環境研究総合推進費 S-6　一般公開シンポジウム

# アジア低炭素社会へのチャレンジ
# Challenges to Low Carbon Asia

## ーアジアはリープフロッグで世界をかえられるか？ー
## Can Asia change the world through leapfrogging?


**日時**　平成 25 年 10 月 17 日(木) 13:00～17:00

**会場**　国連大学 ウ・タント国際会議場

**主催**

環境省 環境研究総合推進費 S-6

アジア低炭素社会に向けた中長期的政策オプションの立案・予測・評価手法の開発とその普及に関する総合的研究（アジア低炭素社会研究プロジェクト）

独立行政法人国立環境研究所

**共催**

国立大学法人東京大学大学院工学系研究科

国立大学法人東京工業大学

国立大学法人名古屋大学大学院環境学研究科

# 開催趣旨

雇用状勢の悪化、中東の政治的不安定さ、貧富の差の拡大、福島第一原子力発電事故以降の我が国のエネルギー情勢の変化など、社会・経済情勢はさまざまな問題を抱えています。一方で、温暖化問題は着実に取り組んでいかなければならない重要な課題です。2010年にカンクーンで開催されたCOP16では、産業化以前の水準から世界の平均気温上昇を2℃以下に抑える観点（2℃目標）から、温室効果ガス排出量の大幅削減が必要であるという目標に合意するとともに、経済成長と同時に持続的発展へとつながる低炭素社会へのパラダイムシフトの重要性が明確化されました。

低炭素社会を実現するにはどういった取り組みが必要でしょうか。平成21年度より開始され環境研究総合推進費S-6では、成長を続けるアジアに焦点をあてて、どうすれば、エネルギー・資源浪費型発展パスを回避して、発展により生活レベルを向上させながらも、低炭素排出、低資源消費の社会に移行できるかを探ってきました。具体的な低炭素社会の実現方策として、資源生産性を向上させて、資源の消費量そのものを減らすこと、二酸化炭素排出量が少ない交通体系を整備すること、二酸化炭素排出量の少ない持続可能なエネルギーシステムの開発・普及に取り組むことなどを取り上げ、これらがどうすれば実現できるかを検討してきました。また、方策実現のための、技術、資金、ガバナンス等の面からについても検討してきました。

これらの要素を組み合わせて、2℃目標を実現するための10の方策とロードマップを、各国の研究者や政策決定者とともに開発し、アジアにおいて低炭素社会が実現可能であることを明らかにしました。本シンポジウムでは、この分野で活躍している海外の専門家からの講演とともに、5年間の研究成果を紹介し、今後進むべき方向について議論します。

アジア低炭素社会研究プロジェクト（S-6）
http://2050.nies.go.jp/

# プログラム

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|---|---|
| 13:00 -13:10 | **開会挨拶**<br>環境省　地球環境局長　関荘一郎<br>国立環境研究所　理事長　住明正 |
| 13:10 -13:25 | **アジア低炭素社会研究の展開**<br>甲斐沼美紀子（国立環境研究所） |
| 13:25 -13:45 | **講演１**<br>**アジアにおけるグリーン成長・低炭素成長に向けた進捗**<br>Heinz Schandl（オーストラリア連邦科学産業研究機構（CSIRO）） |
| 13:45 -15:00 | **セッション１　資源・交通からみた低炭素アジア**<br>【座長】 蟹江憲史（東京工業大学）<br>**発表１　資源生産性からみた低炭素社会への道**<br>森口祐一（東京大学）<br>**発表２　アジアにおける低炭素交通システム実現のための戦略と手段**<br>林良嗣（名古屋大学）<br>【コメンテーター】<br>廣野良吉（成蹊大学）<br>河合正弘（アジア開発銀行研究所）<br>Werner Rothengatter（カールスルーエ工科大学）<br>Heinz Schandl（CSIRO）<br><br>質疑応答 |
| 15:00 -15:20 | 休　憩 |
| 15:20 -15:40 | **講演２**<br>**2℃目標に向けた中国のエネルギー展開**<br>Kejun Jiang （中国発展改革委員会　エネルギー研究所） |
| 15:40 -16:55 | **セッション２　アジア低炭素社会シナリオ**<br>【座長】 甲斐沼美紀子（国立環境研究所）<br>**発表１　アジア低炭素社会シナリオの開発**<br>増井利彦（国立環境研究所）<br>**発表２　アジア低炭素社会実現に向けてのアプローチ**<br>松岡譲（京都大学）<br>【コメンテーター】<br>Kejun Jiang ( 中国発展改革委員会　エネルギー研究所 )<br>亀山康子（国立環境研究所）<br>李志東（長岡技術科学大学）<br>西岡秀三（地球環境戦略研究機関）<br><br>質疑応答 |
| 16:55-17:00 | **閉会挨拶** |

# アジア低炭素社会研究の展開
## ーアジアはリープフロッグで世界をかえられるか？ー

独立行政法人国立環境研究所 社会環境システム研究センター　フェロー
甲斐沼 美紀子

1975 年京都大学大学院工学研究科修士課程（数理工学専攻）修了。工学博士。
1977 年より国立公害研究所（現（独）国立環境研究所）に勤務。1990 年より温暖化の研究に従事。温暖化対策を評価するアジア太平洋統合評価モデルの開発に取り組む。現在、国立環境研究所フェロー。2003 年より北陸先端科学技術大学院大学　客員教授。
1994 年日経地球環境技術大賞、2010 年科学技術政策研究所より、科学技術への顕著な貢献 2010（ナイスステップな研究者）に選定される。2011 年環境科学会学術賞を受賞。
環境経済・政策学会会員。
IPCC 第４次評価報告書および第５次評価報告書の主執筆者（第３ワーキンググループ：緩和策）
主な編著書：「Climate Policy Assessment」Springer, 2003

2005 年の世界の温室効果ガス排出量のうち、アジアは全体のおよそ 36% を占めている。今後見込まれる急速な経済発展を鑑みると、低炭素社会を目指さないシナリオにおいてはアジア地域からの温室効果ガス排出量は引き続き伸び続けることが予想される。低炭素社会の一つの目標は 2050 年までに世界の温室効果ガスを半減させることである。2005 年のアジア地域の温室効果ガス排出量のうち、二酸化炭素（$CO_2$）排出量の占める割合は 6 割であり、アジア低炭素社会実現のためには $CO_2$ 排出量の削減とともに、メタンや亜酸化窒素といった $CO_2$ 以外の温室効果ガス排出量の削減も重要な課題である。低炭素社会実現に向けた対策を講じることによって、エネルギーアクセスの向上や貧困の撲滅といった課題の解決にもつなげることも大きな目標である。

アジアが低炭素社会に移行するのは容易ではなく、中央・地方政府、民間企業、NGO・NPO、市民、そして国際社会それぞれが長期的な視点から目指す社会の姿をしっかりと見据え、担うべき役割を認識して相互協力しながら取り組みを進める必要がある。アジアといっても、国や地域によって発展レベル、資源賦存量、国土や文化などは異なるため、それぞれ効果的な対策は変わりうる。

本プロジェクトは、アジア諸国を、多面的な側面から総合的に低炭素社会へ誘導する政策オプションと、その実現のためのロードマップを策定・提案し、各国が実施可能かつ有効性の高い低炭素社会実現戦略や政策の作成を支援することを目的とする。

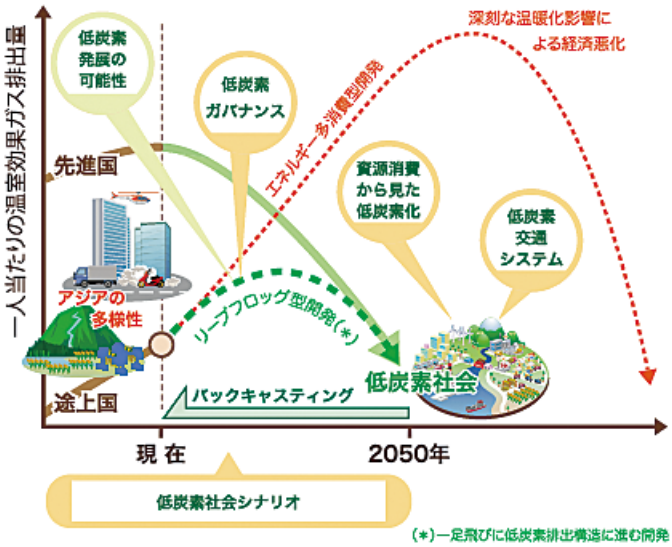
**アジア低炭素研究の主な成果**

・多様なアジアに対して、2050 年世界半減に資するアジア全体の削減策を検討するため、シナリオ構築モデル・ツール群を開発した。
・インド、インドネシア、タイなどの国、インドのアーメダバード、中国の広州、韓国の京畿道、京都市などの都市・地域を対象に具体的な低炭素な将来像を描き、開発したシナリオ構築モデル・ツール群を適用して、それぞれの削減可能性を示した。
・アジア共通政策オプションとして、都市内交通、都市間交通、資源利用、建築物、バイオマス、エネルギーシステム、農業・畜産、森林・土地利用、技術・賃金、ガバナンスに関する方策を取り上げ、10 の方策としてまとめた。

・交通の重要な施策として、貨物高速鉄道により産業コリドーを形成するような、地域間スケールでの産業の鉄道指向型開発を提案した。
・資源利用に関しては、資源の価値を最大限に引き出すモノ使いの重要さを提案し、資源の利用を画期的に減らすモノづくり、寿命を長くするモノづかい、資源を繰り返し使用するシステムづくりの観点から施策を提案した。
・建築物については、自然エネルギーを最大限に利用した空間の創設を提案した。
・エネルギーシステムに関しては、バイオマスをはじめとする再生可能エネルギーを中心とした持続可能な地域エネルギーシステムの確立を提案した。
・農業･畜産に関しては、水田の水管理技術の普及、適切な施肥と残滓の管理、家畜排せつ物からのメタン回収･利用を対象にそれらを促進する施策のロードマップを作成した。
・森林・土地利用に関しては、持続可能な森林管理についての分析を行った。
・これら個別の方策を実現するには、低炭素社会に資する既存技術の普及や市場化、並びに革新的技術の開発が不可欠である。このため、技術移転や普及を促進する制度を取り上げ、障害となっている制度的、経済･資金的、技術的障害を分析し、これらの障害を克服するための、国、産業界、市民、国際社会の役割を明らかにした。
・アジア諸国では、既に、いくつかの国で、低炭素社会に向けた行動計画等を提示している。これらの行動計画や、本プロジェクトで提案した方策を実施するには、法制度やガバナンスが有効に機能し、物理的・経済的・人的資源を有効に活用する必要があるため、低炭素アジアを支えるガバナンスについても提案した。

**今後の課題**

本研究がスタートした５年前に比較して低炭素社会に対する認識は向上し、低炭素社会へのロードマップもいくつかの国、地域、都市において策定された。しかし、これらのロードマップが予定どおり実行され成果をあげていくためには、個別具体的な低炭素システム作りの方法論の共有や、資金の確保など、まだまだ課題が残されている。低炭素技術の導入を促す制度が確立されたとしても、各国の産業や市民、政府といった各主体がその意義と理由を十分理解していなければ、十分な効果が期待できない。省エネルギーに対する理解や、温暖化など低炭素社会に関わる問題に対する知識や理解の深める教育制度の確立なども課題として残っている。また、ロードマップが策定されていない地域については、今後、低炭素社会への舵とりを、既に進んでいる国や、国際社会が支援していく必要がある。




プロジェクトの構成：本プロジェクトは、国立環境研究所（低炭素社会シナリオ担当）、東京工業大学（低炭素ガバナンス担当）、東京大学（資源消費から見た低炭素化担当）、名古屋大学（低炭素交通システム担当）の４つのチームから構成されている。

# アジアにおけるグリーン成長・低炭素成長に向けた進捗

オーストラリア連邦科学産業研究機構
Heinz Schandl

Prof Heinz Schandl holds a PhD in sociology and is an expert for environmental reporting, natural resource management, resource efficiency and sustainable consumption and production. His research links social theory, social metabolism and public policy. He leads CSIRO's research capability in SCP and the Green Economy, is lead-author of a report on Resource Efficiency: Economics and Outlook in Asia and the Pacific commissioned by the UNEP Office in Bangkok and has been a consultant for the OECD, the World Bank and the Asian Development Bank for sustainable natural resource use and green economy. He is an adjunct Professor at the Australian National University School of Sociology and a permanent visiting Prof at the Institute of Environmental Studies at Nagoya University. He is a member of UNEP's International Resource Panel, a council member of the International Society of Industrial Ecology (ISIE), chair of the Socio-Economic Metabolism section of the ISIE, editor of the Journal of Industrial Ecology and editorial board member for the Journal of Material Cycles and waste Management. He has extensive experience in science and project leadership and in providing research that informs public policy in the domain of sustainable natural resource use and sustainable development.

At the start of the 21st century, Asian economies are facing a changing economic context of rising and more volatile natural resource prices. Pressure points of climate change, food and water security and supply security for key natural resources including fossil fuels and metals are converging in an unprecedented matter. The future prosperity and competitiveness of the Asia-Pacific region will depend on well designed policies that guide a transition to sustainable consumption and production (SCP) to allow for resource efficient, low carbon and inclusive growth in the region.

SCP and the green economy are policy domains characterised by complexity, contestation, and uncertainty and will rely, in order to be effective and efficient, on the best available scientific evidence about the quantity of natural resource and emissions that are fuelling economic growth and human development in Asia and the Pacific. Such information will be required to inform the public and policy debate, to help set targets for resource efficiency and emissions intensity and to measure progress towards achieving inclusive green growth.

Over the last decade, the international research community jointly with the United Nations Environment Program (UNEP) and the Organisation of Economic Cooperation and Development (OECD) have developed a comprehensive knowledge base about the amount of natural resources that were used globally and in the Asia-Pacific region and the amount of waste and emissions that have been the backbone of economic and human development. Based on a comprehensive and robust historical record about the relationship of economic growth, resource use and emissions scenarios of future natural resource demands can be established.

In this talk the recent history of economic development, natural resource use and emissions will be reviewed and scenarios about future demands will be presented. We will compare global trends with

trends in the Asia-Pacific region and will discuss trends of important countries including Japan, China and Australia.

During the last four decades, most of the growth in global resource use and emissions has come from the Asia-Pacific region which has now become the largest user of natural resources globally. The resource base has shifted from mainly biomass in the 1970's to a mineral resource base of fossil fuels, metals and construction materials. The main driver of growing resource use and emissions has been consumption with population growth becoming less important. The region has increasingly become a net importer of natural resources which exposes regional growth to the volatility of global natural resource prices. Most importantly, the efficiency at which natural resource have been used in the Asia-Pacific region have been declining since the turn of the century caused by a shift in production form more efficient economies (such as Japan and South Korea) to less efficient ones (such as China and India).

Taking a footprint perspective on natural resource use allows us to attribute material use to final consumption in countries and provides us with an additional perspective about the relationship of economic development and resource use. From a material footprint perspective the landing point for natural resource use based on current modes of consumption and production lies between 25tonnes per capita (such as in Japan) and 35tonnes per-capita (such as in Australia). Multiplied by 9 billion people who will live on the planet this would amount to 270 billion tonnes of natural resources globally or 4 times the level of today leading to unprecedented environmental impacts such as accelerating climate change, depletion of some natural resources, increased degradation of soils and water bodies and fast growing air pollution.

Scenarios will be presented that show the impact of a global carbon price of between 25$-50$ per tonne and large investment into resource efficient technologies can assist a transition to a green economy in Asia and the Pacific and globally without damaging economic growth or employment. The empirical data presented shows that shifting investment from brown to green sectors and activities and supported by appropriate macroeconomic settings (such as a green budget and tax reform and carbon pricing) will be instrumental for the resilience of economic and human development of Asia and the Pacific in the 21th century.

# 資源生産性からみた低炭素社会への道

東京大学大学院工学系研究科都市工学専攻　教授
（S-6-4 チームリーダー）森口 祐一

東京大学大学院工学系研究科都市工学専攻・教授。
同　　新領域創成科学研究科環境システム学専攻・兼担。
京都大学工学部衛生工学科卒業、博士（工学）。
1982 年　国立公害研究所入所、環境庁企画調整局併任、OECD 環境局研修員、国立環境研究所資源管理研究室長、同研究所循環型社会・廃棄物研究センター長などを経て、2011 年 4 月より現職。専門は環境システム工学、特に物質フロー分析。
UNEP 国際資源パネルメンバー、中央環境審議会臨時委員、国立環境研究所客員研究員。
低炭素社会 2050 プロジェクト (2004-2008 年度 ) 交通チームリーダー。
主な編著書：Material Flow Data Book –World Resource Flows around Japan- Third Edition, NIES/CGER.

## 1. はじめに～デカップリングと資源生産性～

現代社会は自然資源の大量消費に支えられている。大量生産・大量消費・大量廃棄型の経済社会から循環型社会への転換は、日本では主に廃棄物問題の緩和、資源の有効利用の観点から提唱されてきたが、エネルギー消費や温室効果ガス排出の削減の面からも大きな意義がある。低炭素社会の直接の目標は、気候変動の防止のための炭素排出量の低減であるが、炭素排出の主因である化石燃料は典型的な非再生可能資源であり、この問題は自然資源の持続可能な利用という面からもとらえることができる。2011 年に国際資源パネルは「デカップリング」に関する報告書を公表し [1)]、経済の成長と資源消費・環境負荷の増大とを切り離すべきこと、それが可能であることを提唱した。デカップリングと密接に関連するキーワードが「資源生産性」であり、より少ない量の物的資源からより多くの価値を生む出すことを目指す概念である。本講演では、この資源生産性という観点からみた低炭素社会への方向性について論じる。

## 2. アジア低炭素社会プロジェクトにおける資源チームの役割

2050 年の世界の温室効果ガス排出量の半減を目標に、アジアにおける低炭素社会を実現する方策の検討を進める研究プロジェクト S-6 の一環として、演者がチームリーダーを務める S-6-4 班では、資源消費からみた低炭素化を研究対象としてきた。

化石燃料の燃焼やセメント原料としての石灰石の消費は、炭素排出に直結する資源消費である。また、工業化・都市化された社会を支える原材料は、その生産段階でのエネルギー消費によって多くの炭素排出を伴う。鉄鋼はその典型例であり、経済の急成長段階ではとりわけこうした炭素集約度の高い原材料が多く生産・消費される。建物や土木構造物は、鉄やセメントを多用するため、建設段階で炭素排出と深く結びついているが、こうした耐久財の蓄積は、その利用段階でのエネルギー消費と密接に関連し、さらに将来の二次資源の供給源という性格ももつ。経済発展と歩調を合わせて消費量が増大する紙などの消費財も含め、物質のストック・フロー、資源の循

環的・効率的利用、これらに伴うエネルギーの消費と温室効果ガスの排出とを関係づけ、体系的に解析することをこの研究チームの研究アプローチの柱としてきた。

他方、低炭素化のための太陽光発電やハイブリッド車などの技術に使われる稀少資源は、少量で大きな価値を生み出すが、対策の大量導入による需要増に対して、資源供給サイドでの課題を整理し、その対応策を明らかにすることも資源チームに求められる役割である。

S-6 プロジェクトがとりまとめた「低炭素アジアに向けた 10 の方策」では、資源チームは、方策 3「資源の価値を最大限に引き出すモノ使い」を提案した。これは、資源生産性の考え方を表現したものであり、(1) 資源の利用を画期的に減らすモノづくり、(2) 寿命を長くするモノづかい、(3) 資源を繰り返し使用するシステムづくり、の 3 つの小方策から構成される。

### 3. 資本の蓄積に着目した資源消費と炭素排出の分析

資源の消費、物質の生産・蓄積と低炭素化は多様な関わりをもつ。経済成長著しいアジアにおける資源需要の高まりは、高い関心を集める問題であり、とりわけ、中国における基礎素材の生産量・需要量の増加は特筆に値する。中国は 1980 年代から世界第一のセメント生産国であるが、2012 年のセメント生産量は世界合計の 60% 近くを占める。鉄鋼生産量においても、2000 年以降の生産量の伸びは著しく、2012 年の生産量は世界合計の約 46% を占める。

本プロジェクトでは、中国における建物、道路、鉄道の建設を対象に、必要な建設資材量に基づく積み上げ計算によって、$CO_2$ 排出量や長寿命化による削減可能性の推計を行った。こうしたボトムアップ型の推計と、生産量、用途別出荷量についてのトップダウン型の推計との不一致を改善するためには、両者を組み合わせた推計が有用である。新たに構築したモデルでは、物的な生活の豊かさの指標として、一人あたりの住宅床面積や、一人あたり乗用車保有台数といった変数をとらえ、経済の急成長とともにこれらのストックが増加することが、鉄鋼やセメントなどの素材の生産量の駆動力となることを表現している。先進国の経験では、これらの物的ストック指標はある水準で飽和する。飽和がどの水準となるのかが、ストックの増大の段階での炭素排出量に大きく影響するが、我々の設定したストックの飽和を考慮した需要のシナリオでは、昨今見られた鉄鋼やセメントの生産量の急増は近いうちに安定ないし減少に向かう結果となっている。

素材の生産に伴う炭素排出は、製鉄やセメント生産などの技術面での効率化、スクラップのリサイクル、建物の長寿命化などによって、緩和することが可能である。建築物や自動車など、蓄積された財の一部は、その使用段階で、初期の資材生産段階よりもさらに大きな炭素排出と結びつくため、増大するストックの管理に着目することが、資源生産性の高い社会の実現の鍵となる。但し、使用段階でのエネルギー消費が大きい、非効率な耐久財の長期使用はライフサイクル全体としてみれば低炭素化には逆行する恐れがあることには注意が必要である。ストックの量的な管理だけでなく、質的な改善が重要であり、一度蓄積されたストックを再構築しなおす大胆な発想も含め、より長期的な視野でみた最適な低炭素化の戦略の提案に向けた精査が必要である。

[1] UNEP/IRP(2011): Decoupling natural resource use and environmental impacts from economicgrowth
http://www.unep.org/resourcepanel/Publications/Decoupling/tabid/56048/Default.aspx

本テーマは、東京大学、立命館大学、みずほ情報総研株式会社、国立環境研究所、名古屋大学の 5 つのチームから構成される。

# アジアにおける低炭素交通システム実現のための戦略と手段

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交通と気候変動、コンパクトシティへのスマートシュリンクなどを研究。
世界交通学会（WCTRS）会長、欧州運輸大臣会議アドバイザー、海外４大学の客員教授、Transport Policy、Transportation Research D、Regional Science の共同／副編集長など国際的なリーダー役を務めている。
土木学会論文賞、同環境賞、世界交通学会オレンジ賞など国内外 15 の賞を受賞。
主な編著書に「Urban Transport and The Environment 」Elsevier,2004、「Transport Moving to Climate Intelligence」Springer,2010、「都市のクオリティストック」鹿島出版会 ,2009 などがある。

今日、アジア途上国の大都市では、経済成長に伴い、モータリゼーションと都市スプロールが急速に進行し、交通渋滞や大気汚染など都市交通に関する様々な課題が顕在化している。各国の問題解決に向けた取り組みでは、増大する交通需要に対し道路インフラ整備を先行させることで、更なる自動車利用を引き起こす悪循環に陥っている。アジアの途上国では、運輸部門からの排出が 4 割程に達する国もあり、経済発展と $CO_2$ 増加とをデカップリングする新たな交通体系モデルを見いだすことが必要不可欠である。

加えて、成長過程にあるアジアの途上国では、今後も世界の他地域と比較して国際旅客・貨物需要の成長率が高く推移すると見込まれる。従来、アジア全域の貨物輸送は沿海部から経済開発が行われたため、海上輸送が支配的であり低炭素輸送である。しかし、経済の発展中心が内陸へ移動と高速道路の整備により、短距離・中距離でトラック輸送が急増している。一方、旅客輸送は、LCC（Low Cost Carrier）の成長により高炭素な航空交通の需要が急増している。今後は、グローバル経済の進展とアセアンにおける 2015 年の AEC（ASEAN Economic Community）成立により、この傾向はより顕著になるであろう。

このような現状を踏まえ、2050 年のアジア低炭素社会を実現しうる具体的な交通システム及び都市像をバックキャスティングアプローチにより提示するとともに、そこに至るためのリープフロッグ的施策群を提案することが今まさに求められている。本プロジェクトでは、アジアにおける低炭素な交通システムのビジョンを提示し、その実現手段を不必要な交通需要を回避する戦略（AVOID 戦略）、低炭素交通手段に転換する戦略（SHIFT 戦略）、輸送エネルギー消費効率を改善する戦略（IMPROVE 戦略）の 3 つの戦略を組み合わせて検討する。

低炭素な都市内交通システムのビジョンとして、シームレスな公共交通モビリティと交通のダウンサイジングを掲げる。この実現のための AVOID 戦略として、コンパクトで階層的な中心機能配置、SHIFT 戦略としてシームレスな階層的公共交通システムの構築、IMPROVE 戦略として自動車車両の低炭素化と物流の効率化を行い、都市拠点を中心に公共交通を利用するライフスタイルと、都市拠点への産業集積を促進するような、統合的な都市交通システムを提案する。低炭素な都市内交通システムは、交通による環境負荷排出と時間損失を抑制し、交通の低炭素性と信頼性を高める。また、資源の制約が強まると同時に、アジア途上国でも 2030 年頃から高齢

化社会へ移行するため、通勤、業務以外の移動需要の多様化に適用可能な都市インフラのストックとしても、有効な土地利用交通システムとなる。さらに、アジアの国間スケールで整備が進む地域間交通システムとの連携を高め、その沿線都市への産業・人口集積のレベルに応じてこれらの戦略を早期に実施することによって、車に依存しない低炭素で持続可能な都市内交通システムが形成される。

一方、低炭素な地域間交通システムのビジョンとしては、低炭素な公共交通モビリティと効率的なサプライチェーンを掲げる。この実現のための AVOID、SHIFT 戦略として、鉄道・水運の整備を軸としたインターモーダル交通システムを構築し、貨物高速鉄道沿線の産業コリドーを形成することで、地域間鉄道を利用するライフスタイルと、産業のイノベーションを誘発するような、地域間スケールでの産業の鉄道指向型開発（産業 ROD: Rail Oriented Development）を提案する。中国から GMS（Greater Mekong Subregion）に至る大陸域内では、旅客輸送を航空から高速鉄道へ、貨物輸送をトラックから鉄道・水運へ転換する効果が高いと考えられる。高速貨物鉄道は、中距離以上では時間短縮効果とともに単位当たり輸送コストの削減も見込まれ、それを軸とした産業集積が期待される。また、IMPROVE 戦略としては、自動車・航空機・船舶の低炭素化がある。これらの戦略を早期に実施することにより、GMS と中国の沿海部から内陸部の都市間は、海運だけでなく高速鉄道を軸にした低炭素な交通機関で結ばれ、従来の道路交通主体の産業成長から一転した、インターモーダル交通システムによる産業コリドーが構築される。

このような低炭素交通システムのビジョンの有効性について、$CO_2$ 排出量を大幅に削減するための各戦略の施策の必要性を定量的に分析した。都市内交通システムについては、鉄道、バス高速輸送システム（Bus Rapid Transit：BRT）、車といった都市内の幹線交通システムを対象に、アジア各都市の経済レベル、人口規模、人口密度に応じて、低炭素となる幹線交通システムの特定を行い、$CO_2$ 排出の大幅削減に必要な路線キロのレベルを示した。また、大規模な都市鉄道整備計画が検討されるバンコクにおいて、将来の交通インフラへの投資可能額を考慮してその有効性を分析した結果、総延長 500 キロの鉄道優先整備の構想を実現した場合、その投資額で道路優先整備を行うより、$CO_2$ 排出削減と時間短縮の両方において有効性が高いことが示された。さらに、今後の高速鉄道整備によって大きな成長が期待されるコンケンやビエンチャンといった中小都市においても、BRT を中心とした低炭素交通システムの導入案を各都市の実務者と検討し提示した。

地域間交通システムについては、サプライチェーンにおける産業立地について、バンコクでの労働コスト上昇による周辺都市への立地分散を現地調査からシナリオ化し、自動車製造業の部品製造・輸送を含めた製造プロセスにおける $CO_2$ 排出量を分析することで、サプライチェーンの低炭素性を比較した。また、サプライチェーンの効率化と低炭素化に必要な交通機関を分析した結果、輸送距離が長いと海上輸送よりトラック輸送や鉄道輸送が優位であるため、時間短縮と排出量削減を同時に目指す場合には高い鉄道輸送の分担率が必要であることが示された。さらに、中国と GMS を結ぶ旅客・貨物両用の高速鉄道網の整備をシナリオ化し、その整備による産業分布、貨物交通需要、$CO_2$ 排出量への影響を分析したところ、大幅な $CO_2$ 削減が期待できることが示された。

本テーマは、名古屋大学、日本大学、横浜国立大学（都市内交通）、東京工業大学、南山大学（地域間交通）の 5 つのチームから構成される。

# 2℃目標に向けた中国のエネルギー展開

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Kejun Jiang

From 1993, Kejun Jiang began the research on climate change relative to energy policy analysis, which focus on energy technology policy assessment, energy supply policy assessment, renewable energy development and energy conservation. Started from 1994, have worked on Integrated Assessment Model(IAM) development for energy and GHG emission scenarios, policies, focusing on China and global analysis. At present He is mainly working on policy assessment for energy and environment policy assessment by leading Integrated Policy Assessment Model for China(IPAC) team. Major focus includes energy and emission scenarios, energy policy, energy system,. energy market analysis, and climate change, local environment policies and international negotiation. Started from 1997, worked with IPCC for Special Report on Emission Scenario and Working Group III Third Assessment Report, leader author for IPCC WGIII AR4 Chapter 3, and leader author for GEO-4 Chapter 2. Now he is CLA in WGIII of IPCC AR5, LA for IPCC AR5 Synthesis Report, and author for UNEP Emission Gaps. His recent research projects include energy and emission scenarios for 2030, low carbon emission scenarios up to 2050, assessment on energy tax and fuel tax, potential for energy target in China, development of Integrated Policy Assessment model etc., He got his Ph.D in Social Engineering Department of Tokyo Institute of Technology.

Globally 2 degree target by 2100 was confirmed in the international negotiation process in recent years. The remained question is whether this target is feasible or not by thinking slow progress in last decades even though Kyoto Protocol set up targets by 2010. The IPCC called research teams on modeling to analyze the possible pathway, policies options, and cost benefit analysis for GHG mitigation. China's $CO_2$ emission from energy and cement process already accounts for nearly 24% of global emission, and the trend is expected to keep increasing. The role of China in the global GHG mitigation is crucial. This paper presents the scenario analysis for China's Energy System in the background of global 2 degree target, and discussed the feasibility for the lower $CO_2$ emission scenario in China. The finding says it is possible for China to limit $CO_2$ emission, reach emission peak before 2025, which make the global 2 degree target feasible, in Which energy system development is a key. And recent progress of key technologies, availability for further investment on low carbon, policy implementation make it much big possibility for China to go to low carbon emission development pathway.

Previous studies on emission scenario shows that it is possible for China to peak $CO_2$ emission by 2030 if strong policies are adopted, and with a relatively high cost. Peaking $CO_2$ emission before 2025 is a very big challenge for China. Modeling study by IPAC on the 2 degree target said it is also still possible for China to peak $CO_2$ emission before 2025, but several pre-condition are needed, including optimazing economy development, further energy efficiency improvement, enhanced renewable energy and nuclear development, CCS etc.

Rapid increase of energy intensive products output in last several years is major driving force for fast energy demand growth. Energy intensive industry consumed more then 50% of energy in China, and accounts for more than 70% newly increased power output. Further trend of energy intensive industry is a key factor for energy and $CO_2$ emission in China. Development of energy intensive industry should be limited. The quick change in the pattern of economy development, means much high social energy conservation rate. Scenario analysis shows many energy intensive products outputs will reach peak before 2020, with a much slower growth rate compared with that in the 11th Five Year Plan, and therefore will significantly change the pathway for energy demand and $CO_2$ emission. This would happen ether through positive policy action to optimize economy structure change, or passively by market over supply, we saw output of many raw material and final consumption good are around half of global output. Rate for infrastructure increase is large enough to support economy development and residential demand in China even though high GDP growth rate, income increase rate and urbanization rate. Export was one of the major driving force

for energy increase, however we do see the large share of Chinese products in the global output, which shows limited space for further increase of the share.

Energy efficiency should be further promoted. During 11th Five Year plan, energy efficiency has been improved significantly. By reviewing what happened in energy efficiency in 11th Five Year Plan, comparing with energy conservation effort in last several decades, and effort in other countries, China now is making an unprecedented action on energy conservation. Energy conservation policy was set as one of national top policies. Energy intensity target was one of key indicator for local government official. Frequency of policy making on energy saving is extraordinary high, which could be seen from policies announced by national government from middle of 2006 to middle of 2008, with a rate one policy per week. A policy framework was well established in 11th Five Year Plan on energy conservation. Such kind of policy circumstance provide well basis for energy efficiency improvement in 12th Five Year Plan and after. Much more specified policy and action on energy efficiency could be implemented such as quick moved higher energy efficiency standard, market based mechanisms, higher building energy code etc. Target is to make China's energy efficiency in major sectors to be one of the best by 2050 to 2030.

China is a now a leading country in new energy and renewable energy. By 2011, installed wind power capacity is 62.7GW, with an increase of 18GW in 2011 which is two third of global newly installed capacity in 2011, and annual growth rate from 2008 to 2011 is higher than 60%. Based on the planning in China, by 2020 renewable energy will take 15% of total primary energy, which include renewable energy not included in national statistics of energy.
In the global 2 degree scenario, power generation from renewable energy could reach 48% of total power generation, leave only 17% for coal fired power generation. Installed capacity for wind solar and hydro is 930GW, 1040GW, 520GW respectively by 2050.

And another key factors is increasing of natural gas use in China. In the enhanced low carbon scenario, natural gas use will be 350BCM by 2030, and 450BCM by 2050. In the 2 degree scenario, natural gas would be around 480BCM by 2030, and 590BCM by 2050. Together with renewable energy, leave coal use in China by 2050 to be lower than 1billion ton.

For $CO_2$ emission, Carbon capture and storage could further contribute $CO_2$ emission reduction.China has to use CCS in the case of large amount of coal use for next several decades. Even with the enhanced low carbon scenario, there will be around 1.8 billion ton coal used by 2050. CCS is essential for China to go to deep cut after 2030. Even though CCS is not yet get into commercial market, and still high cost. However based on the study IPAC team involved for CCS implementation in China, in the Enhanced low carbon scenario(ELC) adopted CCS as one of key mitigation options.

Technology progress is a key assumption for low carbon future in China. The cost leaning curve for wind and solar and many other technologies is much stronger than model used. For example, cost for wind power generation has decrease more than 40% in last two years.. And now in the coastal area, power generation cost for some wind farm already can compete with coal fired power plants.

The progress for end use technologies also move faster than model assumption. Electric appliance such as LED TV, higher efficiency air conditioner, high efficiency car etc., already have higher penetration rate by 2011 then model assumed If policy is right, lower energy demand in the 2 degree scenario much feasible by 2020 and after.

In the meantime, rapid GDP growth rate provide strong support for low carbon development in China. In 11th Five Year Plan period(2006-2011), annual GDP growth rate is 11.2%. But it is 16.7% annual growth rate if calculated based on current value. It is expected by 2015, GDP in China could reach 75trillion Yuan(in current value. The investment need in all modeling study is much small compared with GDP, normally it is smaller than 2 to 4%. If think about the investment in China, new and renewable energy is one of key sector to be promoted in China inside government policies and planning, there could be much more investment on renewable energy in future, even though China already is the biggest country in the world for renewable energy investment in 2011.

It could be concluded there is big potential for China to go to low carbon future, and it is feasible for China to reach peak of $CO_2$ emission before 2025. Technology progress, large amount investment on renewable energy, strong policies with extension from that in 11th Five Year Plan, could provide key support factors.

# アジア低炭素社会シナリオの開発

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1997 年大阪大学大学院工学研究科博士後期課程修了。博士（工学）。
1998 年国立環境研究所入所。2006 年社会環境システム研究領域統合評価研究室長、2011 年より現職。2000 年より東京工業大学連携准教授。
統合評価モデルである AIM（Asia-Pacific Integrated Model）の開発に携わる。IPCC 第二作業部会第五次評価報告書執筆者。環境省中央環境審議会 2013 年以降の対策・施策に関する検討小委員会専門委員などもつとめる。

## 多様なアジアでどのように低炭素社会を実現するか？

環境省環境研究総合推進費 S-6（アジア低炭素社会に向けた中長期的政策オプションの立案・予測・評価手法の開発とその普及に関する総合的研究）では、2050 年の世界の温室効果ガス排出量を 1990 年比半減させることを目的として、今後の温室効果ガス排出量の伸びが大幅に予想されるアジアを対象に、どのような施策によって実現されるかについて、定量的、定性的に検討を行った。アジアは、経済発展の段階が異なるとともに、各国の気候や文化、社会も多様であり、さらに各国が抱える事情も異なるため、それぞれの国において導入される気候変動緩和策が異なることが予想される。このため、本プロジェクトでは、アジア主要国に焦点を当てた個別の分析と、世界全体から見た分析の両方から取り組んでおり、本報告は世界全体を対象とした分析の結果を示すものである。

昨年度までに、本プロジェクトでは、個々の研究成果をもとに、定性的な検討結果として「10 の方策」と呼ばれる個別対策を集約したものを報告してきた（表 1）。「10 の方策」では、個別の施策を列挙するだけではなく、個々の施策の実現や効果を高めるために、どのような準備が必要となるかといったロードマップの検討も行ってきた。本報告では、こうした「10 の方策」で提示された様々な対策を世界モデルに組みこむことで、温室効果ガス排出量がどの程度削減されるかを定量的に評価した結果を示す。

表 1　低炭素アジアの実現に向けた「10 の方策」

| | |
|---|---|
| 方策 1：階層的に連結されたコンパクトシティ【都市内交通】 | 方策 6：地域資源を余さず使う低炭素エネルギーシステム【エネルギーシステム】 |
| 方策 2：地域間鉄道・水運の主流化【地域間交通】 | 方策 7：低排出な農業技術の普及【農業・畜産】 |
| 方策 3：資源の価値を最大限に引き出すモノ使い【資源利用】 | 方策 8：持続可能な森林・土地利用管理【森林・土地利用】 |
| 方策 4：光と風を活かす省エネ涼空間【建築物】 | 方策 9：低炭素社会を実現する技術と資金【技術・資金】 |
| 方策 5：バイオマス資源の地産地消【バイオマス】 | 方策 10：透明で公正な低炭素アジアを支えるガバナンス【ガバナンス】 |

## 2050 年のアジア低炭素社会シナリオを描く

基準となる将来のシナリオは、本プロジェクトで検討してきた 2 つの社会像（Advanced Society と Conventional Society）のうち、Advanced Society を対象としている（表 2）。これらの将来シナリオと、10 の方策で示されたそれぞれの個別対策を、世界を 17 の国や地域に分割した多地域応用一般均衡モデル（アジアについては、日本、中国、インド、東南アジア・その他東アジア、その他アジア（主にインドを除く南アジア）太平洋の 5 地域で構成）に組みこむことで、低炭素社会が従来の発展の姿であるなりゆき社会からどのように転換するかを定量化した。分析に用いたモデルの詳細については、Fujimori et al.(2012) を参照のこと。

表２　将来シナリオの概要

| | Advanced Society Scenario | Conventional Society Scenario |
|---|---|---|
| 全体概要 | 次世代の社会システム、制度、技術等に向けて変革に意欲的・積極的に取り組む社会。 | 社会システム、制度、技術等の変化に慎重で、社会変革にかかるトランジションコストを気にかける社会。 |
| 経済 | 年平均成長率　：3.27%/ 年（世界） | 年平均成長率　：2.24%/ 年（世界） |
| | （2005 ～ 2050）：4.16%/ 年（アジア） | （2005 ～ 2050）：2.98%/ 年（アジア） |
| 人口 | 2050 年総人口　　：69 億人（世界）　46 億人（アジア） | |
| 教育 | 教育の改善に積極的 | 教育政策の標準的な改善 |
| | 平均教育年数：4-12 年（2005 年）→ 11-14 年（2050 年） | 平均教育年数：4-12 年（2005 年）→ 8-13 年（2050 年） |
| 時間の使い方 | 多様なライフスタイルが混在するが、仕事やキャリアアップに費やす時間が比較的長い | 多様なライフスタイルが混在するが、家族や友人との時間に費やす時間が比較的長い |
| 労働 | 失業率（2075 年に 0%を達成） | 2009 年レベルに固定 |
| 政府効率性 | 比較的早い段階から改善 | 徐々にゆるやかな速度で改善 |
| 国際協力 | 貿易障壁や海外直接投資リスクの低減 | アジア各国の協力関係はゆるやかに進む |
| 技術革新 | 高い改善率 | 緩やかな改善率 |
| 運輸 | 高い経済成長率に基づく需要増加 | 緩やかな需要増加 |
| 土地利用 | スピーディーで効率的に土地改良を実施 | 緩やかで、用心深く土地改良を実施 |

**アジア低炭素社会の姿**

図１に示すように、Advanced Society での 2050 年のなりゆき社会では、アジア地域からの温室効果ガス排出量は、32GtCO2eq と 2005 年の排出量の約２倍となる。低炭素社会では、2050 年の排出量は 10GtCO2eq で、なりゆき社会での排出量と比較して 69% の削減となる。2005 年と比較しても 38%の削減となっている。各方策による寄与は、方策６（エネルギーシステム）が最も多く、次いで方策３（資源利用）となっている。一次エネルギー供給の構成を図２に示す。なりゆき社会のアジア全域では、2050 年に一次エネルギーの 87% を化石燃料が占めているが、低炭素社会では、化石燃料のシェアは 54% に低下し、代わって再生可能エネルギーのシェアが 33% を占めるようになる。また、化石燃料も CCS（炭素隔離貯留）によって一部は除去される。このほか、各方策で示した輸送量の大幅な削減や需要側の省エネ対策、農業土地利用における対策等の導入によって、図 1 のような排出経路は実現できる。なお、2050 年時点の温室効果ガス排出削減の限界費用は 344 ドル /tCO2eq である。各方策による効果の詳細については、冊子「アジア低炭素社会の実現に向けて－10 の方策によりアジアはどう変化するか－」を参照のこと。

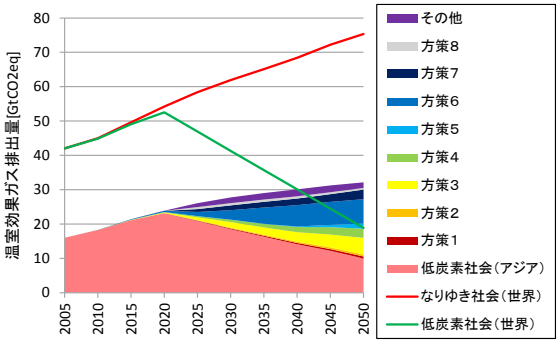


図１　温室効果ガス排出量の推移

このように、アジア低炭素社会の実現に向けた道筋は具体的に描けるようになった。今後はそれをどう実現していくかが課題である。幸い、アジア各国では温室効果ガス排出量の削減に貢献する様々な動きが自立的に芽生えている。こうした動きを大切にしながら、低炭素社会の実現に向けた取り組みを支援することが重要となる。

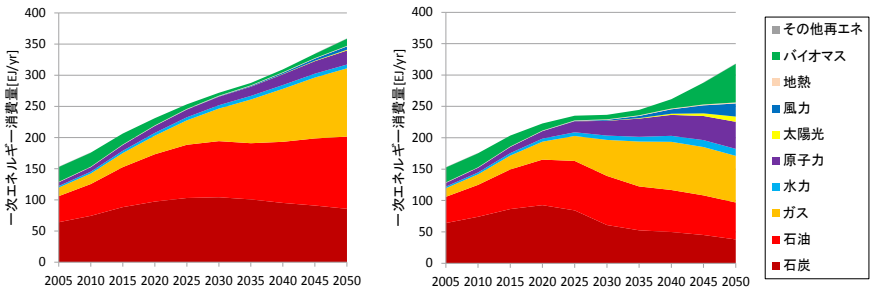


図２　アジアにおける一次エネルギー供給の推移（左：なりゆき社会、右：低炭素社会）

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Fujimori, S., T. Masui and Y. Matsuoka (2012): AIM/CGE [basic] manual, Discussion paper series, Center for Social and Environmental Systems Research, NIES (http://www.nies.go.jp/social/dp/pdf/2012-01.pdf)

本テーマは、国立環境研究所、京都大学、みずほ情報総研株式会社、日本エネルギー経済研究所、地球環境戦略研究機関、広島大学の６つのチームから構成される。

# アジア低炭素社会実現に向けてのアプローチ

京都大学大学院 工学研究科都市環境工学専攻　教授
**松岡　譲**

京都大学大学院工学研究科都市環境工学専攻環境システム工学講座。1950 年生まれ。京都大学大学院工学研究科衛生工学専攻修士課程修了、工学博士。京都大学助手、講師、助教授から、名古屋大学教授を経て、1998 年から現職。専門は、地球環境モデリング。地球環境問題の統合評価モデルの一つである AIM（Asia Pacific Integrated Assessment Model、アジア太平洋地域環境統合評価モデル）の開発などを行ってきた。

低炭素社会は、社会の持続可能性を支える重要な要素の一つである。本講演では、我々がアジア諸国において低炭素社会に向け努力してきた試みを中心に、低炭素社会の実現に向け、それをどのようにデザインするのか、またそこに至るロードマップをどのように描いたらよいかについて、方法論的側面、および、実装的側面から論じる。

低炭素社会開発をデザインするには、社会・経済・技術に関するミクロ的側面のみならずマクロ的側面を一連のメカニズムととらえ、それをベースとした低炭素社会促進に関わる広範囲の政策の解析とその評価が不可欠となる。我々は、ここ十数年にわたり、こうした作業に必要となる解析モデル群を開発するとともに、それらを主要なツールとし、アジア地域を対象に現地調査・研究機関と協働し、国レベルあるいは地域レベルの低炭素社会シナリオを提案してきた。下図は、現在までに、こうした協働作業の対象となった地域であり、8 ヶ国（国全域計画）、12 地域（地域計画）に及んでいる。

本講演の後半は、これらの経験を紹介するとともに、こうした試みを汎アジア的な潮流とするには、今後どのようなことをすべきかについて論じる。


図：現在までに、現地の調査研究機関と共同し LCS シナリオ開発作業を実施した地域は、８ヶ国（国全域計画）、12 地域（地域計画）に及ぶ

# 開会挨拶

## 関 荘一郎

環境省　地球環境局長

1978 年　東京大学工学部卒業。
1978 年　環境庁に入省し、大気保全局、水質保全局、環境保健部で環境汚染対策を担当。
1986 年　2 年間タイ政府環境庁に環境アドバイザーとして勤務。
1988 年　環境庁に復帰し官房国際課で開発途上国を担当。
1989 年　横浜市役所環境保全局出向等
1997 年　環境庁地球環境部調整官として COP3 及び地球温暖化対策推進法の制定を担当。
1998 年　3 年間世界銀行に出向しアジア太平洋局環境社会開発部門上級環境技術専門官として、主に中国への融資を担当。
2001 年　環境省に復帰し、環境管理局ダイオキシン対策室長。
2003 年　環境管理局大気環境課長。
2005 年　廃棄物・リサイクル対策部産業廃棄物課長。
2006 年　廃棄物対策課長。
2008 年　財務省へ出向し長崎税関長。
2010 年　環境省水環境担当審議官。
2012 年　環境省放射性物質汚染担当審議官。
2012 年 9 月より現職。

これまで、地球環境保全、大気・水環境、廃棄物対策などを中心に幅広く国内外の環境行政のポストを歴任した経験を基に地球環境保全に関する環境行政を推進している。

## 住 明正

国立環境研究所　理事長

1948 年生まれ。
1973 年　東京大学大学院理学研究科物理学専攻修士課程終了。
1985 年　理学博士（東京大学）。
1973 年　気象庁入庁。1985 年までの気象庁在職中、1979 年～ 1981 年ハワイ大気象学教室助手を務める。
1985 年　東京大学理学部地球物理学教室助教授。
1991 年　気候システム研究センター教授、気候システム研究センターセンター長、サステイナビリティ学連携研究機構地球持続戦略研究イニシアティブ統括ディレクターを務める。
2012 年 10 月より国立環境研究所理事。
2013 年 4 月より現職。東京大学名誉教授。

1983 年、日本気象学会山本賞「冬季モンスーンの大規模な特徴の研究」、1994 年、日本気象学会藤原賞「熱帯大気・海洋系の相互作用の研究」、2005 年、日経地球環境技術賞を受賞。

主な著作：エルニーニョと地球温暖化、オーム社、116（2003 年）、さらに進む地球温暖化（ウエッジ選書）（2007 年）、気候変動がわかる気象学、やりなおしサイエンス講座 5、NTT 出版（2008 年）
主な共著書：地球史が語る近未来の環境、第 4 章　気候の近未来予測、東大出版社、81-98（2007 年）、サステイナブルな地球温暖化対策を目指して（三村信男と共著）、サステイナビリティ学への挑戦、岩波書店（2007 年）、温室効果ガス貯留・固定と社会システム、コロナ社（2009 年）、気候変動と低炭素社会、サステイナビリティ学、第 2 巻、東京大学出版会（2010 年）。

# セッション１：座長・コメンテーター

## 蟹江 憲史

東京工業大学大学院社会理工学研究科
価値システム専攻准教授
国連大学高等研究シニアリサーチフェロー
（S-6-3 チームリーダー）

北九州市立大学助教授を経て現職。OECD 気候変動・投資・開発作業部会議長、World Economic Forum World Economic Forum Global Agenda Council 委員、Earth System Governance プロジェクト科学諮問委員などを兼任、欧州委員会 Marie Curie Incoming International Fellow 及びパリ政治学院客員教授（2009-2010）などを歴任。専門は国際関係論、地球環境政治。特に、気候変動やアジアにおける越境大気汚染に関する国際制度研究に重点を置き、2013 年度からは環境省環境研究総合推進費戦略研究プロジェクト S-11（持続可能な開発目標とガバナンスに関する研究プロジェクト）プロジェクトリーダー。近著に N. Kanie, P. M. Haas, S. Andresen, 他，“Green Pluralism: Lessons for Improved Environmental Governance in the 21st Century” Environment: Science and Policy for Sustainable Development, Volume 55, Issue 5, 2013, pp.14-30、Norichika Kanie, Michele M. Betsill, Ruben Zondervan, Frank Biermann and Oran R. Young, 2012, "A Charter Moment: Restructuring Governance for Sustainability",Public and Administration and Development, 32, PP. 292-304 など多数。

S-6-3 は、東京工業大学、NIES、関西大学、早稲田大学、国連大学高等研究所の５つのチームから構成される。

## 河合 正弘

アジア開発銀行研究所所長

1971 年東京大学経済学部卒業。1978 年米スタンフォード大学経済学博士号取得。
米ジョンズホプキンス大学や東京大学で教鞭をとる。その間、世界銀行東アジア局チーフエコノミスト、財務省副財務官、同財務総合研究所長を務める。2005 年からアジア開発銀行総裁の特別顧問として地域経済統合を担当後、2007 年より現職。国際経済・通貨・金融問題やアジア地域経済統合など著書多数。

主な編著書：Asian Regionalism in the World Economy: Engine for Dynamism and Stability (Edward Elgar, 2010); Asia's Free Trade Agreements: How Is Business Responding? (Edward Elgar, 2011); Asia and Policymaking for the Global Economy (Brookings Institution Press, 2011); Monetary and Currency Policy Management in Asia (Edward Elgar, 2012)

## 廣野 良吉

成蹊大学名誉教授
公益在団法人地球環境戦略研究機関参与

1954-1959 年　米国シカゴ大学大学院経済学研究科
1959-1960 年　米国カリフォルニア大学産業関係研究所助手
1960-1961 年　日本能率協会産業研究所エコノミスト
1961-1998 年　成蹊大学政治経済学部専任講師、助教授、経済学部教授、定年退職
1998-2011 年　埼玉大学政策科学研究科、国立政策研究大学院大学客員教授。

専門分野：開発経済学 / 環境経済学 / 国際開発協力論。
国内では、経済審議会、対外経済協力審議会、林政審議会、中央環境審議会、ＯＤＡ懇談会等委員を務めると同時に、海外ではアジア、アフリカ、大洋州、欧米諸国の主要な大学院で開発経済学の教育・研究に従事すると共に、アジア開発銀行、世界銀行、経済開発協力機構、国連開発計画等、多くの国際機関で上級管理職を務めた。現在国内外多くの研究機関、財団法人で理事、評議員を務める。

## Werner Rothengatter

カールスルーエ工科大学名誉教授
世界交通学会（WCTRS）前会長

Werner Rothengatter graduated from Business Engineering at Universität Karlsruhe in 1969. While as a Researcher and Research Assistant at the Institute for Economic Policy Research 1970-1978, he earned the PhD in 1972 and the Habilitation in 1978, both in Economics. He worked as a Professor for Economic Theory at Universität Kiel (1979), Professor for Economic Theory and Policy at Universität Ulm (1979-1986), as a Visiting Professor at Vanderbilt University, Nashville, Tennessee (1982), as Head of the Transport Division at the German Institute for Economic Research (DIW), Berlin (1986-1989), and received a call to the Universität Münster, Institute for Transportation Science (1989). Since 1990, he worked as Professor at Universität of Karlsruhe (now the Karlsruhe Institute of Technology (KIT)), Dean of the Faculty of Economics (2003-2004) and Head of the Institute of Economic Policy Research and its Unit of Transport and Communication. Since April 2009 he has retired from University obligations. He retired as well from the Scientific Advisory Committee of the German Ministry of Transport, Construction and Urban Development, which he chaired from 2001 to 2002. In 2010 he was honored with the Francqui-Chair for Logistics at the University of Antwerp and in 2013 with the Jules Dupuit Prize of the WCTRS. He is member of the Advisory Committee of Deutsche Bahn AG and a member of the Reform Commission for Large Projects of the German Ministry of Transport, Construction and Urban Development. He was President of World Conference on Transport Research Society (2001-2007) and is still a member of its Steering Committee. He is a member of the Editorial Advisory Board of the Transport Policy Journal (published by Elsevier) and Editor of the Springer Series on Transport Economics and Policy (together with D. Gillen).

（注）Heinz Schandl 氏については、P.6 参照。

# セッション２：座長・コメンテーター

## 甲斐沼 美紀子

国立環境研究所社会環境
システム研究センターフェロー

1975 年京都大学大学院工学研究科修士課程（数理工学専攻）修了。工学博士。
1977 年より国立公害研究所（現（独）国立環境研究所）に勤務。1990 年より温暖化の研究に従事。温暖化対策を評価するアジア太平洋統合評価モデルの開発に取り組む。現在、国立環境研究所フェロー。2003 年より北陸先端科学技術大学院大学　客員教授。
1994 年日経地球環境技術大賞、2010 年科学技術政策研究所より、科学技術への顕著な貢献 2010（ナイステップな研究者）に選定される。
2011 年環境科学会学術賞を受賞。
環境経済・政策学会会員。
IPCC 第４次評価報告書および第５次評価報告書の主執筆者（第３ワーキンググループ：緩和策）
主な編著書：「Climate Policy Assessment」Springer, 2003

## 李 志東

長岡技術科学大学経営情報系教授

1983 年、中国人民大学を卒業。1990 年に京都大学で経済学の博士号を取得し、日本エネルギー経済研究所研究員、主任研究員、長岡技術科学大学助教授、准教授を経て、2007 年から現職、兼日本エネルギー経済研究所客員研究員、中国発展改革委員会能源（エネルギー）研究所客員研究員、朝日新聞アジアネットワークフェロー。
専門はエネルギー経済学、環境経済学、計量経済学。
著作に、①李志東『中国の環境保護システム』東洋経済新報社、1999 年４月；②李志東他（共著）『中国能源・環境研究文集』中国環境科学出版社、2000 年５月；③薬師寺泰蔵編『アジアの環境文化』慶応大学出版会、1999 年 12 月；④佐和隆光編著『21 世紀の問題群：持続可能な発展への途』新曜社、2000 年３月；⑤Takamitsu Sawa (Ed.), International Frameworks and Technological Strategies to Prevent Climate Change, Springer、2003 年１月；　⑥ Francois Godement, Francoise Nicolas, Taizo Yakushiji, Asia and Europe Cooperating for Energy Security, Brooking Institution Press、2004 年６月；⑦田辺靖雄『アジアエネルギーパートナーシップ』エネルギーフォーラム、2004 年 12 月；⑧Li Zhidong, Dai Yande, Kokichi Ito, Zhang Aling, China's Sustainable Energy Strategies in The 21st Century, edited as the Special Issue of the International Journal of Global Energy Issues, Vol.24, Nos.3/4, 2005；⑨進藤榮一・平川均『東アジア共同体を設計する』日本経済評論社、2006 年６月；⑩北川秀樹『中国の環境問題と法・政策』法律文化社、2008 年３月；⑪Li ZhiDong, Jun Fujimoto, Yasushi Umeda, Zhang Aling, Eco-design of Multilateral Recycling Systems and Development of Circulating Economy in Asia, edited as the Special Issue of the International Journal of Environmental Technology and Management, Vol.11, No.4,2009；⑫薛進軍・他『低炭経済藍皮書：中国低炭経済発展報告 2010』（中国）社会科学文献出版社、2011/3；⑬渡辺利夫・21 世紀政策研究所監修 / 朱炎編『中国経済の成長持続性：促進要因と抑制要因の分析』勁草書房、2011/7；⑭青木玲子・浅子和美『効率と公正の経済分析：企業・開発・環境』ミネルヴァ書房、2012/3；⑮真家陽一編著『中国経済の実像とゆくえ』ジェトロ、2012/6；及び論文等多数。

## 亀山 康子

国立環境研究所
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持続可能社会システム研究室室長

1990 年東京大学教養学部卒。1992 年４月より国立環境研究所研究員、2011 年４月より現職。2006 年より東京大学大学院新領域創成科学研究科環境学研究系連携講座を併任、2011 年より客員教授。専門は国際関係論。主な研究テーマは、気候変動に対する国際協調の可能性に関する研究、及び、持続可能な発展の計測を目指した指標に関する研究。2005 年より日本学術会議連携会員。2008~2012 年度に中央環境審議会地球環境部会臨時委員。主な著書として、亀山康子・高村ゆかり編（2011）『気候変動の国際制度：京都議定書の行方』慈学社出版；亀山康子（2010）『新・地球環境政策』昭和堂等多数。

## 西岡 秀三

地球環境戦略研究機関研究顧問

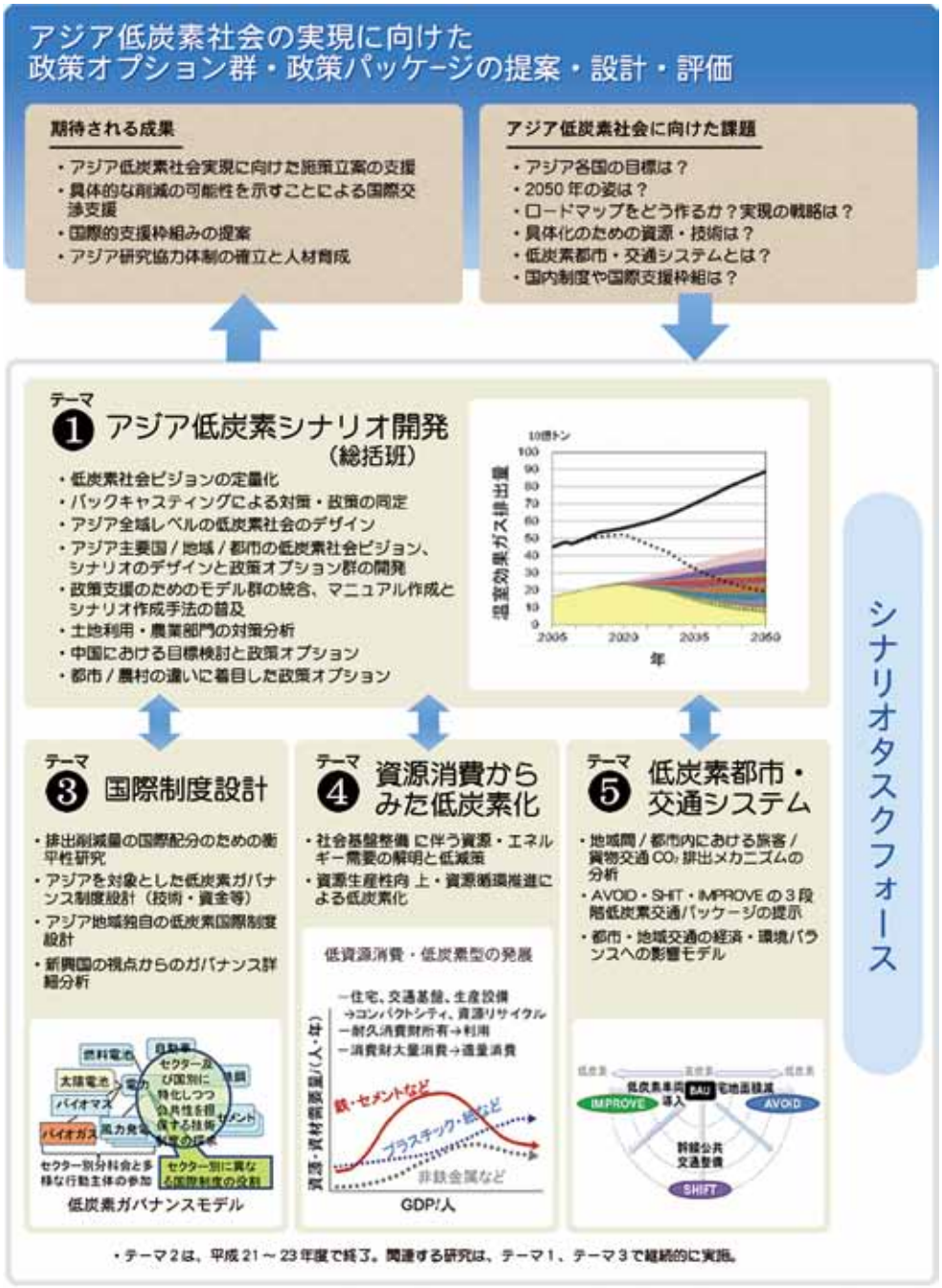
東京大学工学部機械工学科卒、同大学院工学系研究科博士課程修了。工学博士。
旭化成工業・国立環境研究所勤務、東工大及び慶応大学大学院教授、国立環境研究所理事を歴任。1980 年代より IPCC 活動などを通じて温暖化影響評価、抑制策研究に取り組み、現在は先進国及びアジア諸国との低炭素社会研究国際ネットワーク事務局長として、科学的政策立案に努力。2012 年の革新的エネルギー・環境戦略策定において中央環境審議会での日本低炭素シナリオ作成小委員会委員長。
近著：「低炭素社会のデザイン」岩波新書　2011

（注）Kejun Jiang 氏については、P.12 参照。

# アジア低炭素社会研究プロジェクト（S-6）について

| | 研究テーマ | メンバー機関 |
|---|---|---|
| テーマ１ | S-6-1 アジアを対象とした低炭素社会実現のためのシナリオ開発 | NIES、京都大学、みずほ情報総研株式会社、日本エネルギー経済研究所、地球環境戦略研究機関、広島大学 |
| テーマ３ | S-6-3 低炭素アジア実現へ向けた中長期的国際制度設計オプションとその形成過程の研究 | 東京工業大学、NIES、関西大学、早稲田大学、国連大学高等研究所 |
| テーマ４ | S-6-4 循環資源・資源生産性の向上による低炭素社会構築に関する研究 | 東京大学、立命館大学、みずほ情報総研株式会社、NIES、名古屋大学 |
| テーマ５ | S-6-5 アジアにおける低炭素都市・交通システム実現方策に関する研究 | 名古屋大学、日本大学、東京工業大学、横浜国立大学、南山大学 |

（注） S-6-2　アジアの低炭素発展の可能性」は平成 21 年度～ 23 年度で終了。関連する研究は、テーマ 1、テーマ 3 で継続的に実施。



# Challenges to Low Carbon Asia

## Can Asia change the world through leapfrogging?

**Date** October 17, 2013

**Venue** U Thant International Conference Hall,
United Nations University,Tokyo

**Organized by**

**Ministry of the Environment, Japan (MOEJ)**

Low Carbon Asia Research Project (S-6)
supported by Environment Research and Technology Development Fund

**National Institute for Environmental Studies (NIES)**

**Co-organized by**

School of Engineering, The University of Tokyo
Tokyo Institute of Technology
Graduate School of Environmental Studies, Nagoya University

## Background and Purpose of the Symposium

The aftermath of the economic recession, instability in employment, political instability in the Middle East, and a widening gap between the rich and the poor pose many challenges. These uncertainties combine with the availability of new sources of energy, such as shale gas, and the impacts of the nuclear accident at Fukushima. At the same time, measures to address climate change have become increasingly urgent as a result of intensifying concerns about extreme weather events and the medium- to long-term impacts of climate change. At the COP16 meeting held in Cancún in 2010, it was agreed that future global warming should be limited to below 2.0 ℃ relative to the pre-industrial level. The meeting explicitly referred to the importance of a paradigm shift towards building a low-carbon society that offers substantial opportunities and ensures continued high growth and sustainable development.

What kinds of initiatives are needed in order to make the low-carbon society a reality? At the Low Carbon Asia Research Project (S-6) funded by the Environment Research and Technology Development Fund of the Ministry of the Environment, Japan, we have been focusing on the continuously growing Asian region, and exploring how the path of energy- and resources-intensive development can be avoided, and how the region can move to a low-carbon emission and low-consumption society while at the same time improving people's lifestyles through development. As concretemeasures towards the achievement of a low-carbon society, we have suggested (1) improving resource productivity and cutting the consumption of resources themselves, (2) building transport systems that emit less $CO_2$, (3) working on the development and dissemination of sustainable energy systems, and other measures. We have conducted researches on what we can do to realize these ideas, and considered what would be needed in terms of technology, financing and governance systems.

Combining these elements, we have jointly developed with researchers and policy makers in various nations a set of ten actions and roadmaps to meet the 2℃ target and illustrated that it would be possible to realize the low-carbon society in Asia. This symposium presents the research outputs over the past five years and two lectures from overseas experts followed by discussions on LCS challenges.

Low Carbon Asia Research Project (S-6)
http://2050.nies.go.jp/

# Program

| | |
|---|---|
| 13:00 -13:10 | **Opening Remarks**<br>Soichiro Seki<br>Director General, Global Environment Bureau, Ministry of the Environment, Japan<br>Akimasa Sumi<br>President, National Institute for Environmental Studies (NIES) |
| 13:10 -13:25 | **Progress of Low Carbon Asia Research Project**<br>Mikiko Kainuma, NIES |
| 13:25 -13:45 | **Keynote Speech1**<br>**Measuring Progress towards Green Growth and Low Carbon Development in Asia**<br>Heinz Schandl, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia |
| 13:45 -15:00 | **Session1 : Low Carbon Resource Management and Transport Systems**<br>【Chair】 Norichika Kanie, Tokyo Institute of Technology<br>**Presentation 1 Resource Productivity toward Low Carbon Society**<br>Yuichi Moriguchi, the University of Tokyo<br>**Presentation 2 Strategies and Instruments for Low Carbon Transport Sysmtes in Asia**<br>Yoshitsugu Hayashi, Nagoya University<br>【Commentators】<br>Ryokichi Hirono, Seikei Universty<br>Masahiro Kawai, Asian Development Bank Institute<br>Werner Rothengatter, Karlsruhe Institute of Technology, Germany<br>Heinz Schandl, CSIRO, Australia |
| 15:00 -15:20 | Break |
| 15:20 -15:40 | **Keynote Speech2**<br>**Energy Transition in China towards 2℃ Global Target**<br>Kejun Jiang, Energy Research Institute (ERI), National Development and Reform Commission, China |
| 15:40 -16:55 | **Session2 : Asia Low Carbon Society Scenario**<br>【Chair】 Mikiko Kainuma, NIES<br>**Presentation 1 Asia Low Carbon Society Scenario Development**<br>Toshihiko Masui, NIES<br>**Presentation 2 Research Activities for Realizing Low Carbon Societies in Asia**<br>Yuzuru Matsuoka, Kyoto University<br>【Commentators】<br>Kejun Jiang, ERI, China<br>Yasuko Kameyama, NIES<br>Li Zhidong, Nagaoka University of Technology<br>Shuzo Nishioka, Institute for Global Environmental Strategies |
| 16:55-17:00 | **Closing Remarks** |

# Progress of Low Carbon Asia Research Project

**Mikiko Kainuma**
Fellow Center for Social and Environmental Systems Research
National Institute for Environmental Studies (NIES), Japan

Dr. Kainuma received her B.S., M.S., and Ph.D. degrees in Applied Mathematics and Physics from Kyoto University in Kyoto, Japan.
She joined NIES in 1977, and has, since 1990, been engaged with the development of the Asia-Pacific Integrated Model (AIM), which assesses policy options for stabilizing the global climate, particularly in the Asian-Pacific region, with the objectives of reducing greenhouse gas emissions and preventing and mitigating the impacts of climate change. From 2006 to March 2011, she was head of the Climate Policy Assessment Research Section at the Center for Global Environmental Research at NIES. Currently she is a Fellow at the Center for Social and Environmental Systems Research in NIES, and serves as an adjunct professor at Japan Advanced Institute of Science and Technology.
She is a Lead Author of the Intergovernmental Panel on Climate Change (IPCC) Fourth and Fifth Assessment Report (Working Group III: Mitigation of Climate Change).

<Awards>
2011 Academic Award by the Society of Environmental Science, Japan
2010 Remarkable Contribution to Science and Technology 2010:NIce STEP Scientists by the National Institute of Science and Technology Policy (NISTEP)
1994 Nikkei Global Environmental Technology Award
<Publication> "Climate Policy Assessment", Springer, 2003

Greenhouse gas (GHG) emissions from the Asian region accounted for approximately 36% of global emissions in 2005. Considering the rapid economic growth expected in the coming decades, the share of emissions from the Asian region is projected to rise even further if efforts are not made toward Low Carbon Societies (LCSs). The reduction of emissions in Asia is imperative for the transition by 2050 to LCS worldwide that has halved GHG emissions. Furthermore, taking measures toward the realization of an LCS may also lead to the resolving of other challenges such as improving energy access, reducing local pollution, and eradicating poverty.

LCS transition by Asia is not an easy task. In order to realize the transition, it is vital that stakeholders including central and local governments, private-sector enterprises, NGOs and NPOs, citizens and the international community, tackle this with a fixed vision from a long-term perspective of the society they wish to achieve, while cooperating with each otherand being aware of the roles they need to play. Depending on the country or region in Asia, the level of development, amount of resources, territorial area, culture and other factors differ. Therefore, the actions that are effective may vary accordingly.

The aim of this project is to provide policy options and roadmaps for each country and region so as to help it develop effective leapfrogging strategies to realize an LCS.

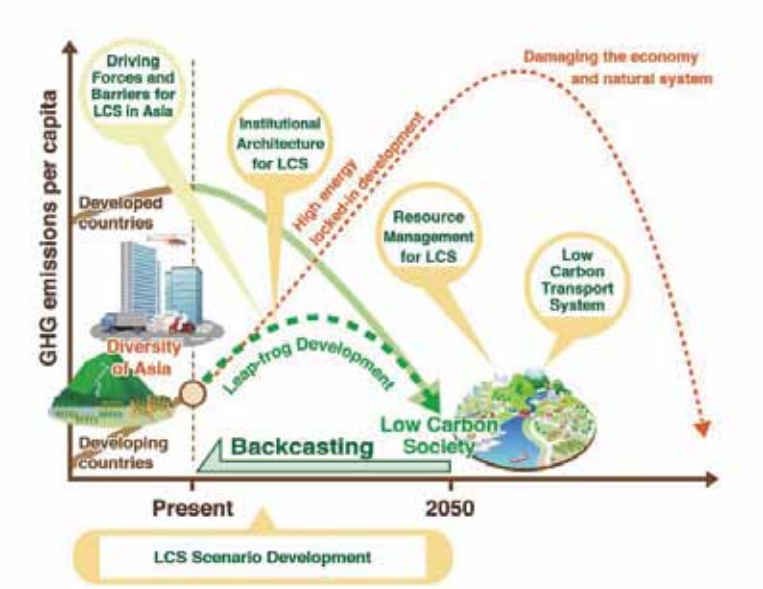
**Main results of this project:**

- A family of scenario development models and tools has been developed to analyze policy options to reduce GHG emissions.

- These models and tools have been applied to various countries and regions such as China, India, Indonesia, Thailand, Ahmedabad city in India, Guang Zhou city in China, and Gyeonggi Province in Korea, and have shown the feasibility of significant GHG emission reductions.
- Ten actions have been proposed to provide guideline to plan and implement the strategies for an LCS in Asia. These actions focus on urban transport, interregional transport, resource and materials, buildings, biomass, energy system, agriculture and livestock, forestry and land use, technology and finance, and governance.The roadmaps to implement these actions are presented and contribution of these actions to GHG emission reductions has been quantified.
- Three main actions proposed to achieve low-carbon urban transport are: compact cities with well-connected hierarchical urban centers, a seamless and hierarchical transport system, and low carbon vehicles. Three main actions to achieve low-carbon interregional transport are: spatial development driven by a low carbon interregional transport system, a rail/water-oriented intermodal passenger/ freight transport system, and low carbon automobile/airplane technologies. The roadmaps to achieve theseactions have also been detailed.
- Three main actions proposed in the domain of sustainable resource use are: production that drastically reduces the use of resources, use of products in ways that extend their lifespan, and development of systems for the reuse of resources.The corresponding roadmaps have been outlined.
- Institutions and governance need to function effectively to implement the proposed actions by utilizing physical, economic and human resources. Transparent and fair governance that supports low carbon Asia is proposed to support their implementation.

**Future Task**

The project has proposed actions and roadmaps to realize LCSs. Many of these actions are in the nature of leapfrogging.However, the practicalimplementation of the actions depends on a number of more specific conditions: sufficient financemust be mobilized; behavioural, institutional and other barriers to the adoption of low-carbon technologiesmust be overcome;and patterns of international, national, and sub-nationalcooperation must be established. Establishment of an education system to enhance understanding of the necessity of LCSis also a challenge to realize LCSs.



# Measuring Progress towards Green Growth and Low Carbon Development in Asia

Heinz Schandl
the Commonwealth Scientific and Industrial Research Organisation (CSIRO), Australia

Prof Heinz Schandl holds a PhD in sociology and is an expert for environmental reporting, natural resource management, resource efficiency and sustainable consumption and production. His research links social theory, social metabolism and public policy. He leads CSIRO's research capability in SCP and the Green Economy, is lead-author of a report on Resource Efficiency: Economics and Outlook in Asia and the Pacific commissioned by the UNEP Office in Bangkok and has been a consultant for the OECD, the World Bank and the Asian Development Bank for sustainable natural resource use and green economy. He is an adjunct Professor at the Australian National University School of Sociology and a permanent visiting Prof at the Institute of Environmental Studies at Nagoya University. He is a member of UNEP's International Resource Panel, a council member of the International Society of Industrial Ecology (ISIE), chair of the Socio-Economic Metabolism section of the ISIE, editor of the Journal of Industrial Ecology and editorial board member for the Journal of Material Cycles and waste Management. He has extensive experience in science and project leadership and in providing research that informs public policy in the domain of sustainable natural resource use and sustainable development.

At the start of the 21st century, Asian economies are facing a changing economic context of rising and more volatile natural resource prices. Pressure points of climate change, food and water security and supply security for key natural resources including fossil fuels and metals are converging in an unprecedented matter. The future prosperity and competitiveness of the Asia-Pacific region will depend on well designed policies that guide a transition to sustainable consumption and production (SCP) to allow for resource efficient, low carbon and inclusive growth in the region.

SCP and the green economy are policy domains characterised by complexity, contestation, and uncertainty and will rely, in order to be effective and efficient, on the best available scientific evidence about the quantity of natural resource and emissions that are fuelling economic growth and human development in Asia and the Pacific. Such information will be required to inform the public and policy debate, to help set targets for resource efficiency and emissions intensity and to measure progress towards achieving inclusive green growth.

Over the last decade, the international research community jointly with the United Nations Environment Program (UNEP) and the Organisation of Economic Cooperation and Development (OECD) have developed a comprehensive knowledge base about the amount of natural resources that were used globally and in the Asia-Pacific region and the amount of waste and emissions that have been the backbone of economic and human development. Based on a comprehensive and robust historical record about the relationship of economic growth, resource use and emissions scenarios of future natural resource demands can be established.

In this talk the recent history of economic development, natural resource use and emissions will be reviewed and scenarios about future demands will be presented. We will compare global trends with

trends in the Asia-Pacific region and will discuss trends of important countries including Japan, China and Australia.

During the last four decades, most of the growth in global resource use and emissions has come from the Asia-Pacific region which has now become the largest user of natural resources globally. The resource base has shifted from mainly biomass in the 1970's to a mineral resource base of fossil fuels, metals and construction materials. The main driver of growing resource use and emissions has been consumption with population growth becoming less important. The region has increasingly become a net importer of natural resources which exposes regional growth to the volatility of global natural resource prices. Most importantly, the efficiency at which natural resource have been used in the Asia-Pacific region have been declining since the turn of the century caused by a shift in production form more efficient economies (such as Japan and South Korea) to less efficient ones (such as China and India).

Taking a footprint perspective on natural resource use allows us to attribute material use to final consumption in countries and provides us with an additional perspective about the relationship of economic development and resource use. From a material footprint perspective the landing point for natural resource use based on current modes of consumption and production lies between 25tonnes per capita (such as in Japan) and 35tonnes per-capita (such as in Australia). Multiplied by 9 billion people who will live on the planet this would amount to 270 billion tonnes of natural resources globally or 4 times the level of today leading to unprecedented environmental impacts such as accelerating climate change, depletion of some natural resources, increased degradation of soils and water bodies and fast growing air pollution.

Scenarios will be presented that show the impact of a global carbon price of between 25$-50$ per tonne and large investment into resource efficient technologies can assist a transition to a green economy in Asia and the Pacific and globally without damaging economic growth or employment. The empirical data presented shows that shifting investment from brown to green sectors and activities and supported by appropriate macroeconomic settings (such as a green budget and tax reform and carbon pricing) will be instrumental for the resilience of economic and human development of Asia and the Pacific in the 21th century.

# Resource Productivity toward Low Carbon Society

Yuichi Moriguchi
Professor, Department of Urban Engineering, The University of Tokyo

Mr. Yuichi Moriguchi is currently a professor at the Department of Urban Engineering, Graduate School of Engineering, The University of Tokyo. He holds Dr. Eng., graduated from the Faculty of Engineering at Kyoto University and joined the National Institute for Environmental Studies (NIES) in 1982. He was engaged in environmental research at NIES until 2011, where he was appointed to the Director of the Research Center for Material Cycles and Waste Management for 2005-2011. His research field covers GHG emission inventory and mitigation strategy, Material Flow and Stock Analysis, Life Cycle Assessment, 3R policy analysis. In his early career, he had also worked for the Environment Agency of Japan and for the OECD Environment Directorate in Paris. He is one of the inaugural members of the UNEP International Resource Panel since 2007 and he had been elected to the chairperson of the Working Group on Environmental Information and Outlooks of the OECD for 2003-2008. He was awarded the 2013 Society Prize of International Society for Industrial Ecology.

## 1.Introduction – Decoupling and resource productivity

Modern society is dependent on massive consumption of natural resources. Transition from a society characterized by mass-production, mass-consumption, mass-disposal to a sound material-cycle society has been proposed in Japan mainly in the context of waste and resource issues, and this shift is also crucial for reduction of energy consumption and GHG emissions. While reduction of carbon emission to mitigate climate change is the main target of low carbon society, this issue can also be discussed in the context of sustainable use of natural resources, as the fossil fuel are the main source of carbon emission and they are typical non-renewable resources. The International Resource Panel (IRP) published a report on “Decoupling” [1)] in 2011, to propose humanity should and can decouple the increase of resource consumption and environmental burdens from economic growth. Resource productivity is another key concept, closely linked with decoupling, to produce as much value as possible from a unit of material resource. This lecture will discuss possible pathways to low carbon society (LCS) from the perspective of resource productivity.

## 2.The role of resources management subproject in the LCS Asia project

S-6-4 subproject has been investigating a LCS from the perspective on resource consumption, as a part of S-6 project for LCS in Asia towards halving global GHG emissions until 2050.

Combustion of fossil fuels and consumption of limestone for cement production are resource consumption with direct carbon emissions. Raw materials to support the basis of industrialized and urbanized society accompany carbon emission through energy consumption in their production stage. Steel is a typical case, and in particular in the stage of rapid economic growth, large amount of such carbon-intensive materials are produced and consumed. Buildings and civil infrastructures are coupled with carbon emissions through intensive uses of steel and cement in construction stage, as well as

through energy consumption in their operation stage. In addition, they are the source of secondary resources in the future. Our research team has adopted system analysis approach to relate stocks and flows of materials, circulative and efficient use of resources, and associated energy consumption and GHG emission associated. Our research target includes less durable materials such as paper, of which consumption is often correlated with economic growth.

On the other hand, we have also dealt with scarce resources, which are used for low carbon technologies such as photovoltaic and hybrid vehicle. Our role is to propose appropriate responses to possible challenges in supply side, which mighty be caused by increasing demand from wide spread of these technologies.

Out of Ten Actions toward Low Carbon Asia, compiled by the S-6 project, out team proposed action 3 “Smart Ways to Use Materials that Realize the Full Potential of Resources” . This is an expression of resource productivity concept, and consists of three sub-actions; (1)Production that dramatically reducesthe use of resources, (2)Use of products in ways thatextend their lifespan (3) Development of systems for thereuse of resources.

### 3.Analysis of resource consumption and carbon emission associated with capital stock

In this way, consumption of resources, production and accumulation of materials, and carbon emission reduction are interlinked in various aspects. Increasing resource demand from emerging economies in Asia attracts attention. In particular, recent increase in production and demand of fundamental materials in China is remarkable. China has been the world leading cement producer since 1980s, and its global production share in 2012 is almost 60%. Steel production also showed steep increase after 2000, and its global share in 2012 is about 46%.

In our subproject, we accounted the demand of raw materials for construction of buildings, roadways and railways by applying process analysis approach, and estimated CO2 emission and its reduction potential by prolonging lifetime of these capital goods. In order to solve existing discrepancies between this kind of bottom-up approach and top-down estimate by production and shipment statistics, the combination of two approaches seems useful. On our new model, we adopted indicators of physical wealth such as per capita floor space of residential buildings, per capita motor vehicle ownership. The model regards rapid increase of these capital stock indicators as the driving force of the production of raw materials such as steel and cement. These per capita physical stock indicators would saturate according to the empirical analysis for developed economies. While saturation level will significantly affect carbon emissions in expansion of stocks, our demand scenario with saturation level forecasted turning to more stable or even decreasing trend in near future, compared to recent steep increase of steel and cement production.

Carbon emissions by raw material production can be mitigated by technological efficiency improvements, recycling of scrap, and extension of lifetime. As some of the stocks such as buildings and motor vehicles accompany with larger amount of carbon emissions in their operation stage than initial production stage, the management of increasing stock is one of the key factors in realizing a society with higher resource productivity. We have to be careful that longer lifetime of inefficient durables might be contradictory to carbon emission reduction throughout their lifecycle. Not only the management of quantity of stocks but also improvements in quality of stocks is critical, thus we need to apply bold scenarios including reconstruction of existing stocks. Optimum low carbon strategy from long term perspective needs further elaboration.

[1] UNEP/IRP(2011): Decoupling natural resource use and environmental impacts from economicgrowth
http://www.unep.org/resourcepanel/Publications/Decoupling/tabid/56048/Default.aspx

# Strategies and Instruments for Low Carbon Transport Systems in Asia

Yoshitsugu Hayashi
Professor, Graduate School of Environmental Studies, Nagoya University
Director, International Research Centre for Sustainable Transport and Cities

He obtained DEng in Tokyo University in 1979. His interest includesTransport, Land-use and Environmental Planning,and Smart Shrink into Compact Cities.He has taken international leadership as the President of World Conference on Transport Research Society (WCTRS), an advisor for European Conference of Ministers of Transport, a visiting professorfor 4 oversea universities, a co-chief editor of international academic journals, such as Transport Policy, Transportation Research D, and Regional Science. He has been rewarded with 15 domestic and international awards, such as the Best Paper Award and the Environmental Award from Japan Society of Civil Engineers, and the Orange Award from WCTRS. His recent publication books are "Urban Transport and The Environment" , (Elsevier,2004), and "Transport Moving to Climate Intelligence" (Springer,2010).

In Asian developing megacities, economic growth has caused rapid motorization and urban sprawl, giving rise to various problems such as traffic congestion and air pollution. Nevertheless, their transport planning has prioritized road development in response to growing transport demand, resulting in a vicious circle in which even greater car use is induced. As some of Asian developing countries derive nearly 40% of $CO_2$ emissions from the transport sector, a new transport system is required for them to decouple growth in $CO_2$ emissions from economic growth in order to realize "sustainable transport" .

Moreover, the high growth of interregional passenger and freight transport demand is expected in Asian developing countries. As a result of the spatial pattern of economic development in Asia that has taken place mainly in coastal areas, interregional freight transport throughout Asia has currently been low carbon by domination of maritime transport. However, according to economic development shift to inland areas, truck transport has been increasing for short and medium distances. As for interregional passenger transport, demand for high-carbon air transport is increasing in Asia due to the growth of Low Cost Carriers (LCCs). Interregional transport will grow further from the establishment of the ASEAN Economic Community (AEC) in 2015.

Accordingly, it is important to identify necessary land-use transport systems and measures with a backcasting approach so as to realize Asian low-carbon society in 2050 in a leap-frog manner. This project is aimed at proposing the visions of low-carbon transport systems in Asia. Then, it examines the levels of necessary policies for the visions in combination with strategies for low-carbon transport to AVOID unnecessary transport demand, to SHIFT transport modes to lower carbon ones, and to IMPROVE energy efficiency in transport.

The vision of low-carbon urban transport systems is seamless public transport mobility and downsizing transport, which requires transit-oriented urban lifestyle and environmentally-friendly industrial agglomeration. It can be realized with a hierarchically connected compact city that consists of well-connected hierarchical urban cores (AVOID), hierarchical public transport system (SHIFT), and low-carbon and efficient road transport system (IMPROVE). The transport systems would provide low-carbon

and reliable transport services by reducing $CO_2$ emissions and travel time. As resource constraints become more serious and Asian developing countries will enter into an ageing society from 2030, the systems could also be effectively adaptable for more diverse transport demand than commuting and business travel as urban infrastructure stock. Furthermore, by implementing the strategies earlier in an integrated way with interregional transport development in Asia, urban transport systems would become less car-dependent, low-carbon, and more sustainable.

The vision of low-carbon interregional transport systems is efficient supply chain and low-carbon public transport mobility, which requires rail-oriented industrial innovation and lifestyle. As it can be realized by mainstreaming rail and water transport, we propose Industrial Rail-Oriented Corridor Development (ROD) on an interregional scale (AVOID), integrated with rail/water oriented intermodal transport system with freight High-Speed Rail (HSR) development (SHIFT), and low-carbon vehicle/aircraft/vessel technologies and operation (IMPROVE). Within the continental region ranging from China to the Greater Mekong Sub-region (GMS), shifting from air and road transport to rail and water for freight would be highly effective. Additional reductions of $CO_2$ emissions can be expected by industrial agglomeration around the freight HSR corridors over long distances that are economically viable by reducing transport time and cost. By implementing these strategies earlier, coastal and inland regions from China to GMS would be connected more not only by maritime transport but also by HSR, and would generate more rail-oriented industrial corridors in a totally different way from conventional road-oriented industrial development.

We quantitatively examined the effectiveness of policies for the low-carbon transport strategies to realize the visions. In terms of urban transport systems, the necessary levels of Mass Transit development to achieve the target of $CO_2$ mitigation are estimated on a city-wide scale in Thailand by identifying a low-carbon arterial transport mode in each city according to their levels of economic development, urbanization, and motorization. Moreover, our spatial analysis showed that rail-oriented development in Bangkok would be more effective for $CO_2$ mitigation and time saving, by shifting transport demand from road to rail, than road-oriented development. Furthermore, for growing local cities, such as Khon Kaen in Tlailand and Vienchien in Laos, we conducted more case study analyses to propose low-carbon transport development plans based on Bus Rapid Transit (BRT) systems, in collaboration with local policy makers.

As for interregional transport systems, we investigated the potential of supply chain improvement for $CO_2$ mitigation from automobile manufacturing in the GMS, where industries are dispersed from Bangkok due to rising labor cost, by comparing the impacts of industrial location involved in the supply chain. By identifying the optimal modal share of freight transport to reduce the target of $CO_2$ emissions on case study routes in the GMS, we also found that, while HSR is more advantageous for time and cost saving in long transport distance than maritime transport, the high percentage of HSR use is required to concurrently reduce transport time and $CO_2$ emissions at necessary levels. Moreover, our analysis showed the significant potential effect on $CO_2$ mitigation from HSR development connecting China and the GMS for passenger and freight transport.

# Energy Transition in China towards 2℃ Global Target

**Kejun Jiang**
Energy Research Institute (ERI), National Development and Reform Commission, China

From 1993, Kejun Jiang began the research on climate change relative to energy policy analysis, which focus on energy technology policy assessment, energy supply policy assessment, renewable energy development and energy conservation. Started from 1994, have worked on Integrated Assessment Model(IAM) development for energy and GHG emission scenarios, policies, focusing on China and global analysis. At present He is mainly working on policy assessment for energy and environment policy assessment by leading Integrated Policy Assessment Model for China(IPAC) team. Major focus includes energy and emission scenarios, energy policy, energy system,. energy market analysis, and climate change, local environment policies and international negotiation. Started from 1997, worked with IPCC for Special Report on Emission Scenario and Working Group III Third Assessment Report, leader author for IPCC WGIII AR4 Chapter 3, and leader author for GEO-4 Chapter 2. Now he is CLA in WGIII of IPCC AR5, LA for IPCC AR5 Synthesis Report, and author for UNEP Emission Gaps. His recent research projects include energy and emission scenarios for 2030, low carbon emission scenarios up to 2050, assessment on energy tax and fuel tax, potential for energy target in China, development of Integrated Policy Assessment model etc., He got his Ph.D in Social Engineering Department of Tokyo Institute of Technology.

Globally 2 degree target by 2100 was confirmed in the international negotiation process in recent years. The remained question is whether this target is feasible or not by thinking slow progress in last decades even though Kyoto Protocol set up targets by 2010. The IPCC called research teams on modeling to analyze the possible pathway, policies options, and cost benefit analysis for GHG mitigation. China's $CO_2$ emission from energy and cement process already accounts for nearly 24% of global emission, and the trend is expected to keep increasing. The role of China in the global GHG mitigation is crucial. This paper presents the scenario analysis for China's Energy System in the background of global 2 degree target, and discussed the feasibility for the lower $CO_2$ emission scenario in China. The finding says it is possible for China to limit $CO_2$ emission, reach emission peak before 2025, which make the global 2 degree target feasible, in Which energy system development is a key. And recent progress of key technologies, availability for further investment on low carbon, policy implementation make it much big possibility for China to go to low carbon emission development pathway.

Previous studies on emission scenario shows that it is possible for China to peak $CO_2$ emission by 2030 if strong policies are adopted, and with a relatively high cost. Peaking $CO_2$ emission before 2025 is a very big challenge for China. Modeling study by IPAC on the 2 degree target said it is also still possible for China to peak $CO_2$ emission before 2025, but several pre-condition are needed, including optimazing economy development, further energy efficiency improvement, enhanced renewable energy and nuclear development, CCS etc.

Rapid increase of energy intensive products output in last several years is major driving force for fast energy demand growth. Energy intensive industry consumed more then 50% of energy in China, and accounts for more than 70% newly increased power output. Further trend of energy intensive industry is a key factor for energy and $CO_2$ emission in China. Development of energy intensive industry should be limited. The quick change in the pattern of economy development, means much high social energy conservation rate. Scenario analysis shows many energy intensive products outputs will reach peak before 2020, with a much slower growth rate compared with that in the 11th Five Year Plan, and therefore will significantly change the pathway for energy demand and $CO_2$ emission. This would happen ether through positive policy action to optimize economy structure change, or passively by market over supply, we saw output of many raw material and final consumption good are around half of global output. Rate for infrastructure increase is large enough to support economy development and residential demand in China even

though high GDP growth rate, income increase rate and urbanization rate. Export was one of the major driving force for energy increase, however we do see the large share of Chinese products in the global output, which shows limited space for further increase of the share.

Energy efficiency should be further promoted. During 11th Five Year plan, energy efficiency has been improved significantly. By reviewing what happened in energy efficiency in 11th Five Year Plan, comparing with energy conservation effort in last several decades, and effort in other countries, China now is making an unprecedented action on energy conservation. Energy conservation policy was set as one of national top policies. Energy intensity target was one of key indicator for local government official. Frequency of policy making on energy saving is extraordinary high, which could be seen from policies announced by national government from middle of 2006 to middle of 2008, with a rate one policy per week. A policy framework was well established in 11th Five Year Plan on energy conservation. Such kind of policy circumstance provide well basis for energy efficiency improvement in 12th Five Year Plan and after. Much more specified policy and action on energy efficiency could be implemented such as quick moved higher energy efficiency standard, market based mechanisms, higher building energy code etc. Target is to make China's energy efficiency in major sectors to be one of the best by 2050 to 2030.

China is a now a leading country in new energy and renewable energy. By 2011, installed wind power capacity is 62.7GW, with an increase of 18GW in 2011 which is two third of global newly installed capacity in 2011, and annual growth rate from 2008 to 2011 is higher than 60%. Based on the planning in China, by 2020 renewable energy will take 15% of total primary energy, which include renewable energy not included in national statistics of energy.
In the global 2 degree scenario, power generation from renewable energy could reach 48% of total power generation, leave only 17% for coal fired power generation. Installed capacity for wind solar and hydro is 930GW, 1040GW, 520GW respectively by 2050.

And another key factors is increasing of natural gas use in China. In the enhanced low carbon scenario, natural gas use will be 350BCM by 2030, and 450BCM by 2050. In the 2 degree scenario, natural gas would be around 480BCM by 2030, and 590BCM by 2050. Together with renewable energy, leave coal use in China by 2050 to be lower than 1billion ton.

For $CO_2$ emission, Carbon capture and storage could further contribute $CO_2$ emission reduction.China has to use CCS in the case of large amount of coal use for next several decades. Even with the enhanced low carbon scenario, there will be around 1.8 billion ton coal used by 2050. CCS is essential for China to go to deep cut after 2030. Even though CCS is not yet get into commercial market, and still high cost. However based on the study IPAC team involved for CCS implementation in China, in the Enhanced low carbon scenario(ELC) adopted CCS as one of key mitigation options.

Technology progress is a key assumption for low carbon future in China. The cost leaning curve for wind and solar and many other technologies is much stronger than model used. For example, cost for wind power generation has decrease more than 40% in last two years.. And now in the coastal area, power generation cost for some wind farm already can compete with coal fired power plants.

The progress for end use technologies also move faster than model assumption. Electric appliance such as LED TV, higher efficiency air conditioner, high efficiency car etc., already have higher penetration rate by 2011 then model assumed If policy is right, lower energy demand in the 2 degree scenario much feasible by 2020 and after.

In the meantime, rapid GDP growth rate provide strong support for low carbon development in China. In 11th Five Year Plan period(2006-2011), annual GDP growth rate is 11.2%. But it is 16.7% annual growth rate if calculated based on current value. It is expected by 2015, GDP in China could reach 75trillion Yuan(in current value. The investment need in all modeling study is much small compared with GDP, normally it is smaller than 2 to 4%. If think about the investment in China, new and renewable energy is one of key sector to be promoted in China inside government policies and planning, there could be much more investment on renewable energy in future, even though China already is the biggest country in the world for renewable energy investment in 2011.

It could be concluded there is big potential for China to go to low carbon future, and it is feasible for China to reach peak of $CO_2$ emission before 2025. Technology progress, large amount investment on renewable energy, strong policies with extension from that in 11th Five Year Plan, could provide key support factors.

# Development of a Scenario for Realizing a Low Carbon Asia

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Received his doctorate degree (engineering) from the Graduate School of Engineering, Osaka University in 1997. Joined NIES in 1998. Assumed the post of Head of the Integrated Assessment Section, Social and Environmental Systems Division in 2006, and has been in his current position since 2011. Coordinate Associate Professor at Tokyo Institute of Technology since 2000.
Has engaged in the development of the Asia-Pacific Integrated Model (AIM), an integrated assessment model. Contributed to the IPCC Fifth Assessment Report as a lead author of the IPCC Working Group II. Also serves as a member of expert panel of the Post-2013 Mid-Term Policymaking Subcommittee, Central Environmental Council, the Ministry of the Environment, Japan.

## How can a Low Carbon Society be achieved in the diverse countries of Asia?

Project S-6 "Research project to Establish a Methodology to Evaluate Mid to Long Term Environmental Policy Options toward Asian Low-Carbon Societies (Low-Carbon Asia Research Project)" has been conducted under the auspices of the Environment Research and Technology Development Fund of the Ministry of the Environment. In this project, qualitative and quantitative studies have been conducted to determine what actions can be taken to achieve the objective of cutting in half the 1990 levels of the world's greenhouse gas (GHG) emissions by 2050 in Asia, a region in which dramatic increases in GHG emissions are expected in the future. As the countries of Asia differ in terms of their stage of economic development and have diverse climatic conditions, cultures, societies and present circumstances, the climate change mitigation policies that will beintroduced in each country are expected to differ. For this reason, thisproject employsboth bottom-up approach and top-down approach. The bottom-up approach means individual analyses focusing on the major countries of Asia, and the top-down approach means an overall analysis from a global perspective. This report presents the results of the top-down approach.

In project activities up through the previous fiscal year, a report entitled "10 Actions Toward Low Carbon Asia" (Table 1) was compiled, summarizing individual actions that represent the results of the qualitative study based on research conducted for the individual countries of Asia. The "10 Actions" report did not simply list the individual countermeasures but also included a study of the roadmap that defines the preparations needed to achieve and increase the effectiveness of the individual countermeasures. This report presents the results of the quantitative study in which the various countermeasuresproposed in the "10 Actions" report were incorporated into a global model in order to determine the degree to which GHG emissions can be reduced.

Table 1. Ten Actions for Realizing a Low Carbon Asia

| | |
|---|---|
| Action 1 : Hierarchically Connected Compact Cities(Urban Transport) | Action 6 : Low Carbon Energy System Using Local Resources (Energy System) |
| Action 2:Mainstreaming Rail and Water in Interregional Transport (Interregional Transport) | Action 7 : Low Emission Agricultural Technologies (Agriculture & Livestock) |
| Action 3 : Smart Ways to Use Materials that Realize the Full Potential of Resources (Resources & Materials) | Action 8 : Sustainable Forestry and Land Use Management (Forestry & Land Use) |
| Action 4 : Energy-Saving Spaces Utilizing Sunlight and Wind (Buildings) | Action 9 : Technology and Finance to Facilitate Achievement of LCS (Technology & Finance) |
| Action 5 : Local Production and Local Consumption of Biomass (Biomass) | Action 10 : Transparent and Fair Governance that Supports Low Carbon Asia (Governance) |

## Developing a Scenario for Realizing a Low Carbon Asia by 2050

Of the two future scenarios studied in this project, the Conventional Society Scenario and the Advanced Society Scenario, the Advanced Society Scenario was used as the basis for this study (Table 2). Based on thisAdvanced Society Scenario, the individual actions presented in the "10 Actions" report were incorporated into a multi-regional global computablegeneral equilibrium model in which the world was divided into 17 countries and regions (with Asia being made up of the five regions of Japan, China, India, Southeast Asia and rest of East Asia, and rest of the Asia-Pacific region), in order to analyze quantitatively what changes would occur in low carbon society as compared to the reference society. For details regarding the global model that was used for this analysis, see Fujimori et al. (2012).

Table 2. Overview of Future Scenarios

| | Advanced Society Scenario | Conventional Society Scenario |
|---|---|---|
| Overall Features | Society that is highly motivated and actively working to achieve a transition to next-generation social systems, programs, technologies etc. | Society that is cautious about making changes to social systems, programs, technologies and so on and that is concerned about the transition costs of social change. |
| Economy | Average annual growth rate: 3.27%/year (global)<br>4.16%/year (Asia) | Average annual growth rate: 2.24%/year (global)<br>2.98%/year (Asia) |
| Population | Total population in 2050: 6.9 billion (global) and 4.6 billion (Asia) | |
| Education | Active efforts to improve education<br>Average number of years of schooling: 4 - 12 years (2005) → 11 - 14 years (2050) | Standard improvements to educational policy<br>Average number of years of schooling: 4 - 12 years (2005) → 8 - 13 years (2050) |
| Use of Time | Diverse mix of lifestyles, but a comparatively long period of time spent on work and career advancement | Diverse mix of lifestyles, but a comparatively long period of time spent on time with family and friends |
| Work | Unemployment rate of 0% achieved by 2075 | Fixed at 2009 level |
| Government Efficiency | Improved from a comparatively early stage | Improved gradually at a slow pace |
| International Cooperation | Lower trade barriers and reduced foreign direct investment risk | Gradual progress in establishing cooperative relationships among countries in Asia |
| Technical Innovation | High rate of advancement | Gradual advancement |
| Transportation | Increased demand resulting from high economic growth rate | Gradual increase in demand |
| Land Use | Speedy and efficient land improvement | Gradual and cautious land improvement |

## Envisioning a Low Carbon Asia

As Figure 1 shows, under the referencesociety, GHG emissions from Asia in 2050 would be 32 GtCO2eq, or roughly double the region's emissions in 2005. In the low carbon society, emissions in 2050 would be only 10 GtCO2eq, a 69% reduction as compared to the referencesocietyand 38% lower than even 2005 emissions. Of the 10 Actions, the contribution of Action 6 (Energy System) would be greatest, followed by the contribution of Action 3 (Resources & Materials).

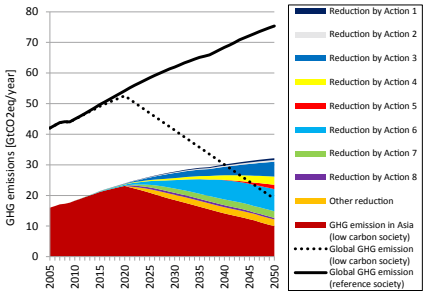


Figure 1 Changes in GHG emissions

Figure 2 shows the makeup of the primary energy supply. Under the referencesociety, fossil fuels would account for 87% of the primary energy supply in Asia in 2050. In the low carbon society, however, the share of fossil fuels would drop to 54%, and in their place renewable energies would account for 33%. In addition, a portion of fossil fuels would be eliminated through carbon capture and storage. Moreover, as shown in Figure 1, paths to the elimination of GHGs would also be created through a dramatic reduction in the amount of transportation, energy conservation policies on the demand side, agricultural land use policies and so on as indicated in each of the 10 Actions. The marginal cost of eliminating GHGs in 2050 would be USD344/CO2eq. For more information on the benefits of each of the 10 Actions, see the pamphlet entitled "Realizing Low Carbon Asia-Contribution of Ten Actions"

In this way, it is now possible to envision a specific path to the achievement of low carbon societies in Asia. The question is how to achieve this vision in the future. Fortunately, many efforts to help reduce GHGs are beginning to emerge spontaneously in the countries of Asia. It is essential that we nurture these efforts and support activities to achieve a low carbon Asia.

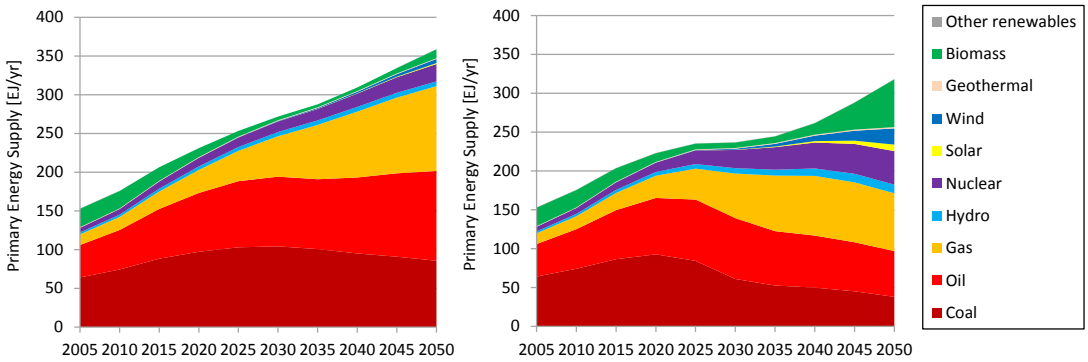


Figure 2 Changes in primary energy supply in Asia (Left: reference society,Right: low carbon society)

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# Research Activities for Realizing Low Carbon Societies in Asia

Yuzuru Matsuoka
Professor, Graduate School of Engineering, Kyoto University

He is an integrated assessment modeler, leading more than 20 years the chair of Environmental Systems Engineering, Department of Environmental Engineering, Graduate School of Engineering, Kyoto University. He is also the director of Research Center for Environmental Quality Management, the leader of Global Center for Education and Research on Human Security Engineering for Asia Megacities, Kyoto University, and also the leader of the project on Developing Asian Low Carbon Societies supported by JICA and JST(Japan Science and Technology Agency).

From the later 80's, he continues research on global environmental issues, especially on climate change problem from a view point of integrated assessment modeling. As a core modeler of AIM, he developed various kinds of integrated models. In addition to modeling activities, he contributed to IPCC Second and Third Assessment as a Lead Author, Millennium Assessment as an editor and other global environmental projects.

In this presentation, not only a methodological framework but also the implementation aspects of how to promote low carbon development within a context of national/regional socioeconomic development are introduced, and the applications in Asian countries/regions are reported.

Coupling of macro-economic transition policies with microscopic section specific mechanism, such as deployment mechanisms of end-use type energy efficient technologies or environmentally conscious lifestyles, and exploring feasible and efficient implementation based on a systematic analysis of the whole system is indispensable for achieving low carbon development.

Several tools for assisting these processes are developed, and how to couple the tools, and how to integrate the outputs of the tools towards low carbon policy actions are discussed.

We have proposed these models as core tools to design Asian region's national and local Low Carbon Society plans, and conducted collaborative studies with each country's domestic research and implementation institutions. In the latter half of my presentation is devoted to the introduction of these experiences, and also the future prospects of the approach.


Figure : Up to now, we applied and are applying our LCS Scenario approach to 8 nations and 12 regions in Asia regions

# Opening Remarks

## Soichiro Seki

Director General
Global Environment Bureau,
Ministry of the Environment,
Japan

**Education:**

| | |
|---|---|
| Mar.1978 | Graduated from the University of Tokyo, Faculty of Engineering |
| Oct.1977 | Passed the Advanced Level State Civil Service Examination (Class A) for Civil Engineering |

**Career:**

| | |
|---|---|
| Sep.2012 | Director-General, Global Environment Bureau, Ministry of the Environment (MoE) |
| Aug.2010 | Deputy-Director-General, Minister' s Secretariat, MoE |
| Jul.2008 | Director-General, Nagasaki Customs, Ministry of Finance |
| Jul.2006 | Director, Waste Management Division, Waste Manag ement and Recycling Department, MoE |
| Jul.2005 | Director, Industrial Waste Management Division, Waste Management and Recycling Department, MoE |
| Jul.2003 | Director, Air Environment Division, Environment Management Bureau, MoE |
| Apr.2002 | Director, Dioxins Control Office, Environmental Manage ment Bureau, MoE |
| Jun.1998 | Dispatched to the International Bank for Reconstruction and Development (IBRD) |
| Apr.1997 | Senior Policy Coordinator, Global Environmental Issues Division, Global Environment Department, Planning and Coordination Bureau, Environment Agency (EA, now MoE) |
| Jul.1994 | Assistant Director, Water Quality Management Division, Water Quality Bureau, EA |
| Jun.1992 | Assistant Director, Air Regulation Division, Air Quality Bureau, EA |
| Apr.1992 | Assistant Director, Planning Division, Air Quality Bureau, EA |
| Jul.1991 | Director, Coordination Department, Environment Conservation Bureau, City of Yokohama |
| Oct.1989 | Director, Pollution Control Bureau, City of Yokohama |
| Mar.1986 | Dispatched to Environmental Agency of Thailand |
| Sep.1985 | Assistant Director, International Affairs Division, Minister's Secretariat, Ministry of Health and Welfare |
| Aug.1985 | Assistant Director, Health Affairs Division, Environmental Health Department, Planning and Coordination Bureau, Ministry of Health and Welfare |
| Apr.1978 | Joined Ministry of Health and Welfare |

## Dr. Akimasa Sumi

President
National Institute for Environmental Studies (NIES)

Born in 1948, he received his B.D. and M.S. in Physics, and D.Sc. in Meteorology from the University of Tokyo (UT) in 1971, 1973 and 1985 respectively.

He entered the Japan Meteorological Agency (JMA) in 1973, and was affiliated with JMA through 1985. He was a research associate at the University of Hawaii between 1979 and 1981.

In 1985, he was invited to UT as an associate professor of the Department of Meteorology, where he remained until 1991. Having served as a Professor and Director at the Center for Climate System Research at UT till 2004, he then became Executive Director of the Transdisciplinary Initiative for Global Sustainability, Integrated Research System for Sustainability Science, UT, and has since been chiefly engaged with the area of "Sustainability Science".

He was appointed President of the National Institute for Environmental Studies (NIES) in April 2013.

His research interests include numerical weather prediction; climate system dynamics; and climate simulation. He has contributed to many international research projects as a leading member, including Tropical Ocean Global Atmosphere (TOGA), and Tropical Rainfall Measuring Mission (TRMM).

# Session1 : Chair and Commentators

## Norichika Kanie

Associate Professor, Tokyo Institute of Technology
Senior Research Fellow, United Nations University - Institute of Advanced Studies

Norichika Kanie is an associate professor at the Graduate School of Decision Science and Technology, Tokyo Institute of Technology, Japan. He is also a Senior Research Fellow at United Nations University Institute of Advanced Studies (UNU-IAS). His research focuses on international environmental governance, and is leading a three year strategic project on Sustainable Development Goals (FY2013-FY2015) funded by the Ministry of Environment, Japan. Among others he serves as a scientific steering committee member of the Earth Systems Governance project of IHDP, and the chair of the Working Party on Climate, Investment and Development (WPCID) at OECD. From August 2009 to July 2010 he was a Marie Curie Incoming International Fellow of the European Commission and visiting professor atSciencesPo, Paris. His recent publications include:N. Kanie, P. M. Haas, S. Andresen, 他, “Green Pluralism: Lessons for Improved Environmental Governance in the 21st Century” Environment: Science and Policy for Sustainable Development, Volume 55, Issue 5, 2013, pp.14-30、Norichika Kanie, Michele M. Betsill, Ruben Zondervan, Frank Biermann and Oran R. Young, 2012, "A Charter Moment: Restructuring Governance for Sustainability",Public and Administration and Development, 32, PP. 292-304.He received his Ph.D. in Media and Governance from the Keio University.

## Masahiro Kawai

Dean and CEO, Asian Development Bank Institute (ADBI)

Masahiro Kawai is ADBI's Dean and CEO. He was previously special advisor to the ADB president in charge of regional economic cooperation and integration. Before that he was in the academia, first as an associate professor of economics at The Johns Hopkins University and later as a professor of economics at the University of Tokyo. He also served as chief economist for the World Bank's East Asia and the Pacific Region and as deputy vice minister of finance for international affairs of Japan's Ministry of Finance. He holds a BA in economics from the University of Tokyo and a PhD in economics from Stanford University.

Dr. Kawai has published a number of books and more than 150 academic articles (in English) on economic globalization, regional economic integration and cooperation in Asia, and the international currency system. His recent co-edited books include: *Asian Regionalism in the World Economy: Engine for Dynamism and Stability* (Edward Elgar, 2010); *Asia's Free Trade Agreements: How Is Business Responding?*(Edward Elgar, 2011); *Asia and Policymaking for the Global Economy* (Brookings Institution Press, 2011); *and Monetary and Currency Policy Management in Asia* (Edward Elgar, 2012).

## Ryokichi Hirono

Profession Emeritus, Seikei University and Councellor, Institute for Global Environmental Strategies (IGES)

1954-59 University of Chicago, Graduate Division, Department of Economics, U.S.A.
1959-60 Assistant to Director, Institute for Industrial Relations, University of California, Berkeley, U.S.A.
1960-61 Economist, Japan Management Association, Tokyo
1961-98 Instructor, Assistant and Associate Professor, and Promfessor, Seikei University, Faculty of Economics and Business
1998-2011 Visiting Professor, Saitama University, Graduate School of Policy Science, Urawa, and Graduate Institute for Policy Studies (GRIPS), Tokyo
Research interest: Development Economics/Environmental Economics/ International Development Cooperation
Professional Career: In Japan, member on many government advisory committees including Prime Minister’ s Economic Deliberations Council and International Economic Cooperation Council, Forest Policy Council, Central Environment Council, ODA Policy Committee, and overseas, visiting professor at universities in Asia, Africa, Europe, Oceania and North America and in senior management position at UNDP and UNESCAP and adviser at ADB, OECD, and World Bank. Currently serving on the board at many research institutes and foundations.

## Werner Rothengatter

Professor em., Karlsruhe Institute of Technology (KIT)
Former President, World Conference on Transport Research Society (WCTRS)

Werner Rothengatter graduated from Business Engineering at Universität Karlsruhe in 1969. While as a Researcher and Research Assistant at the Institute for Economic Policy Research 1970-1978, he earned the PhD in 1972 and the Habilitation in 1978, both in Economics. He worked as a Professor for Economic Theory at Universität Kiel (1979), Professor for Economic Theory and Policy at Universität Ulm (1979-1986), as a Visiting Professor at Vanderbilt University, Nashville, Tennessee (1982), as Head of the Transport Division at the German Institute for Economic Research (DIW), Berlin (1986-1989), and received a call to the Universität Münster, Institute for Transportation Science (1989). Since 1990, he worked as Professor at Universität of Karlsruhe (now the Karlsruhe Institute of Technology (KIT)), Dean of the Faculty of Economics (2003-2004) and Head of the Institute of Economic Policy Research and its Unit of Transport and Communication. Since April 2009 he has retired from University obligations. He retired as well from the Scientific Advisory Committee of the German Ministry of Transport, Construction and Urban Development, which he chaired from 2001 to 2002. In 2010 he was honored with the Francqui-Chair for Logistics at the University of Antwerp and in 2013 with the Jules Dupuit Prize of the WCTRS. He is member of the Advisory Committee of Deutsche Bahn AG and a member of the Reform Commission for Large Projects of the German Ministry of Transport, Construction and Urban Development. He was President of World Conference on Transport Research Society (2001-2007) and is still a member of its Steering Committee. He is a member of the Editorial Advisory Board of the Transport Policy Journal (published by Elsevier) and Editor of the Springer Series on Transport Economics and Policy (together with D. Gillen).

* The profile of Dr. Heinz Schandl is on page.26.

# Session2 : Chair and Commentators

## Mikiko Kainuma

Fellow Center for Social and Environmental Systems Research, (NIES)

Dr. Kainuma received her B.S., M.S., and Ph.D. degrees in Applied Mathematics and Physics from Kyoto University in Kyoto, Japan.
She joined NIES in 1977, and has, since 1990, been engaged with the development of the Asia-Pacific Integrated Model (AIM), which assesses policy options for stabilizing the global climate, particularly in the Asian-Pacific region, with the objectives of reducing greenhouse gas emissions and preventing and mitigating the impacts of climate change. From 2006 to March 2011, she was head of the Climate Policy Assessment Research Section at the Center for Global Environmental Research at NIES. Currently she is a Fellow at the Center for Social and Environmental Systems Research in NIES, and serves as an adjunct professor at Japan Advanced Institute of Science and Technology.
She is a Lead Author of the Intergovernmental Panel on Climate Change (IPCC) Fourth and Fifth Assessment Report (Working Group III: Mitigation of Climate Change).
<Awards>
2011 Academic Award by the Society of Environmental Science, Japan
2010 Remarkable Contribution to Science and Technology 2010:NIce STEP Scientists by the National Institute of Science and Technology Policy (NISTEP)
1994 Nikkei Global Environmental Technology Award
<Publication> "Climate Policy Assessment" ,Springer, 2003

## Li Zhidong

Professor, Nagaoka University of Technology

Li Zhidong is a professor at Nagaoka University of Technology Japan, and a visiting researcher at the IEEJ (Institute of Energy Economics, Japan) and ERI/China (Energy Research Institute, National Development and Reform Commission, China). He is a member of the Green Energy Project of Nagaoka University of Technology, which is adopted as 21st Century COE program by the Japan Ministry of Education and Science.

He graduated from China People's University (Renmin University) in 1983, and received a PhD in economics from Kyoto University Japan in 1990. He worked as a professional economist at the IEEJ from 1990 to 1995, mainly focusing on econometric analysis of world energy outlook and world oil market modeling. He has been a main contributor of Japan-China joint study project focusing on China's economy, energy and environment from 1999 to 2003. He is the author/co-author of number of books and articles published in academic and professional journals and publishers.

## Yasuko Kameyama

Head, Sustainable Social Systems Section, Center for Social and Environmental Systems Research, (NIES).

Dr. Kameyama has been a researcher at NIES since 1992. She is also a visiting professor at Graduate School of Frontier Science, the University of Tokyo since 2011. Her background is international relations. Her major areas of interest include multilateral negotiation and institutions on climate change, and indicators to measure sustainable development. She was a member to the Global Environmental Sub-Committee of Central Council of the Environment, Japan, between years 2008 and 2012. She has many publications both in Japanese and English. Some of the latest publications in English include Kameyama, Y., et.al, eds. (2008) Climate Change in Asia: Perspectives on the Future Climate Regime, Tokyo: United Nations University Press.

## Shuzo Nishioka

Senior Research Advisor, Institute for Global Environmental Strategies (IGES)

Member, Central Council of Environment Japan
Member, Environment Council of Tokyo Metropolis
Secretary General, Low Carbon Society Research Network (LCS-RNet) / Low Carbon Asia Research Network (LoCARNet)

Graduated Faculty of Engineering (Dr. in Control Engineering) University of Tokyo in 1962. After 12 years engineering experience in Asahi Chemical Co. Ltd, joined National Institute for Environmental Studies of Japan (NIES). Research areas there were regional and global environmental assessment and environmental policy.
Served as professor of Tokyo Institute of Technology and Keio University in 1997-2001 and as Executive Director of NIES in 2001-2007.

From late 1980's, devoted in climate change issues and engaged in IPCC from 1988 to 2007 mainly in impact assessment methodology. In 2004 -2009, lead a policy related research of Japan Low Carbon Society Project, to explore the scenario of 70% GHG reduction in 2050 in Japan. This works was extended to Prime Minister Fukuda's Low Carbon Society policy (60-80% reduction in 2050) declared at Toyako Summit. And the methodology developed there was applied to discussion for Innovative Energy-Environment Strategy after Fukushima in 2012. He chaired the Sub-committee in charge of this work, consisted of more than 100 experts, at Central Council of Environment,

His recent work focuses on international collaboration on low carbon society research for supporting Asian countries' leap-fogging to low carbon world.

* The profile of Dr. Kejun Jiang is on page.32.

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