High efficiency electricity production from SRF/REF through gasification

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Valmet

Valmet

Leading global developer and supplier of process technologies, automation and services for the pulp, paper and energy industries

Valmet key figures 2015

Orders received
EUR 2,878 million

Net sales
EUR 2,928 million

EBITA before NRI[1]
EUR 182 million

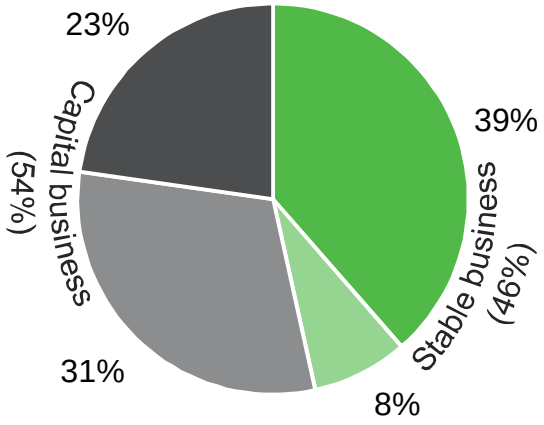
EBITA margin (before NRI[1])
6.2%

Employees
12,306

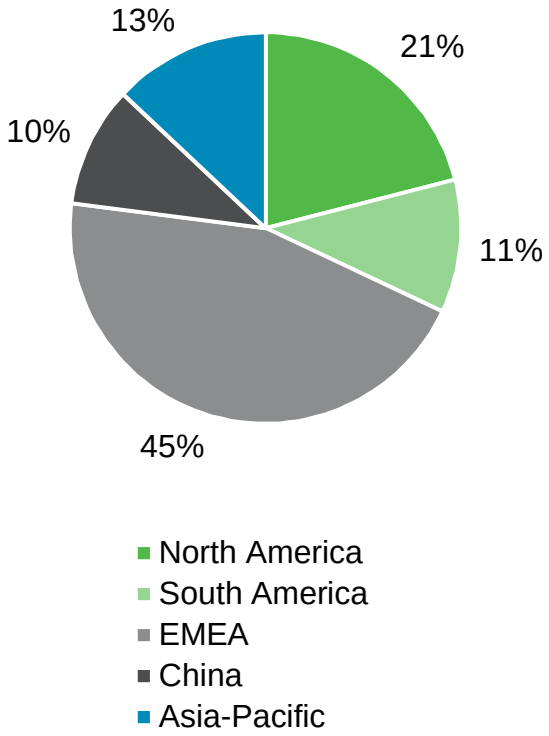
Market position
#1-2 Services
#1-3 Pulp & paper automation
#1-2 Pulp
#1-3 Energy
#1 Paper, board, tissue

1) NRI = non-recurring items
Stable business = Services and Automation business lines
Capital business = Pulp and Energy, and Paper business lines

Net sales by business line



Net sales by area



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- Waste gasification concept
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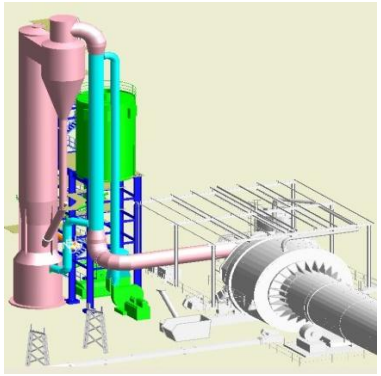
Valmet CFB gasification products

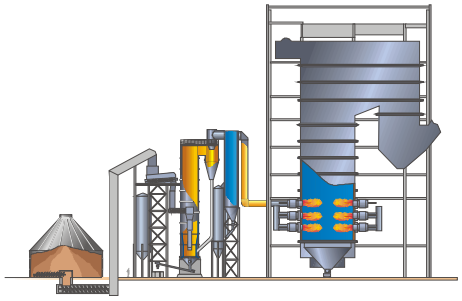
Product gas for industrial kilns

- Woody biomass, bark, peat and waste
- 20 – 110 MW_{fuel} units
- Typically includes a dryer
- Dusty product gas
- Other types of kilns also possible
- Gas cleaning if needed



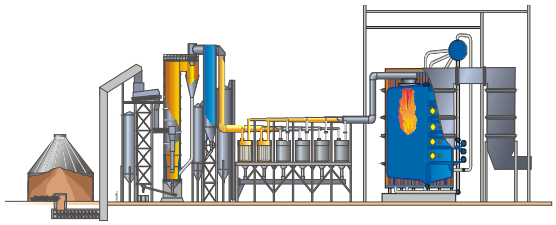
Product gas for power boilers

- Woody biomass, bark, peat and waste
- Superior electrical efficiency
- **Existing boilers**
- 50 –300 MW_{fuel} units
- If needed, can include a dryer
- Gas cleaning as needed



Product gas from waste for power production

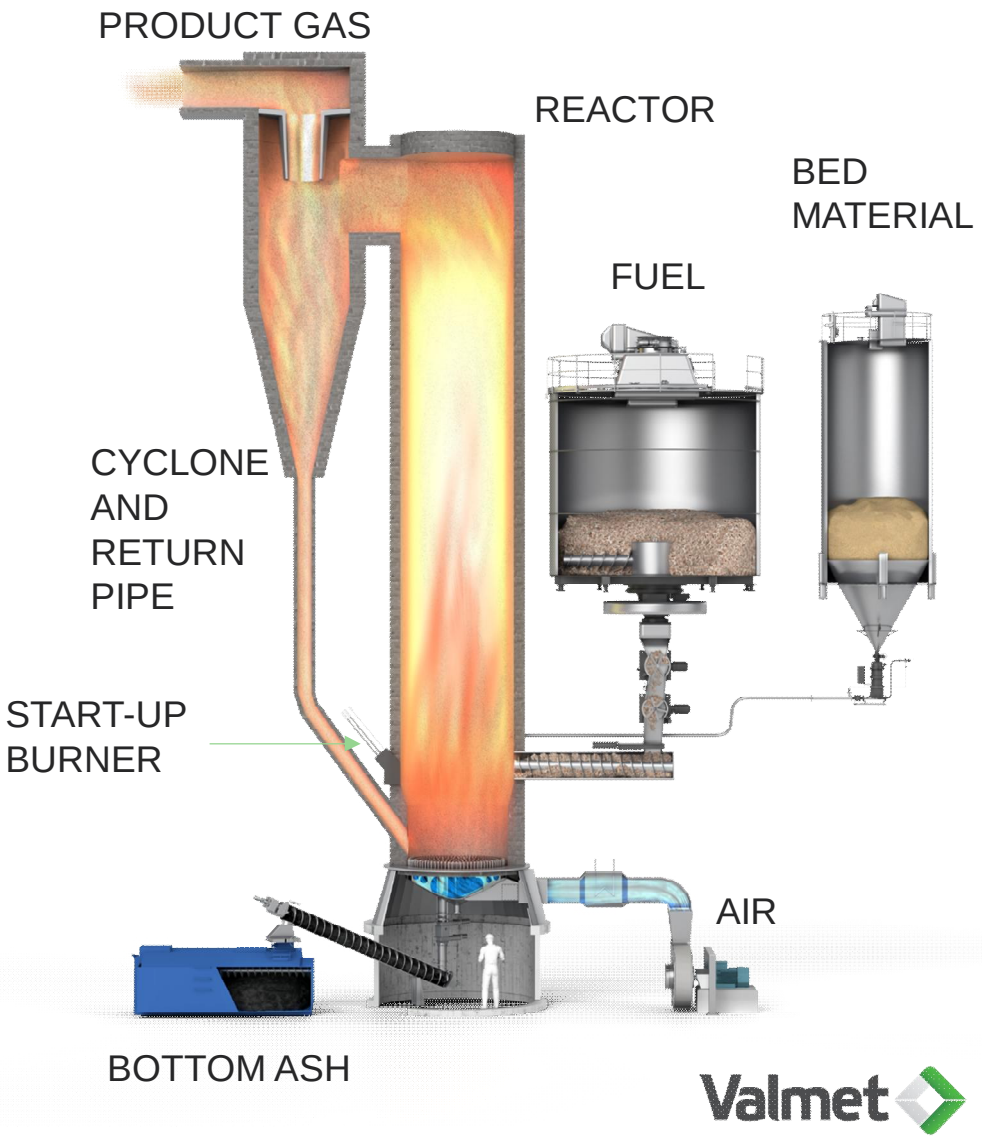
- Waste-derived fuel
- 50 – 150 MW_{fuel}
- High electrical efficiency
- Typically a new gas boiler (existing boiler is also an option)



Valmet CFB Gasifier

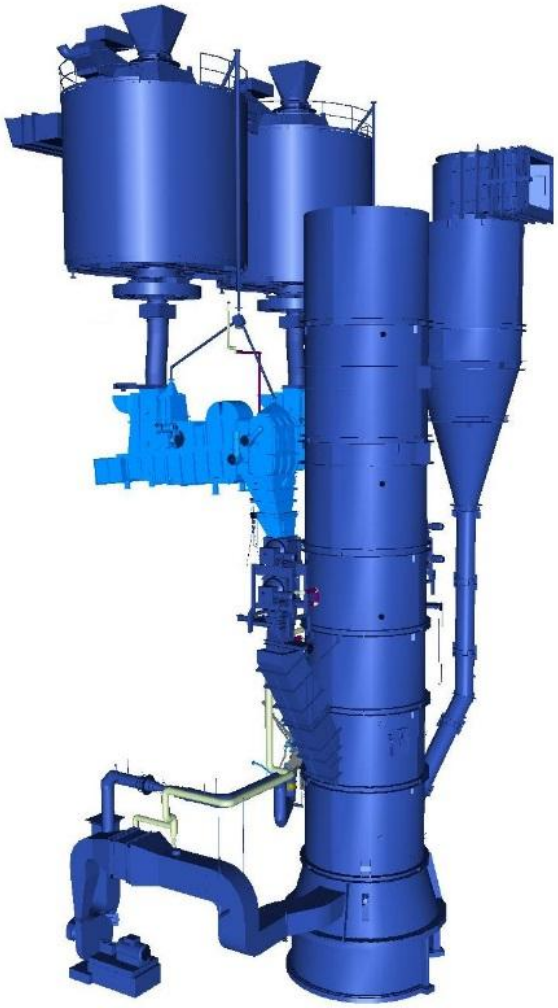
Construction principle:

- Only one air inlet (grid)
- Straight return pipe
- Self standing structure
- Prefabricated refractory



Valmet CFB Gasifier

CFB Gasifier	
Size	20 – 300 MWth
Fuel	Biomass, peat, waste
Gasification media	Air
Operating temperature	750 – 900 °C
Operating pressure	5-30 kPa(g)
Product gas heating value	3-7 MJ/nm^3 (LHV)



Why to gasify prior to combustion?

- In a boiler plant the share of electricity produced increases with the steam temperature and pressure.
- Alkali and heavy metal compounds limit steam values in waste boilers at best to ~75 bar, 520°C. Above the limit the corrosion speed accelerates to intolerable levels
- Valmet waste gasification solution overcomes these limits and enables considerably higher electricity production from waste derived fuels.

How does the gasification enable higher steam parameters?

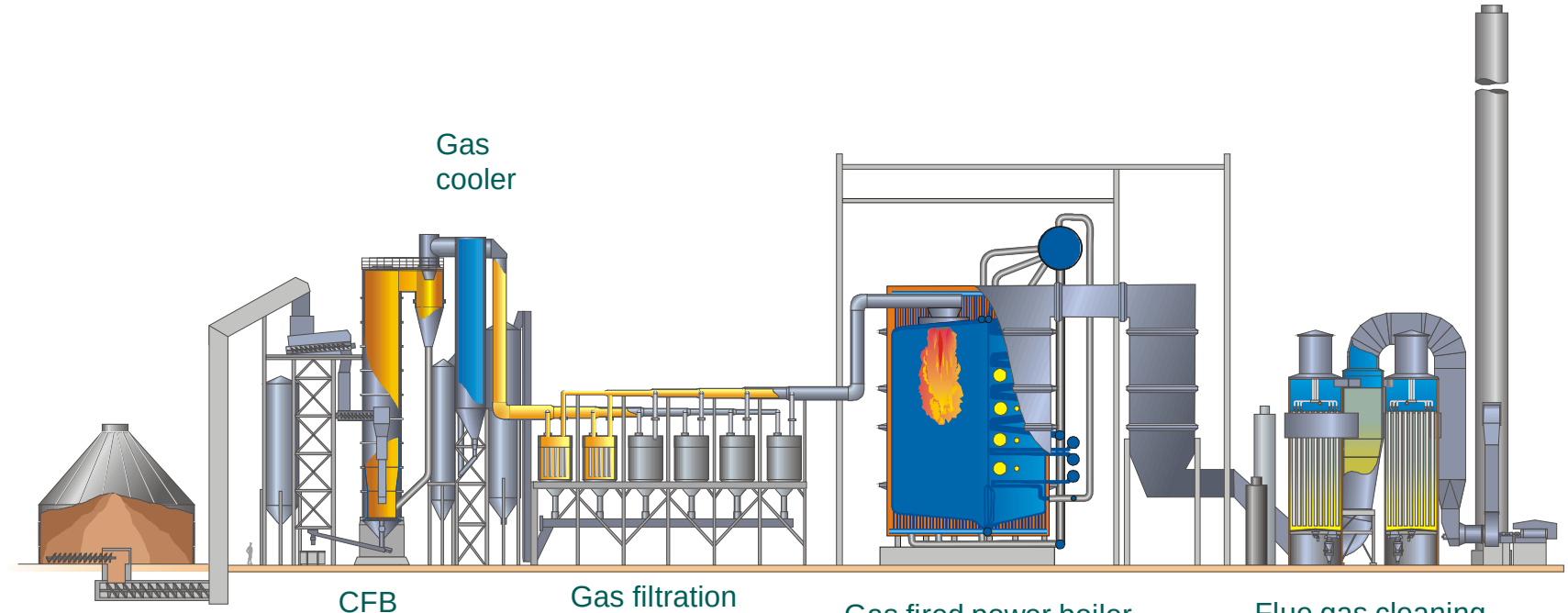
- Fuel is first gasified, then the product gas is cooled down to about 450 °C.
- Corrosive substances solidify at these temperatures, in practical sense completely.
- Solids are filtered out of the product gas stream.
- Solids free gas can be combusted without a risk of enhanced corrosion.

High efficiency solutions

Comparison for 80 MW_{fuel} waste plant (approx. 170,000 tpa)

Conventional incineration based on grate firing	• Steam cycle 400°C / 40 bar • Cycle efficiency <20% • 16 MW_e	
CFB combustion	• Steam cycle 520°C / 75 bar • Cycle efficiency >28% • 22.4 MW_e	+ **~40%** power
CFB gasification + clean gas combustion	• Steam cycle 540°C / 120 bar • Cycle efficiency >31% • 24.8 MW_e	+ **~60%** power

Waste gasification power plant



Kymijärvi II - Waste Gasification plant

Highest efficiency for Energy-from-Waste, *1 million* tonnes processed

- World's largest waste gasification power plant
- 2 gasifiers, coolers and PG filter lines, 1 boiler
- Processes 250 ktpa of waste fuels (RDF & contaminated wood) to produce:
  - 50 MW of electricity
  - 90 MW of district heat
  - CHP efficiency of 87,5 %

- Total investment ~ 160 M €
- 28,000 operating hours since commissioning

Lahti Energia, Lahti, Finland

Start-up 2012

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Gasification history of Lahti Energia

- Year 1998 at Lahti started a CFB gasifier which produces gas for a PC boiler.
- Biomass and waste were gasified, LE had positive experiences in waste gasification.
- Regulations were changing and waste gasification in this way was ending.
- Decision to build an advanced waste gasification plant was made.

- The current waste fuel is assorted waste from industry, commerce and homes.
- This fuel is bought from the market, no gate fees.

Valmet waste gasification

Experiences

- Stable and easy to control
- Capacity achieved with a clear margin
- Tolerates fuel variation with a margin
- Compliance with WID (also with 2 s 850 °C)
  - Ø No need for support fuel
- No corrosion detected
- Availability challenges during the first year
  - Ø Hot gas filtration was the major challenge
  - Ø Operational routines required learning
  - Ø Availability now improved up to the target level

Valmet waste gasification challenge

Hot gas cleaning at Kymijärvi II

Premature filter failures were common in the beginning.

- Over the time filters accumulated combustible ash on them. Filter dp increased.
- This ash oxidated during shut down and start-up causing local overheating.
- Corrected by:
  - A new regeneration system installed 2013
  - Changes in operational procedures.

Lifetime of the filter elements

- At the moment a number of original filters still in use (over 3 years)
- Replacement cycle 3-4 years or more

Kymijarvi II - Emissions

From annual AST/QAL2 measurements

Emission	Limit 0,5h average and unit	2016	2015	2014	2013
NOx	400 mg/Nm^3	211	217	184	152
SO_2	200 mg/Nm^3	40	55	43	32
CO	100 mg/Nm^3	4	1	1	1
Dust	30 mg/Nm^3	< 1*	< 1*	< 1*	1
HCl	60 mg/Nm^3	3	7	2	8
HF	4 mg/Nm^3	< 0,2*	< 0,9*	< 0,2*	<1
TOC	20 mg/Nm^3	< 1*	< 1*	1	1
PCDD/F Compounds	0,1 ng/Nm^3	0,0004	0,001	0,0004	0,001
Hg	50 µg/Nm^3	< 0,7*	< 1,2*	0,1	< 0,02*
Cd+Tl	50 µg/Nm^3	< 0,2*	0,01	< 0,01*	< 0,7*
Sb+As+Co+Cr+Cu+Mn+Ni+Pb+V	500 µg/Nm^3	7,6	2,0	1,5	0,3*

* Means the measured value is below analysis detection limit

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What will be done differently next time?

- More PG filtration capacity with different layout
  - Enables filter regeneration and services without major disturbances to gasification
- More emphasis on fuel quality
  - Oversize particles, especially metals, cause wear and mechanical damage
  - ”Overdimensioning” – out of spec may need to be expected

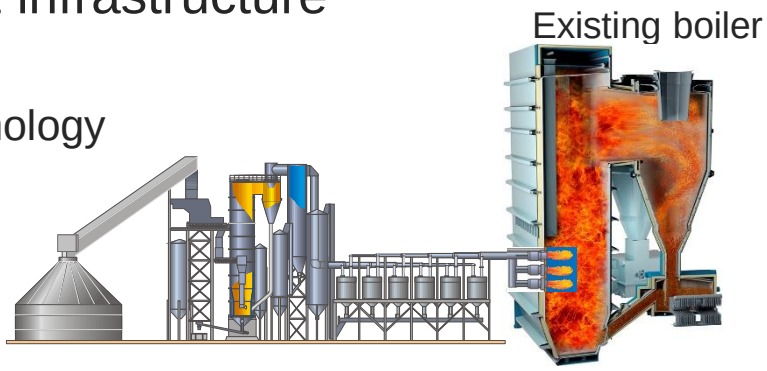
Valmet Waste gasification

- A New Option for Co-firing RDF / SRF

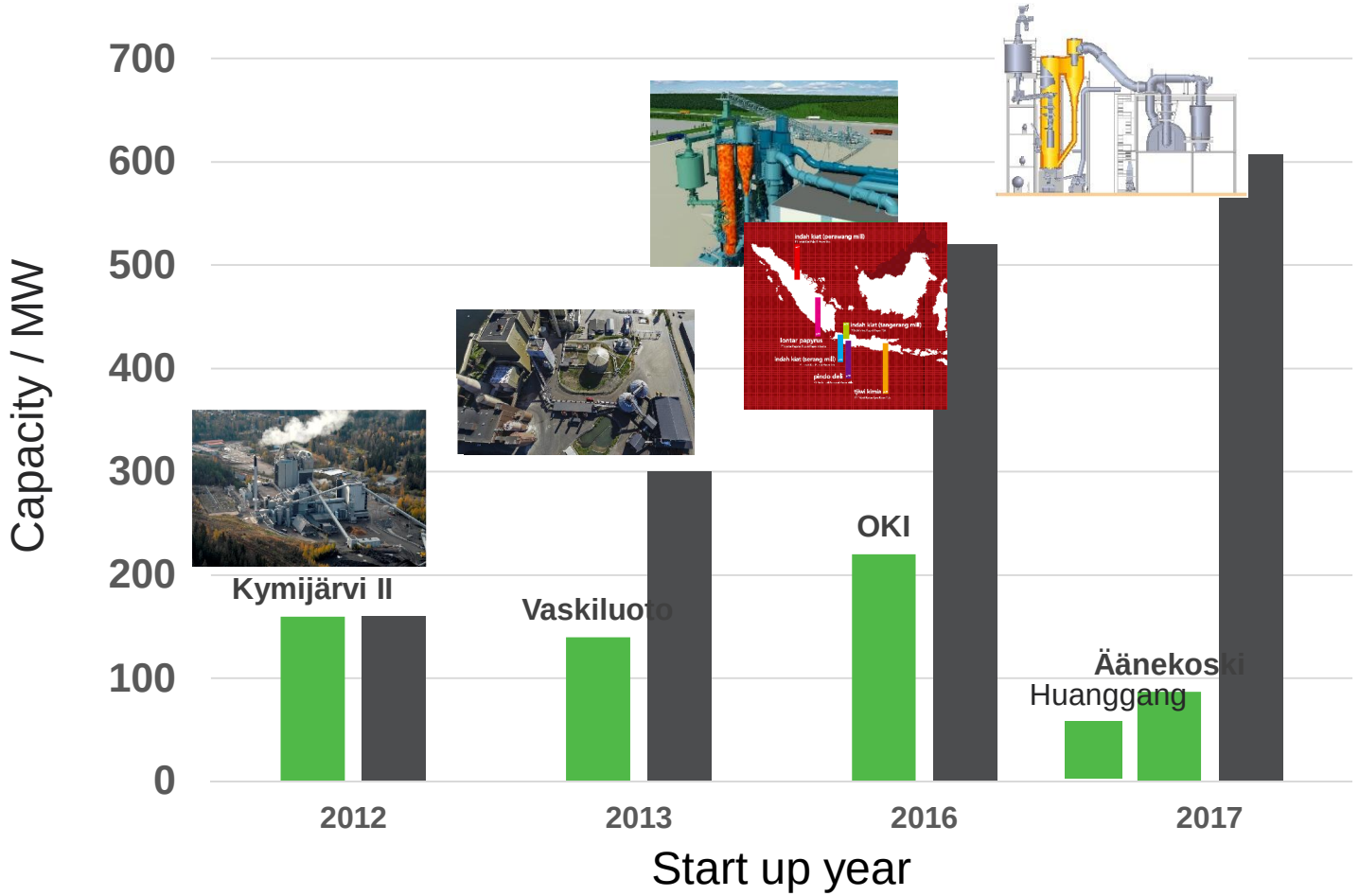
Co-firing of cleaned gas from waste gasification in an existing boiler

- Minimum impact on boiler operation, corrosion, ash quality and emissions
- Highest electrical efficiency from waste to electricity (up to 40 %)
- Waste fuel ash does not contaminate the main boiler ash
- Waste firing capacity can be freely selected
  - Full capacity on main solid fuel still maintained
- Utilization of the existing power plant infrastructure
  - Minimum additional investment
  - Boiler can be PC, CFB or other firing technology

Add-on gasifier and hot gas cleanup



Valmet Power – CFB gasification references



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FORWARD