Asia-Pacific Partnership on Clean Development & Climate

Update on the activities of the APP Oxy-fuel Working Group (OFWG)

Professor Terry Wall

OFWG Project Leader and
University of Newcastle, Australia

Workshop on oxy-fuel technologies,
Grand InterContinental, Seoul, Korea,
Tuesday, March 31, 2009

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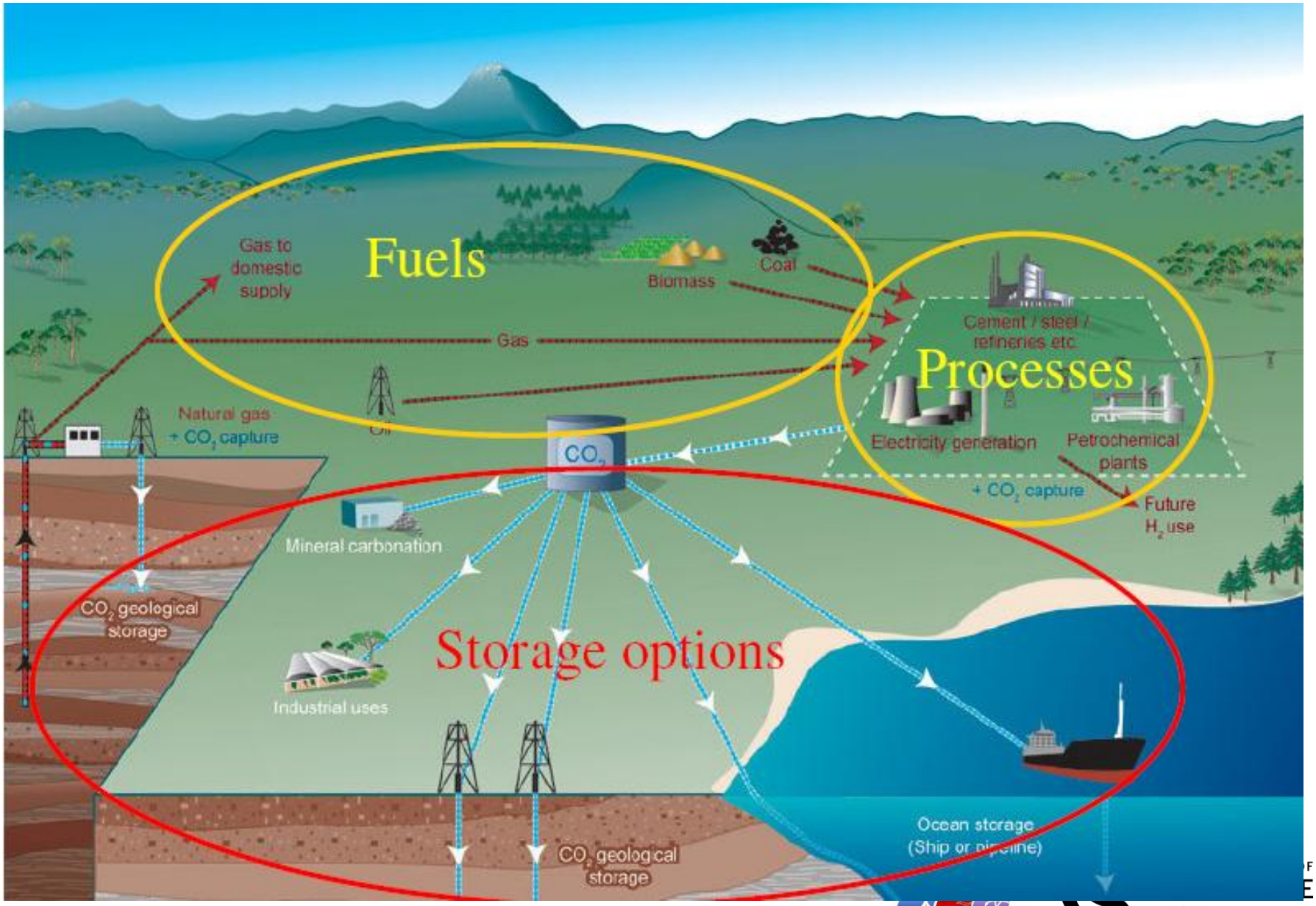
Low Emission Coal Technologies



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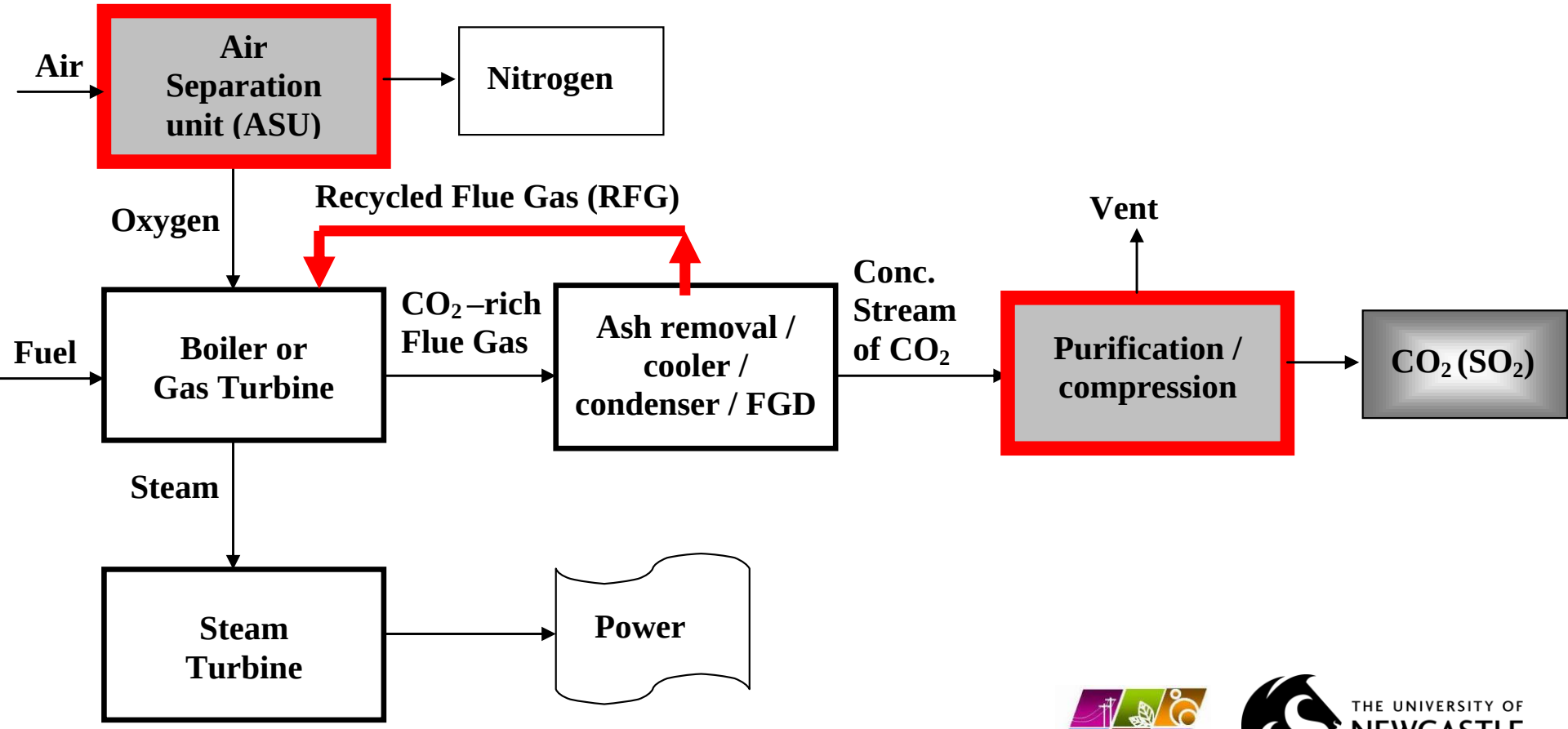
Oxy- fuel



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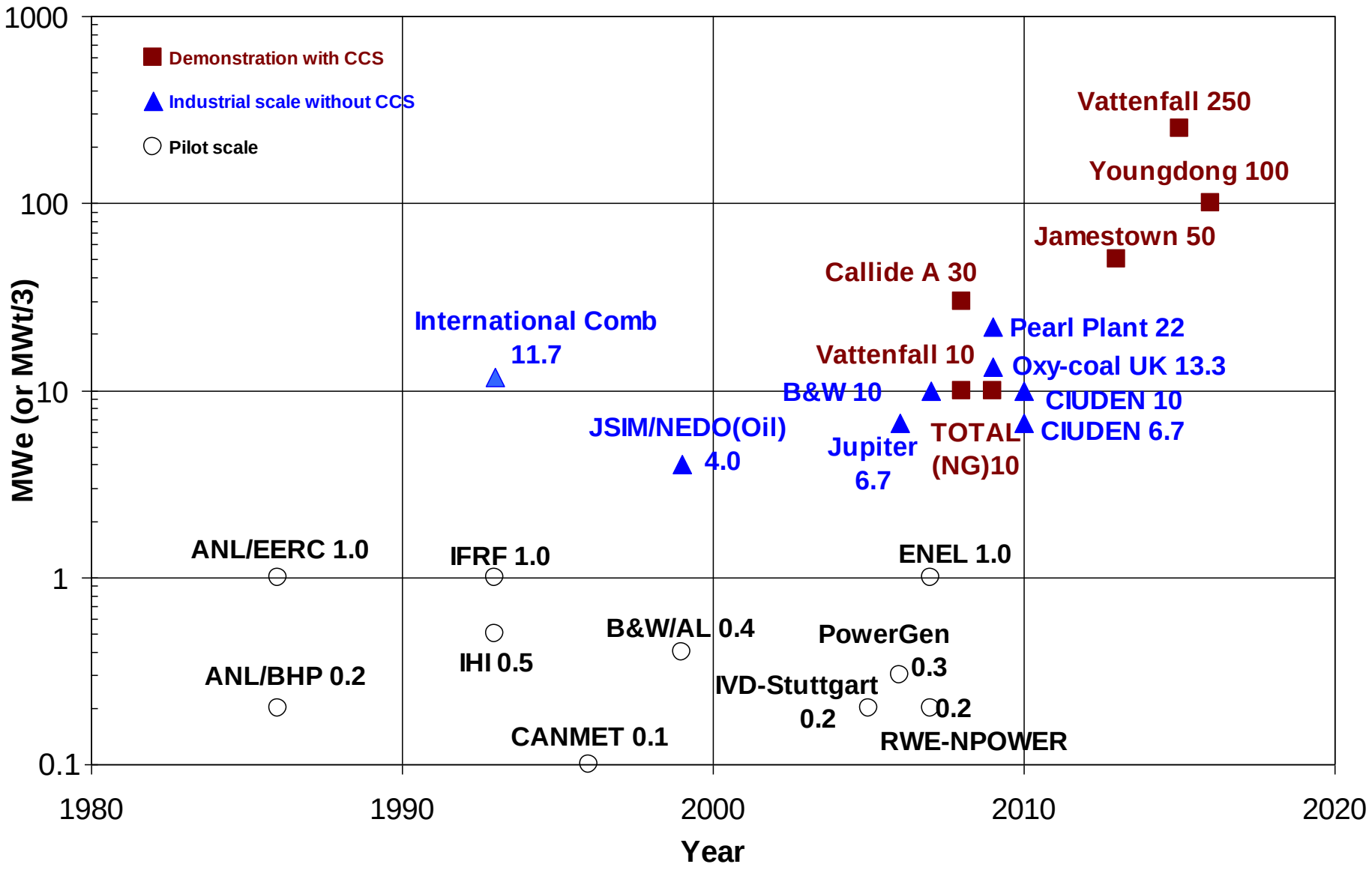
CCS options, with desirable characteristics indicated X

Option	Demonstrated	For retrofit	Can be applied to slip-stream	No O_2 supply	No CO_2 capture	Gives H_2
PCC		X	X	X		
IGCC-CCS						X
Oxyf		X			X	

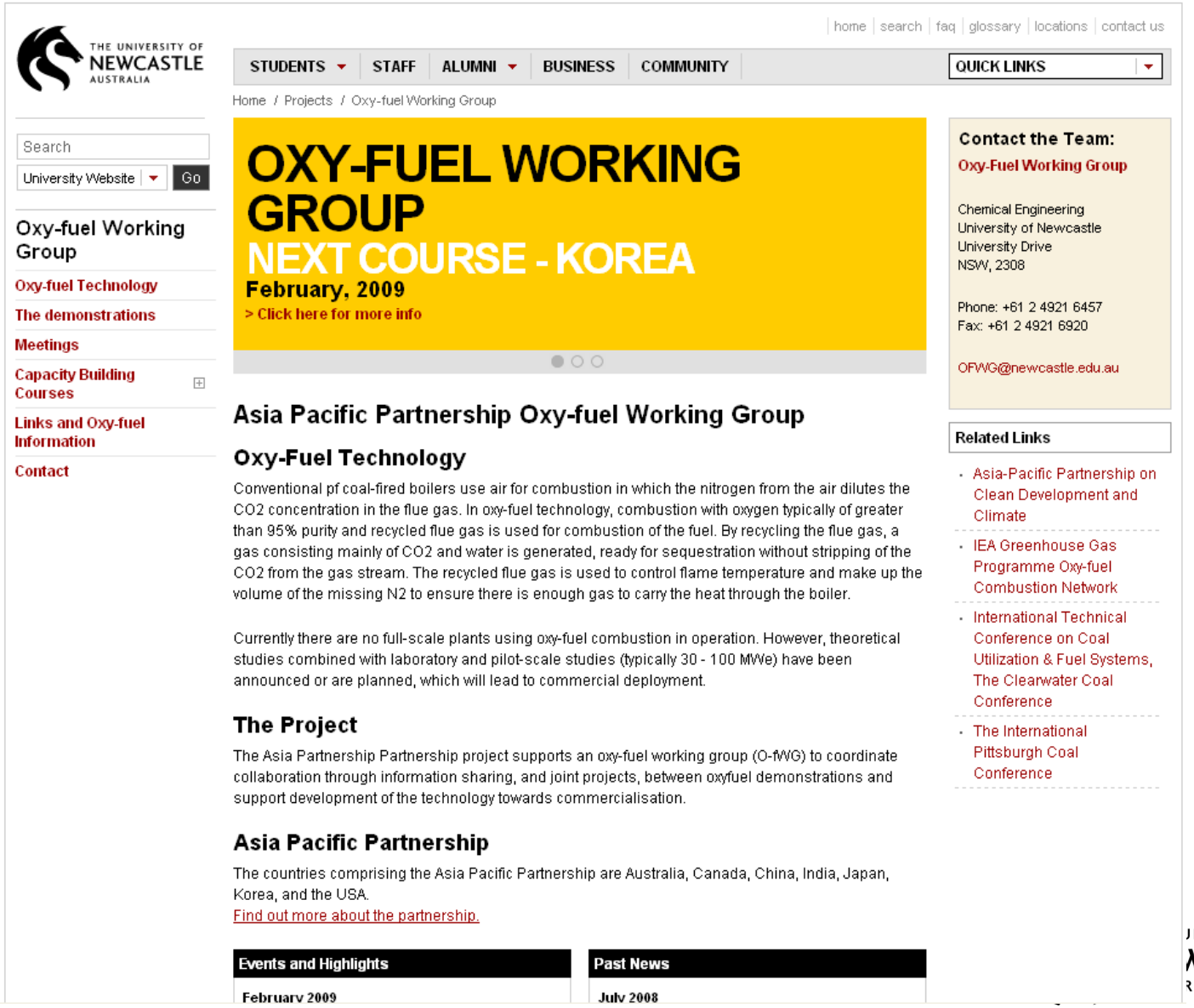
Historical development of oxyfuel technology



Current demonstrations

No	Demo/pilot-plant name	Scale (Demo/Pilot plant)	MW e	New Retrofit	Startup/ Duration	Main Fuel	Electricity generation Yes/No	CO_2 Compression (Yes/No)	CO_2 use/Seq	CO_2 purity	Gas clean up
1	Vattenfall pilot plant, Germany	P (PC)	10	N	2008	Coal	N	Y	Y (partial by truck)	99.90%	SCR ESP
2	Callide (CS Energy, Australia)	P	30	R	2010	Coal	Y	Y	N		FF
3	TOTAL, Lecq, France	P (Industrial)	10	R	2009	NG	Y	Y	Y	99.90%	FGD
4	CIUDEN, Spain	P (PC/CFB)	10	N	2010	Coal		Y	N		SCR FF
5	Youngdong, South Korea	D	100	R	2016	Coal	Y		Y		
6	Jamestown/Praxair Plant, USA	CFB	50	N	2013	Coal	N	N			
7	Jupiter Pearl plant, USA	P	22	R	2009	Coal	N	N			
8	Babcock&Wilcox pilot plant, B&W, USA	P	10	R	2008	Coal	N		N	70% dry	SCR FF
9	Doosan Babcock, UK	P	30	NA	2008	Coal	N		N		

http://www.newcastle.edu.au/project/oxy-fuel-working-group/



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Oxy-fuel Working Group

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OXY-FUEL WORKING GROUP

NEXT COURSE - KOREA

February, 2009

> Click here for more info

Asia Pacific Partnership Oxy-fuel Working Group

Oxy-Fuel Technology

Conventional pf coal-fired boilers use air for combustion in which the nitrogen from the air dilutes the CO2 concentration in the flue gas. In oxy-fuel technology, combustion with oxygen typically of greater than 95% purity and recycled flue gas is used for combustion of the fuel. By recycling the flue gas, a gas consisting mainly of CO2 and water is generated, ready for sequestration without stripping of the CO2 from the gas stream. The recycled flue gas is used to control flame temperature and make up the volume of the missing N2 to ensure there is enough gas to carry the heat through the boiler.

Currently there are no full-scale plants using oxy-fuel combustion in operation. However, theoretical studies combined with laboratory and pilot-scale studies (typically 30 - 100 MWe) have been announced or are planned, which will lead to commercial deployment.

The Project

The Asia Partnership Partnership project supports an oxy-fuel working group (O-fWG) to coordinate collaboration through information sharing, and joint projects, between oxyfuel demonstrations and support development of the technology towards commercialisation.

Asia Pacific Partnership

The countries comprising the Asia Pacific Partnership are Australia, Canada, China, India, Japan, Korea, and the USA.
Find out more about the partnership.

Events and Highlights

February 2009

Past News

July 2008

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Related Links

- Asia-Pacific Partnership on Clean Development and Climate
- IEA Greenhouse Gas Programme Oxy-fuel Combustion Network
- International Technical Conference on Coal Utilization & Fuel Systems, The Clearwater Coal Conference
- The International Pittsburgh Coal Conference

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OFWG project areas from Yokohama 2008 meeting

A survey of some OFWG members and discussion resulted in four project areas to be progressed by the OFWG, with some points made, these being, in order of support indicated by PLs:

Regulations. CO2 quality for geological storage. Stack (flue gas) emissions during operation – ppm or gm/MJ. Gas missions from compression operations

Plant specification guidelines. Plant design and operation

Safety. Materials for high O2 environments.Higher O2 streams safety requirements, >23%O2. Explosions less possibility with O2/CO2 than O2/N2.O2 injection into ash streams with ash containing unburnts

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OFWG: current action list

- Technology status report
- Roadmap
- Capacity building courses
- Projects

    Regulations

OFWG: events, conference involvement and milestones

Hosted the OFWG meeting in Yokohama in February 2008

Participated as keynote speaker in the International Oxy-fuel Combustion Seminar and Workshop in Daejeon , Korea, on August 27-29, 2008

Conducted an Oxy-fuel capacity building course for ~ 60 delegates from South-East Asian countries in Korea in February 2009.

March 2009, chair an Oxy-fuel Workshop at the APP Cleaner Fossil Energy Task Force meeting in Seoul, Korea

May 2009, chair the oxy-fuel panel session of the Clearwater Coal Conference in Florida

Member of organising group of the IEA Oxy-fuel Conference to be held at Cottbus, Germany, in September 2009

Prepare status report and roadmap, address issues delaying deployment at OFWG in Cottbus, September 2009

The OFWG will prepare material for an IEA Clean Coal Centre report on Oxy-fuel Technology Status to be published late 2009

Technology status and roadmap report

….in conjunction with IEA CCC

IEA CLEAN COAL CENTRE

Work Programme

Carbon abatement — In progress

Oxyfuel combustion based capture of carbon dioxide

Robert Davidson

This report will be a review of the status of oxyfuel based CO_2 capture, to be produced in co-operation with the IEA Greenhouse Gas R&D Programme and published to both sets of members.

Oxyfuel combustion with CO_2 capture is one of three generic routes to CO_2 capture. It can be used for both new plant and for retrofit. The latter could be important as an option to offset the carbon lock in that is likely to otherwise occur in the next decade.

Oxyfuel combustion is based on combustion of coal in oxygen with recycle of some of the boiler effluent gas stream to attemperate conditions in the boiler. There has been much research in recent years and the first small demonstration-scale projects are about to come on stream. Several well-known equipment manufacturers are investing heavily in the RD&D, as are some well-known utilities.

Basic research is looking at the properties of the CO_2 stream, particularly the effects of contaminant compounds of sulphur, nitrogen and the effects of mercury. There is a trade-off between purity of oxygen supply and CO_2 product stream. Heat transfer and boiler modelling have influenced designs. There is also considerable investigation into alternative ways of using oxyfuel combustion such as chemical looping.

The first OFWG course

Contributing lecturers

Researchers:
Prof Terry Wall, Dr Jianglong Yu, APP; University of Newcastle, Australia
Dr Stanley Santos, IEAGHG, England
Dr Joerg Maier, University of Stuttgart, Germany
Demonstration proponents:
Dr Sung-chui Kim KEPRI, Korea
Dr Gerry Hesselmann, Doosan Babcock, Scotland
Technology provider:
Yongkyoo Han, Praxair, Korea
Country presentation:
Professor Ningsheng Cai, Tsinghua University, China

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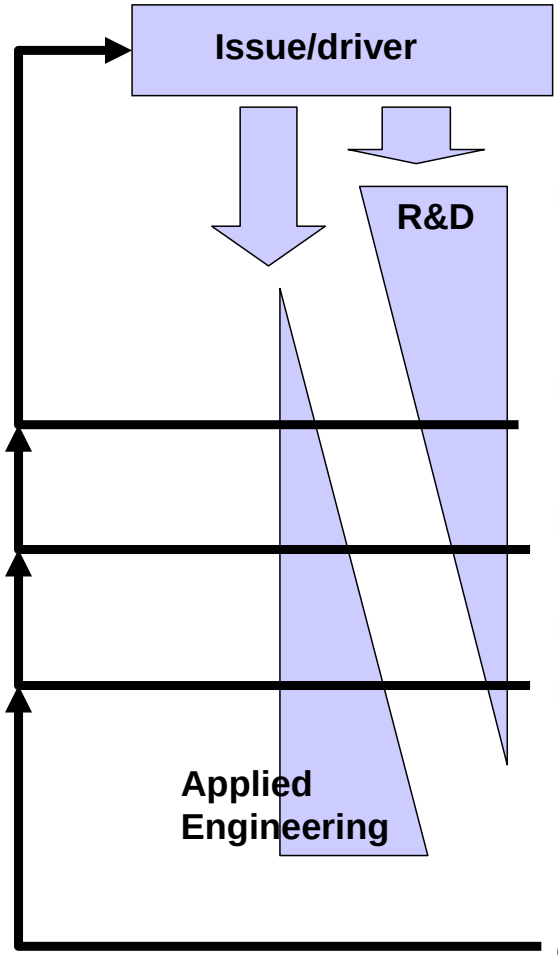
Status report:
Pathway and drivers of technological development of oxyfuel combustion technology



Research

Scientific Understanding

Concept development

Laboratory testing

Concept validation

Pilot testing

scaling , commercial understanding,

Demonstration

Commercial Validation

Technical validation

Performance assessment

Commercial deployment

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Scales for deployment

Laboratory Scale:

Research that investigates and aims to discover fundamental relationships or test new ideas through experiments and measurements at a small scale.

Pilot Scale

Research undertaken to optimise processes and provide design, process and cost related scale-up rules for application at commercial scale.

Pre-Commercial Demonstration

First-of-a-Kind (FOAK) plant deployed at Commercial or near Commercial scale where design, process and cost models can be validated for future application in commercial markets.

Commercial Scale

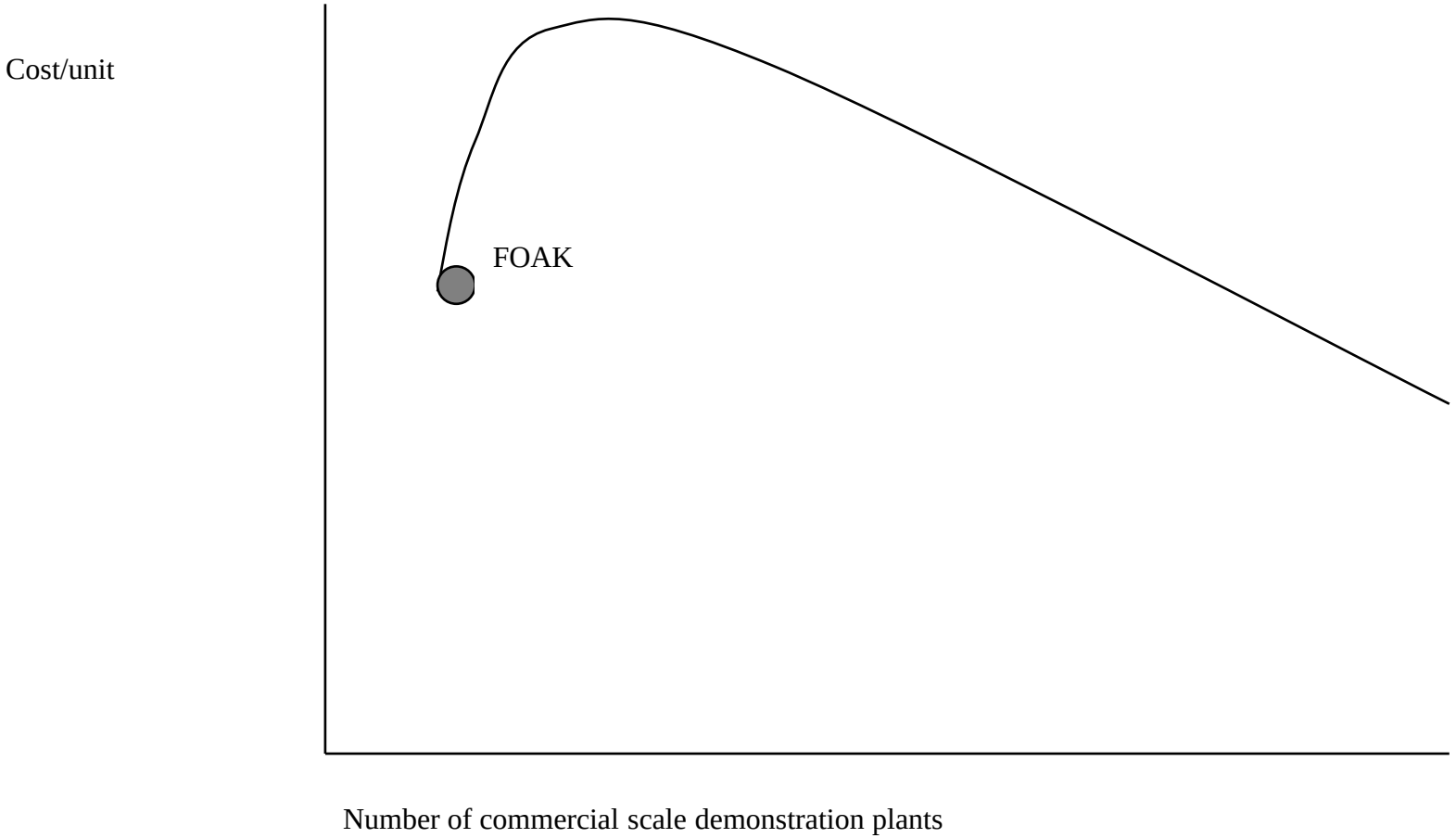
Deployment that is motivated by commercial investment and operates competitively in a fully commercial market

IEA and G8 Workshop recommendation

"The G8 must act now to commit by 2010, to a diverse portfolio of at least 20 fully integrated industrial-scale demonstration projects (>1 Mtpa), with the expectation of supporting technology learning and cost reduction, for the broad deployment of CCS by 2020".

http://ccsassociation.org.uk/docs/2007/Press release on G8 workshop 29 Nov 2007.pdf

Typical development of the cost of a technology from first-of-a- kind (FOAK) plant to commercial deployment



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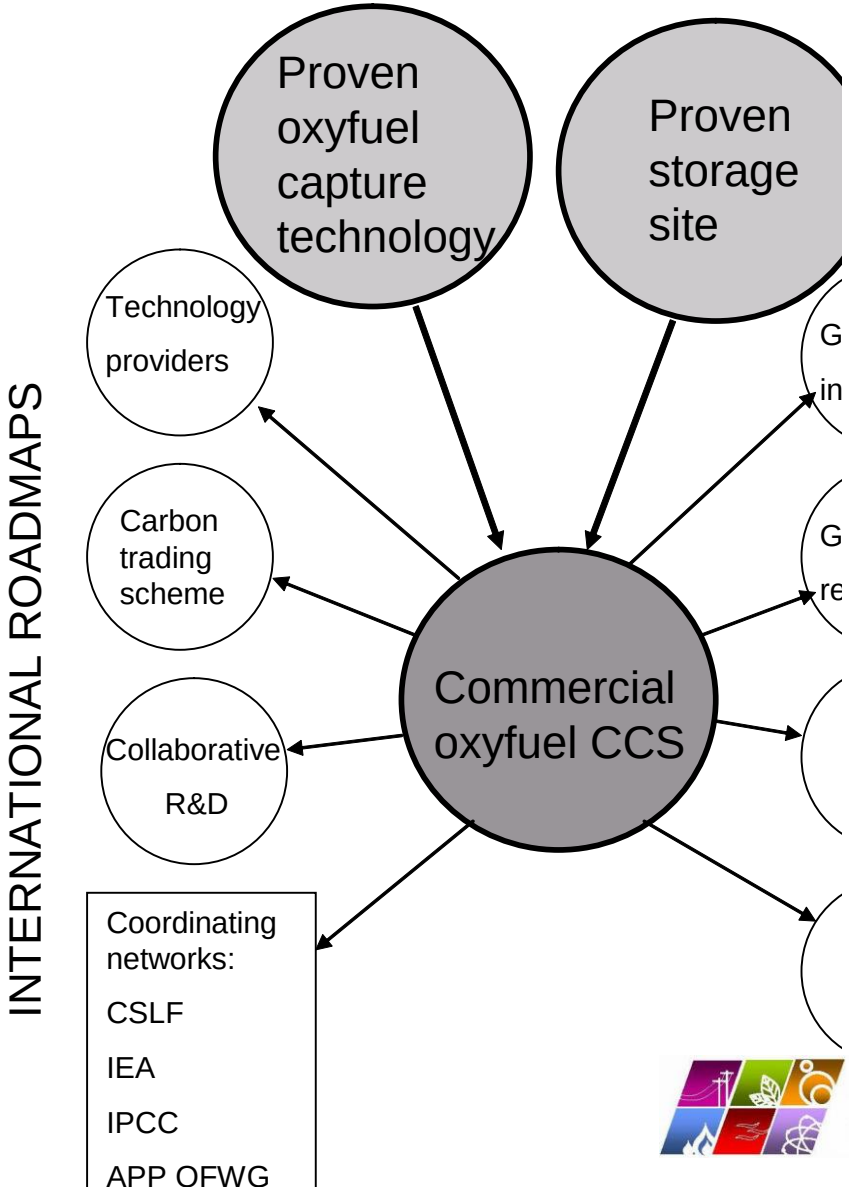
Project components and sequence: Low emission coal power plant with geosequestration, based on a 500MW plant, time halved for 50 MW demonstration

Time, yrs	Power plant, PP	CO2 disposal geology	Permitting
Phase 1 1-2	Concept, pre-feasibility and site selection – cost 1% of PP project	Basin scoping, exploration and appraisal-<$100M	Access to land, exploration licence
Phase 2 2-3	Feasibility and FEED (Front-End Engineering and Design) - 5%	Site validation and feasibility- <$250M	Environmental impact statement. Permitting process and times very location dependant
Phase 3 3-4	Financial close, construction and commissioning - 95%	Storage site and injection licence confirmed	

Roadmaps involved which lead to a commercial oxyfuel CCS plant



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Roadmaps in the literature

Canada's CO2 Capture and Storage Technology Roadmap

(www.co2trm.gc.ca)

CURC/EPRI Roadmap

(http://www.coal.org/UserFiles/File/Roadmap.pdf)

"Clean Coal Technology Roadmap", CURC/EPRI/DOE Consensus Roadmap

(http://www.netl.doe.gov/technologies/coalpower/cctc/ccpi/pubs/CCT-Roadmap.pdf)

UK Energy Research Centre, CO2 Capture and Storage Roadmap

(http://ukerc.rl.ac.uk/Roadmaps/CarbonCapture/CCS_road_map_workshop_Aug08.pdf)

Cleaner power in India: Towards a Clean-Coal Technology Roadmap, pp173-193

(http://belfercenter.ksg.harvard.edu/files/Chikkatur_Sagar_India_Coal_Roadmap.pdf)

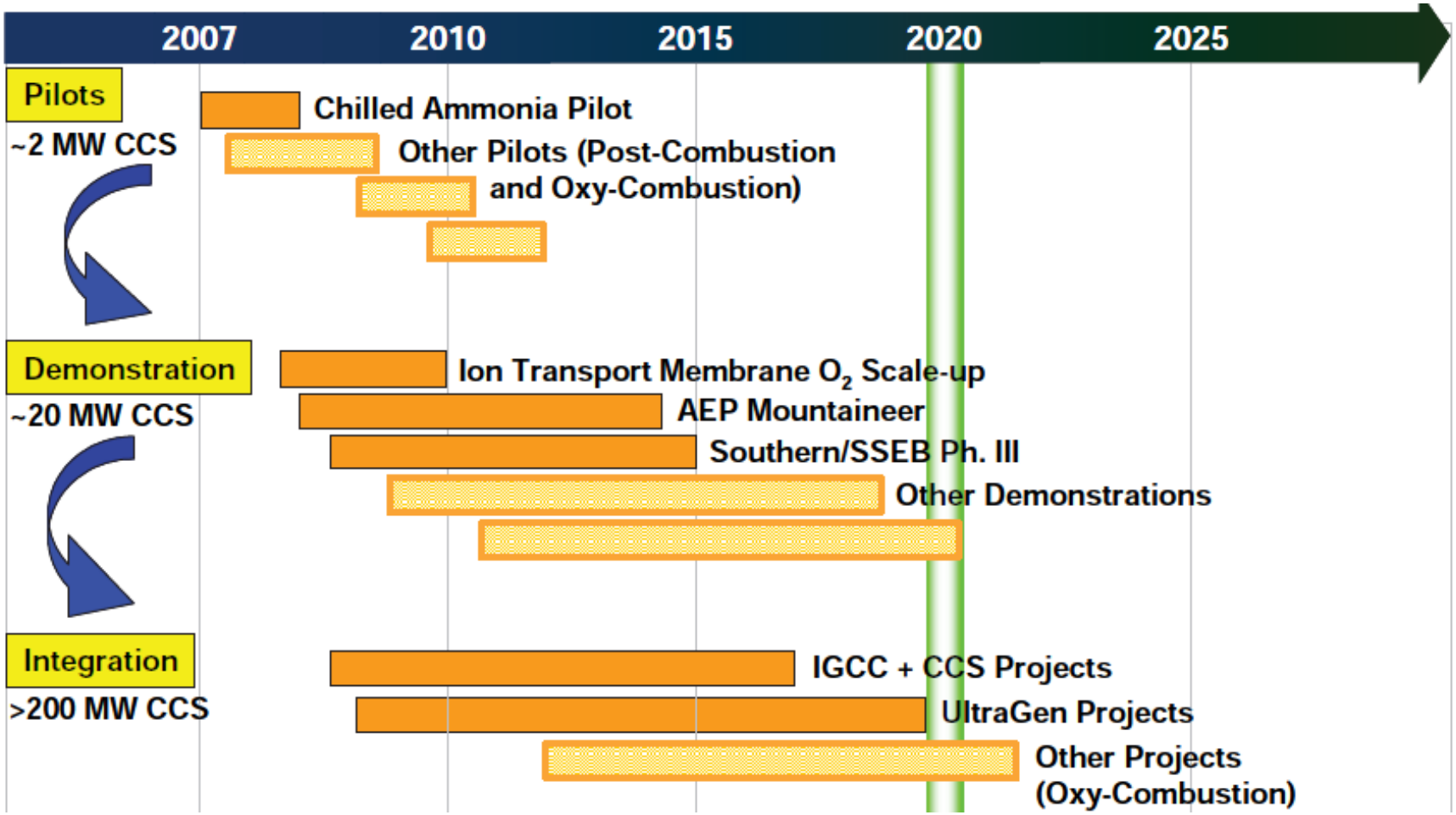
IEA Greenhouse Gas R&D Programme: Review of CO2 capture technology roadmap for power Generation industry

(http://www.ieagreen.org.uk/presentations/SSRoadmap.pdf)

Australia's CCS Technology Roadmap

(http://www.cslforum.org/documents/SaudiArabia/T2_3_CSLF_PJC_DVP_Australia_Jan08.pdf

CCS roadmap for US (Parkes, Maxson et al. 2008) (Novak 2007)



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Times of targets and milestones

Related deployment targets

By 2020 - Improved efficiency of PF plants by more severe steam conditions, such that efficiencies for oxyfuel with capture reaches 42-44% HHV, similar to PCC and IGCC

By 2022 – Commercial availability of CO2 storage, with new coal plants capture and storing 90% of CO2

By 2030 – Further improvement in efficiencies with CCS, > 45% HHV

Related regulatory milestones

By 2014 – Regulatory framework established to allow permitting process to proceed for demonstrations to be operating by 2020

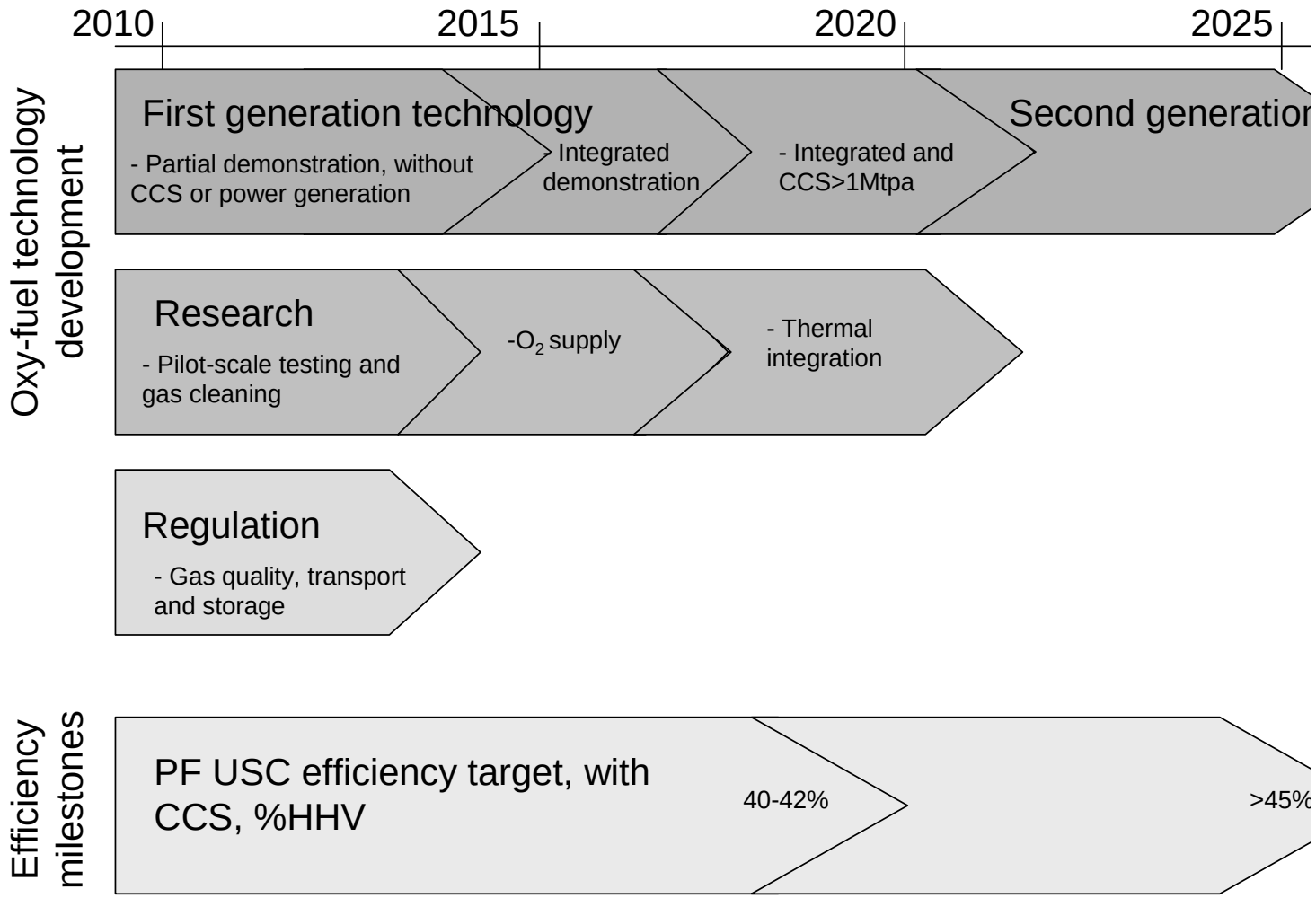
Related research milestones

By 2014 – Gas cleaning technology to meet regulatory requirements for CO2 transport and storage

After 2016 – Alternative oxygen supply technology to ASU such as membranes and chemical looping demonstrated at scale

After 2020 – Second generation oxyfuel plant applied using learnings from first generation demonstrations

Simplified roadmap to deployment of first-generation oxyfuel technology – to be developed further



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