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Assessment of restrictions on public financing for new coal-fired power plants overseas and proposed regulation

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Restrictions on public financing for new coal-fired power plants overseas

- **June, 2013**

U.S. President Obama presented his Climate Action Plan, and called for an end to U.S. government support of public financing for new coal plants overseas, except for

  - **The most efficient coal technology available in the least developed countries with no other economically feasible alternatives**
  - **Facilities deploying CCS technologies**

- **October, 2013**

The U.S. Department of the Treasury announced the guidance for U.S. positions on Multilateral Development Banks (MDBs) engaging with developing countries on coal-fired power plants. The conditions for financing are as follows;

  - **In IBRD and IDA-blend equivalent counties, the plants should deploy CCS to reduce the carbon intensity to a level of 500gCO_2eq./kWh.**
  - **In IDA-only countries, the plants should employ the best available technology that is practically feasible.**

- **The objective of restricting financing is to promote the investment in clean energy by regulating coal-fired power plants that emit more CO2 than other energy .**
- **The finance policy precludes the United States financing new high-efficiency coal-fired power plants in IBRD and IDA-blend countries.**
- **Other governments and MDBs expressed support for the U.S. lending policy.**

International public financing for coal-fired power plants worldwide

- **Rich (2009)**
  - **Examination period: 1994- January 2009**
  - **About $37 billion have been spent on 88 new coal plants and on expansions to and life extensions of the existing plants**
  - **Top three financers: <u>MDBs, Japan, the United States,</u>**
  - **Top three countries receiving funds: Indonesia, the Philippines, China**
- **Schmidt (2013)**
  - **Examination period: 2007- January 2013**
  - **Top three financers: <u>Japan, the United States, MDBs</u>**
- **Ueno et al. (2014)**
  - **Pointing out that estimations by Rich (2009) and (Schmidt 2013) did not fully account for the public financing from the Chinese institutions**
  - **Indicating that China was the major public financer**
- **A carbon emissions performance standard has been proposed to the OECD Export Credit Group (by the U.S. and the U.K.), which will limit export credits for coal power plants (currently under discussion.)**

Problem definitions and research questions

Problem definitions

- **Loophole in the restriction on public financing:**

  There is a possibility that some developing countries construct inexpensive low- or middle-efficiency coal plants with own fund or financed by other financial institutions.

- **It requires time for practical use and deployment of CCS technologies. Why not allow public financing for high-efficiency coal plants to realize stable supply of electricity as well?**

Research questions

- **How much GHGs emissions and average reduction costs will be when a) only new coal plants with CCS are allowed, or b) new highly-efficient coal plants are also allowed ?**
- **To minimize the loophole, what financing conditions are considered?**

Objectives and Method

Objectives

- **We estimate GHG emissions and average reduction costs when**
  - **i) only new coal plants with CCS are allowed, and**
  - **ii) new highly-efficient coal plants (ultra supercritical (USC), advanced USC (A-USC), integrated coal gasification combined cycle (IGCC), integrated coal gasification fuel cell combined cycle (IGFC)) are also allowed.**
- **Moreover, we estimate GHG emissions and average reduction costs in the case in which loophole appears even though considering the case in which only new coal plants with CCS are allowed.**
- **We estimate the amount of financing required to promote the introduction of high-efficiency coal plants in developing countries.**

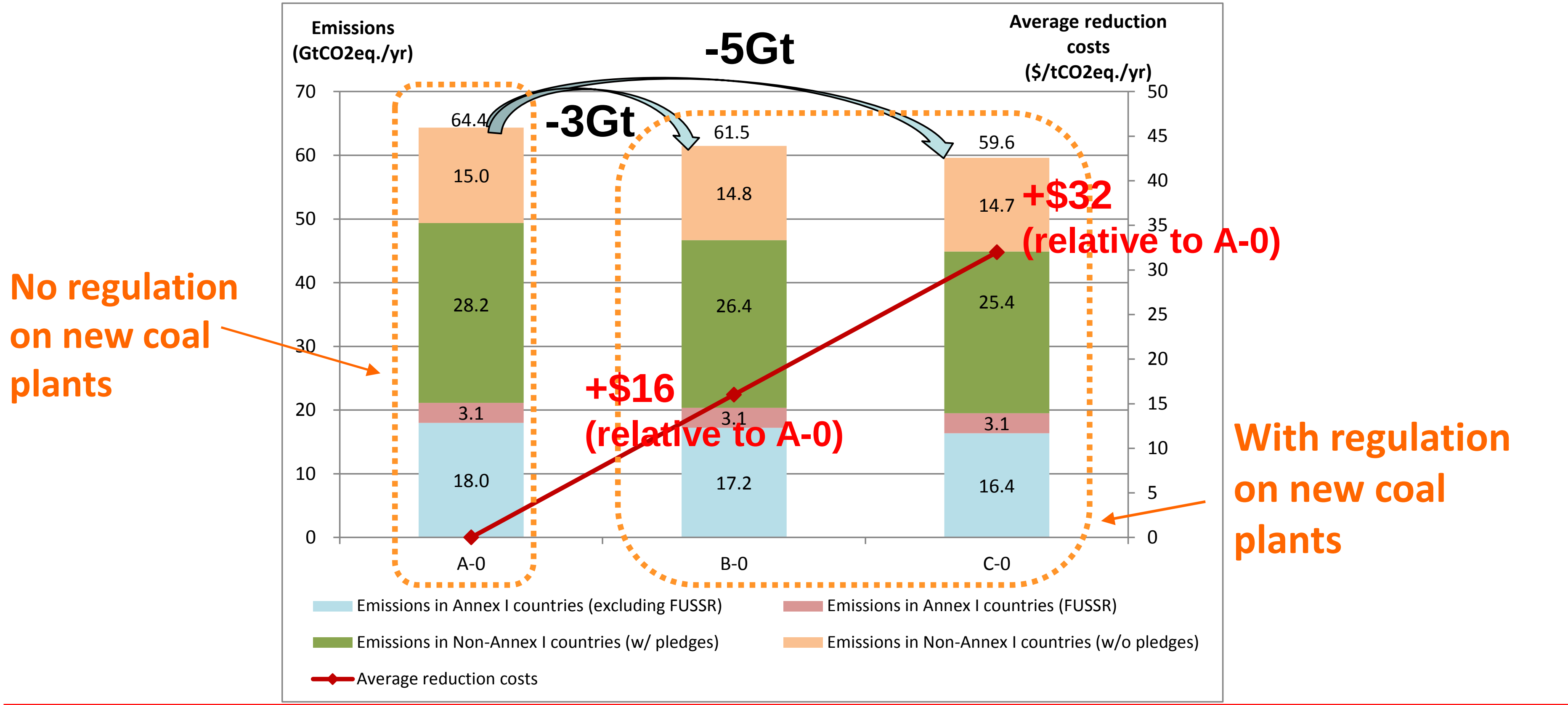
Method

- **Energy System Model DNE21+ is used (see Appendix).**
  - **Time period: 2000 – 2050**
  - **54 regions, and about 300 technologies are considered.**
  - **Especially, the model considers three types of coal plants: i) low efficiency, ii) middle efficiency iii) high efficiency, and CCS technology**
  - **Regional-specific payback periods are incorporated.**

Scenarios

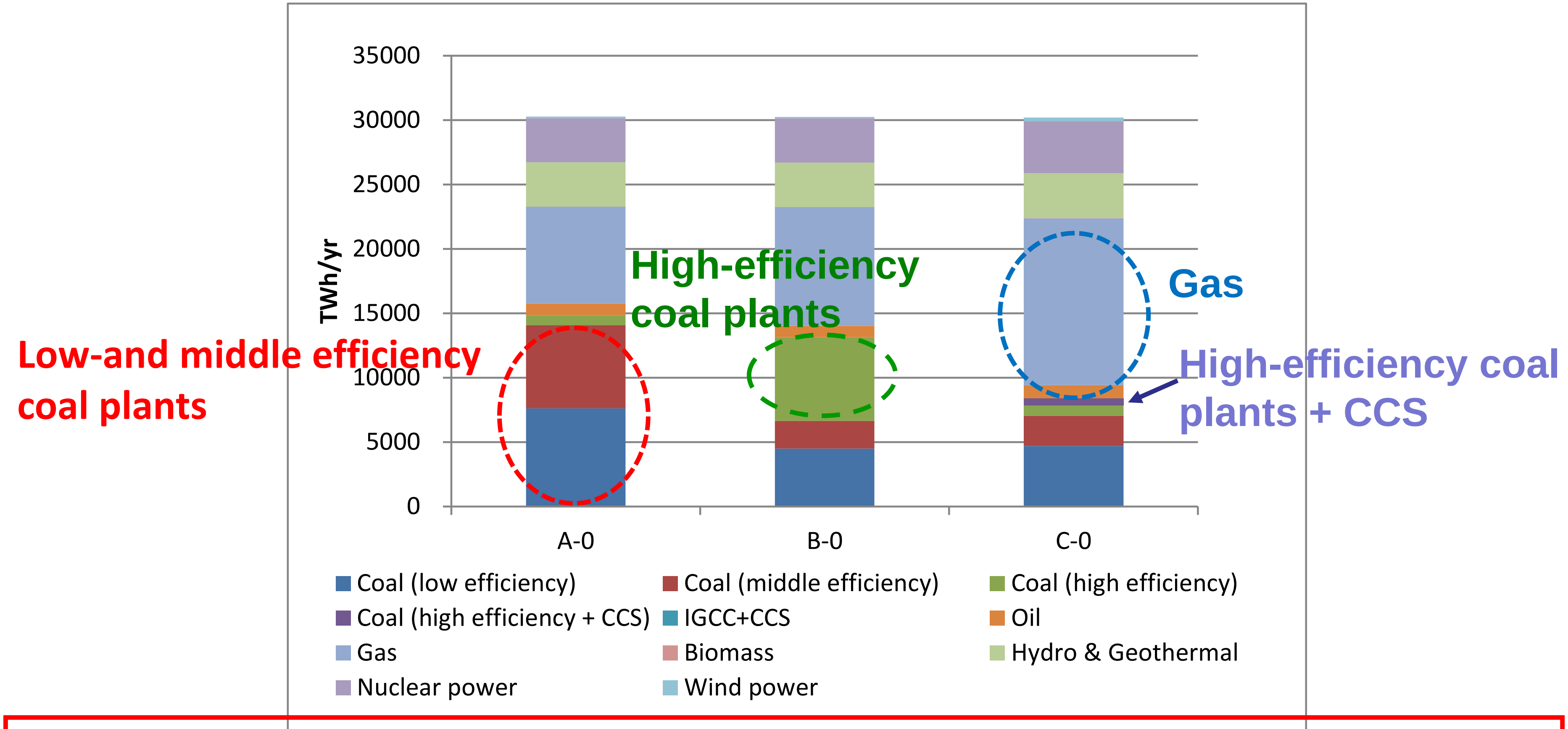
	Assumption on new construction of coal plants	Strengthened targets in 2030 Cancun pledges or MAC in 2020 in parentheses		
		Annex I countries	Non-Annex I countries with pledges	Non-Annex I countries w/o pledges
A-0	All types allowed	No additional climate policy: MAC\$0/tCO_2 (MAC\$0/tCO_2)		
A-1	All types allowed	MAC\$51/tCO_2 (Cancun low pledges jointly achieved: MAC\$39/tCO_2)	Extension of rate pf improvement in CO_2 intensity from 2010 to 2020 (Cancun pledges)	\$0/tCO_2 (\$0/tCO_2)
B-0	Only high-efficiency plants and CCS allowed	No additional climate policy: MAC\$0/tCO_2 (MAC\$0/tCO_2)		
B-1	Only high-efficiency plants and CCS allowed	MAC\$51/tCO_2 (Cancun low pledges jointly achieved: MAC\$39/tCO_2)	Extension of rate pf improvement in CO_2 intensity from 2010 to 2020 (Cancun pledges)	\$0/tCO_2 (\$0/tCO_2)
C-0	Only plants with CCS allowed	No additional climate policy: MAC\$0/tCO_2 (MAC\$0/tCO_2)		
C-1	Only plants with CCS allowed	MAC\$51/tCO_2 (Cancun low pledges jointly achieved: MAC\$39/tCO_2)	Extension of rate pf improvement in CO_2 intensity from 2010 to 2020 (Cancun pledges)	\$0/tCO_2 (\$0/tCO_2)

Global GHG emissions and average reduction costs in 2030 (No additional climate policy)



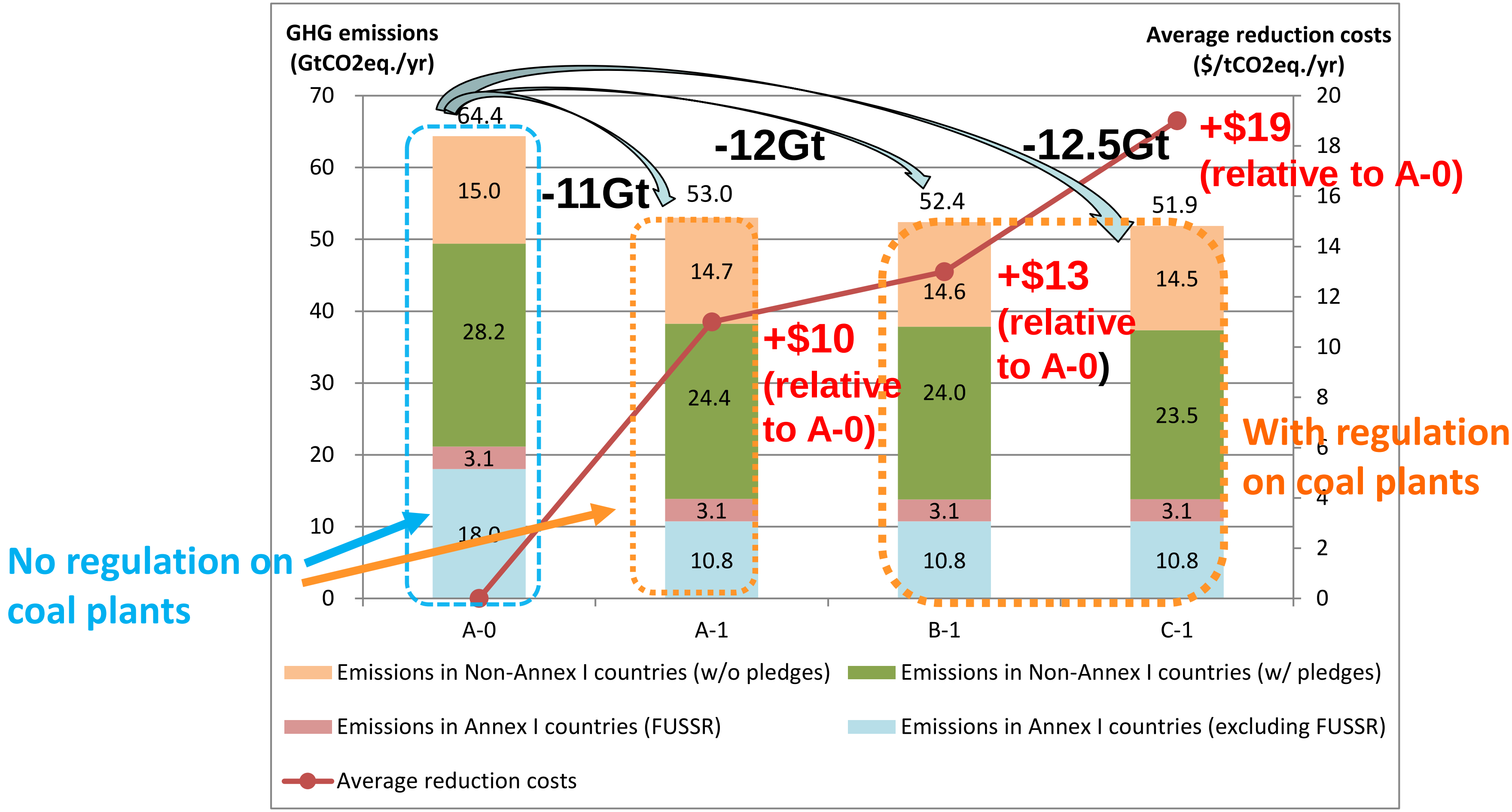
- **If the regulation on new coal plants functions well (C-0 scenario), the emissions will be reduced by 5Gt relative to A-0 scenario, and its average reduction costs will be $32.**
- **Even when new highly-efficient coal plants are also allowed, the substantial amount of reductions (3Gt) will be achieved, which is equivalent of 2.3 times of GHG emissions in Japan in 2012. The average reduction costs will be $16.**

Composition of electricity generation in 2030 (No additional climate policy)



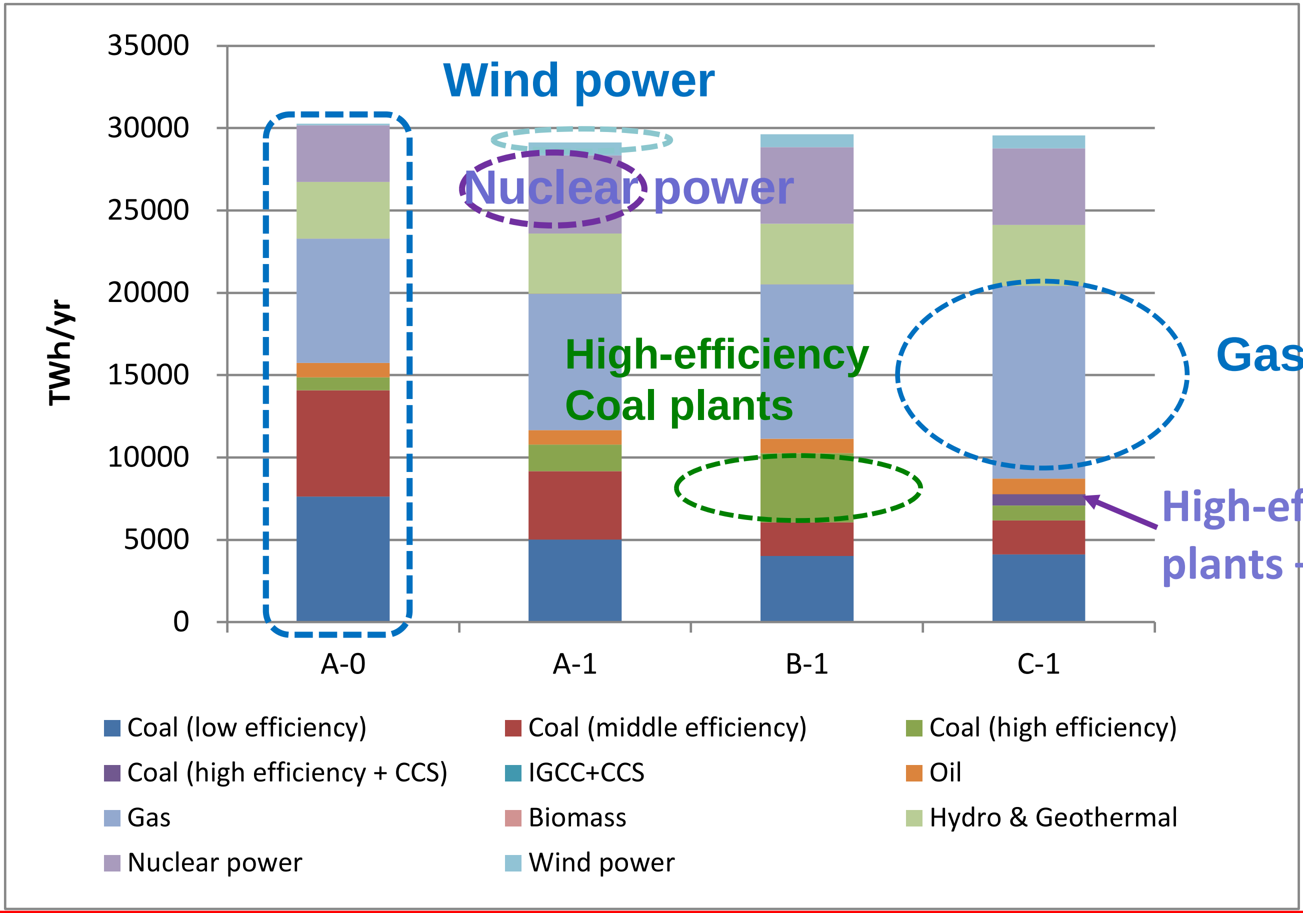
- **Under the regulation on new coal plants (B-0, C-0), power generations by low-and middle efficiency coal plants will be halved relative to those under no regulation (A-0).**
- **Instead, to meet power demand, power generation by highly-efficient coal plants (B-0) and gas plants (C-0) will increase substantially. The power generation by highly-efficient coal plants with CCS is slightly introduced (C-0).**

Global GHGs emissions and average reduction costs in 2030 (With Cancun Pledges in 2020 and strengthened targets in 2030)



- **If the regulation on new coal plants functions well（C-1）, the reduction will be 12.5Gt. Average reduction costs will be $19. Deviation from the costs in base case under regulation on emissions will be smaller than that under no additional climate policy.**

Composition of electricity generation in 2030 (With Cancun Pledges in 2020 and strengthened targets in 2030)



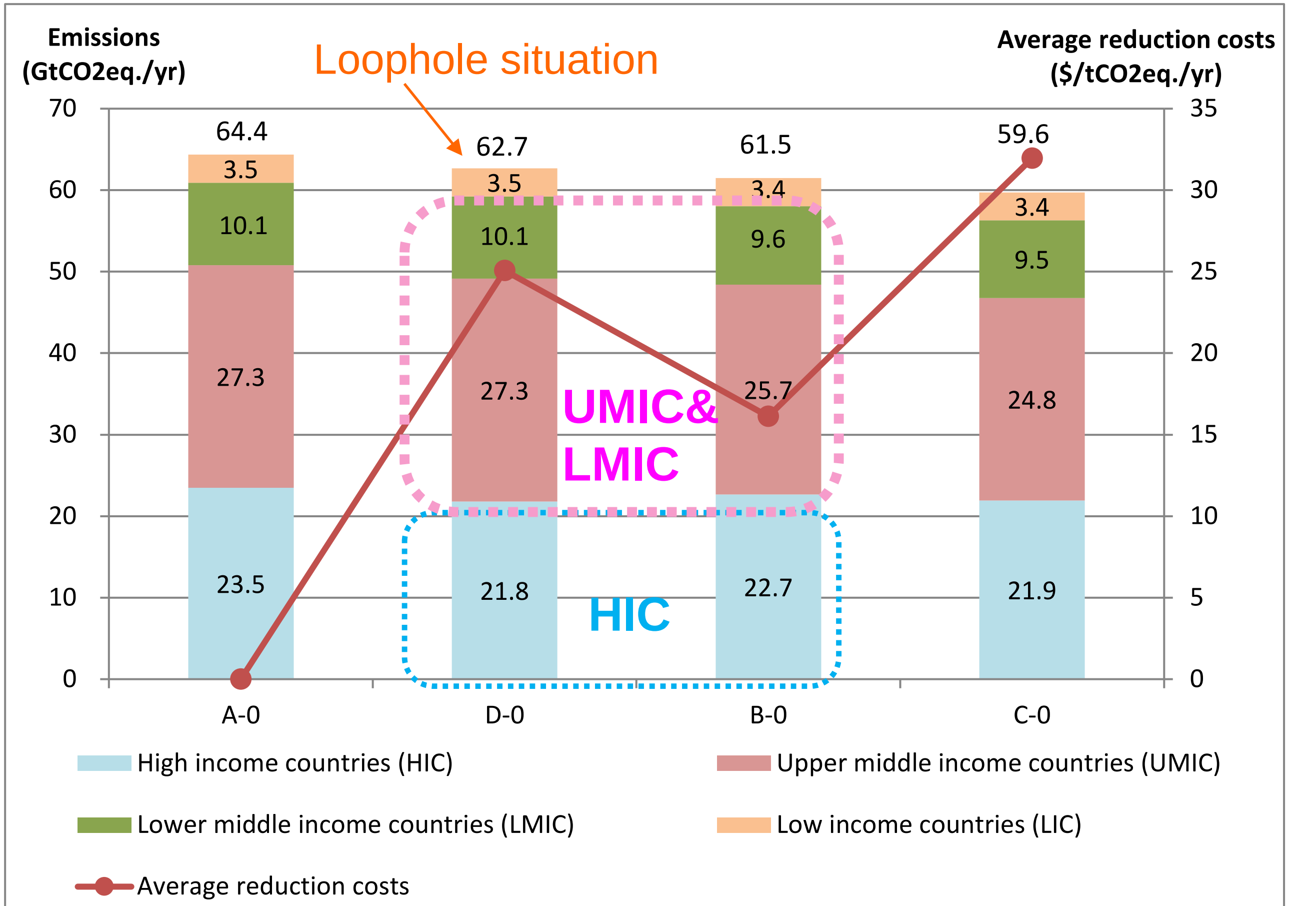
- **With reduction targets, power generation by nuclear and wind powers will increase relative to those under no reduction targets (A-0).**
- **In substitution for low-and middle efficiency coal plants, power generations by highly-efficient coal plants (B-1) and gas plants (C-1) will increase. Power generation by highly-efficient coal plants with CCS will be slightly introduced (C-1).**

Loophole Scenario

- Currently, 1,199 construction of new coal plants have been planned in the world. About 76% of them will be constructed in China and India (Yang and Cui 2012).
- In July, 2014, the leaders of BRICS countries (India, China, Brazil, South Africa and Russia) signed the agreement of establishment of New Development Bank (BRICS Bank) . Financing for new coal plants in developing countries will increase (Pedersen 2014).
- To illustrate the loophole, the D-0 scenario is developed. It shows a situation in which the world is in reality inclined toward the D-0 scenario, even though the C-0 scenario is expected after the financing restrictions imposed.

Regions	Assumption on the construction of new coal-fired power plants
High income countries (HIC)	**Only plants with CCS allowed**
Upper middle income countries (UMIC) and Lower middle income countries (LMIC)	**All types allowed (with own fund or financed by other financial institutions)**
Low income countries (LIC)	**All types allowed (exemption of financing restrictions for the least developed countries)**

Global GHGs emissions and average reduction costs in 2030 (No additional climate policy)



- **The D-0 scenario represents loophole situation. In D-0, emissions in High income countries (HIC) will decrease, however, those in Upper middle income countries (UMIC) and Lower middle income countries (LMIC) will increase when compared with those in B-0 in which highly-efficient coal plants are allowed.**
- **As to the GHG emissions and the average reduction costs, allowing new high-efficiency coal plants (B-0) is preferable to the loophole situation (D-0 scenario).**

Amount of financing for new high-efficiency coal plants

Required expense for each region of developing countries（$/yr）＝

「Increase in the installed capacity (stock) of the high-efficiency coal plants in the B-0 scenario (Relative to Scenario A-0) (MW)」×

「Capital costs of the high-efficiency coal plants（$MW）」×

「Difference in the annual expense (discount rate) between each region and representative developed country」

— fuel cost saving

- **The amount of financing for new high-efficiency coal plants in 2030 (to be built after 2015) would be about $36 billion for UMICs, $2 billion for LMICs and $1.4 billion for LICs. When the saving on fuel cost is excluded, the amount of financing would be about $57 billion for UMICs, $6 billion for LMICs and $2 billion for LICs.**

Discussions (1)

- **When assuming that stringent conditions on emission reductions are applicable to all regions including the developing countries, the incentives to construct low- and middle-efficiency coal plants are low. With restrictions on public financing for coal plants, emissions will be further reduced by CCS technologies. In this case, such restrictions will be justified. ← Small loophole**

  Our results show that when the Cancun pledges are realized in 2020 and reduction targets are intensified in 2030, it is less likely that the option of low-and middle-efficiency coal plant will be selected, even without regulation on new coal plants.

  The difference between average reduction cost when only coal plants with CCS are allowed and the one when no financing restriction exists will be relatively small, therefore, the loophole will not be that large.

- **In reality, however, it is challenging to set stringent reduction targets for all countries. Coal will remain a major source of energy in the future, and if coal plants without CCS cannot be financed, low-and middle-efficiency coal plants will continue to be used under loose restriction on emissions. ← Large loophole**

  Our results show that when there is no additional climate policy, strict financing restriction which allows only coal plants with CCS will result in the loophole scenario and conceivably increase CO_2 emissions globally. If so, minimizing the loophole by allowing new high-efficiency coal plants would lead to an effective reduction in emissions with low reduction costs when compared with the loophole situation.

Discussions (2)

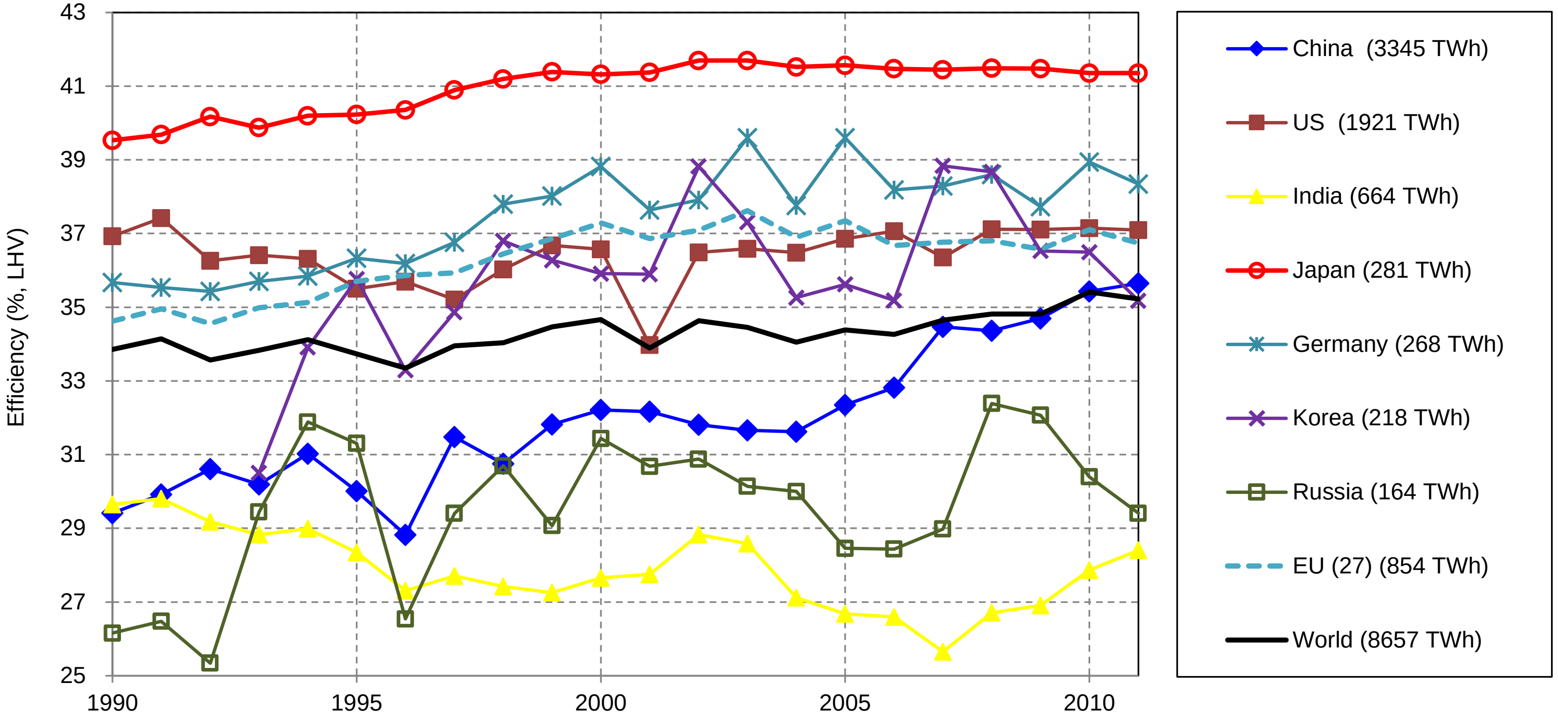
- **Estimated composition of power generation was determined by considering cost efficiency, which implies that not all the low-or middle-efficiency coal-fired power plants would be replaced by high-efficiency plants, but fuel changes, such as switching from coal to gas were fully incorporated.**

- **Therefore, our analysis could be used as one of the measures for an 'ex-ante appraisal' to discern whether there was an economically viable alternative to coal, which is in accordance with the U.S. financing stipulation for low-income countries.**

- **As the restrictions on public financing would only result in the loophole situation, other measures, such as identifying the barriers to low-carbon technologies by region and taking measures to remove those barriers through public financing, could eventually bring about a low-carbon society in developing countries.**

Appendix

Comparison of energy efficiency of coal-fired power plants (LHV, gross thermal efficiency)



Source：RITE (2014) http://www.rite.or.jp/Japanese/labo/sysken/about-global-warming/ouyou/energyefficiency.html; Oda et al. (2012). Numbers in parentheses represent average power generation by coal plants from 2009 to 2011.

- **Regional differences are driven by differences in such as steam conditions, fuel types used, and operation & maintenance.**
- **Not only in developing countries but also in some developed countries (Russia and Australia etc.), low- and middle-efficient coal plants are used.**

There are large potentials of improvement in energy efficiency through transfer of highly-efficient coal technologies.

Global Energy and CO_2 Assessment Model DNE21+ (Dynamic New Earth 21+)

- The model can make a cost assessment of global energy system and CO_2 reduction technologies.
- Linear programming model (minimizing world energy system cost)
- Evaluation time period: 2000-2050
- World divided into 54 regions: U.S. and China are further divided, and the world is divided into 77 regional categories.
- Interregional trade: coal, crude oil, natural gas, electricity, ethanol, hydrogen, CO_2 (CO_2 trade is not allowed in base case), and CO_2 credit
- Bottom-up modeling for technologies in energy supply (power sector etc.) and CCS technologies
- Bottom-up modeling for technologies in demand sides, such as iron & steel, cement, paper & pulp, chemicals, aluminum, transport and residential & commercial sectors
- 300 specific technologies are modeled.
- Top-down modeling for other sectors (energy saving impacts are assessed with long-term price elasticity)

- **We provided many long-term scenario analyses in IPCC AR5.**
- **Analyses and assessments with this model are utilized in many policy review processes by the Japanese government (such as in the mid-term target committee and new low carbon technology plan).**

【Example of the peer-reviewed papers】

- K. Akimoto et al., Assessment of the emission reduction target of halving CO_2 emissions by 2050: macro-factors analysis and model analysis under newly developed socio-economic scenarios, Energy Strategy Reviews, 2, 3-4 (2014);
- F. Sano et al., Assessment of GHG emission reduction scenarios of different levels and different short-term pledges through macro and sectoral decomposition analyses, Technological Forecasting & Social Change (2014)

Technologies assumed in power sector in DNE21+

	Level of efficiency	Capital cost ($/kW)	Generating efficiency (LHV %)
Coal power	Low efficiency (e.g., sub-critical)	1,250	22.0–27.0
	Middle efficiency (e.g., critical in the present; super-critical (SC) in the future)	1,875	36.0–45.0
	High efficiency (e.g., ultra SC in the present; IGCC and IGFC are included in the future)	2,125	42.0–55.0
Oil power	Low efficiency (e.g., diesel)	313	22.0–27.0
	Middle efficiency (sub-critical)	813	37.0–45.0
	High efficiency (critical)	1,375	50.0–60.0
	Combined heat and power (CHP)	875	37.0–47.0*
Gas power	Low efficiency (steam turbine)	375	26.0–32.0
	Middle efficiency (combined cycle)	813	38.0–47.0
	High efficiency (combined cycle with high temperature)	1,375	52.0–62.0
	Combined heat and power (CHP)	875	38.0–48.0*
Biomass power	Low efficiency (steam turbine)	1,500–1,125	18.0–28.0
	High efficiency (combined cycle)	2,750–2,000	36.0–46.0
Nuclear power	Conventional	3,000	–
	Advanced	2,625	–
IGCC/IGFC with CO_2 capture		3,500–2,625	33.0–51.0
Natural gas oxy-fuel power		2,375–1,750	40.7–50.7
Hydrogen power (FC/GT)		1,375	52.0–64.5
Electricity storage (e.g., pumping-up)		1,250	–