Operation Experience of Oxyfuel Boiler

T. Yamada, T. Uchida, T. Gotou, T. Kiga(IHI), C. Spero(CS Energy/COSPL)

OCC3

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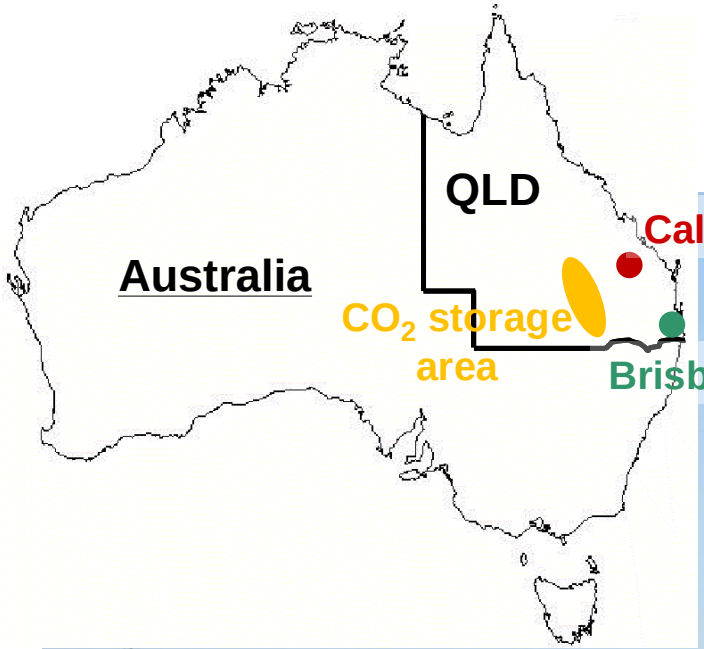
Callide Oxyfuel Project

Presentation outline

- Project & oxyfuel process overview
- Operation experience of oxyfuel boiler
  - > Mode change
  - > Heat absorbed in boiler at 30MWe
  - > Operation range
  - > CO2, NO, SO2, SO3, Carbon-in-ash
- Future test plan
- Concluding comment

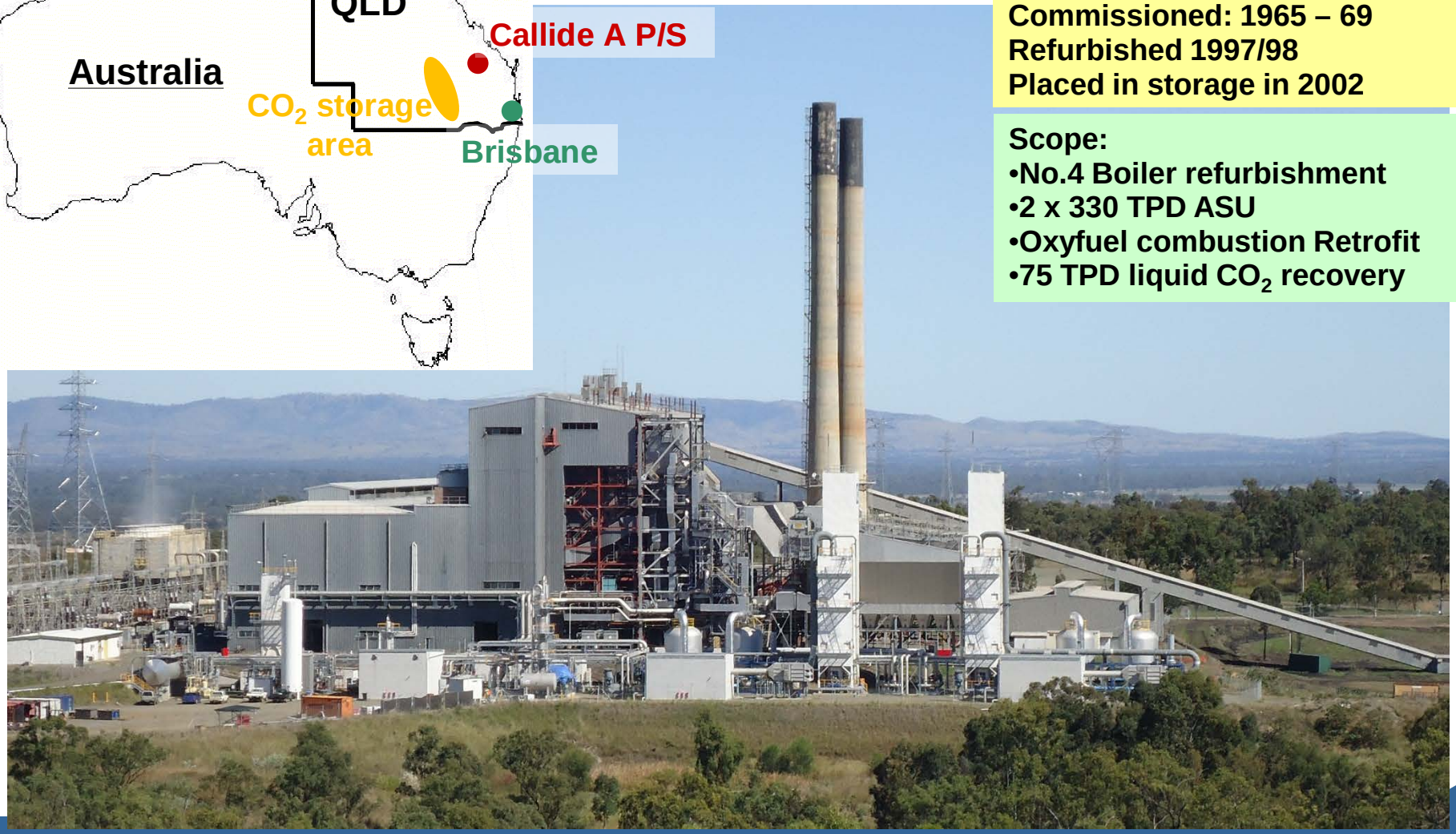
Callide Oxyfuel Project

Callide Oxyfuel Project Overview



Callide A Power Station
Owned by CE Energy
4 x 30 MWe
Steam 136 t/h at 4.1MPa, 465°C
Commissioned: 1965 – 69
Refurbished 1997/98
Placed in storage in 2002

Scope:
- **No.4 Boiler refurbishment**
- **2 x 330 TPD ASU**
- **Oxyfuel combustion Retrofit**
- **75 TPD liquid CO_2 recovery**



Callide Oxyfuel Project -Equipment-

Coal feeder &
Beater type mill

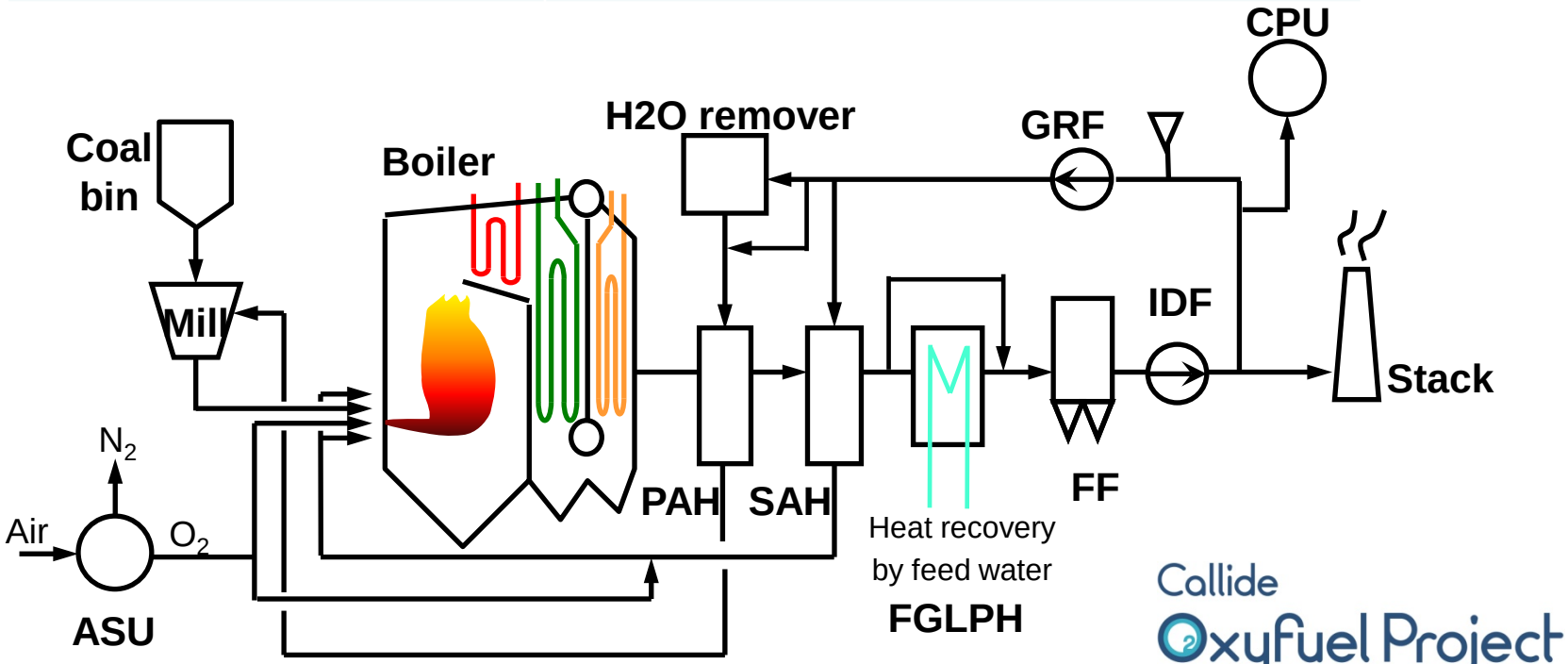
New burner & existing burner

30MWe ST & Generator

Callide Oxyfuel Project

Callide Oxyfuel Process

Items	Description
Generation output	30MW
Coal	Callide coal (High Ash, High Moist. and Low S)
Boiler inlet O2 concentration	27 vol%wet in oxy mode (Normal operation)
Boiler outlet O2 concentration	< 3 vol%wet at 30MW
Supply O2 purity	> 98%
Target CO2 at stack inlet	55wet% in oxy mode



Callide Oxyfuel Project

Operation Experience

- Stable Air ⇔ Oxyfuel mode change
- 3 types of coal : Callide coal, Blend 1, Blend 2
- 30MWe at both air and oxyfuel combustion
- Achievement of target CO_2 value with 55wet% (= 70dry%)
- Obtained test results of any parameter with MW, inlet- O_2, coal.
- Confirmation for behavior of trace elements (SO_3, Hg, etc.)
- Obtained test results of H_2O remover bypass operation
- Inspection after 1 year operation from start of commissioning

History of boiler

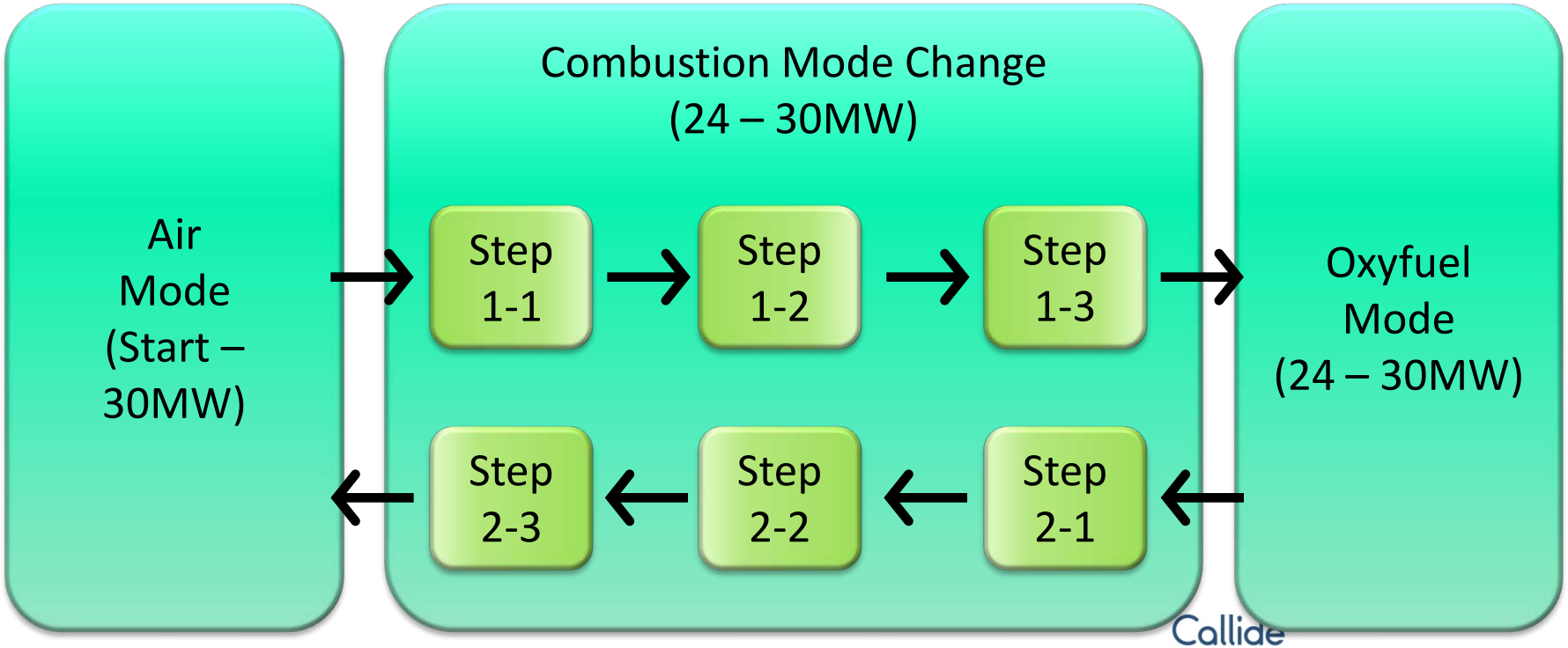
23 March, 2011 - First fire on fuel oil after retrofit
12 March, 2012 - First oxygen injection to boiler
19 March, 2012 - Successful 100% RFG and oxyfiring
6 Nov., 2012 - Over 1000 hours
23 Jan., 2013 - Over 2000 hours
20 June, 2013 - Over 3000 hours

Callide Oxyfuel Project

Combustion Mode Change

< Air ⇔ Oxyfuel combustion mode change >

- Air ⇔ Oxyfuel mode change with one push button
- Sequence run step by step



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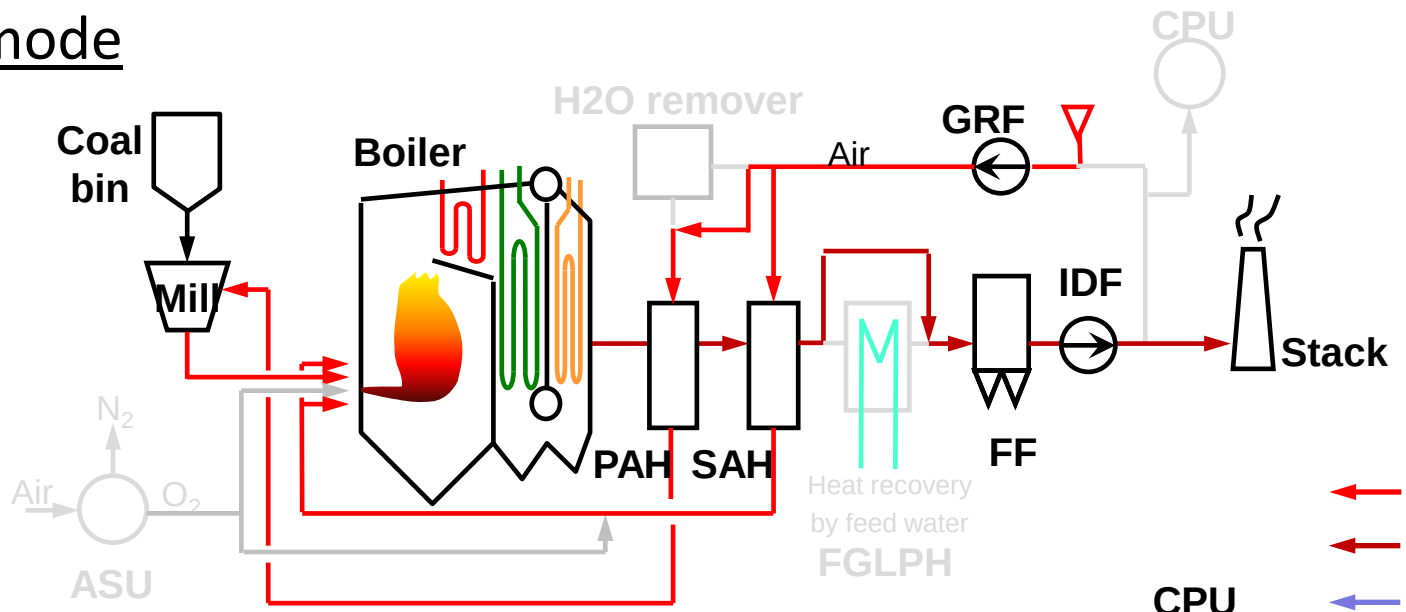
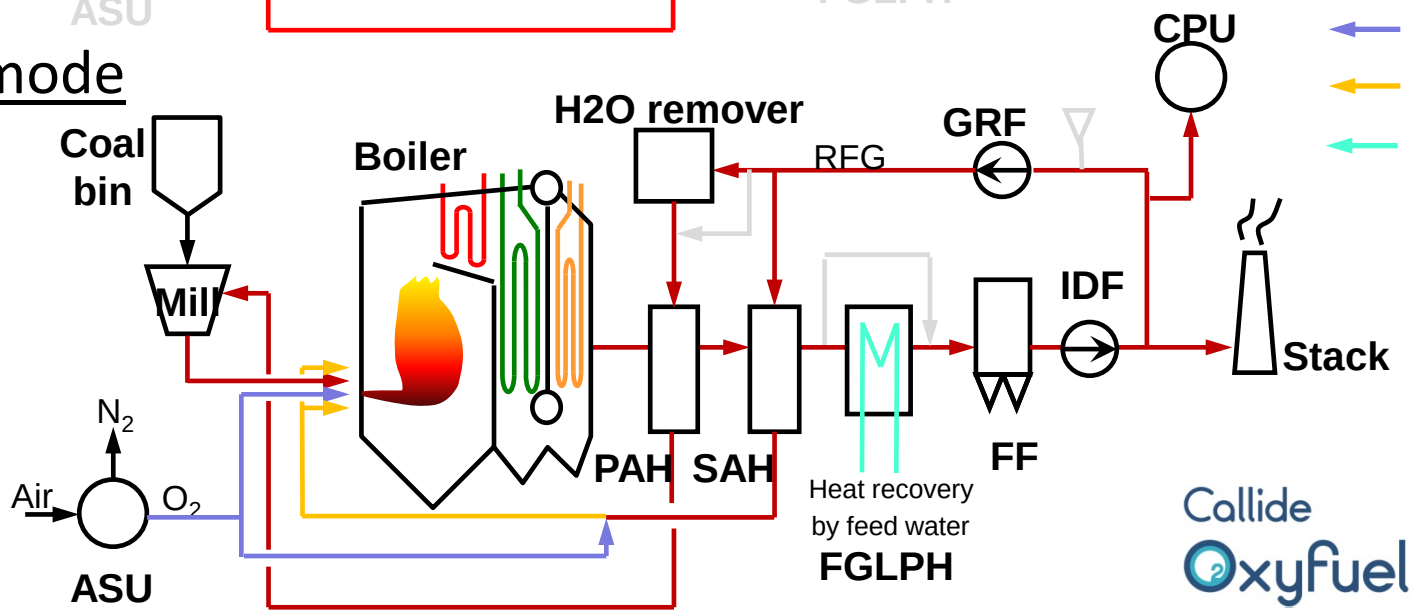
Air and Oxy Process

Air mode



Oxy mode



- Air
- Flue gas / RFG
- Oxygen (O2)
- RFG + O2
- Feed water

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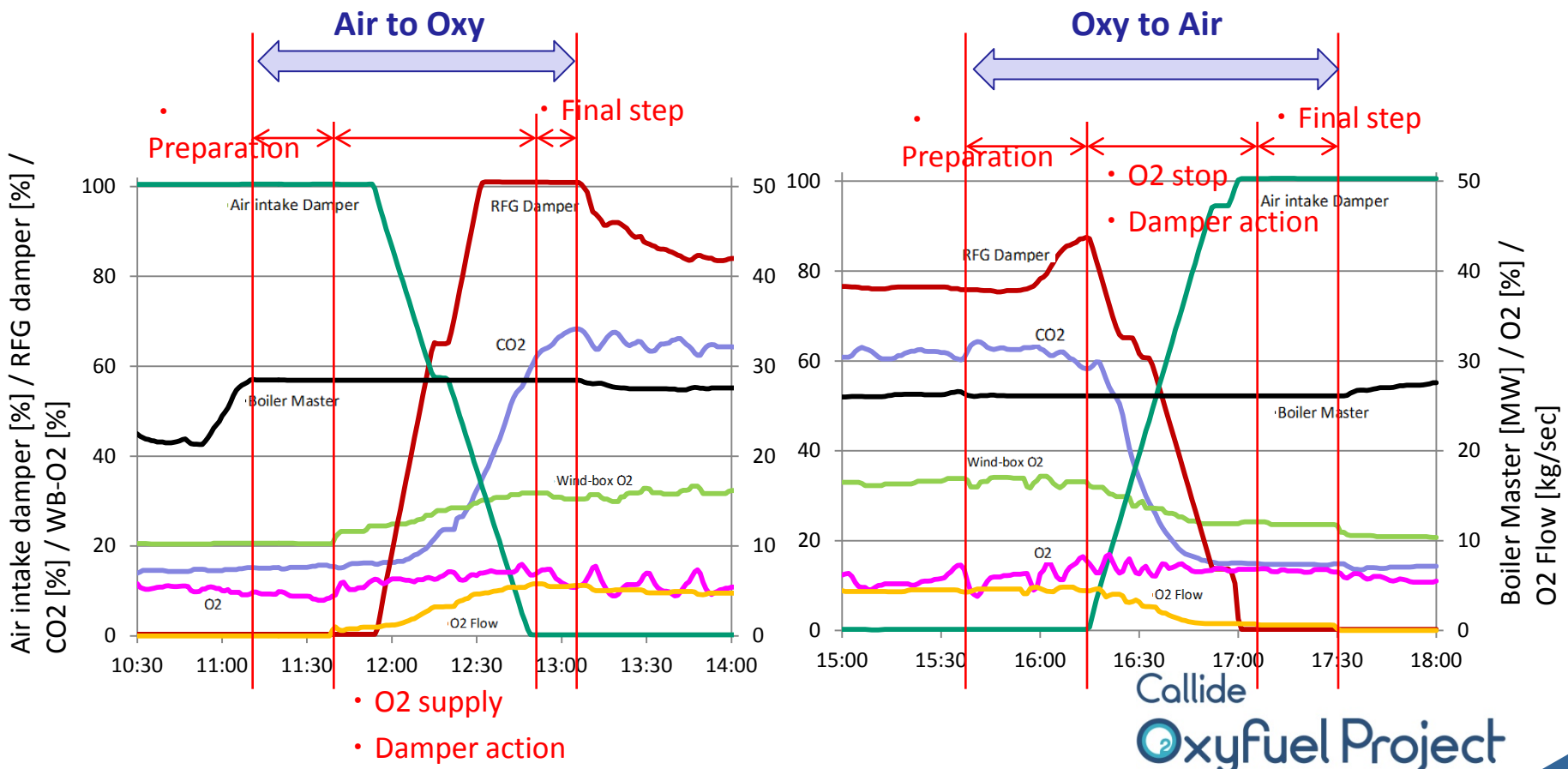
Combustion Mode Change

Mode change is smoothly operated.

> Boiler outlet O2 is almost constant during the mode change

> 1.5 – 2.0 hours is required for the mode change at this moment.



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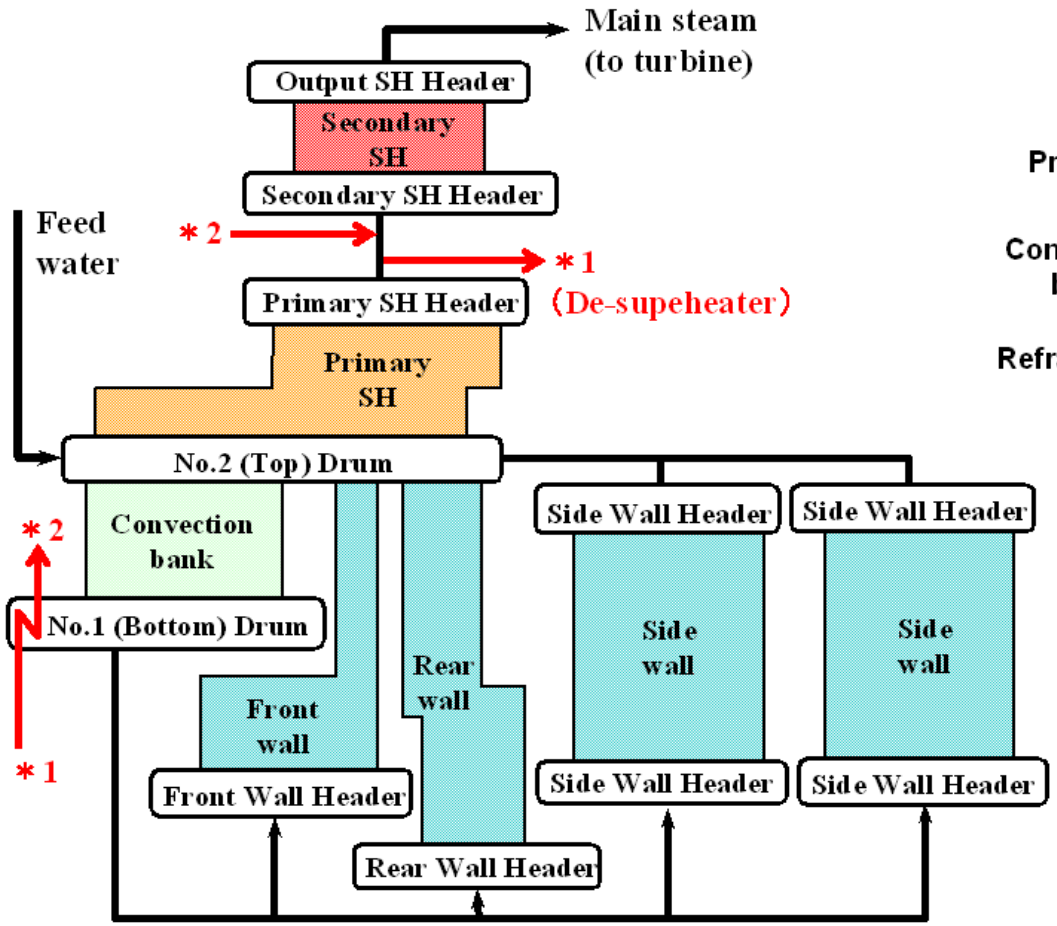
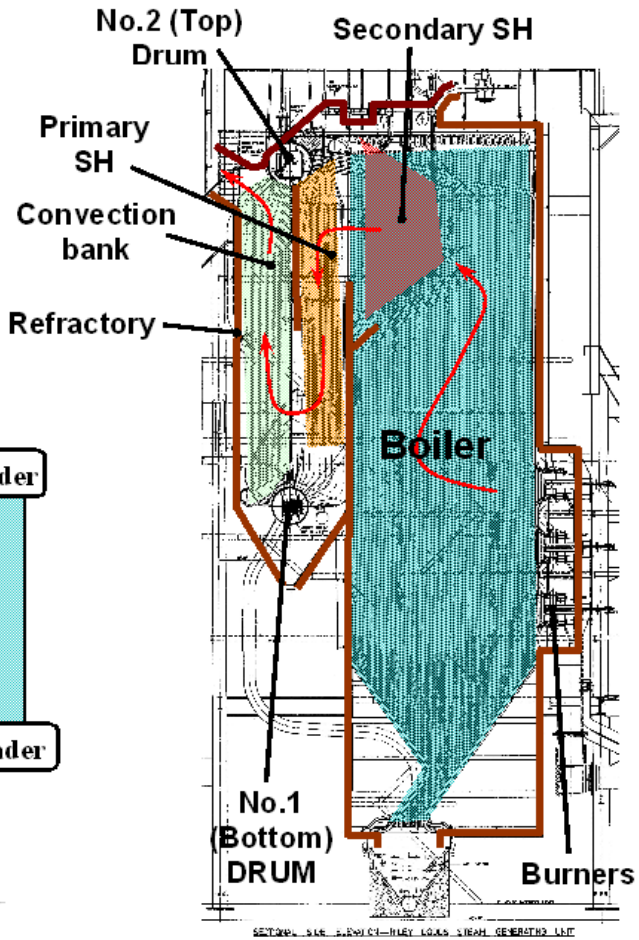
Boiler water & steam process and structure

Water and steam



Side elevation of boiler

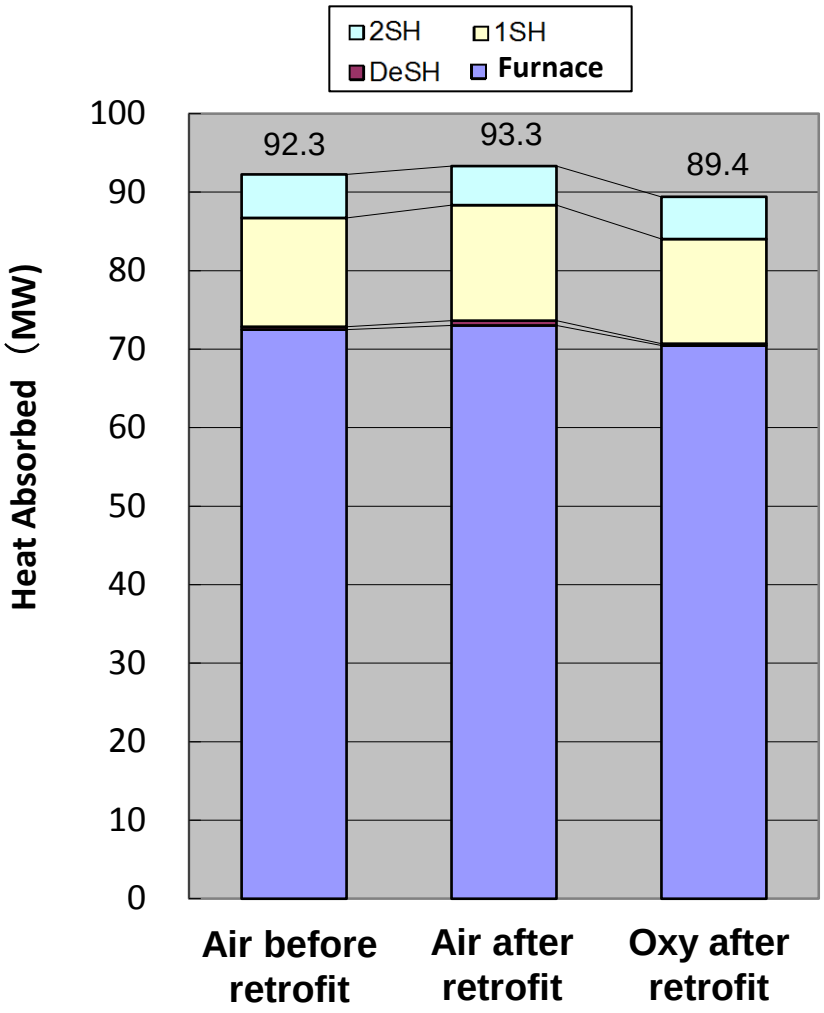


30MW operation

Heat balance of the boiler

Air : 30MW
Oxy : 30MW at inlet-O2 of 27%

- Heat absorbed in Oxy is 3 – 4 % smaller. This is because of the effect of heat recovery at FGLPH.
- The rage of heat absorbed at inlet-O2 of 27% is almost same with air.
  Furnace : 80%
  1SH + 2SH : 20%



> Heat absorbed at “Furnace” is included the convection bank.

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Operation range

Air Mode

> 18 to 30MW

> 3 patterns of mills & burners

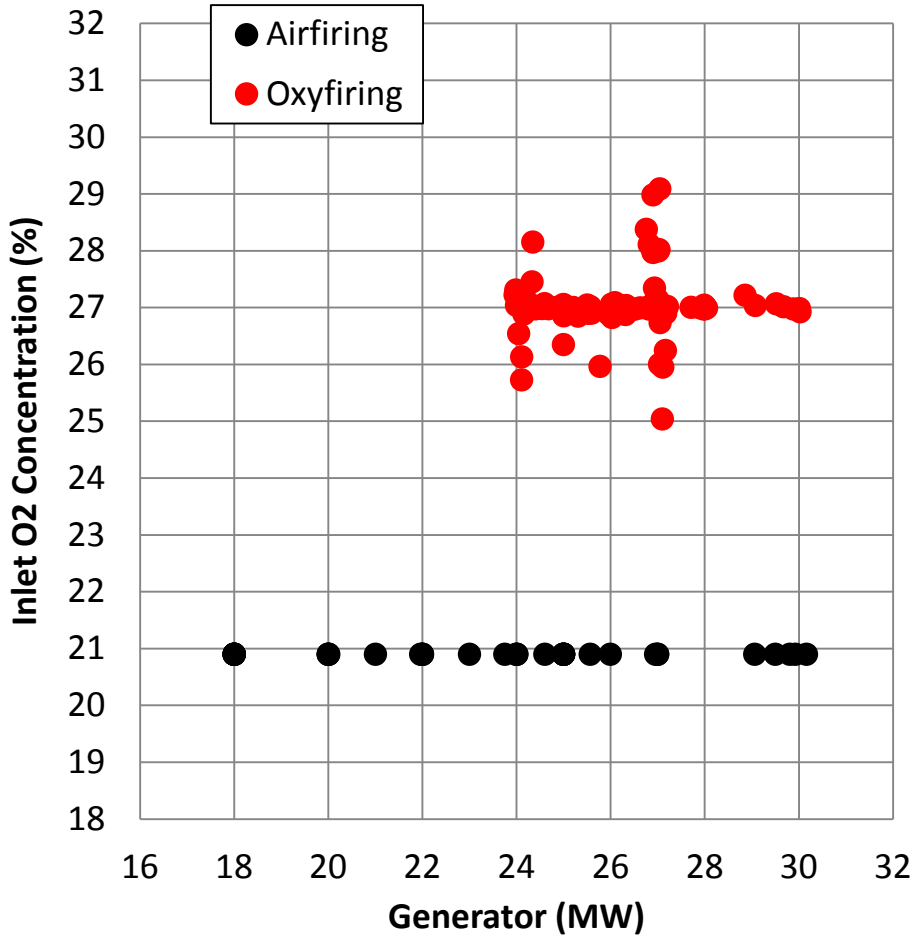
Oxy Mode

> 24 to 30MW

> 3 patterns of mills & burners

> Inlet O2 : 27 % at normal operation

> Various inlet-O2 at 27MW



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Coal

	Unit	Callide	Blend 1	Blend 2
Gross CV	MJ/kg, ar	17.28 – 19.12	20.59 - 21.91	19.04
Total Moisture	%, ar	12.2 – 14.1	11.5 – 12.7	11.8 - 12.5
Proximate				
Ash	%, ar	22.2 – 25.6	18.9 – 20.8	23.7 – 24.8
VM	%, ar	20.4 – 21.9	17.2 - 18.6	21.6 – 21.9
FC	%, ar	38.9 – 43.1	49.3 - 51.0	41.8 – 41.9
Ultimate				
C	%, daf	73.5 – 76.7	80.6 – 81.0	76.6 – 77.9
H	%, daf	3.52 – 3.85	3.76 – 3.84	4.12 – 4.30
N	%, daf	0.95 – 1.07	1.31 - 1.33	1.38 – 1.44
S	%, daf	0.31 – 0.41	0.38 – 0.42	0.41 – 0.42
O	%, daf	18.1 – 23.3	13.4 - 14.0	15.9 – 17.5

Callide coal is mainly used in the operation period and Blend 1 & 2 were used for trace elements measurement, December 2012.

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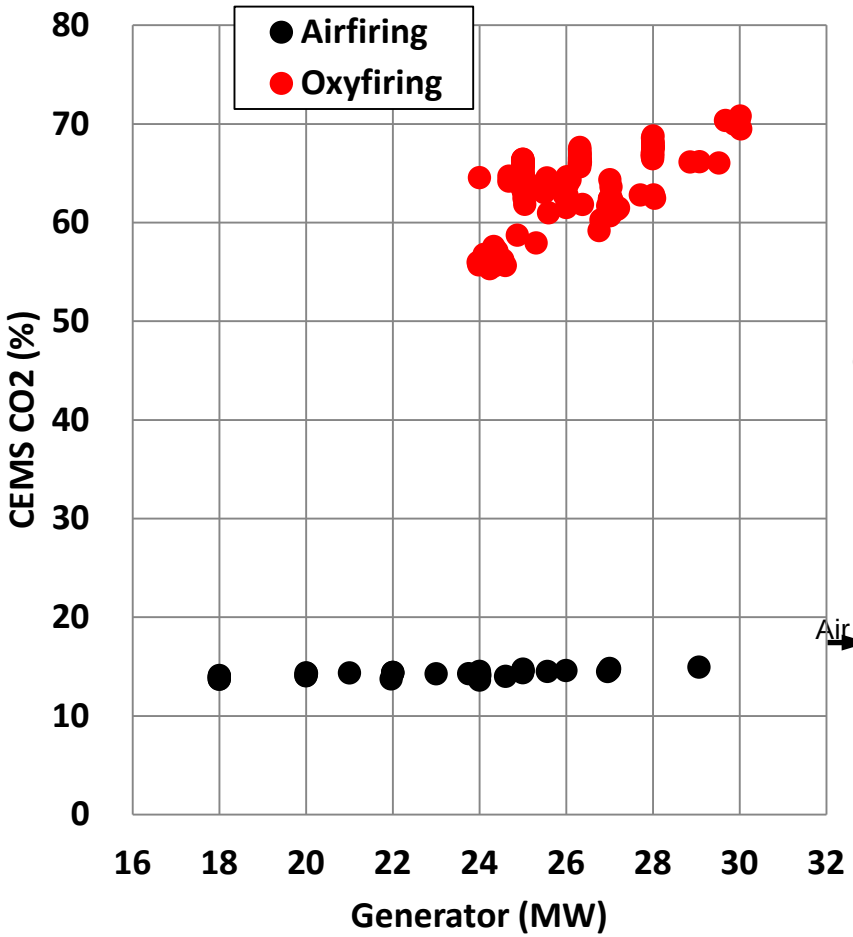
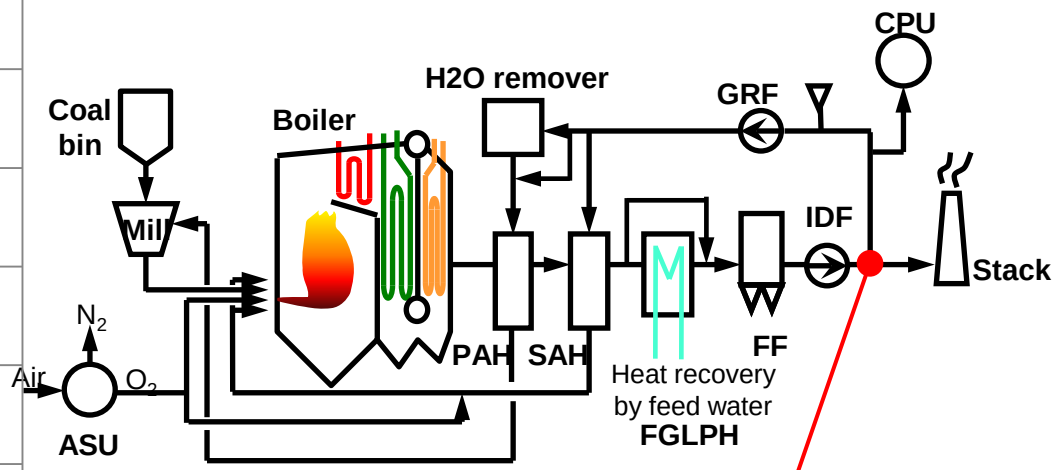
CEMS CO2 conc.



➢Achievement of target CO2 value with 70dry% at 30MW.



CEMS data (O2, CO2, H2O, NO, NO2, SO2, CO)

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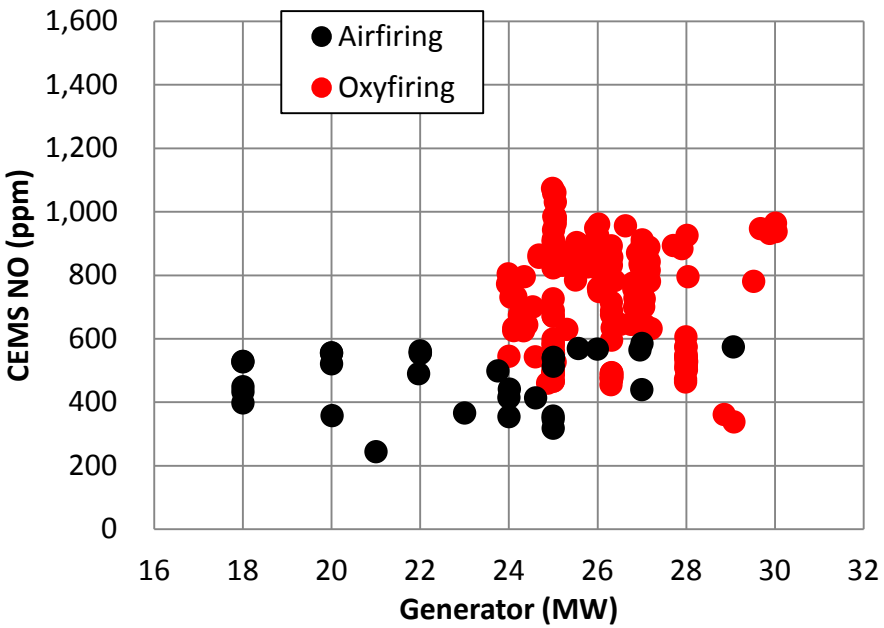
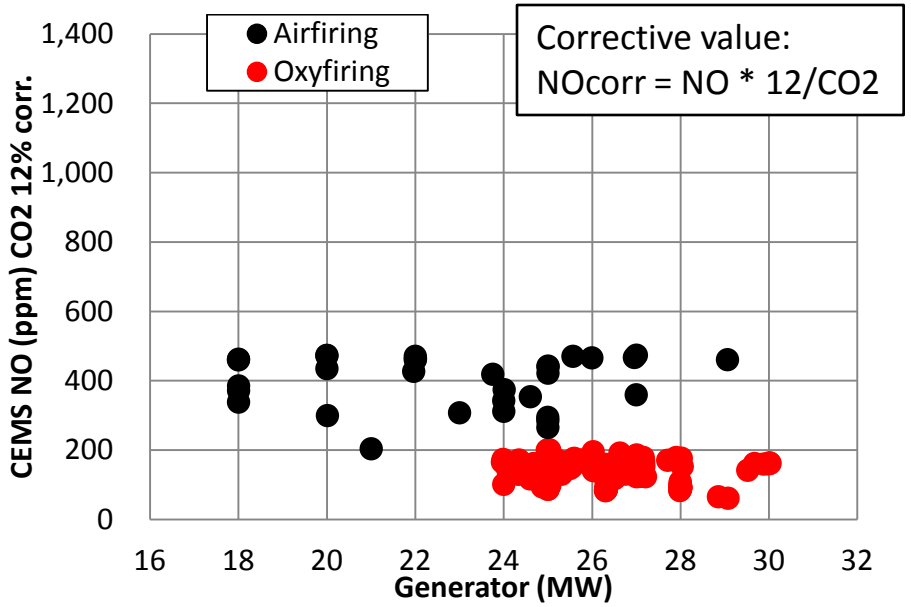
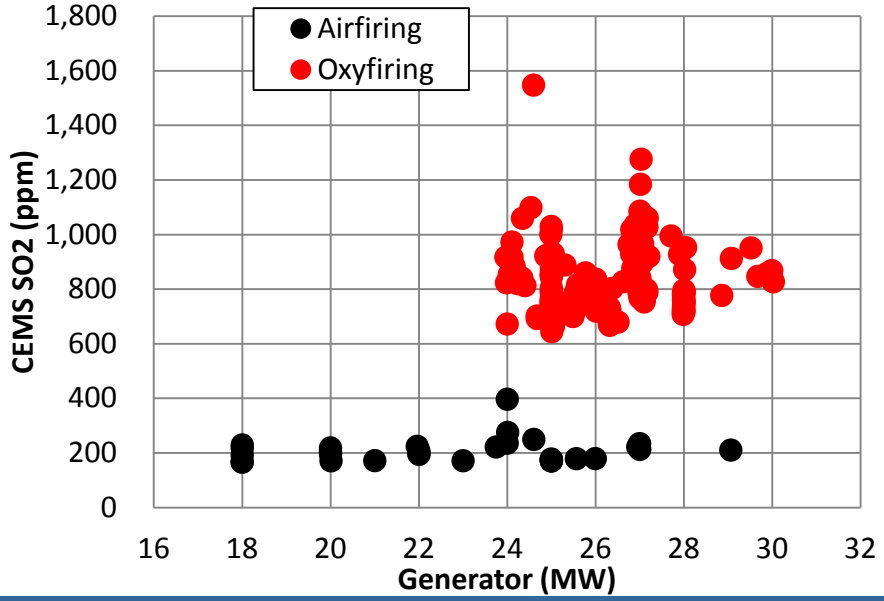
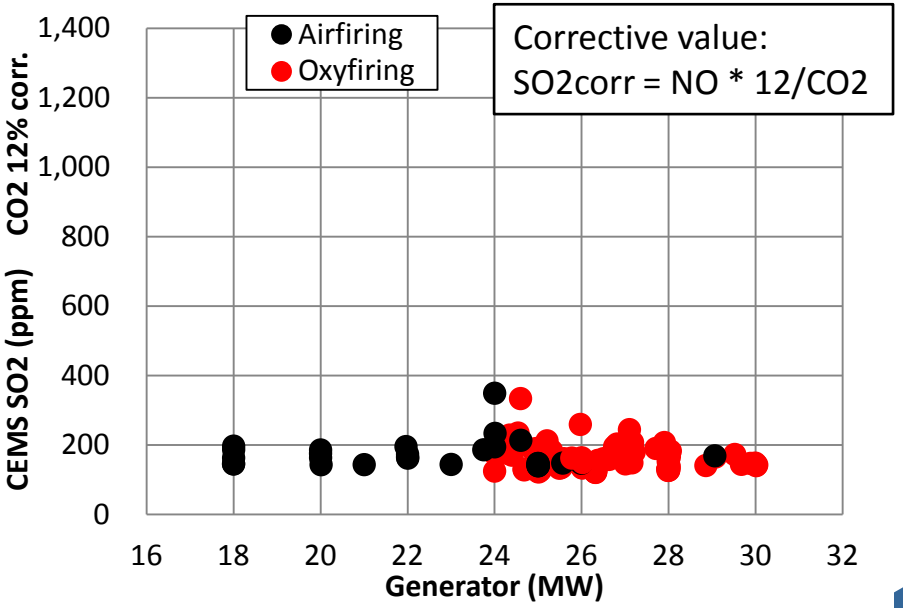
CEMS NO & SO2


Airfiring
Oxyfiring
CEMS NO (ppm)
Generator (MW)
0
200
400
600
800
1,000
1,200
1,400
1,600
16
18
20
22
24
26
28
30
32

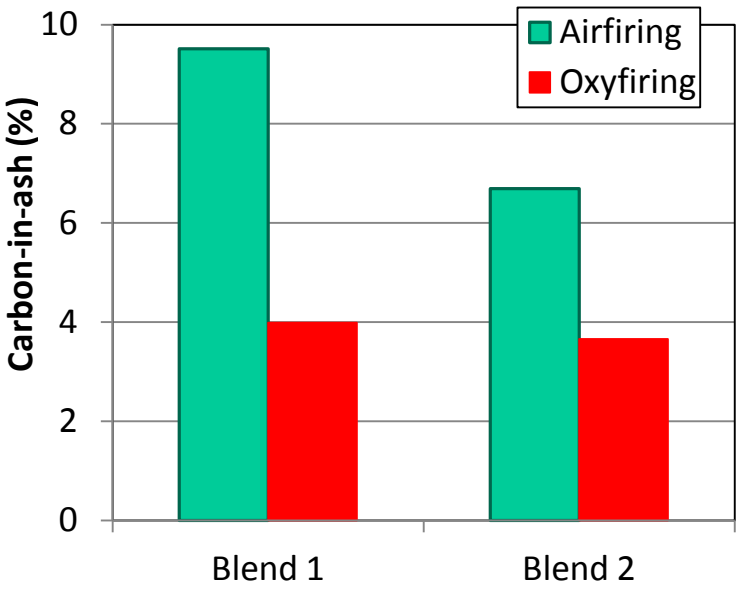

Airfiring
Oxyfiring
Corrective value:
NOcorr = NO * 12/CO2
CEMS NO (ppm) CO2 12% corr.
Generator (MW)
0
200
400
600
800
1,000
1,200
1,400
16
18
20
22
24
26
28
30
32

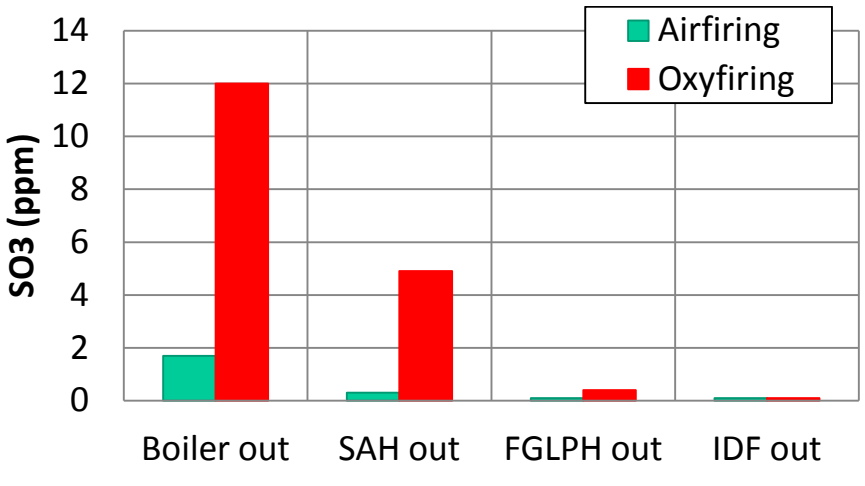

Airfiring
Oxyfiring
CEMS SO2 (ppm)
Generator (MW)
0
200
400
600
800
1,000
1,200
1,400
1,600
1,800
16
18
20
22
24
26
28
30
32

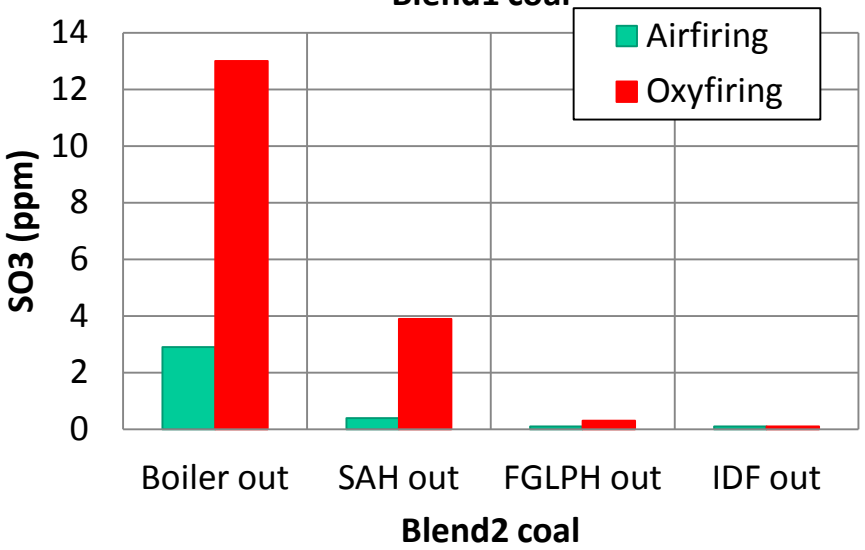

Airfiring
Oxyfiring
Corrective value:
SO2corr = NO * 12/CO2
CEMS SO2 (ppm) CO2 12% corr.
Generator (MW)
0
200
400
600
800
1,000
1,200
1,400
16
18
20
22
24
26
28
30
32

Carbon-in-ash & SO3 with various coal

> Ash weight average from 13 hoppers







- Lower carbon-in-ash at Oxy
- Product SO3 is higher at Oxy, however SO3 at IDF outlet is low enough.

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Summary of oxyfuel operation

- Reliable mode change was achieved.
- Achievement of 30MW operation. Heat balance in the boiler is almost same with air. And the amount of heat absorbed in Oxy is smaller, due to the heat recover at FGLPH.
- CO2 conc. is over 70% at 30MW and is more than targeted value.
- NO in Oxy is decomposed, due to the recirculation.
- Carbon-in-ash in Oxy is lower, due to longer residence time
- SO3 in Oxy is much higher at boiler outlet, however SO3 after fabric filter is less than Detection level.

Most of results of heat absorbed and combustion characteristics are almost same with the results at furnace simulation and pilot-scale combustion test.

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Future test plan

- Turn-down test of the boiler
- Shorten the time for mode change
- Exposure test of tube material in the furnace
- In-furnace measurement
- Direct-O2 injection test
- Inspection

Concluding comment

- Callide Oxyfuel Project is invaluable opportunity to gather the data and know-how of oxyfuel boiler operation to realize CO2 capture technology and we have to obtain and analyze them towards the commercialization of this technology together with Project Participants.

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Callide Oxyfuel Project – Participants

Oxyfuel Project Partners

CS energy

xstrata coal

IHI

AUSTRALIAN COAL ASSOCIATION LOW EMISSION TECHNOLOGIES

Schlumberger

J POWER EPDC

MITSUI & CO., LTD.

Australian Government

Queensland Government

METI Ministry of Economy, Trade and Industry

Supporting Collaborator

JCOAL Japan Coal Energy Center

Thank you!

for more information: www.callideoxyfuel.com

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