Utilization of Low Rank Coal for Power Generation

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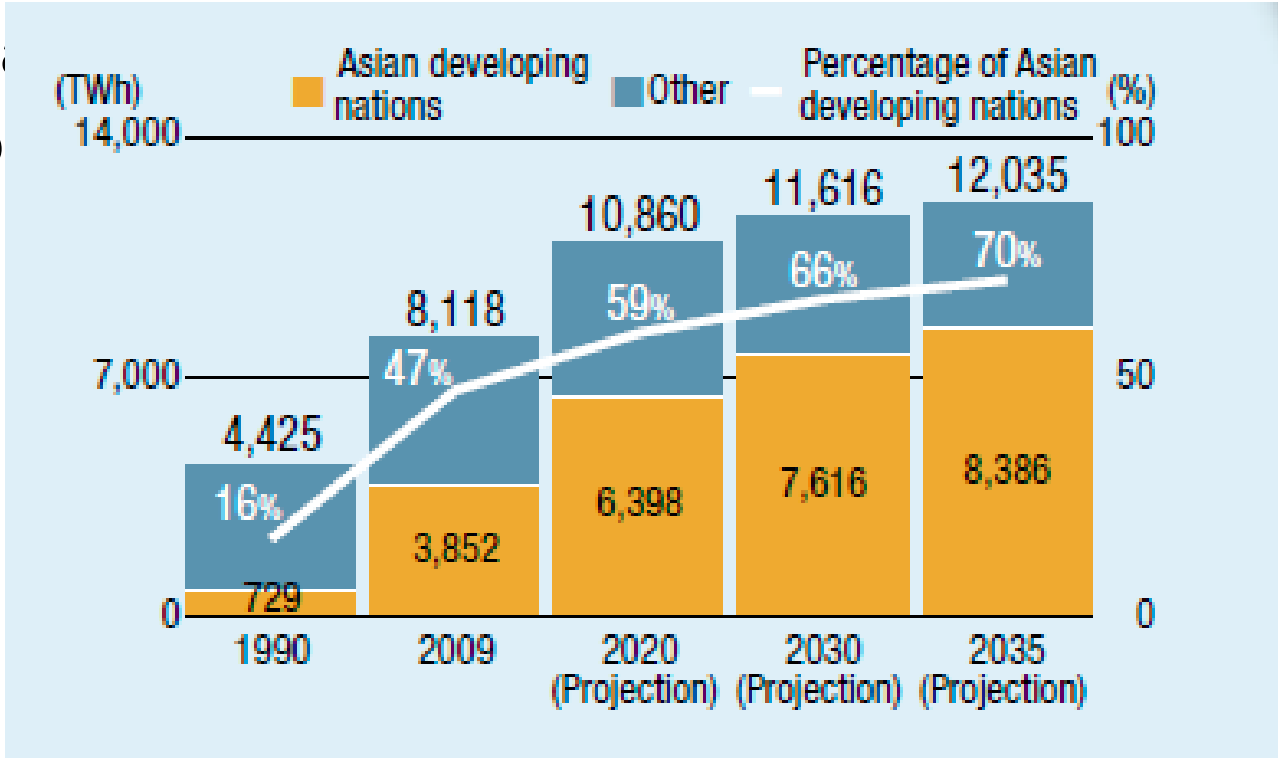
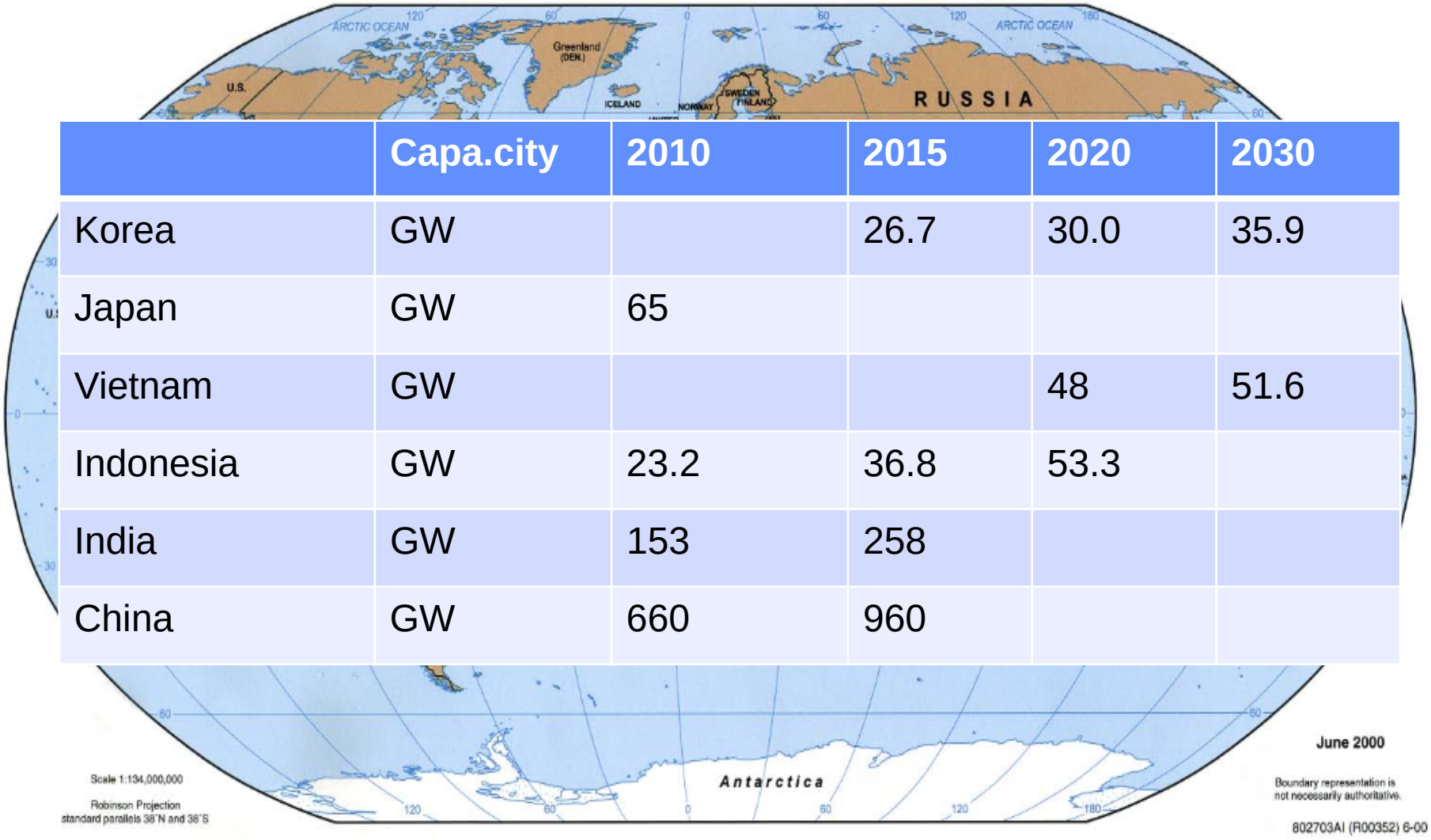
Coal Power Planning

- **Demand increasing hard coal market**
- **Utilization of low rank coal increased**
- **Sh e**
- **Co cted**



Coal power plans of Asian countries



	Capa.city	2010	2015	2020	2030
Korea	GW		26.7	30.0	35.9
Japan	GW	65			
Vietnam	GW			48	51.6
Indonesia	GW	23.2	36.8	53.3	
India	GW	153	258		
China	GW	660	960		

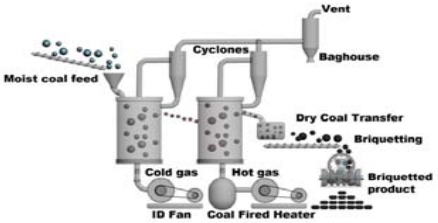
Deposit of coal

M/T	Bituminous/semi-Anthracite	Sub-Bituminous/ Brown	Total
World	509491	474720	984211
North America	116707	139770	256477
S. & Cent. America	7839	13735	21574
Europe	41664	80368	122032
Former Soviet Union	97476	132707	230178
Africa	61162	250	61412
Mid. East	193	-	193
Australia	47300	43100	90400
China	62200	52300	114500
India	72733	2000	74733
Indonesia	770	4450	5220

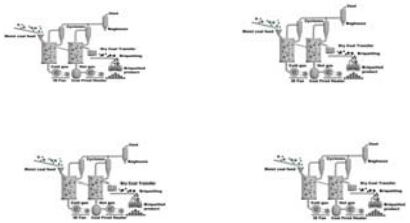
UPGRADING LRC

- **Handling problems with LRC**
  - **Pulverizer stick**
  - **Hopper stay**
  - **Screw feeder plugging**
  - **Low ash fusion temperature IDT~1055°C**
  - **Latent heat loss by High coal moisture**
  - **Self ignition in storage**
- **Remove moisture, ash and Mineral sulfates**

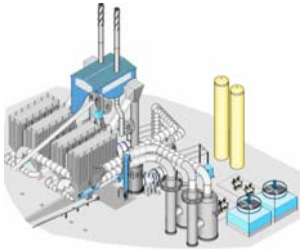
Brown coal upgrading



1000 ton/day



250,000 ton/y unit X 4 units



1MTon/y facility

Dewatering

•HHV 4500kcal/kg
•Water 35~45%
•Ash 2~5%

Ash separation

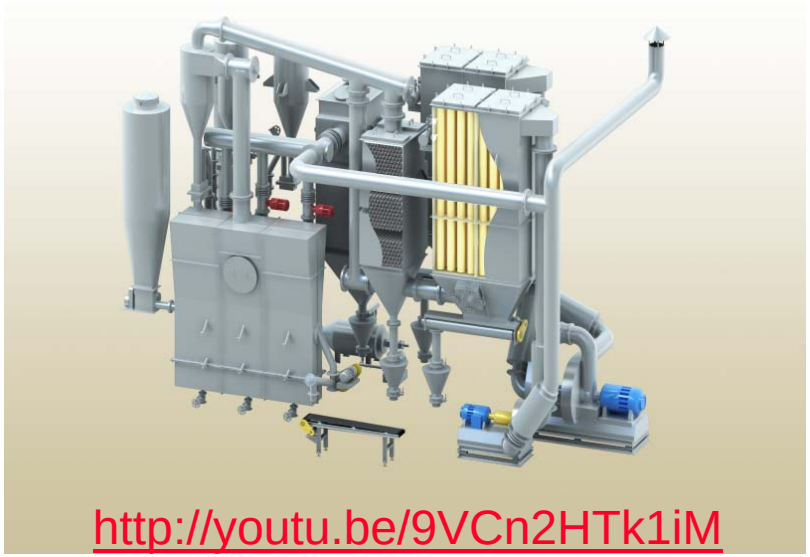
Pore treatment

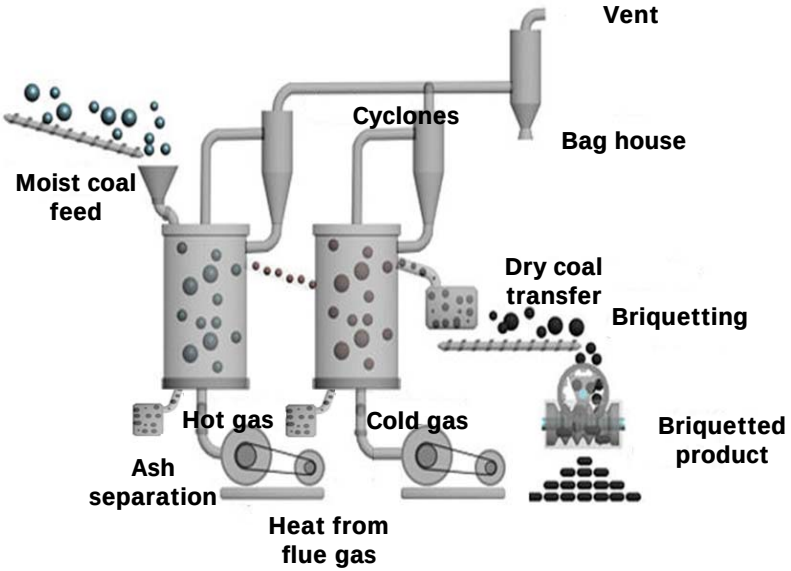
Briquetting

•HHV 6500kcal/kg
•Water 3~10%
•Ash 2~5%

Air Bed Cleaning technology

- **Dry cleaning**
  - **Moisture removal**
  - **Ash classifying by gravity separation**
- **Characteristics**
  - **-3mm particles**
  - **<15% moisture**





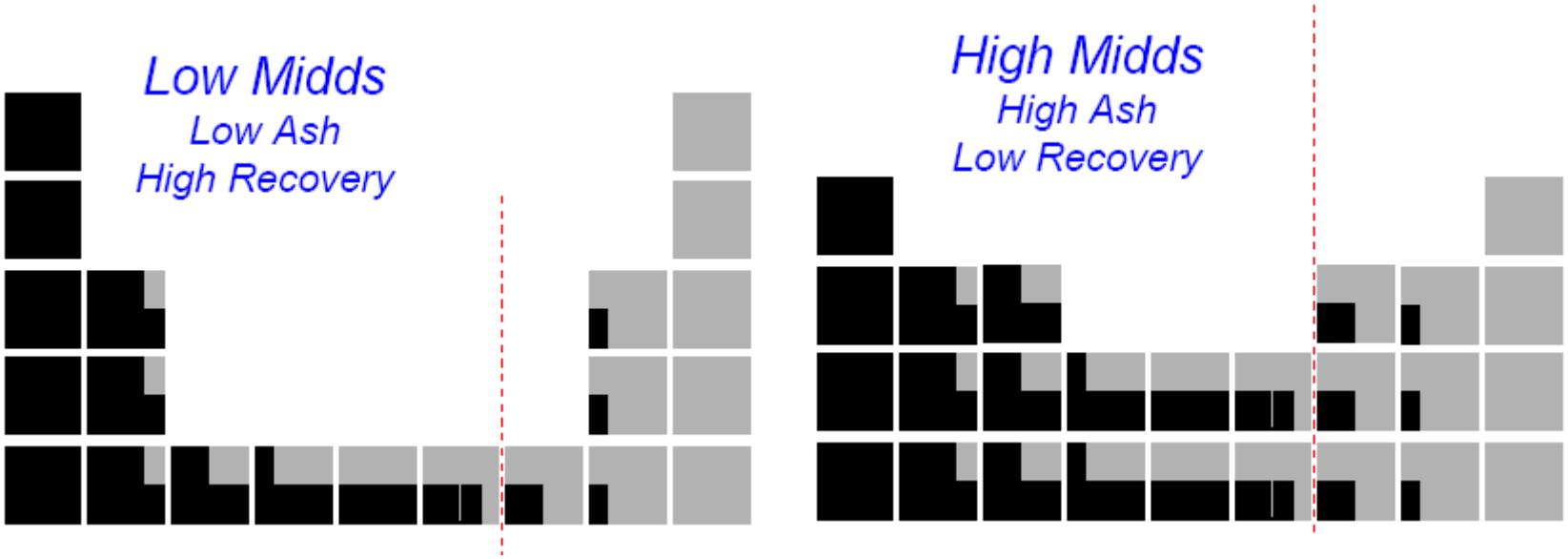
Concept of Fluidized Bed Dryer

Fluidized bed drying has the advantage of temperature control due to uniformity of bed temperature and high drying rate.

Continuous fluidized bed dryer consisting of feeder, plenums, bubbling bed, cyclones, and briquetting machine

Separation of ash by FBD

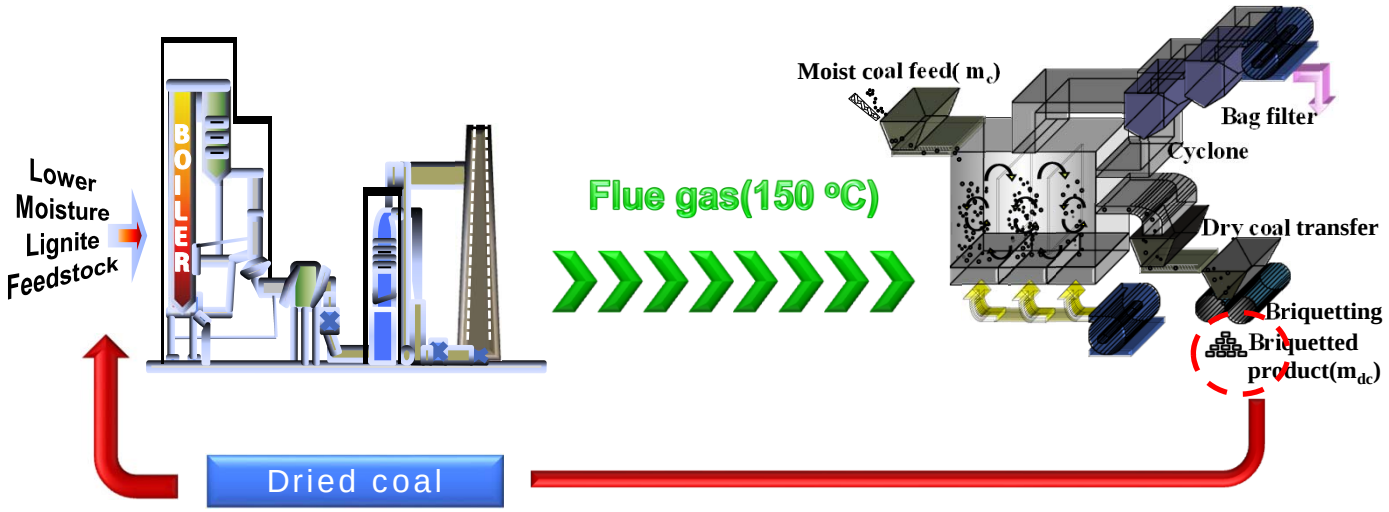
- Operating parameters for hydrodynamic classification
  - Particle size
  - Gas velocity



Adjustment of parameter

A Conceptual model for future power plant

- Supercritical CFBC power plant
- Carbon Capture and gas cleaning system
- Low rank coal drying by flue gas



Case Study for Prototype FBD

Construction and Operation of Demonstration Plant in Indonesia for 30MW Coal Fired Power Plant (2013)

Expected Results

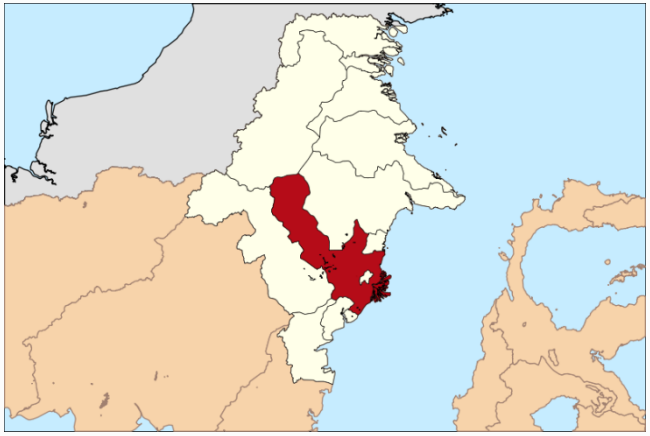
- **Moisture:** 37% → 18%
- **Calorific value:** 4,222kcal/kg → 5,428kcal/kg
- **Combustion Stability:** <800℃ → 822℃
- **Coal Feed Rate:** 19.9t/h →14.3t/h
- **Combustion Air:** 7.4% ↓
- **Flue Gas:** 11.6% ↓
- **Bottom Slag & Fly Ash:** 30% ↓
- **FD/ID Fan Power:** 7.7~11.5% ↓
- **Boiler Efficiency:** 2.9% ↑

KIER Technology Package

- CUPO^{TM}: Coal Upgrading by Palm Oil residue coating

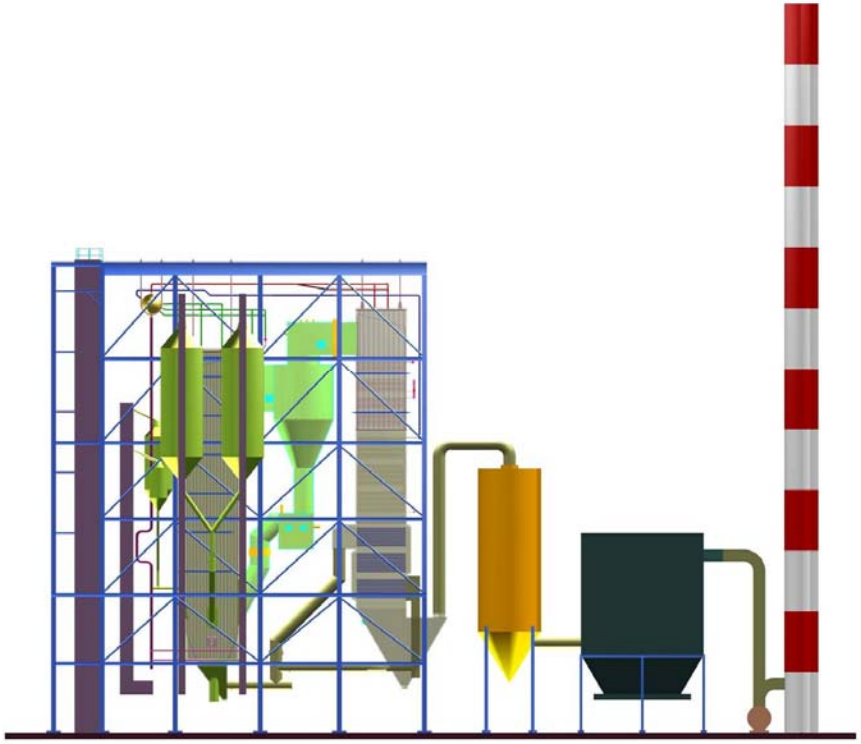
CUPO Coal Briquette

Demonstration project in Indonesia
5000TPD plant
Starting from 2013

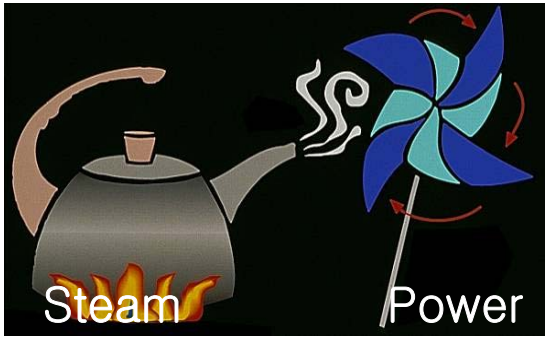


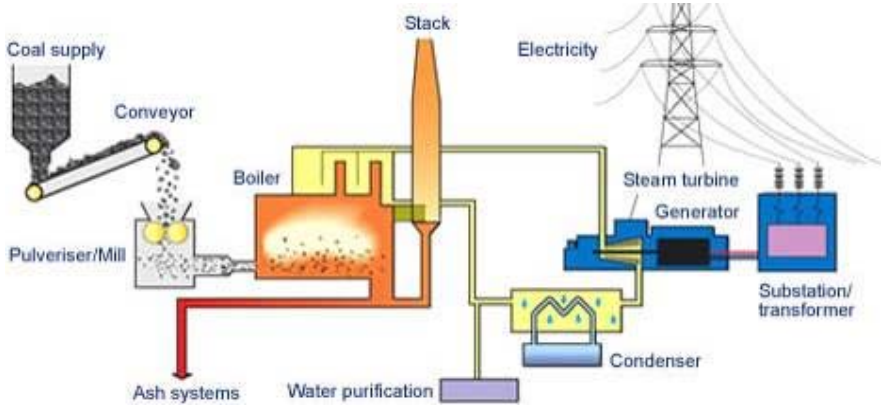
CFBC

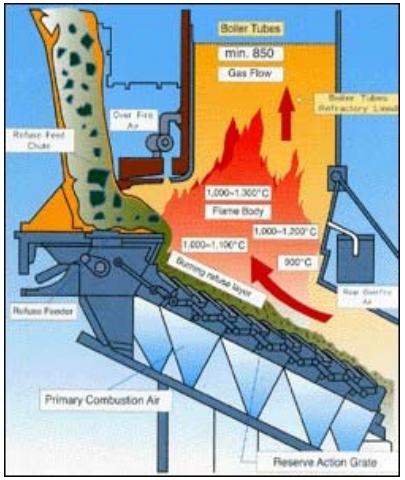
- **A solution to power generation from low rank coal**



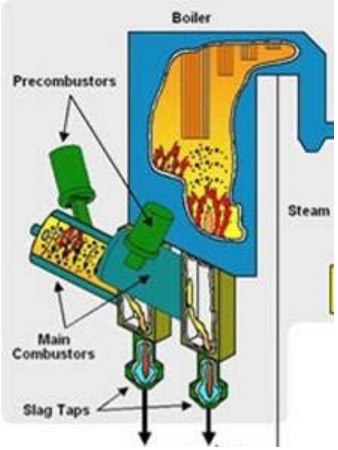
Thermal power generation



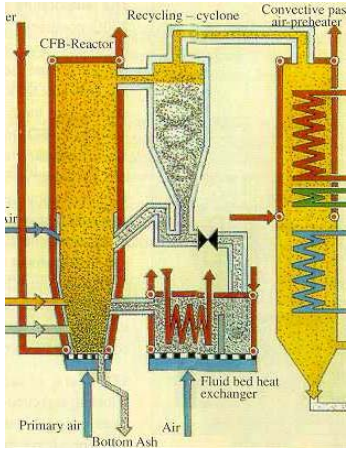




Stoker boiler

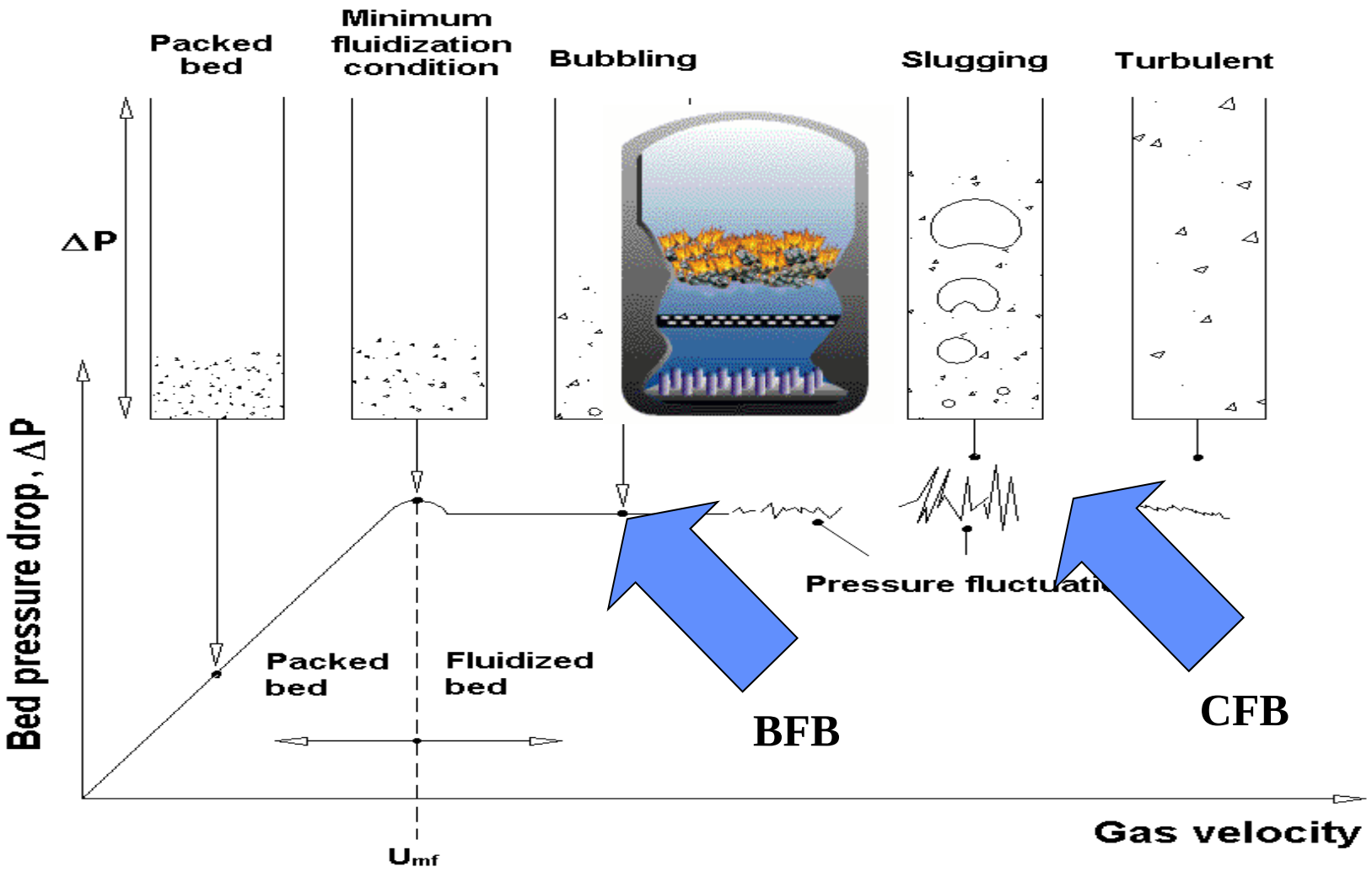


Pulverized coal boiler

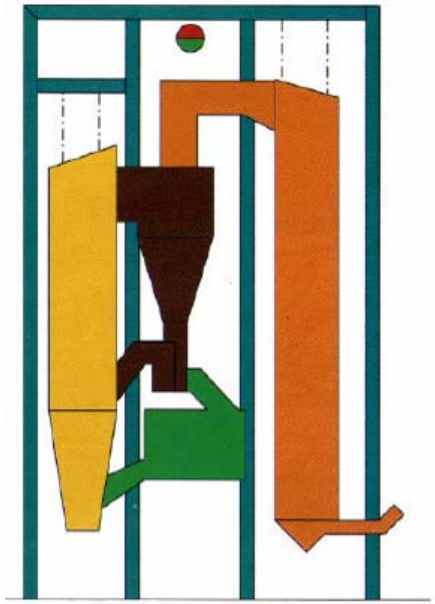


Fluidized bed boiler

Basics of Fluidized Bed Combustion(FBC)

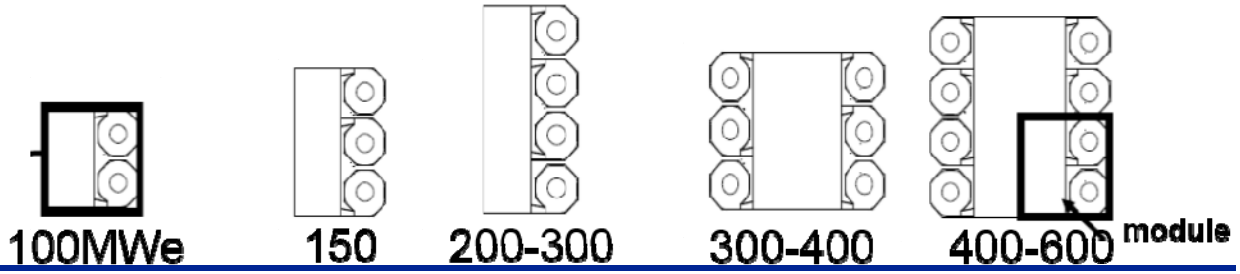


Why CFBC?

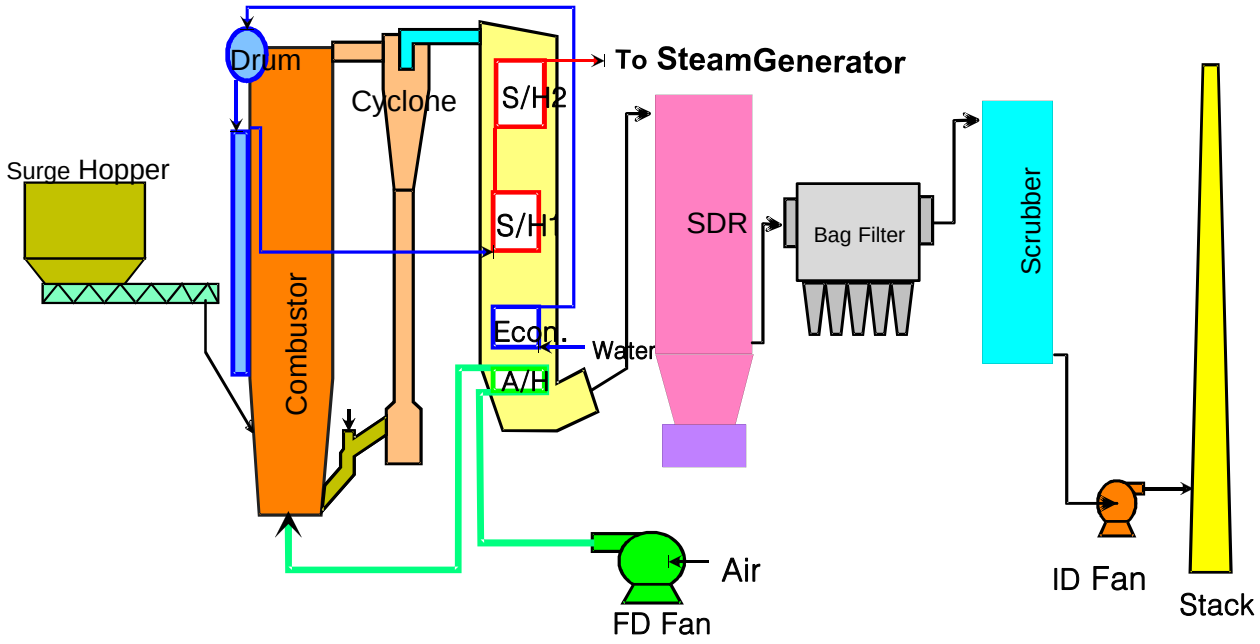


- **An economical way to produce quality power and steam**
- **Stable and easy technology that has been continuously upgraded since 1980**
- **Fuel flexibility from hard coal to biomass**
- **Versatility in size from 2MWe to 600MWe**

➢ **Scale up Scenario**



Other fuel for industrial boiler



2. FBC boiler for Power and Steam

RDF Ho

- 1MWe equivalent
- Industrial boiler for power and steam

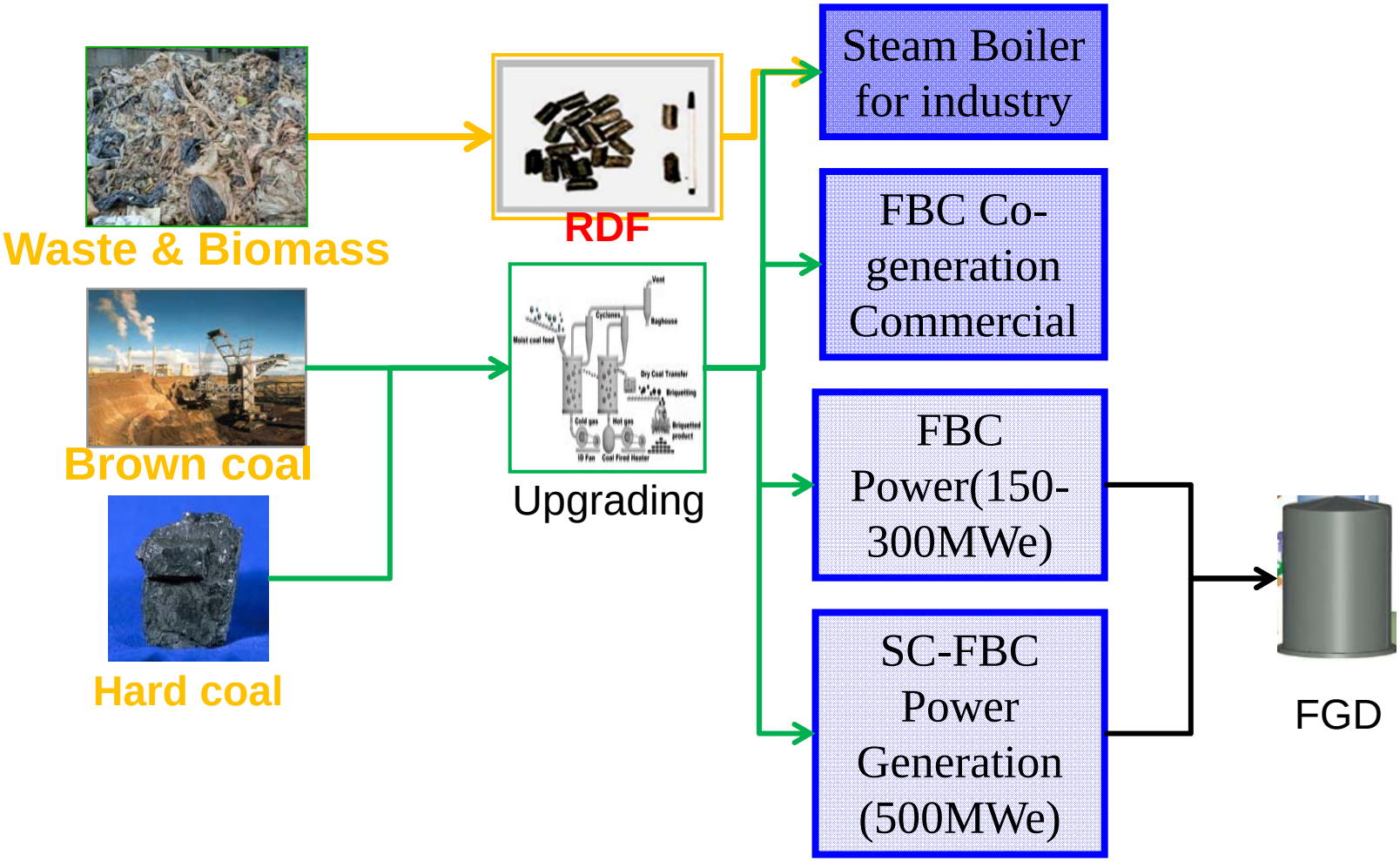
Stack

FBC for Waste Fuel and Biomass

- **10MWe FBC co-generation facility for RDF**
  - **New concept for RDF**
- **Commercial scale FBC with fuel flexibility**
  - **Dispersed generation**
  - **Utilizing RDF, biomass, low rank coal**

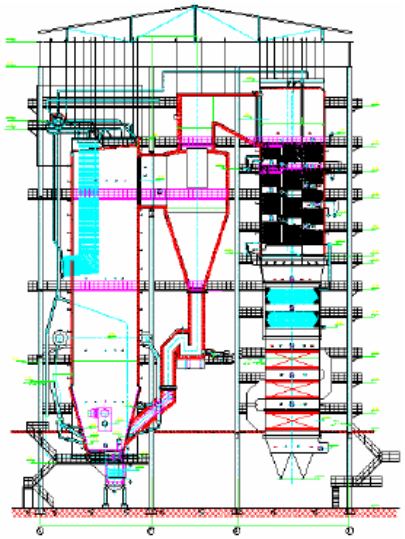
10 MWe CFBC for RDF

Prospect of FB Power Generation

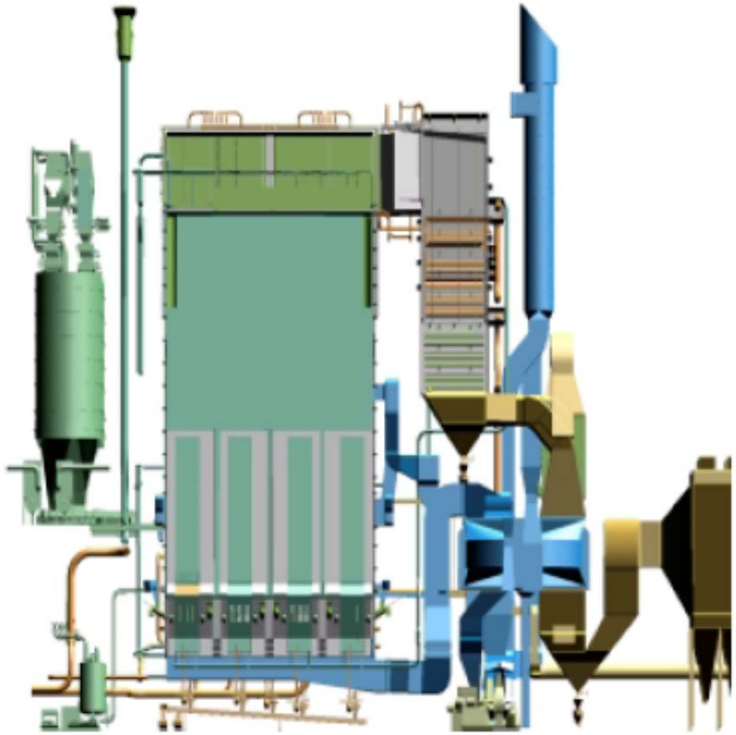


Supercritical CFB (World)

- Large scale power generation >500MWe
- Substitutes ~ 500MWe PC
- Maximum fuel flexibility for power plant
- From low rank lignite to Anthracite
- Low emission
- High efficiency of 45% LHV



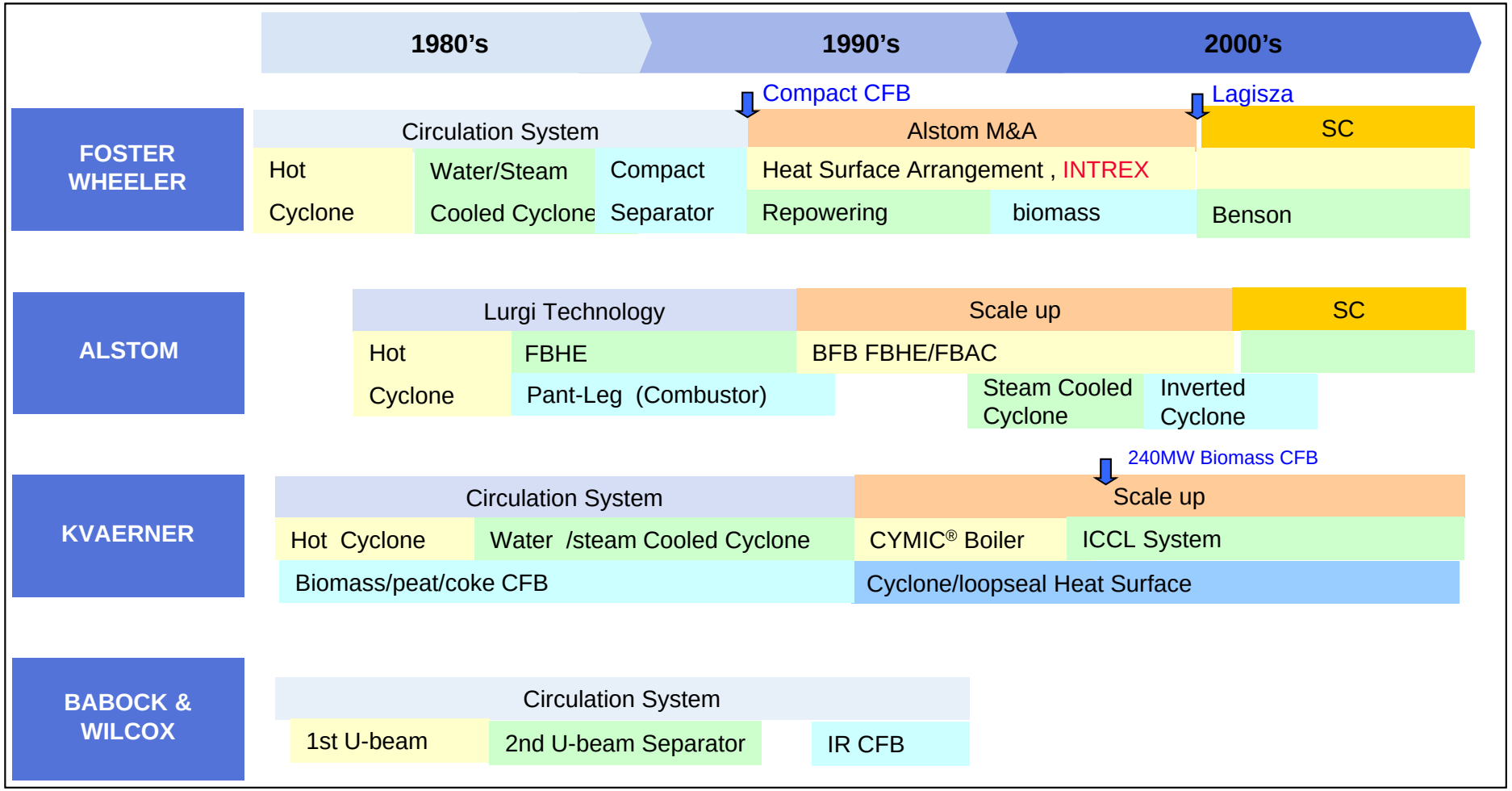
150~300MWe



Lagiza 460MWe

USC-CFB tech tree

Subcritical CFB to USC



Large Scale CFBC

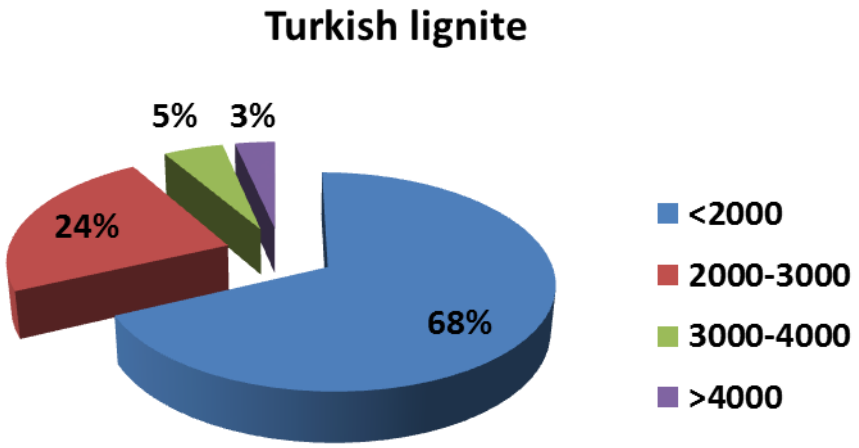
Location	Capacity [Mwe]	Pressure [bar] Final/Reheater	Temperture [C] Final/Reheater	Eff. [% LHV]
Yeosu, Korea	330	171/30	541/541	-
Novocherkasskaya, Russia	330	248/38	565/565	41.5
Lagisza, Poland	460	275/55	560/580	43.3
Samcheok, Korea	550	257/53	603/603	42.4
Baima, China	600	254/44	571/569	43.2
Alstom	600	275	600	-
CFB 800-EU5	830	300/45	600/620	45

- Needs of 300MWe CFBC among Asian countries
- From SC-CFB to U-CFB is the prospect

*Technical report of Doosan Heavy, 2013

Turksh Lignite

- **Candidate for CFB**
  - **Afsin-Elbistan(5.17Bt), Konya-Karapinar (1.83Bt), Manisa-Soma(0.86Bt), Mugla-Milas(0.75Bt)**
- **Upgrading Candidate**



New Project

Capacity(Mwe)	Year	Location	Price(USCents/kWh
600		Tufanbelyi, Adana	1.42
450		Manisan Soma Denis	2.6
>270		Bursa Keles	3.11
?		Konya Karapinar	und
?		Eskisehir	und
?		Tekirdag Saray	und

Turkish coal mines and CFBC

http://www.euracoal.be/pages/layout1sp.php?idpage=475

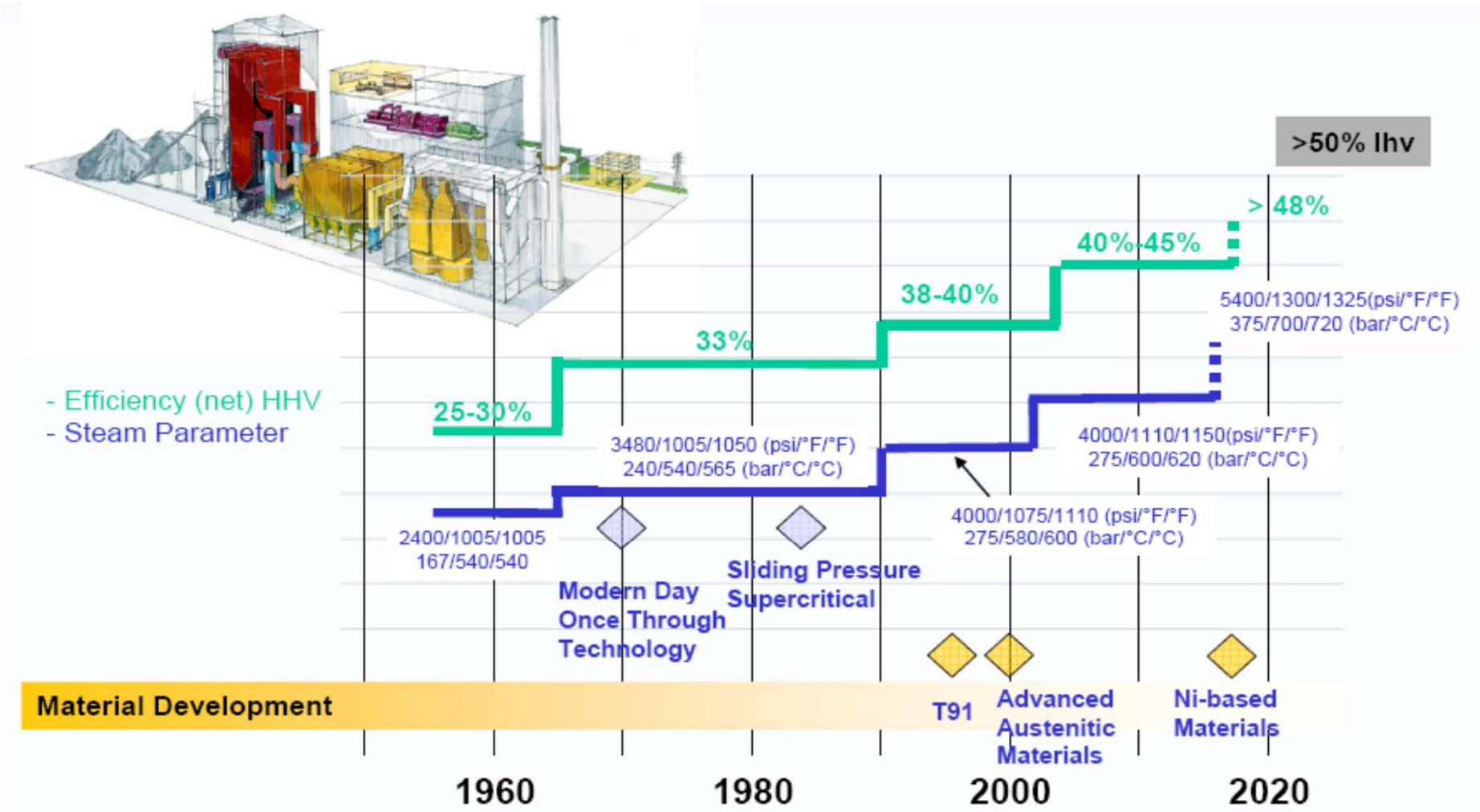
COAL POWER IN THE FUTURE

- **HELE(High Efficiency Low Emission) by coal**

Plant	CO	Nox	SOx	PM	Max capa. Current	CCS penalty
	g/kWh	mg/Nm3			MWe	%
PC(USC)	740	50~100 (SCR)	20~100 (FGD)	10	1100	7~10
PC(A-USC)	670			50	1000	
CFBC	880~900	200 (in situ)	50~100 (in situ)	10	460	
IGCC	740	30	20	1	335	7
IGFC	550	30	20	1	500	

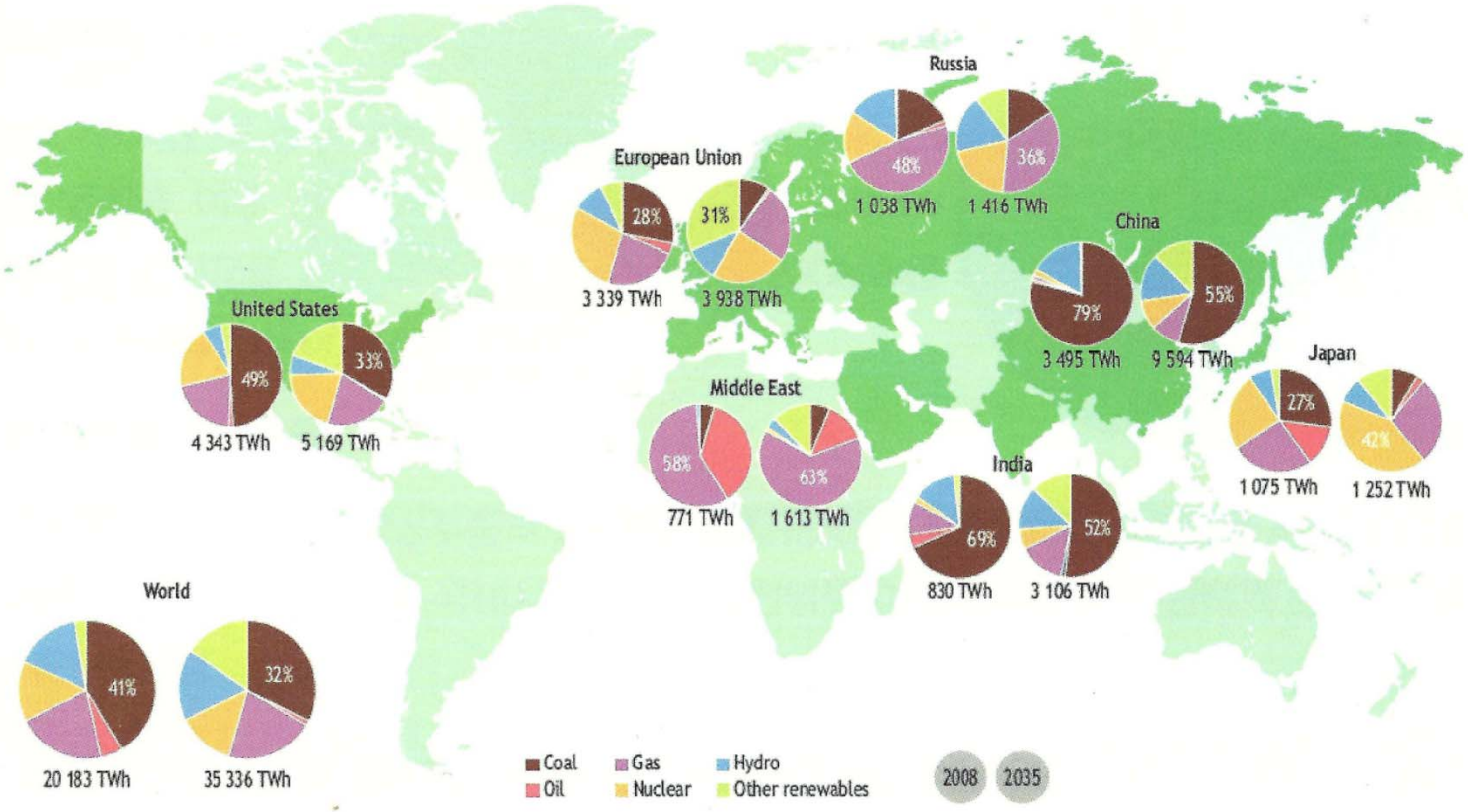
"High Effieicency, Low Emissions Coal Fired Power Generation", Technology Road map IEA 2012

USC Coal Combustion



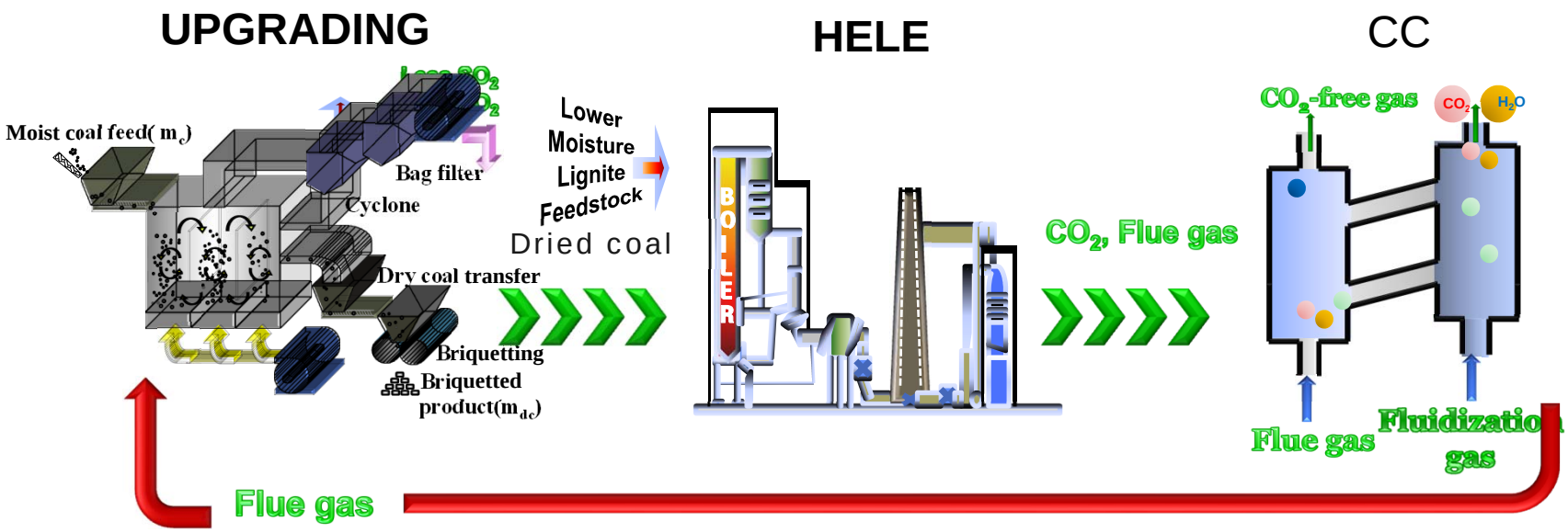
IEA Future Power Generation Plan

Electricity generation by fuel and region in the New Policies Scenario



Note : For each region, the largest source of electricity generation in 2008 and 2035 is denoted by its percentage share of the overall mix.

A Conceptual model of CCT Power Gen W/ CO2 capture



* Tehnology Roadmap, IEA 2012

CONCLUSION

- **Utilization of low rank coal is a major issue in thermal power sector**

- **To increase efficiency coal upgrading and large scale CFBC is necessary**
  - **CFBC is a good solution for low rank coal**
  - **Market will be divided by 500MWe CFBC and 1000MWe PC**
  - **Both CFBC and PC will go further to HSC**

- **HELE will be a much debating problem in the future**

Thank you for your attention!