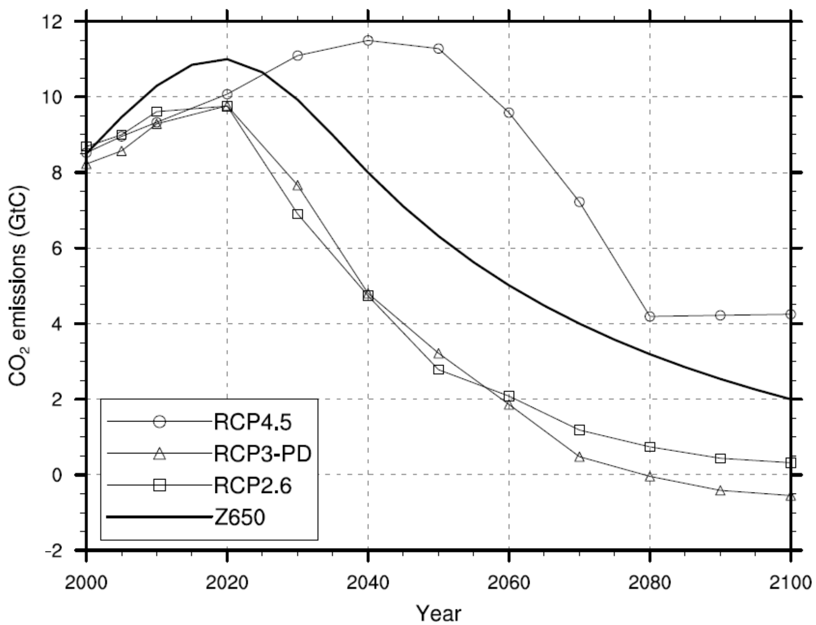
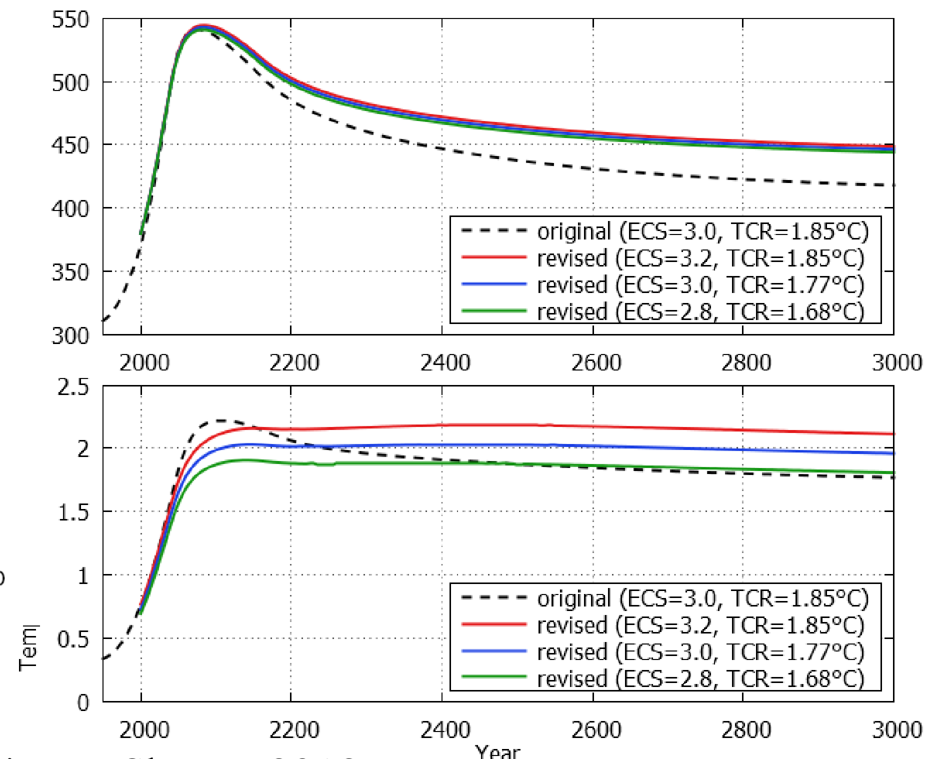
Way to Low Carbon Scenario Z650

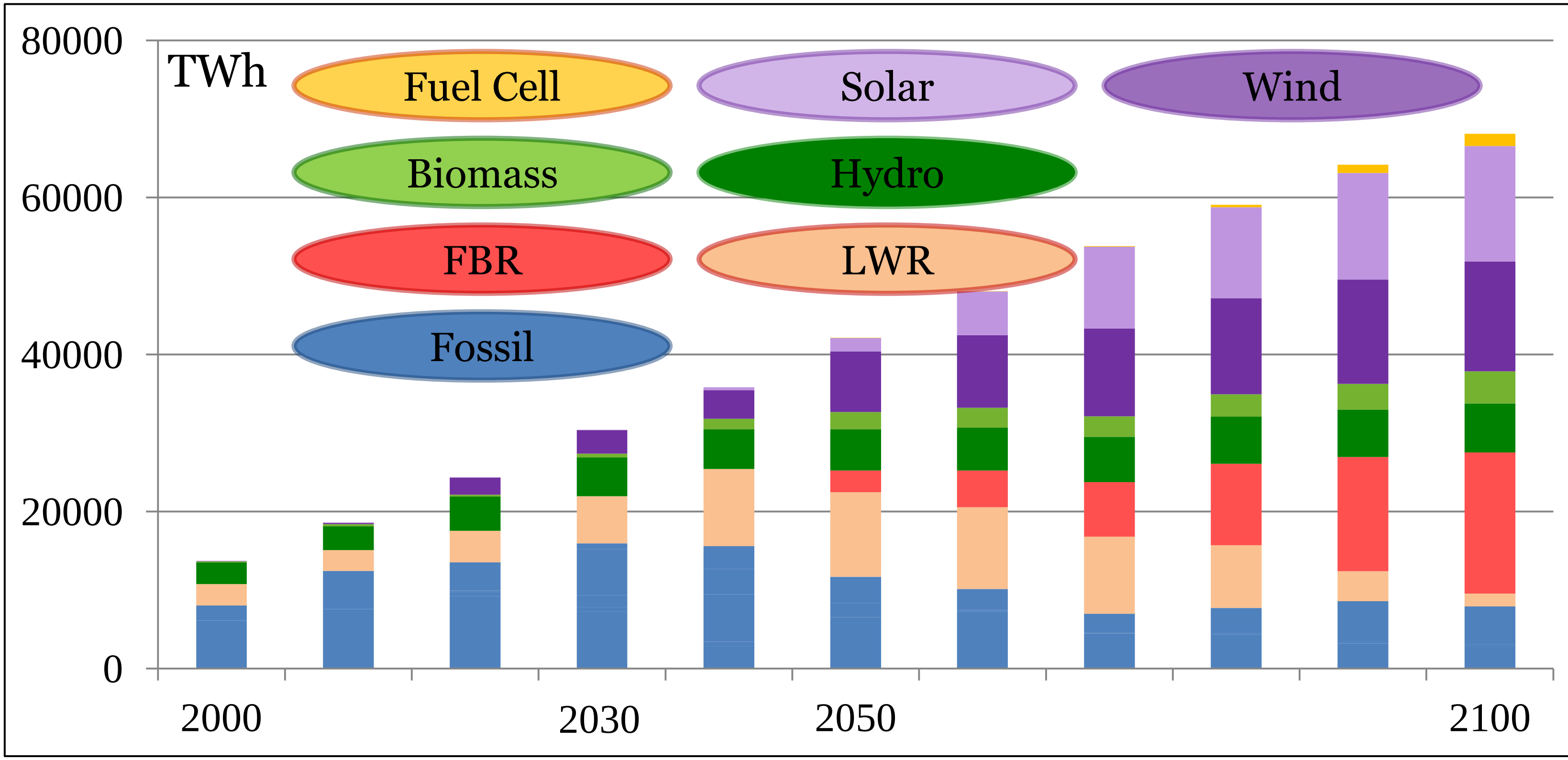
CIGS Fengjun DUAN





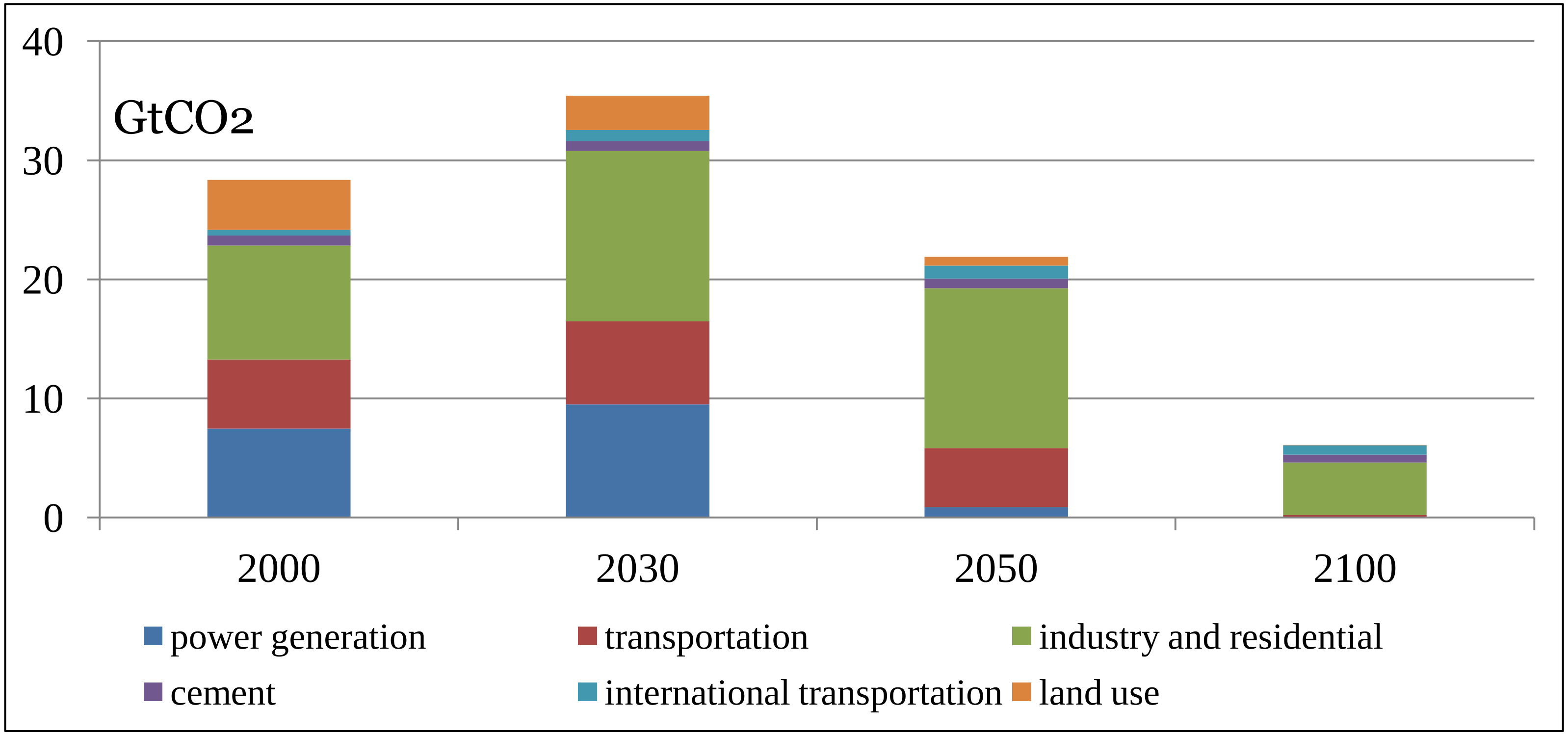
Z650 Scenario and temperature rise
Junichi TSUTSUI, CIGS Symposium on Climate Change 2013

Global Power Generation of Z650



Nuclear Power Capacity (GWe)	2000	2030	2050	2100
LWR	370	810	1,445	220
FBR	-	-	375	2,410

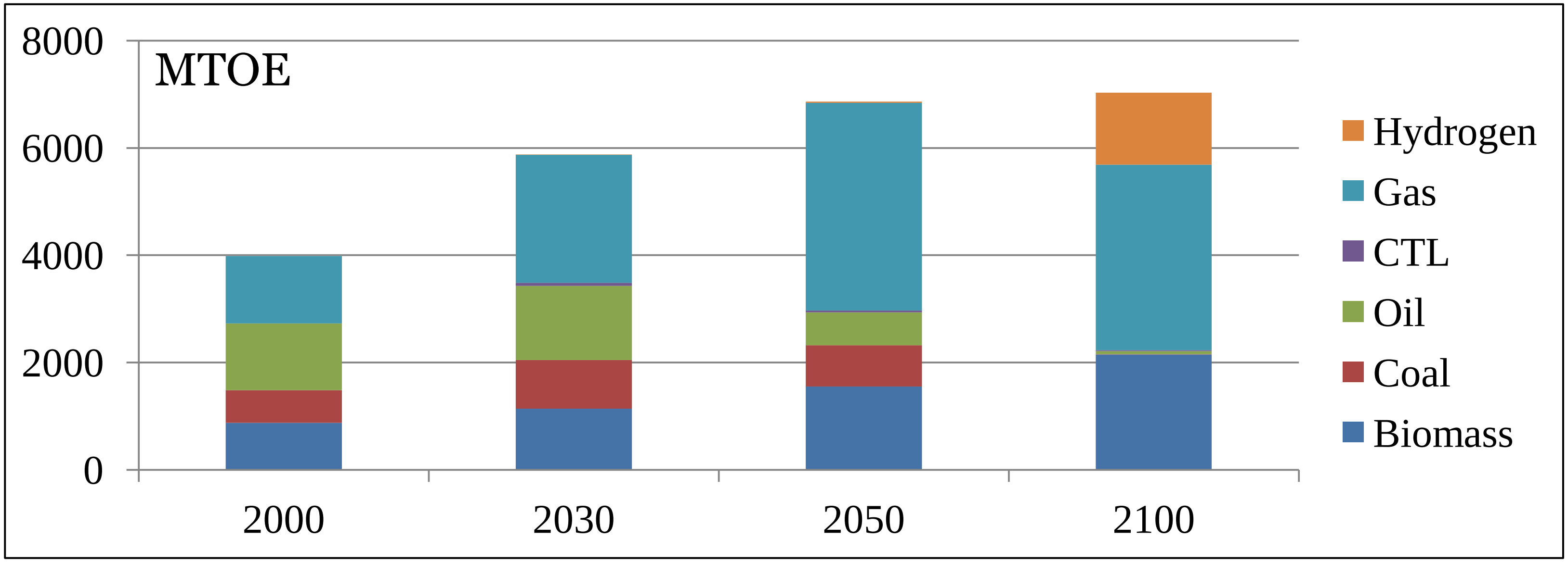
CO_2 Emissions by sectors

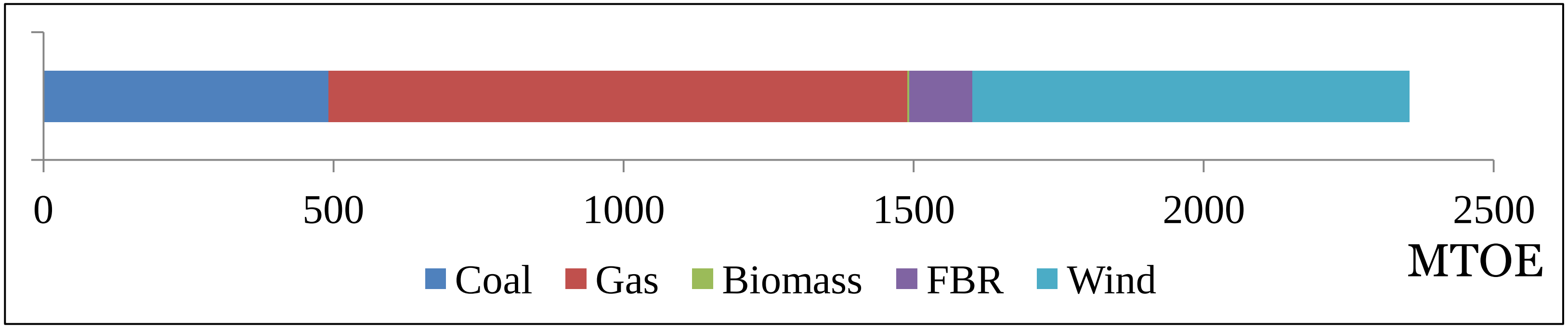


Analysis results through energy engineering model (GRAPE)

・emissions from industry and residential sectors decrease slowly (share in total emissions: 33%→73%)

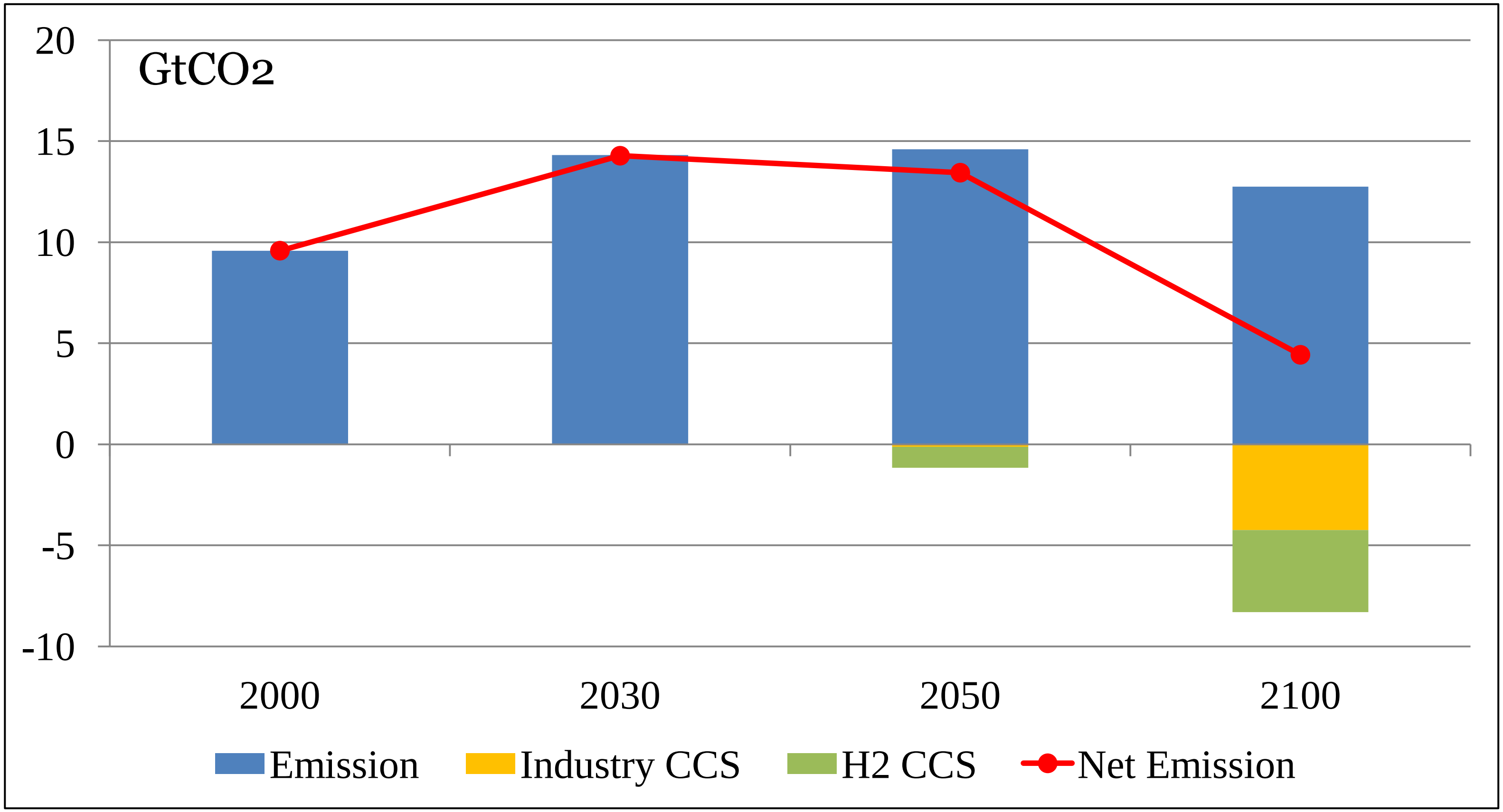
Energy for Industry and Residential



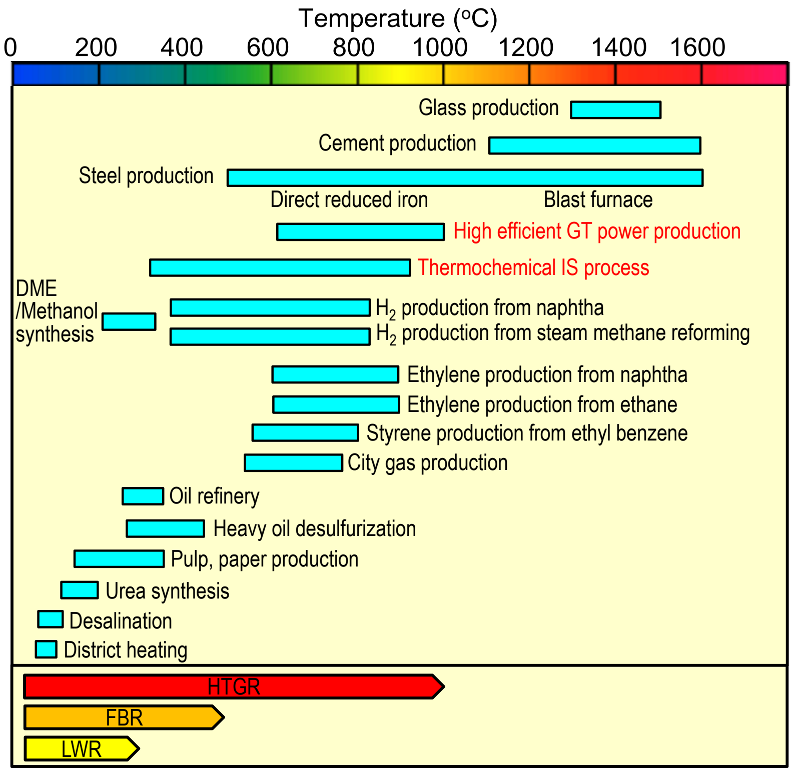


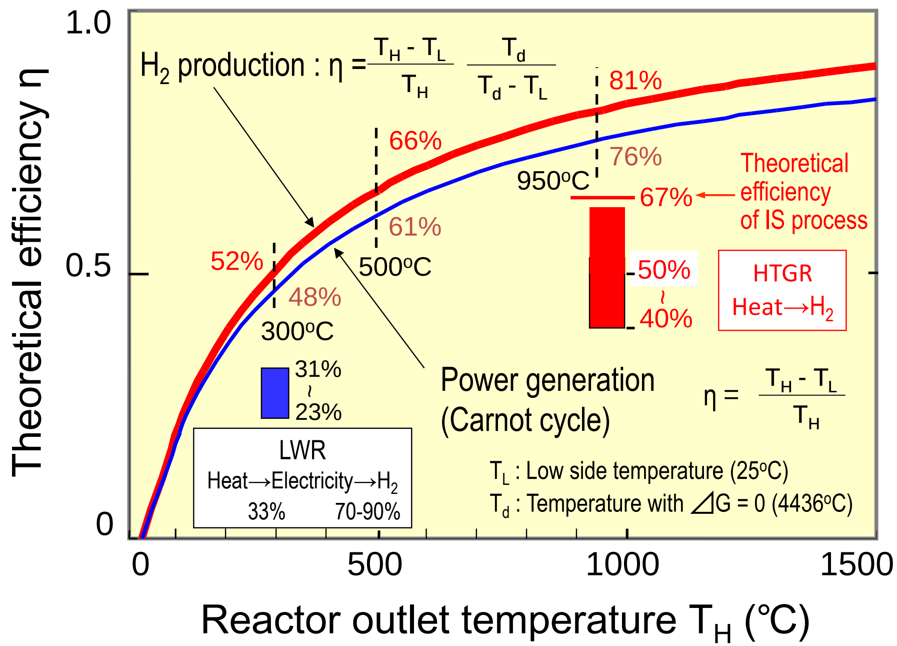
Energy for Hydrogen Production in 2100

Emission from Industry and Residential



Possibility of Heat Supply by HTGR





Masuro OGAWA, CIGS 3rd international symposium on global warming

Sample Scenario for HTGR Utilization

Mission

To keep the same emission pathway by reallocating emissions between power and industrial sectors

Modification

To replace a part of fossil heat resource by HTGR in industrial sector
To replace LWR/FBR by the replaced fossil fuel in power sector

Fuel Target and Scale

Natural gas:
- low carbon intensity and high power generation efficiency
- occupies approximately 20% of total industrial energy consumption

HTGR application scale:
- 2000 module (2030), 6000 module (2050), 6000 module (2100) *
- 1 HTGR module (200MWt with 90% operational rate) = 0.136MTOE

*NGNP: 1000 module in 2030 and 3000 module in 2050 in US

Changes by Modification

<table>
<tr><th colspan="2"></th><th>2030</th><th>2050</th><th>2100</th></tr>
<tr><td rowspan="3">Industrial sector</td><td>Increasing HTGR (GWt)</td><td>400</td><td>1200</td><td>1200</td></tr>
<tr><td>Heat supply* (MTOE)</td><td>218</td><td>653</td><td>653</td></tr>
<tr><td>Replacing gas (MTOE)</td><td rowspan="2">230</td><td rowspan="2">690</td><td rowspan="2">690</td></tr>
<tr><td rowspan="3">Power sector</td><td>Increasing gas (MTOE)</td></tr>
<tr><td>Power generation** (TWh)</td><td>1740</td><td>5215</td><td>5215</td></tr>
<tr><td>Replacing nuclear *** (GWe)</td><td>235</td><td>700</td><td>700</td></tr>
</table>

*the heat utility efficiencies for HTGR and Gas is 80% and 95% respectively
**the power generation efficiency of gas is 65%
***the operational rate of LWR/FBR is 85% in the model

Different Nuclear Scenarios

Current: power only		2030	2050	2100
LWR	Electricity (TWh)	6037	10758	1655
	Fuel (MTOE)	1512	2407	344
FBR	Electricity (TWh)	-	2788	17942
	Fuel (MTOE)	-	551	3342
Primary fuel (MTOE)		1512	2407	344
Cycled fuel (MTOE)		-	551	3342

Cumulative primary fuel (2030~2100): 108GTOE

Different Nuclear Scenarios

Alternative: power + heat		2030	2050	2100
LWR	Electricity (TWh)	4297	5543	0
	Fuel (MTOE)	1075	1240	0
FBR	Electricity (TWh)	-	2788	14382
	Fuel (MTOE)	-	551	2679
HTGR	Heat (MTOE)	218	653	653
	Fuel (MTOE)	272	816	816
Primary fuel(MTOE)		1347	2056	816
Cycled fuel (MTOE)		-	551	2679

Cumulative primary fuel (2030~2100): 106GTOE

Different Nuclear Scenarios

Capacity		2030	2050	2100
Current Scenario	LWR (GWe)	810	1445	220
	FBR (GWe)	-	375	2410
Alternative Scenario	LWR (GWe)	575	745	0
	FBR (GWe)	-	375	1930
	HTGR (GWt)	400	1200	1200

Impact to System Cost

A simple estimation

Cost unit: Billion $			2030	2050	2100
Cost Up	HTGR (1440$/KWt)*	GWt	400	1,200	1,200
		Cost	11.5	34.5	34.5
	Heat Pipeline (3 million $/km)**	km	20,000	60,000	60,000
		Cost	2.0	6.0	6.0
	GTCC (750$/KWe)*	GWe	235	700	700
		Cost	5.9	17.5	17.5
Cost Down	Gas Pipeline (3 million $/km)**	km	20,000	60,000	60,000
		Cost	2.0	6.0	6.0
	LWR (3,600$/KWe)*	GWe	235	700	220
		Cost	16.9	50.4	15.8
	FBR (4500$/KWe)*	GWe	-	-	480
		Cost	-	-	43.2
	FBR Fuel*** (80$/TOE)	MTOE	-	-	663
		Cost	-	-	53.0
Total impact (cost down)			-0.5	-1.6	60.0

*IEA and JAEA **METI (Improvement of Gas Infrastructure) ***IAE(GRAPE)