Global Environmental Policy

Global Environmental Policy 2014

Graduate School, University of Tokyo

December 1, 2014: Lecture
December 2, 2014: Group Discussion

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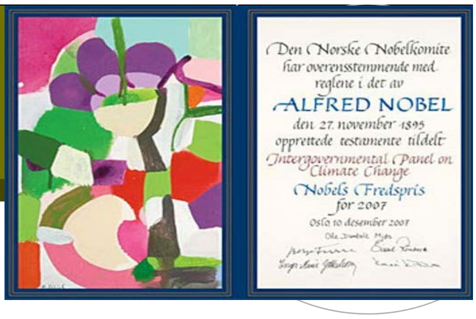
Recent Findings on Climate Change

IPCC Assessment Report

1st: 1990; 2nd: 1995; 3rd: 2001; 4th: 2007; 5th: 2014

What is IPCC?



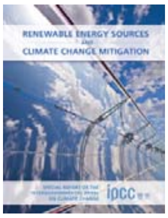
- Intergovernmental Panel on Climate Change (IPCC) was established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) in 1988 to provide the world with a clear scientific view on the current state of knowledge in climate change and its potential environmental and socio-economic impacts.
- The IPCC reviews and assesses the most recent scientific, technical and socio-economic information produced worldwide relevant to the understanding of climate change. It does not conduct any research nor does it monitor climate related data or parameters.
- The work of the organization is therefore policy-relevant and yet policy-neutral, never policy-prescriptive.
- At the end of 2007 the IPCC was awarded the Nobel Peace Prize.

IPCC AR5

- AR5 provides a clear and up to date view of the current state of scientific knowledge relevant to climate change and consists of three Working Group reports and a Synthesis Report (SYR).
  - The Synthesis Report distils and integrates the findings of the three working group contributions as well as the two Special Reports produced during this cycle.
    - The Working Group I contribution provides a comprehensive assessment of the physical science basis of climate change.
    - The Working Group II contribution considers the vulnerability and exposure of human and natural systems, the observed impacts and future risks of climate change, and the potential for and limits to adaptation.
    - The Working Group III contribution assesses the options for mitigating climate change and their underlying technological, economic and institutional requirements.
    - Renewable Energy Sources and Climate Change Mitigation (2011)
    - Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation (2012)

IPCC Fifth Assessment Report (AR5)

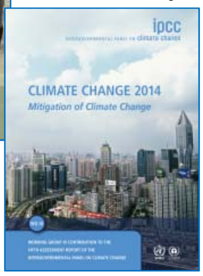
Special Report (2012)
Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation



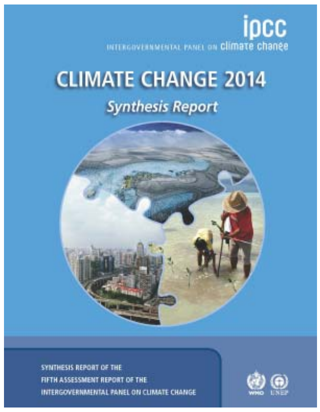
Special Report (2011)
Renewable Energy Sources and Climate Change Mitigation

Climate Change 2013
The Physical Science Basis

Climate Change 2014
Impacts, Adaptation and Vulnerability



Climate Change 2014
Mitigation of Climate Change



Climate Change 2014
Synthesis Report

CLIMATE CHANGE 2014 - Synthesis Report
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Summary for Policymakers

SPM 1. Observed Changes and their Causes
SPM 2. Future Climate Changes, Risks and Impacts
SPM 3. Future Pathways for Adaptation, Mitigation and Sustainable Development
SPM 4. Adaptation and Mitigation

Introduction
Topic 1: Observed Changes and their
Topic 2: Future Climate Changes, Risks and Impacts
Topic 3: Future Pathways for Adaptation, Mitigation and Sustainable Development
Topic 4: Adaptation and Mitigation

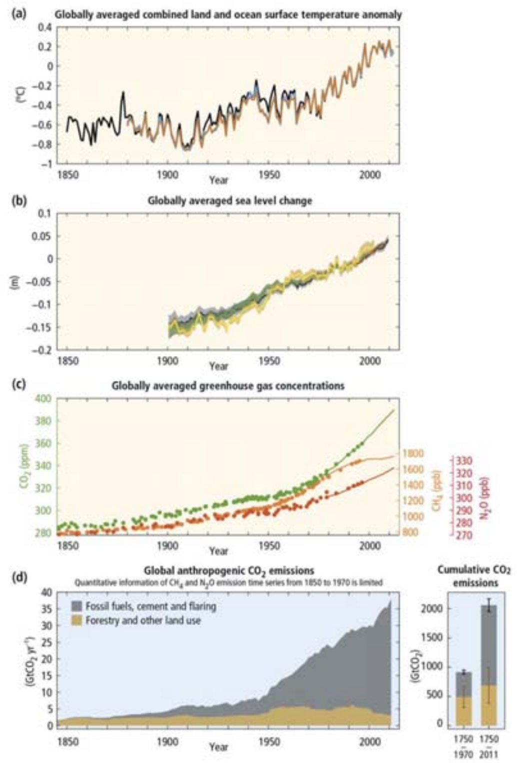
IPCC AR5 SYR SPM
Observed Changes and their Causes

- **Human influence on the climate system is clear, and recent anthropogenic emissions of greenhouse gases are the highest in history. Recent climate changes have had widespread impacts on human and natural systems.**

IPCC AR5 SYR SPM
Observed Changes and their Causes

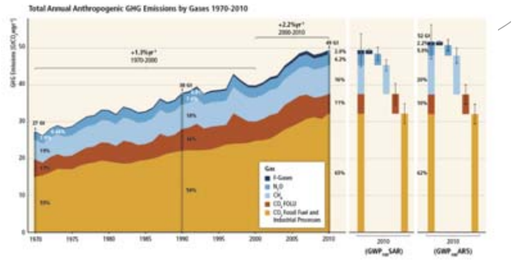
1. **Observed changes in the climate system**

Warming of the climate system is unequivocal, and since the 1950s, many of the observed changes are unprecedented over decades to millennia. The atmosphere and ocean have warmed, the amounts of snow and ice have diminished, and sea level has risen.

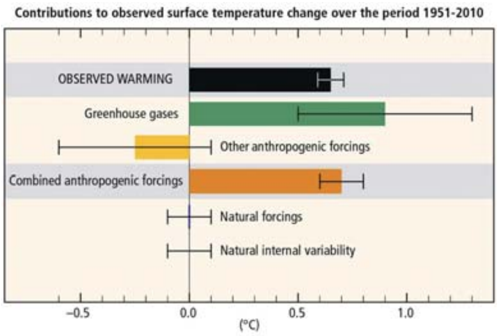


IPCC AR5 SYR SPM
Observed Changes and their Causes

2. Causes of climate change



Anthropogenic greenhouse gas emissions have increased since the pre-industrial era, driven largely by **economic and population growth**, and are now higher than ever. This has led to atmospheric concentrations of carbon dioxide, methane and nitrous oxide that are unprecedented in at least the last 800,000 years. Their effects, together with those of other anthropogenic drivers, have been detected throughout the climate system and are ***extremely likely*** to have been the dominant cause of the observed warming since the mid-20th century.



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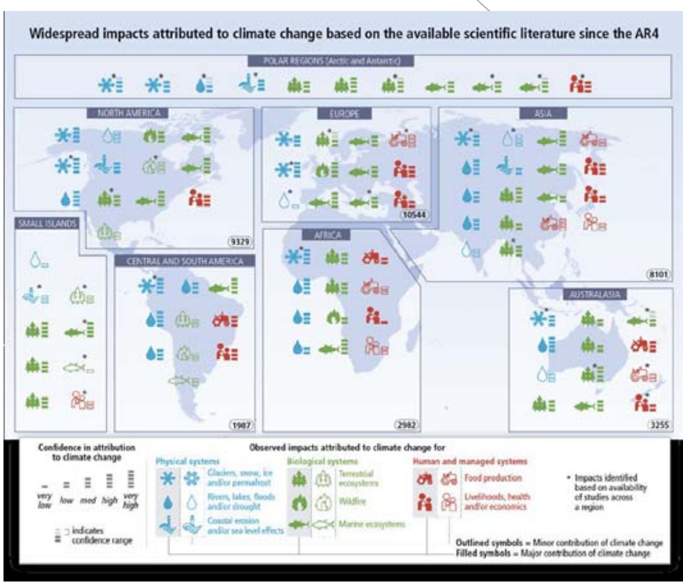
IPCC AR5 SYR SPM
Observed Changes and their Causes

3. Impacts of climate change

In recent decades, changes in climate have caused **impacts on natural and human systems** on all continents and across the oceans. Impacts are due to observed climate change, irrespective of its cause, indicating the sensitivity of natural and human systems to changing climate.



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IPCC AR5 SYR SPM
Observed Changes and their Causes

4. Extreme events

Changes in many extreme weather and climate events have been observed since about 1950. Some of these changes have been linked to human influences, including a decrease in cold temperature extremes, an increase in warm temperature extremes, an increase in extreme high sea levels and an increase in the number of heavy precipitation events in a number of regions.

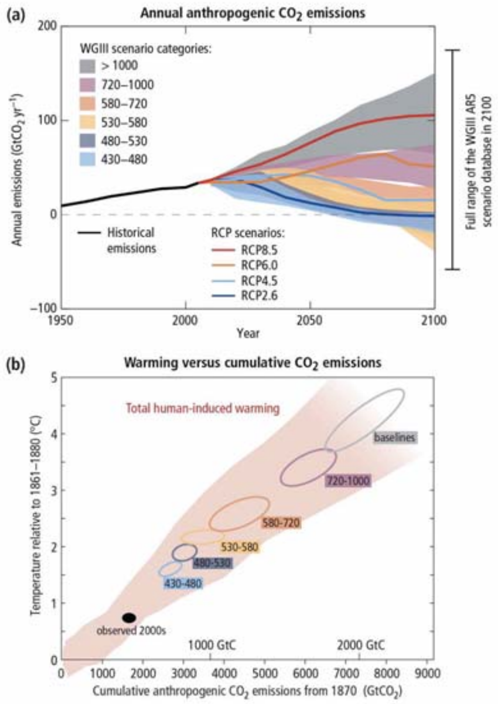
IPCC AR5 SYR SPM
Future Climate Changes, Risks and Impacts

- **Continued emission of greenhouse gases will cause further warming and long-lasting changes in all components of the climate system, increasing the likelihood of severe, pervasive and irreversible impacts for people and ecosystems. Limiting climate change would require substantial and sustained reductions in greenhouse gas emissions which, together with adaptation, can limit climate change risks.**

IPCC AR5 SYR SPM
Future Climate Changes, Risks and Impacts

1. **Key drivers of future climate system**

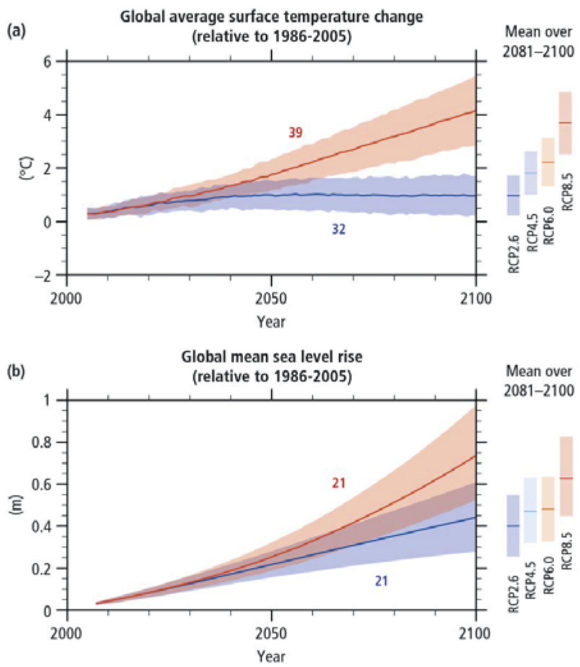
Cumulative emissions of CO_2 largely determine global mean surface warming by the late 21st century and beyond. Projections of greenhouse gas emissions vary over a wide range, depending on both socio-economic development and climate policy.



IPCC AR5 SYR SPM
Future Climate Changes, Risks and Impacts

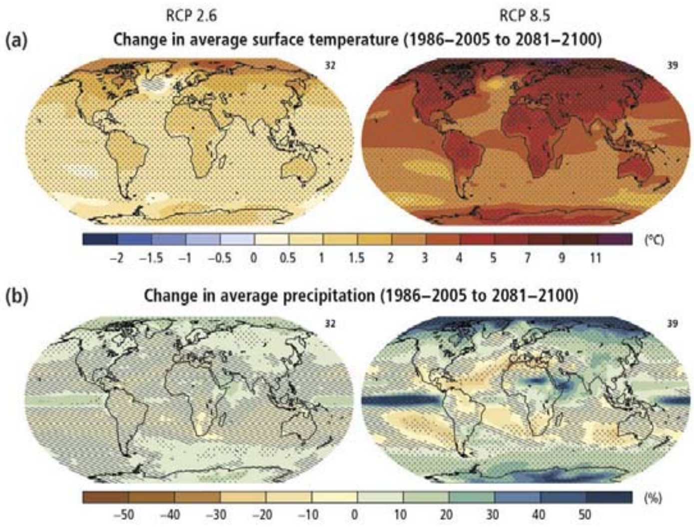
2. **Projected changes in the climate system (1/2)**

Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is *very likely* that heat waves will occur more often and last longer, and that extreme precipitation events will become more intense and frequent in many regions. The ocean will continue to warm and acidify, and global mean sea level to rise.



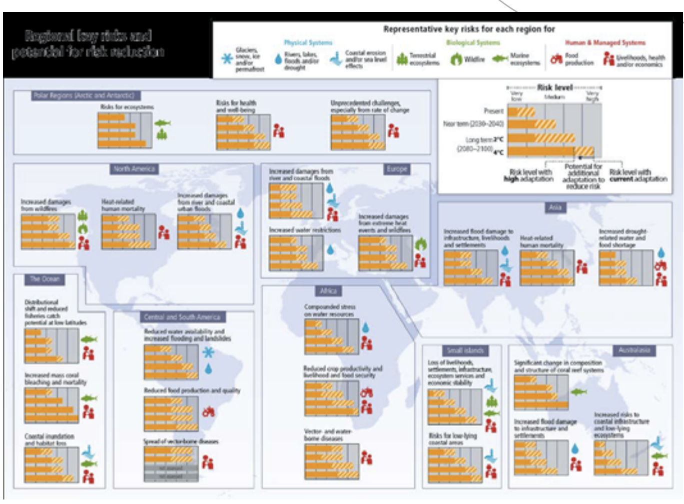
2. Projected changes in the climate system (2/2)

Surface temperature is projected to rise over the 21st century under all assessed emission scenarios. It is ***very likely*** that **heat waves** will occur more often and last longer, and that **extreme precipitation** events will become more intense and frequent in many regions. The **ocean will continue to warm and acidify** and global mean sea level to rise.



3. Future risks and impacts caused by a changing climate (1/2)

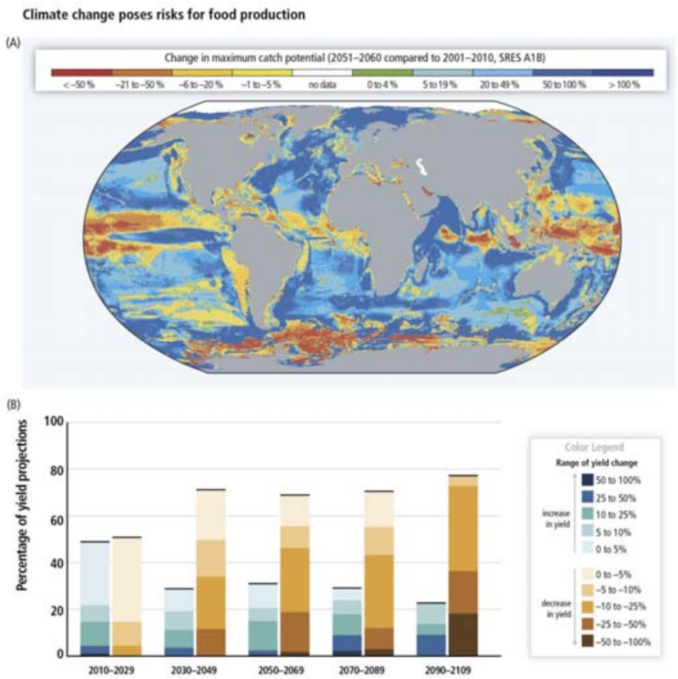
Climate change will amplify existing risks and create new risks for natural and human systems. Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development.



Future Climate Changes, Risks and Impacts

3. Future risks and impacts caused by a changing climate (2/2)

Climate change will amplify existing risks and create new risks for natural and human systems. Risks are unevenly distributed and are generally greater for disadvantaged people and communities in countries at all levels of development.



IPCC AR5 SYR SPM

Future Climate Changes, Risks and Impacts

4. Climate change beyond 2100, irreversibility and abrupt changes

Many aspects of climate change and associated impacts will continue for centuries, even if anthropogenic emissions of greenhouse gases are stopped. The risks of abrupt or irreversible changes increase as the magnitude of the warming increases.

IPCC AR5 SYR SPM
Future Pathways for Adaptation, Mitigation and Sustainable Development

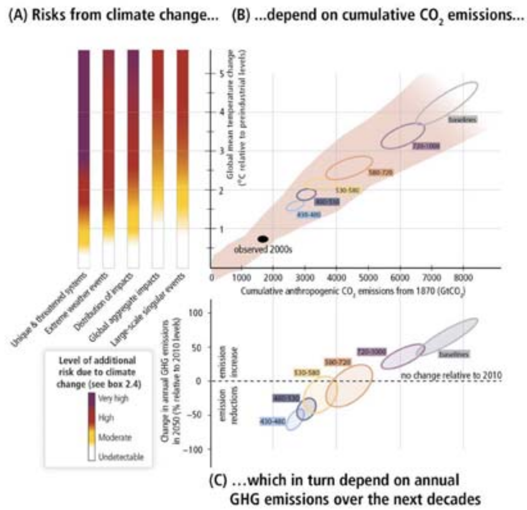
- **Adaptation and mitigation are complementary strategies for reducing and managing the risks of climate change. Substantial emissions reductions over the next few decades can reduce climate risks in the 21st century and beyond, increase prospects for effective adaptation, reduce the costs and challenges of mitigation in the longer term, and contribute to climate-resilient pathways for sustainable development.**

IPCC AR5 SYR SPM
Future Pathways for Adaptation, Mitigation and Sustainable Development

1. **Foundations of decision-making about climate change**

Effective decision making to limit climate change and its effects can be informed by a wide range of analytical approaches for evaluating expected risks and benefits, recognizing the importance of governance, ethical dimensions, equity, value judgments, economic assessments and diverse perceptions and responses to risk and uncertainty.

2. Climate change risks reduced by mitigation and adaptation



Without additional mitigation efforts beyond those in place today, and even with adaptation, warming by the end of the 21st century will lead to high to very high risk of severe, widespread, and irreversible impacts globally (*high confidence*). Mitigation involves some level of co-benefits and of risks due to adverse side-effects, but these risks do not involve the same possibility of severe, widespread, and irreversible impacts as risks from climate change, increasing the benefits from near-term mitigation efforts.

3. Characteristics of adaptation pathways

Adaptation can reduce the risks of climate change impacts, but there are limits to its effectiveness, especially with greater magnitudes and rates of climate change. Taking a longer-term perspective, in the context of sustainable development, increases the likelihood that more immediate adaptation actions will also enhance future options and preparedness.

4. Characteristics of mitigation pathways

There are multiple mitigation pathways that are *likely* to limit warming to below 2˚C relative to pre-industrial levels. These pathways would require substantial emissions reductions over the next few decades and near zero emissions of CO_2 and other long-lived GHGs by the end of the century. Implementing such reductions poses substantial technological, economic, social, and institutional challenges, which increase with delays in additional mitigation and if key technologies are not available. Limiting warming to lower or higher levels involves similar challenges, but on different timescales.

IPCC AR5 SYR SPM
Adaptation and Mitigation

- **Many adaptation and mitigation options can help address climate change, but no single option is sufficient by itself. Effective implementation depends on policies and cooperation at all scales, and can be enhanced through integrated responses that link adaptation and mitigation with other societal objectives.**

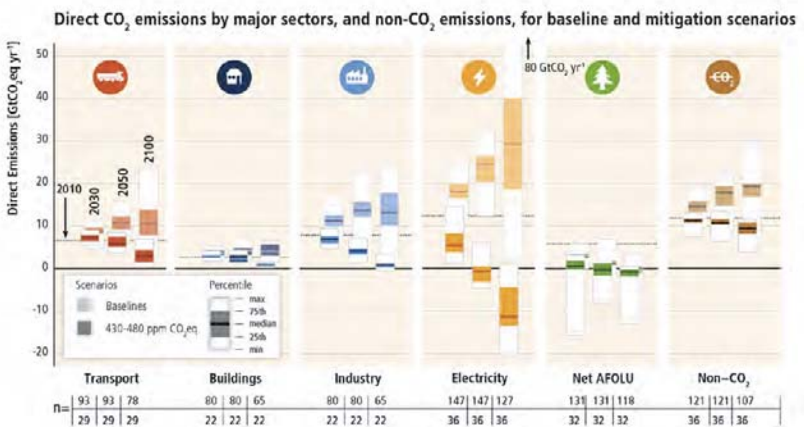
IPCC AR5 SYR SPM
Adaptation and Mitigation

1. **Common enabling factors and constraints for adaptation and mitigation responses**
   Adaptation and mitigation responses are underpinned by common enabling factors. These include effective institutions and governance, innovation and investments in environmentally sound technologies and infrastructure, sustainable livelihoods, and behavioural and lifestyle choices.

2. **Response options for adaptation**
   Adaptation options exist in all sectors, but their context for implementation and potential to reduce climate-related risks differs across sectors and regions. Some adaptation responses involve significant co-benefits, synergies and trade-offs. Increasing climate change will increase challenges for many adaptation options.

3. Response options for mitigation

Mitigation options are available in every major sector. Mitigation can be more cost-effective if using an integrated approach that combines measures to reduce energy use and the GHG intensity of end-use sectors, decarbonize energy supply, reduce net emissions and enhance carbon sinks in land-based sectors.



4. Policy approaches for adaptation and mitigation, technology and finance

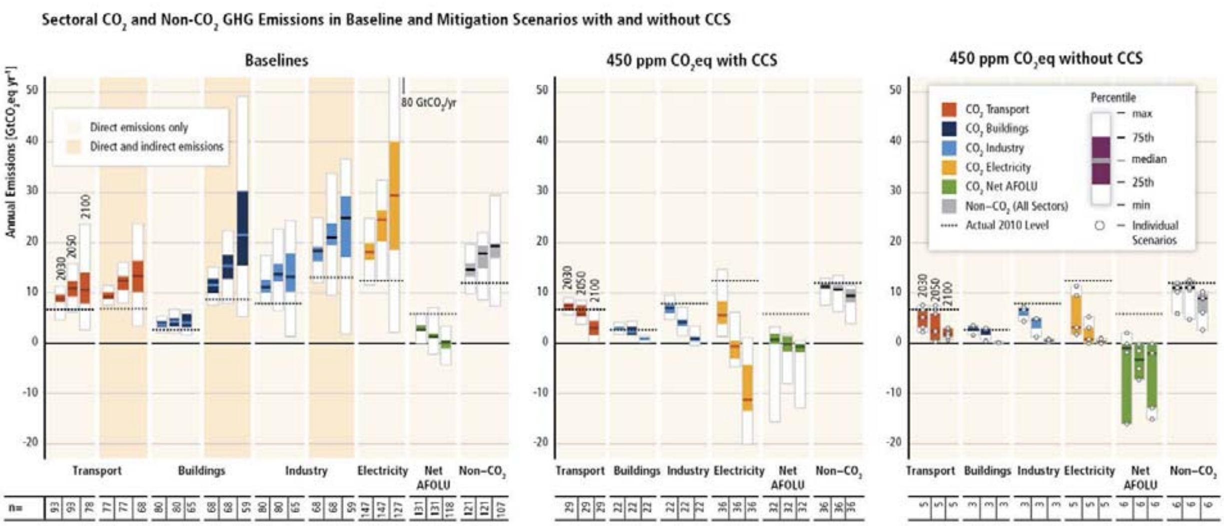
Effective adaptation and mitigation responses will depend on policies and measures across multiple scales: international, regional, national and sub-national. Policies across all scales supporting technology development, diffusion and transfer, as well as finance for responses to climate change, can complement and enhance the effectiveness of policies that directly promote adaptation and mitigation.

IPCC AR5 SYR SPM
Adaptation and Mitigation

5. **Trade-offs, synergies and interactions with sustainable development**

Climate change is a threat to sustainable development. Nonetheless, there are many opportunities to link mitigation, adaptation and the pursuit of other societal objectives through integrated responses (high confidence). Successful implementation relies on relevant tools, suitable governance structures and enhanced capacity to respond (medium confidence).

IPCC AR5 SYR
Response options for mitigation



CO2 emissions by sector and total non-CO2 GHG emissions (Kyoto gases) across sectors in baseline (left panel) and mitigation scenarios that reach about 450 (430 – 480) ppm CO2-eq (*likely* to limit warming to 2˚C above pre-industrial levels) with CCS (middle panel) and without CCS (right panel).

The Road to Kyoto And Beyond

History of Global Warming (1/2)

1827	French mathematician Jean-Baptiste Fourier suggests the existence of an atmospheric mechanism keeping the Earth warmer than it would otherwise be. He likens it to a greenhouse.
1863	Irish scientist John Tyndall publishes a paper describing how atmospheric water vapor could contribute to this mechanism.
1890s	Swedish scientist Svante Arrhenius and American P.C. Chamberlain independently investigate the potential problems that could be caused by carbon dioxide (CO_2) building up in the atmosphere. They both suggest that burning fossil fuels could lead to global warming, but neither suspect the process might already have started.
1890s - 1940	Average surface air temperatures increase by about 0.25 C. Some scientists see the American Dust Bowl (a devastating, persistent drought in the 1930s) as a sign of the greenhouse effect at work.
1940 - 1970	Global temperatures cool by 0.2 C. Scientific interest in global warming declines. Some climatologists predict a new ice age.

History of Global Warming (2/2)

1957	U.S. oceanographer Roger Revelle warns that people are conducting a "large-scale geophysical experiment" on the planet by releasing greenhouse gases. Colleague David Keeling establishes the first continuous monitoring of atmospheric CO_2. He rapidly confirms a regular year-on-year rise.
1970s	A series of studies by the U.S. Department of Energy increases concerns about possible long-term effects of global warming.
1979	First World Climate Conference adopts climate change as major issue and calls on governments "to foresee and prevent potential man-made changes in climate".
1985	First major international conference on global warming in Villach (Austria) warns that average global temperatures in the first half of the 21st century could rise significantly more than at any other time in human history. Warmest year on record. The 1980s is the warmest decade on record, with seven of the eight warmest years of the century.
1987	Global temperatures cool by 0.2 C. Scientific interest in global warming declines. Some climatologists predict a new ice age.

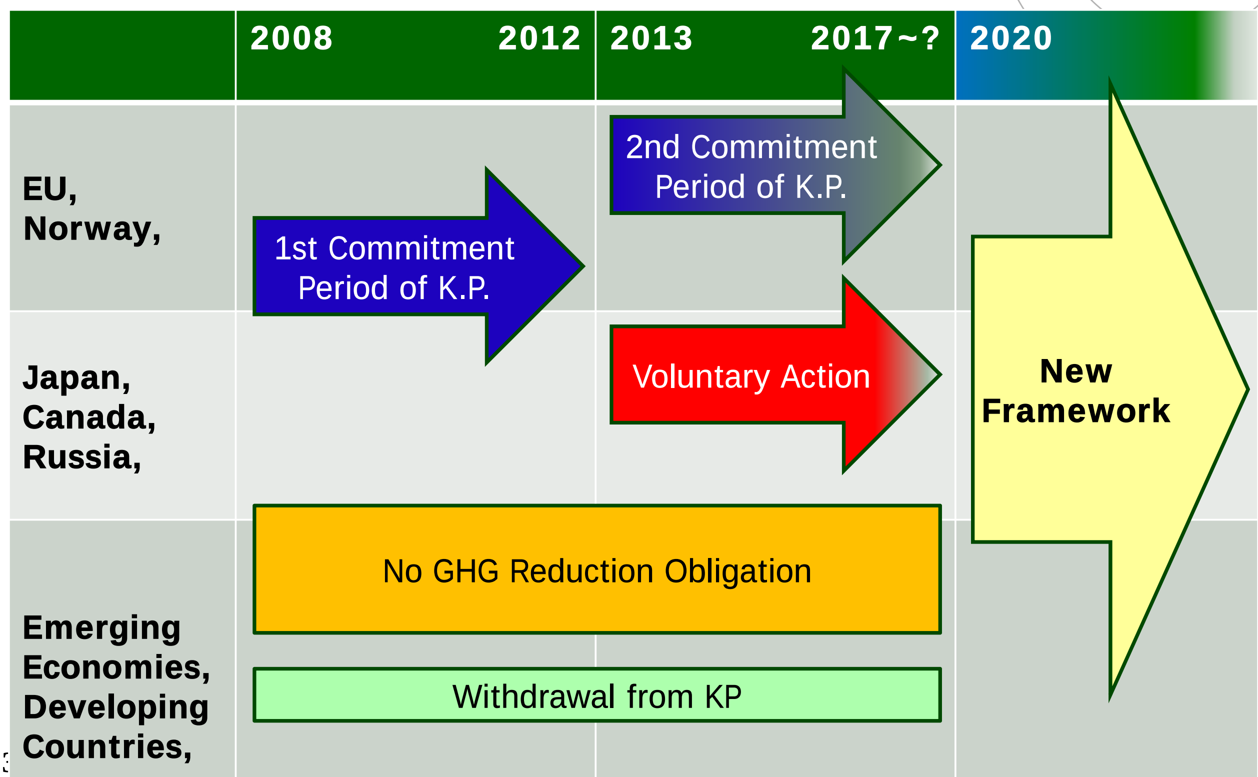
Road to Kyoto

1988	•Heat wave in U.S. granary •Testimony by Dr. Hansen •Toronto Conference •Establishment of IPCC
1990	•IPCC First Assessment Report
1992	•Earth Summit ⇒UNFCCC
1995	•COP-1 (Berlin) ⇒Berlin Mandate •IPCC Second Assessment Report
1996	•COP-2 (Geneva)
1997	•COP-3 (Kyoto) ⇒Kyoto Protocol

UNFCCC

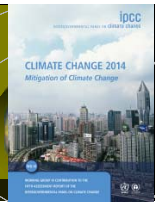
- Sets an initial target for industrialized countries to reduce their GHG emission to 1990 levels by the year 2000.
- Demanded each industrialized nation to submit national communication on GHG emission inventory, and to provide financial and technical assistance to developing countries for the reporting.
- Came into force on 21 March 1994.

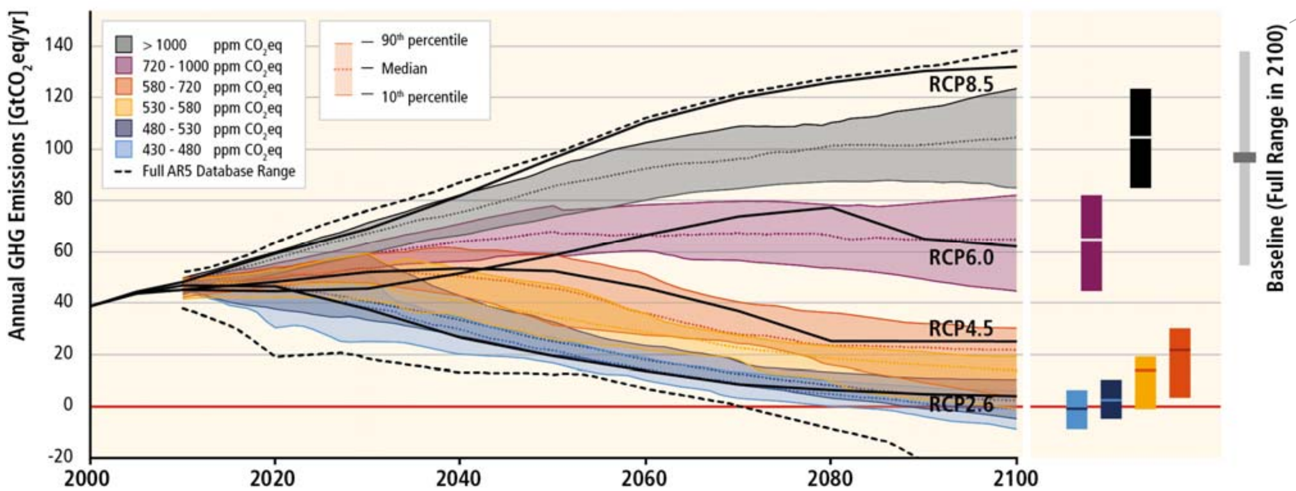
Current and Future Framework



Towards a Deep Reduction of Greenhouse Gas

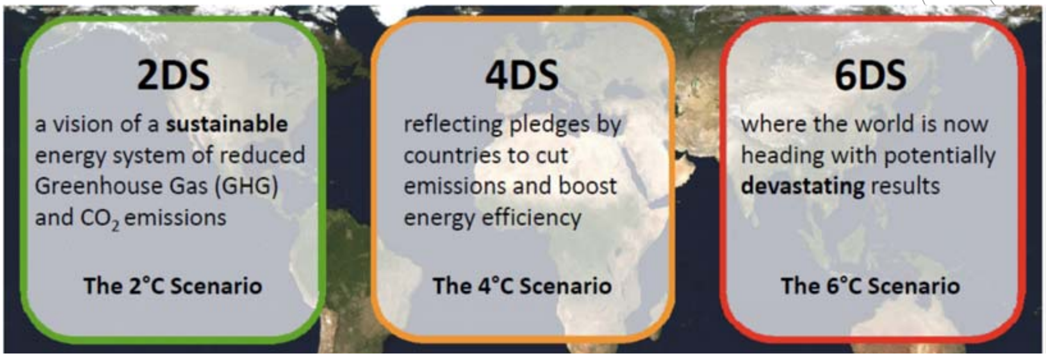
IPCC WG III - AR5
Mitigation of Climate Change

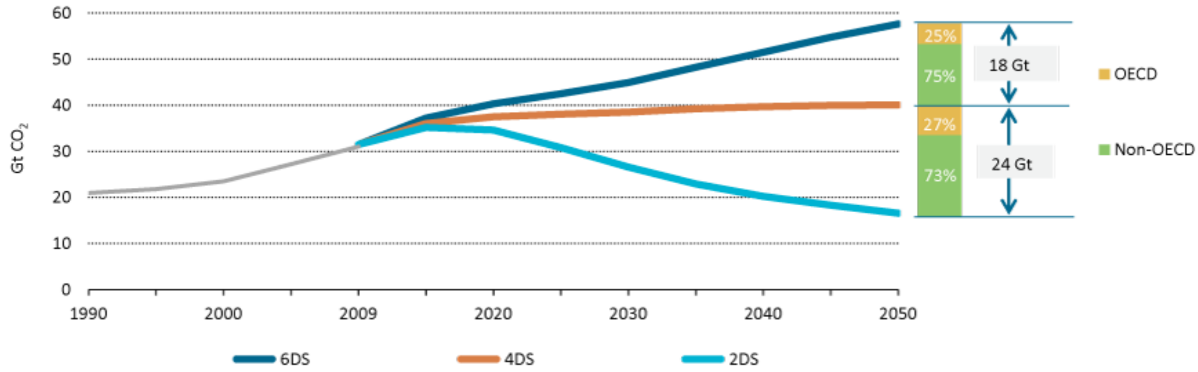




Pathways of global GHG emissions (GtCO2eq/yr) in baseline and mitigation scenarios for different long-term concentration levels.

Energy Technology Perspectives 2014 (IEA)
3 Scenarios





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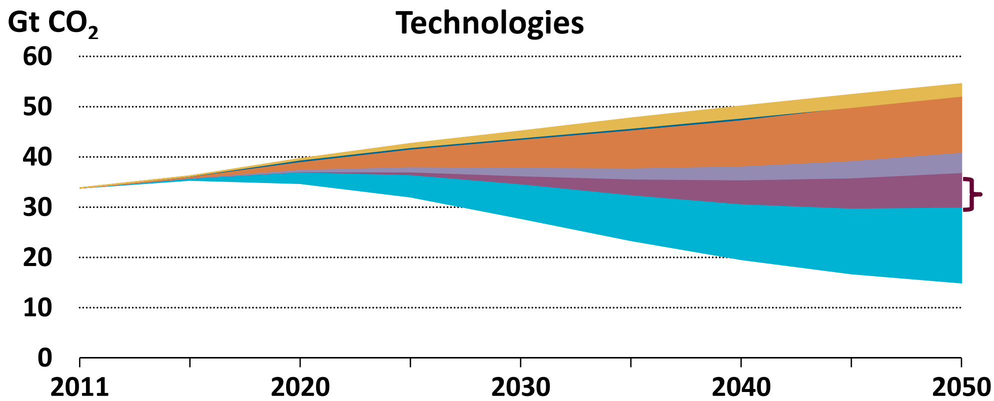
Energy Technology Perspectives 2014 (IEA)
Contribution to Emission Reduction of Technologies



- Nuclear 7%
- Power generation efficiency and fuel switching 2%
- Renewables 30%
- End-use fuel switching 9%
- CCS 14%
- End-use fuel and electricity efficiency 38%

As part of a portfolio of actions, CCS accounts for 14% of total energy-related CO2 reductions needed by 2050.

Note: Percentage represent cumulative contributions to emissions reductions relative to 6DS scenario.

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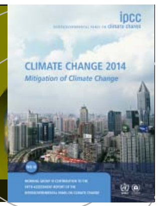
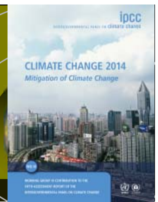
IPCC WG III - AR5
Mitigation of Climate Change



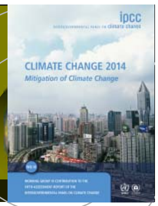
- **Decarbonizing (i.e. reducing the carbon intensity of) electricity generation is a key component of cost-effective mitigation strategies in achieving low-stabilization levels (430 – 530 ppm CO_2eq).**
- **Carbon dioxide capture and storage (CCS) technologies could reduce the lifecycle GHG emissions of fossil fuel power plants.**

IPCC WG III - AR5
Mitigation of Climate Change



- **Many models *could not* achieve atmospheric concentration levels of about 450 ppm CO_2eq by 2100 if additional mitigation is considerably delayed or under limited availability of key technologies, such as bioenergy, CCS, and their combination (BECCS).**
- **CCS is indispensable if we want a new deal for the climate - *Ottmar Edenhofer, co-chair of IPCC WG III.***

IPCC WG III AR5, SPM
Global Mitigation Cost



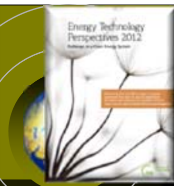
"Under the absence or limited availability of technologies, mitigation costs can increase substantially … "

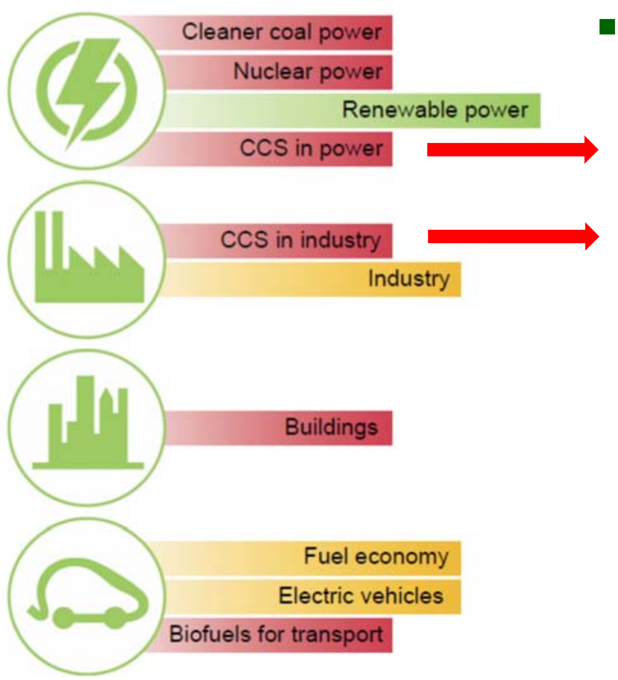
Increase in mitigation costs for 450 ppm scenario

- **No CCS: +138%**
- **Nuclear Phseout: +7%**
- **Limited Solar/Wind: +6%**
- **Limited Bio: +64**

	Increase in total discounted mitigation costs in scenarios with limited availability of technologies [% increase in total discounted mitigation costs (2015–2100) relative to default technology assumptions]			
2100 Concentration (ppm CO_2eq)	No CCS	Nuclear phase out	Limited Solar / Wind	Limited Bio-energy
450 (430–480)	138 (29–297) [N: 4]	7 (4–18) [N: 8]	6 (2–29) [N: 8]	64 (44–78) [N: 8]
500 (480–530)				
550 (530–580)	39 (18–78) [N: 11]	13 (2–23) [N: 10]	8 (5–15) [N: 10]	18 (4–66) [N: 12]
580–650				

ETP 2012
Progress in Clean Energy is too Slow





- **Some of the technologies with the largest potential are showing the least progress**
  - **Development and deployment of CCS is seriously off pace to reach 269 Mt/CO2 captured across power and industrial applications in 2020 in the 2DS. This is equivalent to about 120 CCS facilities.**

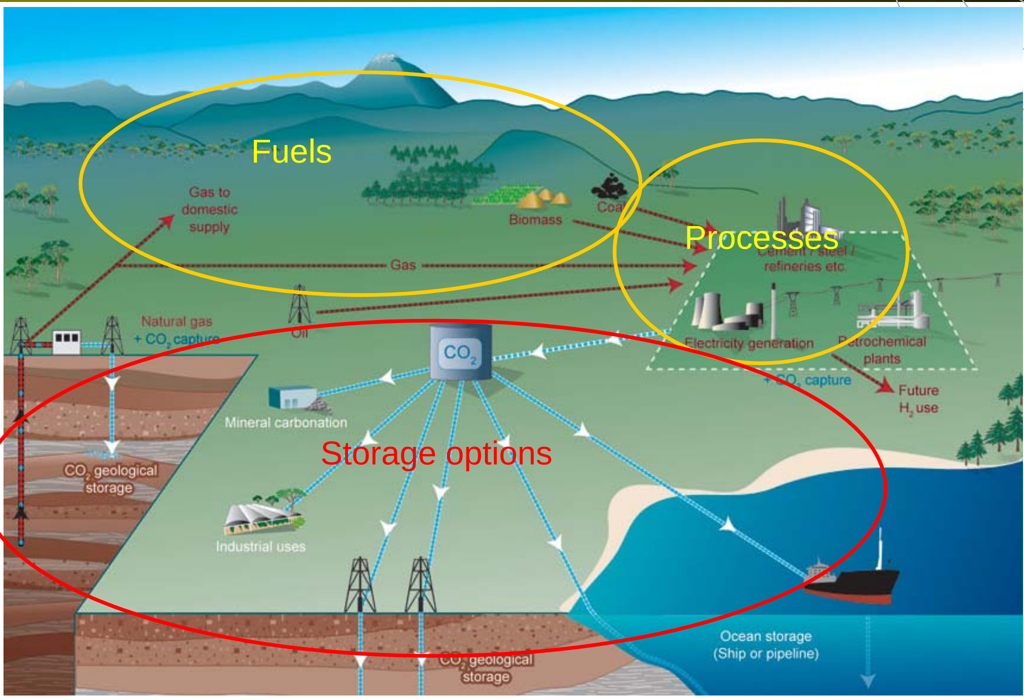
CO_2 Capture and Storage

or

CO_2 Capture and Sequestration

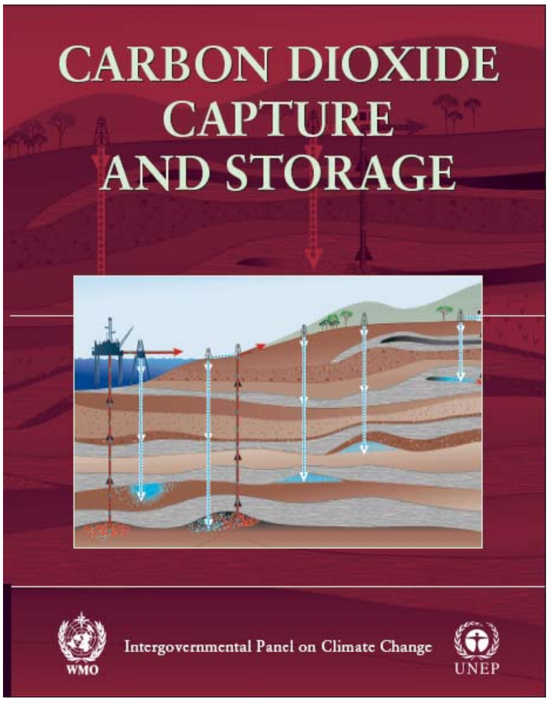
(CCS)

CO_2 Capture and Storage System



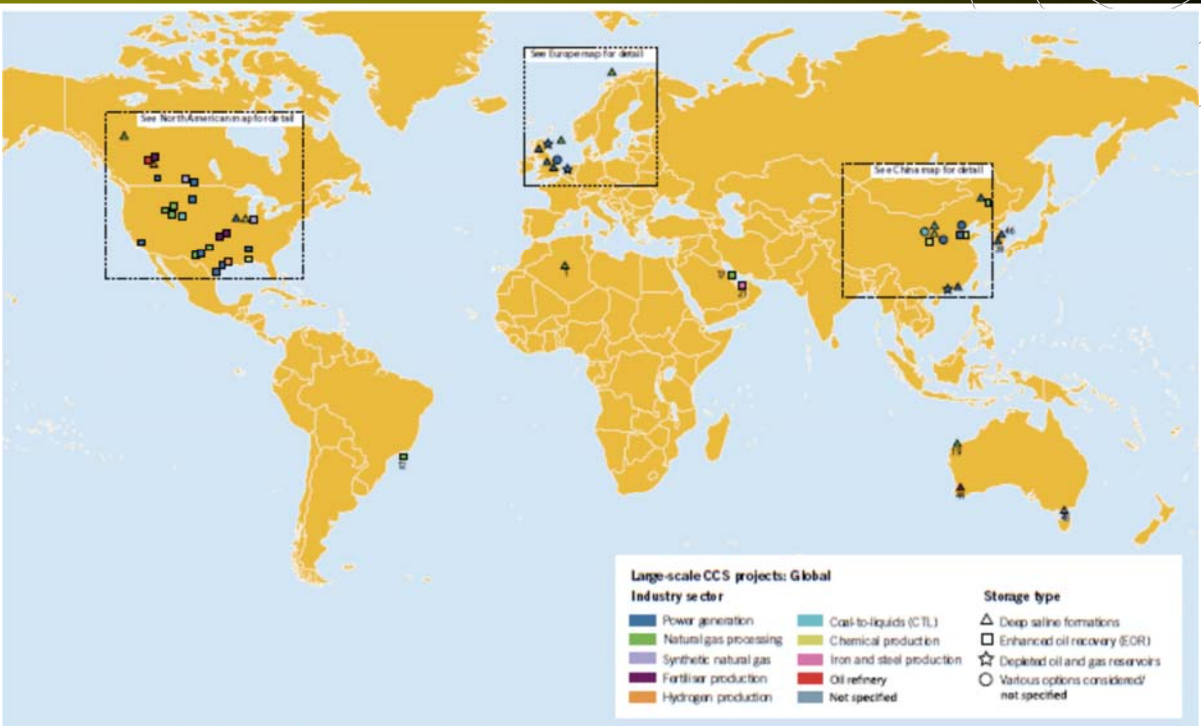
Source: IPCC SRCCS

The IPCC Special Report on Carbon Dioxide Capture and Storage



Large Scale Integrated Project

（Global CCS Institute, 2014）



CCS in G8 Summit

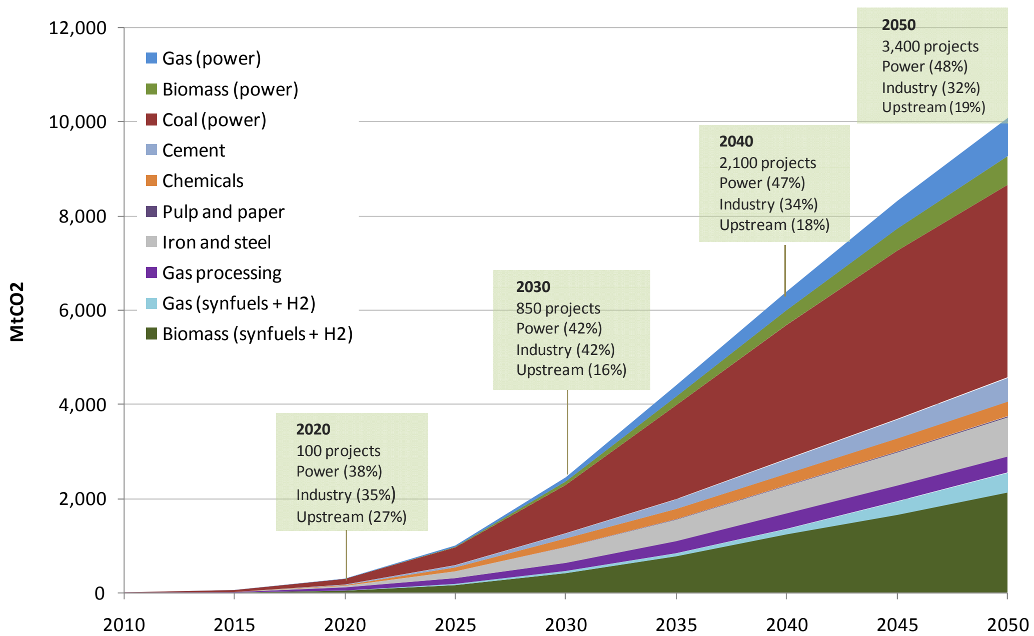
G8 Hokkaido Toyako Summit Leaders Declaration (8 July 200)

31. We will establish an international initiative with the support of the IEA to develop roadmaps for innovative technologies and cooperate upon existing and new partnerships, including carbon capture and storage (CCS) and advanced energy technologies. Reaffirming our Heiligendamm commitment to urgently develop, deploy and foster clean energy technologies, we recognize and encourage a wide range of policy instruments such as transparent regulatory frameworks, economic and fiscal incentives, and public/private partnerships to foster private sector investments in new technologies. **We strongly support the launching of 20 large-scale CCS demonstration projects globally by 2010, taking into account various national circumstances, with a view to beginning broad deployment of CCS by 2020.**

IEA CCS Roadmap

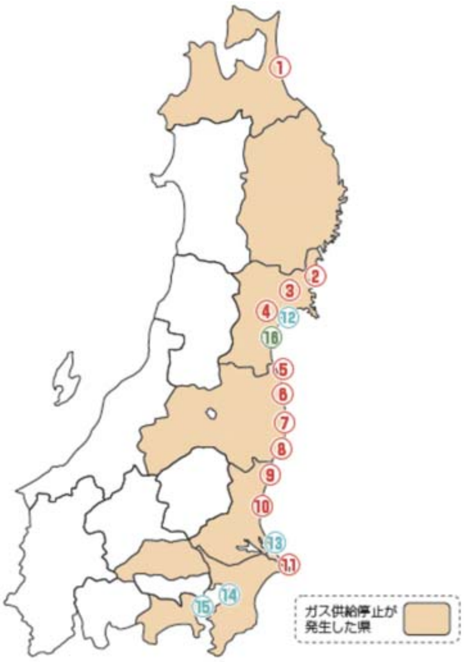
Global Deployment of CCS 2010–50 by Sector

BLUE Map Scenario (~450 ppm)



What Happened after Fukushima Nuclear Accidents

What Happened to the Energy Supply by the Catastrophic Earthquake and Tsunami?
(11 March 2011)



Major installations affected by the earthquake and tsunami

Damaged Plants

- Power Stations
  - Tohoku Grid
    - Fossil
      Hachinohe (250MW), Sendai (446MW), Shin-Sendai (350MW), Haramachi (2000MW), Shinchi (2000MW)
  - Tokyo Grid
    - Fossil
      Hirono (3800MW), Hitachi-naka (1000MW), Nakoto (1625MW), Kashima (4400MW), Kahima (1400MW)
    - Nuclear
      Fukushima-1 (4700MW)
- 3 Refineries
- 1 LNG terminal

Most of the plants have been retrieved !

Shortage of Power Supply

- March to summer 2011 (affected areas)
  - Rotating blackout (March 2011)
  - Forced restriction of electricity use to large customers (-15% in Summer 2011).
  - Voluntary power saving in households.
- 2012 (before Summer)
  - One out of 54 nuclear power stations is running, but would be stopped for scheduled maintenance within a month.
    ⇨ZERO Nuclear
  - In Kansai area, where about a half of the electricity had been supplied by nuclear, power shortage up to 20% was anticipated in the summer of 2012.
    ⇨Two nuclear power stations were re-started through the controversial decision by the Prime Minister

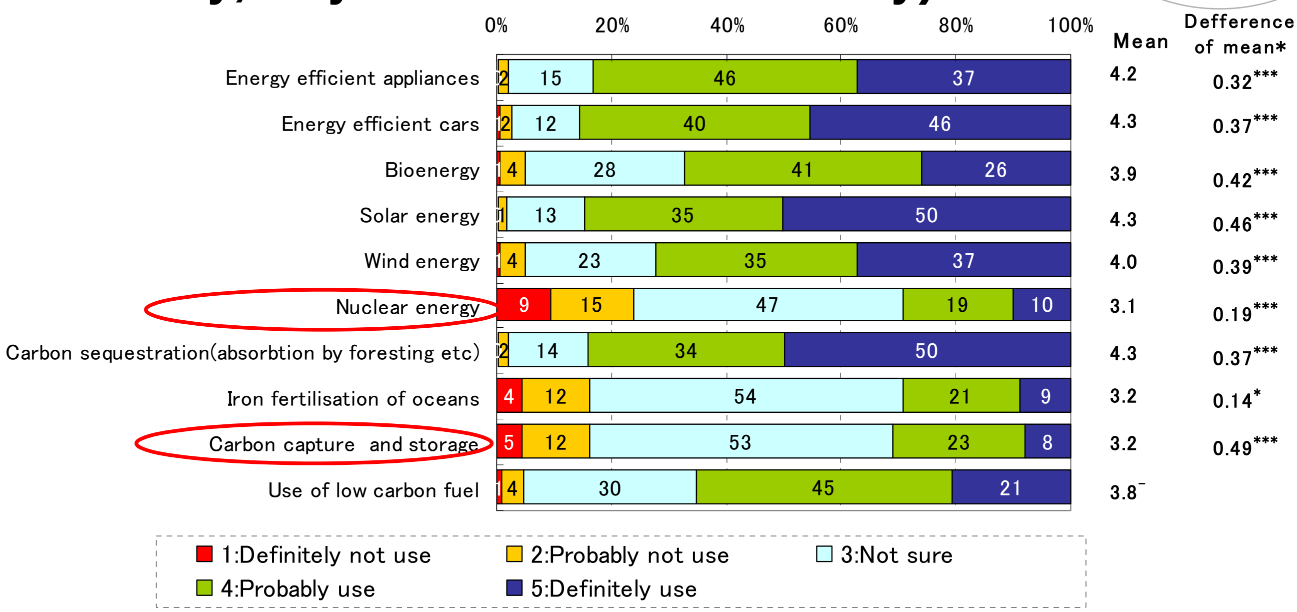
Short- to Mid-term Impacts (1 year to 20 years)

- Possibilities:
  - Forced restriction of electricity use
  - Rotating blackout
  - Unmanageable black-out
- Replacing nuclear electricity (1100MW) by fossil will impose about $1B/y of additional fuel cost.
- CO_2 emission from power sector in 2020 will be 50 to 250 Mton higher compared with BAU if CCS and Nuclear will not be employed.
  - Based on a scenario analysis

Public Perception

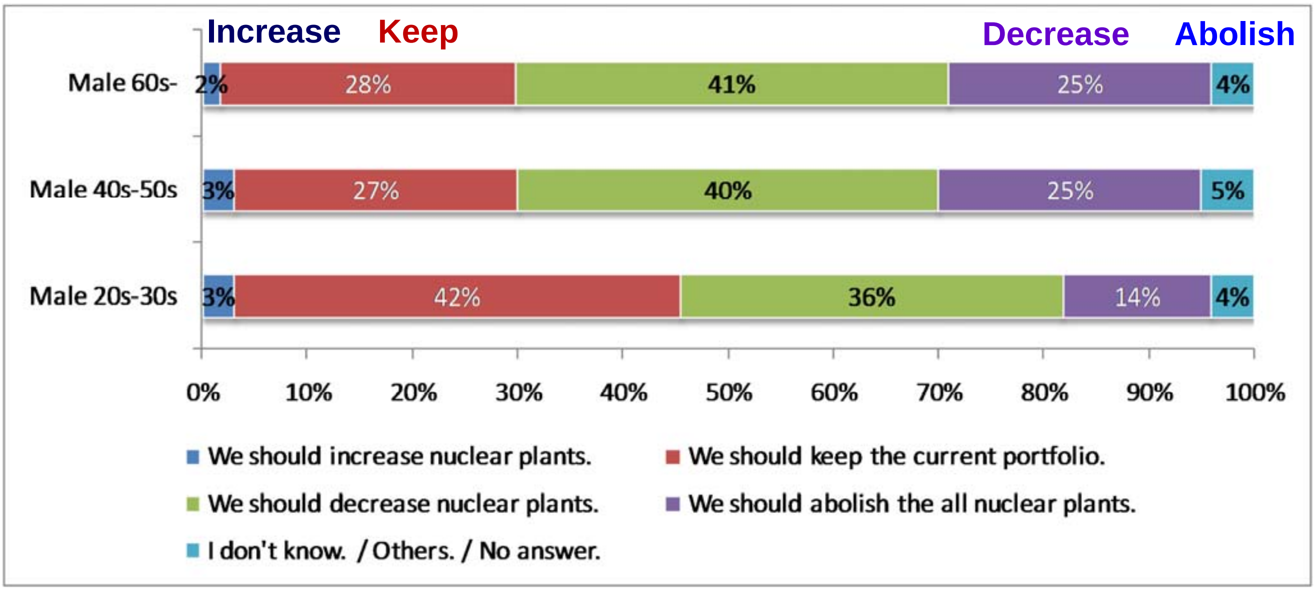
Nuclear and CCS:
Similarity in Perception (AIST Study)

- **If you are responsible for climate policy in your country, do you use .....? (2007 survey)**



Public Opinion on Nuclear
After Fukushima Accident - Media Survey

- **What should we do about nuclear plants in Japan? (October 2011, each sex)**



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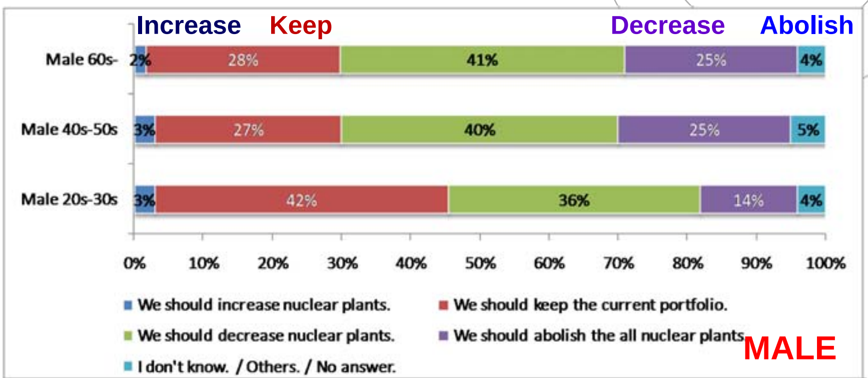
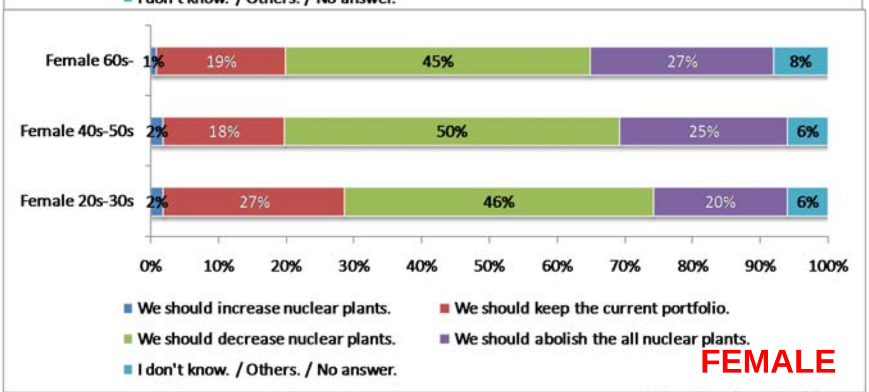
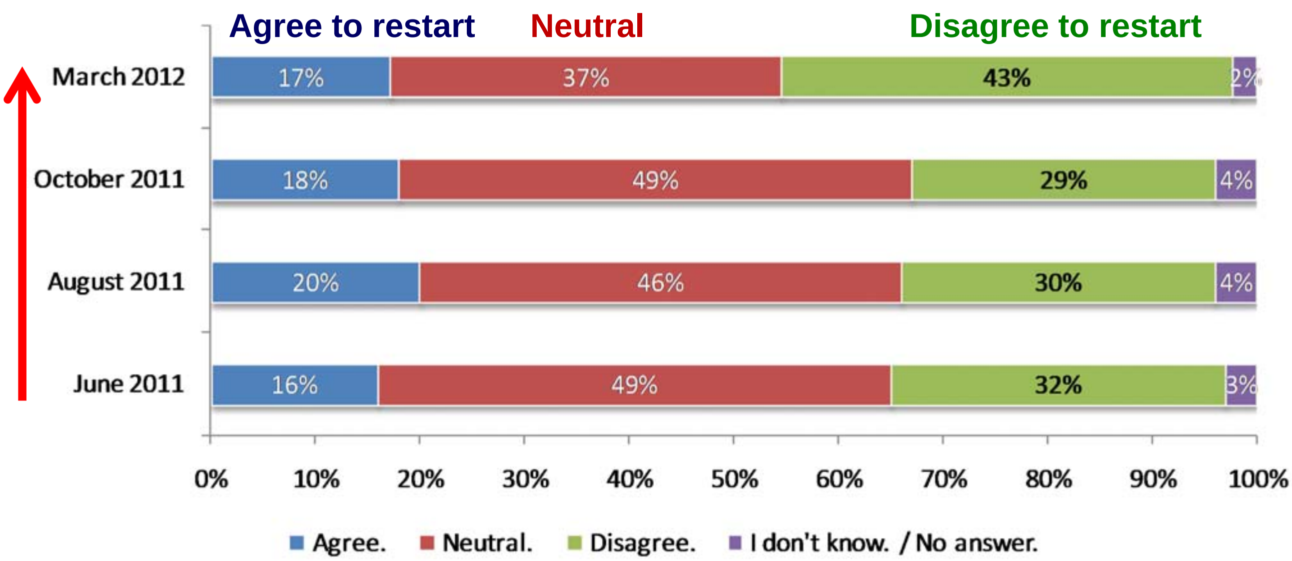




Public Opinion on Restarting Nuclear

- **Are you agree or disagree about restarting operation of nuclear plants that have shut for periodic inspections or earthquakes?**



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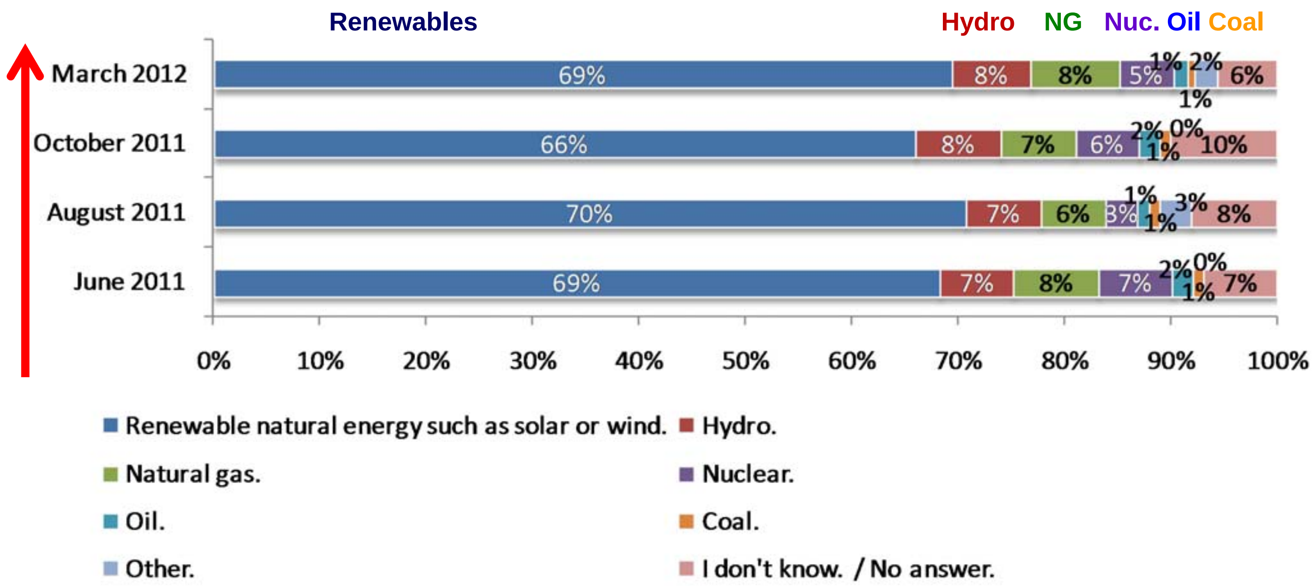
Public Opinion
Future Energy Portfolio

- **What kinds of energy sources should we expand more in the future?**



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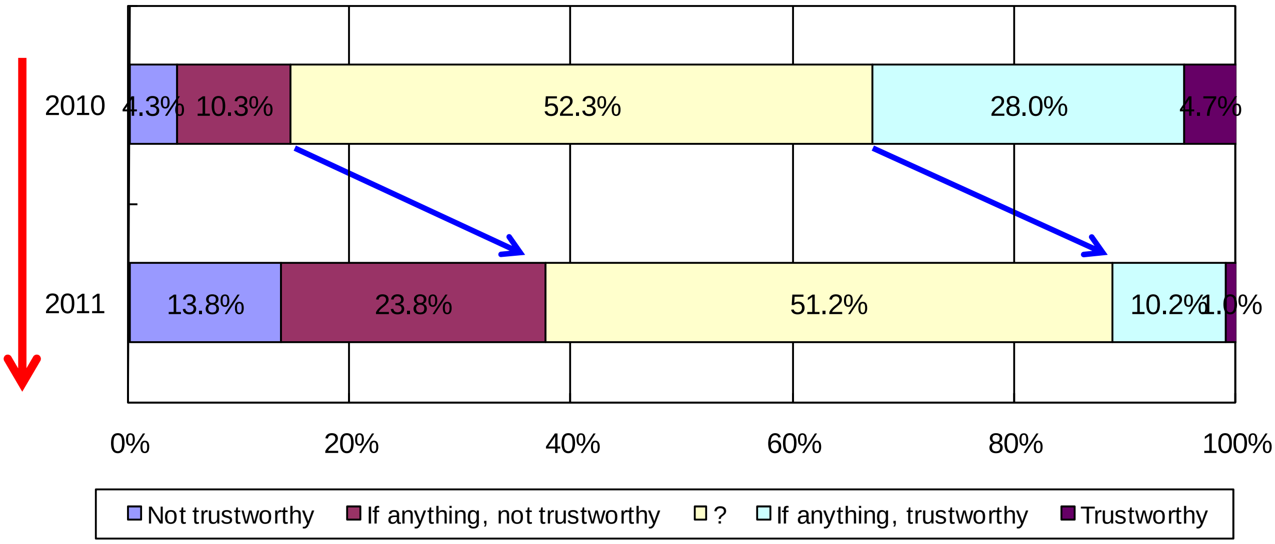
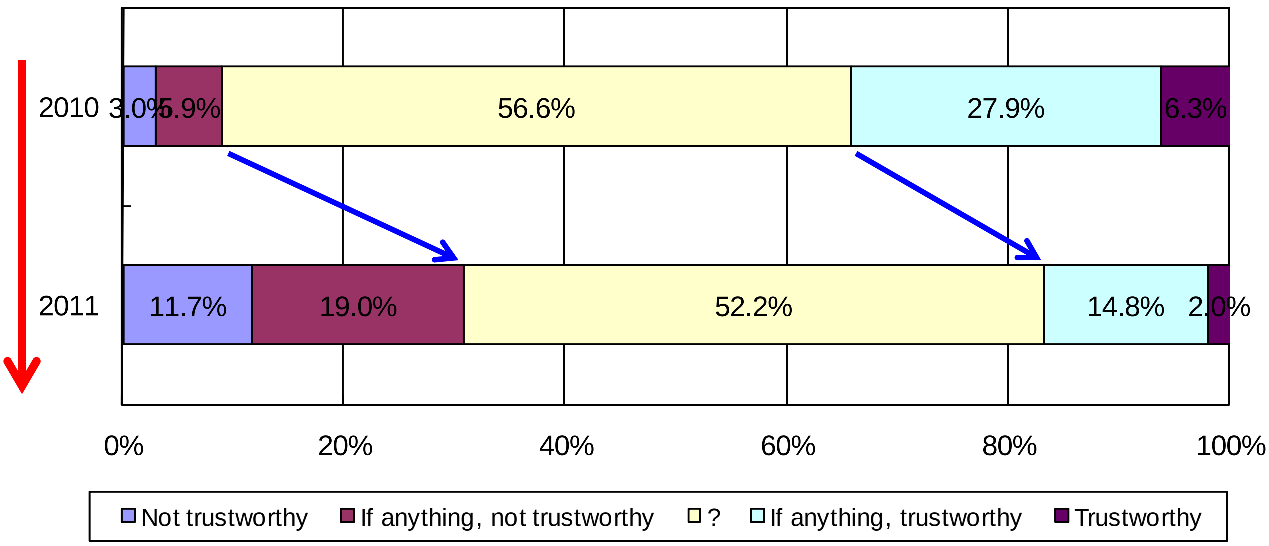
Public opinion - Losing Trusts
Governments

- **Trust in local governments and national government (nuclear safety regulators)**



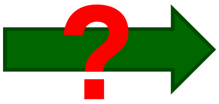
Public opinion - Losing Trusts
Experts

- **Trust in nuclear experts and involved parties**



Rumor, Rumor, Rumor …

Piece of pine trees suffered in an area far from Fukushima



The Gozan no Okuribi Festival (16 August in Kyoto)

- **A proposal was made to send pieces of pine trees suffered by the tsunami to Kyoto to be burned as a part of a famous farewell bonfire to mourn the victims.**

BUT

- **Many of the Kyoto citizens said NO because of unreasonable fear for radiation.**

Rumor, Rumor, Rumor …

- **Request to local authorities other than Tohoku area to accept non-radiative debris arisen from the earthquake and tsunami to help the incineration disposal.**
- **Some of the mayors, etc. said YES**

BUT

- **Only a little amount of debris has been accepted because of strong / hysteric oppositions of local citizens and non-local public.**

Energy Portfolio of Japan in a Age of New Myth?

- Myth of the absolute safety of a Nuclear Power Plant was destroyed with Fukushima accident
- Emerging new myth
  - Absolute dangerousness of Nuclear Power Plants
- Proposed solution for short- to mid-term (~2030, ~2050):
  - Fuel switching from Nuclear/Coal to Natural Gas
  - Renewables

What to Do in Japanese Society? Observations

- Poor knowledge of politicians on energy issues
- Emotional discussion on energy portfolio
  - Nuclear vs. Renewables
  - Promoters of renewables or antinuclear activists try to revenge themselves on electric utilities, policy makers, etc. for long-term indignity by making best use of Fukushima accident.
  - Old fashioned skepticism on renewables of electric utilities, etc. to protect against challenge by promoters.
- Harmful argument by non-expert "intellectuals"
  - General public would be influenced by the opinion of so called "intellectuals" regardless of their expertise
- Emerging new myth
  - Absolute dangerousness of Nuclear Power Plants

What to Do in Japanese Society?
Impossible Dream?

- Improving energy literacy
  - General public, policy makers, politicians, etc.
- Restoration of the public's confidence on scientists, experts, policymakers, etc.
  - Elimination of pseudointellectuals
- Daily life considering RISK
  - Adverse reaction on the term "Risk"
    - Paraphrasing "risk assessment" as "safety assessment" even by the government.
- Education of media
  - Importance of improving media literacy of recipient

Thank you!

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