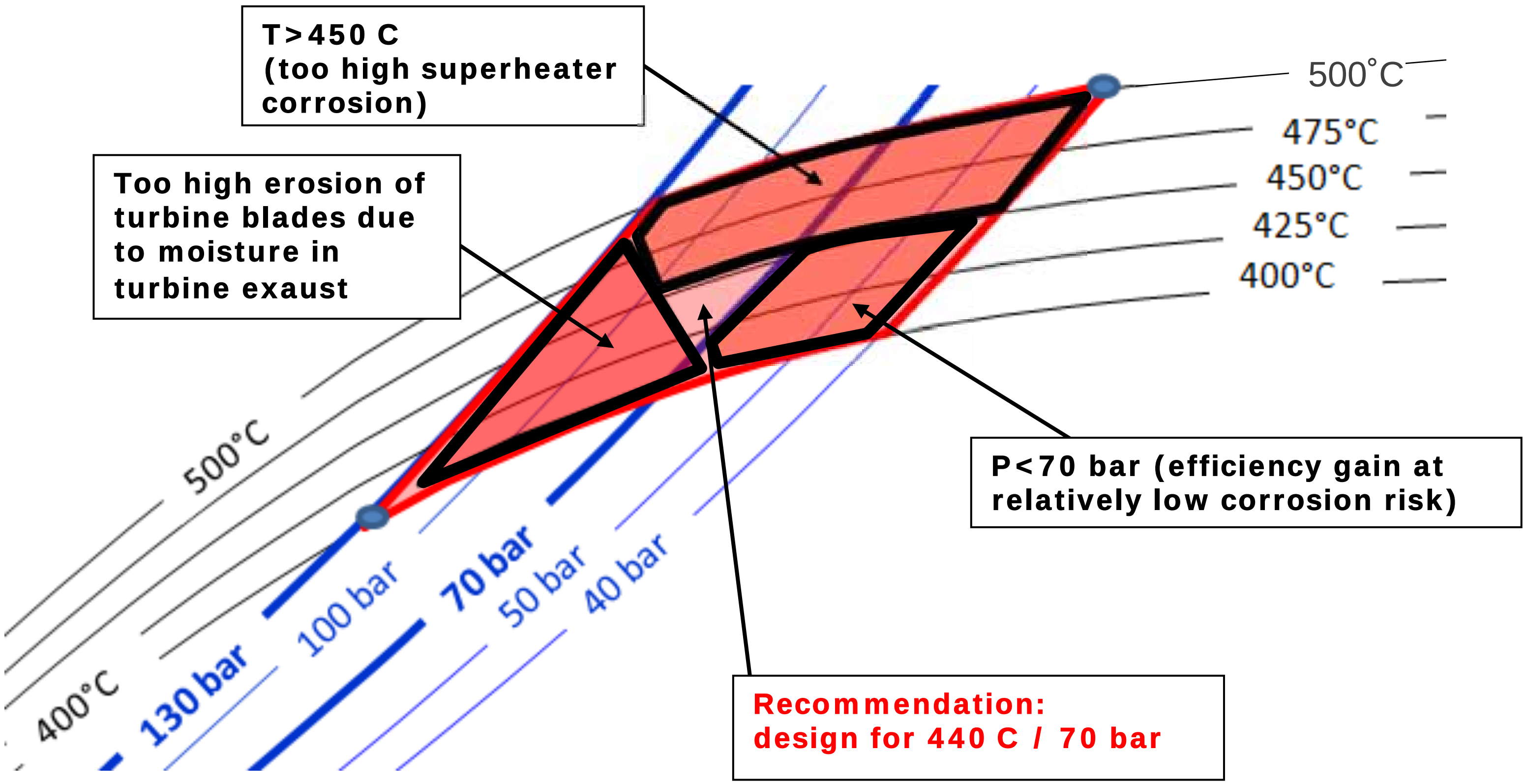
NPV CALCULATIONS

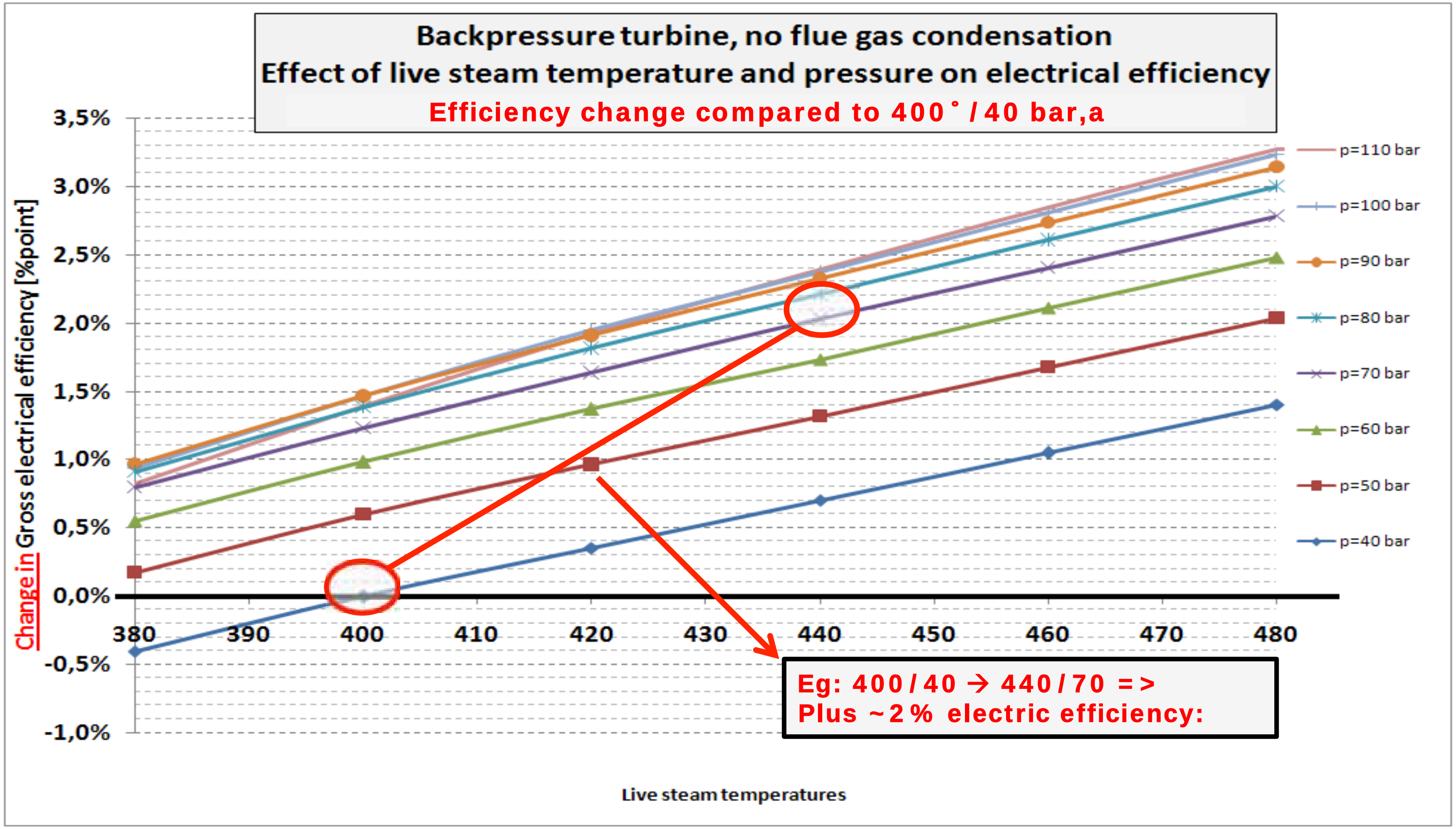


Effects considered:
- 20 year plan period
- Identical availability
- Investment in boiler
- Increased energy sales
- Increased O&M

RECOMMENDATIONS LIVE STEAM PRESSURE



CHANGE IN (GROSS) ELECTRICAL EFFICIENCY



ENERGY EFICIENCY

Basis: Steam data, 440°C / 70 bar,a Wet FGT Front-end SCR Flue gas condensation with heat pumps	**Production**		**Own consumption**	**Energy sales**
	El η_{el} **(brutto)**	**Heat** η_{varme} **(brutto)**	**El** η_{el}	**Total efficiency** η_{total} **(netto)**
Operation without heatpumps	27,2%	65,8%	~ 2,7%	90,3%
Operation with heat pumps	24,8%	81,4%	~ 2,7%	103,5%

Source: Rambøll basic design study

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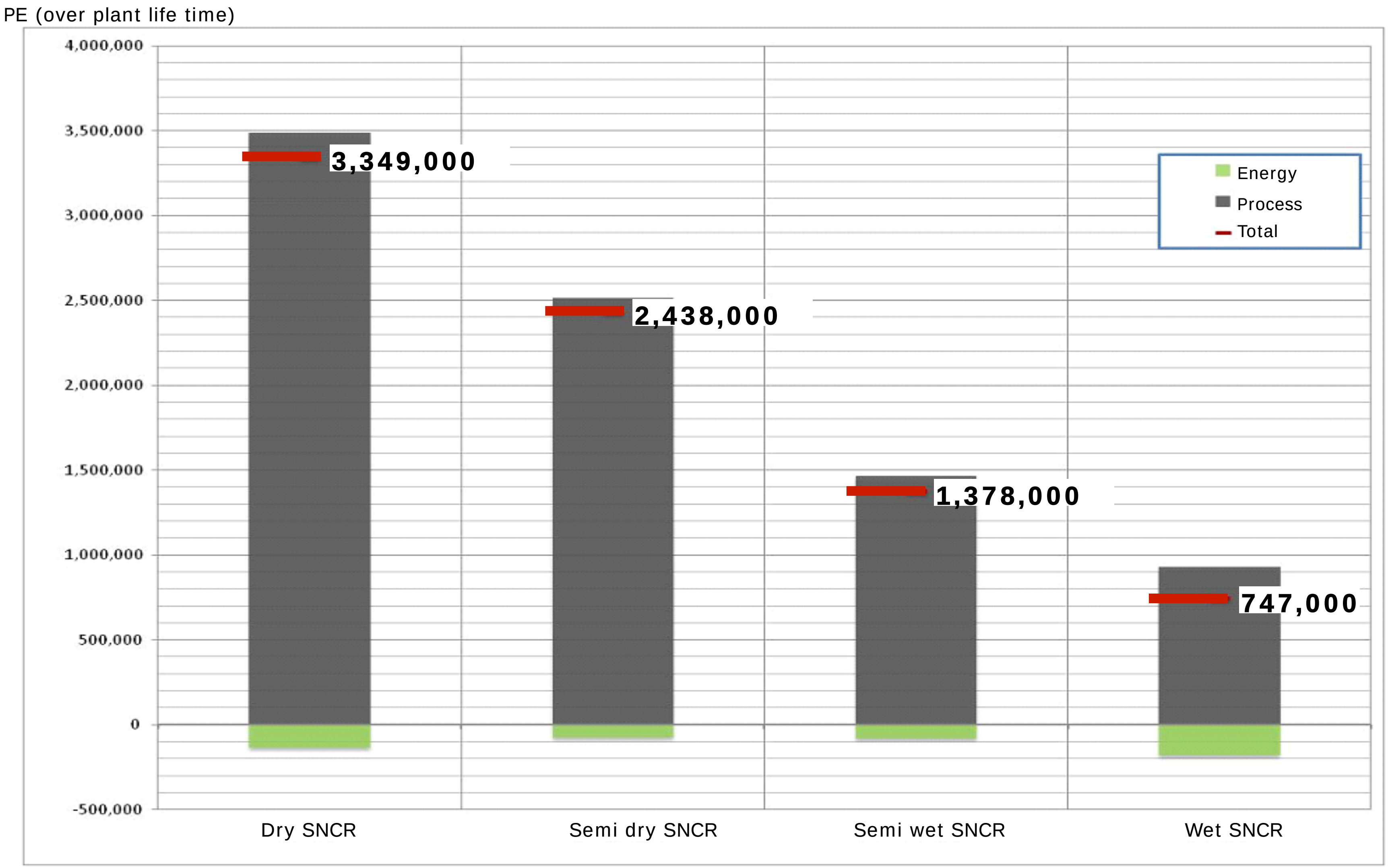
Best Environmental Standard

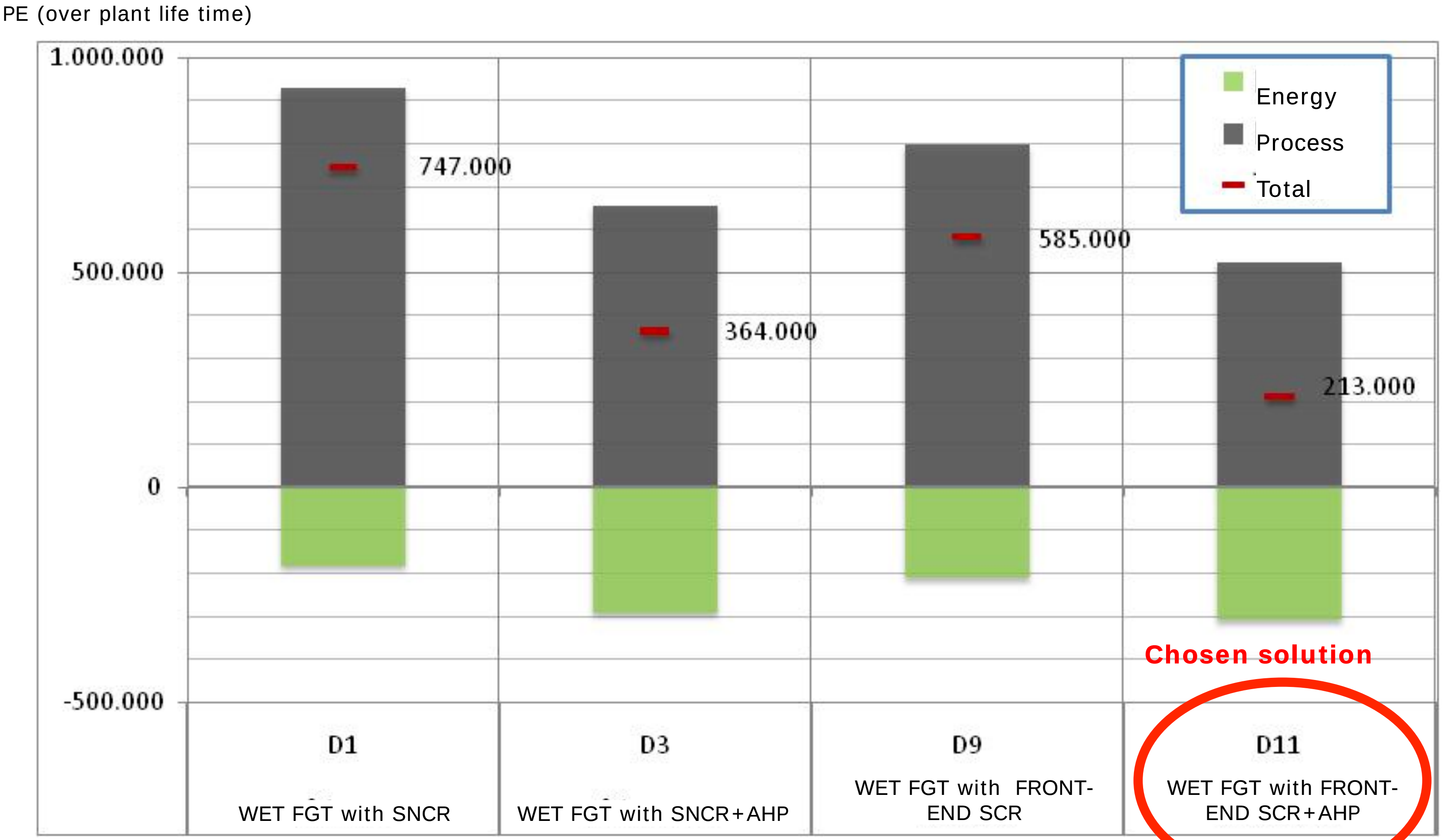
SCENARIOS FOR THE LCA STUDY

- Dry:
  - Reactor (bicarbonate)
  - Baghousefilter
  - Economiser
- Semi-dry:
  - Reactor (hydrated lime)
  - Baghousefilter
  - Economiser
- Semi-wet:
  - Reactor (hydrated lime)
  - Baghousefilter
  - Economiser
  - Wet alkaline scrubber
- Wet:
  - Electrofilter
  - Quench
  - Wet acidic scrubber
  - Wet alkaline scrubber (calciumcarbonate)
  - Baghousefilter (activated carbon)
  - Waste water treatment
- De-NOx
  - SNCR (very low NOx)
  - SCR (tail-end)
  - SCR (front-end between ESP and Economiser)

LIFE CYCLE ANALYSIS OF FGT SCENARIOS



LIFE CYCLE ANALYSIS
SCENARIOS WITH WET FGT ALTERNATIVES

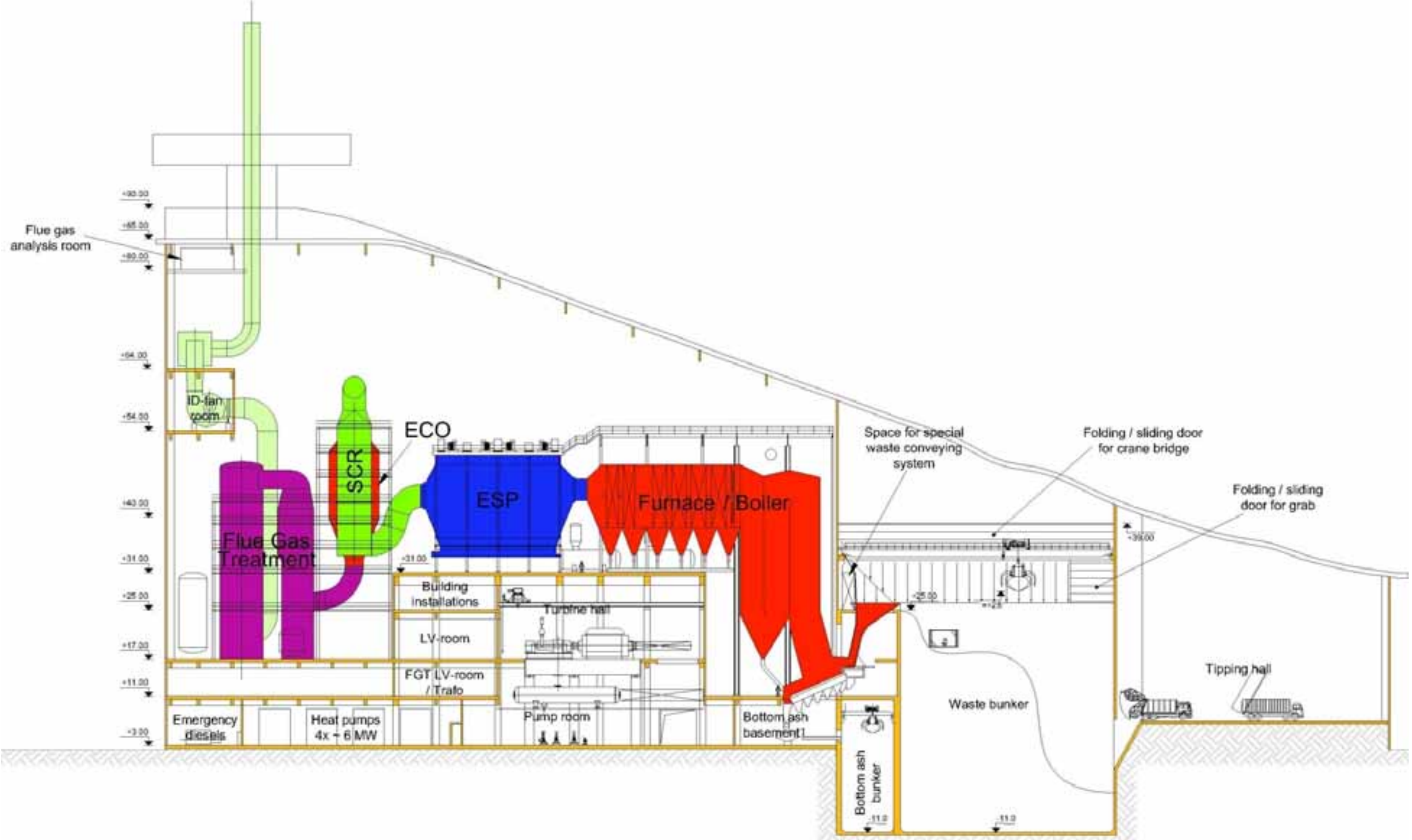


EXAMPLE OF ROBUSTNESS OF FGT SOLUTION

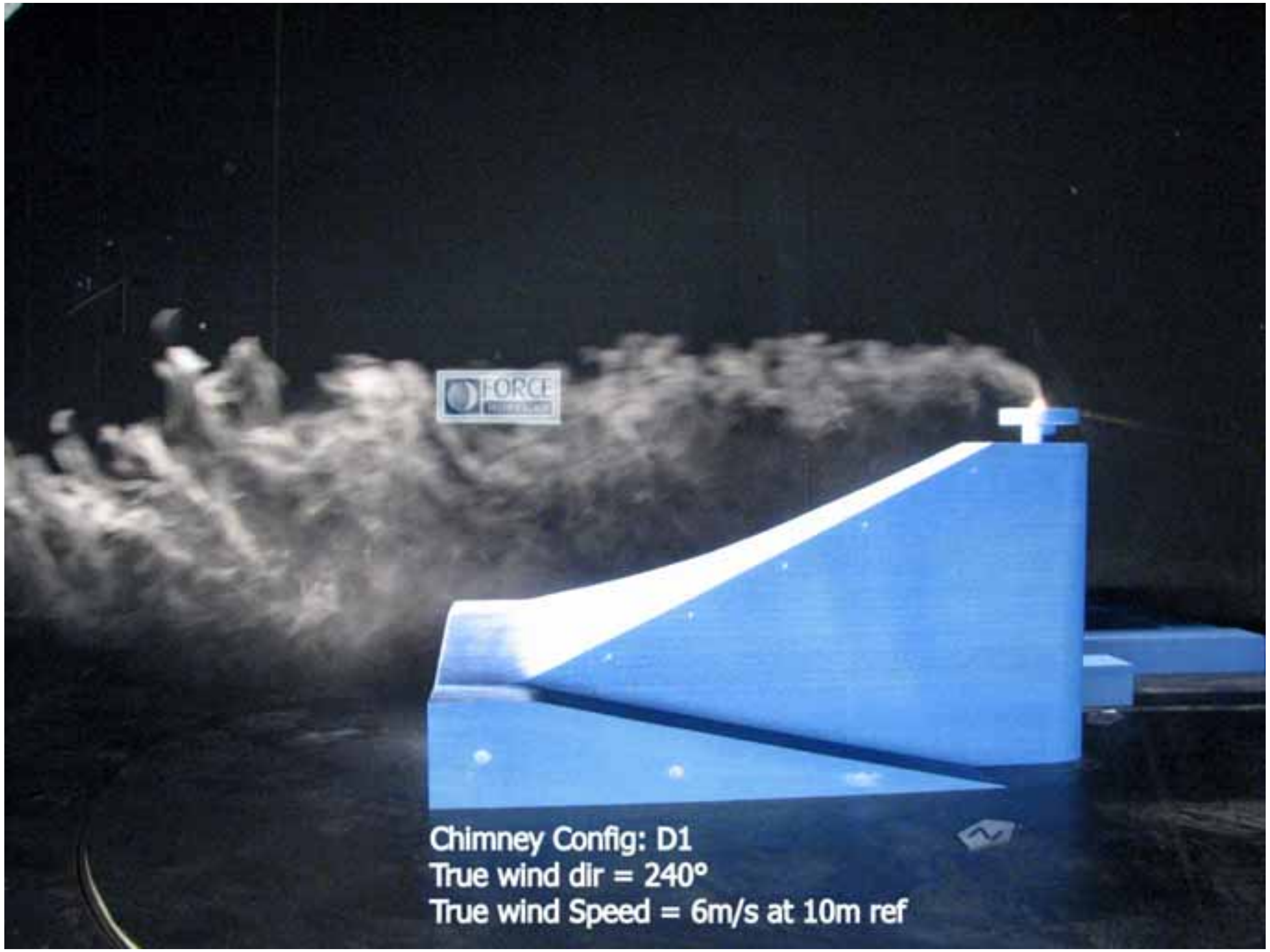
News 2011-11-02:

Potential danish NOx tax increase from 5 kr/kg to 50 kr/kg

PLANT LAYOUT – TECHNICAL CONCEPT



PLANT LAYOUT (WIND TUNNEL MODELS)



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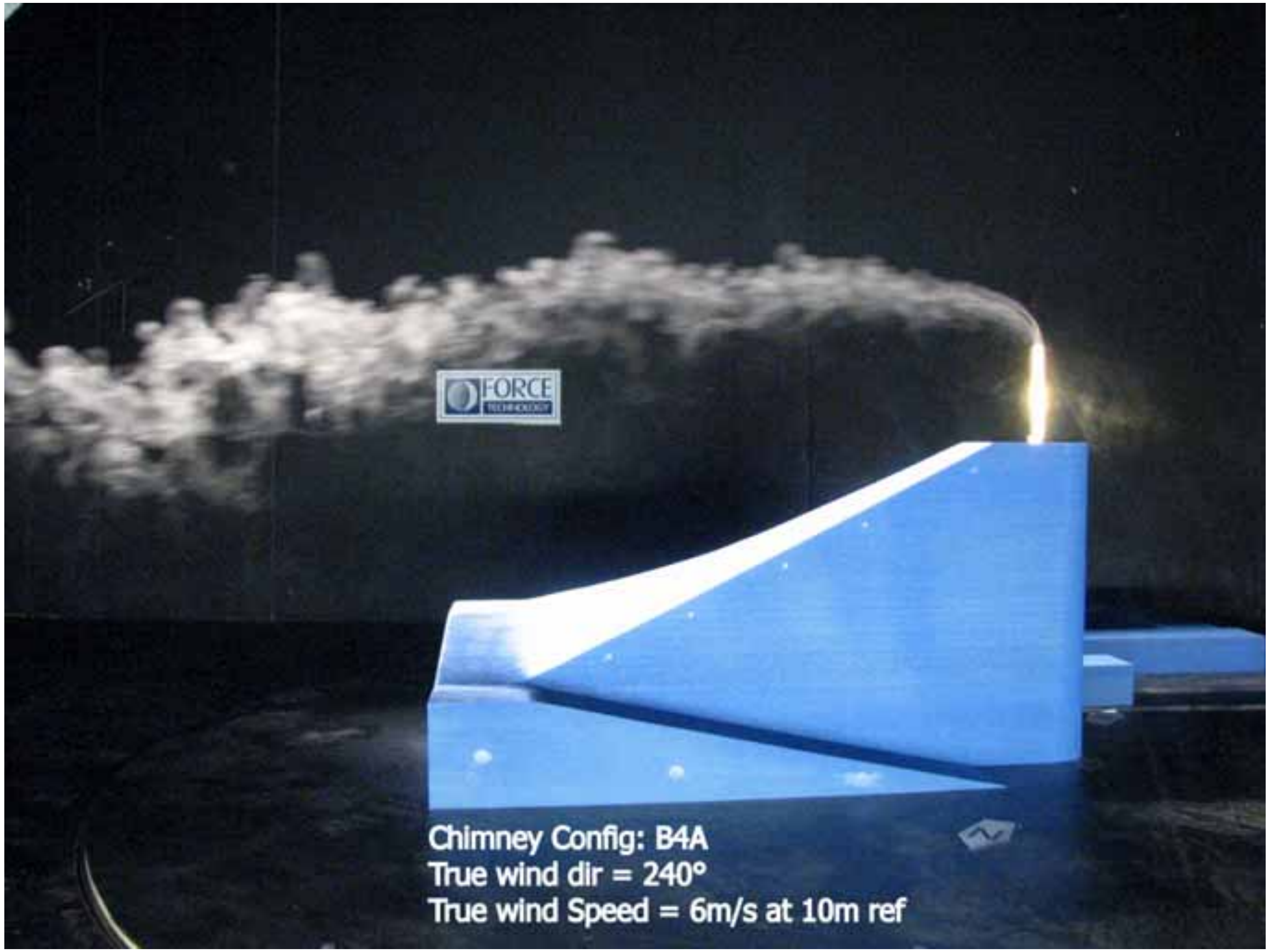

RESULTS

- Created Innovative Ideas
- Lowest Possible Air Emissions and High Energy Efficiency
- Reduces CO_2 Emissions
- A Landmark for the City of Copenhagen
- An Example of a Modern "Next Generation" WTE Plants

=> A Strong Support from the Public and from the City Council

THANK YOU FOR YOUR ATTENTION!

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