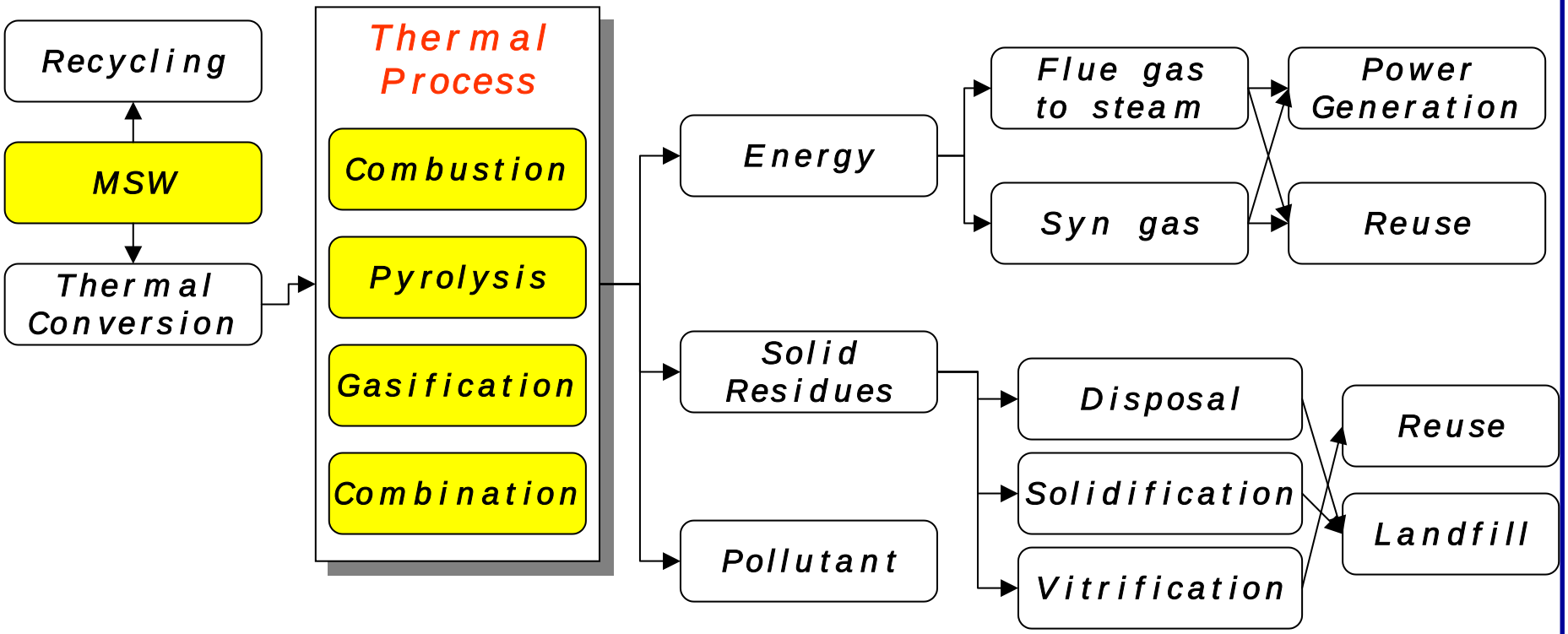
IGCC 기술연구회 발표 자료

“가스화 기술의 환경분야 적용 사례”

발표자 : 유 영 돈
ydnyoo@iae.re.kr

Plant Engineering 센터
고등기술연구원

Thermal treatment option for MSW



MSW : Municipal Solid Waste (도시쓰레기)

Market drivers and novel process for thermal treatment

Market driver

- Reduce the volume of waste
- Render the waste safe and inert
- Recover value from waste (mainly in form of electricity)
- Drive for more sustainable development leading to reuse and recycling initiatives

Novel Process

- Conventional incineration plus vitrification
- Pyrolysis or gasification to produced a syngas which is combusted
- Pyrolysis or gasification to produced a syngas which cooled and cleaned prior to the direct generation of electricity via gas engines
- Pyrolysis or gasification to produce a transportable fuel

Factors affecting the demand for Novel process

Increasing demand

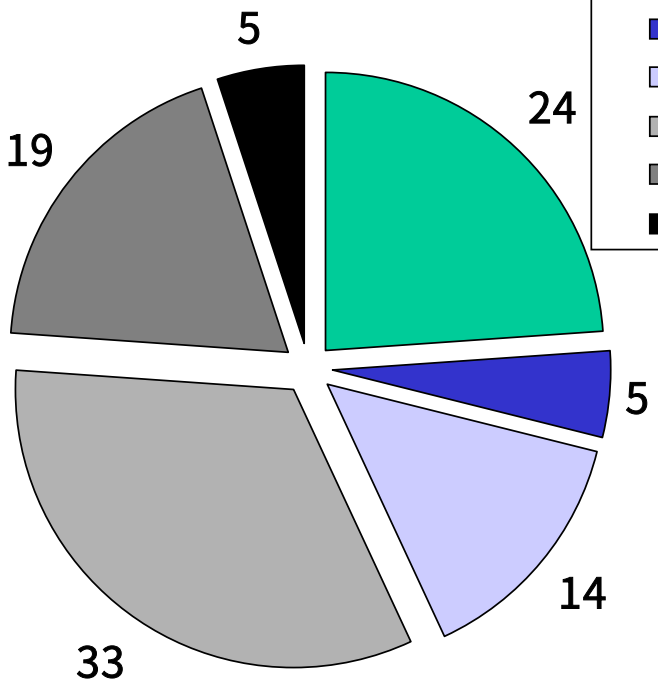
- Desire to recover valuable products and/or energy for waste
- Negative image of incineration
- Perception of new process as "greener" high technology solution
- Constrains on land-filling untreated waste
- Smaller chimney
- Increasing cost of, and regulatory focus on, residue disposal from incinerators
- Compatible with recycling (stable residues)
- Marketing efforts of suppliers

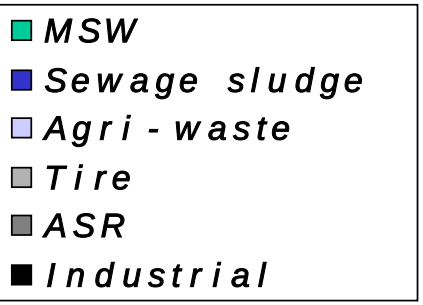
Decreasing demand

- Relatively unproven technology
- Conservative nature of the industry
- Mass burn incineration is proven technology
- Lack of commercial track record by many supplies
- Lack of knowledge of many processes among potential customers
- Reducing amounts of waste in some countries

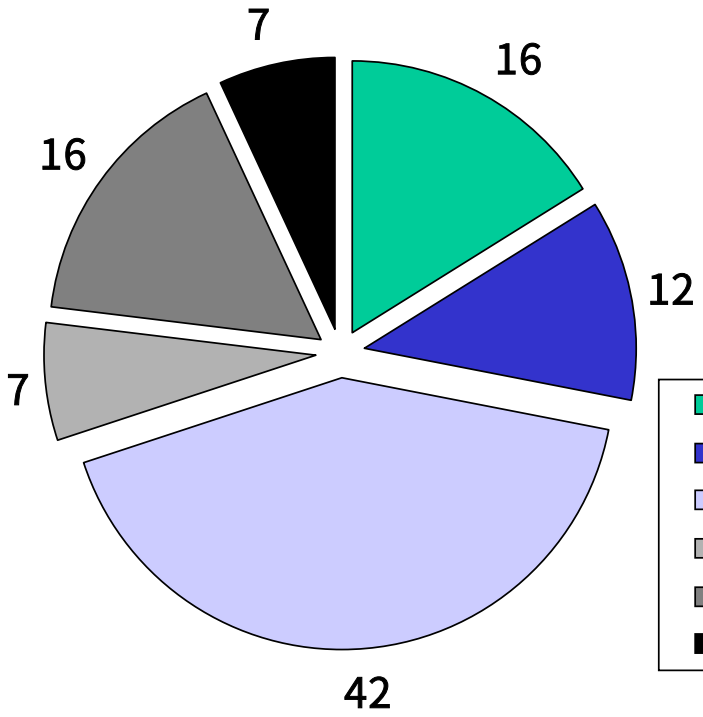
Application of pyrolysis and gasification technologies (1)

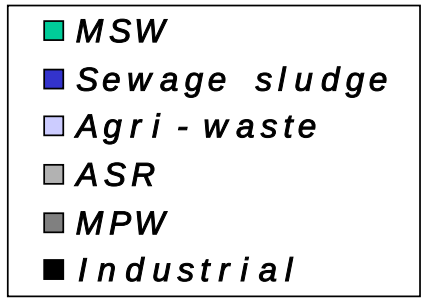
Pyrolysis





Gasification

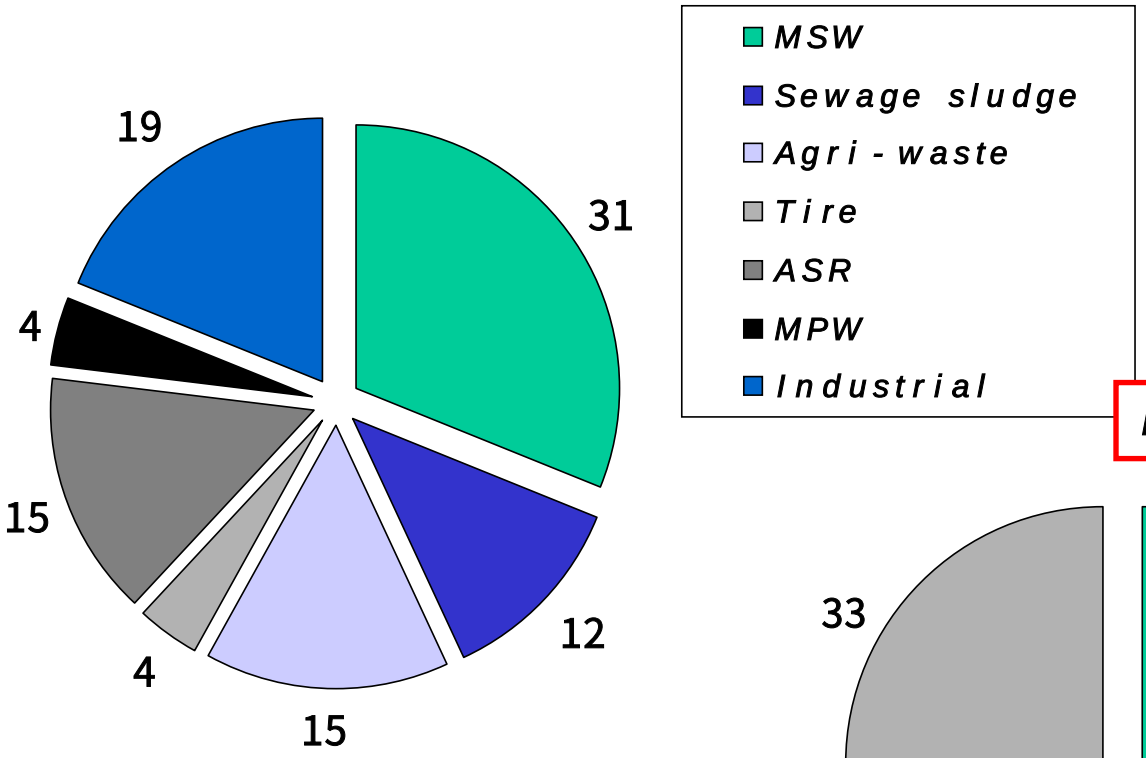




MSW : Municipal Solid Waste
ASR : Auto Shredder Residues

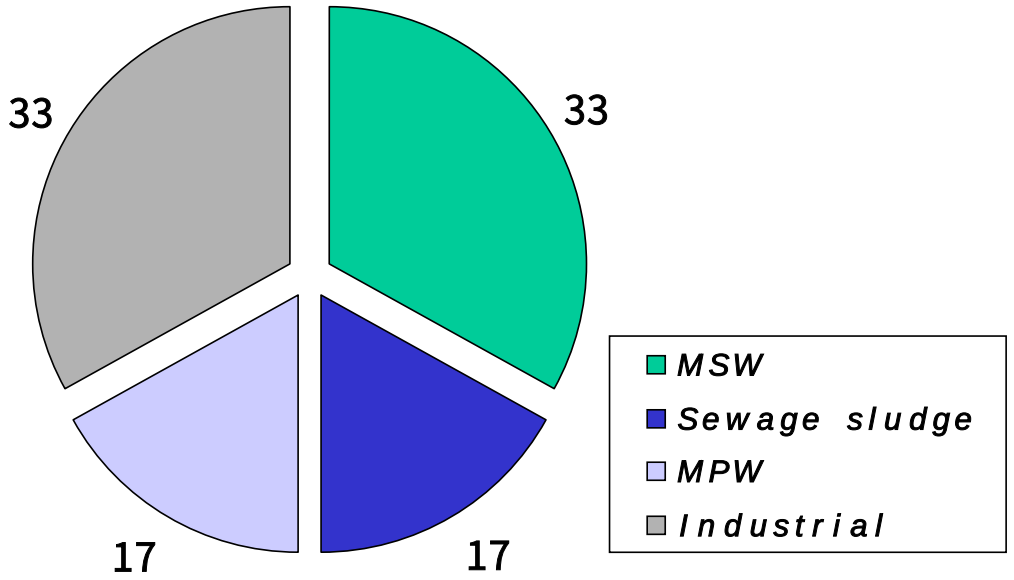
Application of pyrolysis and gasification technologies (2)

Pyrolysis/Gasification + Combustion

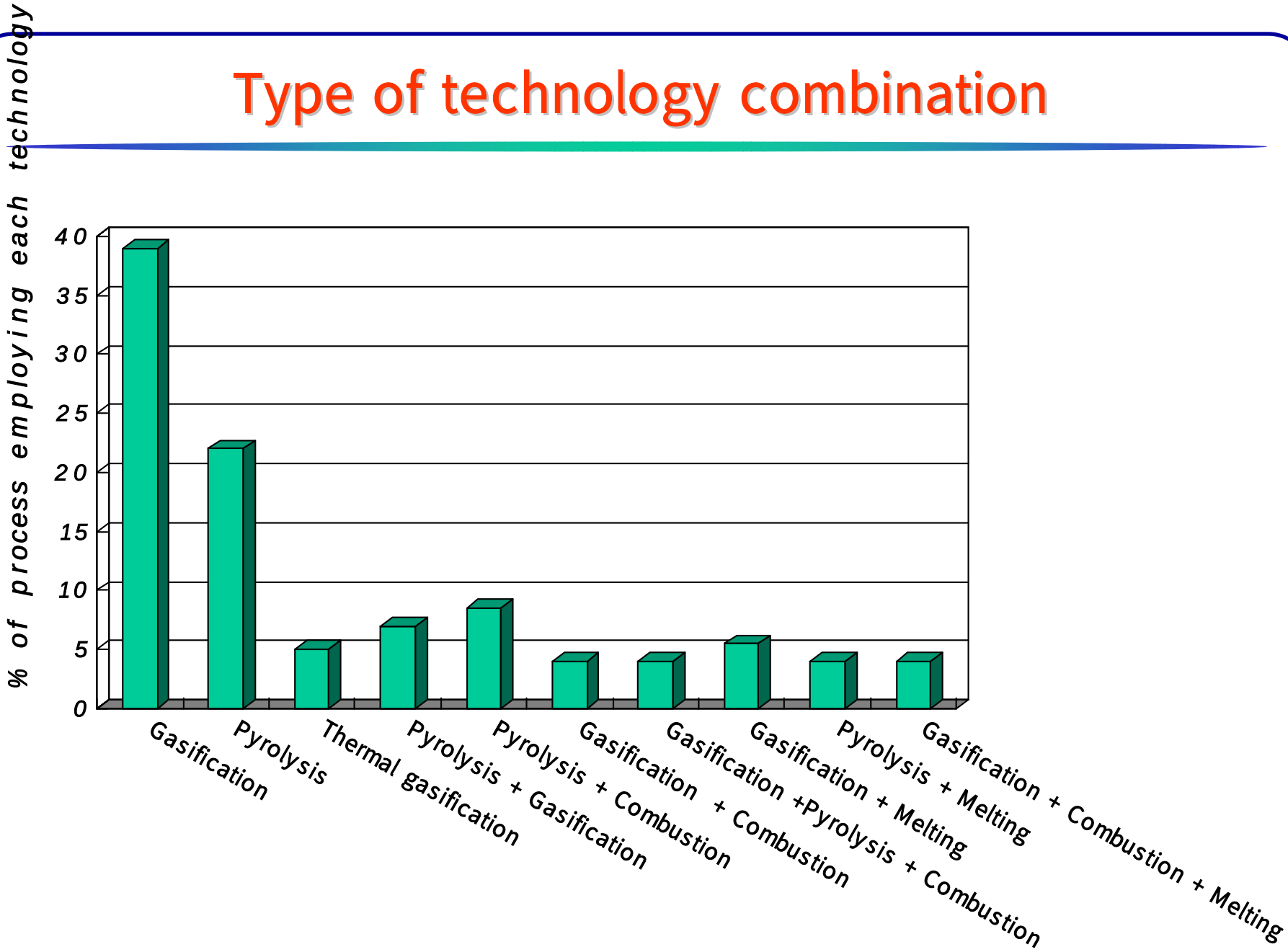


MPW : Mixed Plastics Waste

Pyrolysis + Gasification



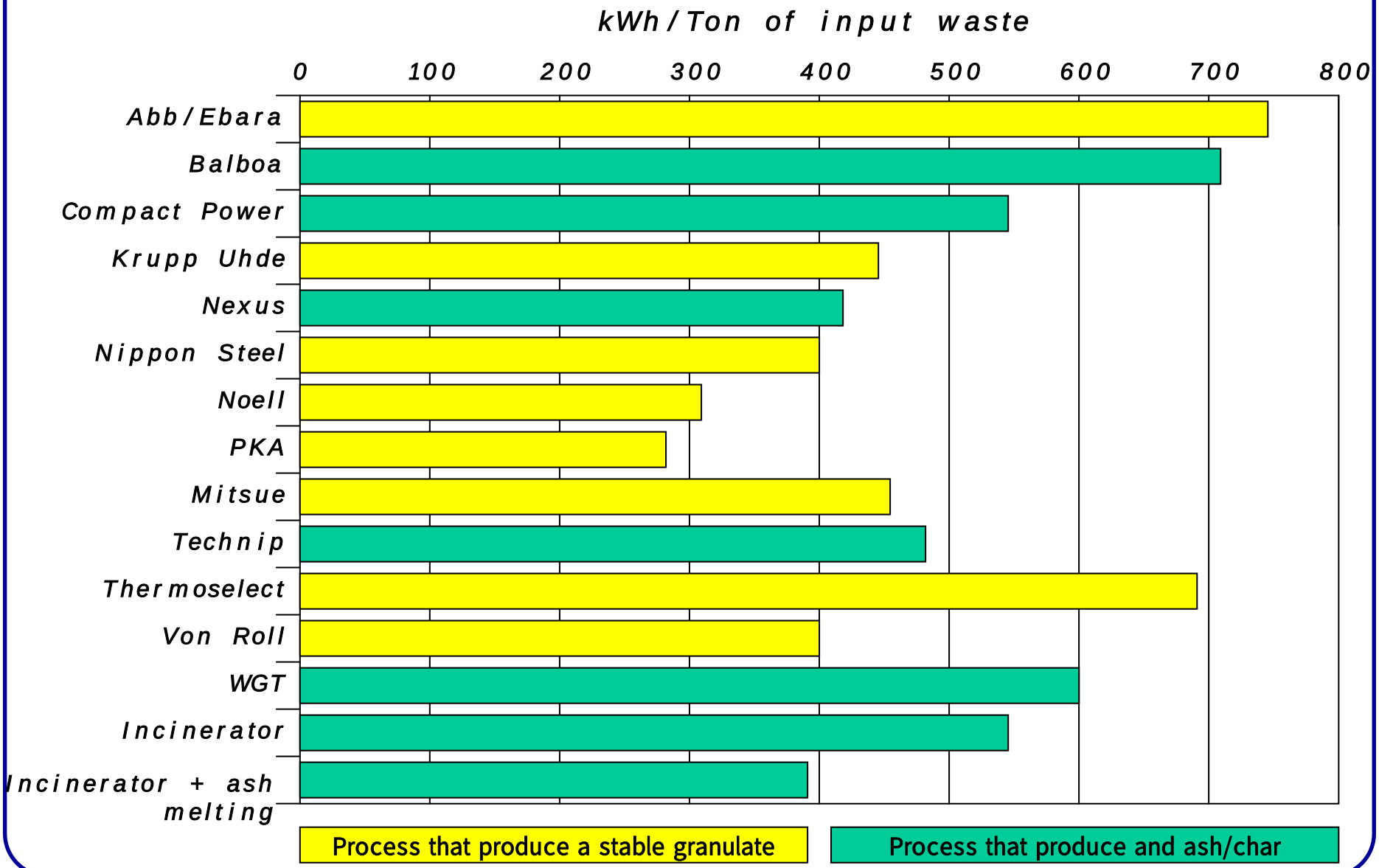
Type of technology combination



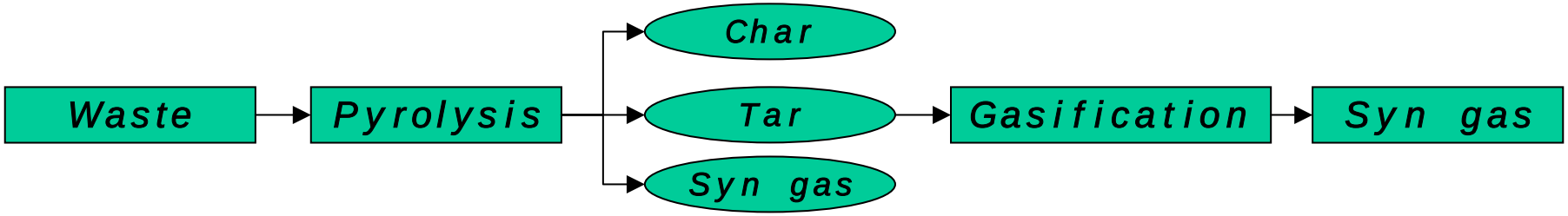
Comparison of commercial status

Status	Suppliers	Process	Markets
Fully Commercial	ABB/Ebara	FB Gasification +Combustion	ASR, MPW
	BG System	Gasification	Argi-fuels
	Foster Wheeler	FB gasification	Argi-fuels, RDF, MPW
	Nippon Steel	Gasification/Melting	MSW, ASR, MPW
	PRME	Gasification	Argi-fuels
Commercial	Conrad	Pyrolysis	Tire
	ESI	Pyrolysis	Sewage sludge
	Ferco	CFB gasification	Argi-fuels
	Heuristic Eng.	Gasification + Combustion	Argi-fuels
	Kvaerner Chemrec	Gasification	Block liquor
	Lurgi	Gasification	Argi-fuels, MSW
	Mitsue	Pyrolysis + Combustion	MSW, ASR
	MTCI	Gasification	Paper, Sludge, RDF
	Sacone	Gasification	Clinical, animal waste
	Takuma	Pyrolysis + Combustion	ASR, MSW
	Technip	Gasification	MSW, MPW
	Thermogenics	Gasification	Argi-fuels, RDF
	Thermoselect	Pyrolysis + Gasification	MSW, Industrial waste
	TPS	Gasification	RDF, Argi-fuels
	Von Roll	Pyrolysis + Melting	MSW, ASR

Comparison of power output

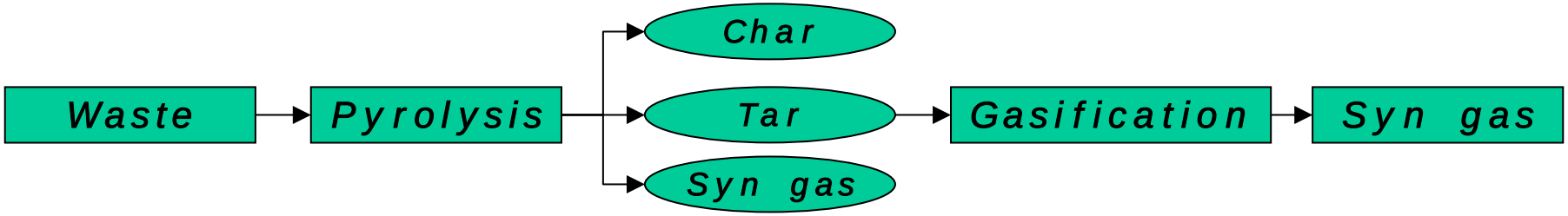


Comparison of process char handling strategies



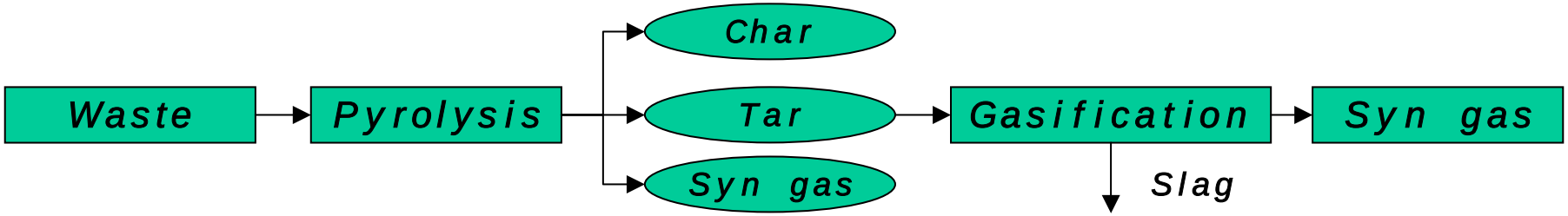
Process	Char handling and processing methods				
	Convert to product	Gasify	Combust	Melt into slag	Dispose
Bal Pac					✔
Compact Power		✔			
ESI			✔		
JND					✔
Nexus	✔ (off-site)		✔(on-site)		
Noell					✔
PKA		✔		✔	
Serpac			✔		
Technip					✔
Thermoselect				✔	
Thide	✔ (off-site)		✔(on-site)		
Traidec			✔		
WGT					✔

Comparison of process tar handling strategies



Process	Tar handling Strategies for "Clean" Syn gas Production			
	Creaking or Gasification	Removal	End use	Gas cleaning process
Battelle		✔	Disposal	WS
EDL	✔	Not applicable		
JND		✔	Disposal	Q + WS
Lurgi (CFB)		✔		Q + WS
Lurgi (LR)	✔	Not applicable		
Noell Pyrolysis		✔	Fuel, Disposal	Q + TS
PKA	✔			
Texaco		✔	Recycle to Gasifier	Q
Thermogenics		✔	Recycle to Gasifier	Q + WEPS
Thermoselect	✔	Not applicable		
TPS	✔	Not applicable		
Von Roll	✔	Not applicable		
WGT		✔	Disposal	Q + WESP +TS

Process which produce a slag for recycling



Process	Process which produce a glass-like slag for recycling			
	Leach test Data available	Oxygen use	Additional fuel	Internal energy recycling (char, syn gas)
ABB/Ebara	✔			
Krupp Uhde (Precon)	✔	✔	✔	
Lurgi (BGL)		✔		
Nippon Steel		✔	✔	✔
Siemens/Mitsue			✔	✔
Noell (GSP)		✔	✔	
PKA	✔	✔		✔
Resorption	✔		✔	✔
Texaco		✔		✔
Thermoselect	✔	✔	✔	✔
Von Roll (RCP)	✔	✔	✔	✔

Mass balance(Waste ; MSW, CV=10MJ/kg)

Suppliers	Process	Input (kg/T-waste)			Recyclable Output (kg/T-waste)						Residue (kg/T-waste)
		O_2	Fuel	Additives	Slag	Syn Gas	Metal	Gypsum	HCl	S	Heavy metal Sludge
Nippon Steel	Gasification /Melting	?	50 (coke)	50	90		10				30
PKA	Pyrolysis Gasification Melting	100	5 (LPG)	11	140	?	20				18
Siemens	Pyrolysis + Combustion	-	35 (LNG)		168		95	10	23		3
Mitsue	Pyrolysis + Combustion	-	-	?	81		12.6				38 (or 19)
Thermoselect	Pyrolysis + Gasification	514	23.3 (LNG)	20	230	895	29			2	19.5
Thermoselect (Kawasaki Steel)	Pyrolysis + Gasification	500	?	?	60	722	1 ~ 6			0.5	
Von Roll	Pyrolysis + Melting	790	5 (oil)	23.2	205		6				18(+ 48)

Main markets currently targeted by specific commercial process (1)

Suppliers	Agricultural residue	Small scale bio-waste	Site-specific industrial waste	Dried Sewage sludge	Small to medium scale MSW	Large Scale MSW	Very large scale integrated plants
ABB					✔		
B9 energy		✔					
Balboa Pacific	✔		✔		✔		✔
Battelle/Ferco	✔						
BG Systems		✔					
BSC/EDL		✔		✔	✔		
Compact Power			✔		✔		
Dynamotive	✔						
Enerkem	✔						
Enersludge				✔			
Ensyn	✔						
EPI	✔						
Foster Wheeler	✔						
GTS Duratek			✔				
Heuristic Eng.	✔	✔					
JND					✔		
Krupp Uhde					✔		

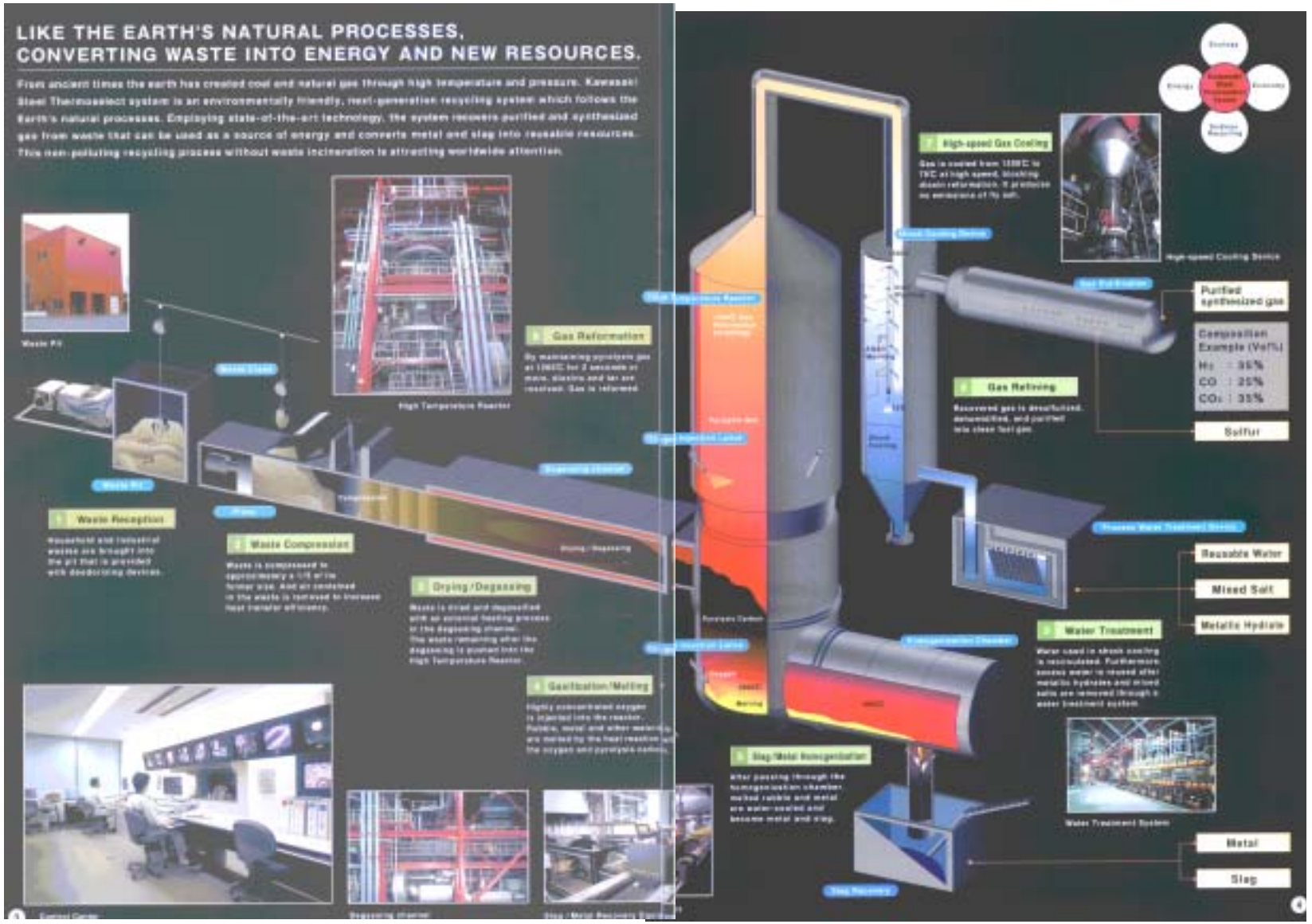
Main markets currently targeted by specific commercial process (2)

Suppliers	Agricultural residue	Small scale bio-waste	Site-specific industrial waste	Dried Sewage sludge	Small to medium scale MSW	Large Scale MSW	Very large scale integrated plants
Kvaerner Chemrc			✔				
Lurgi process	✔		✔			✔	
Mitsue			✔			✔	
MTCI			✔				
Nexus			✔		✔		
Nippon Steel						✔	
Noell			✔				
Organic Power		✔	✔		✔		
Peat		✔	✔				
PKA			✔	✔	✔		
PRME	✔	✔					
Pyrovac	✔				✔		
Resorption			✔		✔		
RGR Ambiente			✔		✔		
Sacone		✔	✔				
serpac			✔		✔		
Technip			✔		✔	✔	

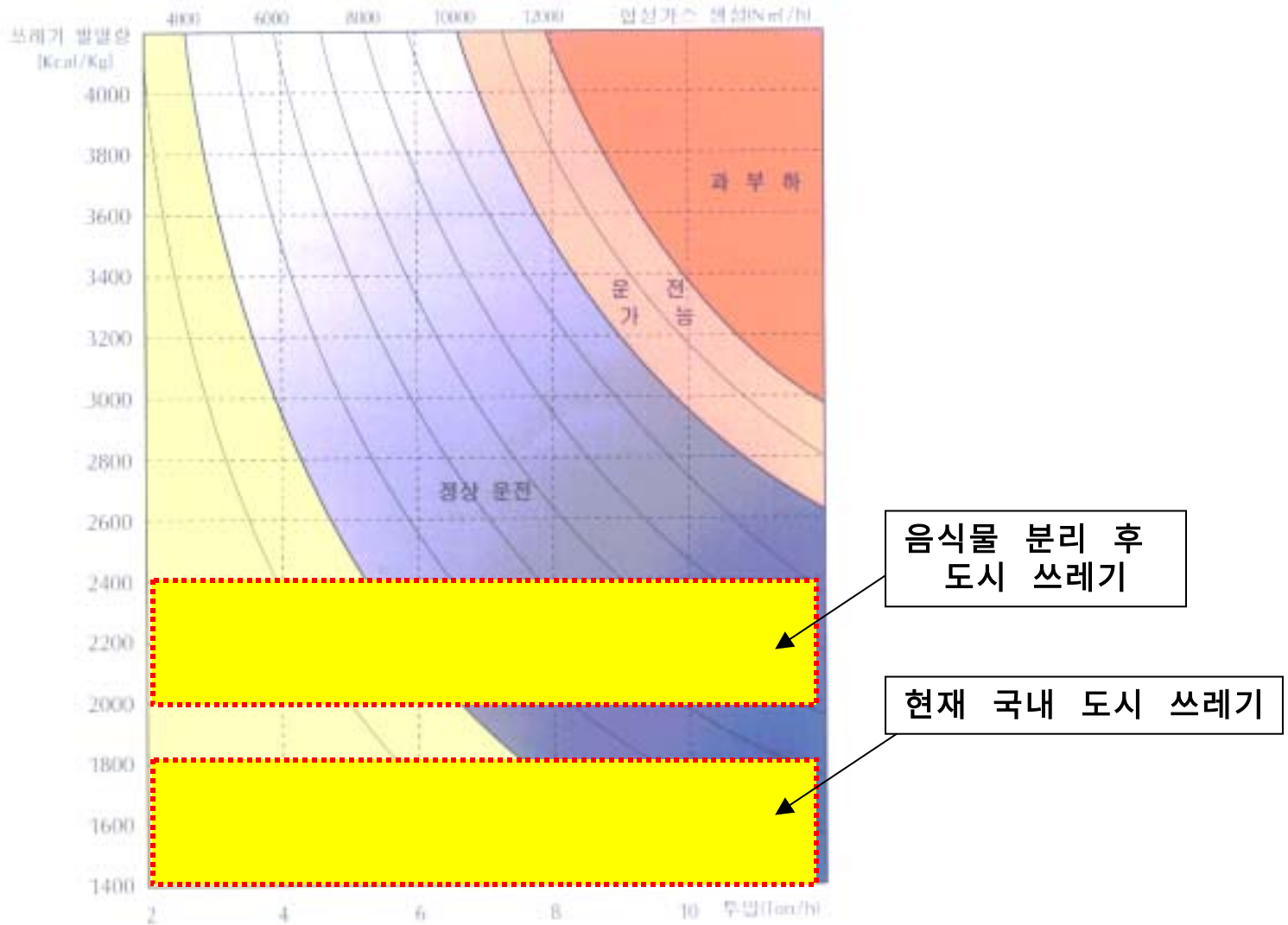
Main markets currently targeted by specific commercial process (3)

Suppliers	Agricultural residue	Small scale bio-waste	Site-specific industrial waste	Dried Sewage sludge	Small to medium scale MSW	Large Scale MSW	Very large scale integrated plants
Thermogenics					✔		
Thermoselect			✔			✔	✔
Thide			✔		✔		
TPS	✔						
Traidec			✔	✔			
UET		✔		✔			
Von Roll						✔	
WGT	✔			✔			
Waste to Energy				✔			
Waterwide	✔	✔					
Wellman		✔	✔				

Thermoselect process



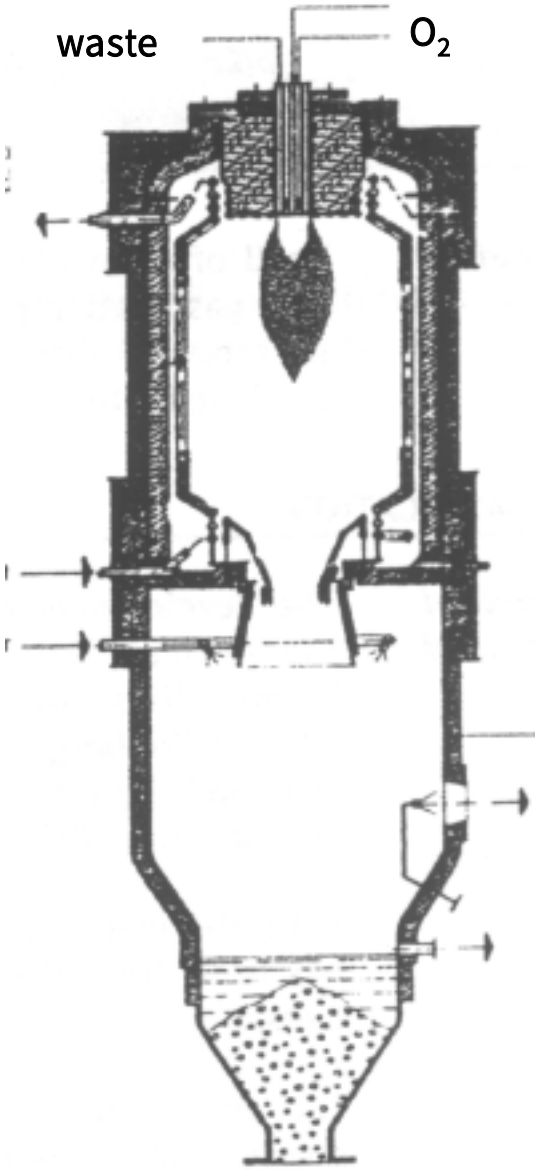
Syn gas production as a function of waste heat content and throughput



96톤/일 144톤/일 192톤/일 240톤/일

Black liquor gasification (Kvaerner Chemrec)

- Waste : Black liquor
- Gasifier
  - ✓ Oxygen blown entrained flow gasifier (Noell gasifier)
  - ✓ 900~ 1000 °C
  - ✓ 20~40 bar
- Capacity : 550T/Dry solid/Day
- Start up : late 2000
- Combined cycle plant

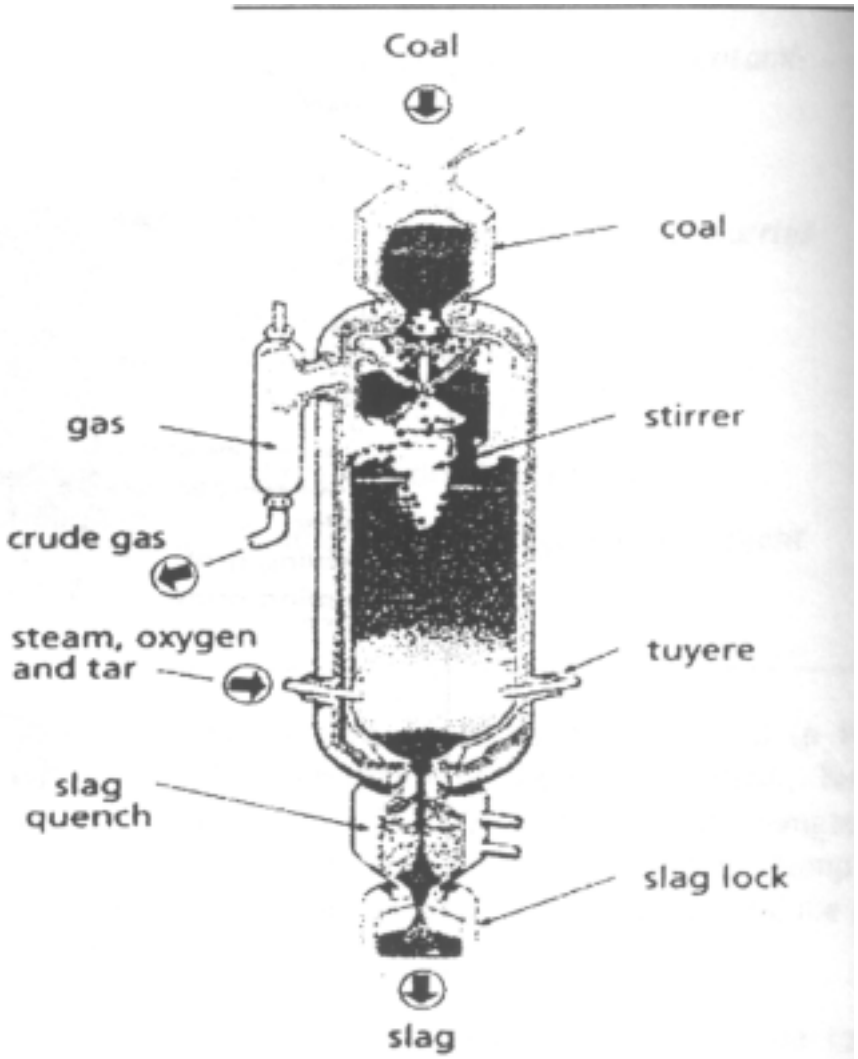


Lurgi gasification technologies

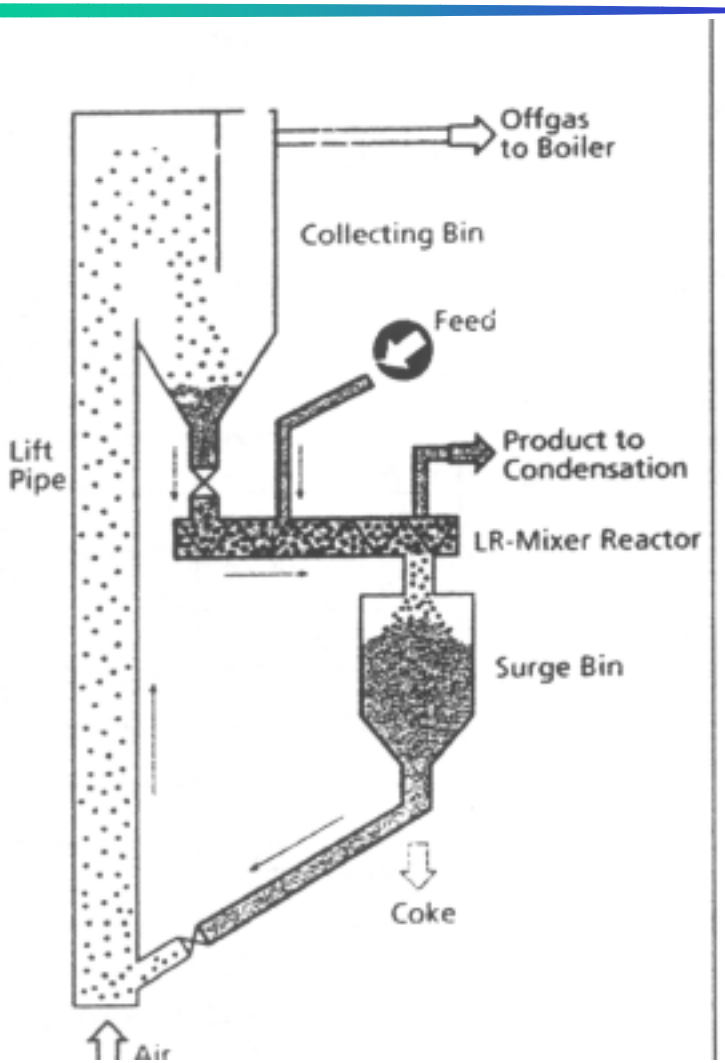
Gasifier type	Feed stocks	Status
Fixed bed	Mixed waste	
BGL slagging	Plastics Sewage sludge Rubber, ASR Contaminated wood Paint residue MSW	Developed for coal gasification
CFB - ZWS - Okogas - Wikonex	Wastes Biomass	
LR	Dried sewage sludge	
Pyromelt	ASR, MSW	Not currently being promoted

BGL : British Gas Lurgi, CFB : Circulating Fluidized Bed, LR : Lurgi Residue
MSW : Municipal Solid Waste

Lurgi gasifier



British Gas / Lurgi Gasifier



LR(Lurgi Residue) Gasifier