

## Long Term Strategy for Mitigating Climate Change

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### 1. Needs for substantial reduction of GHG emission

No need to say that climate change is one of the most serious global environmental issues to be solved as soon as possible. Conference of parties of framework convention of climate change ( COP ) has a key role of determining future direction of mitigation strategy, and the coming COP 15 at Copenhagen in December 2009 will, hopefully, provide with the guideline of reducing greenhouse gases(GHG's) emission, particularly of developed countries for next 10 years.

However climate change is a very long term issue and the final target we pursue is to stabilize concentration of GHG's in the air so as to prevent further change of global climate. This is not an easy task, as stabilization of the level in the air of CO<sub>2</sub>, the main GHG, requires its anthropogenic emission to be equal to the persistent natural absorption of CO<sub>2</sub> in the earth and ocean, which is, according to IPCC 3<sup>rd</sup> report[1], less than 0.1 pg C, while the present anthropogenic emission of CO<sub>2</sub> is about 7 pg C.

Therefore the ultimate target in mitigating climate change is to decarbonize primary energy almost

completely. 88% of world commercial primary energy (2006) being fossil fuels, it will require more than a hundred years to achieve the target.

### 2. Measures for decarbonization

Shown in fig. 1 is the structure of CO<sub>2</sub> emission of Japan.

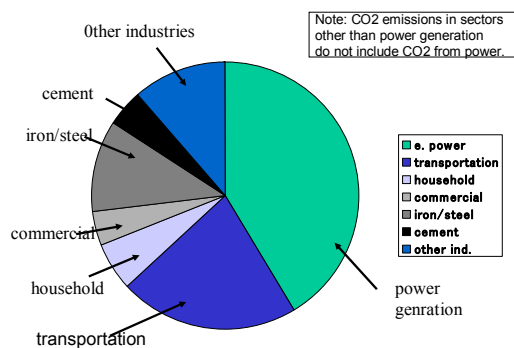


Fig.1 CO<sub>2</sub> emission in Japan(2007)

Most of CO<sub>2</sub> emitted in iron & steel industry and cement industry is from their production processes, so the structural changes in these processes are required to reduce CO<sub>2</sub> substantially. There are already a few studies toward this end such as reduction of iron ores by hydrogen in stead of carbon.

CO<sub>2</sub> emitted in transportation comes mostly from automobiles, which will be in future replaced by electric vehicles and/or fuel cell vehicles. The fuel for the latter is hydrogen, which will be produced by thermo-chemical dissolution of water with the heat from high temperature gas nuclear reactor.

CO<sub>2</sub> in household and commercial sectors comes mainly from spending fossil fuels for low temperature heat demand such as air-conditioning and hot water supply. We expect in future that heat pumps with high coefficient of performance will supply such heat from low temperature renewable energy sources such as geoheat and water sources which are higher in temperature than the outside air. Heat pumps will be operated by electric power, so how much CO<sub>2</sub> will be emitted in these sectors depends fully upon primary energy sources of electric power.

In sum CO<sub>2</sub> from transportation, household and commercial sectors will in future come mainly from generation of electric power which will be main energy for these sectors. Therefore the key measures for decarbonizing these sectors are the same as those for power generation sector.

Three technologies will play key roles: the first is nuclear power, the second renewable energy such as wind and solar power ( photovoltaics ), and the third carbon dioxide capture and storage ( CCS ).

Nuclear power already occupying 16% of global power supply (in kwh, 2006 ), we expect its further expansion in the world. Although the life time of uranium resource is limited, adoption of nuclear fuel cycle including high breeder reactor will multiple it several ten times. One of the serious barriers of the road toward this direction is the nuclear non-proliferation policy of major countries, which I hope will be reconsidered in future.

Renewables are certainly promising

options and have been rapidly expanding in most developed countries. They have however a problem of output variability when connected to power grids, which is to be solved only by development of large scale, low cost batteries.

CCS is a useful measures for realizing zero emission of CO<sub>2</sub> while utilizing fossil fuels. Therefore we expect the role of CCS as effective measures in the transient period from present to post fossil fuel age. There are many plans in the world to implement it at various plants spending fossil fuels[2], and efforts for reducing costs of capturing CO<sub>2</sub> in flue gases will help realize CCS widely in the world.

### **3.Conclusion**

Stabilization of climate change requires decarbonization of primary energy, which is a very ambitious, long term task. Drastic efforts for more than a hundred years are indispensable to achieve this target.

### **References**

- 1.IPCC 3<sup>rd</sup> report, WG-1, pp.224, Cambridge university press, 2001
2. See Greenhouse cuttings in every issue of Greenhous Issues ( Quarterly Issues), IEA Greenhouse Gas R&D Programme