The first workshop of **Japan–UK** Joint Research Project

Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development

Workshop Summary

June 13th to 16th, 2006
Mita Kaigisho, Tokyo, Japan




defra

UKERC

Tyndall Centre for Climate Change Research

British Embassy Tokyo

Front page photos (from left to right)

Photo1: Japanese Minister of the Environment, Ms. Yuriko Koike, and British Ambassador to Japan, Sir Graham Fry, announced that the Japan-UK joint research project, "Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development," was launched by the Ministry of the Environment of Japan (MoEJ) and the UK Department for Environment, Food and Rural Affairs (Defra) at the symposium "Challenges to Achieve Low Carbon Society - 1st Anniversary of Kyoto Protocol - " held in Tokyo on February 16, 2006. See Appendix I “Press release on Feb. 16, 2006.”

Photo2: Panel Discussion at Open Symposium in June 13, 2006

Photo3: Group photo of participants

Photo4: Discussion at Wrap-up session in June 16, 2006

Photo5: David Warrilow (Defra, UK) and Naoya Tsukamoto (MoE, Japan) co-chaired wrap-up session in June 16, 2006.

Second Edition (October 2006)

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This workshop summary and all presentation materials are also available on the Japan LCS website.

Co-Chairs' Summary

Shuzo Nishioka
(snishiok@nies.go.jp)
Executive Director,
National Institute for
Environmental Studies

Jim Skea
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Research Director,
UK Energy
Research Centre

Workshop

A workshop on "Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development" was held from June 14 to 16, 2006 in Tokyo, hosted and organized by The Ministry of the Environment of Japan (MoEJ) and the Department for Environment, Food and Rural Affairs in the UK (Defra), National Institute for Environmental Studies (NIES), UK Energy Research Centre (UKERC), and Tyndall Centre for Climate Change Research with the advice of the steering committee composed of scientists and governmental officials from Japan, UK, China, Germany, India, Mexico, Russia and USA. We had 54 experts from 19 countries and 6 international organizations, and 65 other participants.

Objectives

The objectives of the workshop were:
a) identifying and understanding the necessity for deep cuts in greenhouse gas (GHG) emissions toward 2050 based on scientific findings,
b) reviewing country-level GHG emissions scenario studies in developed and developing countries,
c) aligning sustainable development and climate objectives,
d) studying methodologies to achieve LCS, e) identifying gaps between our goals to develop country-level LCS scenarios and the current reality and,
f) identifying opportunities for cooperation and how best to cooperate in structuring country, regional and global-level LCS scenarios.

Deep cuts in global greenhouse gas emissions are required to prevent the worst effects of climate change and thus achieve the ultimate objective of the UNFCCC to stabilise greenhouse gas concentrations in the atmosphere at levels which avoid dangerous climate change.

Conclusions

1. Toward a Low-Carbon Society, we need to
   - take actions that are compatible with the principles of sustainable development, ensuring that the development needs of all groups within society are met;
   - make an equitable contribution towards the global effort to stabilise atmospheric concentrations of carbon dioxide and other greenhouse gases at a level that will avoid

dangerous climate change through deep cuts in global emissions;

- demonstrate high levels of energy efficiency and uses low-carbon energy sources and production technologies;
- adopt patterns of consumption and behaviour that are consistent with low levels of GHG emissions.

2. Long term goals can help us define the pathway to achieve LCSs. Developing shorter-term targets can inform and energise the policy-making and implementation processes. Targets should be flexible enough to allow freedom to act in response to an uncertain future.

3. The sustainable development perspective is important, especially from the viewpoint of developing countries, because they have development choices open to them that could allow the achievement of a LCS more cost effectively. They could reach their national sustainable development goals along with a LCS, if suitable policies are coupled with international collaboration at the regional and global levels.

4. The formal international climate framework of the UNFCCC is essential to the development of LCSs. Informal processes such as the Gleneagles Dialogue complement the formal process. We hope that the insights gained at this workshop will provide a useful input to existing international processes.

5. A variety of tools and methods is required to explore pathways including policy scenarios and backcasting methodologies. The latter, for example, first set goals for desirable LCSs and, by working backwards, explore optimal paths for their achievement.

6. Further research is needed for modelling, technology, socio-economics, and policy options assessment.

The next LCS workshop will be held in June 2007 in the UK.

Co-Chairs:
Shuzo Nishioka
Jim Skea

Tokyo, Japan
June, 2006

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Open Symposium




July 13, 2006

Tokyo

Agenda of the Open Symposium on "Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development"

Date: 13th June, 2006
Venue: Mita Kaigisyo: 2-1-8 Mita, Minato-ku, Tokyo 108-0073

Language: Japanese and English (simultaneous translation service available)

13:00-13:15 Welcome address
Yuriko Koike (Minister of the Environment, Japan)
Graham Fry (British Embassy in Tokyo)

13:15-13:40 Avoiding Dangerous Climate Change: Impact and Science of Climate Change
David Warrilow (Defra, UK)

13:40-14:05 Low carbon scenarios for Japan
Junichi Fujino (NIES)

14:05-14:30 Sustainable Development Scenario for a Low Carbon Society Vision for India
P.R.Shukla (Indian Institute of Management, India)

14:30-14:55 Low carbon scenarios for the UK
Jim Watson (SPRU, University of Sussex, UK)

14:55-15:20 What kind of international cooperation we need for global Low-Carbon society
David Jhirad (WRI)

15:20-15:40 Break

15:40-16:55 Panel Discussion "What are keys to achieve Low-Carbon societies through sustainable development?"

Discussion points:

- How to arrive at long-term goals for LCS
- How to develop visions and pathways toward low carbon societies through sustainable development.
  - What is a role of technology, institution, behavior to achieve LCS
  - How to achieve international cooperation for LCS

Coordinator: Jim Skea (UKERC, UK)
Panelist: (5 Minutes per Panel including introduction)
China: Jiang Kejun (ERI)
EU: Thomas Van Ierland (EC)
India: P.R. Shukla (IIM)
Japan: Shuzo Nishioka (NIES)
USA: David Jhirad (WRI)

Comments/Q&A (20-30minutes from floor)

16:55-17:00 Closing Address
Ryutaro Ohtsuka (President of NIES, Japan)

Welcome Address

Yuriko Koike
Minister of the Environment Japan (September 2003 to September 2006)

Good afternoon. First of all, on behalf of the organizers, I would like to express my gratitude to all of you for attending today's symposium entitled Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development.

In February 2005, the Kyoto Protocol came into effect. The target of the Kyoto Protocol is for all developed countries to reduce their greenhouse gas emissions to 5% below 1990 levels during the first commitment period. Achieving such a target will be an epoch making step by all humankind to collaborate on reducing greenhouse gases. However, at the same time, this is considered to be just the first step towards the realization of a low carbon society. In order to leave the earth in a stable state for future generations, we have to make further efforts to reduce greenhouse gases significantly.

The effects of global warming are already being witnessed around the world. Japan's average temperature has risen one degree centigrade within the last 100 years. Himalayan glaciers have receded by a large margin. Sea ice at the Arctic pole has decreased by 20% in the summer time in the past three decades. Also, extreme weather events have been observed in various parts of the world and they are conjectured to be associated with global warming.

The ultimate goal of the United Nations Framework Convention on Climate Change is to stabilize the atmospheric concentrations of greenhouse gases at a level that would prevent dangerous anthropogenic interference with the climate system. Reflecting on the scientific information in the IPCC Third Assessment Report in 2001, for example, we have come to understand that current levels of global greenhouse gas emissions have to be reduced by half between 2050 and 2100 to achieve this goal. The EU Environment Minister's Meeting in 2005 suggested that a reduction of at least 15% and more likely 50% from 1990 levels would be necessary to achieve the goal. At any rate, it has been recognized that we do need drastic reductions in order to halve emissions in the near future.

With this in mind, on February 16th of this year, the first anniversary of the Kyoto Protocol coming into effect, British ambassador Sir Fry and I launched the joint research project "Low Carbon Society Scenarios toward 2050," in which the UK Department for Environment, Food and Rural Affairs (Defra) and Japan's Ministry of the Environment are collaborating to develop a low carbon society. The objectives of this project are to deepen understanding of the need to reduce greenhouse gases to achieve a low carbon society based on scientific findings and to share the image of a low carbon society. Through Japan/UK collaboration, the project seeks to draw a comprehensive vision of the definition of a low carbon society, to disseminate it throughout the

world, and to present pathways toward such a society.

The future of a society is not merely determined by circumstance, but can change according to the goals of citizens. A sustainable society cannot be achieved merely by extending current trends into the future. As opposed to the conventional method of "forecasting," by which the future is projected from the present situation, an alternative method called "backcasting" has recently been attracting attention. In "backcasting", a vision of a desirable future is drawn first, and then pathways to that future are calculated in reverse step-by-step. This joint research project is based on the assumption that we must have less than half of today's greenhouse gas emissions in 2050 and it demonstrates, through the backcasting method, how institutions, technology, and life styles must change, keeping in mind the quality of life of the people who will live in 2050.

This project is mainly carried out on the Japan side by the National Institute for Environmental Studies (NIES) and in the UK by the UK Energy Research Centre (UKERC) and the Tyndall Centre for Climate Change Research. The UK is one of the leading countries involved with climate change work and it has a long term target of reducing its CO2 emissions to 60% of today's levels by 2050. The UK proposed climate change as one of the priority items at the Gleneagles G8 summit last year. In addition, I have heard that research findings from these two research centers have provided excellent input for the UK government initiatives.

In Japan, NIES has been developing the Asia-Pacific Integrated Model (AIM), an economic model for climate change countermeasures. AIM has received international attention and the research project, "Japan Low-Carbon Society Scenarios toward 2050," has been underway since 2004.

With these respective projects in mind, I recognized that Japan/UK collaboration on such research would lead to a high level of achievement, so I decided to propose the launch of this joint research project to Defra.

Another main objective of the project is to share a common vision of a low carbon society with other countries around the world. An international expert workshop will be held for three days from tomorrow, and it will involve a comprehensive survey of research in this field from around the world. Researchers and government representatives from approximately twenty countries and related international organizations will participate in this workshop and take part in scientific discussions on the realization of a low carbon society.

At the 24th sessions of the Subsidiary Bodies to the UN Framework Convention on Climate Change held in Bonn, Germany in May 2006, discussion began on the second commitment period of the Kyoto Protocol. Participating countries agreed to continue their discussion to enhance common understanding amongst all parties to the Convention based on the latest developments in climate change science and an analysis of the potential to reduce greenhouse gas emissions. In this international context, the Japan-UK joint project is expected to make a significant contribution.

As we take the first step in the long path toward achieving a low carbon society, I sincerely hope that the symposium and the international expert workshop will shed more light on the direction we should take. Thank you very much.

Welcome Address

Sir Graham Fry
British Ambassador to Japan

Good afternoon everybody and konnichiwa.

I am very honored to be able to open this symposium today on "Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development", and I am delighted to welcome representatives from over twenty countries as well as many international organizations which are concerned including the World Bank and the IEA. Let me thank the organizers, Japan's National Institute for Environmental Studies for all their hard work, and also our co-hosts Japan's Ministry of the Environment.

In the UK we published an Energy White Paper in 2003 which was subtitled "Creating a Low Carbon Economy". In this white paper, we announced a target for reducing our carbon dioxide emissions by 60% by 2050. We estimate that all developed countries will have to achieve reductions of a similar magnitude in order to stabilize the world's climate. Before setting that target, we analyzed the likely economic impact and we found that as long as we set our economy onto a low carbon pathway now, the cost would be only 0.5 to 2% of GDP by 2050.

Several of the researchers and policy makers responsible for our climate and energy modeling will be speaking this afternoon.

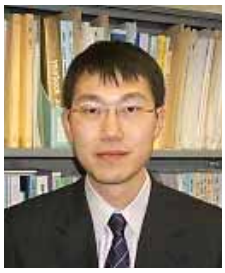
Of course, the UK is not the only country to have ideas about creating a low carbon society. In terms of energy efficiency, our hosts in Japan have already done a great deal towards achieving such an economy. This afternoon's symposium will be followed by a three-day workshop, at which representatives of many developed and developing countries will share their national experiences. They will consider the need for global and national climate science-based targets, they will consider the low carbon scenarios that will help us achieve them, and they will consider how we can all work together internationally.

The outputs of this workshop will be made available to the Gleneagles Dialogue on Climate Change. This Gleneagles process was agreed by the G8 leaders last summer and it brings together twenty countries with significant energy needs. It offers a space for energy and environmental ministers to discuss climate change in a forum separate from but complementary to the main international negotiating process in the UN. The next ministerial meeting will be in Mexico in October and the process will in due course report to Japan's presidency of the G8 in 2008.

Let me conclude my introduction by thanking all of you for coming today and I hope that you will find this afternoon's proceedings interesting and instructive. Thank you very much.

Key-note Speeches

Speakers


David Warrilow Junichi Fujino P. R. Shukla Jim Watson David Jhirad

Avoiding Dangerous Climate Change: Impact and Science of Climate Change

David Warrilow (david.warrilow@defra.gsi.gov.uk)
Head of Science Policy on Climate Change, Defra (UK)

Global temperatures rose by 0.7 C over the last 100 years and the number and severity of weather related disasters have increased recently. Climate models show that recent warming is largely due to increased emissions of greenhouse gases. Unchecked, such emissions will increase global temperatures by up to 6C during this century, with an increasingly adverse impact on all sectors of our societies. We need therefore to adapt to minimise the adverse effects of climate changes which will still occur due to past and current emissions. We also need to tackle the cause by reducing greenhouse gas emissions sufficiently to stabilise their atmospheric concentrations at levels which avoid “dangerous” levels of climate change. The EU has proposed a stabilisation limit of 2C above pre-industrial levels. To meet this goal, urgent action is needed to reduce emissions significantly. For developed countries this implies reductions of between 60 and 80% by 2050. This is a major challenge but many technologies already exist to achieve the necessary deep emission cuts.

Low Carbon Scenario for Japan

Junichi Fujino (fuji@nies.go.jp)
Senior Researcher, National Institute for Environmental Studies (Japan)

According to our latest model calculations, GHG reduction target needs to be about 50% of 1990’s emissions level in 2050 and 75% in 2100 in order that global mean temperature does not exceed 2℃ from the pre-industrial level. This implies that Japan would need 60-80% GHG emissions reduction by 2050. We have examined the “backcasting” method, which first develops emission target representing favorable LCS visions and then discusses the method to achieve it. The paths considering economic impact, technological possibilities, and institutional and lifestyle changes have simulated objectively and consistently using several numerical model analyses.
More details; http://2050.nies.go.jp/material/LCS_BOOKLET_No3.pdf

Sustainable Development Scenario for a Low Carbon Society Vision for India

P. R. Shukla (shukla@iimahd.ernet.in)
Professor, Indian Institute of Management (India)

The presentation made a key proposition that the pathways to achieve sustainable development goals are climate-friendly and offer myriad opportunities for gaining co-benefits, especially in developing countries. Strategies for transition to 'Low Carbon Society (LCS)' therefore should mainstream climate change agenda in development actions by shifting the 'development and climate' frontier through technology innovations and aligned investments, stakeholder interests and actions that deliver co-benefits. Examples from India were presented to illustrate how development and climate actions can be aligned to reduce the cost of transition to LCS as well as the burden to engage in the future global GHG concentration stabilization regime.

Low Carbon Scenarios for the UK

Jim Watson (w.j.watson@sussex.ac.uk)
Senior Fellow, SPRU University of Sussex (UK)

The UK's long-term target for carbon emissions reduction is a 60% reduction from 1997 levels by 2050. This target was proposed by the Royal Commission on Environmental Pollution in 2000, and incorporated into policy in the 2003 energy White Paper. The White Paper suggested that the costs of achieving it would be relatively modest at 0.5-2% of GDP. However, policies to meet it need to be strengthened since the UK is set to miss its interim target of a 20% cut in carbon emissions by 2010. The Tyndall Centre's scenarios for a 60% cut in emissions include international aviation and shipping. They illustrate a variety of ways to meet this goal. The scenarios include extensive decarbonisation of energy supply and/or significant reductions in energy demand. Recent policy has emphasized the need for new nuclear power plants, but these are not a necessary feature of all scenarios that meet the 2050 target.

What Kind of international cooperation we need for global Low-Carbon Society

David Jhirad (djhirad@wri.org)
Vice President for Science and Research, World Resources Institute (USA)

Sustainable development policies and measures (SD-PAM's), implemented to accelerate development in emerging economies, are uniquely powerful drivers to achieve global climate stability. Many developing countries are implementing policies that improve the productivity, efficiency and environmental footprint of their transportation and power systems. Such policies also bring major climate benefits, an important dimension that can be incorporated in the energy and investment policies of all nations. Developed and developing nations can share challenges and learn from each other in this arena. Aligning climate policy more closely with development interests engages the global marketplace, important stakeholder and decision-makers, private industry and the investment community. Combining development and climate policy promotes wider international support for both sets of goals, and has the potential to attract significantly greater investment than would otherwise be available.

Panel Discussion: “What are keys to achieve Low-Carbon Societies through sustainable development?”

Coordinator

Jim Skea, Energy Research Centre (UK)

Panelists

Jiang Kejun, Energy Research Institute (China)
Thomas Van Ierland, European Commissions (EU)
P. R. Shukla, Indian Institute of Management (India)
Shuzo Nishioka, National Institute for Environmental Studies (Japan)
David Jhirad, World Research Institute (USA)

Panel Summary

Dr. Jiang Kejun introduced Chinese government policies for reducing energy consumption. These included medium and long term energy consumption plans, a renewable energy law, and energy efficiency targets for cars. He also emphasized the importance of technology in achieving those goals and plans. International cooperation is also important for achieving LCS in China, because international cooperative actions can have a positive influence on national energy policies.

Mr. Thomas Van Ierland discussed why emission trading at company level is a much needed policy tool to limit greenhouse gas emissions. It translates CO2 emissions into a financial asset, ensures for the necessary attention at directors level and leads to cost effective emission reductions across the economy. The EU emission trading system covers roughly 45 % of EU's CO2 emissions and is linked to the project based mechanisms under the Kyoto Protocol, such as the Clean Development Mechanism. As such the EU is the driving force behind to global carbon market.

Prof. P. R. Shukla argued that, in the near-term, the LCS actions in developing countries will deliver multiple dividends if aligned with the Millennium Development Goals. In the long-run, climate stabilization will require significant technological change. Aligning the development and transfer of low carbon technologies with national sustainable development policies will be the key to a cost-effective transition to LCS.

Dr. Shuzo Nishioka introduced three key factors determining CO2 emissions; Per Capita Activity (Activity/Population), Energy Intensity (Energy/Activity), and Carbon Intensity (CO2/Energy). In order to achieve a Low Carbon Society, drastic reductions in those three factors are required. In concluding, he mentioned the link between people’s happiness and their level of energy use. One Japanese survey had showed that there is no direct relationship between the energy consumption level of a household and the happiness of its members.

Dr. David Jhirad emphasized three critical points in achievement of Low Carbon Society: policy; technology; and institutions. Innovations in each area had to occur in an interactive way. On the

policy side, voluntary measures are not enough - mandatory measures are essential. Second, technological innovation is absolutely essential, particularly in the electricity industry and transportation. While technological innovation needs significant investment, economies of scale should contribute to cost reduction. Thirdly institutional innovation had a great contribution to make to CO2 reduction.

A lively floor discussion followed those short presentations. Mr. Mutsuyoshi Nishimura, Ambassador for Global Environment, Ministry of Foreign Affairs of Japan, started by questioning the EU about directing efforts towards developing countries instead of focusing only on what developed countries can achieve.

In relation to Dr. Nisioka's presentation and Dr. Jim Skea's comments about the "economics of happiness," Igor Bashmakov of the Russian Centre for Energy Efficiency pointed out that, while we use an economic index to assess people's welfare in discussing Low Carbon Societies, we might have a totally different index, such as "the number of smiles per hour". He raised the question – will people necessarily be happier when societies are further developed?

Dr. Amano (Hyogo Prefectural University, Japan) questioned what role the international emission trading system could play in achieving long term CO2 emission reductions. Several panelists responded to this question. It was stated that emissions trading was effective because, through CDM/JI, not only a country but also organizations and private companies can trade. In the future it would be important to have China and India's involvement, as well as that of the United States. However, if developing countries join the system, technological change will happen. This would in turn affect the price of emission allowances and hence the technological situation of the developing country. This might cause a dichotomy between the situations of developed and developing countries.

Finally, Mr. Zhao Jun (the Ministry of Foreign Affairs, China) asserted that it was an important mission for scientists and researchers to present clear visions of what a Low Carbon Society actually was. This point was noted and referred to the subsequent workshop.

In conclusion, Prof. Jim Skea noted that, in spite of having a very diverse panel, there had actually been an extraordinary amount of agreement on the underlying principles to be applied when considering the low-carbon society. We had all endorsed the importance of long-term thinking. We had endorsed the importance of considering technological change, social change and economic development together. And we had all emphasized the importance to give practical effect to these principles. How do we allocate allowances to emit carbon round the globe? How do we address the complicated issues around intellectual property rights and how that might effect the participation of global corporations? These were all difficult issues. According to Prof Skea that was why we needed a low-carbon-society project — not because we have all the answers at the moment, but because we can start to pose the key questions and tease out the answers in the coming months and years. He believed that there had been a very stimulating session, and finished by thanking all the panelists for the work they had put in and the thoughtful way they had answered questions.

Closing Address

Ryutaro Ohtsuka
President, National Institute for Environmental Studies

First of all, on behalf of National Institute for Environmental Studies, I would like to express my sincere thanks and would like to congratulate the speakers, panelists and organizing committee members for great success of today's symposium.

As British Ambassador to Japan, Sir Graham Fry, has stated in the opening address and our Minister of the Environment, Ms. Yuriko Koike, whose presence we had in the middle of the symposium, has also stated, I believe the objectives and concerns of this symposium have been well shared by all contributors and participants.

This project is co-hosted by the Ministry of the Environment of Japan and the UK Department for Environment, Food and Rural Affairs. UK Energy Research Centre and the Tyndall Centre for Climate Change Research, UK, and National Institute for Environmental Studies, Japan, are main research organizations collaborating in this project. NIES is the key organizer of this first workshop. However, as was made apparent during the symposium, the principal idea of the project is to promote collaboration among researchers and policy makers in developing and developed countries as well as various international organizations in order to pursue scientific research and to conduct extensive activities toward achievement of Low-Carbon Societies. In this regard, I am quite pleased that the symposium was wrapped up successfully today.

I would like to emphasize that it is necessary to combine technology, policy and behavioral perspectives in an integrated manner for the huge challenge of aligning the objectives of climate change and sustainable development. Though situations in developing countries and developed countries might be different, various factors such as housing, transportation and international trading intertwine them closely. It is first but an important step to exchange information and promote international cooperation.

While there are universal problems in the world and endemic ones in specific countries and regions, it is becoming more important to develop our visions and to seek concrete pathways. I expect that the three-day workshop beginning from tomorrow, which has participation from researchers and policy makers from about 20 countries, would make a significant contribution towards that end.

Finally, I would like to express my great appreciation to everyone who participated in today's symposium and conclude my address. I believe that the understanding and cooperation of citizens and policy makers in each country are indispensable to make our research activities truly meaningful. Thank you very much.

Expert Workshop

July 14-16, 2006

Tokyo

Agenda of the first workshop on "Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development"

Date: 14th-16th June, 2006
Venue: Mita Kaigisyo: 2-1-8 Mita, Minato-ku, Tokyo 108-0073
Language: English only (no simultaneous translation service)

Co-Chairs: Shuzo Nishioka (NIES) and Jim Skea (UKERC)

June 14, first day of Expert Workshop
9:00 Registration
9:30-9:40 Welcome Address
Toshiro Kojima (MoE, Japan)

Introduction: Sharing the objectives of this workshop
Chair: Shuzo Nishioka (NIES)
9:40-9:45 Junichi Fujino (NIES, Japan) on behalf of the steering committee
0-1 "Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development"

- Possible discussion points:
  - Why do we need a LCS?
  - How much global GHG emission reduction we need?
  - How can we set country-level greenhouse gas reduction targets?
  - How can we achieve LCS scenarios; what kind of methods do we have?
  - How can we align a LCS with sustainable development objectives?
  - What kinds of options are available for different countries?
  - What kind of national, regional and global cooperation would be useful?

9:45-10:00 Discussions

Following each session has 30 min (25 min presentation and 5min Q&A) key-note presentation, 20min (including one or two quick comment and Q&A) country review, and discussion with discussant (each discussant prepares two slides for 5 min talk to start the discussions clearly)

Session 1: "Why Do We Need Low Carbon Societies?"
Chair: Martin Weiss (Federal Environmental Agency, Germany)

10:00-10:30 Hideo Harasawa (NIES)
1-1 “Impact and Science of Climate Change on the Asia-Pacific Region”
(25min presentation and 5min Q&A)

10:30-11:00 Tom Kram (RIVM, Netherlands)
1-2 “Meeting a Two Degree Target Under Climate Uncertainty: Integrated Scenarios for Land-Use and Energy for Low Stabilization Targets”

11:00-11:20 Tea

11:20-12:00 Discussion
Discussant: Naoya Tsukamoto (MoE, Japan)
(Each discussant prepares two slides for 5 min talk to start the discussions clearly)

12:00-13:30 Lunch

Session 2: How to develop scenarios: Methodologies for LCS
Chair: Jiang Kejun (ERI, China)

13:30-14:00 Mikiko Kainuma (NIES, Japan),
2-1 “Emission Scenarios: SRES, post-SRES, MA, UNEP/GEO, and LCS”

14:00-14:30 Yuzuru Matsuoka (Kyoto University, Japan),
2-2 “Modeling Activity to Support Japan “LCS toward 2050” Project”

14:30-14:50 Neil Strachan (PSI, UK)
2-3 “UK Scenarios Development Method”

14:50-15:10 Jean-Charles Hourcade (CIRED, France)
2-4 “New modeling approach of transitions towards an F4 Society Modeling Program Supported by IDDRI”

15:10-15:30 Christoph Erdmenger (Federal Environmental Agency, Germany)
2-5 “Scenarios for a Low Carbon energy System in Germany”

15:30-16:00 Tea

16:00-16:20 Antonio Soria (Sustainability in Industry, Energy and Transport Unit, European Commission)
2-6 “Low Carbon Scenarios: European Commission Development Method”

16:20-16:40 Edmundo de Alba A. (National Institute of Ecology, Mexico)
3-5 “Mexico toward LCS”

16:40-17:30 Discussion
Discussant: Thomas Van Ierland (EC), Keigo Akimoto (RITE, Japan)

18:00-20:00 Reception at Mita Kaigisho, hosted by MoEJ

June 15, second day of Expert Workshop

Session 3: Win-Win Strategies: Aligning Climate Change and Sustainable Development Objectives
Chair: Kirsten Halsnaes (UNEP/RISO, Denmark)

9:30-10:00 P.R.Shukla (Indian Institute of Management, India)
3-1 “Aligning Climate Change and Sustainable Development Objectives: Perspectives Framework and Illustrations from India”

10:00-10:20 Emilio Lebre La Rovere (Centro Clima/COPPE/UFRJ, Brazil)
3-2 “Aligning Climate Change and Sustainable Development Objectives in Brazil”

10:20-10:40 Stanford Mwakasonda (University Cape Town, South Africa)
3-3 “Aligning Climate Change and Sustainable Development Objectives in South Africa

10:40-11:00 Tea

11:00-11:20 Ram Shrestha (AIT, Thailand)
3-4 “Aligning Climate Change and Sustainable Development Objectives in Thailand”

11:20-12:00 Discussions
Discussant: Francisco de la Chesnaye (EPA)

12:00-13:00 Lunch

Session 4: How to Achieve LCS: Low-Carbon Options
Chair: Jim Watson (SPRU, University of Sussex, UK)

13:00-13:30 Jae Edmonds (PNNL, USA)
4-1 “The Role of Technology in a Low Carbon Society”

13:30-14:00 Jose Alberto Garibaldi (Energeia, Mexico)
4-2 “Beyond Low Hanging Fruits: A programmatic Environment for Resilient, Low Carbon Economies”

14:00-14:20 Ralph Torrie (ICF consulting, Canada)
4-3 “Low Carbon Scenarios for Canada”

14:20-14:40 Jiang Kejun (ERI, China)
4-4 “Low Carbon Options in China”

14:40-15:00 Igor Bashmakov (Center for Energy efficiency (CENEF), Russia)
4-5 “Russian Energy and Carbon Emissions: Coming from 2005 to 2050”

15:00-15:40 Discussions
Discussant: Makoto Akai (AIST, Japan), Ritu Mathur (TERI, India)

15:40-16:00 Tea

Session 5: Break out groups: discussions of LCS and sustainable development
Chair: P.R.Shukla (IIM, India)
16:00-16:10 Jim Watson (SPRU, UK)
4-7 How to facilitate break out discussions

- Role of 'starters' (brief kick off presentation (5-10 mins))
- purpose of this break out groups: one possibility is that the outputs from these discussions should feed into the second UK workshop

16:10-18:00 Break out discussions
Possible Groups;
Group1: Arriving at Long Term Goals for LCS (Session1)
Group2: Role of Technology, Institution, Behavior to Achieve LCS (Session4)
Group3: Aligning LCS and Sustainable Development (Session3)
Group4: International Cooperation for LCS (Session6)
10-15 people for each group
Each group has chair, rapotour, and starter

Cross-Cutting questions;

- What is the current state of knowledge about [the topic of the break-out group] in individual countries?
- What are the commonalities between countries and what are the differences?
- What are the key research questions that need to be addressed to advance knowledge?
- What are the opportunities for cooperation between countries, what are the barriers?

- How could the UK-Japan project help to take forward the agenda?

List of group coordinator

Group	Chair	Starter	Rapotour
Group1: Target	Weiss	Nishioka	Cornelius
Group2: Options	Watson	Bashmakov	Pandey
Group3: Win-Win	Skea	Kejun	Kapshe
Group4: International	Shukla	Jhirad	Cabezas

Adjourn

June 16, third day of Expert Workshop

Session 6: How to Achieve LCS: National and Global Cooperation
Chair: Jean-Charles Hourcade (CIRED, France)

9:30-9:50 Martin Weiss (Federal Environmental Agency)
6-1 “International Cooperation on Climate Change in the UNFCCC Framework”

9:50-10:10 David Warrilow (Defra)
6-1 “Climate change: A G8 Overview”

10:10-10:40 Michael Taylor (IEA)
6-2 “Energy Technology Perspectives Scenarios and Strategies to 2050”

10:40-11:00 Tea

11:00-11:20 Akio Takemoto (MoE, Japan)
6-3 “Energy Technology Perspectives: Scenarios and Strategies to 2050”

11:20-12:15 Discussion
Discussant: Tae Yong Jung (World Bank)

12:15-13:30 Lunch

Wrap-up
Co-Chairs: David Warrilow (Defra, UK) and Naoya Tsukamoto (MoE, Japan)

13:30-15:00
1) Identifying possible solutions: Report back from group discussions

10min for each group

7-1 Group1: Arriving at long term goals for LCS

7-2 Group2: Role of technology, institution, behavior to achieve LCS

7-3 Group3: Aligning LCS and sustainable development

7-4 Group4: International cooperation for LCS

2) Next steps (2007 WS)

- How to support and share information with other countries who may want to develop LCS scenarios
- How to cooperate on research activities using existing research community
- When and where our output will feed into (next workshop, Gleneagles Dialogue etc.)

15:00-15:30 Tea

Closing

Co-Chairs: Shuzo Nishioka and Jim Skea

15:30-16:25 Co-Chairs' summary

16:25-16:30 Closing Address

David Warrilow (Defra, UK) and Naoya Tsukamoto (MoE, Japan)

Adjourn

Welcome Address

Toshiro Kojima
Vice Minister of Global Environmental Affairs
Ministry of the Environment Japan

Ladies and Gentlemen,
On behalf of the Ministry of the Environment of Japan, I would like to extend a warm welcome to the participants, who have traveled to Japan from all over the world to join this workshop.

As familiar to all of you here, the Kyoto Protocol entered into force in February this year. It is the first legally-binding instrument to combat climate change and, therefore, the Kyoto Protocol is symbolic and important. At the same time, we all know that in order to achieve Low-Carbon Societies, further drastic reduction of Green House Gases is indispensable. In order to ensure healthy and sustainable life for future generations, the Kyoto Protocol is only a first step.

The ultimate objective of the UNFCCC is stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference in the climate system. There are several interpretations of the necessary level of stabilization. For example, the Third Assessment Report of the IPCC indicates that at least 50% reduction is necessary and needs to be achieved between 2050 and 2100. The council of the European Union pointed out in March 2005 that reduction is necessary at least by 15% and perhaps as much as 50% by 2050 compared to 1990 levels. From those discussions, we can arrive at a common understanding that we have to reduce the emission of green house gases by 50% or more in the very near future.

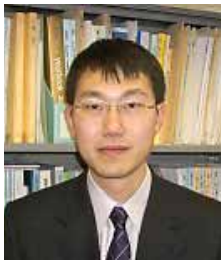
Under such circumstances, the Ministry of the Environment of Japan and UK Defra launched this joint research project on February 16th, the first anniversary of the Kyoto Protocol. The objectives of the project include:
- Firstly, to share common understanding of the necessity of drastic reduction of greenhouse gases;
- Secondly, to develop emission scenarios both in developed and developing countries and to investigate co-benefit or win-win strategies that will contribute to sustainable development; and
- Lastly, to describe in concrete steps of necessary actions, the ways to achieve Low-carbon societies as concrete steps of necessary actions.

I hope that the project will contribute to he sharing of clear visions of Low-Carbon Society among stakeholders and that the project will provide good guidance on what we have to do toward creating Low-carbon societies.

The UNFCCC's 24th SBSTA meeting was held in Bonn last month, and the Parties started discussion on the second commitment period of the Kyoto Protocol. Parties agreed to continue their discussion to share common understandings based on the latest climate potentials.

I am confident that this joint research project will make a great contribution in the context of international collaboration. I believe that the cooperative efforts among participants gathering here will show us the direction in moving toward Low-Carbon Societies. Thank you very much.

Introduction: Sharing the objectives of this workshop



0-1 Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development

Junichi Fujino (fuji@nies.go.jp)
Senior Researcher, National Institute for Environmental Studies (Japan)

One important characteristic of the climate system is its inertia. Because of past and current greenhouse gas emissions, a certain increase in global temperature is unavoidable. Such increases in temperature carry profound risks. Even a small increase in temperature is likely to have significant impacts on ecosystems and species, and might lead to increased drought and extreme rainfalls, with severe consequences for our society. LCSs are necessary to avoid dangerous climate change. There is no silver bullet to achieve LCSs. A portfolio of options and international cooperation are necessary to realize global LCS. Aligning sustainable development & climate change actions can reduce the burden and facilitate the transition to stabilization.

The objectives of the workshop are;
a) Identifying and understanding the necessity for deep cuts in greenhouse gas (GHG) emissions toward 2050 based on scientific findings, b) Reviewing country-level GHG emissions scenario studies in developed and developing countries, c) Aligning sustainable development and climate objectives, d) Studying methodologies to achieve LCS, e) Identifying gaps between our goals to develop country-level LCS scenarios and the current reality and, f) Identifying opportunities for cooperation and how best to cooperate in estimating country, regional and global-level LCS scenarios.

Key questions for this workshop are;
a) What are the key issues?
b) What are the barriers and how can we overcome them?
c) What kind of cooperation we can build?

We have looked for the possible solutions during this workshop (table 1) to achieve LCS in common ways and in different ways.

Table 1 Workshop Schedule

Day 1: June 14	Day 2: June15	Day 3: June 16
Introduction **Session 1:** **Long-term Goals** **Session 2:** **Methodologies**	**Session 3:** **Win-Win Strategies** **Session 4:** **Low-Carbon Options** **Session 5:** **Break out groups**	**Session 6:** **Cooperation** **Wrap up** **Closing**

Session 1 "Why Do We Need Low Carbon Societies?"

Session Summary

Chair: Martin Weiss (martin.weiss@uba.de)
Scientific Employee, Federal Environmental Agency
(Germany)

Hideo Harasawa (NIES, Japan) presented on "Impacts and Science of Climate Change on Asia-Pacific Region". He highlighted the wealth of ongoing impact research in the Asia Pacific Region (including IPCC, APN AIACC, Global Warming Research Initiative, Global Environmental Research Fund and Global Warming Research Project). Impacts and risks have been identified with regard to, inter alia, glacier retreat, heat waves, typhoons and other storms, wheat and rice productivity and water stress. Although results and recommendations for adaptation strategies are available for several regions and sectors, some gaps remain. New regional scenarios with higher resolution will be analyzed. Given observed and projected impacts, adaptation will have to be a key element of climate policy in addition to mitigation.
Tom Kram (MNP, Netherlands) presented on "Meeting a Two Degree Target under Climate Uncertainty: Integrated Scenarios for Land-Use and Energy for Low Stabilization Targets". Recent analysis shows, that a 2°C target requires stabilization of greenhouse gases around or below 450 ppm CO_2 equivalents. This is found to be technically feasible with a portfolio of known technologies and policy options. Costs are strongly depending on baseline assumptions. There are other barriers than costs. A sense of urgency is needed to enable the required large changes in the energy system. For extensive bioenergy use, interactions with biodiversity and sustainable development need to be explored further.

Discussion:
There is a consensus that we need to aim for big reductions – without necessarily defining exactly how big these will have to be. Nevertheless, it is important to further increase awareness of climate change risks by looking at regional impacts and cost of inaction. This should include likely political costs of, e.g., more frequent extreme events or disruptive changes.
An adequate response to climate change has to be equitable and aligned with sustainable development. The path to a Low Carbon Society could look fundamentally different for developed and developing countries.
Beyond discussing the scale of required reductions by the middle of century we should give a clear message on the required next steps and time-frames for action in the short term. There is a window of opportunity to do this, but it is closing rapidly. There is a role for the broader society to play in creating this vision and taking action. We need to understand the drivers of emissions and how we can deviate from business as usual. There are many opportunities to do this but also barriers to understand and overcome.

1-1 Impact and Science of Climate Change on the Asia-Pacific Region

Hideo Harasawa (Harasawa@nies.go.jp)
Director, National Institute for Environmental Studies
(Japan)

There are some global warming impacts researches in Asia-Pacific regions. For example, Chapter 10 of the IPCC 4th assessment report to be published in spring of 2007, the CAPABLE program of Asia Pacific Network (APN), Assessment of Impacts and Adaptations to Climate Change (AIACC) in the region, and the Global Warming Research Initiative of the Council for Science and Technology Policy, the Global Environmental Research Fund of the Ministry of Environment, the Global Warming Research Project in NIES. The research results have been compiled and utilized for global warming policy making and educating the public.

In AP region, the impacts due to ongoing warming have been identified as follows.
Retreat of Glaciers

Tianshan Glaciers (disappeared by 22% for the past 40 years)
Tibettian Glaciers (disappeared 4420km^2 (9%) for the past 30 years)
Himalayan Glaciers (500,000 km^2 to 100,000 km^2 by 2035)
Heat Wave: 45-49^{o}C in May, 2003 in India (1600 death)
2-3^{o}C increase in July, 2004 in Japan (heat stroke patients more than 600 in Tokyo)
Typhoon: 10 typhoon landed in 2004 in Japan (>200 death, 120 billion $ damage)
Increasing damage in Philippines (900 death, Nov. 2004, >500, Dec. 2004)
Wind Storm: Increasing wind storm in Mongolia

Thanks to rapid development of a high resolution climate model and a region climate model using nesting method, impacts research can use high special resolution climate scenarios (20 – 100km). In addition, extreme events are predicted by this climate model, so it is possible to assess future extreme events' impacts as well as impacts due to average temperature increase. Some examples are demonstrated in the workshop such as extreme heat waves impacts on rice production and heat stress on human health. From these preliminary results, we found that global warming will affect both impacts in average in long term and more severe extreme events' impacts in short term.

The followings are a brief summary of the presentation.

1) Impacts of Global Warming have been observed in AP region.
2) Significant impacts will be predicted in all sub-regions and sectors.
3) Precise regional climate prediction is necessary to conduct regional vulnerability assessment.
4) Adaptation is key measures to mitigate current and future impacts.
5) Research Needs
   To identify Hot spots/sectors in AP region
   To assess long-term and short-term (extreme events) impacts and adaptation measures
   To identify thresholds of impacts
   To assist capacity building of Impact researchers in AP region

1-2 Meeting a Two Degree Target Under Climate Uncertainty: Integrated Scenarios for Land-Use and Energy for Low Stabilization Targets

Tom Kram (tom.kram@mnp.nl) and Detlef van Vuuren
Programme Manager, Netherlands Environmental Assessment Agency (Netherlands)

Introduction

The debate on what targets to pursue for long-term climate change, pursuant to the principles of the UN-FCCC, is dominated by two rather disjunctive sets of concerns. On the one hand target-oriented consideration of what targets will be true to the principle of avoiding dangerous interference with the climate. On the other hand technology, policies and measures oriented concerns over what emissions reductions are feasible and affordable, so not interfering with human development goals and ambitions.

Stabilization targets under uncertainty

The first issue is hampered by the multitude of uncertainties throughout the entire cause-effect chain, which seriously limits the traditional cost-benefit approaches to the problem. Even when that is left aside, and impact-relevant climate targets are selected, e.g. derived from precautionary principle arguments, deterministic cost-efficiency approaches remain problematic. This is illustrated by evaluating recent literature on probability distribution functions (PDF) for the all-important climate-sensitivity parameter. Taking the envelope of PDFs, it is shown that atmospheric concentration targets of 550 ppm (in CO2-equivalent terms) do not offer good prospects of achieving the 20 temperature increase target adopted by the EU and several of its member states.

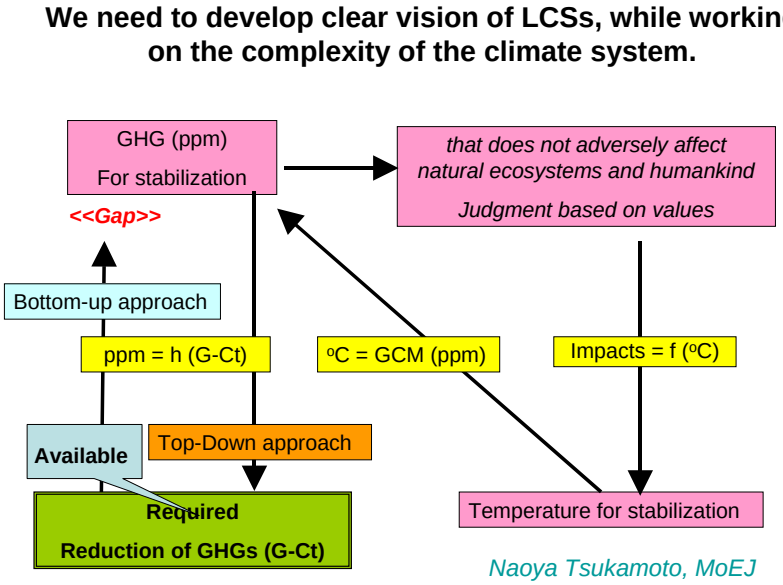
Feasibility of low stabilization targets

From the other side of the argument, 550ppm was until recently often considered to be about the minimum achievable in light of technological and economic challenges involved already with reaching the 550 ppm mark, let alone undercut it substantially. The study reported here argues that on the one hand a level of 450 ppm would do much more justice to the ultimate EU climate target, and on the other hand that it looks conceivable to arrive at 450 ppm, albeit after a limited overshoot induced by the inertia of the global system. Conceivable is to be interpreted as feasible with use of technologies that are known today, and without overstretching the rates of change required in the emissions producing systems from their baseline trend. But also assuming that all parties will subscribe to participate in an efficient, co-operative global scheme. Further, the role of land-use as part of the problem as (net) emitter, and as part-of-the-solution to provide for bio-energy and enhanced carbon stocks looks indispensable. Even though most emissions, and thus reductions, are associated with the energy sector, land-use related processes need to be considered in a consistent way to make low stabilization futures possible. Subject to those conditions, reaching a target as low as 450 ppm, does not seem to be prohibitively expensive at the global level. Sectors and countries could face much higher costs than the globally averaged number; hence adequate cost-sharing mechanisms are equally important. The indicative cost of the mitigation measures compared to GDP falls nicely in the range found in literature.

Discussant Presentation

Naoya Tsukamoto (Naoya_Tsukamoto@env.go.jp)
Director, Ministry of the Environment
(Japan)

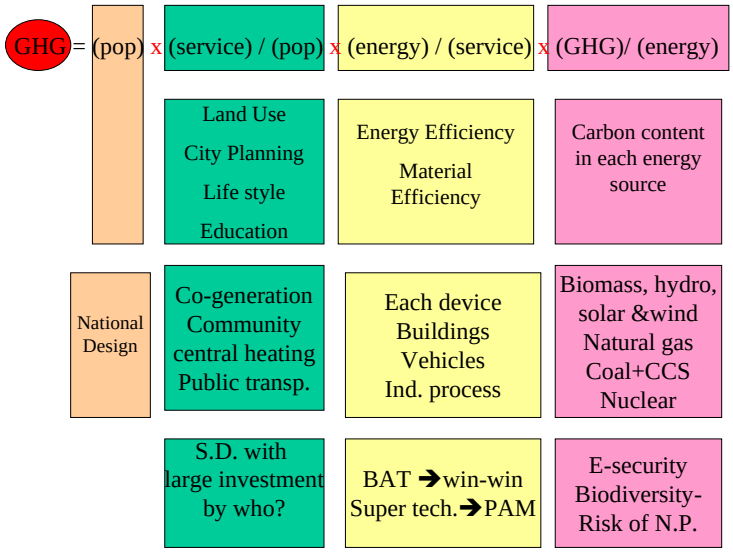
There are three scientific functions to deal with LCSs: (1) the relationship between temperature rise and impacts, (2) climate sensitivities (the relationship between GHG concentrations and temperature rise), and (3) the relationship between GHG emissions and atmospheric GHG concentrations. Each of the function inherits uncertainty, which makes it difficult for us to interpret the ultimate target of the article 2 of UNFCCC, i.e. at which level we should stabilize the atmospheric GHG concentrations. The coming IPCC AR4 report will provide us more precise information on these relationships. However, science is not powerful enough to let us make affirmative decision. Science cannot provide us 100% certain answer till everything is too late. Furthermore, in some countries, such as Japan, there still exists "gaps" between available and required reduction of GHGs. Under such circumstances, it is more difficult to define and make decision to move for LCS.



LCS is a good tool to deal with this tangling situation. We have enough confidence on the very basic balance equation of the earth that the human being emits twice as much as GHGs that the earth absorbs annually. So, if we want to stabilize the atmospheric concentration of GHGs at certain level, it is obvious that we have to reduce total GHG emissions by half. This idea provides us very clear view on what we have to do for the future. People say it is very difficult to reduce GHG, say, by 10 % because there are not exists enough flexibility or parameters to change. Then, how about 50% reduction? You do not have to stick on the existing systems and you would obtain much more flexibility to design the society. And science helps us to decide by when we have to achieve LCSs.

Now, the discussion is not "why we need LCSs" but "when and how we will achieve LCSs". The basic scientific equation established by Prof. Kaya provides us fundamental idea on how to

achieve LCSs. (see the right diagram). We have as much as three elements to work on. One is



Naoya Tsukamoto MoEJ * Sink is intentionally neglected here.

energy efficiency per required service. This is quite popular and definitely co-benefits with sustainable development. Another is GHG intensity per energy consumption. We can control this by selecting a good portfolio of energy sources and this element also provides good opportunities for some developing countries. The other is necessary service per population. This is a very attractive and challenging element because it requires us very imaginative view on what our societies will be in the future. This element requires integration of LCS target into sustainable development objectives, where both objectives can reinforce each other.

Session 2 "How to Develop Scenarios: Methodologies for LCS"

Session Summary

Chair: Jiang Kejun (kjiang@eri.org.cn)
Director, Energy Research Institute
(China)

Backcasting methodology is crucial for LCS. A combination of detailed snapshot models and transition models need to be used. Since the idea of LCS is ambitious, besides conventional options for short-term carbon reduction, trend-breaking interventions will be required. Besides technology and enduse efficiency improvement options, changes in social infrastructure and governance need to be considered. However, models conventionally used for forecasting will also be useful for specific analysis.

Some of the key modeling issues/questions for LCS are:

- What specific models are useful for LCS?
- How to consider changes in social infrastructure, lifestyle/behaviour, and governance?
- How to consider technological learning?
- What should be the baseline?
- How to integrate issues other than climate change, like poverty reduction and energy security, in the LCS methodology? (These are especially important for developing countries)

Involving developing countries in LCS2050 exercise is important. While the backcasting methodology will also be useful for LCS analysis for developing countries, the model details will be different for them. Different priorities of developing countries, such as economic growth, poverty elimination, energy security and co-benefits, too need to be considered. Therefore, among various possible options to achieve LCS, technological ones are likely to play the most crucial role for the developing countries.

Achieving a clear definition of LCS among all participants/stakeholders is crucial. Such a definition at the level of a country must be consistent with global level reduction targets.

LCS2050 exercise may also provide useful inputs for 2012 negotiations and UNFCCC reporting.

2-1 Emission Scenarios: SRES, post-SRES, MA, UNEP/GEO and LCS

Mikiko Kainuma (mikiko@nies.go.jp)
Project Leader, National Institute for Environmental Studies
(Japan)

A long-term view of multiplicity of future possibilities is required to consider the ultimate risks of climate change, assess critical interactions with other aspects of human and environmental systems, and guide policy responses. Scenarios offer a structured means of organizing information and gleaning insight into the possibilities (Morita et al., 2001). Scenarios are characterized by several perspectives such as qualitative vs. quantitative, exploratory vs. normative, and baseline vs. policy scenarios (Alcamo, 2001). The SRES are baseline scenarios based on four storylines expressing different views of future world development pathways, especially in the degree of globalization vs. regionalization and economic growth vs. environmental protection. The Post-SRES scenarios explored stabilization pathways based on the SRES. MA and UNEP/GEO scenarios are also based on storylines and quantified by several modeling teams. These are exploratory scenarios.

Normative approaches are often used for LCS analysis. Normative scenarios start with a prescribed vision of the future and then work backwards in time to visualize how this future could emerge. The realization scheme of LCS differs country by country. Analysis for most of LCS scenarios indicates that the rate of change (improvement) of energy intensity and carbon intensity needs to be 2-3 times greater than the previous 40-years historical change. Technological and institutional breakthrough is required to achieve LCS.

Table 1 Examples of scenarios

Scenario name / Theme	Exploratory or Normative	Baseline or Policy	References
IPCC SRES scenarios 'Global GHG baseline emissions'	Exploratory	4 baseline scenario 'families': A1, A2, B1 and B2	Nakicenovic et al., 2000
IPCC Post-SRES scenarios 'Global CO2 stabilization scenarios'	Exploratory	6 types of policy scenarios based on 4 SRES scenario 'families' aiming to stabilize atmospheric CO2 concentrations by 2150	Morita et al., 2001
Millenium Ecosystem Assessment (MA) scenarios 'Global scenarios with ecosystem services'	Exploratory	4 scenarios without specific distinction between baseline and policy: Technogarden, Global Orchestration, Adaptive Mosaic, Order from Strength	Millenium Ecosystem Assessment, 2005
UNEP/GEO 'Global/regional environmental scenarios'	Exploratory	3 baseline scenarios and 1 policy scenario: Market First, Policy First, Security First, Sustainability First	UNEP/GEO3, 2002
LCS scenarios 'Regional/country scenarios with deep cuts in GHG emissions'	Normative	Policy scenarios based on regional/country perspectives	See other pages of this LCS workshop report

References

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Millennium Ecosystem Assessment (2005) Ecosystem and Human Well-being, Island Press.

Nakicenovics et al. (2000) IPCC Special Report on Emissions Scenarios (SRES), Cambridge Press.

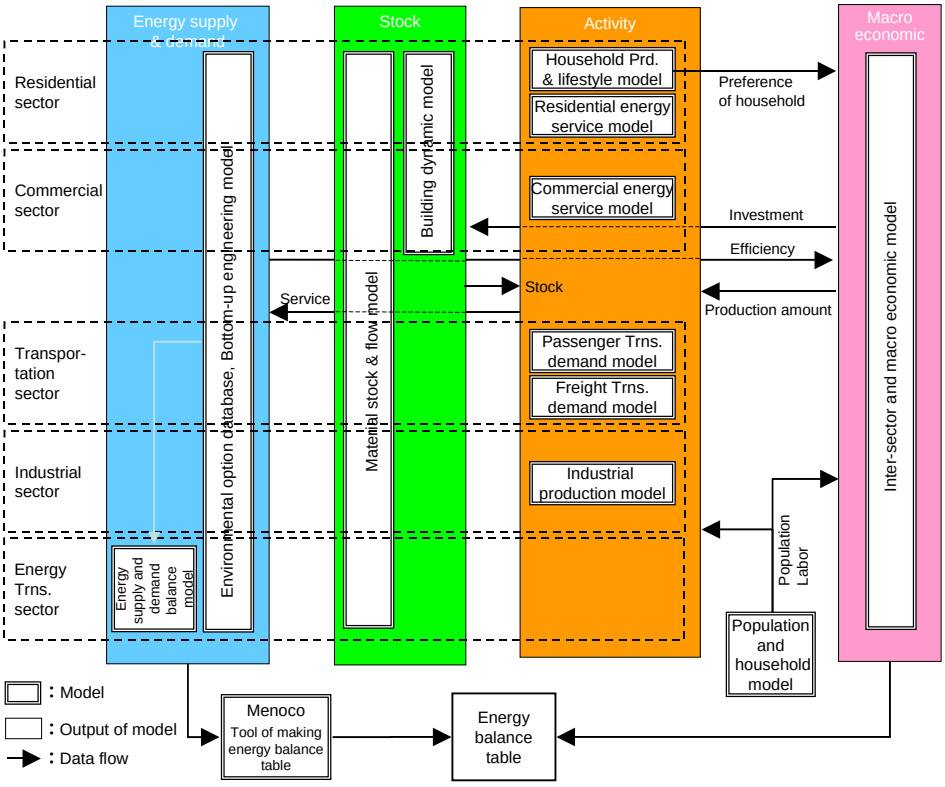
UNEP (2002) Global Environment Outlook 3, UNEP-Division of Early Warning and Assessment

2-2 Modeling Activity to Support Japan "LCS toward 2050" Project

Yuzuru Matsuoka (matsuoka@envhost.env.kyouto-u.ac.jp)
Professor, Kyoto University
(Japan)

In order to evaluate the feasibility and social impacts of the trend-breaking options, which are necessary to realize Japan's low carbon society, the driving forces of energy consumption and CO2 emission associated with socio-economic changes in each sector, as well as the effectiveness of trend-breaking options need to be simulated and evaluated. In the simulation, the characteristics and constraint conditions of each sector should be taken into account. It is also important to ensure consistency among the sectors.

In the project, "Low Carbon Society Scenarios towards 2050", several element models are developed to evaluate the efficiency of trend-breaking options and to keep the consistency of the envisioned future society. In the presentation, firstly, the overall and mutual framework of the element models was introduced with the following diagram. And based on it, some preliminary results which realize Japan's low carbon society were reported.



2-3 UK Scenarios Development Method

Neil Strachan (strachan@psi.org.uk)
Senior Research Fellow, The Policy Studies Institute
(UK)

In the UK, there have been considerable efforts over the last 5 years to develop methods to construct and quantify low carbon energy scenarios. Recent UK energy scenarios include those developed by the Royal Commission on Environmental Pollution (RCEP), the Cabinet Office - Department of Trade and Industry (DTI), and the Tyndall Centre.

A typology of energy scenarios can be broken out into descriptive and normative. Descriptive scenarios include:

- Forecasting: Extrapolation from existing energy system, based on historical trends and expert opinion, with a resulting shorter-term focus.
- Exploratory scenarios: Illuminating key drivers at the landscape level, able to encompass surprises, and with a focus on longer term technological change.
- Technological scenarios: Focus on static representation of technologies, with less detail on social drivers.

Normative Scenarios include:

- Visions: Specific viewpoints of desirable energy futures, which encompass surprises and social change.
- Back-casting: Pathways to reach a desired end-point, relying heavily on stakeholder consultation.
- Roadmaps: Also with stakeholder consultation, and aiming to identify key barriers, opportunities and key timing of actions.

Of the recent UK energy scenarios, RCEP (2000), which was a basis for UK Energy White paper (including the 60% CO_2 reduction target by 2050), was a technological scenario. Cabinet Office-DTI (1999 – 2006) which was the UK government quantification of the 60% CO_2 target, and included quantification using the MARKAL dynamic optimisation model, was an exploratory scenario. Tyndall Centre (2005), which used a scenario generation approach and included additional sectors (i.e., aviation), was a back-casting approach

In modelling the Cabinet Office-DTI Scenarios, three scenarios (both carbon constrained and unconstrained) were defined based on detailed qualitative descriptions of scenarios by the titles of Baseline, World Markets and Global Sustainability. In practice the modelling quantification of these was much simpler and focused on energy prices (oil, gas, coal), and energy demand projections (by sector). Sensitivity runs were carried out on innovation and diffusion by technology class and by energy efficiency.

A range of scenario quantification issues have emerged from the UK experience and include:

- Focus:
  - Scale of task to reach target; what do future (unconstrained carbon) worlds look like? Metrics include population, GDP, energy demands, global energy prices
  - Differentiation of pathways; for a state of the world, what can policy makers influence? Metric include technology costs, efficiency uptake, local energy prices
- Ensuring a valid comparison between base and carbon policy cases
- Are scenarios different enough?
  - Categorizing the range of uncertainties
  - Capturing the interactions between uncertainties
- Which modelling outputs?
  - GDP impacts, fuel use, technology uptake and costs, security implications etc
- Which modelling tools?
  - e.g., MARKAL: great technological detail and can add: elastic demands, Macro component, learning curves
  - What to account for or endogenize in the model?

2-4 New modeling approach of transitions towards an F4 Society Modeling Program Supported by IDDRI

Jean-Charles Hourcade (hourcade@centre-cired.fr)
Director, Centre International de Recherche sur l'Environnement et de Développement[1]
(France)

A division by four of world GHGs in industrialized countries cannot be reached without technological breakthrough and deep changes in final demand. Such a breakthrough will not been achieved unless industry sees the F4 objective as a mobilizing utopia instead of a pure constraint

To help policy discussions about how to reach such an objective, the current state of the art in long term modeling has to be improved. A shared diagnosis was made by modelers and 25 industry supporting a program at the Iddri (Institut du Développement Durable et de Relations Internationales) that progress has to be made in the following directions

- The consistency of the dialogue between *macro-economists and sector-based expertize*
- To scrutinize more in dept what type of innovation at the product level (buildings, appliances, vehicles, infrastructure) would be implied by such a significant transformation of the energy content of *final demand* (material content, recycling, durability)
- To represent *transition mechanisms* in real economies experiencing many types of *disequilibrium* 'instead of focusing only on steady state economies'
- To represent the influence of non energy related macroeconomic parameters in an opened world economy (level of integration or fragmentation of world markets, dual economy and unemployment, evolution of saving capacities and capital flows
- Capacity to represent *controversial judgments* about technology and the evolution of world globalization

This program in meant to bring new insights, within a three years period (ending in December 2007) on how to minimize the costs to meet a F4 objective, which in turn supposes to clarify the three following intertwined questions:

- what is the relative role of:
  - The decarbonisation of *energy supply* (fuel switching and minimisation on the conversion losses
  - The *end – use energy efficiency*

[1] The Cired is a research team of the Ecole des Hautes Etudes en Sciences Sociales (Ehess), the Ecole Nationale du Génie Rural des Eaux et Forêts (Engref) and of the Ecole Nationale des Ponts et Chaussées (Enpc) recognized as joint Research Unit of the Centre National de la Recherche Scientifique (Cnra) and of the Centre International de Recherche sur l'Agriculture et le Développement (Cirad)

- *Structural changes* in final demand of goods and services (dematerialisation of growth patterns)
- *Macroeconomic* policies including trade policy, overseas aid policy, funding mechanisms,

- What mix of policy signal in required in addition to carbon – prices to trigger changes in sectors (such as transportation or urban planning) in which the cost of energy represent a minor driver of long term trend

- What 'climate regime' is capable to incite

  - Industry to provide responses to the first three challenges (technologies, products)
  - Goverments to provide the most favorable macroeconomic context and to mobilize –non carbon price only - policies

The program set scenarios articulating three main sets of visions of consumption patterns (Building, housing equipments, Obsolescence rates, Mobility), Location patterns (Urban forms, Sea-side vs. continental) and technological patterns (Economies of scale vs distributed technologies, Material efficiency vs. renewable, Recycling). It is conducted by organizing systematic exchanges of information between modelers and the industry about the sector dynamics at the world level and about the potential for technical breakthroughs at the end use product in addition to those envisaged on the energy supply.

2-5 Scenarios for a Low Carbon energy System in Germany

Christoph Erdmenger (christoph.erdmenger@uba.de)
Head of Unit I 4.2 "Energy Supply," Federal Environment Agency (UBA) (Germany)

Germany has seen a number of activities on energy models and particularly on low carbon society scenarios in recent years. The most prominent of these were a number of scenarios developed for a parliamentary commission from 2000-2002, based on two parallel model developments. One of the models was coordinated by the Wuppertal Institute for Climate, Environment, Energy (WI), the other by the Institute of Energy Management and Efficient Energy Use (IER). The first model was based on work conducted for the Federal Environment Agency and has been developed since then reflecting recent data and more detail, particularly on renewable energy integration.

The "Sustainable Energy Supply" scenarios were given a fixed target to reduce GHG emissions in Germany by 40% by the year 2020, by 50% by the year 2030 and by 80% by the year 2050, relative to 1990. They exclude the use of Carbon Capture and Storage (CCS) and foresee the implementation of German low on phasing out nuclear power until 2023.

In order to reach the given GHG-reduction target, the main measures implemented in the scenarios are efficient energy use (including), fuel switch from coal to gas in electricity generation and a high share of renewables.

The increase of efficiency leads to a decrease of primary energy consumption by approx. 50% until 2050. This is based on introduction of efficient technology (e.g. in industry, power plants), systemic solutions (e.g. cogeneration, cascades of heat use, mobility based on public transport) and energy-efficient consumption patterns (e.g. in housing, mobility).

At the same time the share of renewables increases to 50%. This is based on a continuation of the rapid growth of wind and biomass supply in electricity generation and the assumption that solar geothermal power will contribute high shares on the long term. Furthermore the import of renewable power from other countries, e.g. in Northern Africa, is projected to contribute 10-15% to primary energy demand.

In terms of economic impacts, the additional cost for climate policies appear to be moderate, even in case relatively low fossil fuel prices are assumed. The system costs of all scenarios would be around 9 per cent of GDP by the year 2050, with some 0.3 to 1.2 per cent additional cost in the "Sustainable Energy Supply" scenarios.

2-6 Low Carbon Scenarios: European Commission Development Method

Antonio Soria (antonio.soria@cec.eu.int)
Coordinator, Institute for Prospective Technological Studies, EC
(Spain)

The purpose of the talk was to share with the audience the on-going modeling effort within the European Commission in order to exploit and improve the POLES mode with the necessary features to extend the model time horizon from 2030 to 2050, to develop sound and well-founded long term energy and GHG emission scenarios under different hypothesis. This is a minimum requisite to analyze alternative stabilizations option by the end of the century.

The first part of the talk was a description of the main POLES features, emphasizing the details of the standard demand equations for energy intensive sectors (including short-term and long-term price elasticity), how demand for energy services at country level translates into international demand for energy carriers, and how international markets clear up.

The second part of the talk was devoted to the presentation of preliminary results obtained with the model in the DG RTD-financed WETO-H2 study (World Energy Technology Outlook). This study is conducted by a consortium including LEPII-EPE, IPTS, Enerdata and other partners. Of particular interest for the purpose of the seminar was the scenario labeled as Carbon Constrained Case within the WETO study. This scenario does not represent any long term EU climate policy target, simply intends to explore a future of ambitious carbon policies and their consequences on the energy systems (results were presented up to 2030). The constraints chosen were consistent with a long term trajectory allowing stabilization in CO2 concentrations in the range of 500 - 550 ppmv.
A peak in emissions between 2020 and 2030, at a level that doesn't exceed + 50 % compared to 1990 emissions is expected. Total emissions can stabilize between 2015 and 2025-2030 and then start a decrease. The peak in emissions seems to corresponds to the crossing of a 25-30 €/tCO2 threshold, and this would take place by 2012 for Annex 1 and by 2025-2030 for Non-Annex 1. The crucial sectors to achieve reductions seem to be the energy transformation ones. The Carbon Constrained Case as formulated in WETO describes a very significant reduction scenario (from factor-2 to factor-4) for Europe in a consistent world context.
It seems to indicate that ambitious climate policies:

- increase the long-term sustainability of world oil and gas resource use, as well as Europe's energy self-sufficiency
- require an intensified development of each one of the four key energy portfolios: 1/ efficiency 2/ renewable 3/ nuclear energy 4/ CCS

Those two latter results seem to be relatively robust since they emerge also from other modeling analysis.

Discussant Presentation

Thomas Van Ierland (tom.van-ierland@ec.europa.eu)
Policy Officer, European Commission
(Belgeum)

LCS scenarios have to be developed across long time frames, typically up to 2050 and beyond. They need to assess both the effect of no specific action as well as targeted policies and this across different regions and sectors. It was pointed out by several speakers this offers modellers a whole set of methodological tools, i.e. forecasting or back-casting, normative or descriptive, optimisation or technical pathways.

Speakers indicated that the applied methodology needs to lead to concrete, plausible, quantitative scenario's that are perceived as potentially consistent with technological progress, economic development and societal evolution. This long time frame can lead to large differences in emissions scenarios and required mitigation efforts. This necessitates that modellers provide clarity on the applied assumptions. The long time frame implies substantial growth potential in developing countries and thus the need for scenarios that also focus on developing countries.

Discussant Presentation

Keigo Akimoto (aki@rite.or.jp)
Senior Researcher,
Research Institute of Innovative Technology for the Earth
(Japan)

The following points will be important for the methodologies for developing scenarios of LCS.

1) Forecasting vs. Back-casting, and their methodologies, e.g., static/recursive and intertemporal models, equilibrium and optimization models

The back-casting approach will be useful for developing scenarios of LCS, and we should also choose the appropriate methodologies for the back-casting approach.

2) Treatment of technology learning: Exogenous vs. Endogenous

Technologies are key for LCS. A modeling study of endogenous technological change has indicated to the possibility of energy systems having both low and high CO2 emissions with the lowest cost (Gritsevkyi & Nakicenovic, 2000). Exogenous or endogenous technological change should be selected for developing scenarios of LCS. Methodological difficulty and uncertainties should be also considered for the endogenous treatment.

3) Baseline scenarios/emissions are the key for the reduction cost of CO2 emissions. Scenarios of LCS will include not only GHG mitigation measures but also changes in our lifestyles. How should we distinguish between Non-intervention (Baseline) and Intervention scenarios and treat them for developing the scenarios?

4) Global warming is a serious issue, but we also have many other issues, e.g., poverty, energy security, to be tackled. How should we consider the priority of global warming and integrate them into LCS?

Session 3 "Win-Win Strategies: Aligning Climate Change and Sustainable Development Objectives"

Session Summary

Chair: Kirsten Halsnaes (kirsten.halsnaes@risoe.dk)
Sustainable Development Coordinator/Senior Research Specialist
UNEP Risoe Centre on Energy
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This session highlighted a very important issue – perspectives on sustainable development based on views of developing countries. This is especially important since the pathways to achieve a low carbon society are open for the developing countries, and since a common understanding of sustainable development as a framework for a low carbon society is evolving.

As per conventional perspective, it is often expected that, there are trade-offs between environmental quality and socio economic development. However, there is a need to recognize that pathways to achieve developmental goals can be climate-friendly; and sustainable development can be a driving force for addressing climate change challenges. The development and climate "frontier" can be expanded through: Innovations (technology, institutions), international and regional cooperation, targeted technology and investment flows, aligning stakeholder interests, and focusing on inputs rather than outputs.

The international discussions are now focused on the steps beyond 2012 including the participation of the developing countries. It is clear that taking isolated targets of emission reduction without taking sustainable development into consideration is not on the agenda of developing countries. There is a need to take an integrated approach to sustainable development and a low carbon society. This requires that development and climate priorities are aligned. Given the growth and mitigation potential in the developing countries, it is more efficient to take a path of co benefits rather than exclusively focusing on mitigation. Some of the developing countries, through emission reduction efforts have created good examples of such win-win strategies.

In general, developing countries have high energy intensity which is an area of concern. In most of the developing countries, with a few exceptions, fossil fuels (coal, oil and gas) have a dominant share. Thus enhancing efficiencies emerge as one of the possible options for emission reduction. Developing a regional cooperation about energy imports and for cleaner energy initiatives (hydro, renewable, wind, etc.) is another important direction to take.

The sustainable development and low carbon society discussion indicates that policy implementation will require significant transformations in the world energy regime. Therefore, quantification of emissions reductions under a sustainable development regime versus "current policy" baselines is necessary. In place of accounting and measuring the effect of development

actions for performance evaluation, it is important to ensure that these initiatives move in the right direction. The challenge is to recognize the factors that will drive the future such as - growth, population, national and regional circumstances, etc. for a country.

Each individual country will take their development path on the basis of its local resource endowments. It is therefore important, to focus on the potential barriers and incentives, that can help developing countries in moving towards a lower carbon future. Making low carbon technologies and finance available to developing countries is one such measure. In addition to direct incentives, market based price signals are also needed. Finally is necessary to spell out the incentives in terms of support programmes for sustainable development and climate policies.

3-1 Aligning Climate Change and Sustainable Development Objectives: Perspective Framework and Illustration from India

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(India)

The presentation began with four key propositions: *i. climate change is a derivative problem of development, ii. development is the key to mitigative and adaptive capacities, iii. dealing with climate change exclusively is very expensive, and iv. strategies for dealing with sustainable development and climate change have many common elements, and aligning these would reduce costs and minimize welfare losses*. In contrast to the conventional paradigm wherein economic development and climate change are viewed in conflict, the presentation favored the 'development and climate' perspective which rests on two complementary propositions: *i. pathways to achieve sustainable development goals are climate-friendly, and ii. sustainable development is the driving force for addressing climate change challenges, especially in developing countries.* The key arguments suggested that 'Low Carbon Society' (LCS) should mainstream climate change agenda in development actions by shifting the 'development and climate' frontier using innovations, co-benefits, focused technology and investment flows and aligned stakeholder interests. An example of how achievement of Millennium Development Goals and related national targets in India was complementary to climate agenda was presented.

Following the articulation of the conceptual framework, case studies demonstrating the opportunities to shift 'development and climate' frontier in India were presented. The first case study showed that India's energy security concerns are intertwined with climate change and that energy policies framed on India's sustainable development vision could well align energy security and low carbon future. It was shown that the per capita carbon emissions from India would remain low throughout the century, compared to global averages, under most scenarios. Yet, India can further contribute to cost-effective stabilization, offering low cost mitigation opportunities under appropriate incentives. The second case study showed that joint mitigation of SO_2 and CO_2 emissions would accrue substantial co-benefits, though netting these would require aligning national and global environmental regimes, which the current climate regime instruments, including CDM, are unable to do. The third case study showed that India's electricity reforms have reduced the carbon content of electricity compared to the baseline, though the actual carbon content of electricity in India has increased over past 15 years due to increasing pressure on water resources upstream from existing hydro dams and inability to quickly bring on stream the new multi-purpose hydro projects due to sustainability concerns. The fourth case study presented the co-benefits of co-operation for establishing an efficient energy and water markets in South-Asia. The direct economic benefits from lower cost of energy and electricity and indirect benefits from lower SO_2 and CO_2 emissions which together have value equivalent to 1% increase in region's GDP over the period 2010 to 2030, besides substantial spillover benefits from flood control and superior water supply. The fifth case study showed the how climate change impacts and sustainable development

in the region are linked in case of a new railway line constructed through the climate sensitive hilly region in the western coast of India.

The conclusions included: *i. cost-effective transitions to LCS in developing countries would be best achieved via sustainable development directed actions, ii. Significant opportunities for co-benefits exist, though these will have to be netted through policies and programs that align development and climate agenda, iii. mitigation and adaptation cost for reaching any global stabilization target is lower when development pathway follow sustainability goals, iv. stabilization regime would induce significant mitigation and adaptation in India; altering energy system and imposing significant costs, and v. India's transition to Lower Carbon Society would deliver sizable global benefits.*

3-2 Aligning Climate Change and Sustainable Development Objectives in Brazil

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The 1st National Communication of Brazil to the UNFCCC included the inventory of Brazilian GHG Emissions in 1990 and 1994. Total CO2 emissions reached 1 billion tons in 1994. Most important are CO2 emissions from LULUCF (776 Million tons), more than three times higher than emissions from the combustion of fossil fuels (237 million tons). Therefore, in the short term, LULUCF can provide the main contribution to curb total CO2 emissions in the country. These emissions increased 2% from 1990 to 1994. The main challenge is to limit deforestation, which has drivers that go far beyond economic factors. Improved governance may increase enforcement of existing laws and regulations to avoid illegal deforestation in the Amazon region, and thus reduce these emissions. This was the case recorded in the last season 2005-2006, according to preliminary data. Continuing and amplifying these efforts will contribute both to the country's more sustainable development and to mitigate climate change. However, in the medium and long-term, CO2 emissions from fossil fuels combustion will be dominant, as they are bound to increase with the economic and social development of the country. From 1990 to 1994 these emissions increased 16%.

The main options in the energy field to align climate change and sustainable development objectives in Brazil include:

•Energy efficiency in industry and transport
•Natural gas in industry, residential and commercial sectors
•Hydropower potential to be tapped
•Ethanol from sugar cane for use as car fuel: domestic production and exports
•Biodiesel to be blended to diesel oil and fuel buses and trucks in the transport sector
•Renewable power generation in remote areas (promoting access to electricity for rural population)

While additional policies will be required to fully develop the mitigation potential of the above options, important efforts are already underway in the case of biofuels for transportation, through the Ethanol and Biodiesel programmes, as illustrated below:

Ethanol Program

•largest commercial application of biomass for energy production and use in the world;
•Successfully showed technical feasibility of large-scale sugarcane ethanol production and use to fuel car engines;
•Two million cars running on ethanol (peak of 4.4 million in 1993) + flex-fuel cars => 4.6 billion liters/year + 6.4 billion liters/year for gasohol (25% anhydrous ethanol + 75% gasoline);
•Sugar cane bagasse use as an industrial fuel and for power generation has been growing;
•Surplus of electricity to be injected in the grid;
•Foreign exchange savings;
•720,000 direct jobs and more than 200,000 indirect jobs in rural areas;
•Curbing the increase of local air pollution;
•Mitigation: 6 to 10 million tons of carbon/year since 1980;

Biodiesel Program

The recently launched Brazilian Biodiesel Program allows for using several different vegetal oils as raw materials (castor bean, soybean, oil palm, sunflower and others) for biodiesel production.
The initial target is for 2% of biodiesel in the blend with regular diesel oil in 2006.
Policy support: financial support, credit and R&D promotion to increase the efficiency and productivity of the biodiesel production.
Diesel oil = 2.70 kg CO2/liter
Methyl esther (biodiesel) = 0.3 kg CO2/ liter
Ethyl esther (biodiesel) = nearly zero or 0.05 kg CO2/ liter (as the process uses renewable ethanol from sugarcane)

Conclusions: Relevance of Bioenergy in Brazil and Prospects for other countries

•Share in total energy supply = 30% (2004);
•Main biomass energy resources: wood, charcoal, sugarcane bagasse, rice husks, ethanol from sugarcane, vegetal oils, biodiesel;
•Agricultural land availability:
•Land used by agriculture sector: 50 million ha;
•Land used by sugar cane crops: 5 million ha;
•Estimated land for ethanol production: 2.5 million ha;
•Total Brazilian agricultural land: 140 million ha (exclusive of land suitable for forest plantations);
•Land still available for agriculture: 90 million ha.

Challenges for expanding the use of modern liquid biofuels across the world include the links between biofuels and international commodities markets (eg ethanol x sugar, biodiesel x castor oil, palm oil, soybeans): effects of price subsidies, WTO rounds, large scale bioenergy programs on international prices of feedstocks and final products.

3-3 Aligning Climate Change and Sustainable Development Objectives in South Africa

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(South Africa)

A multilateral approach involving all countries is key to effectively addressing climate change. While it is a well known fact that emissions from the industrialized countries are substantially greater than those from the developing South, rapidly growing emissions from the latter region require that they take a "common, but differentiated responsibility" to address, albeit, future emission paths. The challenge for the South developing countries, however, has always been on modalities and rules of engagement, given that climate change is not seen as a priority by developing countries.

As the commitment period beyond the Kyoto targets (2008–12) draws closer, the question of how developing countries might participate in the effort against global warming becomes more urgent. There have been different schools of thought on the participation, ranging from mandatory requirements, such as quantified emission limitation targets, to pledges to make their development path more sustainable. Expanding on involvement of developing countries in reducing their future greenhouse (GHG) emissions by taking the sustainable development route has resulted into a number of suggestions, including proposals of a system whereby pledges are made by developing countries to implement sustainable development policies and measures (SD-PAMs).

SD-PAMS is essentially an approach whereby, starting from development objectives, countries would map out the implementation of policies and measures in a manner that would take cognizance of the need to mitigate or adapt to climate change. The approach has a basis in the articles of the Climate Convention. The approach focuses on implementing policies for sustainable development, rather than setting emission targets. Countries begin by examining their development priorities and identifying how these could be achieved more sustainably, either by tightening existing policy or implementing new measures. The next step is to identify synergies between sustainable development and climate change, that is, those SD-PAMs that also result in reductions of GHG emissions. Thus, the major contribution of SD-PAMs lies not in promoting mitigation effort per se, but in changing the reference scenario of emissions from "conventional" to "sustainable."

Using South Africa's development objectives as an example, it is noted that the development focus is on growth, job creation, and access to key services including energy services and housing. In promoting greater diversity in energy supply, increasing the percentage of renewable energy in the electricity generation mix is a particular goal. The government strategy aims to generate 5 percent of the national grid supplied power—including import/export—from renewable technologies, mainly from micro-hydro, biomass-fueled turbines, solar thermal, wind turbines, and photovoltaics.

A national target for renewable energy sources can lead to local environmental benefits, and GHG reductions.

On providing housing to communities, it has been observed that at least 50 percent of all new houses built incorporated climate conscious solar passive design principles in their construction, thereby eliminating the need for space heating and cooling, with consequences in GHG emission avoidance.

While the SD-PAMs commitment would initially be voluntary, a simple reporting system should be established to formalize the commitment of those countries that pledge to implement SD-PAMs. This would require a decision of the Conference of the Parties to establish a registry of SDPAMs, regular reporting by Parties on their SD-PAMs, and support from the Secretariat for maintaining records of implementation. If voluntary commitments prove successful, a next step would be to make SD-PAMs mandatory for a group of middle-income developing countries.

3-4 Aligning Climate Change and Sustainable Development Objectives in Thailand

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Thailand's economy is heavily a fossil fuel intensive and highly energy import dependent. In 2005 alone, the value of crude oil imports in the country accounted for 9.6% of the GDP (about US$17 billion). If the economy continues to grow at the current rate, the demand for energy is expected to increase as well in the future. This increasing demand for energy will not only put pressure on the country's economy due to increased energy import dependency but would also increase GHG emissions and other harmful local air pollutants. It is therefore important for developing countries like Thailand to align climate change and sustainable energy development objectives towards low carbon economy.

There exists a large potential for energy efficiency improvements in Thailand which can promote climate friendly sustainable energy development, particularly in manufacturing (e.g., energy-intensive cement, steel and paper production) and power sectors. For example, in cement industry alone, klinker production in Thailand used about 18.5% more energy than the best available technology (BAT) in 2004; as such, improving the energy efficiency of cement production to that of BAT would reduce the industry sector energy consumption by 2%. Besides energy efficiency improvements, shift towards biofuels in road transportation and promotion of new and renewable technologies are potential climate friendly sustainable options in the country over the long run. Indeed, the Thai government has already initiated biofuel program that targets replacing use of gasoline and diesel in 2008 by 10% in road transportation by alternative fuels such as ethanol and palm oil. Also, as part of the renewable portfolio standard (RPS) for new power plants, the Thai government mandated that 4 percent of their generation capacity must come from renewable energy such as solar, wind or biomass by 2011 as compared to 0.5 percent in 2002. However, additional measures, such as adoption of clean and efficient technologies/fuels in electricity generation and transportation together with energy conservation, would be necessary to move towards low carbon Thai economy in the future.

3-5 Mexico: Toward LCS

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Place in the world: 14th in total emissions and 17th in CO2 per capita (3,460 kg/capita).
Mexico has fulfill all the commitments with the UNFCCC and the Kyoto's Protocol.
LCS in Mexico (1)

No present specific policy has been established to explicitly lower the carbon content of the economy

But correlated policies and measures have been taken to save energy and mitigate carbon emissions to achieve:

- Lower energy intensity of economy
- Substitute of fuel oil to gas for combustion
- Energy saving (Strong campaign at Government, industry, transport, households)
- Incentives for the use of renewable energy
- Progressive energy price adjustments
- Less loses of energy in transformation at refineries and gas plants•
- Less losses at transmission and distribution of electric energy•
- Reduction of energy waste (30% last year, in flaring, transport, distribution and stocking)•
- Industrial use of alternate fuels, including use of waste
- Larger International Cooperation in Climate Change (Bilateral MoUs, UNFCCC, Kyoto's CDM, IPCC)

Several scenarios for GHG emissions have been developed, nationally and with international cooperation specially for the energy sector (most of them up to 2030), but to the year 2050 only one scenario is been developed: The WEC methodology is been use to favor a

- Less Government Engagement trajectory and a
- More Integrated Cooperation

in comparison with other Policy Scenarios

Mexico considers that lowering the carbon content of the economy is one of the tools available to fulfill the objectives of the Convention, and is interested in studying the possible trajectories for a Low Carbon Society as part of the future options for a National Policy decision making.

The prompt promotion between the Mexican scientific community to elaborate scenarios for the year 2005 was proposed as one of the main Country's interest for the continuation of the fruitful cooperation with Japan and UK, and the rest of the interested international community, as the main result of the NIES- DEFRA workshop.

Discussant Presentation

Francisco de la Chesnaye (Delachesnaye.Francisco@epa.gov)
Chief of Climate Economics Branch, Environmental Protection Agency
(USA)

Sustainable Development measures influence Climate Change in the following perspectives (IPCC WG3, CCT on CC on CC& SD by L. Srivastava and T. Heller):

- Improve access to reliable and affordable energy services (stress on decentralised and renewable energy systems, modern biomass technologies, cleaner liquid and solid fuels, energy efficiency, etc.)
- Changing unsustainable production and consumption patterns
  - Establish and support cleaner production programmes and centres
  - Incentives for investment in cleaner production and eco-efficiency
  - Develop production and consumption policies… reducing environmental and health impacts…
- Promote an integrated approach to policy making at the national, regional and local levels
- Sectors that are significant to both Climate Change and Sustainable Development: Water, Energy, Health, Food, Ecosystems (Biodiversity and forestry), Human settlements, & Disaster preparedness

Several important aspects have been presented in Session 3 from the view points of how development and climate actions could be aligned. And some questions for discussion are posed as follows:

- What does "Low Carbon" mean, (lower carbon, lowest carbon, no carbon) in the context of development?
- Better understanding and projections of key energy and economic drivers, including:
  - Regional Economic growth
  - Population growth
  - Energy and resource endowments and structural economic shifts
  - Global issues (trade, migration)
- What are we committed to over the next 30+ years in terms of:
  - Current and near-term installed capacity, primarily in the power generation and transportation infrastructures, and resulting emissions
  - Climate change (consider impacts, vulnerability and adaptation)
  - Other international policy priorities
- What are win-win strategies across all these policies that also work at the local, national, and international levels
  - Look at one example: Expanding the use of modern liquid biofuels across the world. Links between biofuels and international commodities markets (e.g. ethanol x sugar, biodiesel x castor oil, palm oil, and soybeans): effects of price subsidies, WTO rounds, large scale bioenergy programs on international prices of feedstocks and final products.

Session 4 "How to Achieve LCS: Low Carbon Options"

Session Summary

Chair: Jim Watson (w.j.watson@sussex.ac.uk)
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(UK)

A combination of technological innovation, policy implementation, institutional and behavioral changes will be necessary in creating pathways to reach LCS goals. These elements should not be treated in isolation from each other. Options to put societies on a path towards lower carbon emissions will also need to be reconciled with existing policies to address other goals such as energy security, land use and competitiveness. A key issue for some countries is the consideration of other greenhouse gases besides carbon dioxide and the role of changes in forestry and other carbon sinks.

Many scenarios and models focused on a range of technology options. Significant technological options exist for large efficiency improvements and carbon reduction, and it is necessary to look at multiple options over short and long runs. In addition, significant changes in infrastructure of buildings, transport, industrial and other sectors will be required. Participation of both the public and private sectors will be essential to implement such changes. It is important to consider interactions between low carbon technologies that might be deployed (sometimes their potentials cannot simply be added together as isolated 'wedges'), issues of path dependency, and spillovers from implementation of these options.

Priority options will depend on regional or national resource contexts of countries, and on developmental needs (for example, clean coal in China and rural biomass based technologies in India). Some of the key options highlighted by a number of contributions are:

- Efficiency improvements in both end-use and supply sides. Efficiency includes a wide variety of potential options (e.g. for power generation, transport, buildings and appliances). It can be achieved by a combination of technology and behaviour change
- Biofuels and other renewables; the analysis of biomass options needs to take into account forestry and landuse changes
- Carbon capture and storage, especially for medium term mitigation. Uncertainties remain about the extent to which it can be implemented on the scale suggested by some models

In addition, there exists a complementary role for non-CO2 reduction options.

A number of institutional and policy issues were highlighted.

- Strong commitments to change technologies will have to be made continuously throughout this century
- Economic incentives to support the deployment of low carbon options must be consistent with

long–term strategies

- International financial and other institutions to facilitate technology transfer are crucial to strengthen and direct mitigation activities within developing countries
- There is a need to build institutions to promote R&D and diffusion of new technologies
- The funding base of scientific research and associated partnerships needs expansion
- Financial policy requires a programmatic approach and institutions/mechanisms designed for specific initiatives; its objective must be to create an enabling environment for desired investments
- More research is needed on potential of behavioral/institutional changes

Several areas of uncertainty will need to be taken into account in the implementation of options. These include: the risks and potential of CCS and nuclear options; the treatment of agriculture and Land-use including implications for the use of bioenergy; appropriate mechanisms for technology transfer; and the treatment of behaviour and decision-making.

4-1 The Role of Technology in a Low Carbon Society

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New scenarios have been developed at the Joint Global Change Research Institute (JGCRI) that explore potential futures with and without policies to stabilize climate change. These scenarios were developed using the 14-region MiniCAM model of long-term energy, economy, agriculture, land use, atmosphere and climate. The reference scenario, which examines the implications of proceeding without further actions to limit climate change, is characterized by a global population that reaches a maximum of 9 billion people in the second half of the 21st century and then declines to 8.5 billion people at the end of the century. The scenario assumes heterogeneous economic growth with the presently developed nations of the world continuing to experience productivity growth, and some developing countries, notably China, India and other South and East Asia embarking on an economic transition. The global energy system expands to approximately 1400 exajoules (EJ) per year by the end of the century, fueled largely by fossil fuels, though renewable and nuclear energy forms gain market share. Limited conventional oil implies a transition to unconventional liquids to fuel a rapidly growing transportation sector. Fossil fuel CO_2 emissions increase to more than 20 petagrams of carbon (PgC) per year by the end of the 21st century.

Stabilization of radiative forcing at four different levels are examined: 3.4 watts per meter squared (W/m^2), 4.7 W/m^2, 5.8 W/m^2, and 6.7 W/m^2. These in turn correspond to stabilization of CO_2 at approximately 450 parts per million (ppm), 550 ppm, 650 ppm, and 750 ppm respectively. Stabilization is affected by assuming that all nations participate in an economically efficient emissions control regime. Thus, all nations are assumed to face the same price of carbon, as well as corresponding prices for methane, nitrous oxide, CFCs, HFCs, and SF_6. The economically efficient price of CO_2 rises at the rate of interest plus the average rate of removal from the atmosphere, because CO_2 is a "stock" pollutant. Thus, unlike traditional "flow" pollutants such as SO_2 or local air pollutants, an economically efficient price can be expected to rise, doubling at a regular rate, in this case the price of carbon doubled approximately every 15 years.

This rising price of carbon and other greenhouse gases dramatically changed the global energy system. The more stringent limits on climate change, e.g. 3.4 W/m^2, began with relatively high values for carbon and these escalated rapidly, leading to a more rapid peak in global CO_2 emissions and a subsequent decline. Regardless of the level of climate change stabilization, CO_2 emission must always peak and decline thereafter, but in less stringent control cases the peak is higher and later and the subsequent decline is delayed.

The global energy system is dramatically changed in stabilization regimes. Electric power generation shifts from fossil fuels, largely natural gas and coal, to renewable and nuclear energy

and to fossil fuels with CO_2 capture and storage technologies. Buildings and industry increase their use of electricity, which becomes increasingly carbon free. However, the transportation sector shifts increasingly to the use of biofuels. The growth of biomass crops for their energy content requires land. It is important to note that terrestrial carbon emissions associated with land use can be just as important as fossil fuel carbon emissions. Thus, unless terrestrial carbon emissions from land-use change such as deforestation face the same carbon price as fossil fuel carbon emissions, accelerated deforestation can occur.

Finally, we note that the non-CO_2 gases play an important role in managing the costs of climate change. Technologies that limit emissions of gases such as methane can relax the need for energy-related CO_2 emissions controls by hundreds of EJ.

4-2 Beyond Low Hanging Fruits: A programmatic Environment for Resilient, Low Carbon Economies

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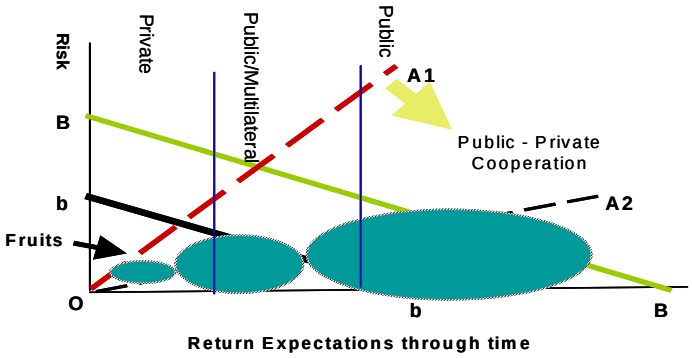
Energeia
(Mexico)

A Regional View on the Potential of Programmatic Approaches

A low carbon society requires policy and regulatory enabling environment to facilitate the investments required for a low carbon trend; the market is key, but unlikely to do this on its own. The Investment framework coming out of the G8 summit in Gleneagles offers an opportunity to address potential trend-breaking interventions. If Latin America is taken as an example, only tenuous decoupling between energy consumption and economic growth has happened between 1975 and 2005, with gas the most significant current change since 1975 -and now becoming the most likely source for future power sector expansion. Meanwhile, overall Infrastructure investment has been decreasing, with fiscal, energy and environment policies frequently at odds, and policies subsidizing dirtier, scarcer fuels. Changing infrastructure would likely require 0.6 trillion in clean energy plus massive adaptation insurance/mechanisms, with access, security and competitiveness being interconnected challenges. Meanwhile, multiple no regret and win – win opportunities remain



untapped in terms of domestic policy, investment flows and carbon finance.

Carbon Markets so far have only been a very minor fraction of investment flows. In spite of its recent massive expansion, the lack of long term domestic and international frameworks to reduce risk are likely to maintain the purely market-centered carbon market shift towards industrial gases -the quick wins or low hanging fruits. These are clearly insufficient for a low carbon future. The graph seeks to illustrate the problem. Currently, the private sector faces high risks (the line O-A1), and would like short term returns (the line b-b). In this context, the opportunities –the fruits- are limited to the tiny CDM centered ellipse and the medium one available under existing conditions. However, reducing risk through a supportive long term policy environment, and combining sources of finance –private multilateral and public- to reflect their different risk-taking capacity can shift the line to O-A2, opening untapped possibilities under the larger ellipse –a sustainable development position.

Regional Latin American consultations at the ECLAC and the IADB have shown that such opportunities exist and are being developed in public transport, waste management, lightning, energy efficiency, cogeneration, fuel switching, and large city based projects. Current carbon revenue can play a crucial role in catalyzing policy to improve the policy coordination, enhance project return rate facilitate enabling environment. An investment Framework operating together with government policies and measures can help underpin a programmatic approach to carbon finance, creating opportunities to increase the policy relevance of a low carbon future. By expanding opportunities for emission reductions, such an approach combined with a long term international goal, can help support the common interests of both developed and developing countries in a long term and vibrant carbon market, while securing the finance required to help regional transitions to a low carbon, climate resilient and sustainable future.

4-3 Low Carbon Scenarios for Canada

Ralph Torrie (RTorrie@icfi.com)
Vice President, ICF International
(Canada)

Recent research by ICF International for the National Round Table on Environment and the Economy has resulted in a Canadian scenario for low emissions in which greenhouse gas emissions are reduced by 60% by 2050. Systematic Solutions' *Energy 2020* systems dynamics model was used as the basic analytical platform complemented by the macroeconomic model of the Canadian Centre for Spatial Economics. The *Energy2020* model contains a highly disaggregated representation of Canadian energy use by fuel, subsector and end use, with a long historical calibration. Energy use was driven forward under a "business-as-usual" scenario and emission reduction techniques and technologies were then identified to close the gap between the "business as usual" level of emissions in 2050 and the targeted level. The scenario analysis was restricted to energy-related greenhouse gas emissions.

A low emission scenario in Canada faces a combination of challenges that is unique among the OECD economies: a growing population, a large and growing fossil fuel production sector geared to exports, relatively high levels of energy intensive manufacturing activity, and relatively inexpensive fuel and electricity. As a result, energy-related greenhouse gas emissions in 2050 grow to 1,300 Mt eCO_2 in the business-as-usual scenario from their 2005 level of about 600 Mt eCO_2 and the target emission level of only 250 Mt eCO_2.

Several dozen separate technologies and measures were analyzed for either using fossil fuels more efficiently, reducing the carbon intensity of energy use, and capturing and storing CO_2 emissions from fossil fuel combustion. The impact of each measure was analyzed both independently against the business-as-usual baseline and in the context of an integrated scenario in which all the measures were included. An aggregated portrayal of the results is presented in the form of a Socolow wedge diagram in Figure 1 below. While the sum of the impacts of the individual measures totaled over 1,600 Mt eCO_2, the combined impact in the integrated scenario was just enough to meet the target emission reduction of 1,050 Mt eCO_2.

Key and evidently necessary components for achieving the low emission future include:

- ✓ Energy efficiency improvement is by far the single largest component of a low emission future and is a necessary and enabling condition for renewable energy to have a significant impact.
- ✓ Cogeneration and renewable electricity, if developed on a much more efficient end use base, could displace central thermal power plants in a transformed electricity sector
- ✓ In the transportation sector, much greater vehicle fuel efficiency is the key for the long term biofuel alternatives to effectively displace fossil fuel

- ✓ Carbon capture and storage technology must be deployed on a large scale if oil and gas production proceeds to expand as projected in Canada.
- ✓ Over the long term, more energy efficient urban forms and a continued move to a higher value added economy with a relatively smaller role for the traditional primary producers, will contribute significantly to reducing greenhouse gas emissions from their "business as usual" levels.

Additional observations include:

- ✓ Long lived capital stock is a priority for beginning the transition to a low emission future. The buildings being constructed today will still be standing in 2050 and it is much cheaper to achieve energy efficiency and low emission technology in a new building than to retrofit it later.
- ✓ In low emission futures the interactions between the efficiency gains and the potential for new sources is much stronger than in conventional outlooks. For example, in the power sector, the efficiency gains in a low emission future greatly change the marginal power plant choices.
- ✓ In Canada, there are a number of trends that are exogenous to the energy economy but which have the potential to significantly moderate the growth of greenhouse gas emissions; for example: urban redensification, refurbishment of post-War infrastructure, and the continued trend toward higher value added production and improved energy productivity
- ✓ The same technologies and techniques that lead to lower greenhouse gas emissions deliver important collateral benefits, benefits that may be more highly valued than greenhouse gas reductions. For example: security against uncertain energy commodity supply, financial and economic savings from reduced fuel and electricity costs, reduced air pollution and improved public health, higher performance buildings, employment generation across a broad spectrum of skills and professions, and technological advancement and enhanced economic competitiveness in the global marketplace.

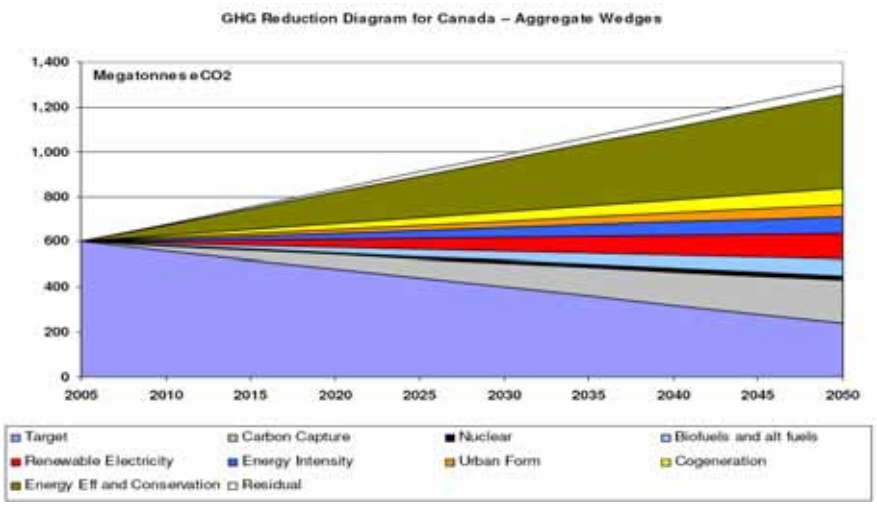


Figure 1

4-4 Low Carbon Options in China

Jiang Kejun (kjiang@eri.org.cn)
Director, Energy Research Institute
(China)

Due to energy supply pressure and environment problem, energy efficiency and renewable energy development are the important focus in future. China could have a low carbon emission future with effort on energy efficiency improvement and renewable energy development, with availability of new technologies. IPAC modeling team in Energy Research Institute simulated future energy demand and carbon emission from energy activities, and the results shows it is possible to keep energy demand in 2050 lower than 2.8billion toe, to support economy development with population around 1.5 billion, and CO2 emission could be stabilized after 2040.

In order to go to a low carbon future, some action should be done right now. A group of technologies identified in this study are already well available in market which needs full penetration. Further diffusion of some of these technologies needs strong policy support which could be very low cost. Another important thing we should do right now is more investment on new technology R&D, by China and other countries. If new technologies could not be available at lower cost, it is hard to really reach the target of low carbon scenario. Low carbon society is important for all world, with common available technologies and policies. Pioneers for technology R&D should be encouraged for both public and private involvement. Because of very large amount of coal use in China now and in future, clean coal technology development is crucial for China. China could contribute more on clean coal technology R&D, with collaboration with other countries. Without such kind of technologies, it is hard to reduce CO2 emission from fossil fuel use, in China and other countries.

There are already a lot of policies on energy and other GHG emission related sectors. Such kind of effort should be fully encouraged to reduce the growth rate of GHG emission in China. Because of domestic energy and environment need, it is possible to reach a low carbon future in China. We concluded as following:

- There are already a large amount of new technologies available to be implemented in China. Policies such as fiscal polices including energy tax should be adopted at early time
- New advanced technologies is crucial for future low carbon society, such as advanced power generation system, transport system, higher efficiency electric appliance, building
- More investment is urgently needed now for technology R&D. International collaboration is expected to work on this
- Investment on new technology will benefit on economy development
- Chinese government is making full effort to reduce energy demand increase in China as national strategy. If the strategy could be implemented, there will be strong support for low carbon society in 2050

4-5 Russian Energy and Carbon Emissions: Coming from 2005 to 2050

Igor Bashmakov (bashmako@online.ru)
Executive Director, Centre for Energy Efficiency
(Russia)

Three general energy transitions laws: the law of long-term energy costs to income stability; the law of growing energy quality and the law of growing energy productivity. They are essential for shaping long-term projections. The basis for all three is the existence of amazingly stable in time and universal across countries energy costs to income ratios (energy costs to GDP, energy costs for housing to personal income and energy costs for transportation to personal income). Limits of energy purchasing power set up thresholds, exceeding which brings slow down of economic growth and the asymmetry to energy demand to price elasticity. Author argues that theoretical postulate on substantial production factors substitution used in the production functions theory may be incorrect. In reality, innovations mainly lead to the substitution of low quality production factor by the same higher quality one. Growth of energy quality with stable costs to income ratio is accompanied by growing energy productivity. Those behavioral and macroeconomic constants are crucial when long-term futures are modeled. Average annual energy productivity growth rates decline. It took the USA and the UK from 50 to 70 years to reduce energy intensity by a factor of two and 130-150 years to improve it by a factor of 4. So F4 is possible, the question is how soon? China managed to get its F4 over 35 years (since 1971).

Recently Russia has started facing energy shortage. In 1998-2005 its GDP AAGR was 6.8%, non-oil-and-gas GDP AAGR- 7.7%, namely this sector generates growth in domestic energy demand. On the other hand recently oil and gas production slowed down after independent private companies (responsible for about all production increment in 2000-2004) faced recently more difficulties in continuation of business. In spite of GDP energy intensity AAGR as high as 5.0%, the energy consumption AAGR was 1.5-2%. Production capacities, including those in energy sector built in the Soviet Era, are fully loaded. So, economic development model have to switch from development by loading (previously built capacities) to development by building (expanding capacities). Shortage of power capacity and natural gas recently became a hurdle for the economic growth. Energy intensity decline was mainly driven by GDP growth, which in turn was promoted by growing oil production and services, while industrial energy intensity stayed about the same since 1990. Ability to raise tariffs to mobilize investments in the energy sector is limited by low purchasing power of 80% of the Russian population.

In 2005, after governmental control was re-established over the oil and gas industry, production stagnated. President wanted control over oil and gas rent and centralized rent distribution. Oil and gas industry became less cost effective due to the fact, that part of oil and gas rent is distributed through higher production costs. Property rights were weakened, and energy planning horizons for investors shrank. Gas and power markets are not competitive or transparent, and are controlled by

the government. Access of foreign capital to oil and gas reserves development is limited to small fields only.

No one can "buy time". Russian energy sector was not ready to switch from development by loading to development by building. Oil: production and export may start declining after 2010 – 2015. Natural gas: production stagnates, domestic consumption grows, and export may decline. Coal: lack of clean technologies limits the scale of application. Power sector: Russian economy faces shortage of power capacities. Energy efficiency: the least exploited Russian energy resource and the cheapest way to "buy time" to go beyond "energy capacity limits of growth". Potential is 260 mtoe.

Projections of Russian energy supply in 2005-2050. RUSEN - 2050 high emission scenario is not realistic: needed natural gas volumes exceed all overbold gas production estimates. To implement this scenario, Russia has to add as much proved gas and oil reserves as it has today. RUSEN - 2050 realistic emission scenario: it is very likely that Russia will nor exceed its 1990 emission level before 2050 even without specific climate mitigation policy. The less energy efficiency improvements Russia will manage to achieve, the lower economic growth it will have, with CO2 emission nearly stable in all foreseeable scenarios.

Discussant Presentation

Ritu Mathur (ritum@teri.res.in)
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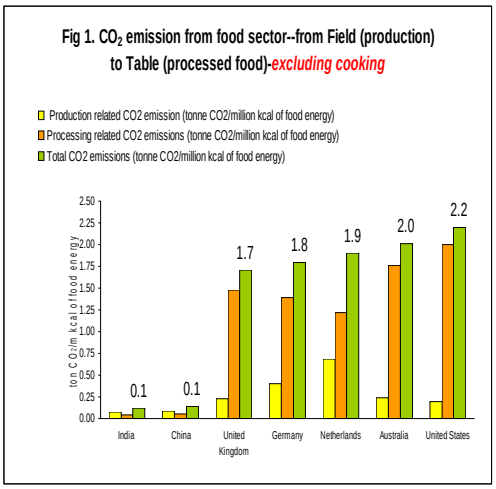
(India)

The session reiterated the need to undertake action to reduce the ill-effects of climate change. Despite the uncertainties associated with the exact magnitude of emission trajectories, it is important to identify and prioritize LCS options in order to move towards a more efficient and environmentally sound world. Developing countries should ensure that "they do not become tomorrow what developed countries are today" and should focus on sustainable development with climate change co-benefits. The developed world on the other hand has an important role to play in moving towards sustainable lifestyles, providing examples and directions of efficient energy use that the lesser developed countries can adopt and emulate, as well as providing finance and technology transfer to facilitate the uptake of efficient and environmentally sustainable technologies by the developing countries.



Figures 1 & 2 illustrate the differences that exist amongst countries in terms of energy requirements to provide the same level of useful energy service.

Though there was no clear consensus on the definition of LCS, the discussant proposed that LCS should catalyze a movement towards a desirable state in the future whereby all economies progress towards achieving lower levels of CO_2 per unit of energy service delivered. Inherent in this definition is the impact of the lifestyles we adopt and the efficiencies with which industrial outputs are achieved.

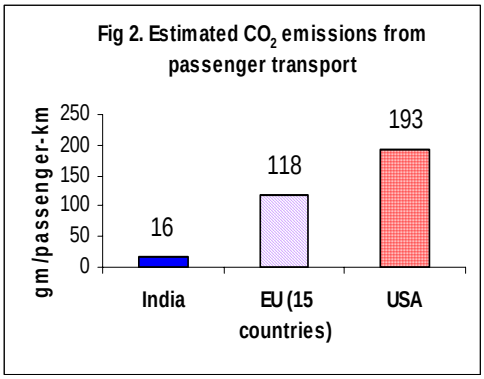
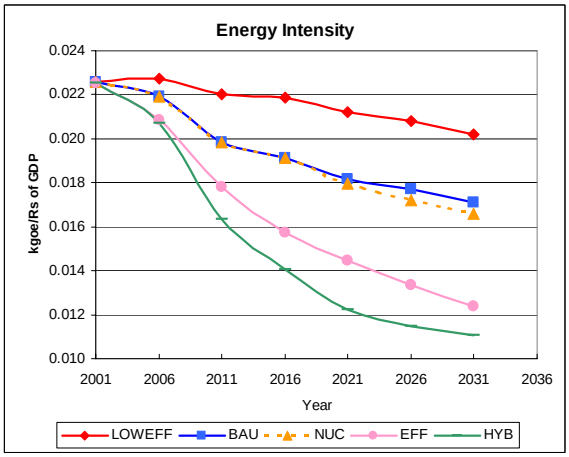
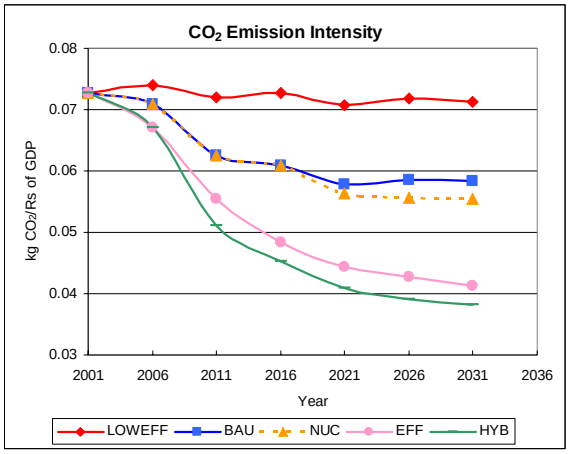


Fig. 3 Reducing trend of energy & CO_2 emission intensity





Source: TERI Analysis, 2005

Figure 3 illustrates how energy intensity as well as CO_2 emissions intensity is expected to decrease in India over the next 3 decades. It must be noted that even the BAU trajectory (which incorporates the current plans of the Government of India - primarily targeted towards the country's developmental objectives) indicates that the country is already expected to progress along a more efficient and environment friendly energy pathway. Moreover there exist several additional options that if adopted could drive the economy towards even higher sustainability.

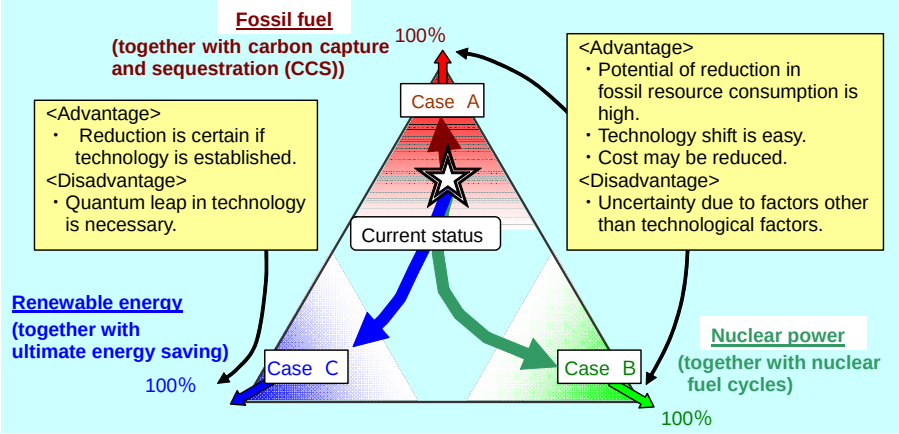
Discussant Presentation

Makoto Akai (m.akai@aist.go.jp)
Principal Research Scientist,
National Institute of Advanced Industrial Science and Technology
(Japan)

"Energy technology vision 2100 (ETV 2100)" in Japan has been developed to establish strategic energy R&D plan by identifying technologies and developing technology portfolio to prepare for resource and environmental constraints, and considering optimum R&D resource allocation in METI. Three extreme cases and possible pathway to achieve the goal have been examined (See Figure 1).

Implications from ETV 2100 to an approach to LCS from energy policy are as follows:

- Assumption on CO2/GDP improvement:
  - 1/3 in 2050
  - Less than 1/10 in 2100
- Key discussions:
  - Nuclear and CCS, especially as a mid-term option, would increase the flexibility of energy supply and demand structure with moderate cost.
    - CCS would contribute to deep reduction and hydrogen economy but might not be a truly sustainable option from the viewpoint of resource depletion.
  - Energy efficiency is the key!



- **Cases A & C assume least dependency on energy saving**

Figure 1 Three Extreme Cases and Possible Pathway to Achieve the Goal

Session 5 "Break Out Sessions"

Group 1 "Arriving at Long Term Goals for LCS"

Chairperson: Martin Weiss, (martin.weiss@uba.de)
Scientific Employee, Federal Environment Agency
Germany

Starter / Initiator: Shuzo Nishioka, (snishiok@nies.go.jp)
Executive Director, National Institute for Environmental Studies
Japan

Rapporteur: Steve Cornelius (steve.cornelius@defra.gsi.gov.uk)
Senior Scientific Officer, Department for Environment, Food and Rural Affairs
UK

Martin Weiss, Shuzo Nishioka and Naoya Tsukamoto initiated discussion in the group on how to define dangerous levels of greenhouse gases and reduction targets. Three key themes came out of the discussion, these related to the magnitude of emissions reductions needed; the timing or urgency of these reductions; and the priorities of different countries.

The required magnitude of global emissions reductions:

- A large reduction in global greenhouse gas emissions is needed to achieve stabilisation of atmospheric greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous climate change.
- The size of required global emissions reduction is not known exactly but it is clear that stabilisation of atmospheric greenhouse gas concentrations at any level requires large reductions in the long term.
- The stabilisation level chosen will determine the timing of these large cuts in global emissions which is required.

The urgency of global emissions reductions

- Short-term action should be set in a long-term context (several decades or more) as it takes a long time to address emission trends and to avoid climate change impacts.
- To break away from the baseline trend in a serious manner we are going to have to act in a meaningful manner – we can't wait too long to start doing things as we may put ourselves on a path towards climatic changes we are not willing or able to cope with.

- A common vision of LCS could lead to increased stability in international cooperation, a simultaneous move from all countries – though in different ways.

Priorities for different countries

- Climate change is just one priority on a list of many for different countries.
- The entire world needs be on a sustainable development path. Each country is headed to the same destination but the starting points, consequently the pathways are different – there is a common understanding of the global challenge ahead, but action that needs to be taken by different countries over the next decades is different.
- There can be climate change co-benefits from sustainable development and there are development choices to make which will not harm development but lead to reduced greenhouse gas emissions.

It was noted that this discussion should not be taken forward in isolation – that though we need a focus on climate change we need to be aware of other fora.

Group 2 "Role of Technology, Institution, Behavior to Achieve LCS"

Chairperson: Jim Watson, (w.j.watson@sussex.ac.uk)
Senior Fellow at SPRU, University of Sussex
UK

Starter / Initiator: Igor Bashmakov, (bashmako@online.ru)
Executive Director, Centre for Energy Efficiency
Russia

Rapporteur: Rahul Pandey, (rahulanjla@yahoo.co.in)
Adjunct Professor, Indian Institute of Management
India

Technology:

- Technology as a **pervasive concept** that links with behavior and other issues, so should not be defined too narrowly
- Setting **priorities** for technologies will be important; How to handle **interactions**
- **Backcasting** and long term results different from forecasting results – for ex. Storage (CCS) as short term option vs renewable energy as long term option
- Important to look at **portfolio** of technologies over long term – commitments for developing R&D, business investments
- Long-term trends of costs are normally not considered in investment decisions – decision making framework needs improvement

Behavior/institutions:

- Need for **broader scenarios** as opposed to just technology scenarios, to address social inertia, institutions etc.
- Examples/attempts of new social behaviors are important
- **There is a need to model lifestyles** explicitly – for ex. Japan scenarios
- Behavioral assumptions exist behind model based technology scenarios but are **often not explicit**
- Results of deep cut scenarios from models can be used to look at behavior changes or social system required in a specific country context, for ex. Educational systems; Incentives for building capabilities in businesses; etc.

Issues for DCs

- Generally, efficiency in DCs much lower; Need to look at various barriers to penetration/diffusion of efficient infrastructure and technology systems
- Existing **IPR system** is a barrier to tech transfer -- needs to change
    - Ex: Barrier to spread of modern clean coal technology in China
    - Required: **Involvement of govts** in R&D may create more opportunity for tech transfer; **Joint R&D** between ICs and DCs

Unintended consequences of LCS

- Analysis of LCS scenarios need to take into account **co-benefits and potential conflicts with other, broader policy objectives** (e.g. security)
- **Unintended consequences** of LCS policies might be an issue – e.g. LCS in one country at expense of high carbon society in others
- Trend of energy intensive industries shifting to DCs need to be considered in scenarios (C leakage)
- Gaps in prices – rising prices may not be an advantage for CC; For ex. Possibility of shift to coal due to high gas/oil prices (In such cases, alternate sources of fuels need to be considered; For ex. High oil prices may lead to shift to other sources of oil)

Group 3 "Aligning LCS and Sustainable Development"

Chairperson: Jim Skea, (jim.skea@ukerc.ac.uk)
Research Director, UK Energy Research Centre
UK

Starter / Initiator: Kejun Jiang, (kjiang@eri.org.cn)
Director, Energy Research Institute, Beijing
China

Rapporteur: Manmohan Kapshe, (kapshem@manit.ac.in)
Assistant Professor, Maulana Azad National Institute of Technology
India

Chairperson Dr. Jim Skea initiated the breakout group discussion with his initial comments. He expressed that win-win is very wide in conceptualization. The focus of win-win strategies is local but the global considerations are important. There are different technologies available in the different parts of the worlds. The questions is- how do these contribute to the win-win. What policies do we need for achieving this? Policies and priorities of different countries have different focus and there is a need to align these finding out commonalities. The climate change negotiations give a global framework and how to integrate the local and global policies. Lastly there is a need to discuss- Where does all this link with the LCS?

Initiator Dr. Jiang Kejun discussed four key issues identified for the group.

- **How far the developing countries can contribute? (The potential)**
- **The need of policy for promoting such steps**
- **Learning form other countries and cooperation**
- **Linking with LCS project**

Summary of the Proceedings compiled as per the Key Issues:

1. How far the developing countries can contribute? (The potential)

Win-win options have a significant potential in many developing countries. LCS for developed and developing countries are not two different things as focus is local but the global considerations are important. Development choices are open to developing countries that could allow achievement of a LCS more cost effectively. Both economic as well as social issues are important. Different approaches for different sectors e.g. the industry may take up energy efficiency easily but for the households it may be difficult. Also very important thing is, if developed countries could have LCS, many of policy options and technology options could be adopted in developing countries through exchange of knowledge, technology learning and diffusion. Therefore availability of these policy options and technology options are crucial for further contribution from developing countries.

2. The need of policy for promoting such steps

One of the prime questions was - are LCS and SD objectives aligned and are there synergies which can be utilized? The discussion revolved around following issues. Energy efficiency and behavioral

aspects of use of energy are important for sustainable development. There is a need for augmenting the investments and there is a need to explore the available alternatives. There is a possibility of giving more incentives or developing market based instruments. Short term and long term perspective on policies and there effect is required. Investment lock-in to unsustainable technologies is a problem and efforts are required to avoid this. Government support is critical which is reflected in public procurement and product standards. Policies related to setting of suitable incentives for investors and the fostering of public awareness and lifestyle change can be on important step. Many technologies for LCS are available now with higher cost, policy to encourage investment on reducing the cost and new technologies are important for a common future on LCS.

3. Learning form other countries and cooperation

Realizing win-win options requires international collaboration. Knowledge transfer (policies and practices) and technology sharing is the prime area of international collaboration. Most effective technology transfer often comes through the private sector. Recent decreases in the investments in Research and Development (R&D) in energy sector in developed countries is an issue of concern. However, there is increase in energy R&D in some developing countries Collaboration at the regional levels is also important. There are several important international collaboration regime such as Kyoto Protocol (and maybe post Kyoto), APP, G8 Summit, these international collaboration should heavily contribute on finding pathway for LCS and catching up from developing countries on LCS.

4. Linking with LCS project

Fostering of public awareness and lifestyle change will help both in LCS and sustainable development. R&D in all countries is critical to a sustainable, low carbon future. Taking early action will help to reconcile the Low-Carbon Society with sustainable development. Engaging people with wider knowledge base related to sustainable development issues is one of the possible outcomes of LCS project.

5. Conclusions

The discussion centered on finding out whether there win-win solutions and how to make best use of them for LCS and sustainable development. It was concluded that there are significant potentials in many developing countries. These can be classified as Technical possibilities where available choices range form improving Energy efficiency to moving over to Alternate fuels such as Nuclear, Wind, and Biomass. It is important to explore LCS future in developed countries by policy options and technology options, which could contributing to catching up from developing countries on LCS in longer term view point. Actually many technologies are available now, but cost is high. Effort to reduce the cost and make the technologies widely available for diffusion is a key for LCS. Most important steps need to achieve this include Government support, social acceptability and political will. International collaboration, trade regimes, financial instruments and investments in R&D are some other supporting steps. Some of the benefits from such initiatives are Energy security, land conservation, reduced pollution, sustainable cities and environmentally sustainable transportation. There are some measures common to all countries whereas other issues, e.g. energy poverty and household energy efficiency, need careful assessment in their local context. Overall a sustainable development perspective is important for LCS.

Group 4 "International Cooperation for LCS"

Chairperson: P. R. Shukla, (shukla@iimahd.ernet.in)
Professor in Public Systems Group, Indian Institute of Management
India

Starter / Initiator: David Jhirad, (djhirad@wri.org)
Vice President for Science and Research, World Resources Institute
USA

Rapporteur: Pedro Piris-Cabezas, (piris1974@yahoo.es)
Graduate Student, Yale University

LCS entails broad cooperation in a relatively very long policy horizon framework. It should involve a wider range of domestic and international agents and issues (Climate Change is not simply an environmental problem) than those involved with purely energy and high GHG intensive sectors. LCS must involve governments (which set the overall framework and can provide long-term predictable policy signals), businesses (who bring technological innovations into the market place), the financial sector (private, public and multilateral) and civil society (whose engagement can help align and legitimate diverse stakeholders). Their incentives and risks have to be jointly addressed.

Carbon market and international investment frameworks are vital to enlarge access to resources required to achieve LCS goals. Large scale infrastructure and capital flows are required. Countries' deployment of policies and regulatory environment can help create the conditions required to support it. Multilateral agencies (World Bank, Regional Development Banks, IMF) need to assess present roles and instruments, and reshape them where needed in consultations with regions and countries to tackle Climate Change while enhancing credibility and diminishing risks. International trade can be potentially tapped to foster transition to a LCS. The role of WTO is important here.

A common pool resource mechanism such as a special global fund for technology innovations and transfer would enlarge the set of options for transiting to LCS. The sharing of intellectual property rights would maximize returns from R&D investments. The technology fund could also enable south-south technological exchanges. **A** comprehensive range of technologies should be considered, differentiated by regions and countries. International R&D collaboration, both public and private, should also be enhanced. International R&D funded by the private sector could make a real difference in the transition to a sustainable low carbon future.

The transition to a LCS will also require the active engagement of local authorities, who have large direct and indirect influences on the level of GHG emissions in their communities. The role of international cooperation between local authorities –particularly large cities- must be expanded.

In conclusion, cooperation for LCS involves a long policy horizon framework, a wider range of domestic and international actors, and issues and a comprehensive range of technologies and policy measures. There is a need for stronger political leadership and policy signals, both at domestic and international levels. Carbon market signals and investment framework are central to prompt activities and deploy resources required to achieve LCS goals. Mainstreaming climate change policies into economic policies, infrastructure development and poverty reduction can help achieve LCS goals through sustainable development.

Session 6 "How to Achieve LCS: National and Global Cooperation"

Session Summary

Chair: Jean-Charles Hourcade (hourcade@centre-cired.fr)
Director, Centre National de la Researche Scientifique
(France)

UNFCC is a comprehensive framework that facilitates international cooperation, while becoming the focal point and avoiding fragmentation. It is presented as a formal framework in contrast with other parallel processes such as those established under the G8 or the Asian Pacific Partnership.

The informal frameworks provide an opportunity to exchange information on research and innovation, stimulates ideas to make the conditions for energy research and innovation more effective, encourages closer working, and identifies specific areas of mutual interest where there is scope for enhanced research cooperation and where initiatives for facilitating this either do not exist or could usefully be complemented. Alternatively, it is also suggested that these informal frameworks could help establishing an effective framework in order to achieve maximum reduction by all major emitting countries and address UNFCCC's ultimate objectives.

A pathway that will stabilize CO2 in the atmosphere at sustainable levels can be achieved through a huge and well coordinated international effort. The costs are not disproportional but it urgently requires sustained effort and investment by both the public and private sector in developed and developing countries. This is consistent with continued rapid growth of energy demand in the developing world. There has to be a stronger political will to move forward a more sustainable energy future with known technologies, which is feasible. Clear and predictable incentives for LCS are necessary in order to encourage appropriate technology and measures.

Large scale infrastructure and capital flows are required. A new framework for clean energy and development, including investment and financing could be developed within the World Bank. The private sector and regional development banks should be involved in order to create broad platforms to invest at scale in key lower carbon energy systems. These investments have to become more attractive to the finance community and should include both mitigation and adaptation.

Regarding the Post 2012 commitments it should be ensured that there is no gap between the first and the second commitment periods. A consensus establishing an effective framework which brings about maximum reduction efforts by all major emitting countries, while enabling all countries to take effective mitigation measures in accordance with their own capabilities, has to be built.

6-1 International Cooperation on Climate Change in the UNFCCC Framework

Martin Weiss (martin.weiss@uba.de)
Scientific Employee, Federal Environment Agency
(Germany)

Outline

1. Cornerstones of UN cooperation
2. State of the post-2012 process
3. Relevance for and of LCS

Summary

The UNFCCC framework for international cooperation on climate change provides for, inter alia, an ultimate objective (Art.2), principles for cooperation (Art.3) and commitments for monitoring and reporting of greenhouse gas emissions. Annex I countries are asked to return their emission levels to 1990 levels by 2000 and Annex II countries should assist developing countries, e.g. through financial assistance and transfer of technologies. An important achievement of the cooperation is the Kyoto Protocol, that asks Annex I countries to collectively reduce GHG emissions to 5% below 1990 levels by 2008-12. These targets are legally binding with a strong compliance system and allow for trading in emission rights and project based mechanisms. Annex-I countries are roughly on track to meet their commitments, despite high increases in some countries. The international carbon market is highly dynamic and mainly driven by the EU-ETS and the CDM. To keep this important market in place, due attention is needed on reaching a post-2012 international climate policy agreement.

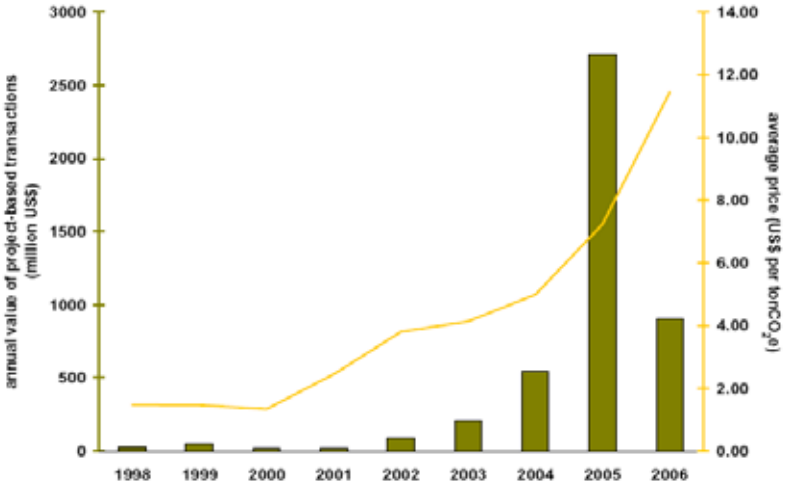


Figure 1 Annual volumes of project-based emission reductions transactions and annual average price

For the period beyond 2012, three important processes have been started in Montreal (COP 11): The Dialogue on long-term cooperative action under the UNFCCC, the AWG on further commitments for Annex I countries (Art. 3.9) and the review of the Kyoto Protocol (Art. 9). The AWG asks for scientific analysis of emission trends and mitigation potentials in Annex I countries, including a long-term perspective on required global emission reductions. The Dialogue under the UNFCCC addresses, inter alia, sustainable development, adaptation, technologies and market based mechanisms. Issues under discussion are an aspirational long-term goal for climate policy cooperation, new ways of assistance in adaptation, the role and types of targets, markets and trading in international climate policy, sectoral approaches, dual or no-lose targets, sustainable development policies and measures (SD PAMS) and ways to enhance deployment and development of low carbon emitting technologies.

For both processes, the work on Low-Carbon-Society scenarios can be a vital scientific input and provide a positive and credible vision of the long-term perspectives of climate policy. The LCS analysis is an important opportunity for trust building, capacity building and information exchange. Furthermore with its backcasting approach, it provides policymakers with a sense of urgency and scale of necessary short-term action. The just established Carbon Market offers a tool for guiding investments that should be continued and strengthened. Visions for the post-2012 phase are just emerging – positive incentives for sustainable development are key to involving more countries. The UNFCCC offers a unique and comprehensive framework to facilitate co-operation and integrating broader discussions into a widely accepted negotiating arena.

6-2 Climate Change: A G8 Overview

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Head of Science Policy on Climate Change,
Department for Environment, Food and Rural Affairs
(UK)

International action is essential if the world is to avoid dangerous climate change. The UN's Framework Convention on Climate Change, and its Kyoto Protocol, provides the international framework and mechanism for tackling climate change. At Montreal last December, Parties to the Convention agreed to consider the development of the Protocol post 2012 as well as to engage in a wider Dialogue on addressing climate change under the Convention. The UK fully supports the UNFCCC process but it recognises that international negotiations can benefit from informal discussions between countries. As a result climate change was one of the UK's top priorities during its Presidency of the Group of 8 industrialised nations (the G8, which accounts for nearly half of global CO2 emissions) in 2005.

The UK hosted a major international scientific meeting: **"Avoiding Dangerous Climate Change."** This showed that the impacts of climate change were likely to be greater than previously expected and that deep cuts in emissions were needed to stabilise greenhouse gas at levels which would limit temperature rises to the EU's target of 2C. This was followed by a meeting of Energy and Environment Ministers from the G8 and from 5 key developing countries – Brazil, China, India, Mexico and South Africa - and other key countries with the greatest energy needs to explore what might usefully form a wider dialogue on how to proceed in combating climate change.

The **G8 heads of government summit** at Gleneagles in July 2005 recognised that human activity was contributing to climate change and that urgent action was needed to move to a low carbon economy. A **Plan of Action** covering climate change, clean energy and sustainable development was agreed, including specifically improvements to energy efficiency in appliances and buildings, cleaner vehicles, aviation, work on developing cleaner fuels, renewable energy and promotion of research and development and the financing of future projects.

The G8 also initiated the **Gleneagles Dialogue** between G8 and the 5 key developing countries with significant energy needs. The Dialogue will allow more informal discussions to continue on the issues surrounding climate change and measures to tackle it. The next ministerial meeting will be in Mexico in October 2006 and will cover adaptation, market mechanisms and economics; and technology development and transfer. The G8 has also invited the **International Energy Agency (IEA)** and **World Bank** to undertake further work on actions to reduce emissions, and improve funding for clean technologies in developing countries.

The Gleneagles Dialogue is complementary to the official UN processes on climate change, and provides an informal platform for discussing innovative ideas and new measures. It should contribute to countries approaches to developing low carbon societies. We hope that the output from this workshop will be of use to the Dialogue.

6-3 Energy Technology Perspectives: Scenarios and Strategies to 2050

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(France)

Secure, reliable and affordable energy supplies are fundamental to economic stability and development. The threat of climate change, the erosion of energy security and the growing energy needs of the developing world all pose major challenges for energy decision makers. They can only be met through innovation, the adoption of new cost-effective technologies, and a better use of existing energy-efficient technologies. The IEAs new publication, *Energy Technology Perspectives 2006*, presents the status and prospects for key energy technologies and assesses their potential to make a difference by 2050. It also outlines the barriers to implementing these technologies and the measures that can overcome such barriers.

The world is not on course for a sustainable energy future. Indeed, if the future is in line with the trends projected in the Baseline Scenario prepared for this study, CO2 emissions will be almost two and a half times their current level by 2050, even given this takes into account energy efficiency gains and technological progress that can be expected under existing policies. Surging transport demand will continue to put pressure on oil supply. The carbon intensity of the world's economy will increase due to greater reliance on coal for power generation – especially in rapidly expanding developing countries with domestic coal resources – and the increased use of coal in the production of liquid transport fuels.

But this alarming outlook can be changed. The Accelerated Technology scenarios (ACTs) – that form the backbone of the book – demonstrate that by employing technologies that already exist or are under development, the world could be brought onto a much more sustainable energy path. The scenarios show how energy-related CO2 emissions can be returned to their current levels by 2050 and how the growth of oil demand can be moderated. They also show that by 2050, energy efficiency measures can reduce electricity demand by a third below the Baseline levels. Savings from liquid fuels would equal more than half of today's global oil consumption, offsetting about 56% of the growth in oil demand foreseen in the Baseline Scenario.

Nevertheless, even in the ACT scenarios, fossil fuels still supply most of the world's energy in 2050. Demand for oil, coal (except in one scenario) and natural gas are all greater in 2050 than they are today. Investment in conventional energy sources will, therefore, remain essential.

A portfolio of technologies is needed. Energy efficiency is crucial to reducing CO2 emissions in the short and long term. CO2 capture and storage will be crucial coal is to continue to provide secure, low-cost electricity in a CO2 constrained world, it will also be crucial to minimizing mitigation costs

in countries with large coal reserves, but relatively modest other national energy sources. Nuclear, where acceptable, and renewables will also be crucial to decarbonising the electricity sector. The more efficiency use of natural gas in the economy will also be important, as will biofuels in transport. Hydrogen and fuel cell vehicles may, with significant efforts and breakthroughs, be able to play a significant role in decarbonising transport in the long term.

In all five of the ACT scenarios, demand for energy services is assumed to grow rapidly, especially in developing countries. The scenarios do not imply that the growth in demand for energy services is constrained in developing or developed countries. Rather they show how this demand can be met more intelligently and with lower CO2 emissions through the implementation of a wide range of policies including increased research, development and demonstration (RD&D) efforts and deployment programmes, as well as economic incentives to advance the uptake of low-carbon technologies. The policies considered are the same across all five ACT scenarios. What varies are assumptions about how quickly energy efficiency gains can be achieved, about how quickly the cost of major technologies such as CCS, renewables and nuclear can be reduced, and about how soon these technologies can be made widely available. A sixth scenario, TECH Plus, illustrates the implications of making more optimistic assumptions on the rate of progress for renewables and nuclear electricity generation technologies, as well as for advanced biofuels and hydrogen fuel cells in the transport sector.

The costs of achieving a more sustainable energy future in the ACT scenarios are we believe affordable, none of the technologies required are expected – when fully commercialised – to have an incremental cost of more than USD 25 per tonne of avoided CO2 emissions in all countries, including developing countries. However, there will be significant additional transitional costs related to RD&D and deployment programmes to commercialise many of the technologies over the next couple of decades.

6-4 Climate Change Policy Frameworks: UNFCCC and Partnerships

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(Japan)

Based on the progress made at the COP11 and COP/MOP1 in Montreal, Canada, held in December 2006, all parties started discussion related to the post-2012 framework on climate change under the UNFCCC and its Kyoto Protocol. Japan and some Annex I countries expressed the views on a possible set of elements for the future framework, such as the need to address UNFCCC's ultimate objective, the need to continue discussion to reach agreement on long-term goals and ways to achieve them, and the importance of establishing an effective framework which brings about maximum reduction efforts by all major emitting countries. On the other hand, some developing countries insisted the importance of sustainable development, technologies and adaptation, continuation of CDM, and the need of early commitments by developed countries for further reduction of green house gases.

Although the UNFCCC will stay as the central forum to discuss an international framework on climate change, it is also important to promote a variety of bi-lateral, regional and international partnerships and dialogues in order to complement the efforts implemented under the UNFCCC and its Kyoto Protocol.

Today, there are a number of dialogues to share concerns and to build consensus among the countries for international actions to address climate change, such as the G8 initiative on Climate Change, Clean Energy and Sustainable Development and the Asia-Pacific Seminar on Climate Change. Through these dialogues, both the developed and developing countries began to share the views that it is essential for future climate regime to address sustainable development problems, technology solutions, adaptation needs and the use of the market mechanisms.

Based on this recognition, Japan has been developing bi-lateral and regional partnerships to promote policies and measures on the elements, such as the Asia-Pacific Partnership on Clean Development and Climate (APP), Japan-US joint co-benefit program and the Asia-Pacific Network for Global Change Research (APN).

Discussant Presentation

Tae Yong Jung (tjung@worldbank.org)
Senior Energy Economist, The World Bank
(USA)

The practical challenges for the LSC can be summarized as follows:

- **Values of Carbon:** The biggest challenge is how to set the value on carbon. The whole global society needs to consider the issue of carbon in its decision making. Without the value of carbon, it is difficult to move the whole global community to the LSC.
- **Infrastructures:** The new infrastructures are 'must' conditions for promoting LSC. However, how to finance and mobilize the huge investment requirement in this sector is one of big challenges.
- **Knowledge sharing:** The best practice, good examples of policies and measures for LSC should be shared among all stakeholders. How to achieve is one of big challenges.
- **Communicating with other decision making groups and stakeholders:** LSC is not the issue of environmental sector. Hence, it is very critical to develop some communication tools and ways with other sectors to disseminate the idea of LSC.
- **More analysis on Driving Forces**: LSC is not a just intellectual and conceptual exercise, which can not be achieved by 'if and then' types of analysis. More rigorous and fundamental analysis on driving forces for the energy consumption patterns and life styles are important challenges leading toward LSC.

Appendices

Press Release on Feb. 16, 2006

Japan-UK Joint Research Project
Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development

MoE, Japan / Defra, UK

1. Outline

The Ministry of the Environment of Japan (MoEJ) and the UK Department for Environment, Food and Rural Affairs (Defra) are jointly promoting a scientific research project: Developing visions for a Low Carbon Society through sustainable development. They will promote studies toward achieving a Low Carbon Society (LCS) by 2050 in collaboration, encourage other countries to engage in LCS studies, and jointly hold series of international workshops. The first workshop will be held in 2006 in Tokyo.

2. Objectives

The objectives of the joint research project are to:

(1) Understand the necessity for drastic reduction of greenhouse gas (GHG) emissions in order to achieve a LCS based on scientific findings, and to and disseminate this understanding;
(2) Review country-level studies on GHG emissions scenarios;
(3) Investigate pathways to achieve a LCS at country level in a globally harmonized manner, which are composed of concrete actions and innovations including both legal/social/ behavioral systems and technological solutions;
(4) Identify bottle-necks, barriers and opportunities for achieving a LCS;
(5) Contribute to the development of international cooperation between researchers working towards a LCS; and
(6) Share the images of a Low Carbon Society.

3. Scientific Background

The emission reductions we make, or do not make, in the next few years, critically affect our ability to meet environmental goals for long-term climate protection. Because of past and current greenhouse gas emissions, a certain increase in global temperature is unavoidable. Such increases in temperature carry profound risks. Even a small increase in temperature is likely to have significant impacts on ecosystems and species, might lead to increased drought and extreme rainfalls, with severe consequences for our society. The Third Assessment Report (TAR) of the Intergovernmental Panel on Climate Change (IPCC) and other, more recent, studies have indicated the following:

① An increase of even 1^{o}C in global average surface temperature compared to pre-industrial levels is likely to have significant impacts on fragile ecosystems including coral reefs
② Negative impacts on agriculture, water resources, and human health would appear on a global scale for a temperature increase between 2 and 3^{o}C
③ Serious risk of large scale, irreversible system disruption, such as reversal of the land carbon sink and destabilisation of the Antarctic ice sheets, is more likely above 3^{o}C. Such levels are well within the range of climate change projections for the century.

It is vital to consider how the current upward trend in greenhouse gas emissions can be halted. The ultimate objective of the United Nations Framework Convention on Climate Change (UNFCCC) is "stabilization of greenhouse gas concentrations in the atmosphere at a level that would prevent dangerous anthropogenic interference with the climate system".

The European Union has a target to limit the increase in global average temperature to 2^{o}C above pre-industrial levels. When this target was adopted in 1990, it was thought that this equated to atmospheric carbon dioxide levels below approximately 550 parts per million (ppm), but in 2001 the IPCC suggested that a limit closer to 450ppm might be more appropriate. Since pre-industrial times, we have already seen atmospheric carbon dioxide concentration rise from 270 to 380ppm. So we are already approaching the lower limit of 450ppm, which re-emphasizes the need for urgent action.

In Japan, the Sub-Committee for International Climate Change Strategy under the Central Environment Council recommended in its second Interim Report that "taking all this scientific knowledge into account, we think starting point for studying long-term targets should for now be the approach that would limit the temperature increase to 2^{o}C".

The joint research project will use the same premise of a 2^{o}C limit, with some flexibility, for each participating study; this corresponds to a reduction of global anthropogenic GHG emissions by more than half of the existing levels over the period 2050 to 2100 in order to stabilize atmospheric GHG concentrations between 2100 and 2150.

4. Project Format

(1) Organizations leading on the research

Japan: National Institute for Environmental Studies (NIES)

UK : UK Energy Research Centre (UKERC) and Tyndall Centre for Climate Change Research

(2) International Workshops

The first international workshop will be held in Japan from June 14 to 16, 2006, involving researchers and governmental officials from about 20 countries, and international organizations. Prior to the workshop, a public symposium will be held in Tokyo on June 13, 2006. A second workshop will be held in 2007.

5. Scope and characteristics of the research

The joint research project will use a top-down or "back-casting" approach to identify what is required over the long term to realize stabilization of global temperatures. The vision of a Low Carbon Society will be described along with the scale of cuts required in GHG emissions compared to current levels. The project intends to identify what can be done now and in the future by summing up concrete actions and innovations needed, in terms of legal/social systems, technologies, and life-styles. It is intended to cover studies on the requirements of people living in the 2050 world, as well as studies on various aspects of LCS including energy supply, structure of industry, structure of cities and countryside, and transportation systems.

List of Invited Participants for Expert Workshop

Mr. Jean Acquatella	UN ECLAC	Chile
Dr. Makoto Akai	AIST	Japan
Dr. Keigo Akimoto	RITE	Japan
Dr. Edmundo de Alba A.	INE	Mexico
Dr. Igor Bashmakov	CENEf	Russia
Mr. Andrew Bolitho	Defra	UK
Mr. Francisco De La Chesnaye	EPA	USA
Mr. Steve Cornelius	Defra	UK
Dr. Jae Edmonds	PNNL	USA
Mr. Grant Ehiobuche	Embassy of Nigeria	Nigeria
Mr. Christoph Erdmenger	FEA	Germany
Dr. Junichi Fujino	NIES	Japan
Mr. Jose Alberto Garibaldi	Energeia	Mexico
Dr. Kirsten Halsnaes	UNEP/RISO	Denmark
Dr. Tatsuya Hanaoka	NIES	Japan
Dr. Hideo Harasawa	NIES	Japan
Dr. Jean-Charles Hourcade	CIRED	France
Mr. Willem Thomas van Ierland	EC	EU
Mr. Innocent A. Iwejuo	Embassy of Nigeria	Nigeria
Dr. David Jhirad	WRI	USA
Mr. Zhao Jun	MFA	China
Dr. Tae Yong Jung	World Bank	USA
Dr. Mikiko Kainuma	NIES	Japan
Dr. Manmohan Kapshe	MANIT	India
Dr. Jiang Kejun	ERI	China
Mr. Frank (Fu-Kuang) Ko	INER	Taiwan, China

Mr. Toshiro Kojima	MOE	Japan
Dr. Tom Kram	RIVM	Netherlands
Prof. Robert Lowe	UCL	UK
Dr. Yin-Pang Ma	INER	Taiwan, China
Dr. Toshihiko Masui	NIES	Japan
Ms. Ritu Mathur	TERI	India
Dr. Yuzuru Matsuoka	Kyoto University	Japan
Mr. Stanford Mwakasonda	ERC	South Africa
Mr. Yoshio Nakura	MOE	Japan
Dr. Shuzo Nishioka	NIES	Japan
Mr. Mauro Meirelles de Oliveila Santos	MCT	Brazil
Dr. Rahul Pandey	IIM	India
Mr. Pedro Piris-Cabezas	Yale University	
Dr. Emilio Lebre La Rovere	UFRJ	Brazil
Dr. Tamotsu Sato	MOE	Japan
Prof. Ram Manohar Shrestha	AIT	Thailand
Prof. P. R. Shukla	IIM	India
Prof. Jim Skea	UKERC	UK
Dr. Antonio Soria	EC-IPTS	Spain
Dr. Neil Strachan	PSI	UK
Mr. Akio Takemoto	MOE	Japan
Mr. Michael Taylor	IEA	France
Mr. Ralph Torrie	ICF International	Canada
Ms. Sachiko Tsukahara	MOE	Japan
Mr. Naoya Tsukamoto	MOE	Japan
Mr. David Warrilow	Defra	UK
Dr. Jim Watson	SPRU	UK
Mr. Martin Weiss	FEA	Germany

The first workshop of Japan-UK Joint Research Project

"Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development"

June 14th to 16th, 2006
Mita Kaigisyo, Tokyo, Japan

Executive Summary

Introduction

A workshop on "Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development" was held from June 14 to 16, 2006 in Tokyo, hosted and organized by the Ministry of the Environment of Japan (MoEJ) and the UK Department for Environment, Food and Rural Affairs (Defra), National Institute for Environmental Studies (NIES), UK Energy Research Centre (UKERC), and Tyndall Centre with the advice of the steering committee composed of scientists and governmental officials from Japan, UK, China, Germany, India, Mexico, Russia and USA. Prior to the workshop, a public symposium was held in Tokyo on June 13, 2006.

Dr. Shuzo Nishioka of NIES and Dr. Jim Skea of UKERC co-chaired the Workshop. 54 experts from 19 countries, 6 international organizations, and 65 other participants attended.

The objectives of the workshop were:

a) identifying and understanding the necessity for deep cuts in greenhouse gas (GHG) emissions toward 2050 based on scientific findings,
b) reviewing country-level GHG emissions scenario studies in developed and developing countries,
c) aligning sustainable development and climate objectives,
d) studying methodologies to achieve LCS,
e) identifying gaps between our goals to develop country-level LCS scenarios and the current reality and,
f) identifying opportunities for cooperation and how best to cooperate in estimating country, regional and global-level LCS scenarios.

This summary has been produced by the steering committee. It does not represent the formal views of any of the participants or countries involved in the workshop.

1. What do we mean by a Low-Carbon Society?

A Low-Carbon Society:

- takes actions that are compatible with the principles of sustainable development, ensuring that the development needs of all groups within society are met;
- makes an equitable contribution towards the global effort to stabilise atmospheric concentrations of carbon dioxide and other greenhouse gases at a level that will avoid dangerous climate change through deep cuts in global emissions;
- demonstrates high levels of energy efficiency and uses low-carbon energy sources and production technologies, and
- adopts patterns of consumption and behaviour that are consistent with low levels of GHG emissions.

For developed countries, achieving a LCS is likely to involve making deep cuts in carbon dioxide emissions by the middle of the 21st century. It will involve the development and deployment of low-carbon technologies and changes to lifestyles and institutions.

For developing countries the achievement of a LCS must go hand in hand with the achievement of development goals. This would be with a view to achieving an advanced state of development with carbon intensity commensurate with those of developed LCSs.

2. Why do we need Low-Carbon Societies?

Global emissions of greenhouse gases are projected to reach levels during the next 100 years, which could have serious negative effects on the climate system, natural environment and human society. Deep cuts in global greenhouse gas emissions are required to prevent the worst effects of climate change and thus achieve the ultimate objective of the UNFCCC to stabilise greenhouse gas concentrations in the atmosphere at levels which avoid dangerous climate change. Although there is some debate over the precise magnitude of emission reductions required at the global level, in part due to uncertainty in climate sensitivity and the nature of the impacts expected, it is clear that developed country emissions need to be reduced by at least about half of current levels by 2050. In addition, developing country emissions need to be limited in a way which enables the achievement of their development goals. Many of our choices today and in the near future will determine our emissions pathways for decades to come. Urgent action is therefore required to keep options available to achieve the magnitude of cuts required. Delay in acting now would increase the burden of climate change impacts and emissions reductions for future generations.

3. How can we achieve Low-Carbon Societies?

Long term goals can help us define the pathway to a LCS. Developing shorter-term targets can inform and energise the policy-making and implementation processes. Targets should be flexible enough to allow freedom to act in response to an uncertain future.

There is a need to identify priority options that can be implemented in the short term which help to make early progress towards low carbon goals. These priorities would vary from country to country and will depend on economic circumstances and resource endowment. Policies for low carbon options should be durable and consistent with long–term strategies. Carbon markets and appropriate financial instruments provide effective incentives.

There exist numerous potential pathways towards a sustainable LCS. The options should be evaluated from a variety of economic and societal perspectives including regional, national and global. A combination of technological innovation, policy implementation, institutional and behavioural change will be necessary. These elements should not be treated in isolation from each other. They should be integrated with existing policies that address other social goals such as energy security, access, competitiveness and land-use.

There is no single option for achieving a LCS. The approach to some measures will be common to all countries. Other issues, for example energy poverty and household energy efficiency, need careful assessment in their local context. LCSs are likely to require substantial changes in areas such as the built environment, transport, and industrial and service sectors. There will also be a need to implement these changes in harmony with other development goals. Therefore, a portfolio of sustainable emission reduction measures is required, which will take into account regional specificities. Key options include;

- Demand reduction through energy efficiency and lifestyle change. It is important to accelerate the historical rate of energy efficiency improvement through incentives, institutional and behaviour change.
- Biomass along with other renewables. These play important roles in many national energy systems, and also have the potential to achieve substantial carbon emissions reductions. The development of this set of options needs to take into account prudent use of land and forestry.
- Carbon capture and storage. This was identified as a likely bridging technology that could reconcile continuing fossil fuel use with lower carbon emissions. The scale of carbon capture and storage required by many LCS scenarios is substantial. It is not yet clear to what extent this can be realised in practice.

4. How to align Low-Carbon Societies with Sustainable Development

The sustainable development perspective is important, especially from the viewpoint of developing countries, because they have development choices open to them that could allow the achievement of a LCS more cost effectively. They could reach their national sustainable development goals along with a LCS, if suitable policies are coupled with international collaboration at the regional and global levels. LCSs could bring additional benefits such as energy security, land use and conservation, reduced pollution, and environmentally sustainable cities and transportation

The successful development of LCSs must involve a wider range of domestic and international actors than those involved with purely energy and high GHG intensive sectors.

Necessary actors include:

- governments (which set the overall framework and can provide long-term predictable signals),
- businesses (who bring forward innovations),
- the financial sector (private, public and multilateral) and
- civil society (whose awareness can help align diverse stakeholders).

Their incentives and risks have to be jointly addressed.

Countries' deployment of policies and the regulatory environment they set can help create conditions required to support large scale infrastructure and capital flows.

A wide range of policies is needed. Critical to these are government support, reflected in public procurement, product standards, the setting of suitable incentives for investors and the fostering of public awareness and lifestyle change.

Realising win-win options also requires international collaboration. Trade regimes could encourage technologies and products that will enhance sustainable development while lowering carbon emissions. Knowledge transfer related specifically to the LCS can play a key role in supporting sustainable development in a wider sense. Knowledge transfer can cover research, policies and practices as well as technology.

The most effective technology transfer often comes through the private sector, which is supported by clear market signals, especially the establishment of a long-term price for carbon in international market.

The availability of efficient technologies is crucial in realising win-win opportunities, especially from the long-term perspective. Public and private investment in technology R&D can play an important role in developing win-win opportunities. Increasing the overall volume of energy R&D in all countries is critical to a sustainable, low carbon future. While recent decreases in the volume of energy R&D in developed countries is a move in the wrong direction, there are encouraging signs of increases in energy R&D in key developing countries. Coordinating public and private R&D activity would help to focus investments.

Effective policies to encourage the deployment of technologies are also critical.

A key priority is to avoid lock-in to unsustainable technologies. Some investments, for example in power plants, may have a lifetime of decades. Taking early action with long-term perspectives will help to reconcile the LCS with sustainable development.

5. International cooperation

The formal international climate framework of the UNFCCC is essential to the development of LCSs. Informal processes such as the Gleneagles Dialogue complement the formal process. We hope that the insights gained at this workshop will provide a useful input to existing international processes.

There is a need for stronger political signals at domestic and international levels. The role of the Clean Energy Investment Framework, currently being developed by the multilateral financial institutions, in particular will be crucial. International Financial Institutions (World Bank, Regional Development Banks, IMF) could usefully assess present instruments and reshape them where needed in consultations with regions and countries to enhance policy credibility and diminish investment risks. Regional institutions can play a central role in advancing country dialogues and examining conditions that facilitate the required capital replacement.

A resource mechanism such as a special global fund for technology innovations and transfer would enlarge the set of options for transitions to LCSs. Likewise international trade can be potentially tapped to foster transitions to LCSs.

6. Further Work and Research

A variety of tools and methods are required to explore pathways including policy scenarios and backcasting methodologies. The latter, for example, first set goals of desirable LCS and, by working backwards explore optimal paths for their achievement. However further research is needed. Among the ideas discussed at the workshop were:

Modeling

- How can we coordinate the development of baselines and policy scenarios?

Technology

- What risks and potentials are associated with individual technological responses?
- What impact will technological learning have on speed and cost of implementation?

Socio-Economics

- What are the costs of action and of inaction with respect to climate change at the

regional and global level?

- What is the most cost effective way to achieve a LCS individually and internationally?
- What influence do social infrastructure, lifestyle/behaviour, and governance have on the ability to achieve a LCS?

Policy option assessment

- What short term policy implications follow from the long-term goals?
- How to integrate issues other than climate change, like poverty reduction and energy security, in the LCS methodology?

7. Next Steps

A further workshop will be held in 2007 in UK. Participants provided concrete suggestions regarding focus, content and participation in the 2007 workshop:

- the next workshop should be outcome oriented;
- a wider range of LCS scenarios should be presented, with more opportunity to go into detail and focus on similarities and differences between scenarios; and
- the workshop should engage a wider range of stakeholders including business leaders.

Participants also considered opportunities to disseminate information on LCS activities:

- a semi-popular compilation of LCS results and scenarios could be compiled; and
- the 2007 workshop could generate a map of LCS activities.

International Steering
Committee
Tokyo, Japan
June, 2006

International Steering Committee

“Japan–UK Joint Research Project Developing Visions for a Low-Carbon Society (LCS) through Sustainable Development”

The Ministry of the Environment of Japan (MoEJ) and the Department for Environment, Food and Rural Affairs in the UK (Defra) are jointly promoting a scientific research project toward achieving a Low-Carbon Society by 2050.

The objectives of the joint research project are:

- Identifying and understanding the necessity for deep cuts in greenhouse gas (GHG) emissions toward 2050 based on scientific findings (e.g. 50% global GHG emissions reductions in 2050 to 2100 compared to 1990 levels).
- Reviewing country-level GHG emissions scenario studies in some developed and developing countries such as Japan, UK, Australia, Brazil, Canada, China, France, Germany, India, Mexico, Russia, South Africa, Thailand, and USA. Looking at possible options such as for supply-side, demand-side, policy, institution, financial, lifestyle based on national circumstance.
- Aligning sustainable development and climate objectives: win-win strategies. Investigating possible co-benefits of LCS such as tackling poverty; other environmental concerns (air pollution, water, land use, etc); and energy security.
- Studying methodologies to achieve LCS, such as depicting visions and pathways (i.e. back-casting); qualitative modeling of the future society; possible combination of options (technological, institutional, behavioral); financial mechanisms; LCS scenarios harmonization at national, regional and global levels.
- Identifying gaps between our goals to develop country-level LSC scenarios and the current reality.
- Sharing best practice and information; identifying opportunities for cooperation and how best to cooperate in estimating country, regional and global-level LCS scenarios.

“Japan Low-Carbon Society Scenarios toward 2050”

This research project, initiated in 2004, is sponsored by Global Environment Research Fund of MoEJ. The objective of the project is to propose concrete countermeasures to achieve LCSs in Japan by 2050, including institutional change, technology development and lifestyle change. More than 50 research experts have studied together to develop visions and roadmaps.
This project supports the “Japan–UK Joint Research Project.”

http://2050.nies.go.jp/

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