Comparison of RITE DNE21+ Scenario and ETP2008 Scenario

July 22, 2008

International Energy Agency (IEA) released Energy Technology Perspective (ETP) 2008 on June 6, 2008. In this paper, we compare the analysis scenario of RITE DNE21+ and IEA ETP2008 to characterize DNE21+ and look into the common perspectives on energy and global warming measures.

1. Introduction

IEA ETP2008 is modeled with a bottom-up approach of particular technologies to seek the energy system to minimize the total worldwide energy costs over all the assessment period up to 2050 and has quite a similar structure to that of RITE DNE21+. Table 1 shows the features of DNE21+, IEA ETP2008 (analysis focused on 2050) and IEA World Energy Outlook (WEO) 2007 (analysis focused up to 2030)

Table 1 Comparison of RITE DNE21+, IEA ETP2008, IEA WEO2007

	RITE DNE21+	IEA ETP2008 (based on ETP model and MARKAL)	IEA WEO2007 (World Energy Model (WEM) Ver.11)
Model type	Dynamic optimization	Dynamic optimization	Simulation (partial equilibrium)
Assessment period	2000-2050	2005-2050	2005-2030
Divided regions	54	15	21
Technology particulars	Particular	Particular	Relatively simple

2. Model Assumption

(1) Population scenario

Table 2 shows assumed population of IEA ETP2008 and DNE21+. Slight differences can be found but both use United Nations' World Population Prospects, The 2006 Revision and the assumptions are almost the same.

Table 2 The world population prospects in RITE DNE21+ and IEA ETP2008

(billion people)

	2005	*2015*	*2030*	*2050*
RITE DNE21+ (2008.3)	6514.8	7295.1	8317.7	9191.3
IEA ETP2008	6464.8	7295.1	8246.7	9191.3

(2) Macro-economic scenario

Table 3 shows assumed GDP by IEA ETP2008 and RITE DNE21+. Note that RITE DNE21+ is based on MER (market exchange ratio), while IEA ETP2008 is based on PPP (purchasing power parity).

Table 3 GDP projections by RITE DNE21+ and IEA ETP2008

	2005-15	*2015-30*	*2030-50*
DNE21+(2008.3) (**MER**, %/yr)			
OECD	2.7	2.2	1.0
Transition economies	3.6	2.4	5.4
Developing Asia	6.2	4.9	3.8
Middle East	4.4	3.5	4.6
Africa	3.9	3.2	5.2
Latin America	3.5	2.9	5.0
World	3.2	2.8	2.3
IEA ETP2008 (**PPP**, %/yr)			
OECD	2.5	1.9	1.4
Transition economies	4.7	2.9	3.4
Developing Asia	6.9	4.8	3.6
Middle East	4.9	3.4	2.9
Africa	4.5	3.6	3.6
Latin America	3.8	2.8	2.8
World	4.2	3.3	2.6

3. Baselines and Scenarios to Reduce 50% World Emissions by 2050

(1) Overview measures

Figure 1 shows IEA ETP2008 analyses of sectoral and technological reductions to halve the world CO2 emissions by 2050. Fig.2 and Fig.3 show DNE21+ analyses as

well. It could be said that both analyses are quite similar., The baseline emissions are upwardly revised from 58 GtCO2 in ETP2006 to 68GtCO2 in ETP2008, because China and India have high economic growth potentials and the soaring prices of oil and gas cause a shift to coal. Compared with the baseline emissions in DNE21+, relatively big differences are considered seemingly, which is largely due to different definitions of baseline emissions in ETP2008 and DNE21+. More details are described hereinafter.

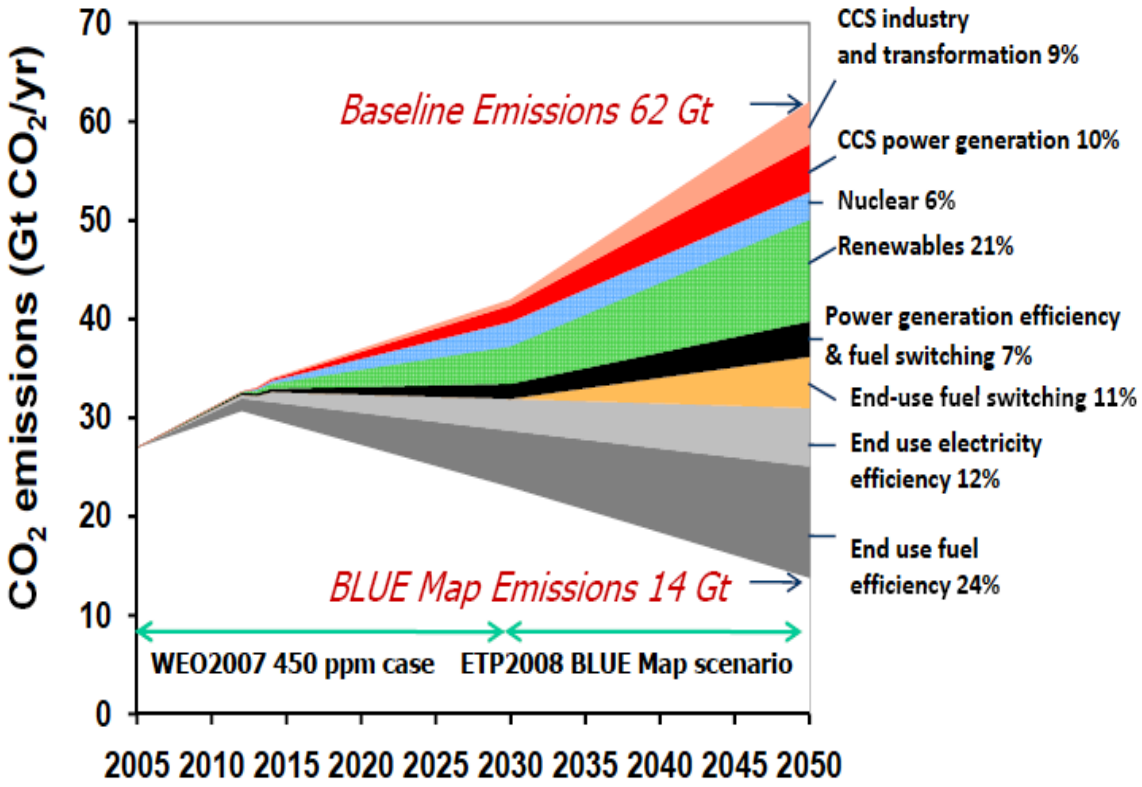

Fig.1 IEA ETP: Cutting energy related CO2 emissions in half by 2050

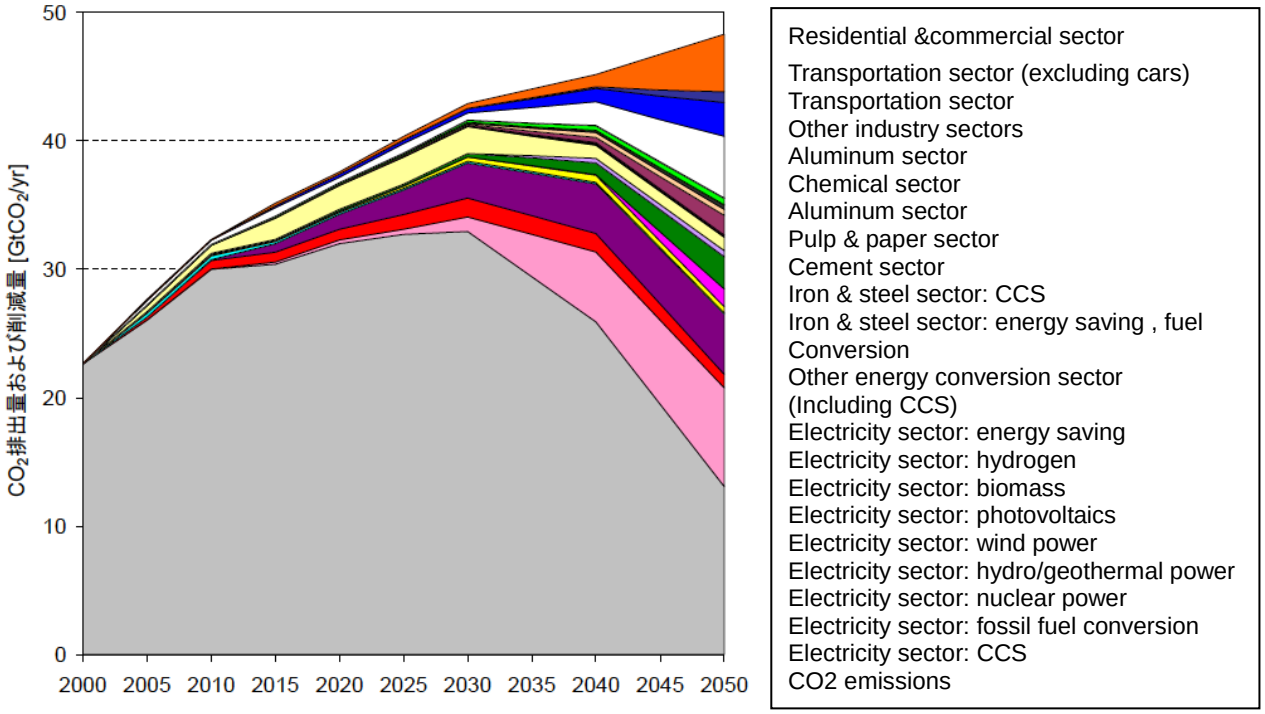

Fig.2: DNE21+ (March, 2008): Cutting energy related CO2 emissions in half by 2050

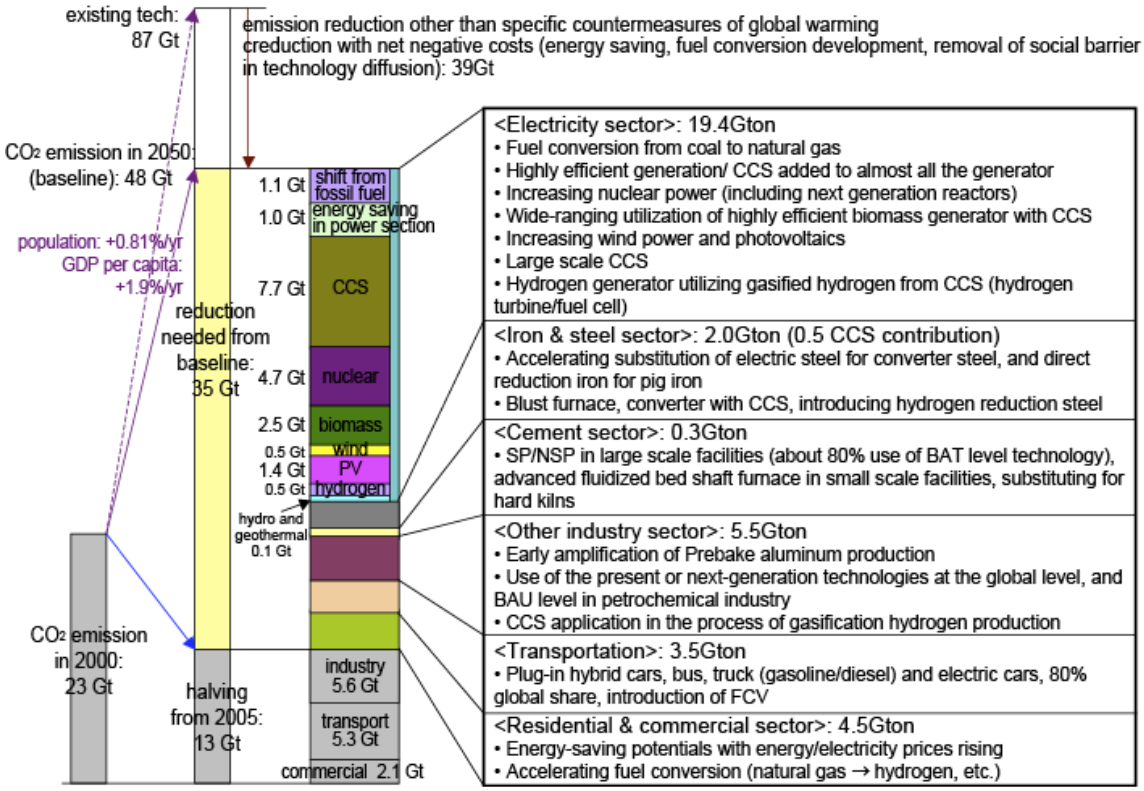

Fig.3 DNE21+ (March, 2008): Cutting energy related CO2 emissions in half by 2050
(at the year of 2050 shown in section,)

ETP2008 assesses the marginal cost from 200 to 500 $/tCO2 to halve CO2 emissions by 2050 (Fig.4), whereas DNE21+ estimates 334$/tCO2 (Fig.5). Both models have the similar findings.

As previously noted, 2050 baseline emissions of ETP2008 62 GtCO2 and DNE21+ 48GtCo2 seem to be quite different but Fig.4 shows that the marginal cost to reduce 15GtCO2 would be negative net in ETP. DNE21+ baseline emissions are equivalent to the emissions assumed that all the measures are taken in case of the negative marginal cost. According to this definition, ETP2008 emission is 62-15=47 GtCO2, therefore both models have the similar baseline emissions. The comparison of Fig. 4 and 5 would make it easier to find the reduction costs of both are similarly associated with the marginal abatement costs.

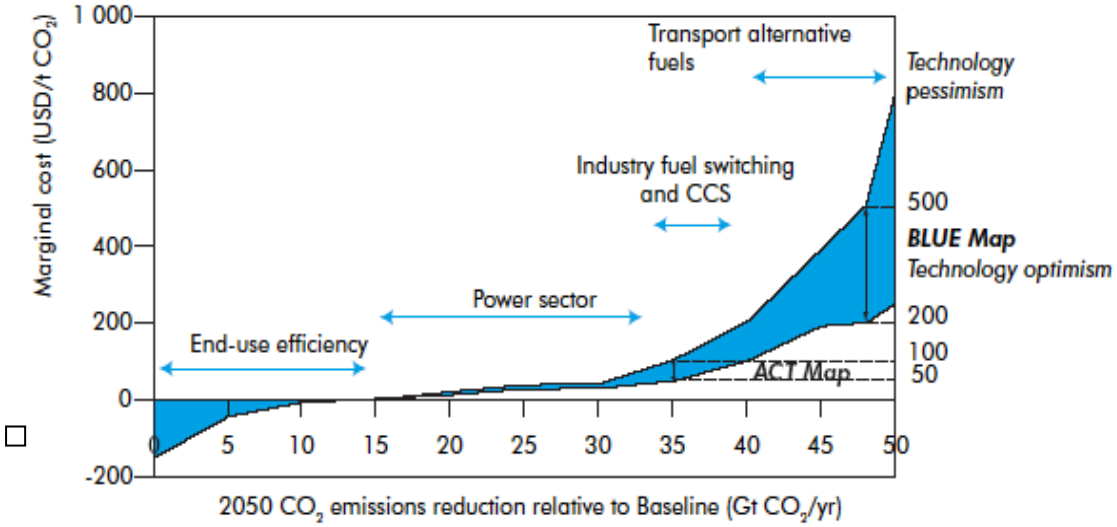

Fig.4 IEA ETP 2008: Marginal abatement cost for the global energy system, 2050

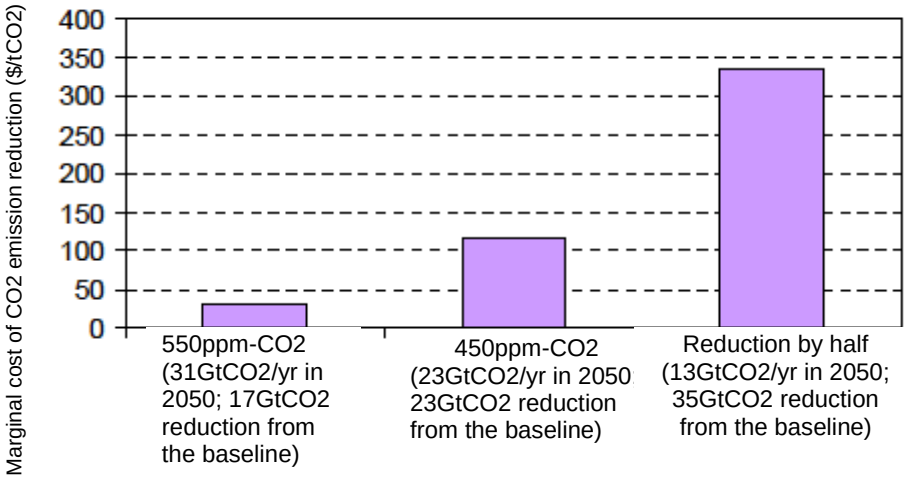

Fig.5 RITE DNE21+: Marginal abatement cost for the global energy system, 2050

Note) The abatement costs for 550ppm, 450ppm and reduction by half are comparable to those for 32, 40, 50 GtCO2 emissions in Fig.4, since DNE21+ baseline is assumed that the abatement cost is 0.

(2) Electricity sector

Fig. 6 and 7 show the global electricity production scenarios in IEA ETP2008 and DNE21+ respectively. Both scenarios appear similar, except wind power in 'BLUE MAP 2050' is estimated more than that 'In reduction by half in 2050' and biomass 'In reduction by half in 2050' is more than that in 'BLUE MAP 2050.'

Fig. 7 and 8 shows additional facility investment in the electricity sector from 2010 to 2050. They indicate that massive investments are required.

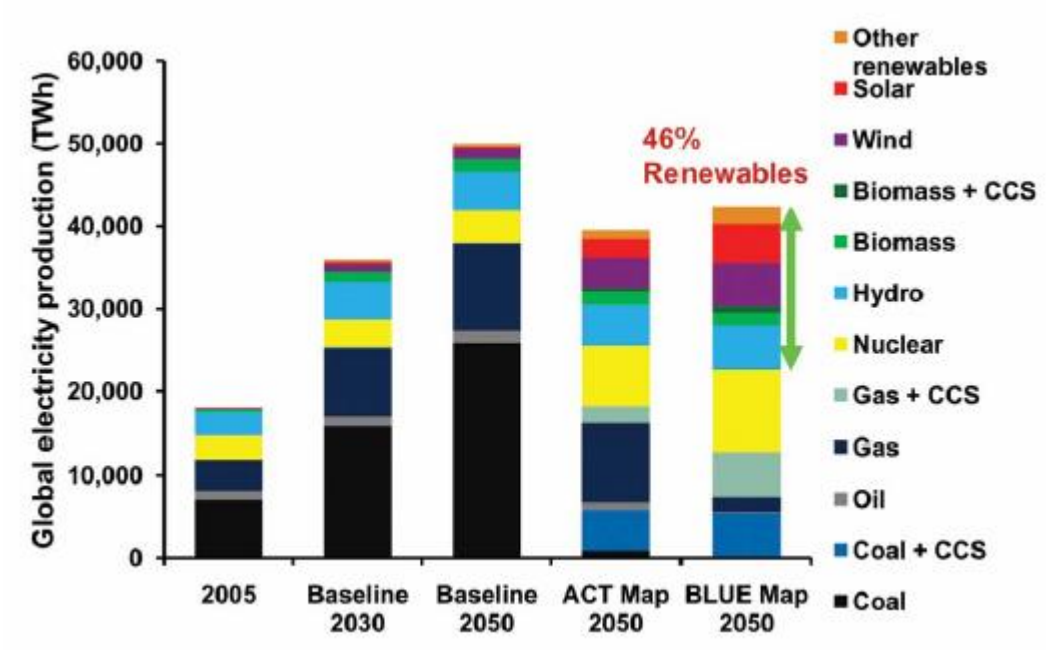

Fig. 6 IEA ETP 2008: Global electricity production by fuel in the Baseline, ACT Map and BLUE Map scenarios, 2005, 2030 and 2050

Note) ACT MAP: Based on the assumption of 50$/tCO2. emissions in 2050 are almost the same level in 2005

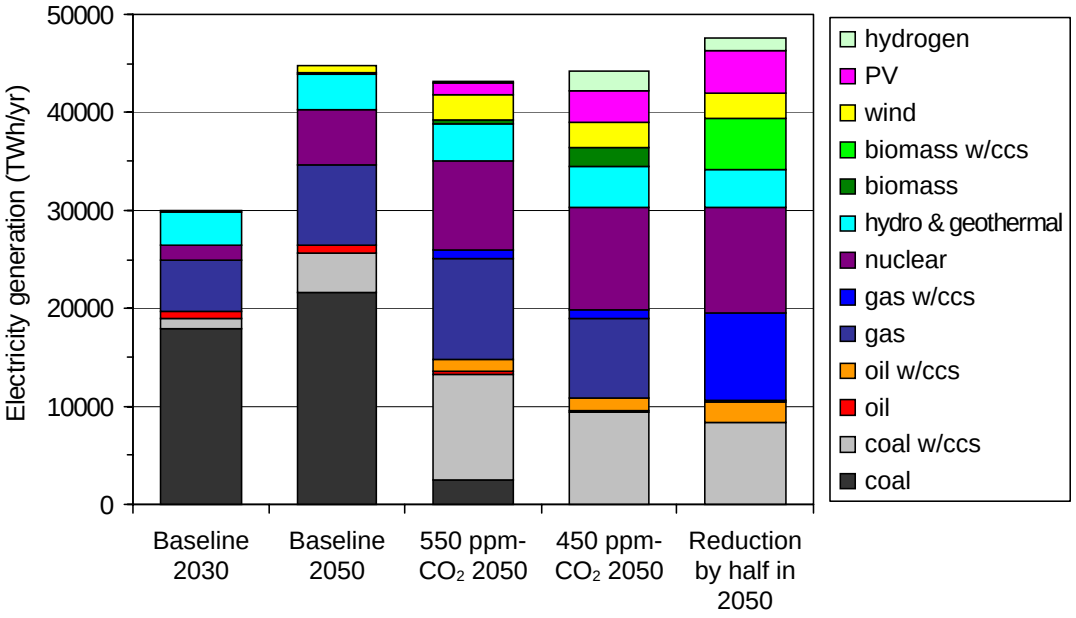

Fig.7 DNE21+: Global electricity production by fuel in five scenarios

Note) 550ppm-CO2: emissions in 2050 are 34 GtCO2, MAC is 31$/tCO2
450ppm-CO2: emissions in 2050 are 23 GtCO2, MAC is 115$/tCO2
ACT MAP in Fig.6 is a scenario between 550ppm-CO2 and 450ppm-CO2 in DNE21+

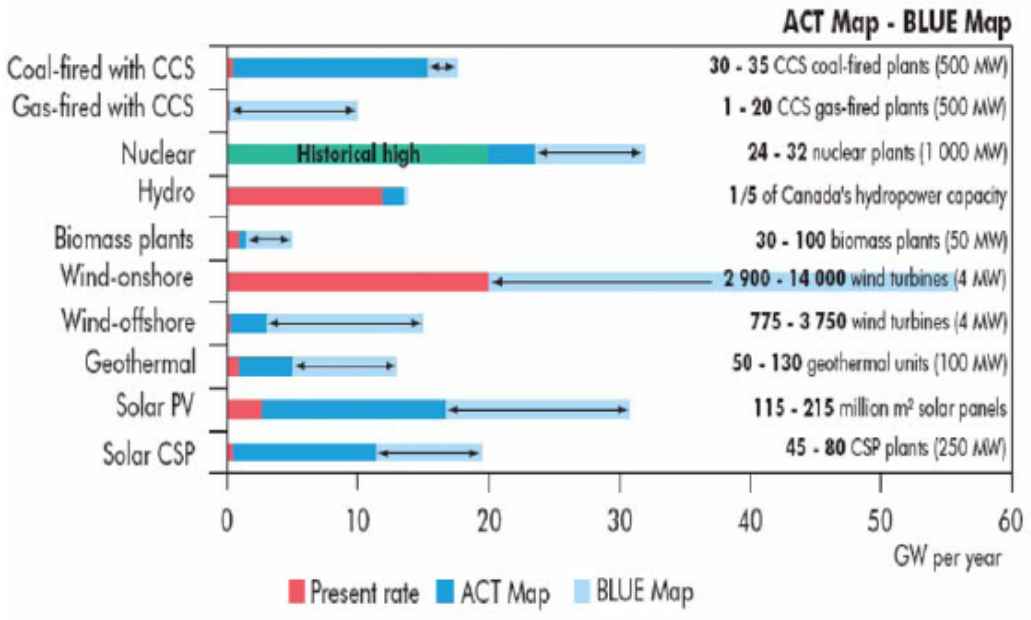

Fig.8 IEA ETP: Additional facility investment in the electricity sector from 2010 to 2050

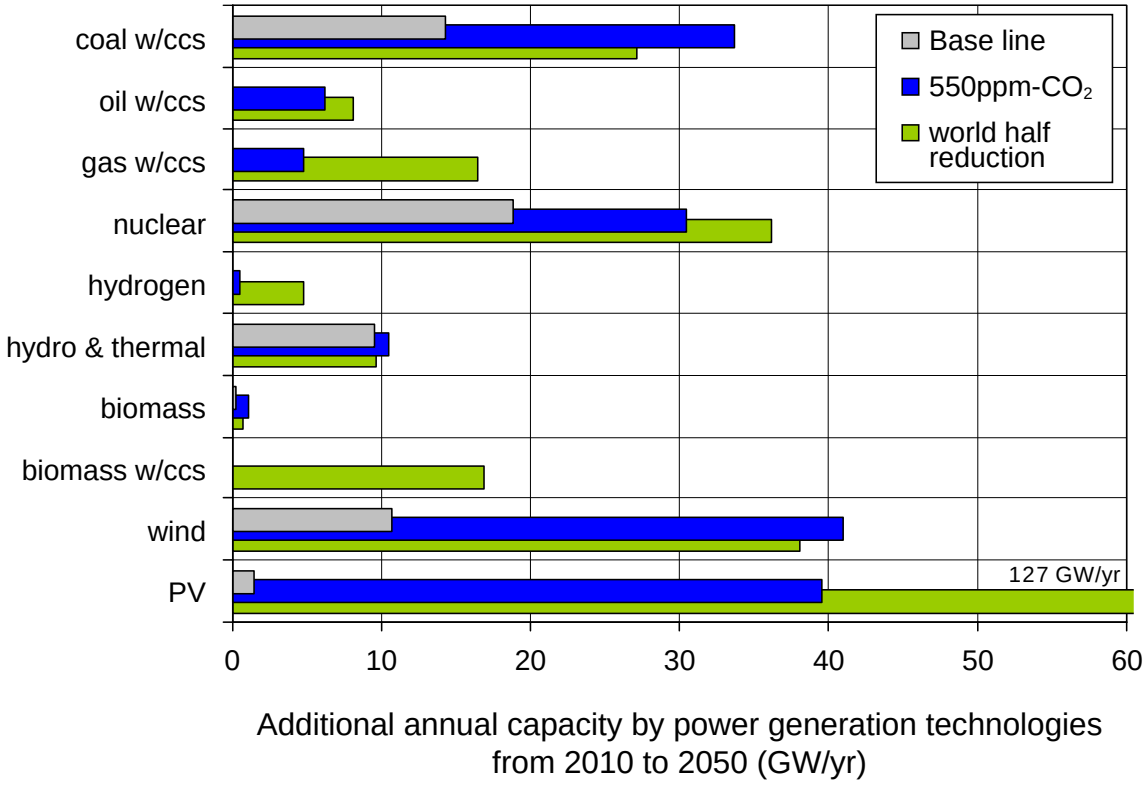

Fig.9 DNE21+: Additional annual capacity by power generation technologies from 2010 to 2050

Note) Hydro, geothermal: assumed the facility operating rate 30%, the technical life for 50 years
Wind: assumed the facility operating rate 20%, the technical life for 30 years
Photovoltaics: assumed the facility operating rate 10%, technical life for 30 years
In comparison of Fig.8 and 9, DNE21+ analyzed more investment in photovoltaics is required, on the other hand, Fig.7 shows the similar electricity production by photovoltaics in both models. This is because DNE21+ estimated the facility operating rate 10% but ETP2008 seems to estimate the higher rate.

(3) Iron & Steal sector

Table 4 shows global crude-steel production and scrap-based EAF steel production scenarios. Crude-steel production is more in ETP2008 scenario than in DNE21+. Also scrap-based EAF steel production is assumed to share more in ETP2008 scenario than in DNE21+. Figure 10 shows ETP CO2 emission scenarios in iron and steel sector. Following efficiency and fuel and feedback switching, CCS is the most effective in reduction. Meanwhile the effects in emission reduction depend on how measures of energy supply sector are accounted for the effects in the final demand sector, which makes direct comparison with DNE21+ difficult

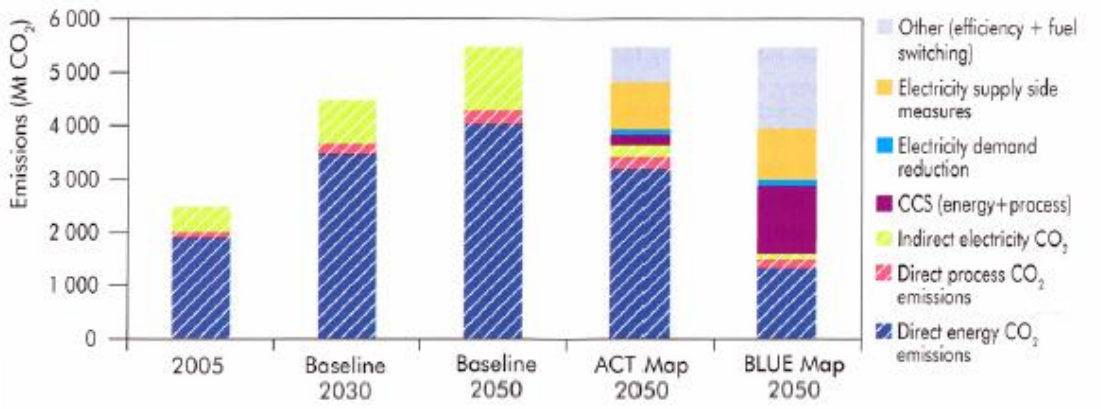

Fig.10 IEA ETP: CO2 emissions and reduction in Iron and steel sector

Table 4: ETP/DNE21+ scrap-based EAF steel production scenarios at 2050

	World crude-steel production (equal in all scenarios)	Scrap-based EAF steel production	
		Baseline	World reduction by half
IEA ETP2008	2.7Gt	1.1Gt	1.4Gt
RITE DNE21+(2008.3)	2.16Gt	0.61Gt	0.83Gt

Note) The numeric values in IEA EYP2008 were represented by reading the graph.

The effective emission reduction in iron and steel sector at 2005 is estimated 2Gt in DNE21+ (fig. 3). Fig.11 shows effective measures such as energy saving, fuel switching and CCS to reduce emissions by half. And Fig. 12 shows effective technological options. In DNE21+, most of improved energy efficiency of blast furnace and basic oxygen furnace is included in the baseline and consequently not allocated to the baseline reduction ratio in the half reduction case.

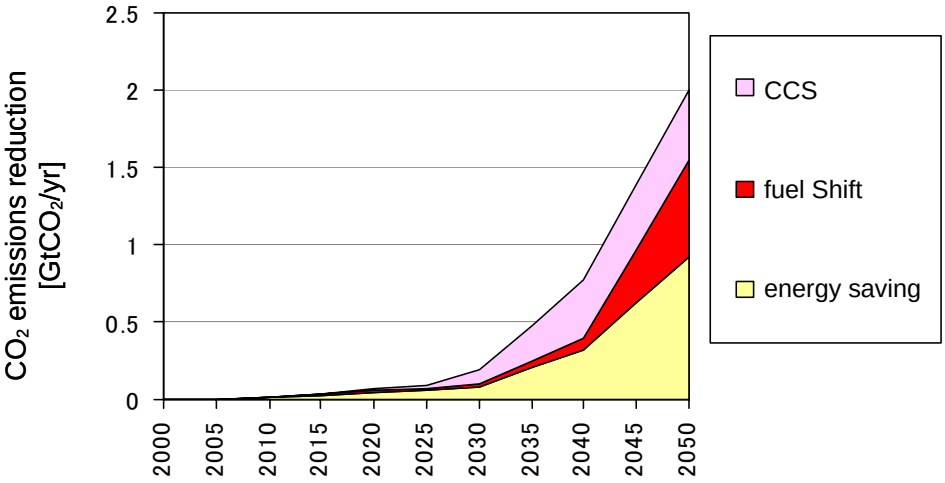

Fig.11 DNE21+ model: iron and steel sector, estimated reduction from the baseline by technology to reduce global emissions half at 2050 (by group)

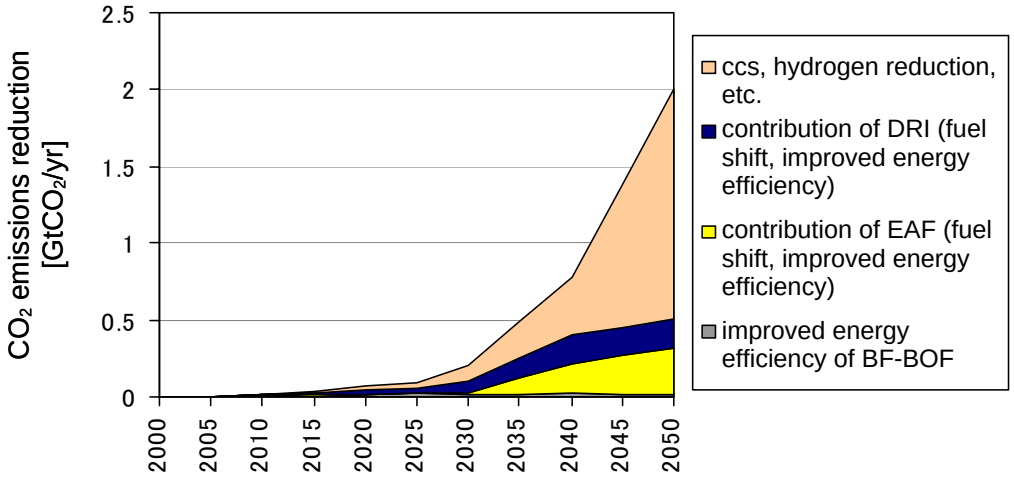

Fig.12 DNE21+ model: Iron and steel sector, estimated reduction from the baseline by technology to reduce global emissions half at 2050 (by option)

Fig.13 shows the baseline and technology scenario of iron and steel sector for the world half reduction in DNE21+.

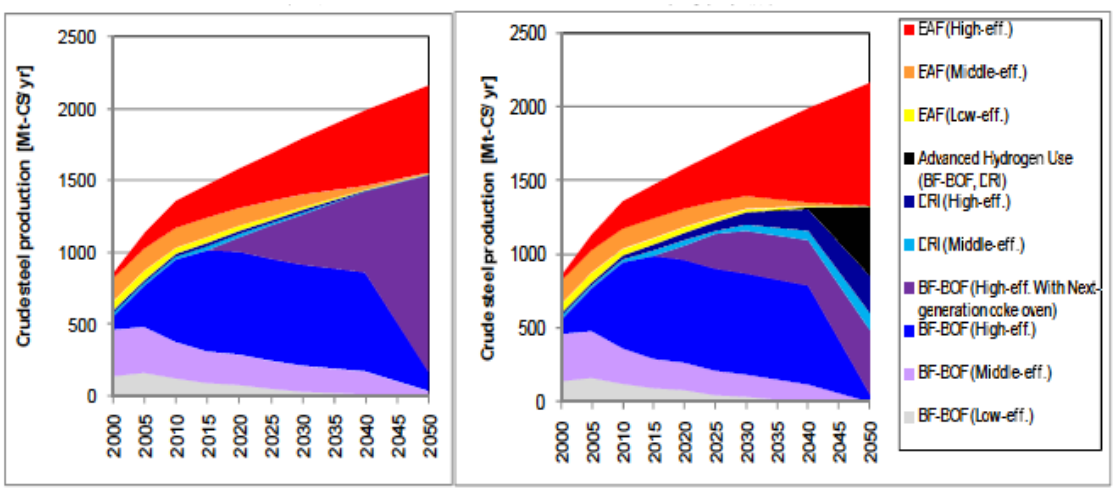

Fig.13 DNE21+ model (March, 2008): Baseline and technology scenario for global half reduction at 2050 in iron and steel sector

(4) Transportation sector

Fig.14 shows energy use by year and scenario and Fig.15 shows light-duty vehicle sales shares by scenario in 2050 of IEA ETP. As for DNE21+, Fig.16 shows by year in the baseline and world half reduction scenarios and Fig.17 shows light-duty vehicle induction scenarios.

Both assessments are significantly similar but ETP tends to assess biodiesel more than DNE21+ at 2050 in the world half reduction scenarios. (Note: The entire transportation sector is included in ETP and only automobiles in DNE21+)

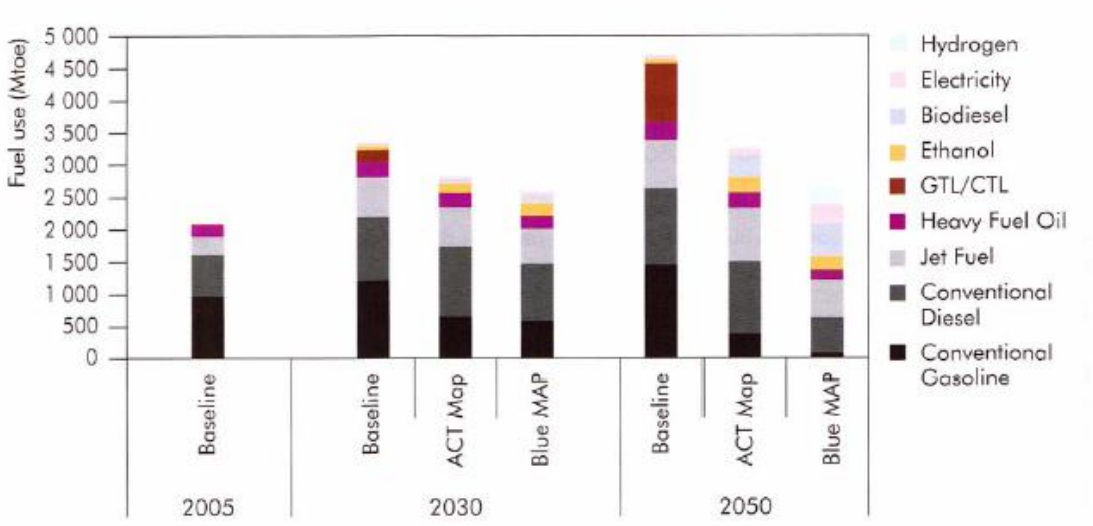

Fig.14 IEA ETP: Energy use by year and scenario in transportation sector

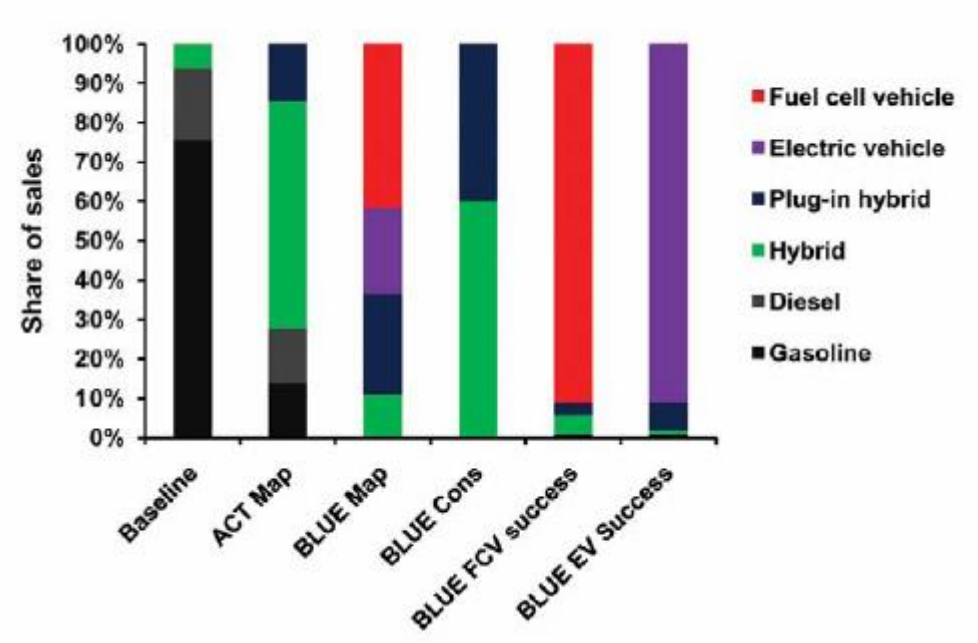

Fig.15 IEA ETP: Light-duty vehicle sales shares by scenario, in 2050

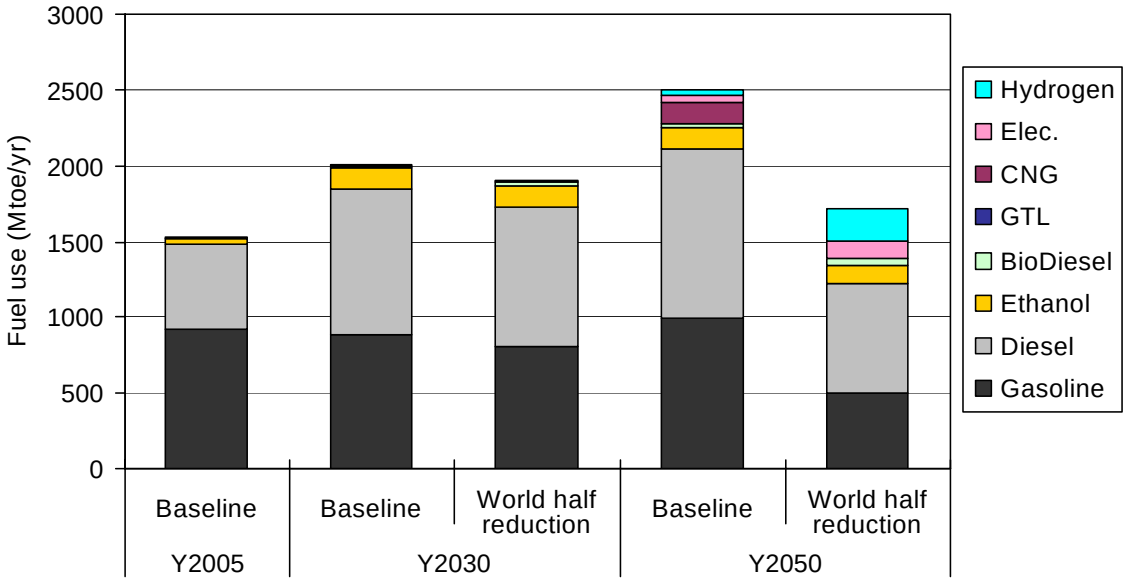

Fig.16 DNE21+: Automobile energy use by year and scenario

Note) Electricity is converted at 0.086 Mtoe to 1TWh.

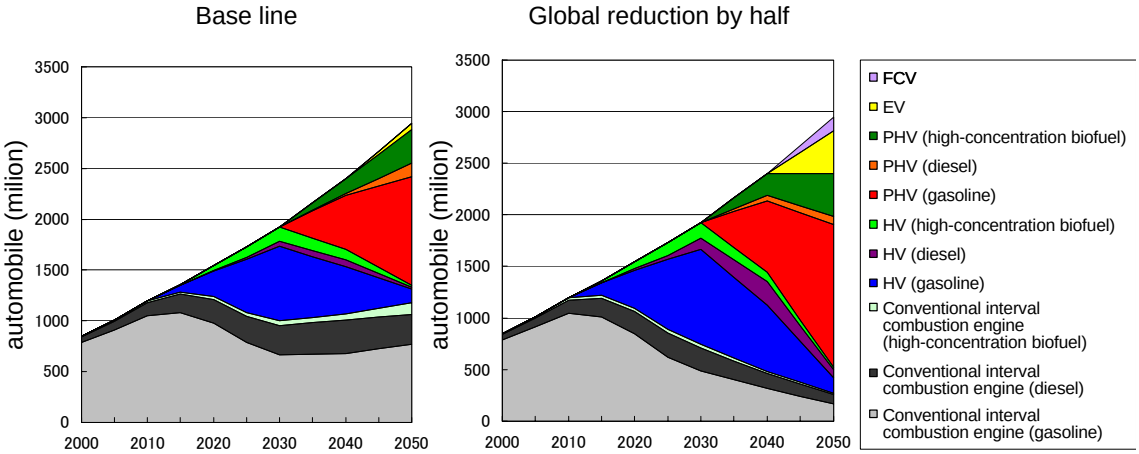

Fig.17 DNE21+: Introduction scenarios of automobiles

(5) Other sectors

Fig.18 and Fig.19 show emission reduction scenarios for the cement sector in IEA ETP2008 and DNE21+. Fig.20 and Fig.21 are for the pulp and paper sector as well. ETP2008 assumes CCS use in the cement and pulp and paper sectors unlike with DNE21+. It needs more consideration whether the prospects of CCS use in the cement and pulp and paper sectors would be practical or not, focused on matching with CCS sites in the scale. Please note that process-based CO2 emissions of the cement sector are not considered in DNE21+.

There are considerable disparities of CO2 emissions in baselines in both cement and pulp and paper sectors as well as the iron and steel sector, since the baseline definitions differ between the models. CO2 emission of the world reduction by half scenario in IEA ETP2008 which includes CCS is less than DNE21+, but the emission is comparatively similar to that of DNE21+, considering the deduction of the CCS emission.

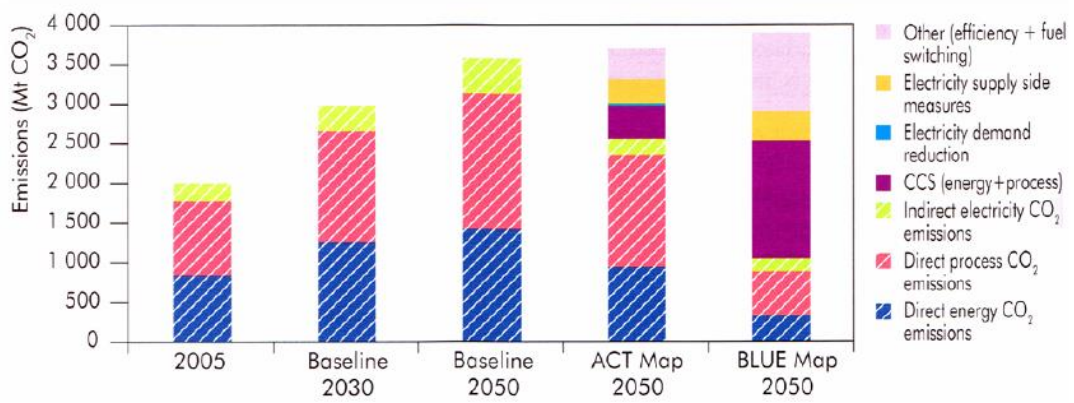

Fig.18 IEA ETP: Cement CO2 emissions in the Baseline, Act Map and BLUE Map scenarios, 2005-2050

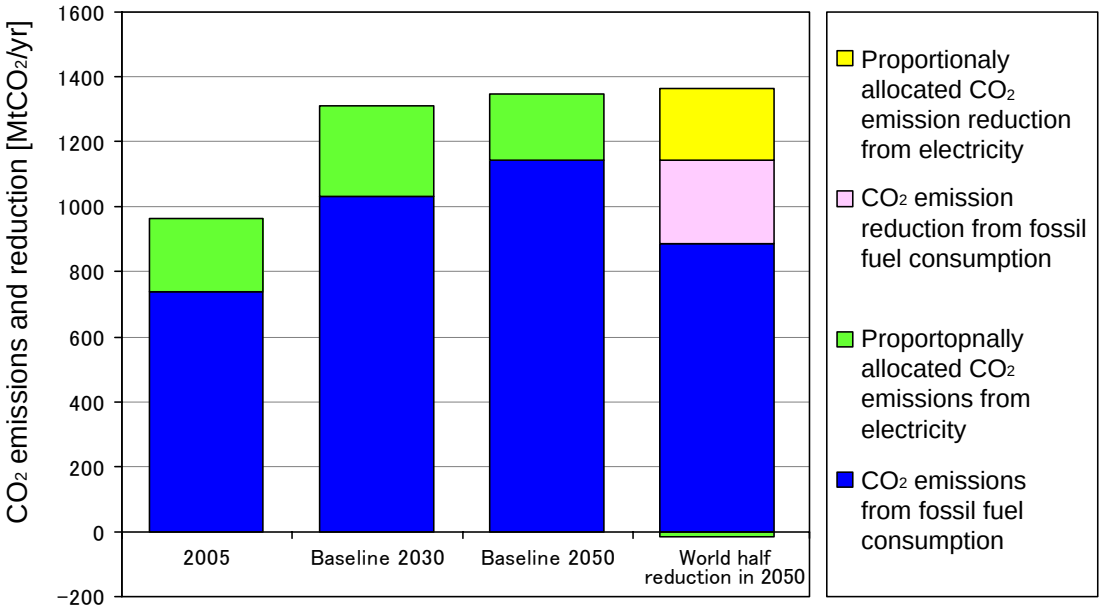

Fig.19 DNE21+: Cement CO2 emissions in the Baseline2030, Baseline 2050 and The world half reduction 2050 scenarios, 2005-2050

Note) CO2 emissions derived from fossil fuel: CO2 emissions from fossil fuel consumption in the relevant sector.
Proportionally allocated CO2 emissions from electricity: Proportionally allocated CO2 emissions from the electricity sector, in proportion as purchased electricity from the sector.
CO2 emission reduction derived from fossil fuel: CO2 emission reduction with fossil fuel consumption suppressed to save energy in the relevant sector.
Proportionally allocated CO2 emission reduction from electricity: Energy-saving allows purchases of less electricity to reduce CO2 emission in the relevant sector, along with the CO2 emission reduction to improve the emission basic units in the electricity sector.
Please note that sectoral CO2 emission reduction in Fig.2, Fig.3 is a different thing.

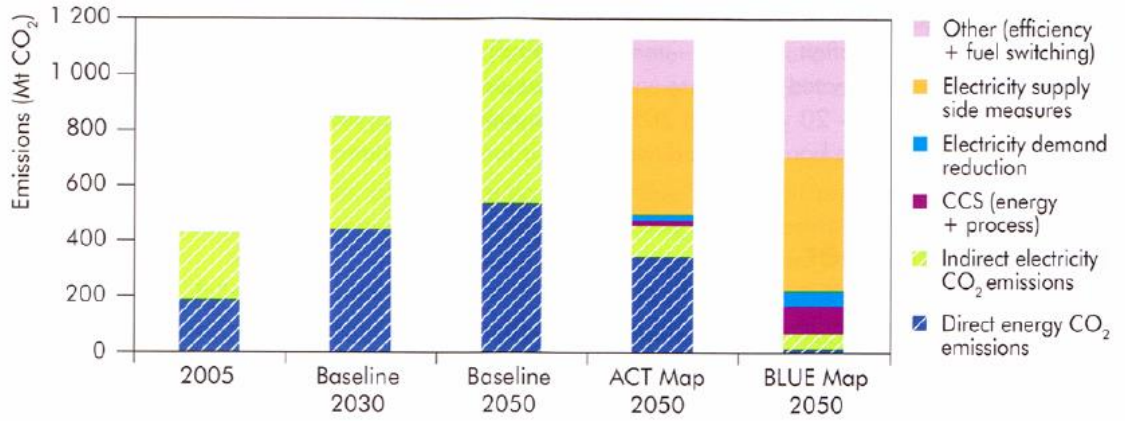

Fig.20 IEA ETP: Pulp and paper industry CO2 emissions in the Baseline, Act Map and BLUE Map scenarios, 2005-2050

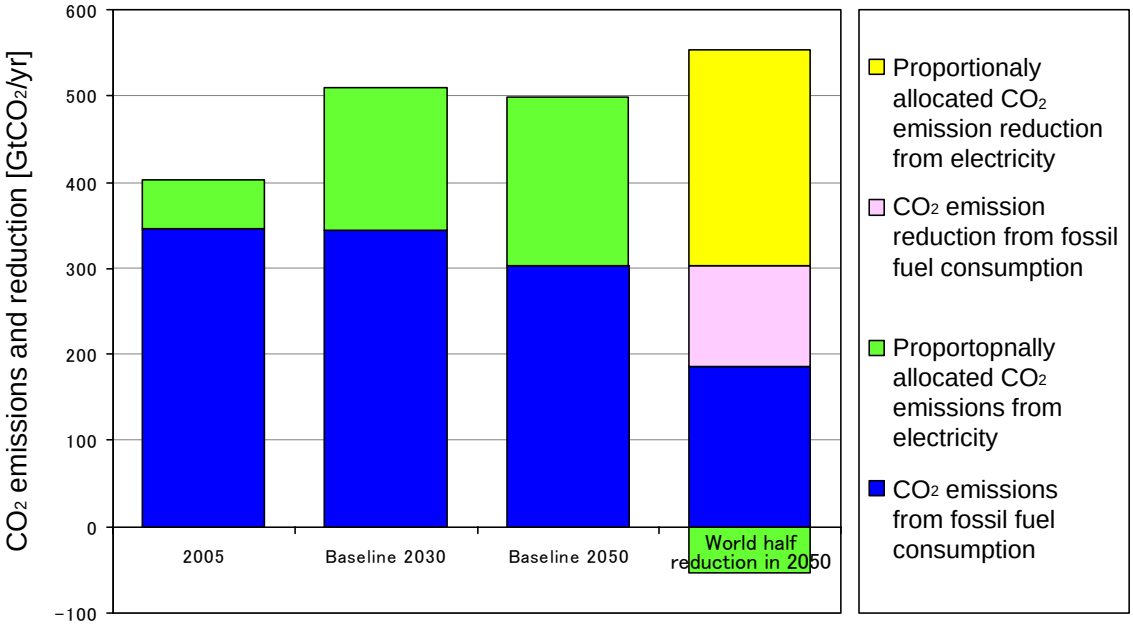

Fig.21 DNE21+: Pulp and paper industry CO2 emissions in the Baseline 2030, Baseline 2050 and The world half reduction 2050 scenarios, 2005-2050

Note) CO2 emissions derived from fossil fuel: CO2 emissions from fossil fuel consumption in the relevant sector.
Proportionally allocated CO2 emissions from electricity: Proportionally allocated CO2 emissions from the electricity sector, in proportion as purchased electricity from the sector.
CO2 emission reduction derived from fossil fuel: CO2 emission reduction with fossil fuel consumption suppressed to save energy in the relevant sector.
Proportionally allocated CO2 emission reduction from electricity: Energy-saving allows purchases of less electricity to reduce CO2 emission in the relevant sector, along with the CO2 emission reduction to improve the emission basic units in the electricity sector.
Please note that sectoral CO2 emission reduction in Fig.2, Fig.3 is a different thing.

4. Summary

In this paper IEA ETP2008 and RITE DNE21+ are analyzed and compared. Varied

model assumptions follow that the future scenarios show variations. Although some different details can be found between IEA and RITE scenarios, overall results analyzed are very similar.

Reference

[1] IEA, Energy Technology Perspective 2008.
[2] IEA, World Energy Outlook 2007.
[3] RITE System Analysis Group, Overview of DNE21+: Global Assessment Model for Energy and Climate Change,
http://www.rite.or.jp/Japanese/labo/sysken/about-global-warming/download-data/DNE21+_Overview.pdf