LOY YANG A POWER STATION
RETROFIT
FOR
CARBON CAPTURE

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LOY YANG A POWER STATION LOCATION

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LOY YANG A STATION – POWER PLANT OVERVIEW

PLANT LOCATION – Latrobe Valley, Victoria, Australia

FUEL SOURCE – Adjacent open pit lignite mine

NUMBER OF GENERATING UNITS – 4

TOTAL GENERATION – 2400 MW (Nominal)

UNIT CAPACITY – 600 MW (Nominal)

ESP FLUES PER UNIT – 2 (Total 8 Flues for the Plant)

CARBON CAPTURE MODULES REQUIRED – 1 per Flue (= 2 per Unit; 8 Total for Plant)

PLANT OWNER – AGL Energy Limited

YEARS BUILT – 1984-88

ABSORBENT – 40% MEA @ 0.22 mol CO2/mol MEA lean amine loading

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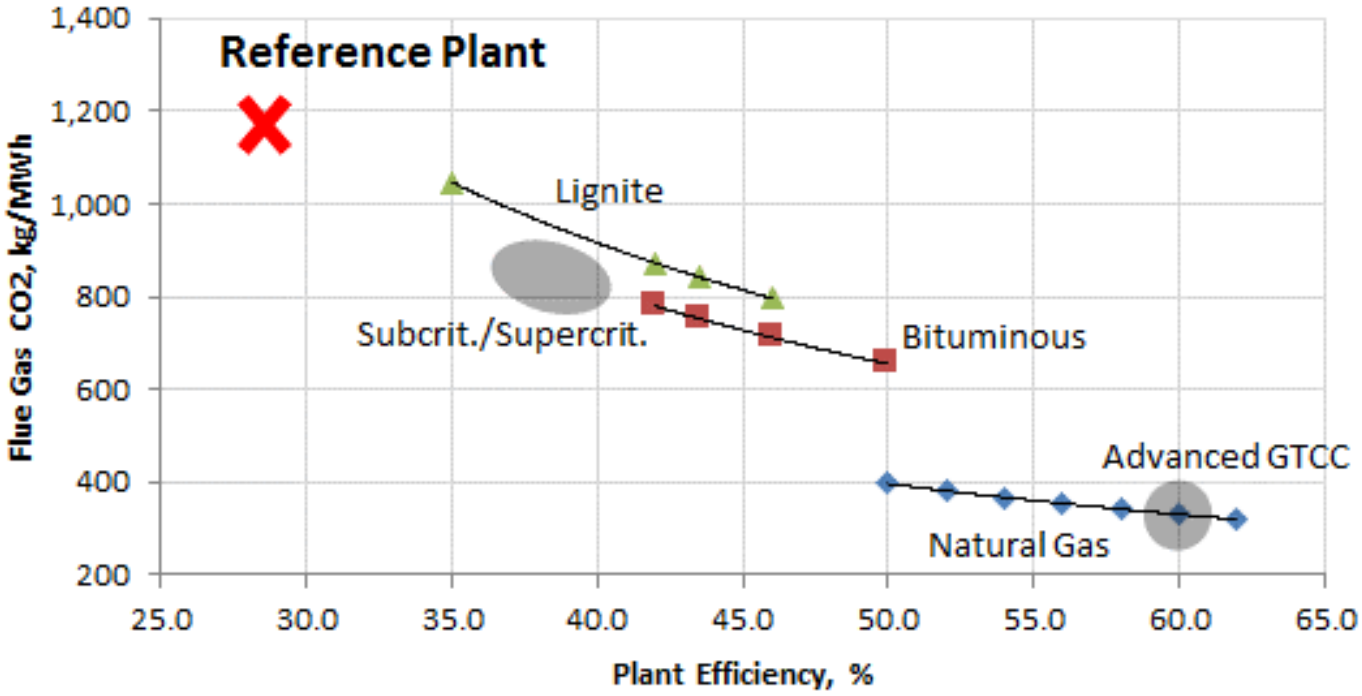
Key Features for Retrofit on the Brown Coal Reference Plant

- Four large units, 568MW gross nominal output on an existing site
- High CO_2/MWh and low thermal efficiency because of fuel properties
- Very low sulphur coal, no FGD
- Nominal 90% capture target
- Must be able to shut off PCC quickly at periods of very high electricity demand



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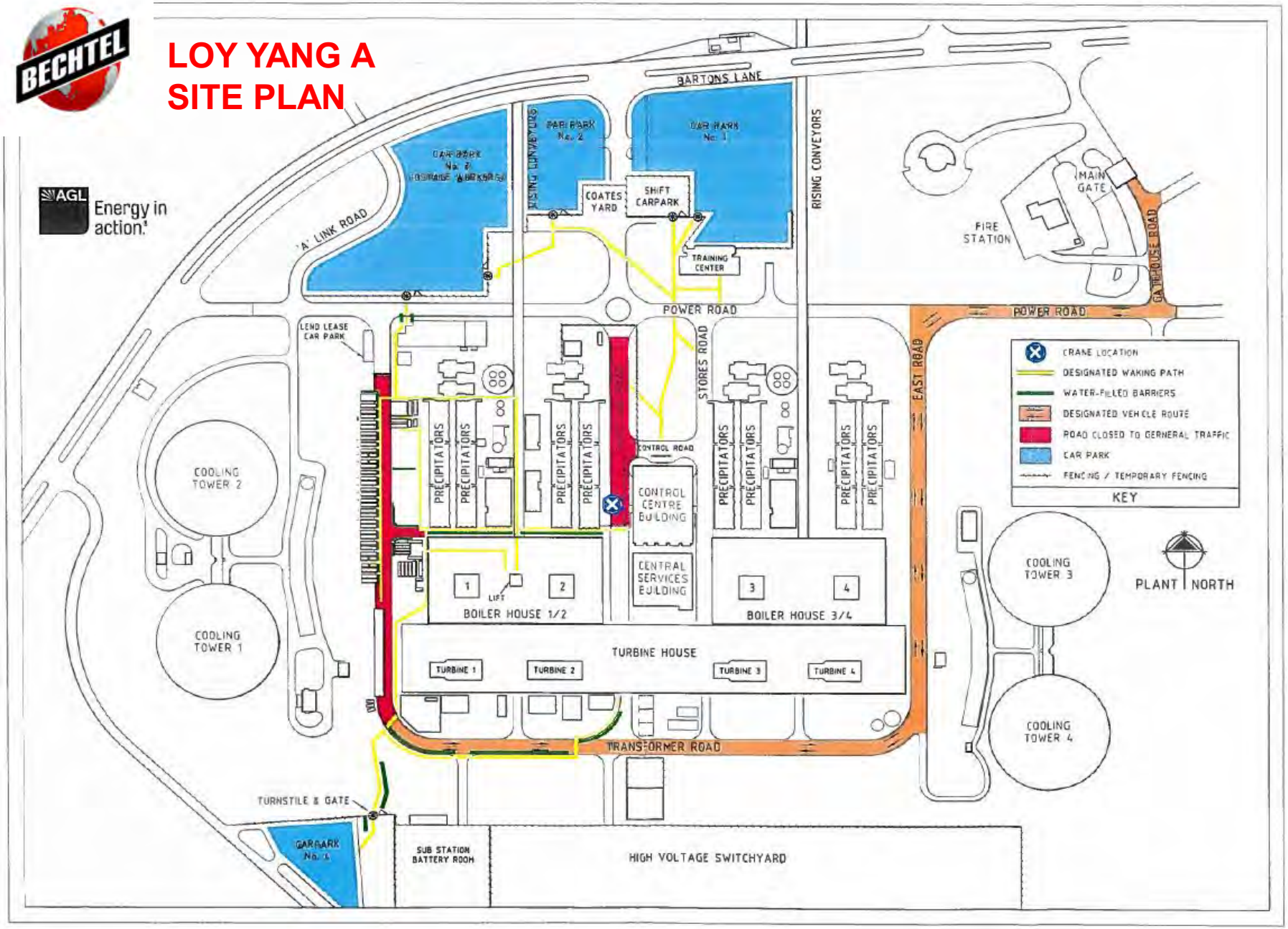
LOY YANG A SITE PLAN



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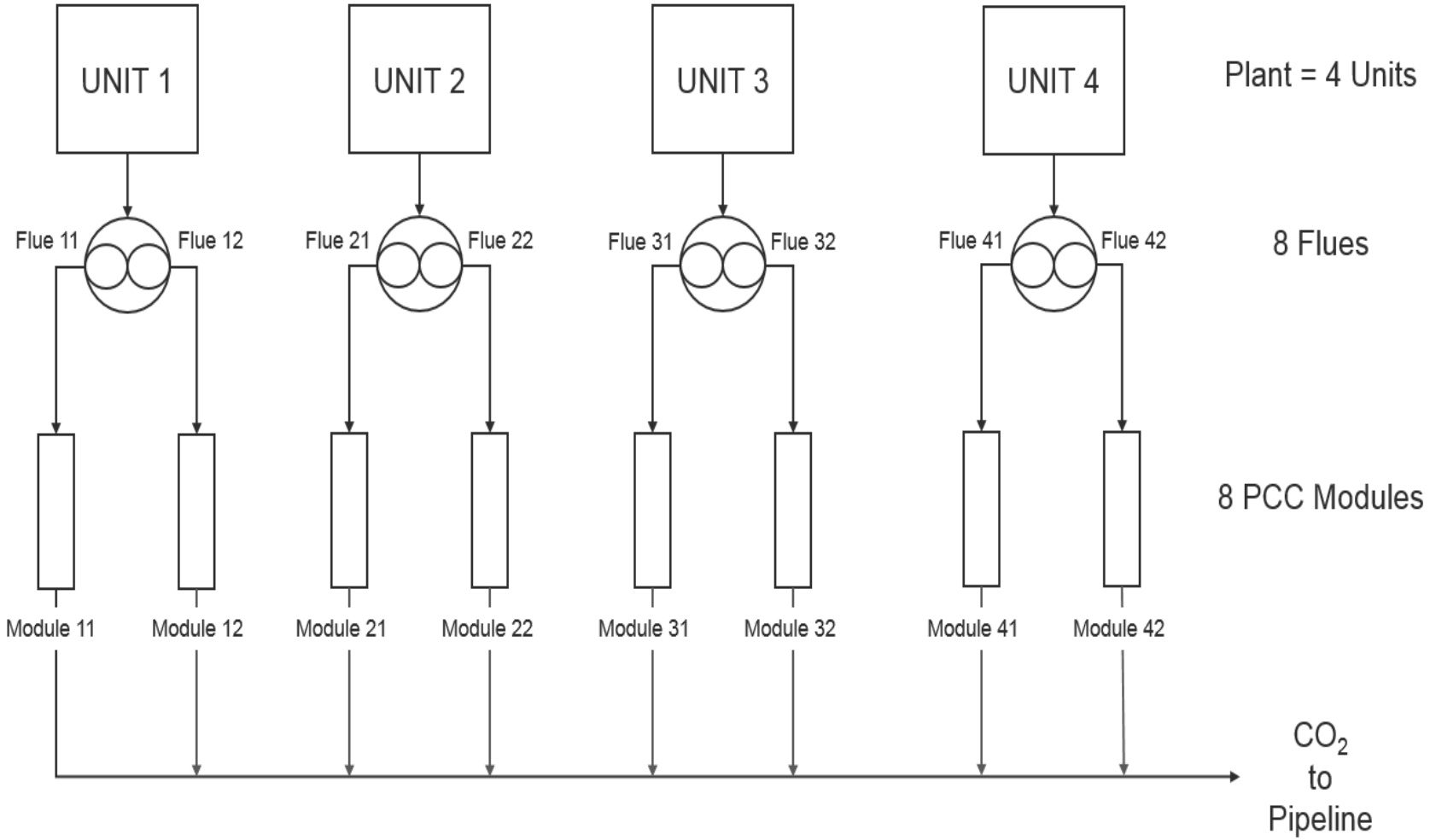
LOY YANG A MAJOR FLUE GAS PATH DESIGNATIONS



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LOY YANG A STATION - RATINGS

RATING	Unit of Measurement	FOR THE PLANT (FOUR UNITS)	PER UNIT (TWO FLUES)	PER FLUE
CO_2 Emitted	Tonnes/day	58,400	14,600	7,300
CO_2 Captured	Tonnes/day	52,560	13,140	6,570
Flue Gas*	SCM/sec	3,120	780	390
	Tonnes/day	330,400	82,600	41,300
Net Elec Output	MW	2,064	516	258

*Design inlet flue gas contains 11.2 vol % CO2, 4.3 vol % O2, 100 ppm NOX, 200 ppm SO2, and 0.5 g/SCM particulates.

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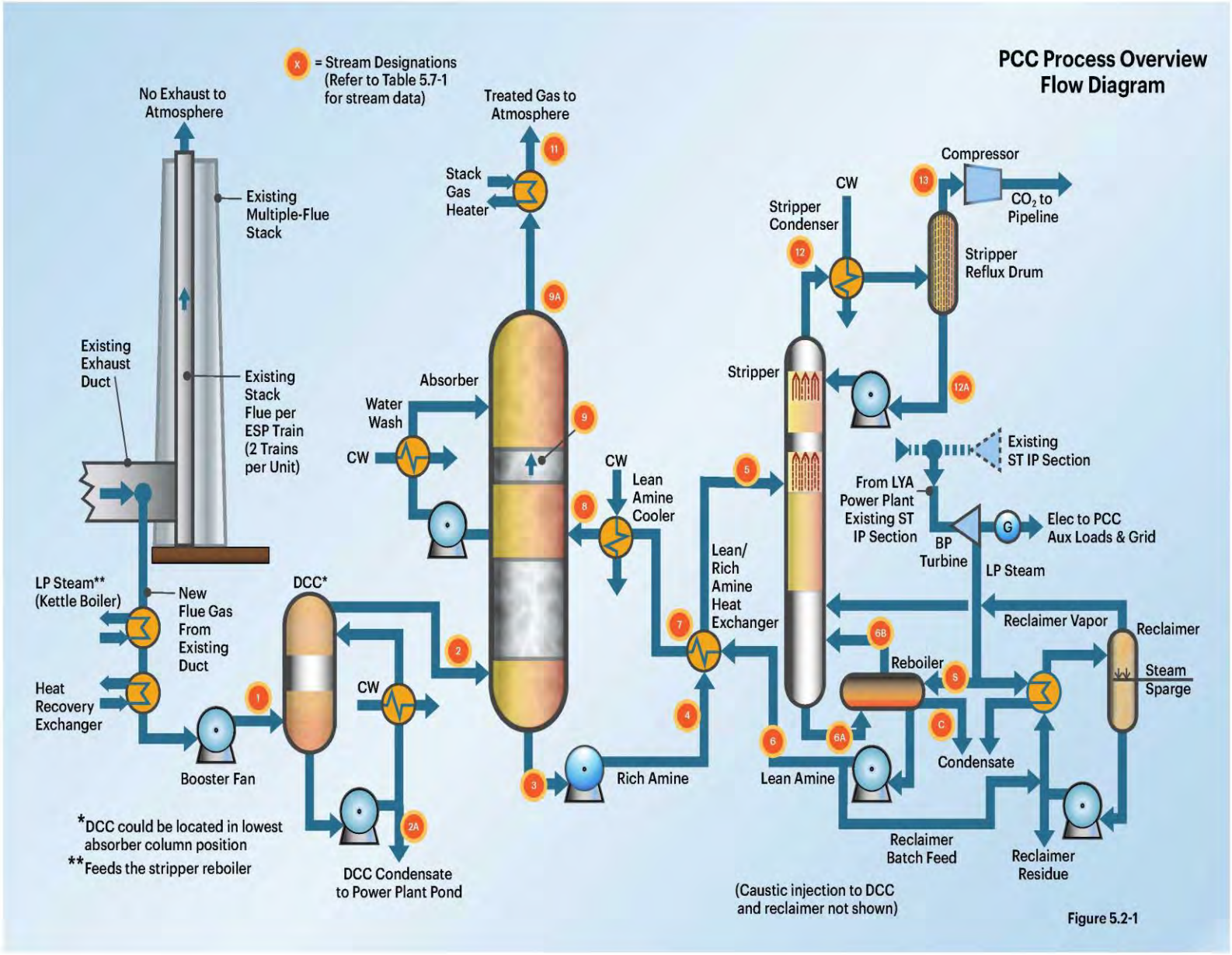

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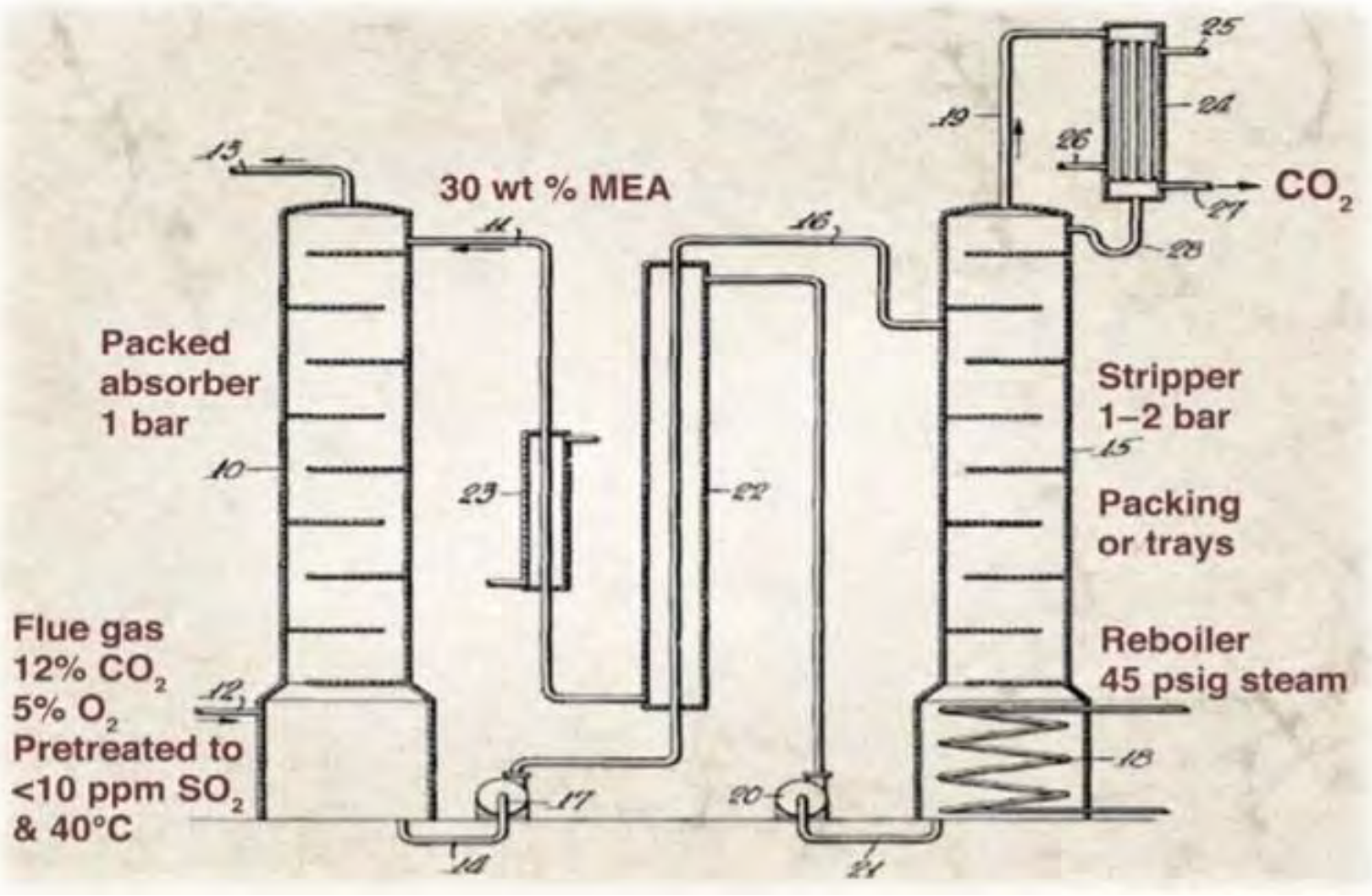
AMINE SCRUBBING PROCESS ORIGIN

The amine scrubbing process invented by Bottoms in 1930

R. R. Bottoms (Girdler Corp.), "Separating acid gases," U.S. Patent 1783901, 1930



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LOY YANG A STATION – CC DESIGN CHARACTERISTICS (per Flue/Module)

CC SECTION	SPECIFIC CHARACTERISTIC	UNIT OF MEASUREMENT	VALUE
Booster Fans	Number of Equipment Items	Each	1
	Capacity each	SCM/sec	400
	Delta P	cm H_20	150
Direct Contact Cooler (DCC)	Number of Equipment Items	Each	1
	Velocity	m/sec	3.0
	Area	m^2	180
	Packing Depth	m	2.16
	Diameter	m	15
	Vessel Height	m	4
Absorber	Number of Equipment Items	Each	1
	Velocity	m/sec	2.3
	Area	m^2	180
	Packing Depth	m	2 x 7.56
	Water Wash Packing Depth	m	1 x 1
	Diameter	m	15
	Vessel Height	m	29
Stripper	Number of Equipment Items	Each	1
	Pressure	bara	1.9
	Packing Depth	m	4
	Diameter at Bottom	m	14
	Diameter at Reflux Section	m	8.5
	Vessel Height	m	23.3
Compressors	Number of Equipment Items	Trains	1
	Stages	no. of	8
	Discharge Pressure	bara	150
	Power Consumption	kW	27,000

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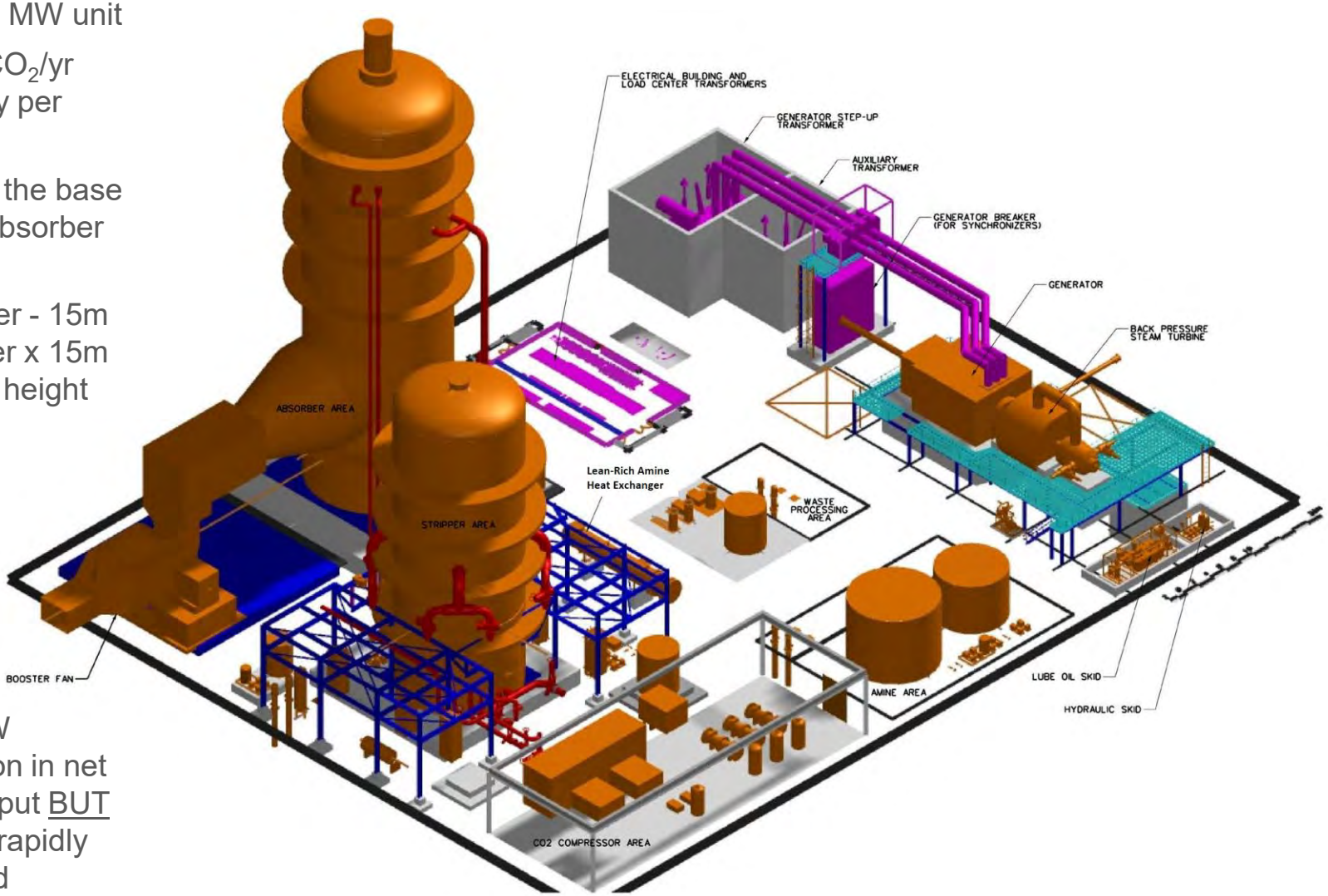
Current Retrofit Study PCC Capture System

- Two PCC modules per 568 MW unit
- 2.4 $MtCO_2$/yr capacity per module
- DCC in the base of the absorber tower
- Absorber - 15m diameter x 15m packed height



- 190 MW reduction in net unit output <u>BUT</u> can be rapidly restored

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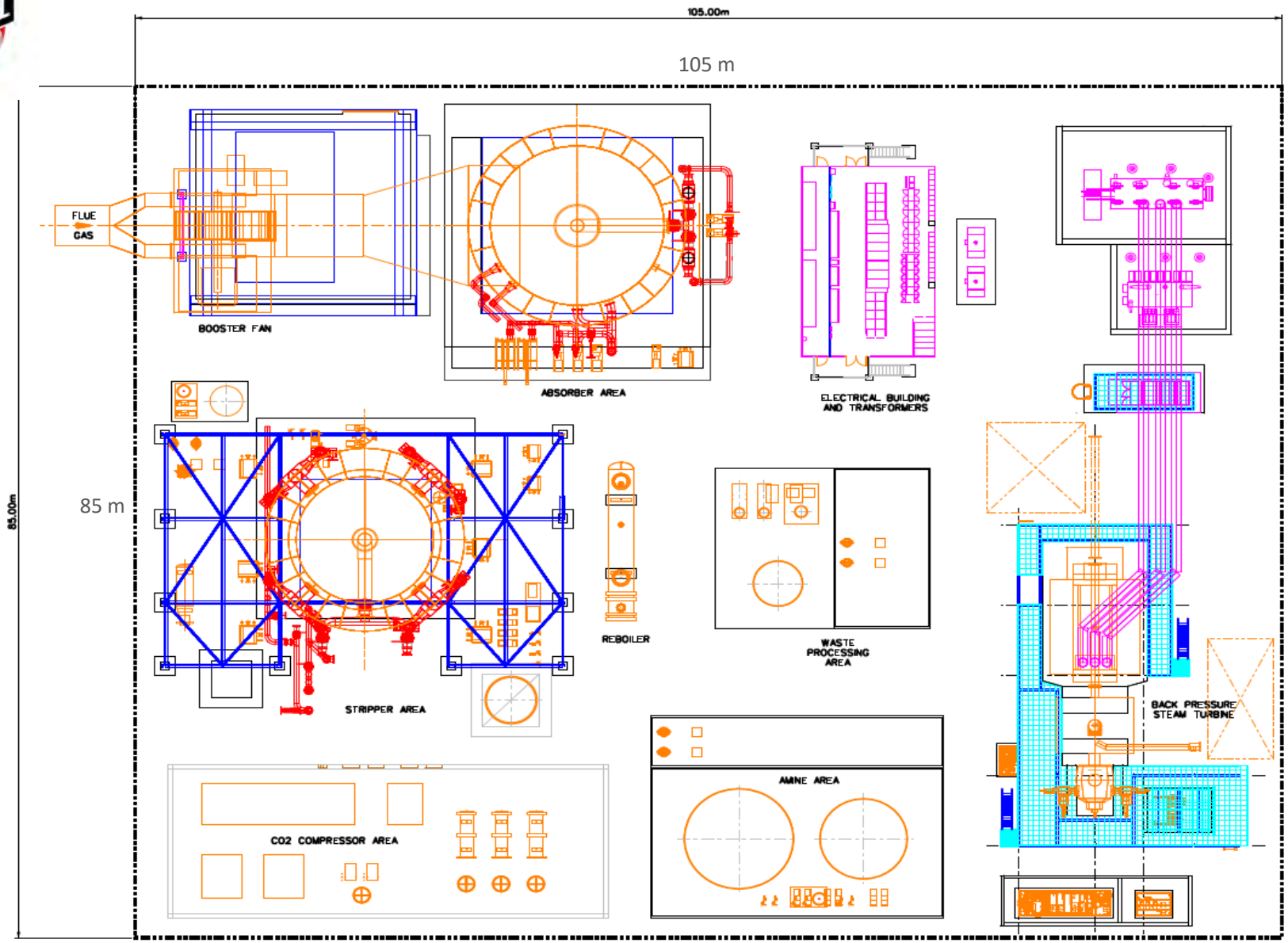
LOY YANG A CO2 CAPTURE MODULE PLAN



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LOY YANG A STATION
CC OPERATING CHARACTERISTICS (PER FLUE/MODULE)

CHEMICALS CONSUMPTION

CHEMICAL	UNIT OF MEASUREMENT	VALUE
MEA (Initial Charge)	Tonnes	1,200
MEA (Annual Use)	Tonnes	649
Caustic (Annual Use)	Tonnes	50

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LOY YANG A STATION

CC OPERATING CHARACTERISTICS (PER FLUE/MODULE)

CC STEAM REQUIREMENT

RATING	UNIT OF MEASUREMENT	VALUE
BP Steam Turbine-Generator	MW (elec)	118.4
Steam in to B/P STG - Temperature	degC	539
Steam in to B/P STG - Pressure	bara	29
Steam in to B/P STG - Flow	kg/hr	749,300
Steam out to Reboiler - Temp	degC	251
Steam out to Reboiler - Press	bara	3.5
Steam out to Reboiler - Flow	kg/hr	749,300

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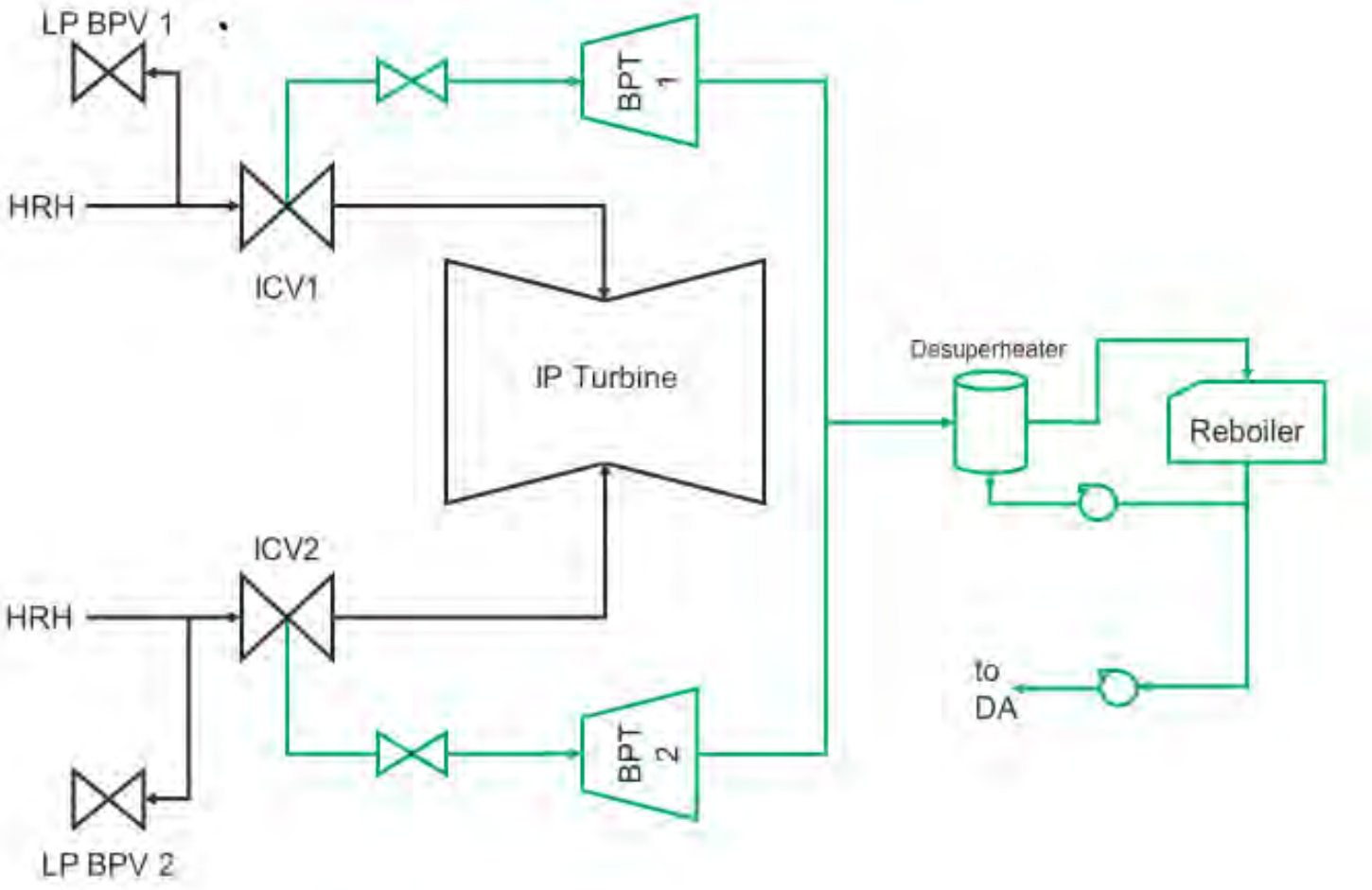
LOY YANG A STATION
BP STG INTEGRATION
(PER UNIT = x2 FLUE/MODULE)



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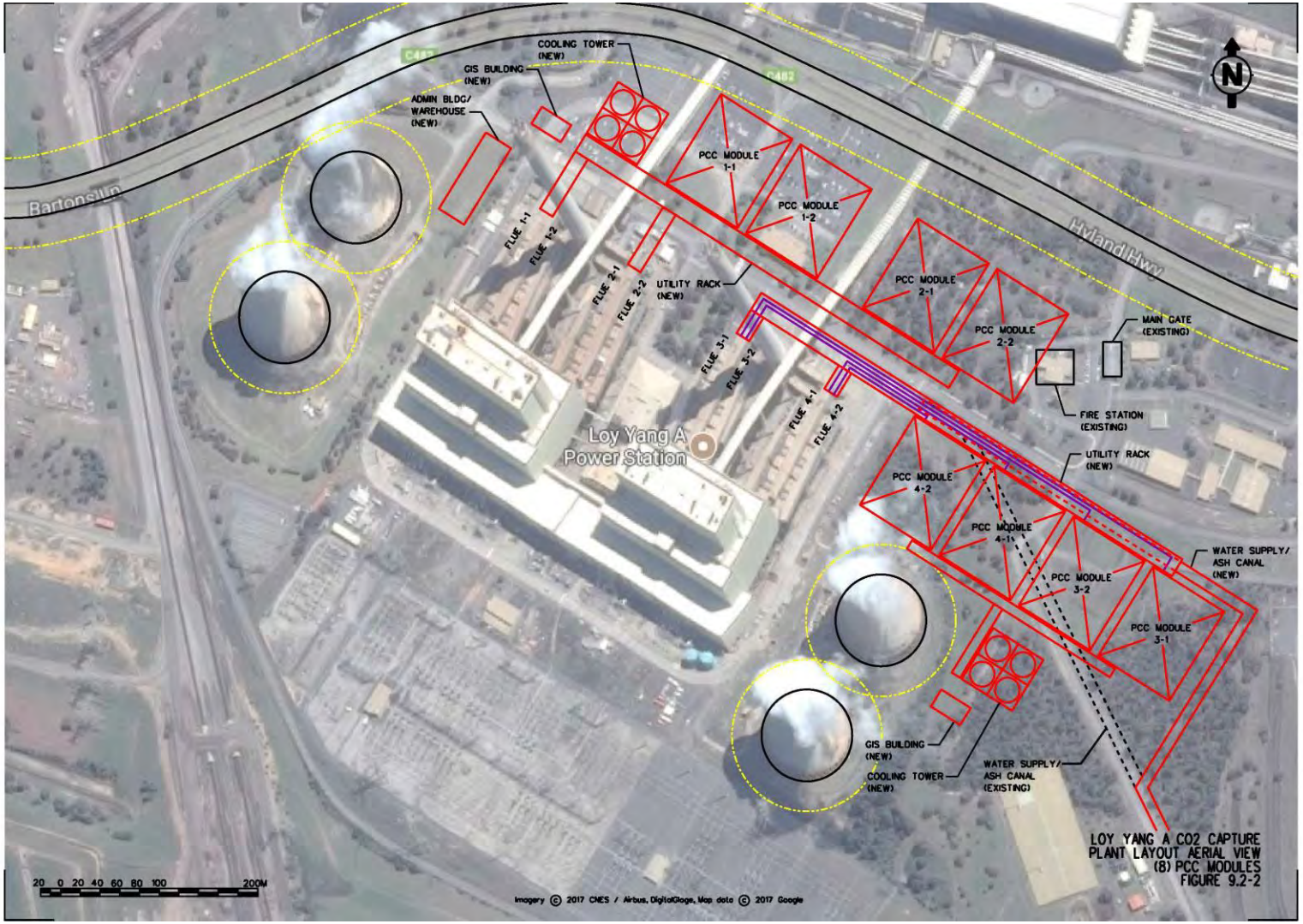
LOY YANG A WITH (8) CO2 MODULES PLACED



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CARBON CAPTURE RETROFIT
FRONT-END SCHEDULE ASPECTS

SPECIFIC FRONT-END ACTIVITY	ACTIVE MONTHS	TOTAL MONTHS
Develop CO2 Project Ownership Structure	-55 to -45	10
Design/Erect Pilot Plant	-51 to -45	6
Run Pilot Plant	-45 to -30	15
Feasibility Study	-30 to -15	15
Engineering Systems Study	-15 to -12	3
Parallel FEED Studies	-12 to 0	12
BEA	0 to 6	6
EPC	6 to 36	30
Commissioning	36 to 40	4

NOTE: Above schedule applies to first CC module only.

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LOY YANG A STATION
CC INDICATIVE COSTS (per Flue/Module)

EPC COST (US$ - 2018)

CC Cost Component	EPC Cost (US$)
Flue and Steam Connections, Including Fans	$60 mil
DCC and Absorber	$210 mil
Stripper, Reboiler, Reclaimer	$100 mil
Compressors	$125 mil
Backpressure STG	$85 mil
Engineering, Const Mgt, Distributables	$138 mil
Initial MEA Charge (1200 Tonnes, 99% Purity)	$2 mil

TOTAL EPC COST (Per Module)	$720 mil

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LOY YANG A STATION
CC INDICATIVE COSTS (per Flue/Module) (2018)

- **OWNER COSTS** (US$) 100 mil
- **COMMISSIONING COST** (US$) 20 mil
- **ANNUALIZED COST** (US$):

CAPITAL COST	TERM	DISCOUNT RATE	ANNUAL COST	$/Tonne CO2 @ 80% CF	$/Tonne CO2 @ 50% CF
840 mil	15 years	15%	$144 mil	$75	$120
840 mil	30 years	8%	$75 mil	$39	$63

CAPITAL COST	TERM	DISCOUNT RATE	ANNUAL COST	$/MWh @ 80% CF	$/MWh @ 50% CF
840 mil	15 years	15%	$144 mil	$126	$201
840 mil	30 years	8%	$75 mil	$66	$105

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