Energy Transition : How far we can go?

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1. About GJETC
1) Purpose

- **Japan and Germany are facing similar challenges**
  - **They should establish a long-term and risk-minimizing energy strategy based on public consensus and sound research.**
  - **At the same time, the ecological modernization should maintain, or even strengthen the international competitiveness.**

- **The German-Japanese Energy Transition Council (GJETC) strives to support both nations to find solutions and strategies to master these challenges.**

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1. About GJETC
2) GJETC Consortium

Organised by:

Wuppertal Institut

HENNICKE CONSULT

ECOS

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Financed by:

sponsored by DBU Deutsche Bundesstiftung Umwelt www.dbu.de

STIFTUNG MERCATOR

経済産業省 Ministry of Economy, Trade and Industry

Federal Foreign Office

jdzb Japanisch-Deutsches Zentrum Berlin ベルリン日独センター Japanese-German Center Berlin

Supported by:

Federal Ministry for Economic Affairs and Energy

AHK Deutsche Industrie- und Handelskammer in Japan 在日ドイツ商工会議所

Media Partner:

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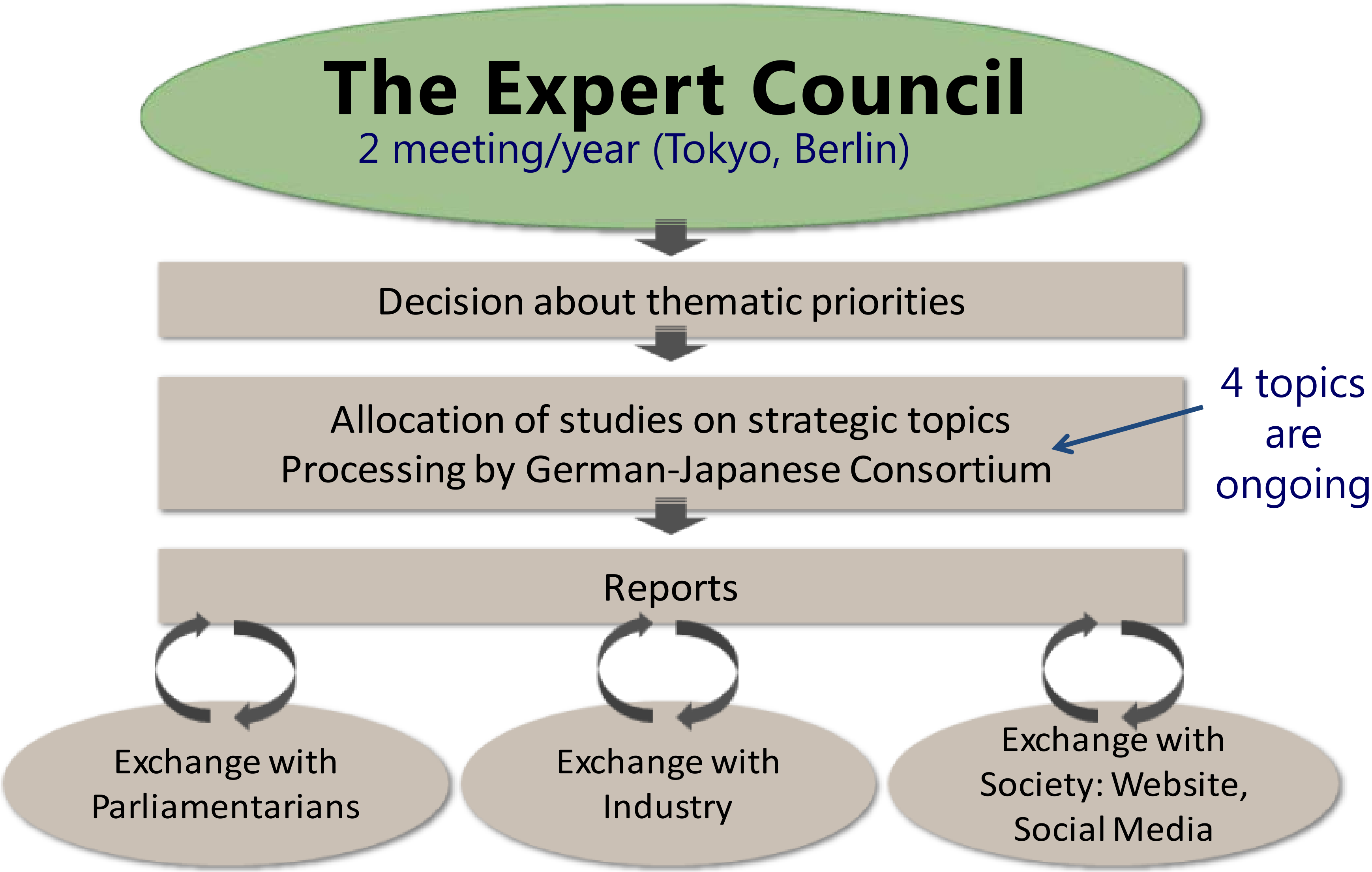
1. About GJETC
3)Dialogue-oriented and Knowledge-based Operation



1. About GJETC

4) Ongoing Study Program - 4 strategic topics -

1. Energy transition as a central building block of a future industrial policy: Comparison and analysis of longterm energy transition scenarios

2. Strategic framework and socio-cultural aspects of the energy transition

3. Allocation of roles and business segments of established and new participants in the energy sector currently and within a future electricity market design

4. Energy end-use efficiency policies and the development of energy service markets

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1. About GJETC
5)Future GJETC Activities and Schedule

Secretariat | **Council** | **Month**

Interim report

Finalisation of the studies by G-J consortia

3rd meeting (J): Sep. 4-5, 2017
Discussion on the final study results and fact sheets

Stakeholder dialogues: Sep. 5, 2017

Finalisation of studies and fact sheets for the public

4th meeting (G): Mid-Feb. 2017
Conclusions and recommendations;
Final report;
Prolongation of the council's work

Final report on results incl. studies and fact sheets

Public closing conference

Month: 2017: 4, 5, 6, 7, 8, 9, 10, 11, 12; 2018: 1, 2, 3, 4

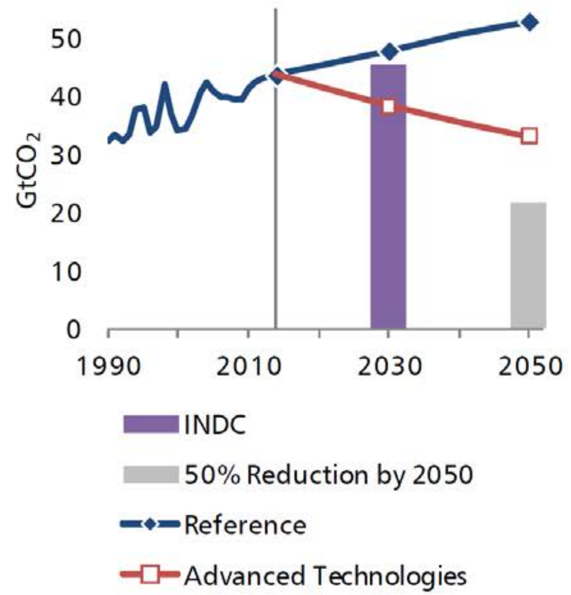
2. Energy Transition

1) Paris Agreement : A step towards global action

❖ Evaluation of Paris Agreement

Good!! ☺☺☺	Over 180 countries, including emerging countries such as China and India, agreed to take actions to reduce emissions. Using bottom-up approach to add individually set reduction targets rather than a top-down approach used by Kyoto agreement where the reduction targets were set first and then allocated to the countries. Method is to evaluate the total target numbers every five years and decide any additional efforts if necessary.
Challenges ☹☹☹	Global GHG emissions will increase from the current level.

❖ GHGs emissions

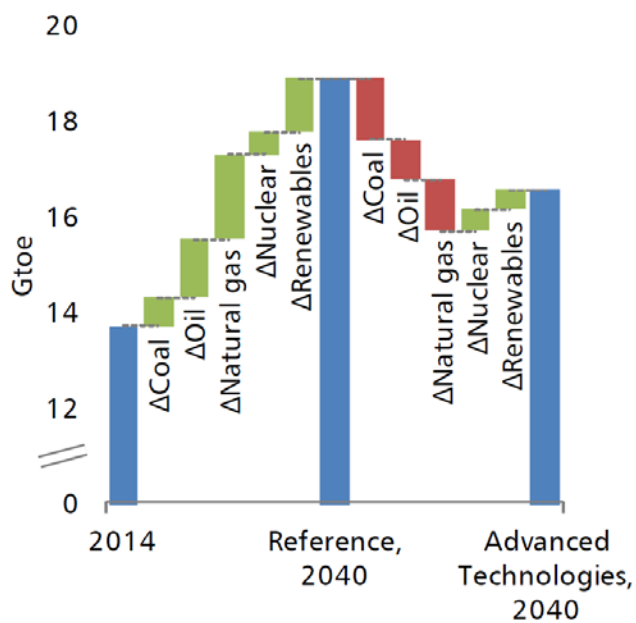


GHG emissions in 2030 under submitted INDC which are set voluntarily by each country are expected to increase from the current level of emissions. Trend will be subdued but 50% reduction by 2050 cannot be achieved.

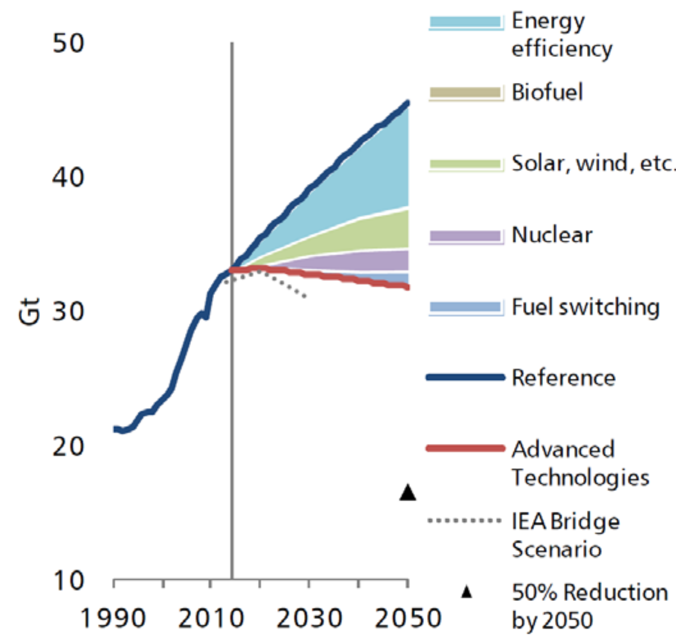
It is necessary to achieve the target agreed under the Paris Agreement and further reduce emissions. It is essential to promote reduction worldwide via technology transfer as well as technology innovation.

2. Energy Transition
2) Global Actions Will Reduce CO_2 by 3.8%

❖ Changes in primary energy consumption



❖ CO_2 emissions and reduction



In the Advanced Technologies Case where the maximum possible CO_2 reduction measures (assuming social acceptance) are introduced, energy consumption in 2040 is smaller than the Reference Case by 2,343 Mtoe or 12%.

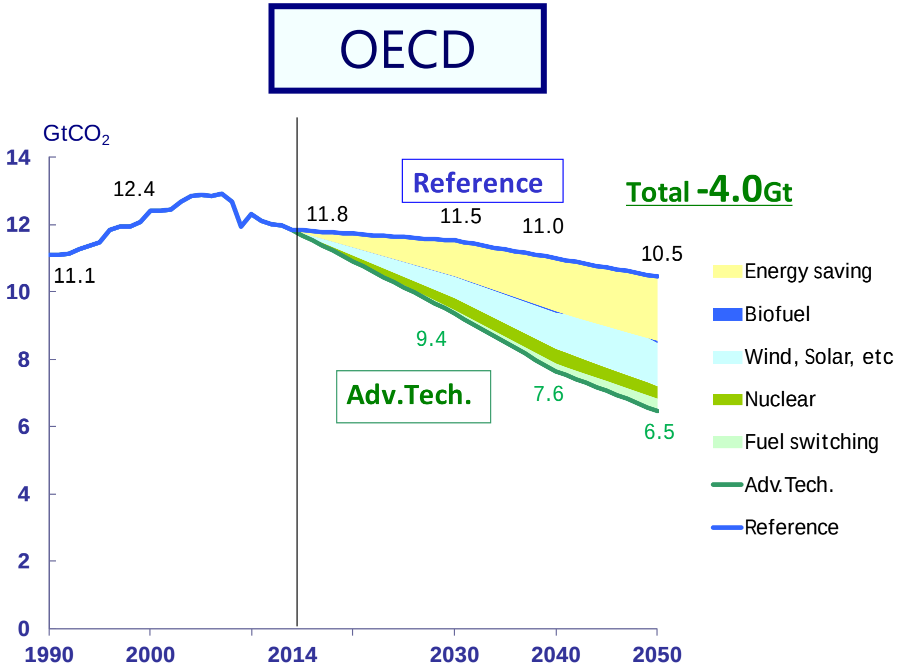
CO_2 emissions in the Advanced Technologies Case will peak at around 2020 and will start to decline after. By 2050, emissions will be reduced by 3.8% from 2014 level and by 13.7 Gt from the Reference Case level which is equivalent to 42% of the global emissions.

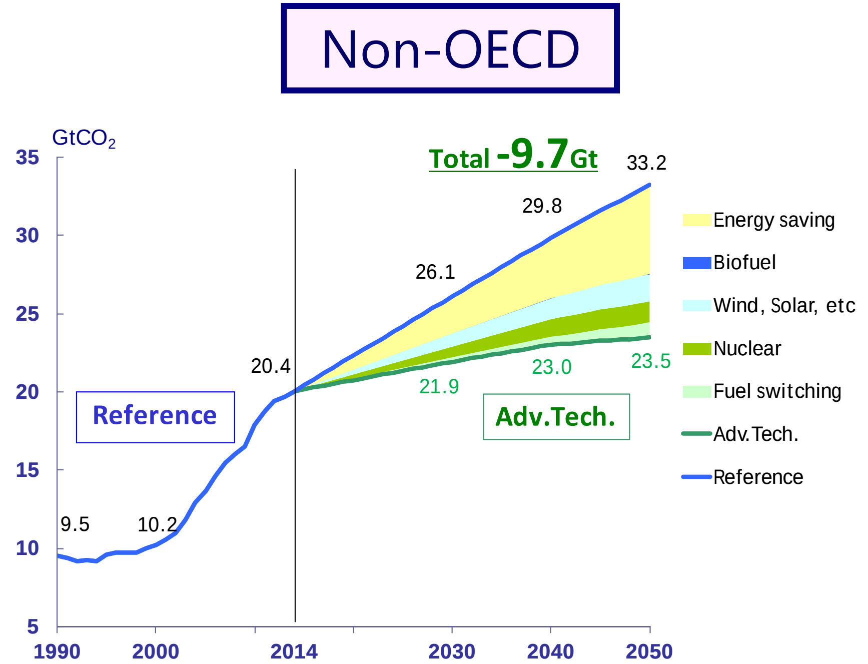
Energy and environmental technologies

	2014	2040		2050	
	Historical	Reference	Advanced Technologies	Reference	Advanced Technologies
Nuclear (GW)	399 (2015)	612	846	694	992
Thermal efficiency					
Coal-fired	37%	41%	41%	42%	45%
Natural gas-fired	41%	52%	53%	54%	57%
Solar photovoltaic (GW)	175	857	1,433	1,216	2,080
CSP (GW)	4	84	220	153	407
Wind (GW)	366	1,170	1,764	1,572	2,417
Biomass power generation (GW)	76	201	226	244	268
Biofuel (Mtoe)	73	120	174	122	203
Share in annual vehicle sales					
PHEV	0%	7%	19%	8%	21%
EV/FCV	3%	8%	26%	10%	36%
Average fuel efficiency of new vehicle sales (km/L)	15	21	28	23	33

CSP: Concentrated solar power, PHEV: Plug-in hybrid electric vehicle, EV: Electric vehicle, and FCV: Fuel cell vehicle

CO2 emission reduction by technology (OECD and non-OECD)





Excludes CCS

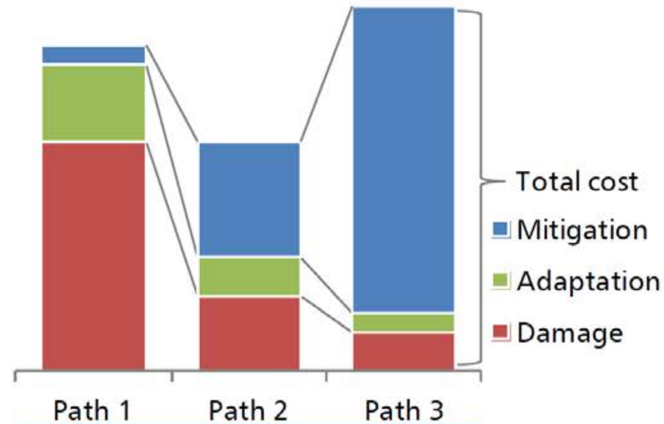
- Various technologies are required to reduce CO_2 emissions. In OECD, energy saving is responsible for the largest share at 47% (or 1.9 Gt). It is followed by renewable energy at 32% (or 1.3 Gt), nuclear at 9% (or 0.4 Gt), and fuel switching at 9% (or 0.4 Gt).
- In Non-OECD countries, energy saving is responsible for more than half of the 9.7 Gt reduction. Supportive measures concerning technology transfer and the establishment of efficiency standards are important to realize those CO_2 emission reduction while further enhancing energy security.

2. Energy Transition
3) Total Cost Minimizing Approach

Mitigation + Adaptation + Damage = Total cost

Mitigation	Typical measures are GHG emissions reduction via energy efficiency and non-fossil energy use. Includes reduction of GHG release to the atmosphere via CCS. These measures ***mitigate*** climate change.
Adaptation	Temperature rise may cause sea-level rise, agricultural crop drought, disease pandemic, etc. ***Adaptation*** includes counter measures such as building banks/reservoir, agricultural research and disease preventive actions.
Damage	If mitigation and adaptation cannot reduce the climate change effects enough to stop sea-level rise, draught and pandemics, ***damage*** will take place.

Image of total cost for each path



	Path 1	Path 2	Path 3
Mitigation	Too small	Reasonable	Too big
Adaptation	Big	Medium	Small
Damage	Big	Medium	Small

Without any measure against climate change, no mitigation cost incurs. On the other hand, adaptation costs and damage will become massive. Tough mitigation measures will reduce adaptation costs and damage but mitigation costs will be notably big.

Climate change issue is a long-term challenge which influences vast areas for many generations. From the sustainability point of view, combination of different measures which reduces the total cost of mitigation, adaptation and damage is important.

2. Energy Transition
4) What Total Cost Minimizing Approach means?

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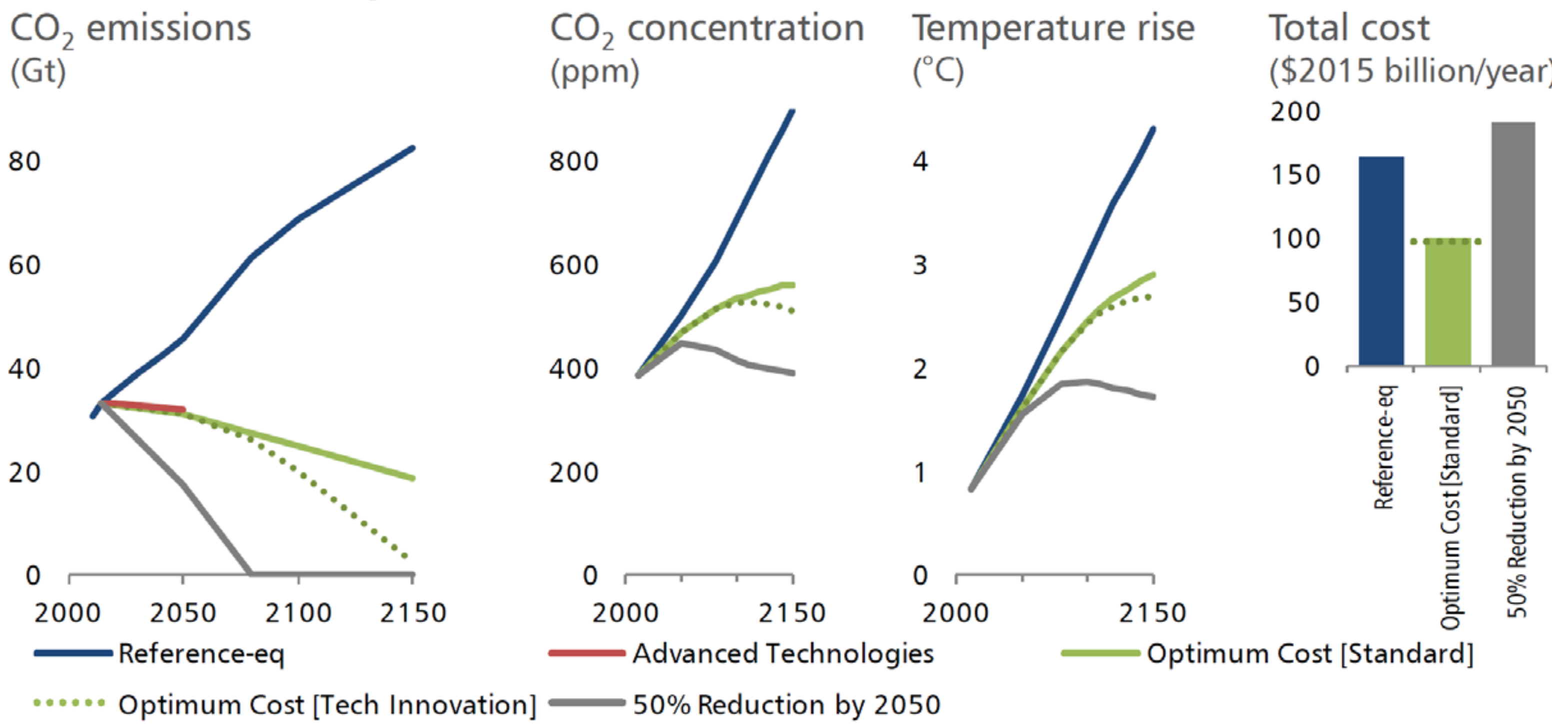
❖ In the ultra long-term paths



CO_2 emissions of the Optimum Cost Path will be much lower than the Reference Case equivalent emissions but not as low as the 50% Reduction by 2050 Case emissions. Emissions in 2150 will be 50% lower than the current level and temperature will rise by about 3℃.

If technology innovations reduce mitigation, temperature rise reaches the peak of 2.7℃ around 2150 and will start to go down. Total cost will be around $100 billion which is much lower than both Reference Case equivalent and 50% Reduction by 2050 Case.

Note: Estimated with climate sensitivity set as 3°C. If CS is 2.5°C, then temperature will rise by 3.7°C, 2.5°C and 1.4°C, respectively for the three cases, namely Reference Case equivalent, Optimum Cost with innovation and 50% Reduction by 2050 Cases, by 2150.

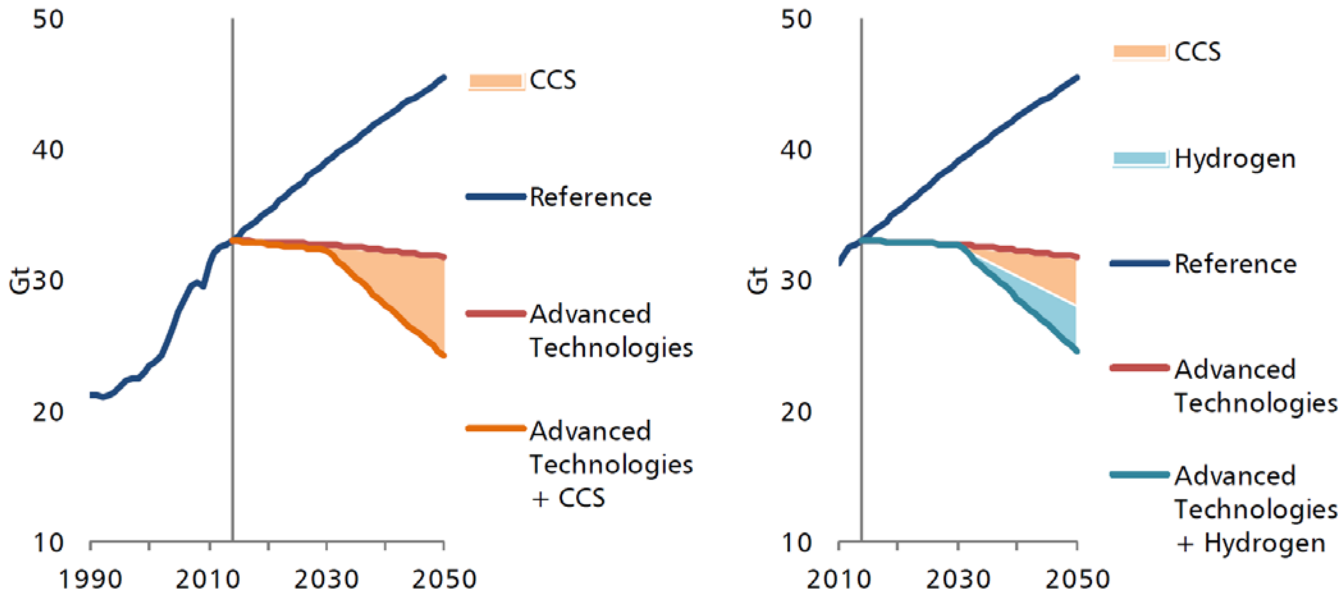
2. Energy Transition

5) Examples: Technology Development for meeting “ 2 ℃ Scenario"

Technologies		Description	Challenges
Technologies to reduce CO_2 emissions	Next Generation Nuclear Reactors	Fourth-generation nuclear reactors including very high temperature and fast reactors are being developed internationally.	Expanding support for research and development of next-generation nuclear reactors, etc.
	Nuclear Fusion	Technology for fusing hydrogen and other elements with small atomic numbers to create energy as the sun does. Deuterium as nuclear fusion fuel exists abundantly and universally. Nuclear fusion does not emit spent fuel as high-level radioactive waste.	Technology for continuous nuclear fusion and containing it a fixed space, reduction of the energy balance and costs, building fundraising and international cooperation systems for large-scale technology development, etc.
	Space Photovoltaic (SPS)	Technology for implementing solar photovoltaic electricity generation in outer space with more abundant sunlight than on earth and for transmitting generated electricity through microwaves wirelessly to earth for use on ground	Developing wireless energy transmission technology, reducing costs for transporting construction materials to outer space, etc.
Technologies to sequestrate CO_2 or to remove CO_2 from the atmosphere	Hydrogen production and usage	Producing hydrogen by converting fossil fuel through steam reforming. CO_2 emissions are subjected to CCS (carbon capture and storage) technology to make hydrogen production free from carbon.	Cutting hydrogen production costs, improving hydrogen production efficiency, developing necessary infrastructure, etc.
	CO_2 sequestration and usage (CCU)	Producing carbon compounds as chemical materials from CO_2 with electrochemical, photochemical, biochemical and thermochemical methods to eliminate CO_2 from the atmosphere	Improving CO_2 volume for capture and effective use and efficiency dramatically, etc.

2. Energy Transition
6) A case of Zero Carbon Hydrogen with CCS

❖ CO_2 emissions and reduction



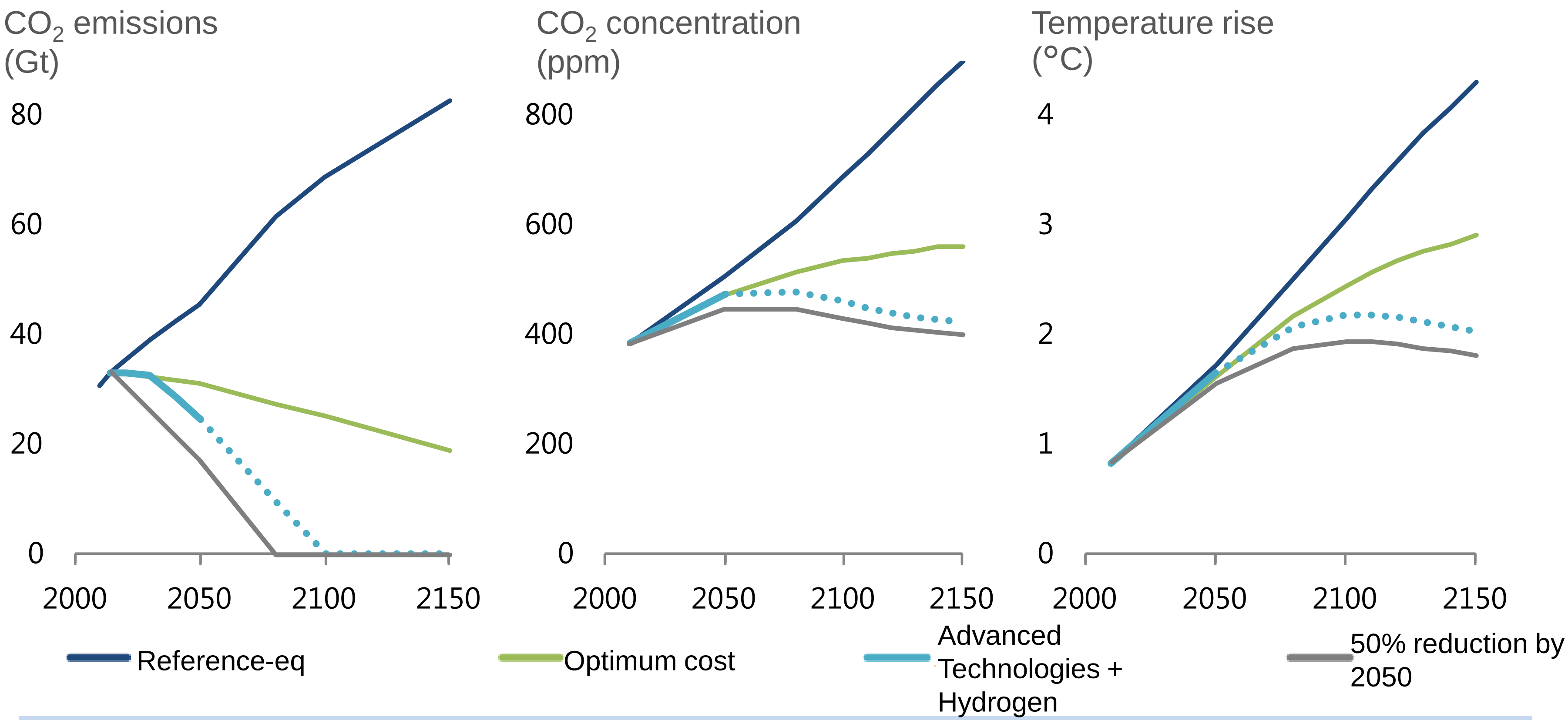
Although there are not small numbers of technical and economical hurdles to be overcome both for CCS and for hydrogen, about 7 Gt of CO_2 can be reduced by 2050.

CCS, however, does not contribute to secure directly energy supply. Hydrogen requires more exhaustible resources such as coal and natural gas for its production. There is no perfect technologies/energy source to solve all of the problems.

2. Energy Transition

7) Hydrogen Can Be a Promising Option

In the ultra long-term paths



CCS and hydrogen, though having technological and economic problems to be solved, are expected to contribute to cutting CO_2 emissions by some 7 Gt in 2050.

If technological innovation allows the CO_2 emission reduction trend to be maintained, the temperature rise will peak at around 2.2 ℃ in 2100 and fall back to around 2.0 ℃ in 2150.

Note: “Advanced Technologies + Hydrogen” means the “Higher Hydrogen Scenario” in the body.

Conclusion

1. **Japan and Germany are facing similar challenges, although there are some differences as well. GJETC attempts to find solutions for those challenges.**

2. **Paris Agreement is an epoch-making agreement, but difficult to achieve when economic growth and measures to address Climate Changes need to coexist.**

3. **The desirable approach not to give up "2℃ scenario" is to minimize the total cost(damage, adaptation and mitigation) together with new technologies such as producing zero-carbon hydrogen from fossil fuels with CCS. CCU technologies leading to negative carbon would make further contribution.**

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IEEJ Website

http://eneken.ieej.or.jp/en

Ranked for three consecutive years within the **Top-3** in the area of **Energy and Resource policy**, according to **the 2016 Global Go To Think Tank Index**, University of Pennsylvania

We provide part of our cutting-edge research results on energy and the environment on our website free of charge.

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