Maximising the Benefits of Residue Upgrading – The Challenges

Why delayed coking?

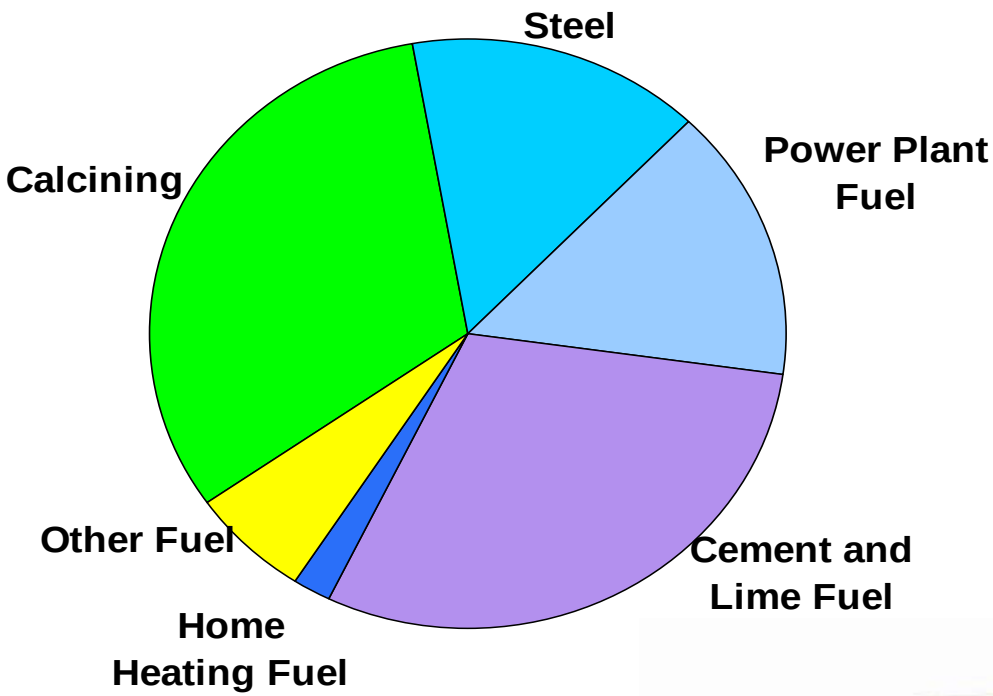


Talking Point 1 – Coke market

When I build a coker, I need to do something with the coke. What can I do with it? Can I make different grades of coke that have different markets?

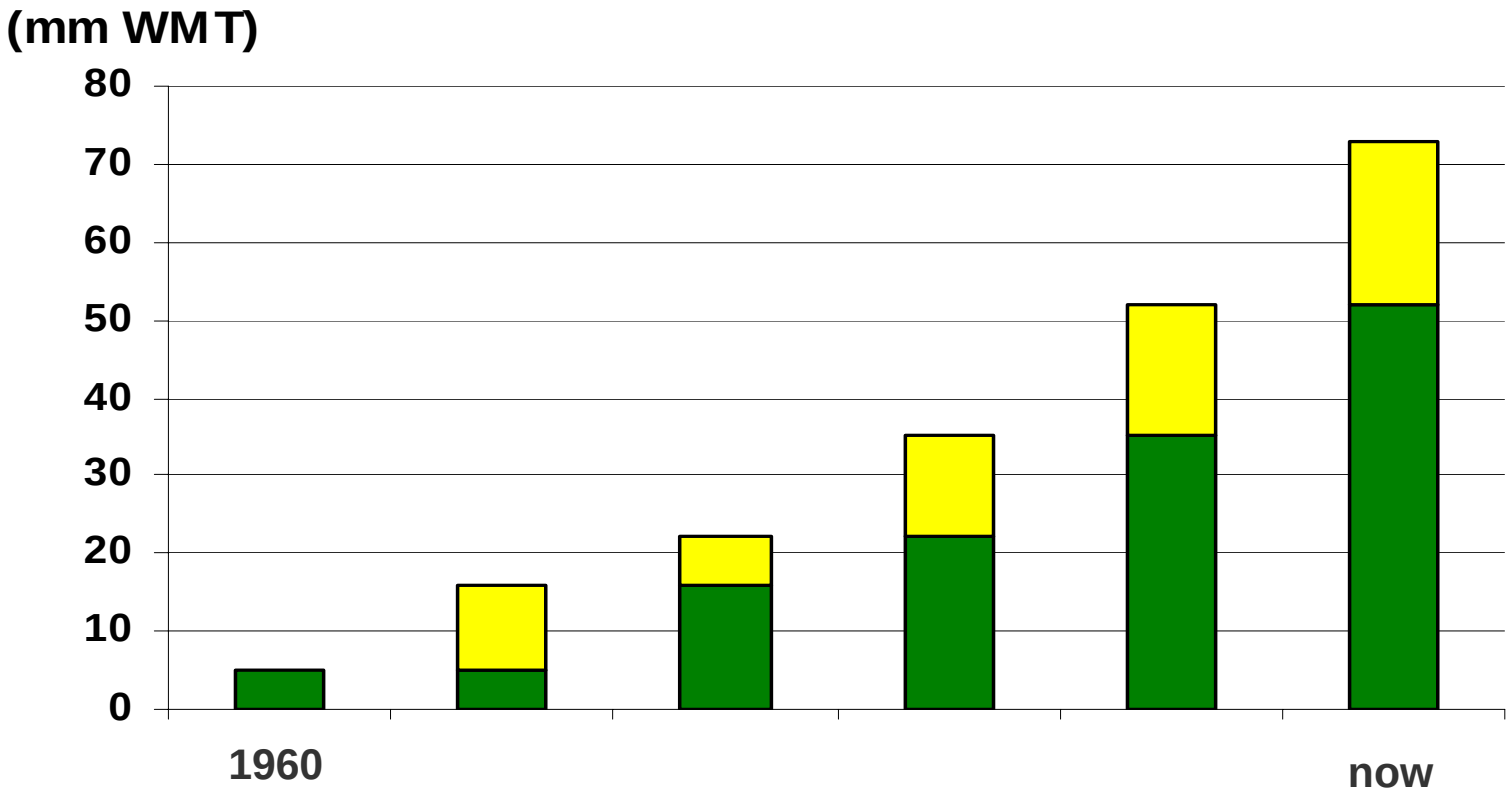
How will I sell my petcoke?

Global petcoke uses by industrial application



Courtesy Oxbow Carbon

How will I sell my petcoke?



Petcoke production has grown steadily for over 40 years.

Courtesy Oxbow Carbon

SYDEC^{SM} coke disposal

- Purchasers include utility stations, cement calcining operations and, increasingly, gasification
  - High calorific value / low ash
- High sulphur coke sold at discount to coal
- Production is over 80 million MTPA worldwide
  - Low, compared to coal
  - Will continue to edge out coal due to price discount
- Numerous competing marketing companies
- Price is low, but the coker value is in the clean liquid products and the conversion of low value HSFO

Why solvent deasphalting?

Talking Point 2

With SDA, I produce asphalt or pitch. What are the markets for this and what other options do I have to market this material?

Why solvent deasphalting?

- Can be used as a fuel in cement kilns, or as a road or roofing bitumen blend stock
- SDA pitch has been visbroken to reduce cutterstock requirements and has been gasified to produce syngas; it has also frequently been coked to further recover its ‘oil’ value
- Asphalt or pitch can be used as a residual fuel oil either uncut at high temperature in captive users or blended with cutterstock and sold

Why CFB?

Talking Point 3

You have talked mainly about CFB's and petcoke. What else can I feed to a CFB?

CFB fuel flexibility

Convert many economical opportunity fuels into valuable steam and power

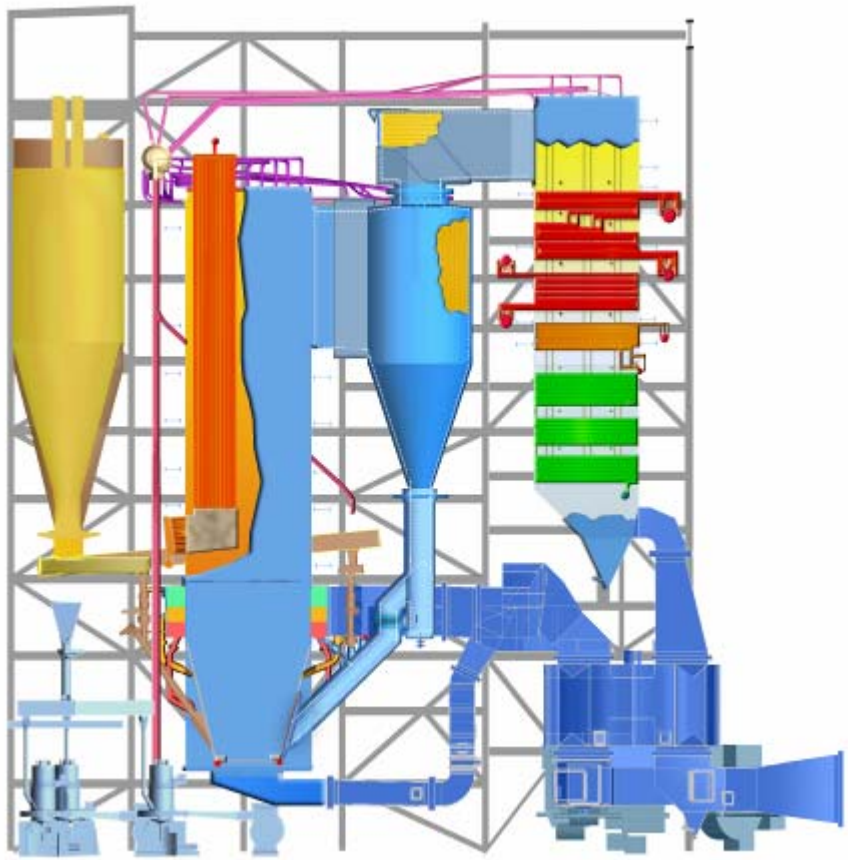
As well as:

- **Waste coal**
- **Agricultural waste**
- **Peat**
- **Tyre derived fuel**
- **Refuse derived fuel**
- **Refinery bottoms**
- **Oil**
- **Natural gas**

CFB case study

CLECO saw the value in the JEA project and decided to build 2 x 330 MWe petcoke utility CFB

- Plant owned by CLECO Power
- EPC contractor is Shaw Group
- Rodemacher site in Boyce, Louisiana
- 2 x 330 MWe CFB boilers on single steam turbine
- Designed to fire 100% petroleum coke, or Illinois #6 coal, or PRB coal
- Designed for co-firing lignite (92%), paper sludge (5%), wood waste (5%)
- Polishing scrubber provides 98%+ overall SO_2 removal and mercury removal
- Commercial operation, July 2009



Why delayed coking?

Talking Point 4:
Environmental controls

Environmental specifications are getting more stringent all the time

How can I be sure that cokers are clean and I will meet atmospheric discharge

The process uses a lot of water for coke cutting. How does this impact on water supplies and effluent discharge

Why delayed coking?

- Enclosed blowdown system with recovery of vent vapors and unconverted oils
- Heater NO_X controls
  - **SCR; low NO_X burners**
- Coke particulates
  - **Wind barriers & wetting systems to prevent windage loss**
  - **Wash stations for mobile equipment**
  - **Coke handling**
    - **Enclosed conveyors or tubular conveyors**
    - **Covered storage 'barns' and reclaimers**
- Water reuse
- Refinery sludge disposal

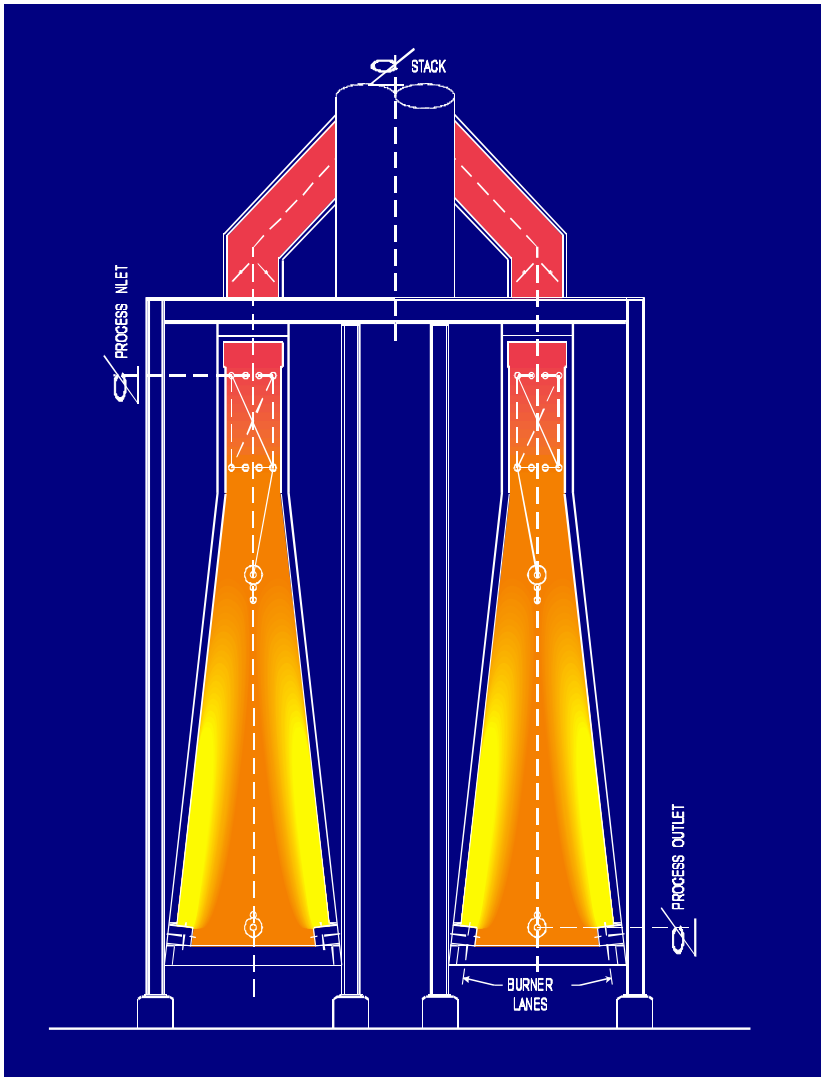
Why delayed coking?

Talking Point 5 – Batch or continuous process

From what I understand, delayed coking is partially a batch process?

How reliable is it ? Is there anything special about the FW design?

SYDEC^{SM} Coker Heaters



Long heater runs

- Advanced designs
- Double-fired
- On-line spalling

Reliable operations

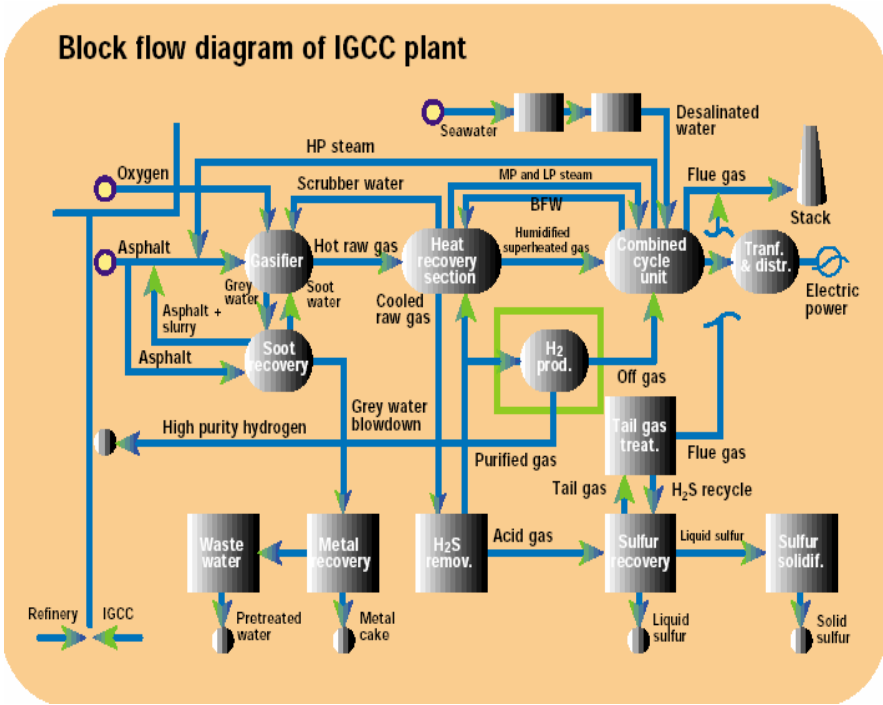
Why IGCC?

Talking Point 6

How practical is it to feed SDA pitch into a gasifier? Do you have any examples?

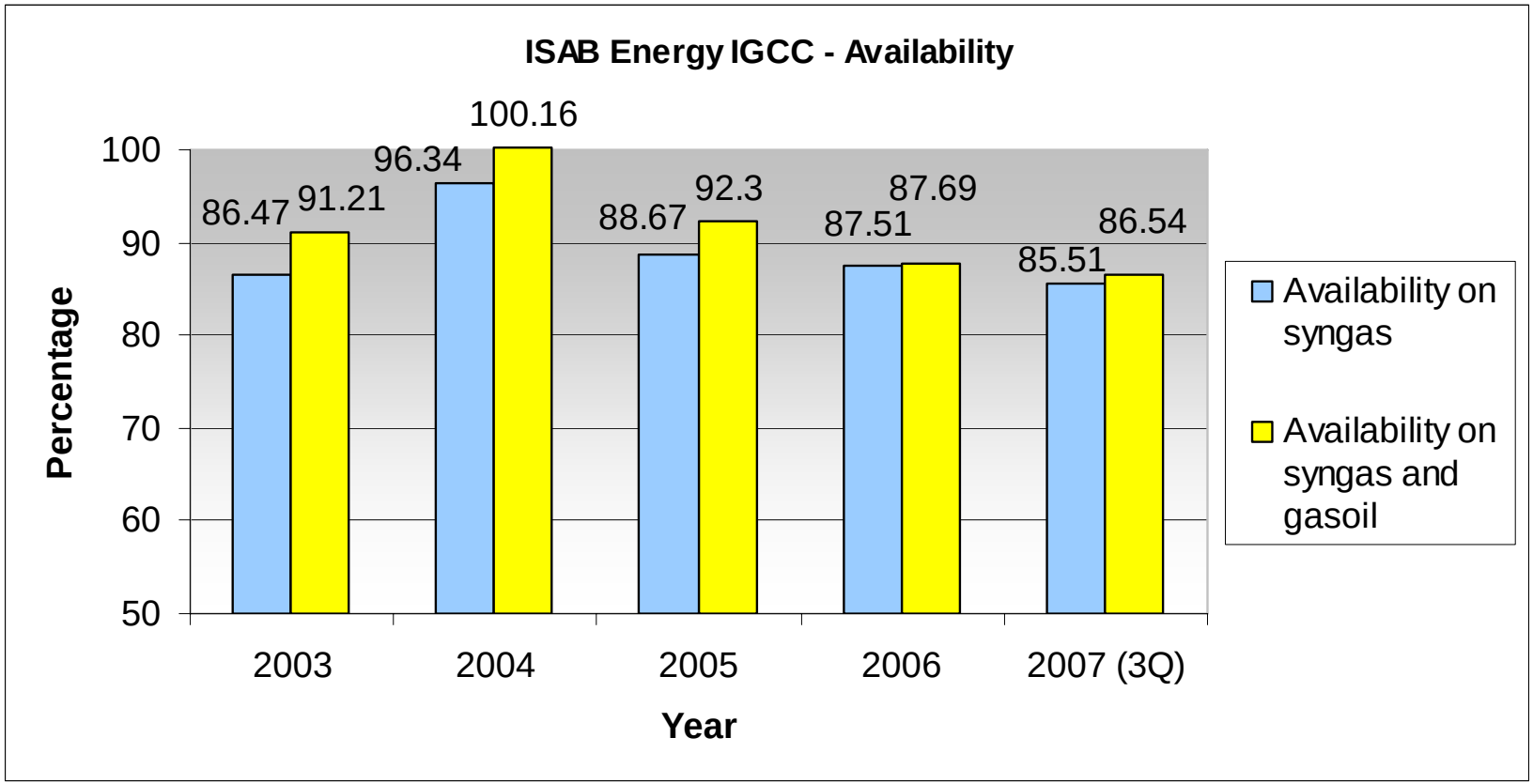
I understand FW was involved in the ISAB project. How is that running? Are there any new developments?

ISAB project: existing IGCC



- Kellogg deasphalting unit
- Feed: asphalt 132 t/h
  sulphur 6%wt
- Two quench-type GE gasifiers
- MDEA based AGR for H_2S removal
- Oxygen Claus SRU + TGT
- Two power train (GT+HRSG+ST) based on GT Ansaldo/Siemens V94.2K
- IGCC power output: 560 MWe

ISAB project: existing IGCC availability



Excellent operating results from the first year of commercial operation

ISAB project: existing IGCC

ISAB project: scope of the new hydrogen plant

Production of 20,000 Nm^3/h for Euro-grade automotive fuels

Three options for ERG:

1. Refinery revamping → new steam reformer
2. Purchase H_2 from external suppliers → new steam reformer

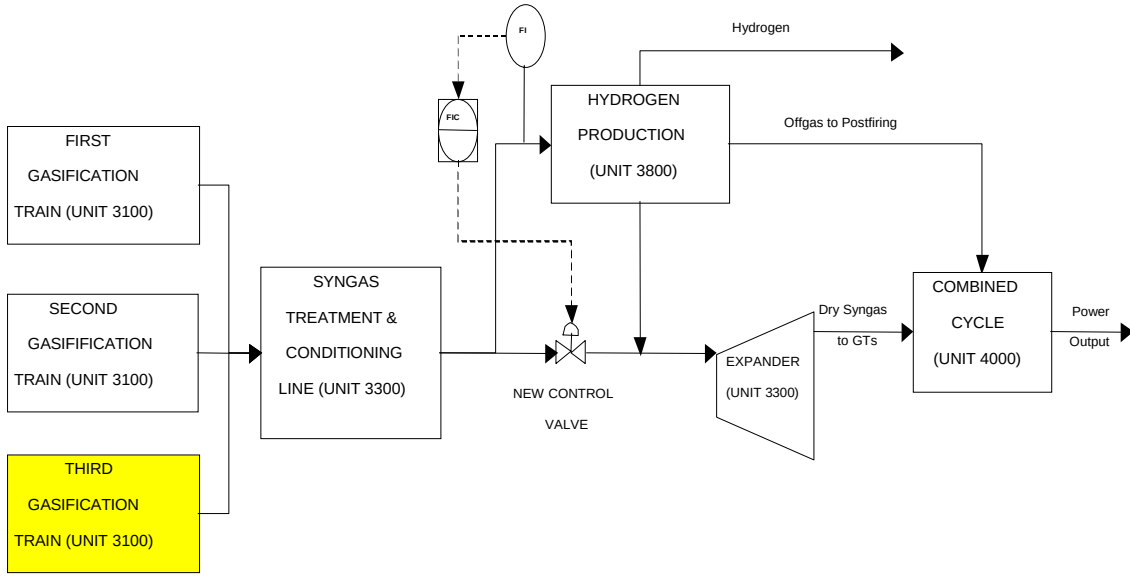
} **ONE OPTION**

3. ISAB Energy IGCC revamping → third gasifier + H_2 plant

The third gasifier is now temporarily on hold due to changed economic factors;
H_2 is recovered from existing syngas flow trough membranes and PSA

ISAB project: revamping of existing facilities

Third Gasification Train



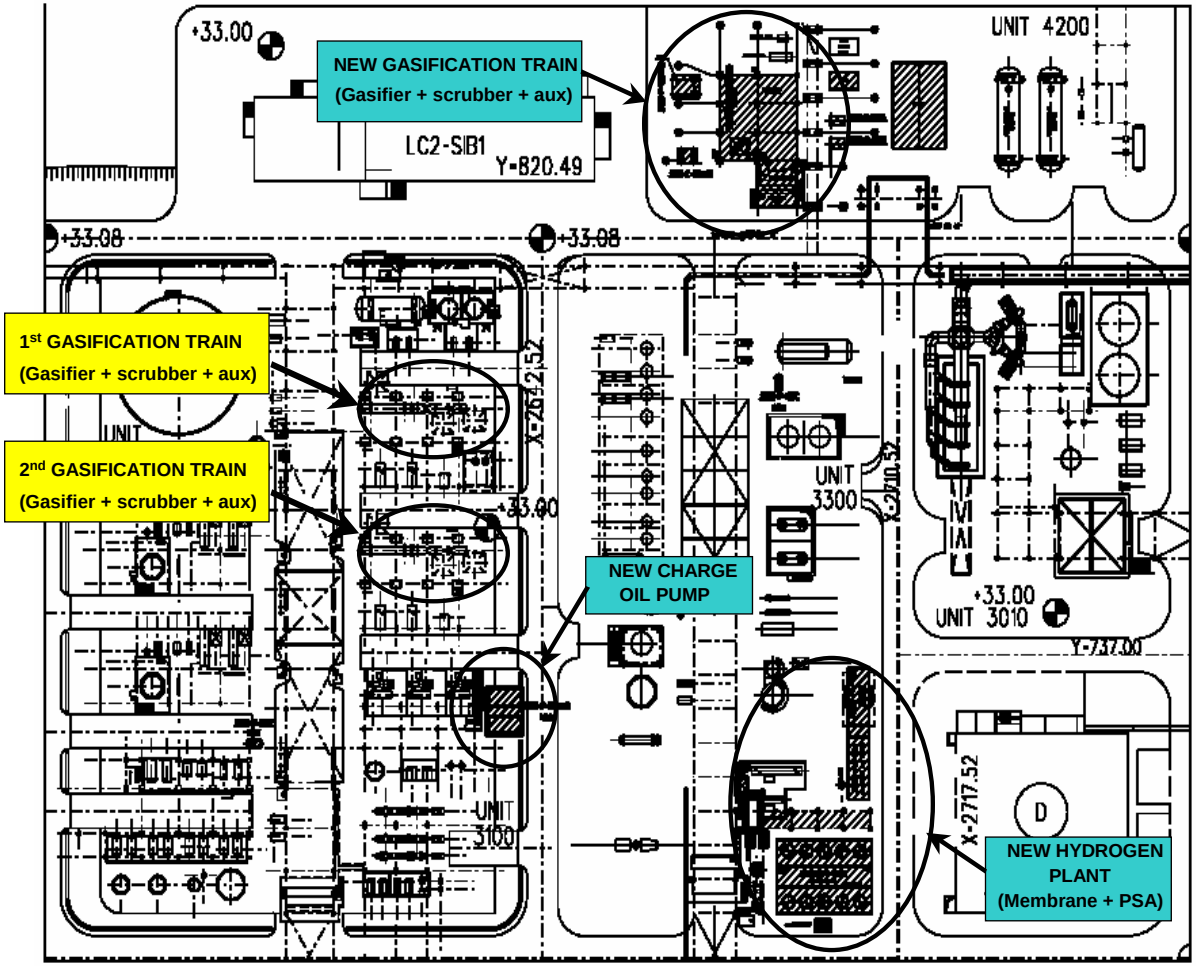
New train facilities:

- Gasifier sized for 18 t/h
- Charge oil pump
- Syngas scrubber
- Quench water system for S/UP & S/D
- Grey water/soot water exchanger

Revamping of existing gasification facilities:

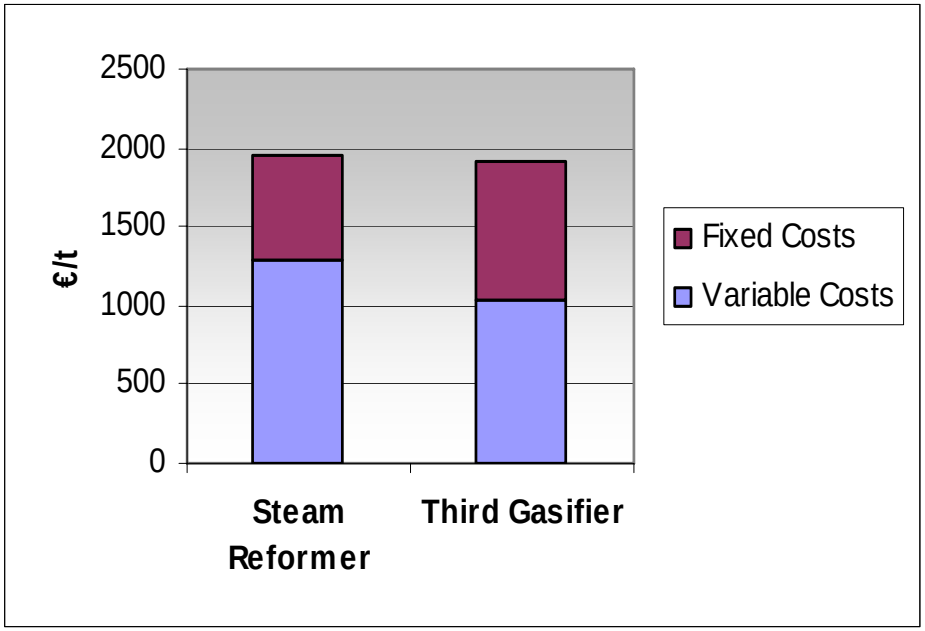
- Cooling water facilities to assure proper cooling of the three gasifiers burners
- New high pressure naphtha pump
- New demiwater diesel pump to cool new gasifier quench ring in case of EPF

ISAB project: plot plan

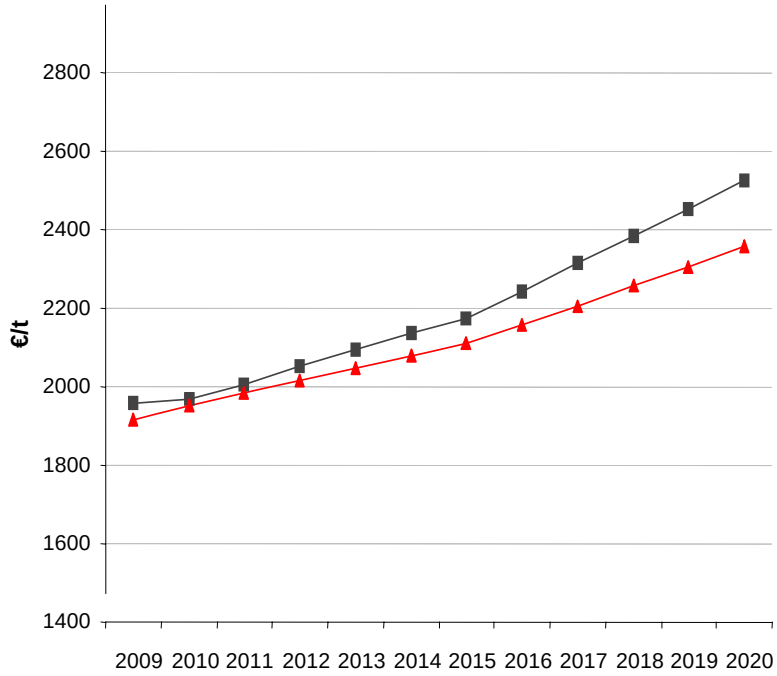


- Third gasifier located in new area far from existing gasifier for constructability reasons
- Charge oil pump located close to existing ones
- Hydrogen plant located within the syngas cooling, saturation and expansion area

ISAB project: scope for hydrogen production



Forecast to 2020: the third gasifier advantages become higher



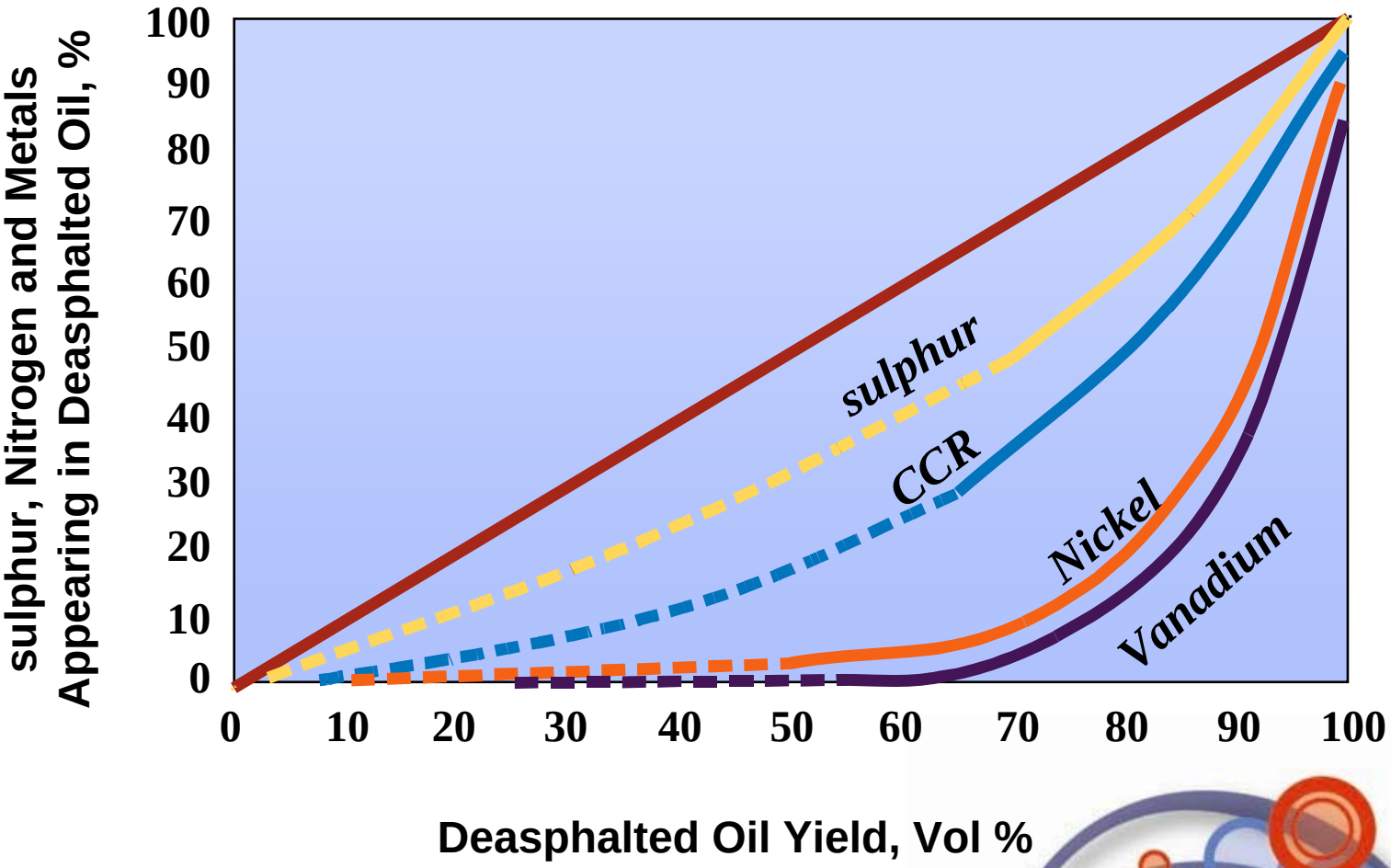
Why solvent deasphalting?

Talking Point 7

SDA appears to be a relatively simple process. Can I really feed the DAO to a hydrocracker? What are the limits? Am I just going to end up with too much low grade material?

How does DAO lift affect properties?

Selectivity in Solvent Deasphalting



Why solvent deasphalting?

SDA High Lift HC Operation Yields

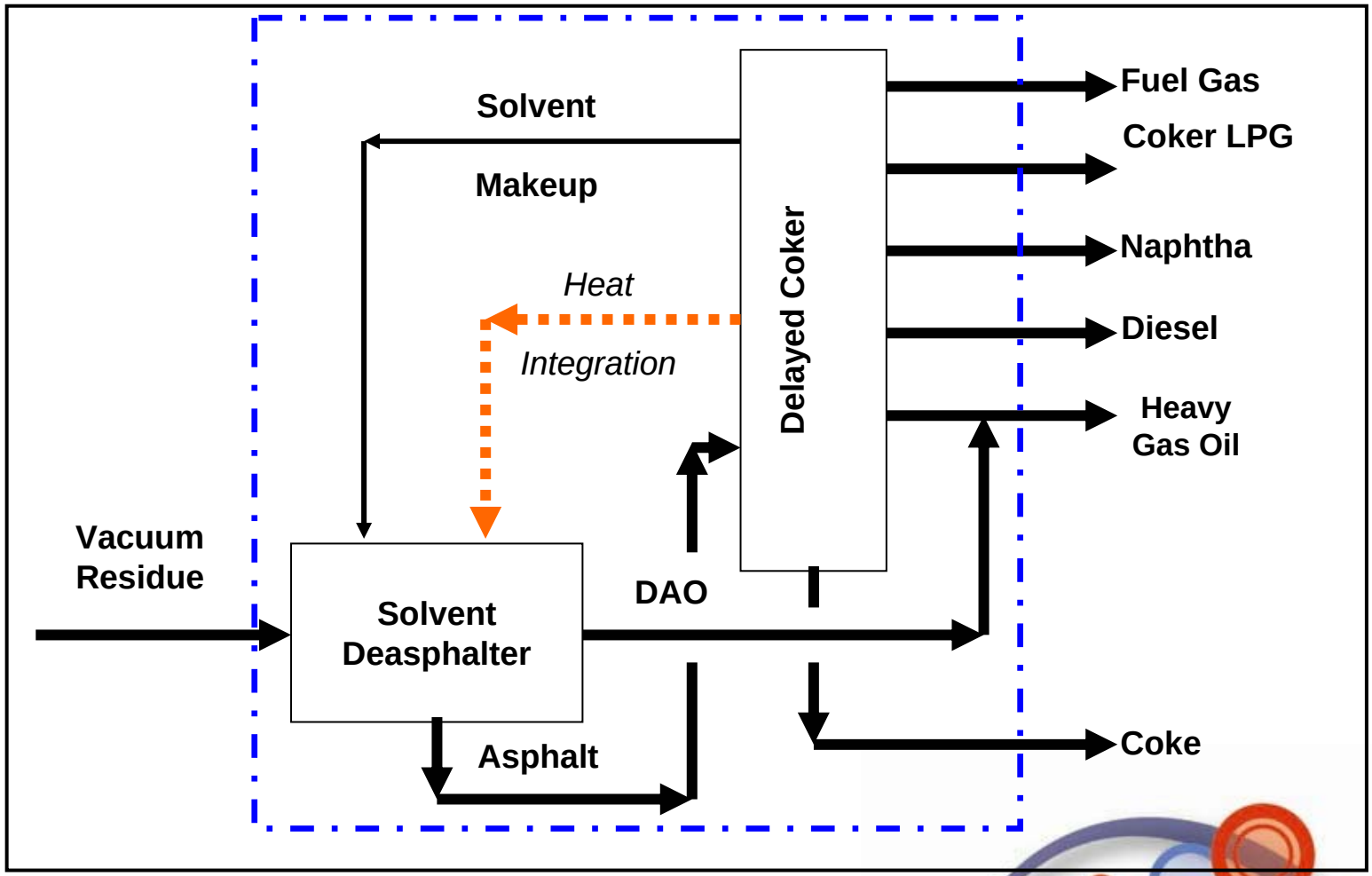
	Feed	DAO	Pitch
Yield, wt. %	100	62	38
°API	8.6	15.9	-3.2
Sulfur, wt. %	1.2	0.5	2.4
CCR, wt. %	17.1	6.1	62.1
Nitrogen, wt. %	0.4	0.2	0.8
Metals, wppm	80	8	196
Viscosity @210°F	5,673	367	1.6E+08
Softening Point, °F			241

Why solvent deasphalting?

Talking Point 8

In the ‘ASCOT’ process, what impact on yields will linking SDA and coking have?

ASCOT^{SM}: SDA and coking



ASCOT^{SM} HC operation yields

	Weight %	Volume%
Vacuum Residue	100.0	100.0
C4^{-} LPG & Gas	3.4	-
C5-350°F Naphtha Cut	4.2	5.8
350-680°F Diesel Cut	8.9	10.3
680°F^{+} Heavy Gas Oil	67.7	71.0
Coke	15.8	-

Why CFB?

Talking Point 9

Refineries typically don't handle solids. What solids handling facilities are required for CFB projects, and what type of quantities are we talking about?

and…..

What has been the refiners experience who have installed these facilities

Why CFB?

CFB projects require handling of petroleum coke, limestone, and CFB ash in a solid dry form.

For a typical 100 MWe CFB plant burning a 7% sulphur coke operating at a 100% capacity, the flow rates (metric tons per day) are approximately:

740 mtpd for petroleum coke
305 mtpd for limestone
370 mtpd for ash

Why CFB?

On-site coke, limestone and ash processing equipment, as well as the CFB, have demonstrated high reliability.

Refiners with CFBs also established robust solids management plans to ensure success:

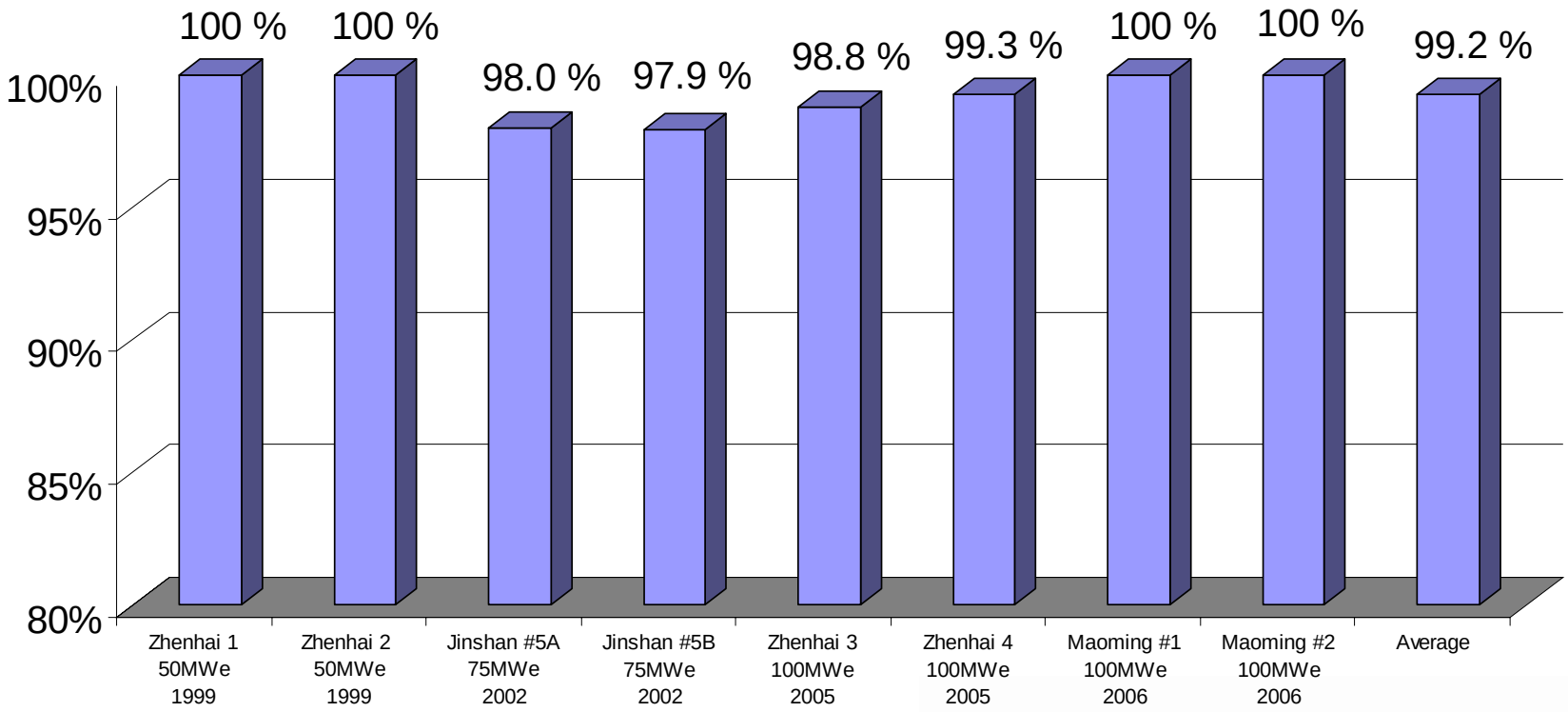
- Domed coke storage and fully covered coke reclamation and conveying equipment. This gives:
  - good reliability
  - good environmental performance

Why CFB?

- Ample short term ash storage capacity combined with long term contracts for ash disposal
  - mine or land remediation
  - landfill
  - roads
- Ample limestone rock delivery capacity and on-site storage combined with on demand grinding and drying

CFB reliability is field-proven - FW petroleum coke CFBs

Reported availability of FW petcoke-fired CFBs



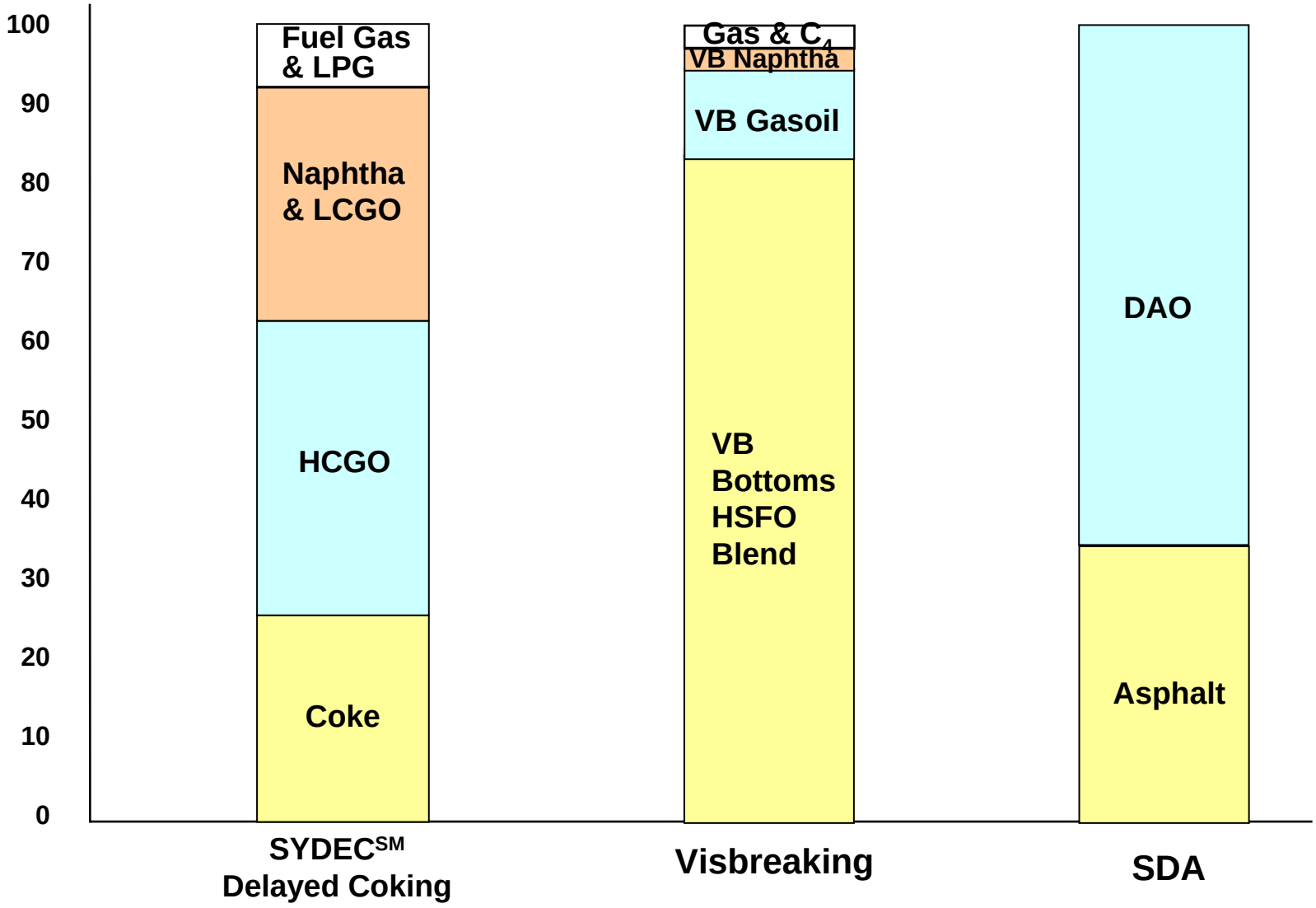
Availability values do not include planned outage downtime (average about 10 days/year),
Years shown represent the commercial operation year for each unit.

Why solvent deasphalting?

Talking Point 10

You mentioned that SDA is relatively less expensive than coking, but what does it do to the yields/returns on investment?

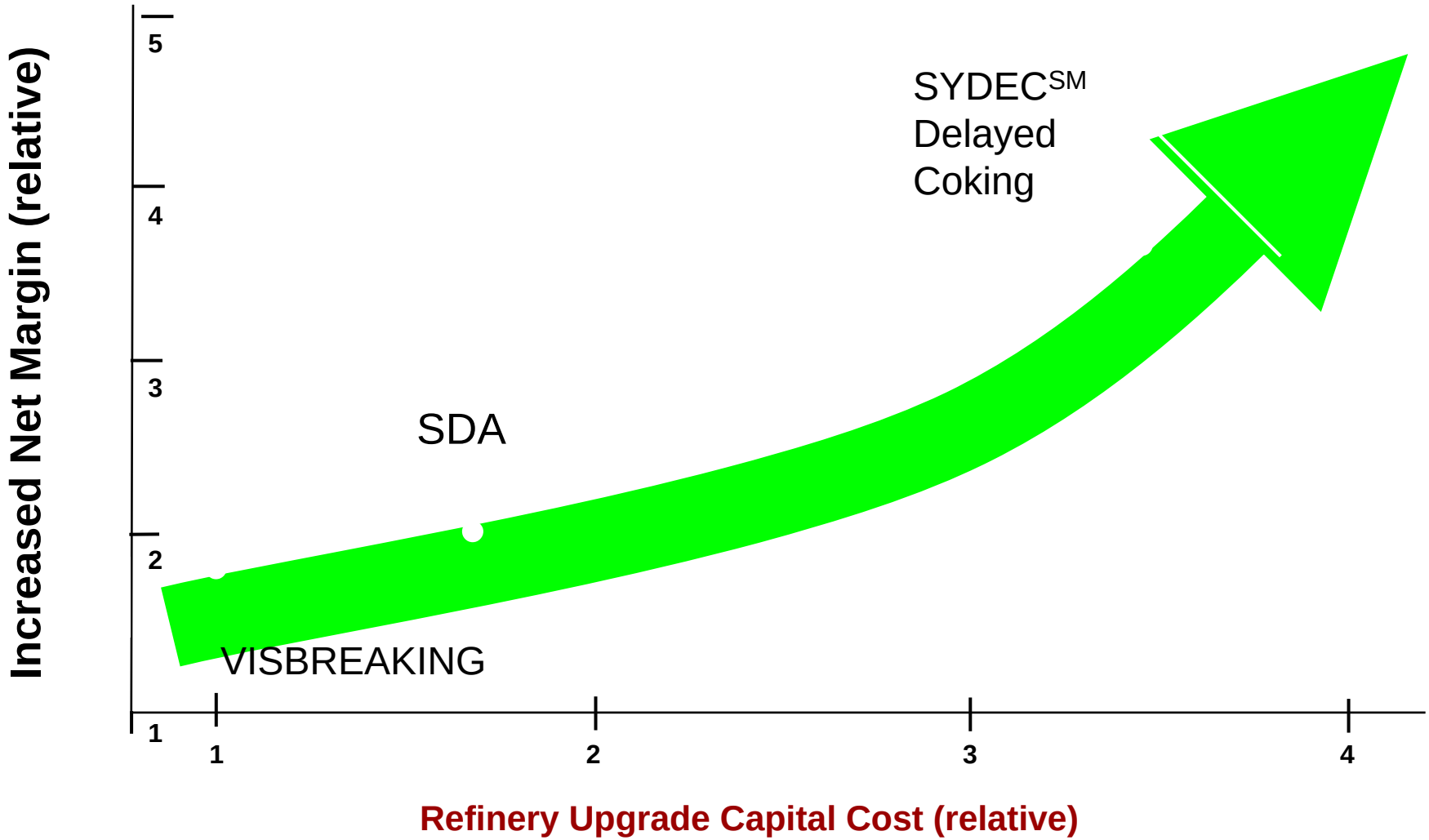
Conversion Comparison



Based on Urals Crude

Residue Conversion Economic Comparison

Increase in Net Refinery Margin



How do I choose what's best for me?

Talking Point 10a

- Following on from the comment on SDA, how do you get all the yields and properties data needed for all process units?

How do I choose what's best for me?

Talking Point 10b

- Also, as a follow on, how can we be sure the investment cost is reasonable?

Why delayed coking?

Talking Point 11 – Coker Revamps

I already have a coker, but it was built some time ago. Can I retrofit any of the environmental and safety devices you've mentioned?

- What can I do to improve environmental and operational performance?
- How can I increase throughput?

Why delayed coking?

Revamp to Increase Throughput!

- Reduce cycle time
  - reduction 18 to 12 hours can provide up to 50% capacity increase
  - for 25% increase in capacity, debottlenecking is usually minor
- Increase pressure
  - more throughput with existing equipment
  - pressure increases of 40% to 75% common
- Reduce recycle
  - reduce recycle to 5% or less and maintain production of clean liquid products
- Combine pressure increase with recycle decrease
  - keeps liquid yield and quality high
- Increase drum capacity
  - extension, replacement, addition
- Reduce feedstock volume by
  - upgrading vacuum unit TBP cut point
  - deasphalting with SDA

Why delayed coking?

Practical considerations: coke dewatering and handling

- Pit or pad extensions
- More coke handling back-up:
  - Additional crane or front end loader
- Higher horsepower for crusher
- Supplemental fines clean-up:
  - Hydroclones and upgrade of maze weir details
- Conversion of direct load operation for shot coke
  - Pat or pit
  - Delta Valve throttle slide valve
  - General Kinematics Corp's dewatering conveyor

Why delayed coking?

Improving Operational Safety Performance

Benchmark against best-in-class for new coker design:

safety interlocks

- Coke drum inlet isolation valves, switch valve, utility valve and bottom unheading
- Coke drum outlet isolation valves and blowdown valves
- Coke drum vent, PSV isolation and drum top unheading device
- Heater pass flow, fuel pressure and combustion air
- Coke cutting system

Why delayed coking?

Delayed coker revamp: project experience

- Foster Wheeler has executed 60 revamps out of 115 projects and major studies since 1990

- Expansions
- Modernisation of facilities
- Safety
  - Interlocks
  - Relief valves
- Environmental
  - Blowdown system refits

- Process improvements
  - Fractionator spray chamber
  - Fractionator fines removal
  - Product coke quality
  - Yield improvements

Why delayed coking?

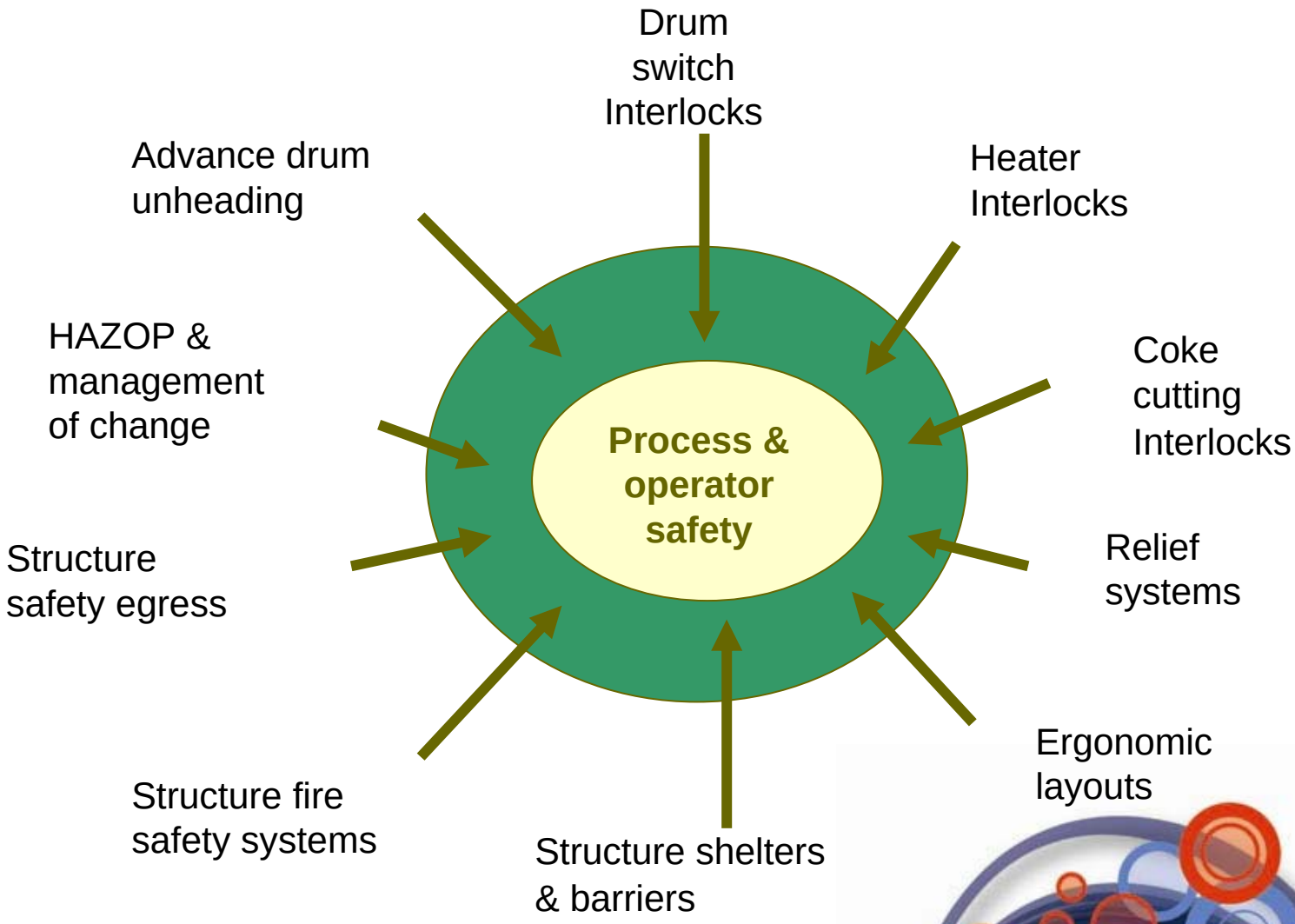


Talking Point 12

Older cokers involve a lot of manual operation is that still the case in modern designs?

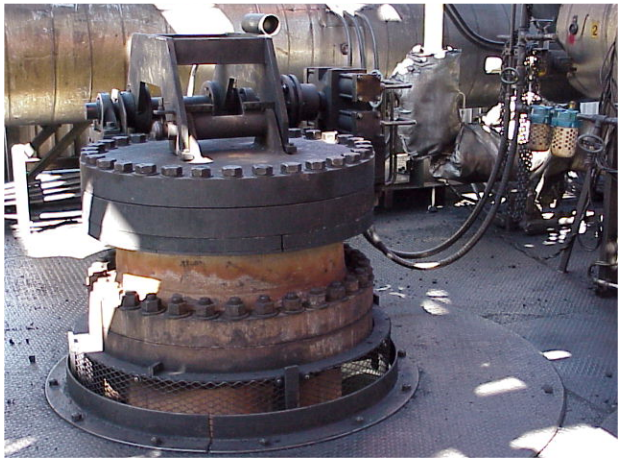
What additional safety features are included in new designs and can they be incorporated with existing plants

SYDEC^{SM} - design for safety



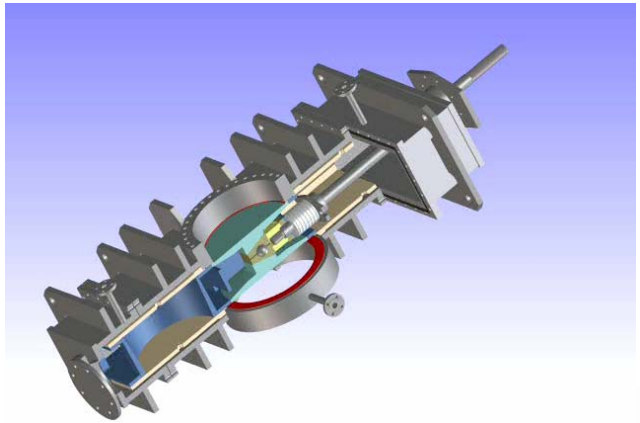
Safety features: unheading

Semi-automatic top device



DELTAGUARD™

US Patents:
6,656,714
6,660,131



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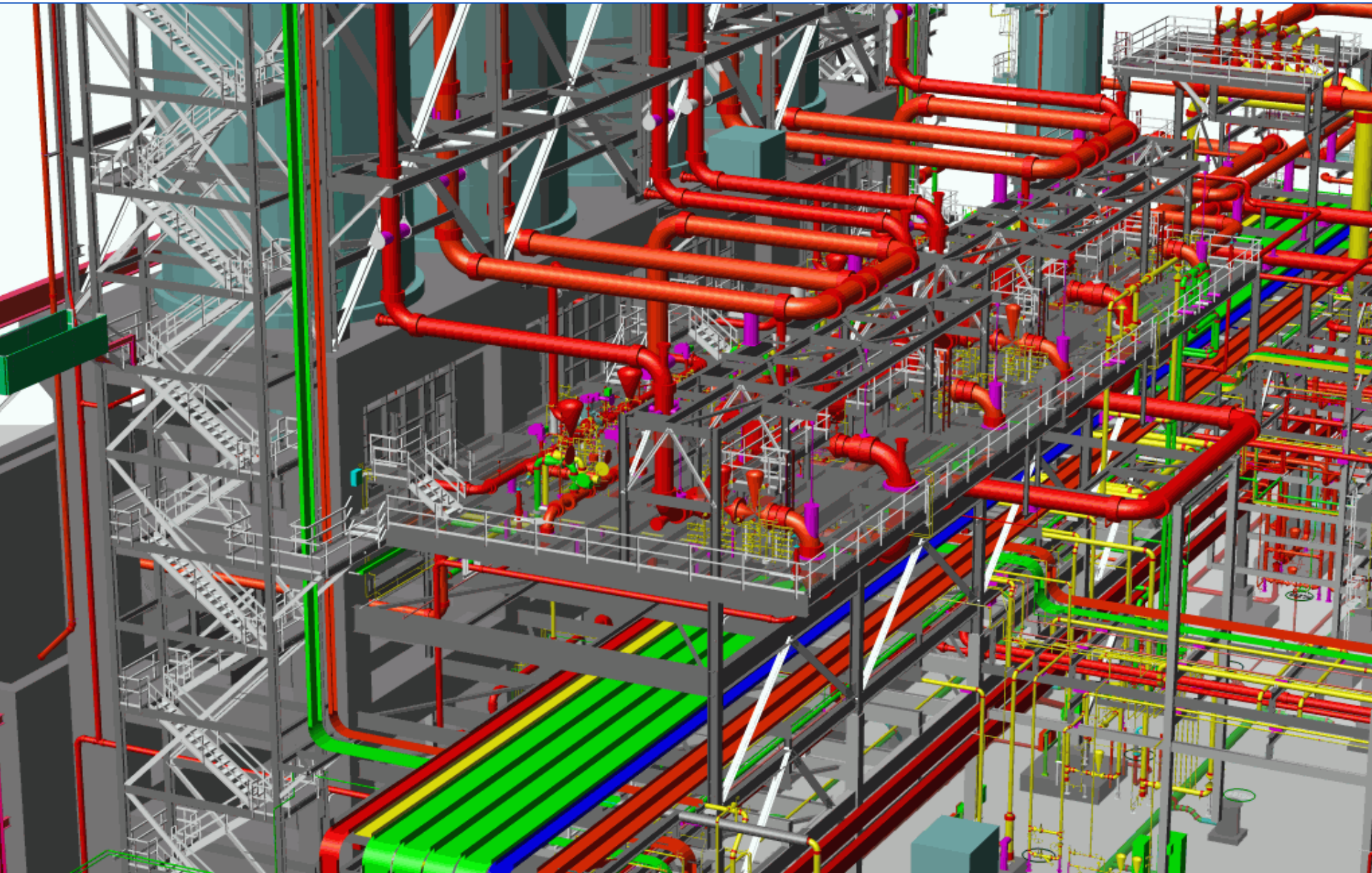
SYDEC^{SM} - design for safety

Safety features: beyond unheading

- Physical design of switch and cutting decks
  - Ease of emergency egress
  - Separating operators from potential harm
- Fire protection systems
- Interlocks

Safety features: unheading and switch deck

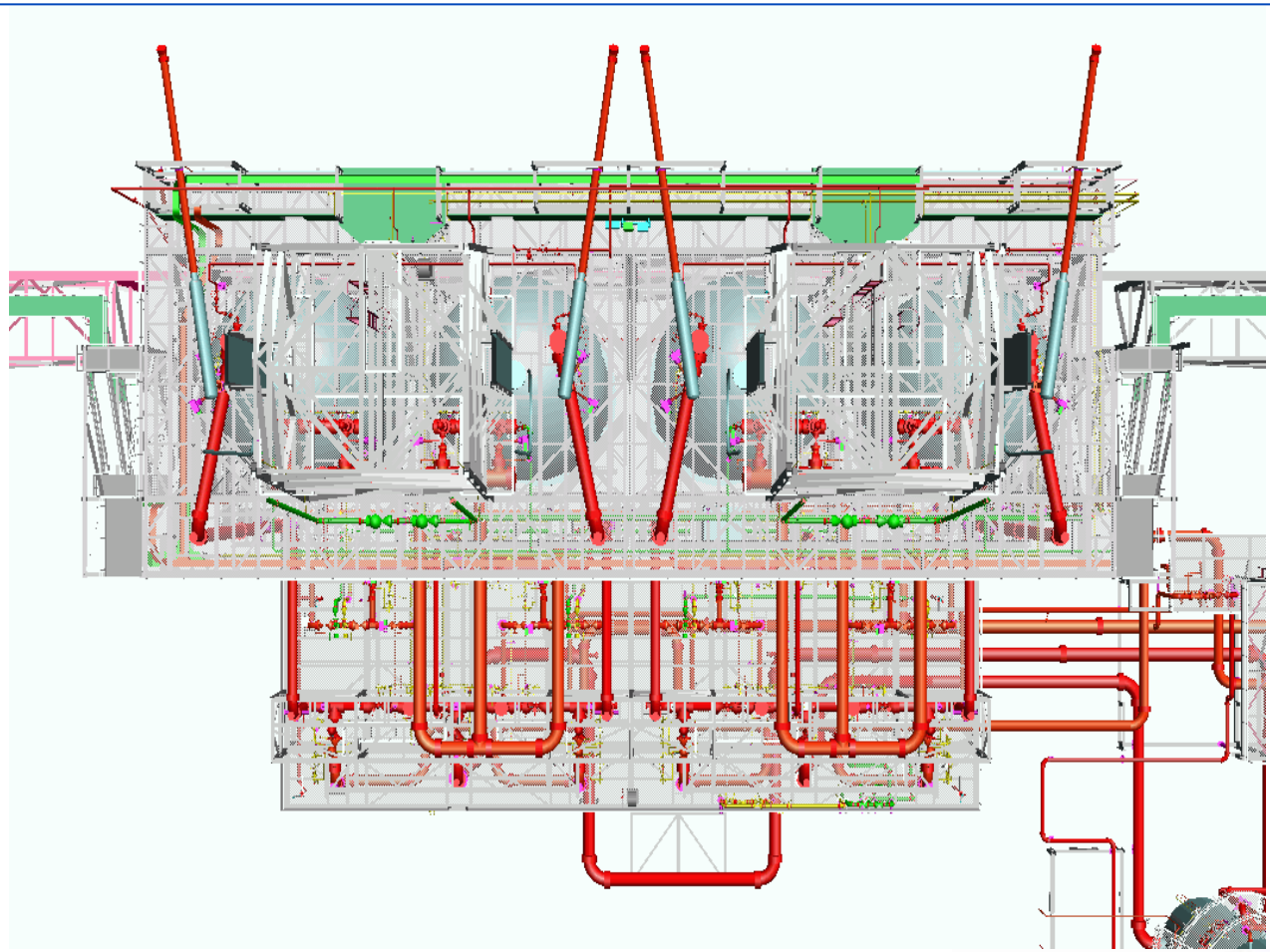


SYDEC^{SM} - design for safety

Safety features: switch deck

- Single level switch / unheading deck
- Barrier walls
- Positioning of control panels
- Layout of piping / valves
- Clear lanes for emergency egress
- Firewalls at elevator and stairways
- Audiovisual alert devices

Safety features: cutting deck layout



SYDEC^{SM} - design for safety

Safety features: cutting deck

- Enclosed cutting shelters
- Clear view of coke pit
- Barrier walls for emergency egress
- Firewalls at elevator and stairways
- Escape towers and chutes
- Escape gondola
- Audiovisual alert devices

SYDEC^{SM} - design for safety

Safety features: fire protection

- Decks and stairwells
  - Fire walls
  - Hydrants and monitors
  - Deluge systems

SYDEC^{SM} - design for safety

Safety features: interlocks

- During cutting
- Physical separation
- Permissives based on tool position during switching and unheading
- Physical separation
- Permissives based on process variables
- Permissives based on valve positions
- Coke drum inlet isolation valves, switch valve, utility valve and bottom unheading
- Coke drum outlet isolation valves and blowdown valves
- Coke drum vent, PSV isolation and drum top unheading device
- Heater pass flow, fuel pressure and combustion air
- Coke cutting system

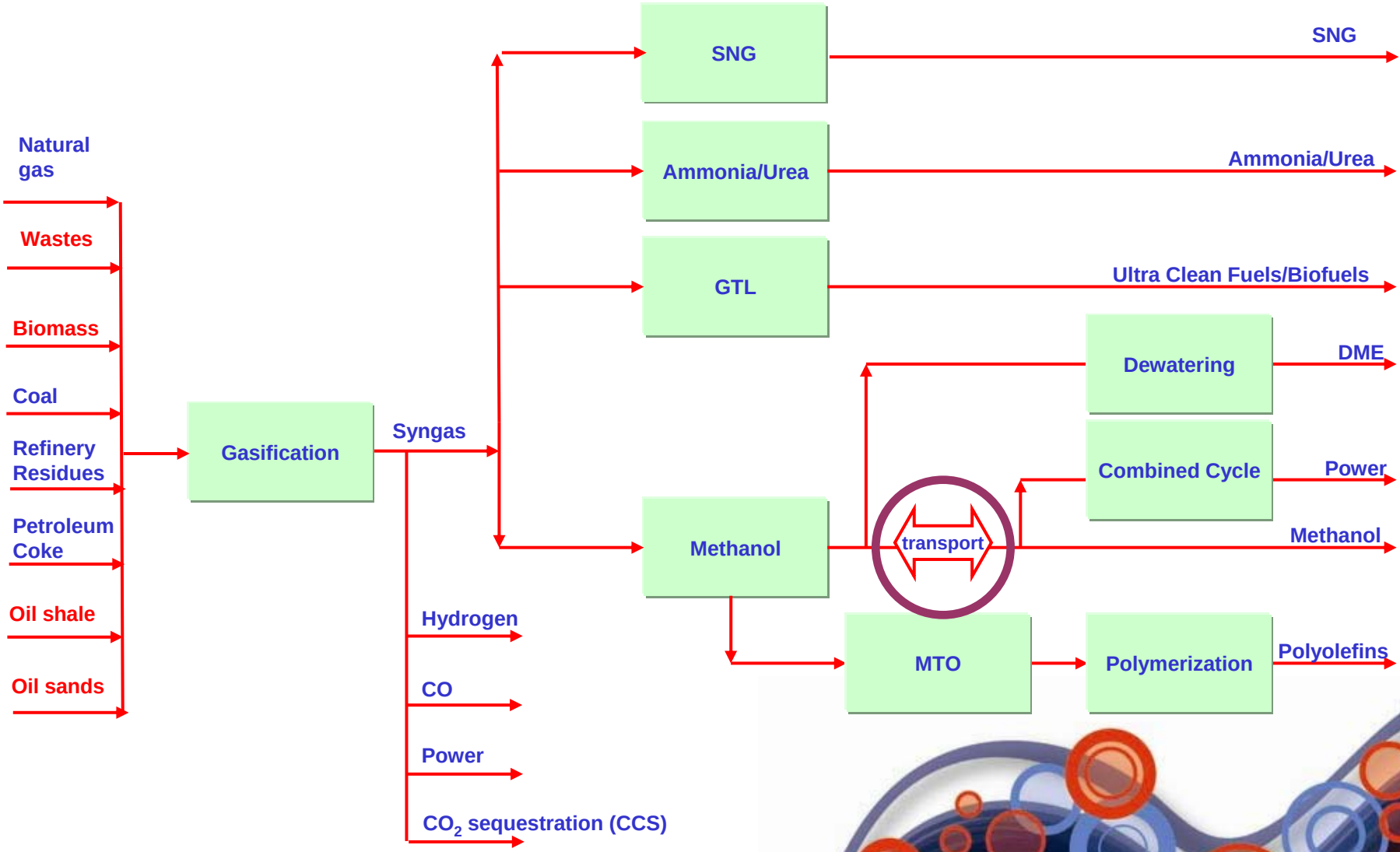
Why IGCC?

Talking Point 13

Reducing CO_2 is becoming a big issue. What impact does IGCC have in this area?

CO_2 precombustion capture is not only an option to separate CO_2 but it is the only commercially proven technology

Why IGCC?



Why IGCC?

Talking Point 14

I heard that many contractors are tied in to one particular technology. What is Foster Wheeler's position?

Why IGCC?

Foster Wheeler can work with any technology

- Solid feed stocks (coal, petcoke):
  GE Energy, Shell, Conoco Phillips, Siemens, Sasol, Lurgi

- Liquid feed stocks (heavy oils, asphalts):
  GE Energy, Shell

Many technology comparison studies made or in progress

Summary

In summary ….

We have discussed:

- some of the key questions relating to coking, CFB, gasification and solvent deasphalting
- how some of these challenges can be overcome

FOSTER WHEELER

Thank You