CONVERSION FROM COAL TO WOOD PELLETS

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RAMBØLL

OVERVIEW

- **Ramboll in brief**
- Why replace fossil fuels?
- Bioconversion – new fuel, new challenges
- Solutions & adaptation
  - Transport & Storage
  - Fuel preparation
  - PA system
- Results – reference project performances
- Summary of key points

RAMBOLL IN BRIEF

- Founded 1945 in Denmark
- Owned by Ramboll Foundation and hence a truly independent engineering and design consultant
- **> 13,000 experts**
- > 300 offices in 35 countries
- **> EUR 1.5 billion revenue**

- Services across the markets:
  - Buildings
  - Transport
  - Environment & Health
  - Water
  - **Energy**
  - Oil & Gas
  - Management Consulting

RAMBOLL ENERGY'S COMPETENCE AREAS

Offshore wind	Waste-to-energy	**Thermal power**	District heating

More than 230 Thermal Power specialists provide clients a one-stop shop of consultancy services based on unique know-how and experience gained from a large number of projects and operational support work on thermal power stations

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WHY REPLACE FOSSIL FUELS?

- **We do not inherit the Earth from our ancestors, we borrow it from our children**

***Native American proverb**

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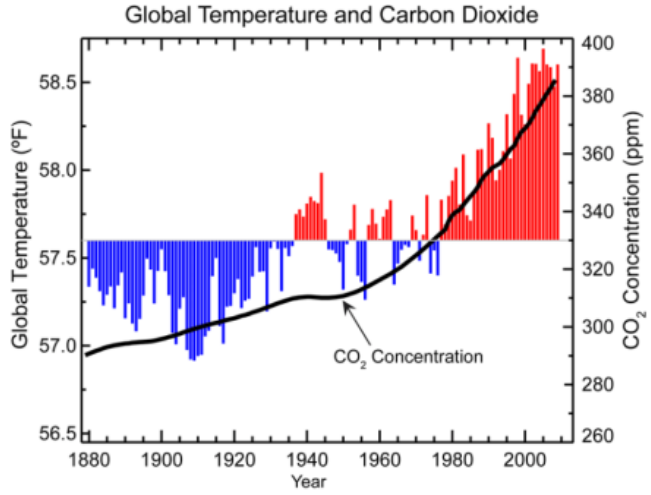
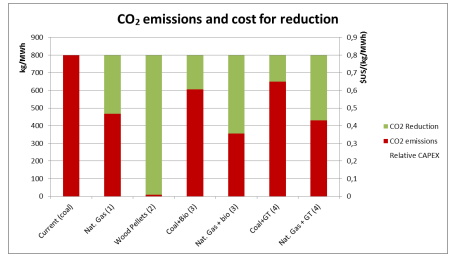
*if wood pellets can be produced locally

WHY REPLACE FOSSIL FUELS - BIOCONVERSION?

- **Company level**
  - Branding / Image: Renewable & sustainability
  - Capitalisation of existing assets – a 'cheap' way towards sustainable power generation
- **Society level**
  - Maintaining reliable & dispatchable renewable source of power
  - Support local economy by maintaining or even increase job positions locally*



Ref: US National Climatic Data Center – NOAA



*if wood pellets can be produced locally

WHY REPLACE FOSSIL FUELS?

Fuel type considerations?

- Wood Pellets, the immediate option as the world market for wood pellet is maturing fast

- Local / Indigenous resources?*, like:
  - Agricultural residues, i.e. straw, PKS, Olive husk etc
  - Forest residues, i.e. thinning, roots etc.
  - other by-products, i.e. sawmill residuals, industrial waste wood etc.

*sustainable yes, but suitability for large scale PF applications to be considered

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BIOCONVERSION – NEW FUEL

White wood pellets has different properties than coal:

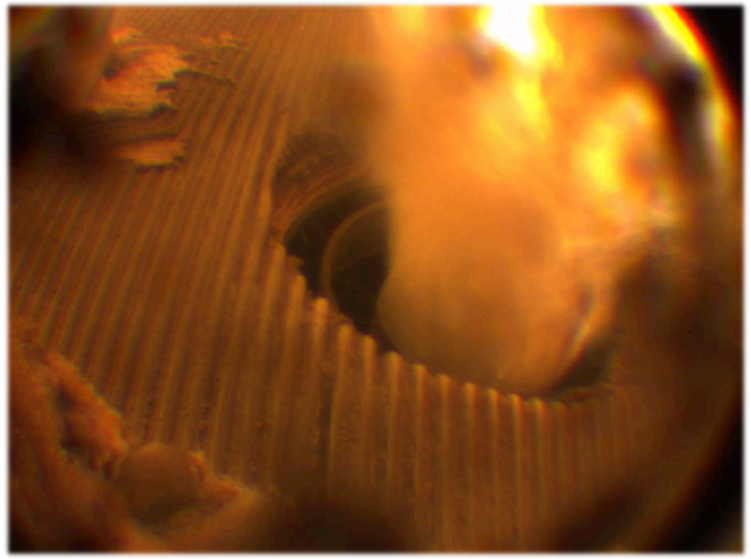
- **Lower calorific value**
- **Lower ash melting point**
- **Hydroscopic**
- **Dusty**
- **Fire & explosion properties**
- **Health issues**

WOOD PELLETS SPECIFICATIONS	EN	
PARAMETERS AND REJECTION LI	Standard	I1 industrial
Physical parameters		Limit
Diameter	EN16127	6 to 8
Length ≤50 mm	EN16127	99.9%
Length ≤40 mm	EN16127	99%
Water content	EN 14774	≤ 10 %
Bulk (apparent) density	EN 15103	≥ 600
Maximum bulk temperature	EN15234-2	≤ 60
Net calorific value at constant pressu	EN 14918	≥ 16,5
Ash content	EN 14775	≤ 1,0%
Elementary composition		
Cl	EN 15289	**≤ 0,03%**
N	EN 15104	**≤ 0,3%**
S	EN 15289	≤ 0,15 %
Trace elements		
As	EN 15297	≤ 2
Cd	EN 15297	≤ 1
Cr	EN 15297	≤ 15

BIOCONVERSION – NEW FUEL, NEW CHALLENGES

Performance
- Milling throughput
- De-rating
- Slagging

Storage
- Stores (dry)
- Transportation (dry)
- Dust



Safety
- Dust explosion mitigations
- Fire control

Emissions
CO2, SO2, NOx

BIOCONVERSION – NEW FUEL, NEW CHALLENGES
DUST MANAGEMENT…..

"THE B….. DUST GETS EVERYWHERE!"

…. AND MAY GENERATE AN EXPLOSION OR CATCH FIRE OUTSIDE THE BOILER

DUST MANAGEMENT IS IMPERATIVE!

BIOCONVERSION – NEW FUEL, NEW CHALLENGES HEALTH, FIRE & EXPLOSION

Safety issues to be paid special attention:

- ✓ **Fire detection & suppression systems**
- ✓ **Explosion detection & suppression or release**
- ✓ **HSE, Health measures**

Basic mitigating precautions:

1. Prevent loading to the plant of hot pellets
2. Prevent formation of self ignition conditions
3. Prevent formation of an explosive atmosphere
4. Design-out ignition sources
5. Reduce consequences

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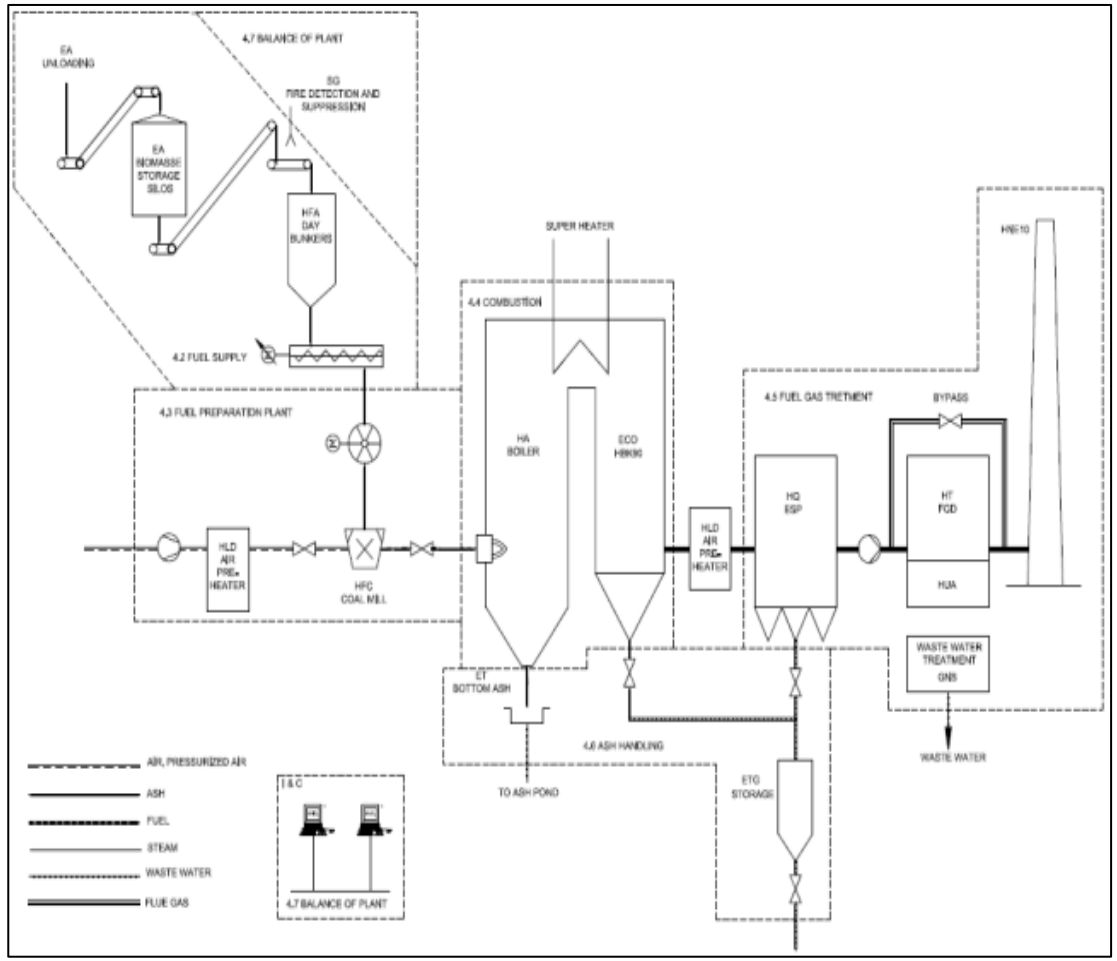
BIOCONVERSION - SOLUTIONS & ADAPTATIONS

Adaptations required throughout the Power station processes:

- ***Wood pellet storage and handling***
- ***Fuel preparation plant***
- ***Combustion***
- ***Flue Gas treatment***
- ***Ash handling***
- ***Balance of plant systems***

Bio-fuel combustion introduces new type of risks than those seen with coal combustion and gives rise to a an increased focus on:

- ***Dust management***
- ***Fire & explosion mitigations***



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TRANSPORT & STORAGE - DESIGN

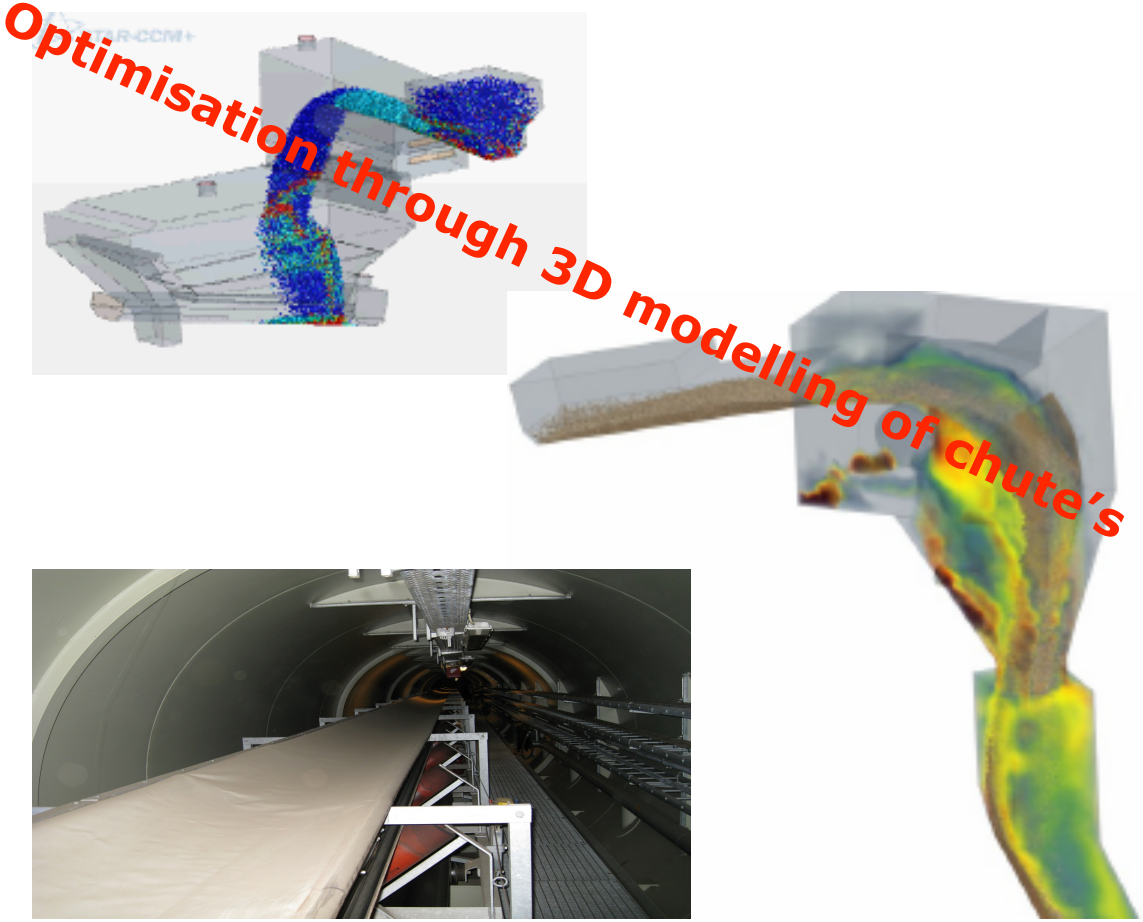
Layout :

- **Avoid fuel degradation & dust generation**
- **Consider redundancy / operational risk scenarios**
- **Optimise footprint but maintain accessibility**

Configuration of:

- **Reception facilities**
- **Storage bypass options**
- **Transportation system**
- **Silo system**
- **Discharge system / concept**

TRANSPORT & STORAGE - DUST MANAGEMENT



Specific design areas to be considered:

- **Reception facilities**
- **Transfer points**
- **Transportation system**
- **Discharge system / concept**

Dust extraction & filters at all transfer points

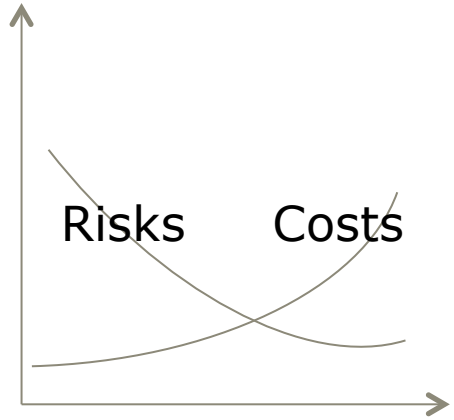
TRANSPORT & STORAGE – ONE OR MULTIPLE SILOS?

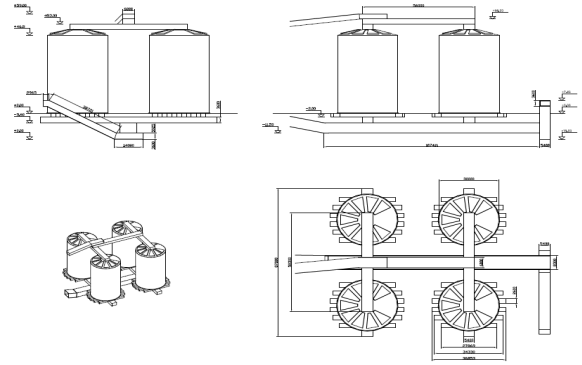
Pro / cons of few or one large silo:

- Reduced CAPEX
- Reduced OPEX
- Small footprint
- Lack of redundancy
- The efficacy of fire suppression systems at risk

Pro / cons of more but smaller stores:

- Reduced fire propagation risk
- Increased redundancy
- Improved efficacy of fire suppression systems
- Increased footprint
- Increased CAPEX
- Increased OPEX





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BIOCONVERSION - CONVERTIBILITY OF MILLS

Mill type	Practical Applications			Comments
	Coal	Co-firing	100% WP BMCR	
Vertical spindle roller mills	√	√	√	Low OPEX
Vertical spindle ball mills	√	√	√	Low OPEX
Tube ball mills	√	(√)	-	Operational issues
Hammer mills	-	√	√	High OPEX, due to wear

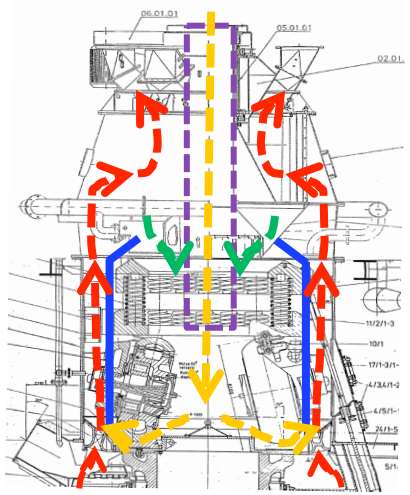
Point being that some type of mills are more suited for grinding wood pellets than others

BIOCONVERSION - COAL TO WOOD MILL MODIFICATIONS
(VERTICAL SPINDLE TYPE)

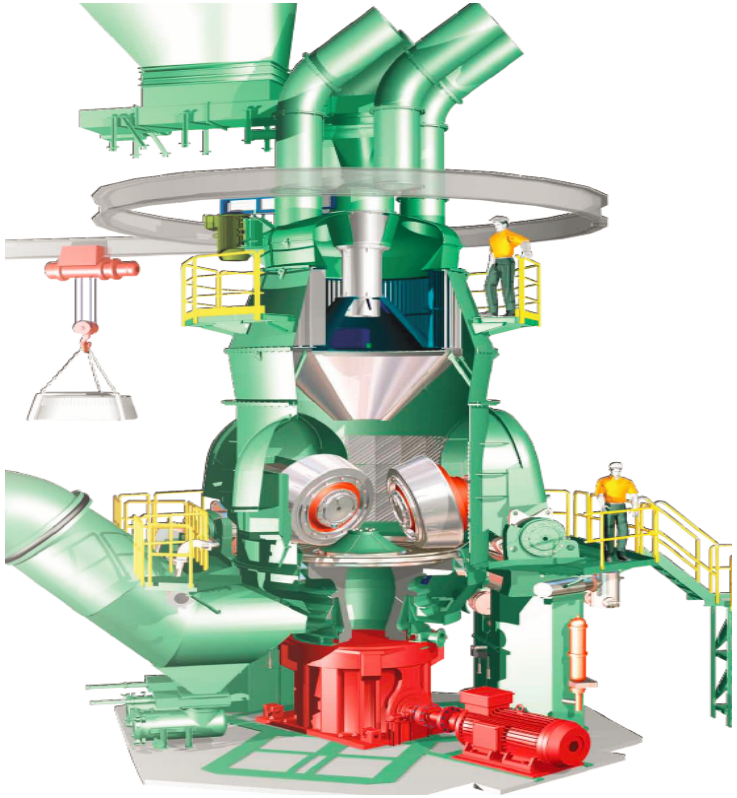
- **Grinding table**
- **Double wall**
- **Classifier**

- **Fire & Explosion suppression system**

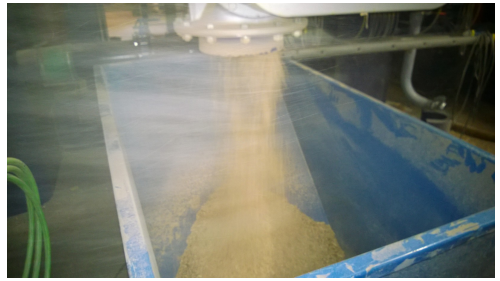
A MUST!

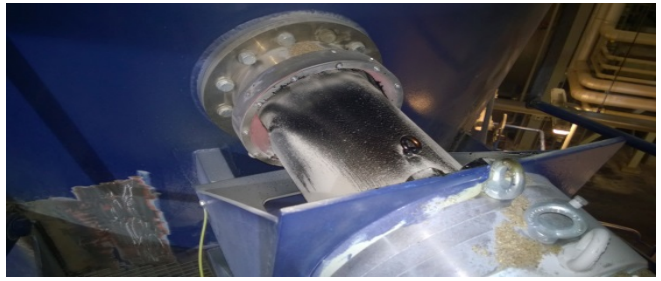


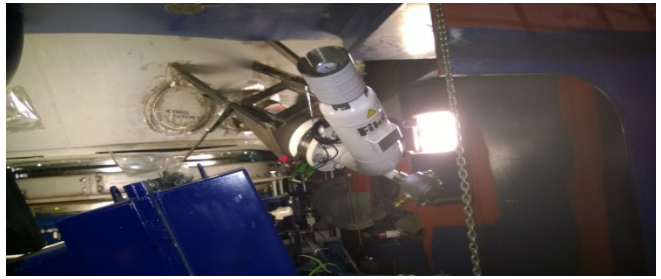
BIOCONVERSION - MILLS CAN BE CONVERTED TO GRIND WOOD PELLETS



Allowing feed of pulverised fuel from mills to multiple burners – **without** cost of new mills







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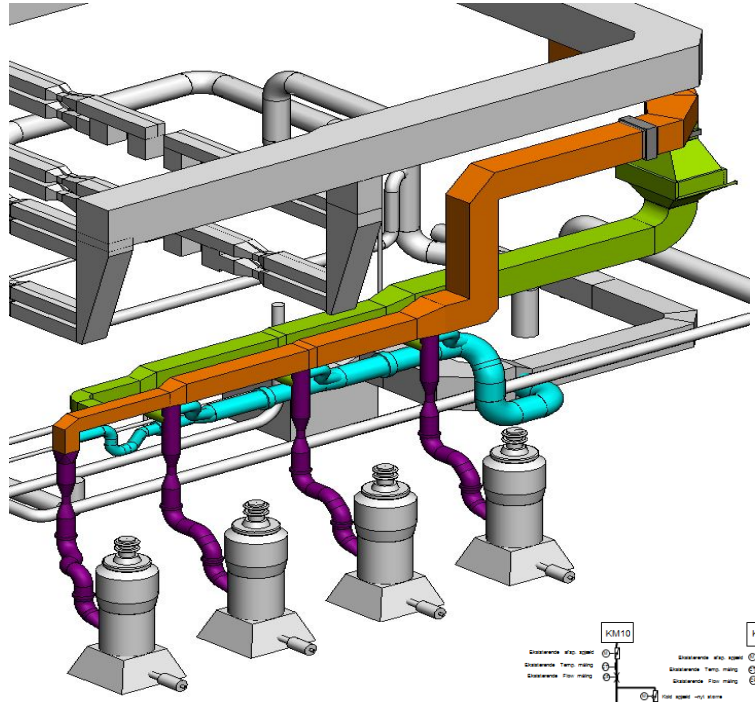
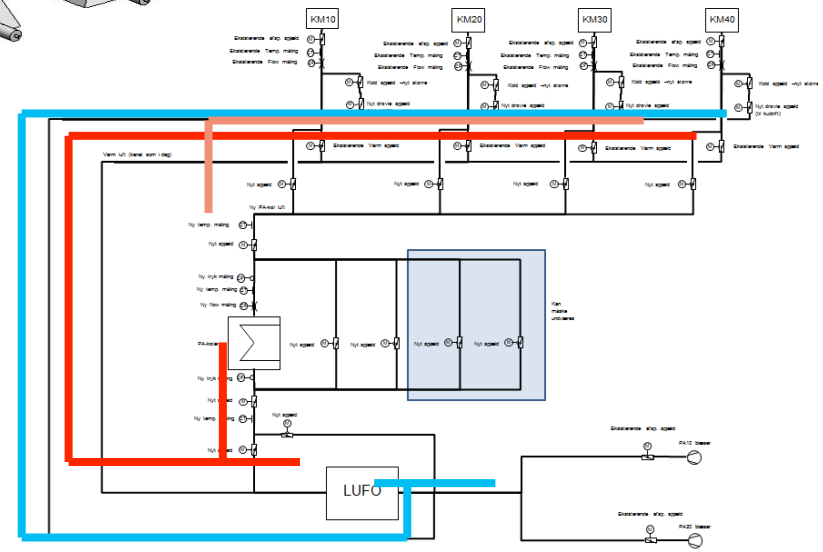
UPGRADING THE PA SYSTEM

PA air to coal mills to be reduced in temperature due to the fire properties of wood pellets from >300C down to 130 – 140C

PA Cooler?

Different plants – bespoke solutions





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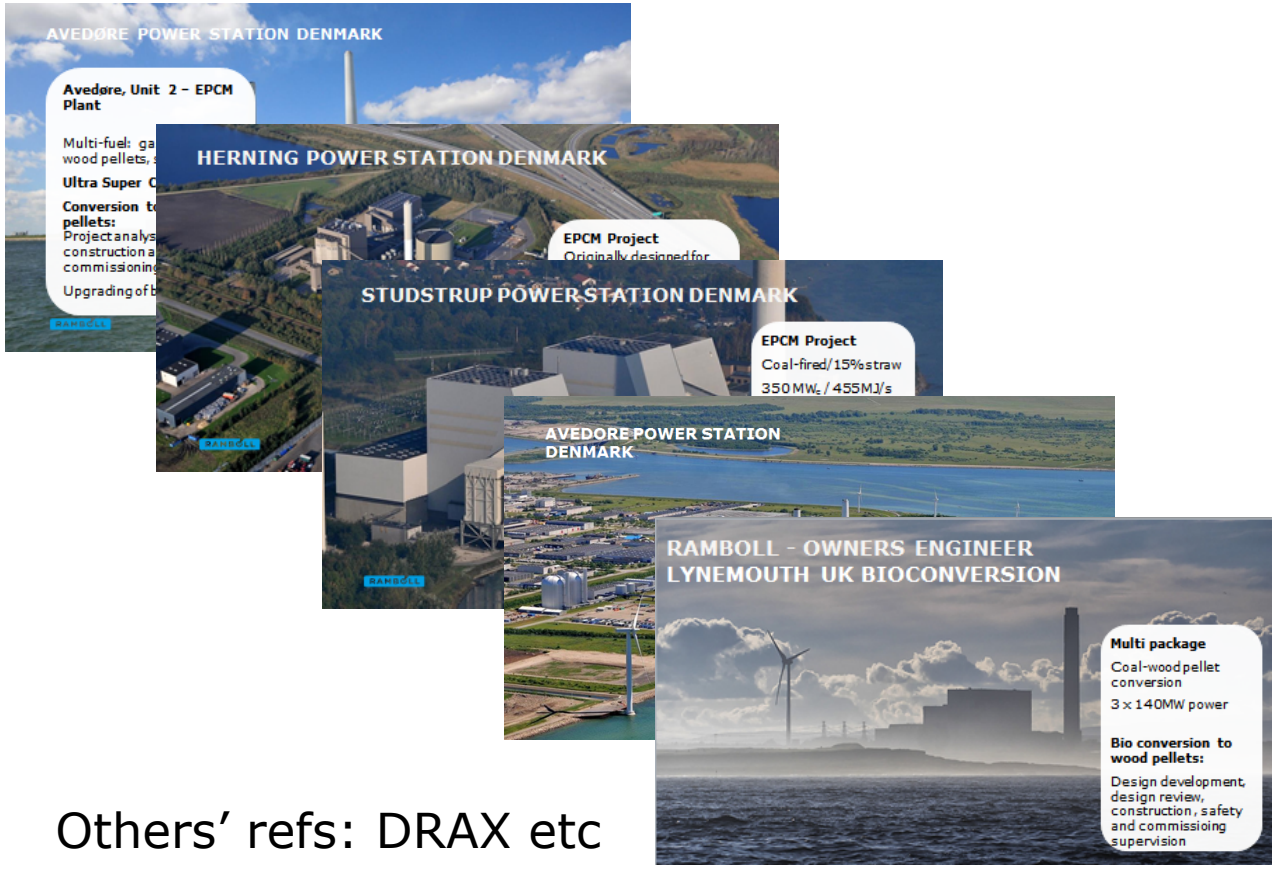
COAL TO BIOMASS CONVERSION - RESULTS



Others' refs: DRAX etc

Performance achievable:

85 – 100% MCR

Emissions:

CO_2 reduced by >90%

SO_2 significantly reduced

NO_x reduced by >50%

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BIOCONVERSION - SUMMARY OF KEY POINTS

- ✓Large scale Bioconversion is **manageable and viable**
- ✓**Good performance** achievable
- ✓Significant **carbon savings available**
- ✓Solution carries the **lowest relative CO2 reduction costs**
- ✓**Careful consideration of fuel risks** required to develop safe design – Dust management - fire and explosion

- ✓**But….Consistent policy support** is required to ensure the successful transition of the thermal power generation business towards a renewable future

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THANKS FOR YOUR ATTENTION

QUESTIONS?

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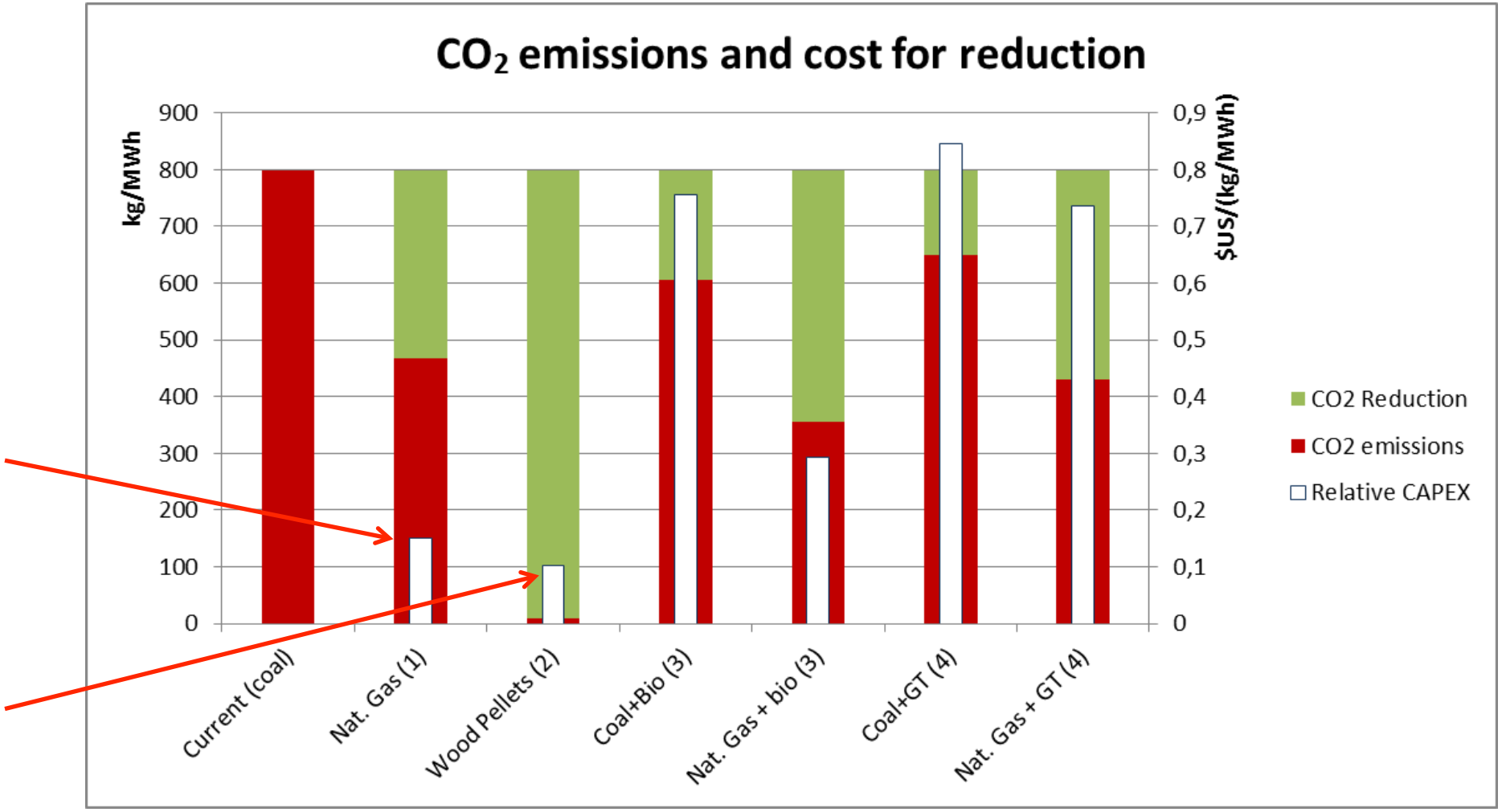
SUMMARY OF OPTIONS



Direct conversion from coal to biomass carries the lowest relative CO2 reduction costs

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