LCS·R Net

How to Achieve Long-Term Transitions towards Full Decarbonisation

Synthesis Report of Eighth Annual Meeting
International Research Network for Low Carbon Societies (LCS-RNet)

6 – 7 September 2016
Wuppertal, Germany

Host:
Wuppertal Institut für Klima, Umwelt, Energie (WI)
Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB)
with support from Deutsche Forschungsgemeinschaft (DFG) and Japanese Ministry of the Environment (MOEJ)

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Preface

The eighth Annual Meeting of LCS-RNet was held from 6th to 7th September, 2016, in Wuppertal, Germany, and was co-hosted by the Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (BMUB) and the Wuppertal Institut für Klima, Umwelt, Energie (WI) with support from Deutsche Forschungsgemeinschaft (DFG) and the Japanese Ministry of the Environment (MOEJ).

The International Research Network for Low Carbon Societies, LCS-RNet, is a network of researchers and governments from the G7 tasked to provide profound contributions to national climate policies. The basic operational concept behind the network is to bring about a profound, broad-based transition of social systems in order to reduce GHG emissions, and thus stabilise climate. In line with this concept, knowledge on policies and mechanisms is shared at both central and local levels; for example, by ensuring that social hubs, such as energy technology systems, industries, urban infrastructures, social systems, financial functions and individuals all aim for effective GHG reductions. The results of our discussions are taken up and explored in academic journals, reported at various meetings of the UNFCCC, and reflected in policies in each country through participants from science, society and policymaking.

With the remarkable success of COP21, the world took a significant step forward to "action" for realising low-carbon societies. Here, we would like to point out that the key issues covered at COP21 and G7 had in fact already been proposed and discussed at the past LCS-RNet annual meetings.

The Paris agreement, however, clearly opened the gate to the path for full transition towards decarbonisation involving society at large. To successfully fulfil this global task, the aims and knowledge of the LCS-RNet thus acquire even greater significance. Henceforth, LCS-RNet has to reconsider its responsibility to provide knowledge to the whole world, as well as promote more concrete and practical actions.

These challenges have been taken up at this year's annual meeting through discussion of "How to achieve long-term transitions towards full decarbonisation". Its four sub themes reflect the key issues in this regard: a) to tackle any future anticipated non-linearities and disruptive interferences with decarbonisation policies, b) to match strategies for economic and wealth development with the global investment programme of energy transition, climate mitigation and adaptation, c) to align these strategies with the overall sustainable development goals and d) the increasingly important role science has to play in providing well-founded solutions and sound strategies for action. Concrete themes discussed in this framework were the pledge to reduce global emissions by strengthening and implementing nationally determined contributions (NDCs), using the capabilities of non-state actors such as cities and financial institutions to implement the Paris agreement, coupling finance for developing countries with capacity development to increase the effectiveness of support from developed countries, and the importance of long-term strategies for zero-carbon societies.

This Synthesis Report was drafted by the session chairs and rapporteurs of the Annual Meeting together with the LCS-RNet Steering Group. Sincere thanks go to the contributions and support provided by Mr. Martin Weiß of BMUB, Ms. Katharina Knoop, Ms. Marie-Christine Gröne and Dr. Johannes Venjakob of WI, as well as Dr. Shuzo Nishioka, Dr. Mikiko Kainuma, Ms. Tomoko

Ishikawa and Ms. Michiko Inoue of the LCS-RNet Secretariat.

We would also like to express our special appreciation to BMUB, the German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety, and MOEJ, the Ministry of the Environment of Japan for their generous support of LCS-RNet activities. We greatly value the support and recommendations provided by governments and LCS-RNet contact points. Particular thanks are due to WI for their strong leadership in planning the meeting and for their hospitality in Wuppertal.

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Key Findings

Since the Paris 2015 Conference there is a near universal agreement on the urgency of taking actions to address climate change. With only about 30 years of GHG emissions budget remaining, the target of zero or near-zero emission by 2050 is acknowledged as necessary in order to achieve the stated goal of capping the temperature increase since pre-industrial times to well below 2 degrees C. Further, these reductions are needed in parallel with the sustainable development goals (SDGs) decided on in New York 2015, which include targets for dematerialisation and avoiding soil degradation. Synergies between low carbon and resource strategies as well as other SDGs need to be exploited to achieve these goals.

The transition process targeted needs to assign active roles to all relevant stakeholders on national as well as subnational levels, including private sector actors. As energy and material supply chains have to be transformed this involves both technology and behaviour changes. Further, there is also a need for better general understanding of the importance of scenario studies on the national level and the overall contribution of science, both of which are expected to help accelerate the transition.

Role of multiple stakeholders

- Multiple stakeholders will play crucial roles in directly contributing to and/or facilitating the transition towards decarbonisation and dematerialisation. These include national governments, cities/local governments, public sector, private sector including industrial and financial sector, civil society and citizen groups, researchers, media, and international organisations.
- Engaging these multiple stakeholders to collaborate in designing and implementing low carbon societies—i.e. low carbon solutions for industry, energy, transport, digitalisation, education—is essential for their success.
- The governments have a triple role in this context. They design and implement the right policies, initiate and moderate collaborative governance processes and make initial investments that in turn encourage private sector investments on a much larger scale.
- National governments need to provide clear and stable signals for economic actors, private households as well as city governments that induce actions on the ground.
- Cross-stakeholder processes must result in cross-sector solutions. For instance, regional or urban development plans need to include phasing out of high carbon industries (for example, coal mining) and the redesign of high resource industries. They need to support such phase-outs by addressing accompanying rehabilitation and re-employment concerns, incentivising low carbon and low resource industries, and harnessing supply-chain wide decarbonisation and dematerialisation through achieving maximum synergy in production and use of resources between different industries. As another example, financial sector businesses need to re-align their priorities, so as to accelerate investment in low carbon and low resource industries and de-incentivise investment in high carbon ones.

Energy-material supply chain transformation

- Since energy and material resource cycles are intertwined, they need to be considered together for possible efficiency improvements in production and consumption processes and in long-term scenario approaches.
- As these cycles cut through multiple-company and multiple-industry networks, solutions for efficiency improvement and carbon reduction need to affect entire supply chains and product-service systems. This will allow assessment of supply chain-wide life cycles, and therefore, identification of optimum ways for extraction, conversion, operation, use, re-use, waste handling and recycling processes. Such analyses will also help in comprehensive assessment of renewable energy generation activities and mitigate potential unintended negative consequences. For example, solar PV manufacturing activities will require strategies to minimise resource use and waste generation in an environmentally sustainable manner.
- Decarbonising energy intensive processing industries, which are responsible for the largest share of industrial GHG emissions, imposes first a unique technological challenge as high-cost breakthrough technologies are needed, second systems challenge as these will consume high amounts of decarbonised energy and finally, as these sectors are typically in strong international competition, such problems are a challenge to be tackled on national levels alone.
- Such a decarbonisation will transform energy-material resource flows and lead to industrial structural changes. A good example of preparing for such structural transformation is the Rotterdam port-industrial area, which is discussing strategies for conversion of the petrochemical cluster under deep decarbonisation strategies, i.e. going for biomass feedstocks combined with carbon capture and storage or producing synthetic feedstocks from hydrogen produced from renewable electricity and recycled carbon.
- Energy and resources should also be analysed jointly within long-term scenarios. Present energy scenarios consider only long-term climate targets without questioning the related resource consumption. A new approach is therefore needed which includes long-term resource targets and development of combined or integrated energy and resource scenarios.

Systems transformation involving both technology and behaviour changes

- Both technology change and behaviour change are required to achieve drastic and permanent decarbonisation corresponding to the 1.5°C target or 1 tonne CO_2 emission per capita. Behaviour change could reinforce and accelerate technology change.
- Since behaviour change is necessary, social science as well as natural science and technological knowledge will play key roles in assessing options and finding solutions for systems transformation in order to solve the climate change crisis.
- Low carbon scenarios also need to incorporate both technological and behaviour changes.
- Innovations that enable technology leapfrogging are critical for achieving the ambitious targets of decarbonisation. Certain ongoing technological innovations point to initial trends towards such non-linear changes, e.g., electric vehicle and battery technology innovations.

- Besides mitigating climate change, technology innovations must simultaneously provide solutions for poverty eradication, which will accelerate their diffusion. Respective designing principles and business models have to be clarified and explored.

Synergy between sustainable development and decarbonisation goals

- Climate change mitigation goals and sustainable development goals (SDGs) are closely related.
- Climate mitigation goals and the process of designing a low carbon transition pathway must be placed firmly within the context of SDGs. This requires researchers and policymakers concerned with climate change to explicitly consider sustainable development co-benefits such as poverty eradication, access to basic infrastructure services of water, sanitation and electricity, and local pollution control. Likewise, researchers and policymakers concerned directly with SDGs need to explicitly consider decarbonisation options such as adoption of renewable energy and carbon pricing and their link with sustainable development.
- Linking climate change and sustainable development goals will also require consideration of impact of decarbonisation measures on local economies and communities. For instance, while decarbonisation measures include closure of high carbon industries (such as fossil fuel intensive industries), fast and effective implementation of such measures will require addressing new needs of rehabilitation, re-skilling and re-employment (that arise out of large scale closure of old industries) in a comprehensive manner.

Importance of scenarios

- Scenarios are both quantitative tools for supporting decisions as well as tools for communication to stakeholders.
- As communication tools, scenarios are intended to show possible futures, raise awareness and dialogue at multiple levels—global, national, local—and thereby facilitate transparency and stakeholder (including citizen) participation and mobilisation for low carbon society transitions.
- Therefore, an important transformative role of scenarios is to enable participatory approaches in the quest to assess, select and implement solutions for climate change mitigation combined with further targets like long-term resource efficiency.
- Since there are significant uncertainties over many aspects of future societies, economies and technologies, researchers must construct and analyse a wide range of scenarios that depict a variety of possibilities. This will permit assessment of novel options that have not been widely reflected in existing scenarios with regards to technologies, systems and behaviour changes to identify robust solutions towards decarbonisation.

New, transformative role of science

- Addressing deep-rooted societal problems such as climate change and meeting radical targets of 1.5°C temperature increase, 1 tonne CO_2 emission per capita and 80–95% GHG emissions reduction call for a new role of science. Science should strive to play a transformative role in a society that urgently needs to address these problems. The process and methods of science should therefore be drawn from the goal of ‘service to society’.

- Science needs to develop from a conventional, normal and reductionist paradigm to one that is transformative and trans-boundary oriented. Structures of specialised departments and disciplines need to be modified to forward a new science that is inter-disciplinary, trans-disciplinary, and multi-stakeholder based.
- Inter-disciplinary and trans-disciplinary processes imply integration of multiple disciplines, integration of natural and social sciences, and adoption of 'synthesis' as a major method besides 'analysis'.
- Multi-stakeholder processes imply continuous interaction and dialogue between scientists and other stakeholders in society including policymakers, non-government agencies, citizens, and businesses. They also imply action research focused on solving critical societal problems.
- The priorities and agenda of research funding needs to change so as to reflect the new role and importance of science, i.e. to address fundamental problems such as climate change and low carbon transition through inter-disciplinary, trans-disciplinary, integrated, multi-stakeholder and synthesis based approaches.
- In order to effectively play such a transformative role, science must be in the 'commons' rather than in private control.

Messages from LCS-RNet: Need for paradigm shift and tighter link between policy and science

Paradigm shift

- As we only have about 30 years of global carbon budget left, solving the climate change crisis has now acquired a new level of urgency. The Paris 2015 Agreement underscored this by calling on achieving the max 2°C temperature increase, making efforts towards 1.5°C, transitioning to a decarbonised society, and institutionalising the intrinsic value of carbon mitigation and removal. This transition calls for a paradigm shift.
- Such paradigm shift requires a new role for science, one that has a much stronger focus on inter-disciplinary, trans-disciplinary and multi-stakeholder processes aimed at solving climate change and related fundamental problems of society. This will require development and use of action research approaches as well as innovative, dynamic and interactive qualitative-quantitative methodologies.

Linkage between policy and science

- While science has an unquestionably crucial role to play in assessing, selecting, designing and implementing the most effective policies for addressing climate change mitigation and sustainable development goals, a gap still exists between science and policy, which needs to be bridged.
- For science to be effective in providing knowledge for implementation, it needs to engage multiple stakeholders—national and city governments, private sectors (including financial), citizen groups and others. Policymakers, on the other hand, need to give clear signals for decarbonisation and dematerialisation via use of policies and investments.
- The primary contribution of LCS-RNet is to bridge this gap by providing a much needed platform for dissemination of scientific knowledge and dialogue among key stakeholders.

1st session

Session Reports

Plenary Session 1:

How to trigger the non-linear transformation towards full decarbonisation (by 2050) as targeted by G7 (Elmau) and COP21 (Paris)?

Chair: Jim Watson, UKERC
Rapporteur: Rahul Pandey, Integrated General Systems Analysis Laboratories

Speakers:
Karen Smith Stegen, Jacobs University Bremen
Jens Burgtorf, GIZ

The opening session delved into the ways of transforming societies towards full decarbonisation and the challenges related thereto.

Karen Smith Stegan spoke of two possible disruptive strategies required to bring about the desired transformation. The first, "Climate Czars", entails radical, unilateral implementation of measures to remove carbon by elected governments; in other words, non-democratic, urgent and determined interventions by democratic governments aimed at averting climate change by bypassing normal, time-consuming routes of selection, decision making and implementation. Democratic consent confers legitimacy on a government to carry out procedural justice as well as distributional justice for the people, and in order to address far-reaching crises such as climate change through urgent, unilateral actions, it may be necessary to compromise on procedural justice. Even in such cases, however, distributional justice must be delivered in order to gain societal acceptance and smooth implementation of hard measures. This would imply providing adequate compensation to parties likely to suffer economic, employment or other losses and parties whose activities and skills lose value in the new, decarbonised economy. These include, for instance, individuals and organisations whose existing economic activities, investments and skills depend heavily on fossil fuels.

The second strategy, "Power to the People", emphasises bottom-up, decentralised ownership of decisions and actions by local groups, organisations and communities at both small and large scales. On the small scale they equate to collective actions by small groups of citizens and companies. For example, a significant proportion of Germany's wind and solar energy generation is owned by citizen associations. At larger scales, such efforts witness devolution of responsibility, authority, incentives and targets at the lower levels of workers and communities. An example of a bottom-up, self-monitored citizen organisation is the Intifada movement. The key motivation for the second strategy is that the local people, communities and companies build and own the low carbon pathways of the future.

Jens Burgtorf underscored the importance of strategic foresight, which is about making sense of uncertainty, anticipating possible consequences of different courses of actions and preparing for various likely futures—the motivation behind the 'Delphi Energy Future 2040' study. It gained broad insights from over 350 experts representing various sectors and nationalities around the world through a systematic Delphi process with the objective of exploring future energy systems in Germany, Europe and the world in 2040 and beyond. The emphasis was on spotting trace signals of possible

major future trends and gathering diverse views (including non-mainstream), and thus identifying various possible futures for energy systems, rather than making exact predictions. The utility of the study is in identifying possible 'game-changers' and 'trend-breaks' early on and supporting preparations for strategy planning. The methodology involved multiple steps: identifying 56 crucial theses from the views of global experts, followed by an anonymous, iterative process involving over 350 energy experts concerning evaluation of the theses and the likelihood, region and timeframe of certain developments to occur in the future (1st round of inputs → sharing anonymous feedback of results → 2nd round of inputs). This resulted in 13 future energy system storylines for 2040.

These narratives indicate climate actions gaining momentum triggered by several factors such as ecological disasters, demands from citizens and consumers, strong environment and renewable energy policies in China and India, effectiveness of global climate regime and regional carbon pricing in inducing divestment from fossil energy, and renewable energy becoming economically attractive (including in decentralised mode) due to both carbon pricing and technology innovation. Innovative technology combinations such as solar PV and storage (in both electricity generation and mobility sectors) and new business models spurred by ICT and digital innovations are among the game-changers. Such game-changers offer great opportunities for development and leapfrogging to emerging economies, including Africa. While urbanisation continues, low-cost renewable energy and electrification are likely to foster decentralised and localised self-governance energy structures, thereby driving the emergence of sustainable cities as well as sustainable rural areas.

These results point to not only the possible futures but also the major game-changing strategies and challenges to enable transition to a decarbonised world.

Summary and key findings of the session

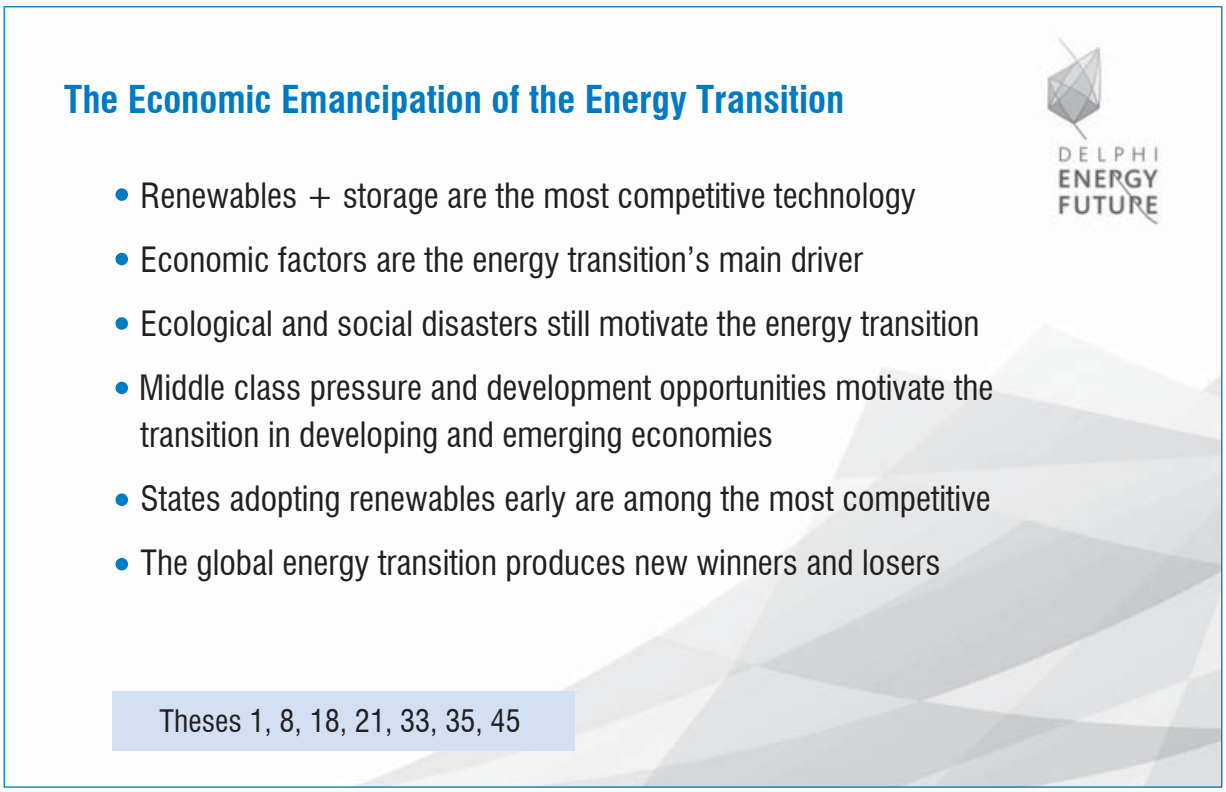
- Sociopolitical strategies to deal with disruptive events and non-linear developments are crucial to a timely and successful response to climate change crises.
- Strategic foresight required to prepare for possible futures outcomes from analysing likely trends, including current trace signals of probable major shifts in the future, and consequences of alternative actions under uncertainty.
- Multi-pronged actions including pressure from citizens, policies such as carbon pricing, and innovations such as PV, storage and digitalisation of renewable energy systems could foster decentralised, self-governing and sustainable energy systems in cities and rural areas.

Concrete/practical steps for low carbon transformation

- One of two alternative sociopolitical strategies need to be pursued in different regions depending on the suitability: (i) unilateral selection and implementation of low carbon measures while ensuring distributive justice in terms of compensation to those suffering losses in the low carbon transition; (ii) bottom-up, decentralised sustainability actions by local groups of citizens and organisations.
- Financial and other support for innovations of game-changing technology combinations such as PV and storage, and digitalisation of renewable energy systems must be enhanced with the objective of making

them economically competitive. Likewise, states will need to integrate renewable energy systems, in addition to carbon pricing, into national development policies. Simultaneously, middle class citizens, civil society groups and consumer associations must exert greater pressure to demand low carbon governmental accountability.

- In order to develop sustainable cities and rural areas, self-governing energy systems based on low-cost renewable energy need to be implemented.



Source: Presentation by Jens Burgtorf

Session Reports

Parallel Session 1.1:
How to deal with non-linear and disruptive developments: long-term scenarios, modelling, innovation and structural change

Chair: Toshihiko Masui, NIES
Rapporteur: Masahiro Suzuki, IGES

Speakers:
Detlef van Vuuren, PBL and University of Utrecht
Patrick Criqui, University of Grenoble Alpes and CNRS
Martin Weiß, BMUB

This session, chaired and moderated by Toshihiko Masui from NIES, initially revisited the key climate targets set by the Paris Agreement, and addressed the gap between the targets and the current ambition level of GHG mitigation as shown by the parties' INDCs. He then emphasised the importance of accelerated implementation of measures necessary to achieve these targets and discussed the significant role that models and long-term scenario building exercises can play in transitioning to a zero-emissions society. The session welcomed three eminent speakers: Detlef van Vuuren from PBL and University of Utrecht (Netherlands), Patrick Criqui from University of Grenoble Alpes and CNRS (France), and Martin Weiß from the Federal Environment Ministry of Germany.

Detlef van Vuuren introduced recent developments in scenario analysis based on the integrated assessment models (IAMs) by presenting the scenario matrix architecture of SSPs (Shared Socio-economic Pathways), discussing the implication of the Paris Agreement for existing scenarios, and identifying areas for further research. He stressed, in particular, (1) that all SSP scenarios point to the need for all power sectors to be fully decarbonised by 2050–2060; (2) the need to evaluate whether achieving negative emissions is necessary, especially in light of the release of the upcoming report by IPCC on 1.5 degrees; and (3) the urgent need to integrate modelling and scenario building exercises with transition sciences, to ensure implementation of such scenarios is feasible.

Patrick Criqui introduced the governance levels, scientific paradigms and policy instruments for deep decarbonisation pathways. He presented a matrix of four governance scales and three research paradigms, and explained the current practices in each category. For example, in global governance and IAMs he showed that near-term climate action by 2030 is critical to achieving the 2 degrees target, and that delayed action only leads to the need for unprecedented mitigation spanning subsequent decades. He also introduced French efforts in developing an energy transition strategy to 2050 as an example of a national governance/decarbonisation scenario paradigm, and global efforts in DDPP (Deep Decarbonisation Pathways Project) as a showcase for global governance and national decarbonisation scenarios paradigm. After a brief introduction covering many scenario building exercises within these categories, he stressed that it is time to move from producing scenarios to sharing experiences.

Martin Weiß discussed, from the policymaker perspective, the benefits and challenges of incorporating the results of modelling and scenarios into actionable policy measures, especially in light of the Paris Agreement, which requires countries to dive into deep low-carbon transition. He shared

the dilemma of adopting "no-regret" policies under pressure to act early in full view of uncertainties. He pointed out that most existing scenarios often (only) focus on technological and economic feasibilities, and that such scenarios would further benefit by being integrated with social transition. In addition, accessibility and usability of the scenarios, as well as the role of scenarios per se as a tool to communicate with policymakers, multiple stakeholders and the public in the process of designing future strategies, were suggested as areas of scenario building and modelling exercises needing improvement.

Summary and key findings of the session

- Long-term scenarios and models provide important inputs for low/zero-carbon policymaking.
- The current ambition level of GHG mitigation fails to achieve 1.5/2.0 degrees, thus accelerated policy implementation is critical.
- In addition to further enhancing scenario building and modelling exercises, existing efforts and results must initially be communicated to and accessible by multiple stakeholders, including the public.

Concrete/practical steps for low/zero carbon transformation

- Further bridge the gap between the results of models and actionable policy measures.
- Incorporate transition sciences into scenario building and modelling exercises.
- Enhance the level and depth of communication among all the relevant stakeholders regarding transitioning to a zero-emission society.

4 governance scales x 3 research paradigms

	IAMs - Integrated Assessment Models	NATIONAL DECARBONIZATION SCENARIOS	SECTORAL & URBAN TRANSITION STUDIES
GLOBAL / INTERNATIONAL	IPCC IAMC AMPERE / ADVANCE GECO 2015…	Deep Decarbonization Pathways Studies 2014 & 2015	New Climate Economy Reports 2014 & 2015 Low Carbon Technology Partnership (WBCSD)
REGIONAL / EUROPEAN LEVEL	2030 EU INDC 2050 Energy Roadmaps …	?	?
NATIONAL	National E3 MODELS MARKAL-TIMES	Trajectories of Energy Transition e.g. Energiewende in G. National Debate in Fr.	?
SUB-NATIONAL / COMMUNITY	?	?	McKinsey MACCs LUTI models (TRANUS, NEDUM) …

Source: Presentation by Patrick Criqui

Session Reports

Parallel session 1.2:
What are the potential contributions of, and how can we better involve the non-state actors, including cities and finance industries?

Chair: Giulia Gallucio, CMCC/FEEM
Rapporteur: Akihisa Kuriyama, IGES

Speakers:
Margaretha Breil, FEEM
Noriko Fujiwara, CEPS
Maike Venjakob, WI and Stefan Thomas, WI
Julia Terrapon-Pfaff, WI

This session addressed the role of non-state actors for taking on climate change issues. The first presentation, by Margaretha Breil from FEEM, highlighted the importance of cities for mitigation activities given that 75% of energy consumption and 80% of GHG emissions originate from urban areas. Transitions will require new orientations—future visions of cities can help inform short and medium-term decisions that could alter the course of trends. Complex visions, however, require systematic and inclusive approaches based on consolidated foresight and scenario approaches, for example. Foresight activities can create a platform for reflection, debate, and design of local urban futures with stakeholders, and scenarios are means for examining the factors and trends that can influence future developments. To effectively envision future situations, a backwards procedure (back-casting) approach often works better than normal scenarios, as transiting to a post-carbon future will require trends to be interrupted as well as deep changes. Combining participatory visions and back-casting scenarios can help clarify common aims and identify complex strategies for opportunising change and tackling potential obstacles. From her experiences with the POCACITO research project, she reports that in many case study cities, energy and transport were prioritised as sectors needing change, but also that changes in land use patterns, urban form and local economy and food production were needed to trigger key transformations at the urban level.

The second presentation, by Noriko Fujiwara of CEPS, introduced the roles of industries and companies in addressing climate change issues, and how to gain their participation in UNFCCC processes. Three means were put forward for the business sector: NACZA, High-level events, and the Market Mechanism / Sustainable Development Mechanism. While the shares of GHG emissions from the business sector are 25% for electricity and heat production and 21% for industry, they can help in mitigation actions via international initiatives such as the UNEP climate initiatives platform, CDP, science-based targets and We Mean Business. NAZCA has registered 11,165 commitments, but the Paris agreement and the COP decision call for more involvement from non-state actors. High-level events convened in conjunction with COP provide a platform for engaging non-state actors in high-level discussions on progress regarding climate action and joint commitments. Under the MM/SDM, private entities, once authorised, may join the mechanism and participate in the implementation of NDCs.

The third presentation, by Maike Venjakob and Stefan Thomas from the Wuppertal institute, introduced a new joint research project between Japan and Germany. Both countries are confronted with similar energy transition challenges,

and in particular in insuring it is risk-free and internationally competitive. The joint research programme addressed key priority concerns such as energy systems and market design to reduce electricity demands.

The fourth presentation, by Julia Terrapon-Pfaff of the Wuppertal Institute, introduced the WISIONS project and discussed how small-scale energy projects in the Global South, often implemented and promoted by non-state actors, can contribute to decarbonisation. WISIONS' mission is to make clean energy the default solution for basic energy needs in developing regions by helping local partners identify successes and scaling them up via regional networks, marketing and demonstration.

Decentralised, small-scale solutions play an important role in avoiding carbon-intensive development pathways in developing countries, despite difficulties in quantifying their environmental benefits, and the network approach can help give practitioners a say in the energy discussion.

Summary and key findings of the session

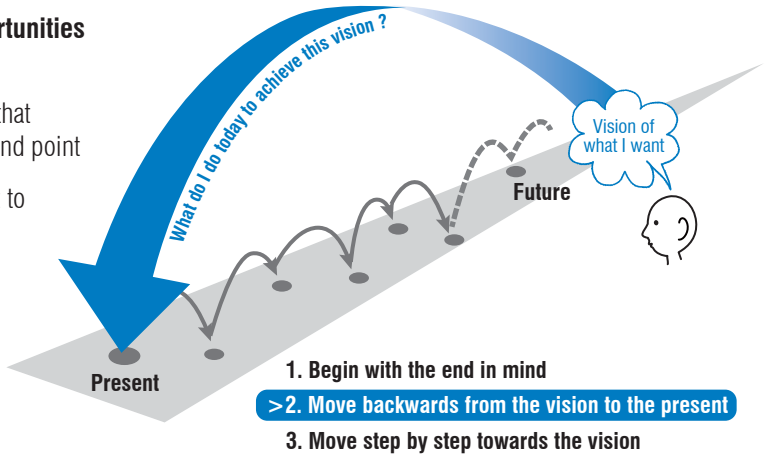
- Transition to decarbonised society with non-state actors can be started from small/pilot projects with a comprehensive impact assessment, provided common, long term goals remain visible.
- The research society and international negotiations remain key platforms to share best practices, findings and lessons learnt with other non-state actors around the world.
- Climate policy's appeal to non-state actors in initiating mitigation activities is important.

Concrete/practical steps for low carbon transformation

- Share best practices from the business sector in international climate change negotiations to develop a framework for facilitating action by the non-state sector.

Methods: Participatory Backcasting

1. Define a normative "desired" end point (the **vision** from the previous visioning workshop)
2. Consider potential **obstacles** and **opportunities** in reaching the end point
3. Identify **milestones** or interim projects that would signify progress in reaching the end point
4. Define **actions** that must be taken to get to the end point
5. Validate the **robustness** of actions in the case of other background scenarios playing out



POCACITO

Source: Presentation by Margaretha Breil

2nd session

Session Reports

Plenary Session 2:
How could a "new deal" for green growth be designed and achieved?

Chair: Jean Charles Hourcade, CIRED
Rapporteur: Christophe Cassen, CIRED

Speaker:
Jean Charles Hourcade, CIRED

This session explored ways to catalyse implementation of the low carbon transition in light of the Paris Agreement. COP21 sent a strong political signal of the urgency and compelling nature of the transition, particularly in Art 2, which calls for alignment of financial flows along a new trajectory of global economic development. On the other side, however, there is a temptation amongst 'climate agnostic' decision-makers to postpone action until the end of the current economic doldrums. Succumbing to this temptation would deprive the international community of a tool to respond to today's challenges of finding robust sources of growth, reducing debt, creating jobs, preventing and alleviating poverty and fulfilling Sustainable Development Goals (SDGs).

We thus need to build on the positive message on the urgency of climate action and its long term co-benefits and consider how to launch a new deal to trigger a Green Growth regime. At the centre of this regime lies an innovative financial intermediation proposal designed to link the climate and macroeconomic agenda. Its unique feature consists of combining public guarantees on a new asset which allows the Central Bank to provide new credit lines refundable with certified reduction of CO_2 emissions (carbon certificates) priced at a Value of Climate Remediation Activities (VCRA). This would help reduce the uncertainty risks of investment in green infrastructure and boost final demand in the world economy over the short term. Art 108 of the Paris Agreement, which calls for recognising the "social, environmental and economic value" of carbon mitigation measures (SVMA), could act as an anchor for such a system. Numerical simulations stress the positive impacts for Europe of such a system, in the short term, on the labour market, trade balance which lead to more inclusive development.

Summary and key findings of the session

- Convincing climate agnostic policy-makers to accelerate the low carbon transition in the short term requires a "new deal" based not only on a comprehensive policy package that includes fiscal reforms (using carbon price as the lubricant of change) but also innovative financial systems as the 'fuel' of change.
- Based on Art 108 of the Paris Agreement, agreeing on Social Value of Mitigation Actions (SVMA) would act as an anchor to this innovative financial system by expressing the value of a 'common good', as it would add value to a new class of publicly-guaranteed assets to lower investment risks into green infrastructures.
- This policy package would bridge the 'credibility gap' of climate policies and help move trillions of dollars to finance the low carbon transition. It would also help in untying the Environment Gordian Knot between North and South countries and solving the '100G$ and beyond' commitments of the Paris Agreement.

Session Reports

Parallel Session 2.1:
Carbon pricing and redesign of financial instruments as a lever for change

Chair: Christophe Cassen, CIRED
Rapporteur: Rahul Pandey, Integrated General Systems Analysis Laboratories

Speakers:
Alfredo Sirkis, Centro Brasil no Clima
Etienne Espagne, CEPII
Michael Jakob, MCC

This session saw insightful discussion on carbon pricing and monetary instruments, especially those based on the positive social value of carbon emission reductions, required to drive deep decarbonisation.

Alfredo Sirkis emphasised the need to recognise the intrinsic social and economic value of carbon reduction and removal as a precondition to transitioning to meet the 2 degrees or stricter target as mentioned in paragraph 108 of the Paris Agreement. This is the next logical step forward from, and in line with, Article 2 of the Paris Agreement that exhorted the global economies to make financial flows consistent with a pathway towards low GHG emissions and climate-resilient development.

Even if the presently committed INDCs were implemented, we would still be a long way off meeting this target. An amount of 100-120 billion USD per year is also insufficient compared to the overall investment needed for low carbon options. Although carbon markets and real pricing mechanisms, including carbon price for taxation and ending subsidies on fossil fuels, have helped clean energy compete, these efforts are inadequate and beset with problems of double counting and national policy domain constraints. In contrast, positive pricing of carbon removal based on the COP21 'recognition of value' principle has the potential to drive faster and targeted investments and actions towards decarbonisation. It could be backed by governmental guarantees for carbon reduction certificates issued by a 'Climate Club' of major governments, central and development banks and multilateral institutions. As governments can provide guarantees worth billions of dollars, this would remove the perception of high upfront costs and risk for private financial sectors, which might nudge them into channeling much larger investment sums. Key challenges for this proposal are to establish a single institution capable of implementing it, design the agreements to manage carbon reduction certificates, determine the basis for their allocation and price, and deal with potential opposition.

Etienne Espagne elaborated on the three systemic risks of climate change (physical risks, liability risks and transition risks), the lack of integrated policy response and inadequacy of present instruments to deal with them, and how climate finance can help avoid them.

Since COP21 the social value of carbon has gained wider recognition, and consequently, more integrated policy initiatives have begun.

Policies that mitigate climate systemic risk must entail information sharing, specific investment vehicles, macro-prudential instruments, extension of monetary policy objectives to include attaching social value to carbon, and restoring confidence in the financial system through collective insurance mechanisms and central bank interventions. France has proposed a commission be set up at the UN level to provide social value metric for carbon and specific instruments to reduce risk.

Michael Jakob introduced his ideas on carbon

pricing revenues to finance infrastructure access and thereby meet the twin goals of mitigating climate challenge and eradicating poverty. Carbon pricing could thus combine GHG emission reduction and socio-economic development in the framework of sustainable development goals (SDGs).

Carbon pricing will generate revenues which could be used to build essential infrastructure such as for health, sanitation, water and electricity, and hence foster sustainable development. Attaching a price to carbon would also overcome the distributional challenge typically faced with subsidy mechanisms; and it could have a doubly progressive distribution impact, as a higher proportion of poor people would pay less but gain greater access to infrastructure.

Further, carbon could be priced by a particular country in accordance with its existing infrastructure gap, and the international community could facilitate in fair distribution of carbon price revenue among nations based on their infrastructure needs. Fossil fuel subsidy reform could also release additional funds that could supplement carbon price revenue for building infrastructure.

International climate finance could provide funds in exchange for carbon pricing instead of project-based finance. This could assist in domestic resource mobilisation for SDG financing.

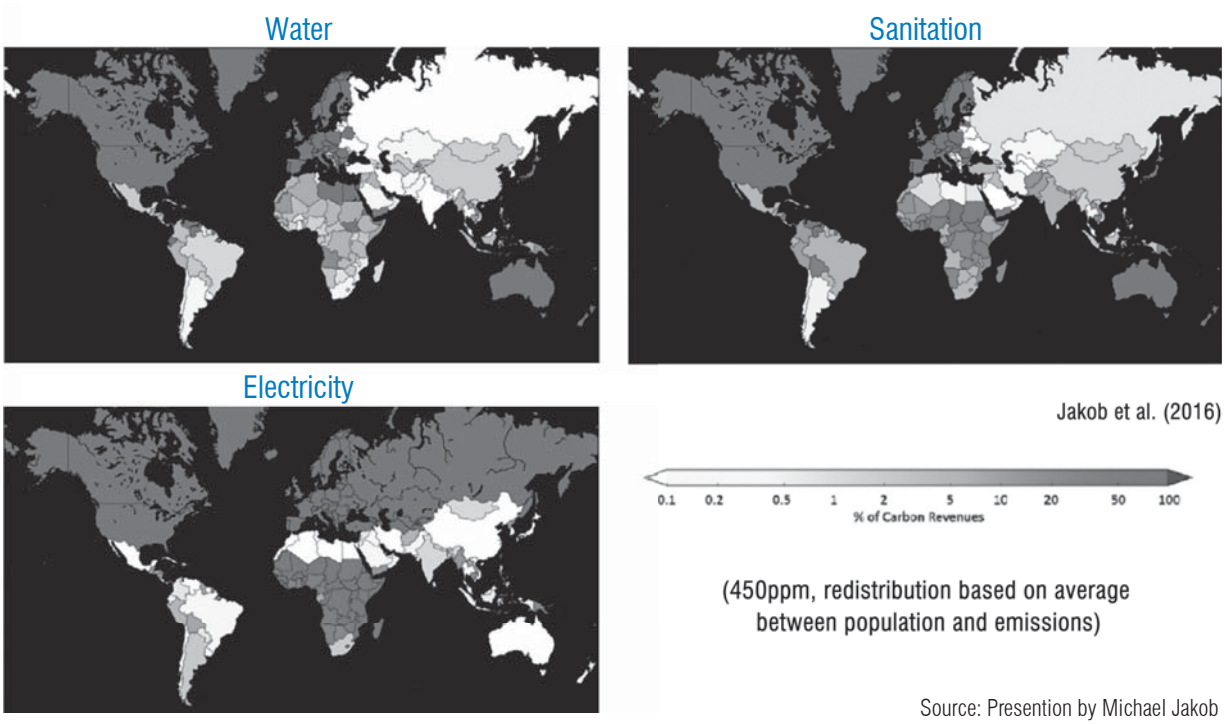
Summary and key findings of the session

- While INDCs, carbon markets and real pricing mechanisms cannot meet the 2 degrees target, positive pricing of carbon emission reduction based on the COP21 'recognition of the social, economic and environmental value of mitigation actions' principle could drive faster and targeted investments and actions towards decarbonisation.
- Mitigating systemic climate risks requires an integrated policy response including information sharing, specific investment vehicles, macro-prudential instruments, extension of monetary policy objectives to include a social value of carbon, and restoring confidence in the financial system through collective insurance mechanisms and central bank interventions.
- Carbon pricing revenues could finance infrastructure and sustainable development, especially in developing countries, and thus help to meet the two key challenges—poverty reduction and climate change mitigation.

Concrete/practical steps for low carbon transformation

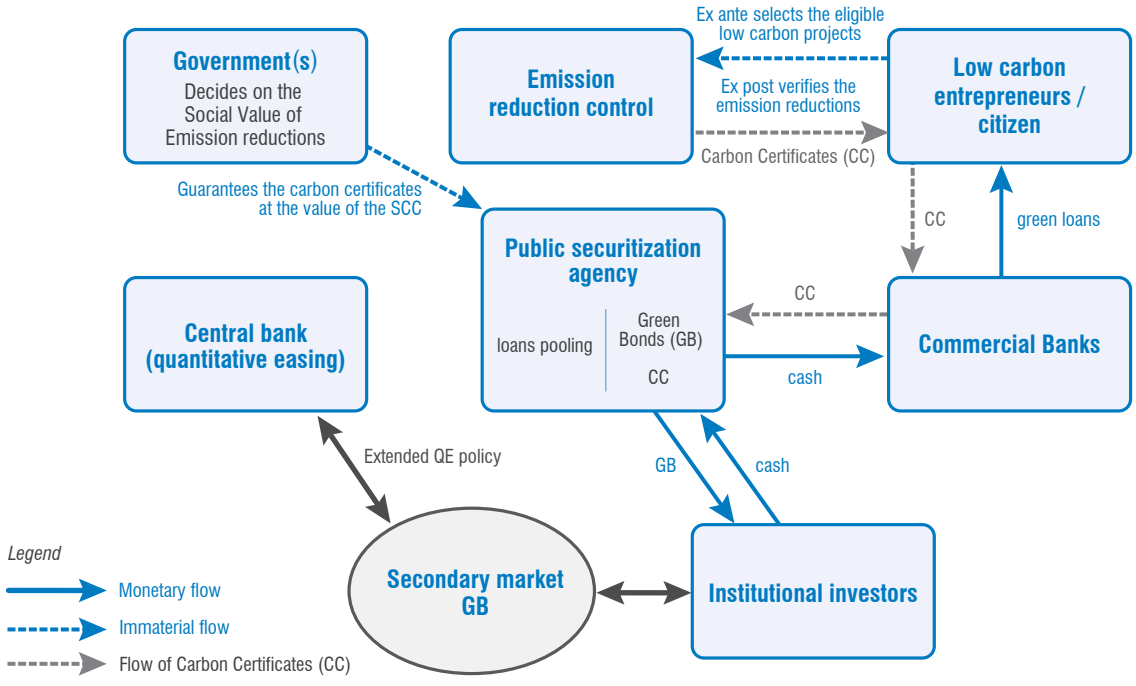
- Institution(s) and mechanisms of carbon reduction certificates that embody a positive value of carbon emission reduction and are backed by guarantees from major governments need to be worked out and implemented.
- It is crucial to estimate the social value of carbon to reduce systemic climate risks, a task that should be tackled at the UN level.
- Carbon pricing must be linked to building infrastructure for sustainable development and poverty alleviation.

Share of Carbon Pricing Revenues (2015-2030)



Source: Presention by Michael Jakob

A proposition (Hourcade et al., 2015)



Source: Presentation by Etienne Espagne

Session Reports

Parallel session 2.2:
Climate financing (lessons learned from financial instruments already implemented)

Chair: Tomonori Sudo, Ritsumeikan Asia Pacific Univ.
Rapporteur: Akihisa Kuriyama, IGES

Speakers:
Simon Buckle, OECD Environment Directorate
Peter B. Meyer, University of Louisville / The E.P. Systems Group, Inc.
Thomas Wyns, VUB
Christine Wörlen, AREPO

This session highlighted the issues on climate financing, particularly lessons learned from financial instruments already implemented.

The first presentation, made by Simon Buckle of the OECD Environment Directorate, provided results of analysis on climate finance by OECD member states.

Buckle pointed out several high-level issues on mobilising climate finance, including the need for systems transformation and resilience, coherent and effective public interventions, and closing the gap between climate investment needs and flows. He also reported on the progress of several works done by OECD: 'Research collaborative on tracking private climate finance', as well as statistics for tracking officially supported climate finance using the OECD Development Assistance Committee (DAC) statistics system.

The OECD estimates 57 billion USD of climate finance, 22.8 billion of which comprised bilateral finance, was mobilised during 2013–2014. Through the process of estimation, OECD found it challenging to develop a methodology to assess mobilised private finance attributed to public finance.

Among others, adaptation activities suffer from 'underfunded' finance, according to the OECD's estimation. According to DAC statistics, 75% of climate-related development finance was allocated to mitigation. Most activities were supported by concessional or non-concessional loans, and 80% of the mitigation finance was received by the middle income countries. Conversely, 37% was allocated for adaption, and 39% of adaptation finance was received by LDCs, and most were supported by grants. Challenges for the OECD are improvements in coverage, quality and communication of DAC statistics as well as outreach with country partners to improve its accessibility.

The second presentation was given by Peter B. Meyer, and highlighted finance in urban climate actions based on the work for the Second Assessment Report on Climate Change and Cities (ARC3-2) carried out by Urban and Climate Change Research Network (UCCRN). Meyer pointed out several issues on urban climate finance: Cities require about 6 trillion USD for annual infrastructure investment, but availability of finance is limited due to the lack of city's creditworthiness in the international financial market. Several international initiatives, such as 'Low Carbon Livable Cities', 'City Creditworthiness Initiative', 'Compact Mayors' and 'Emerging and Sustainable Cities Programme', were introduced. In reference to CCFLA's work, six major barriers were identified: uncertainty over regulatory and tax policy, difficulty in incorporating climate goals, lack of city expertise, insufficient city control, high transaction cost and lack of proven funding model. In addition, he pointed out the low awareness of the financial sector on climate

risks to capital, as well as new opportunities for profit and the importance of shifting fossil fuel subsidies to support renewable energy and energy efficiency projects. He also emphasised the need for carbon pricing and carbon risk disclosure by standardisation of the data protocol and reporting so as to make clear the risk and return profile of climate actions for private investors, and to make projects bankable even if the city itself lacks creditworthiness.

The third presentation was made by Thomas Wyns, who provided an overview of a report 'Decarbonising Europe's Energy Intensive Industries – The Final Frontier', which identifies options for deep GHG emission reductions by EU energy intensive industries: chemicals, steel and cement. He highlighted innovative process technologies, which significantly improve emissions performance compared to current (state-of-the-art) technologies. However, moving towards decarbonisation in these industries needs to look beyond process changes and consider other relevant options such as product and business innovations. Further, he emphasised the need for investment in transitioning technology over the coming 10–15 years and that public policy needs to play a catalytic role. From the result of his analysis, he summarised four policy recommendation, or, role of public policy includes cohesive vision on competitive future of EU energy intensive industries; support modernization and rationalization in case of production over–capacity; support pilot of promising new process technologies, and; use public procurement product standards to create new market. At the end of his presentation, he proposed a design for the EU-ETS innovation fund. In July 2015, the European Commission proposed specific amendments to the current EU ETS, to become operational from 2021. The innovation fund is part of this proposal. Some of the key factors he pointed out as necessary to improve the EU-ETS Innovation Fund are technology achievement parameters, performance milestone-based reward enabler, financing mechanism portfolio, governance, public procurement option, and fast-track state aid approval.

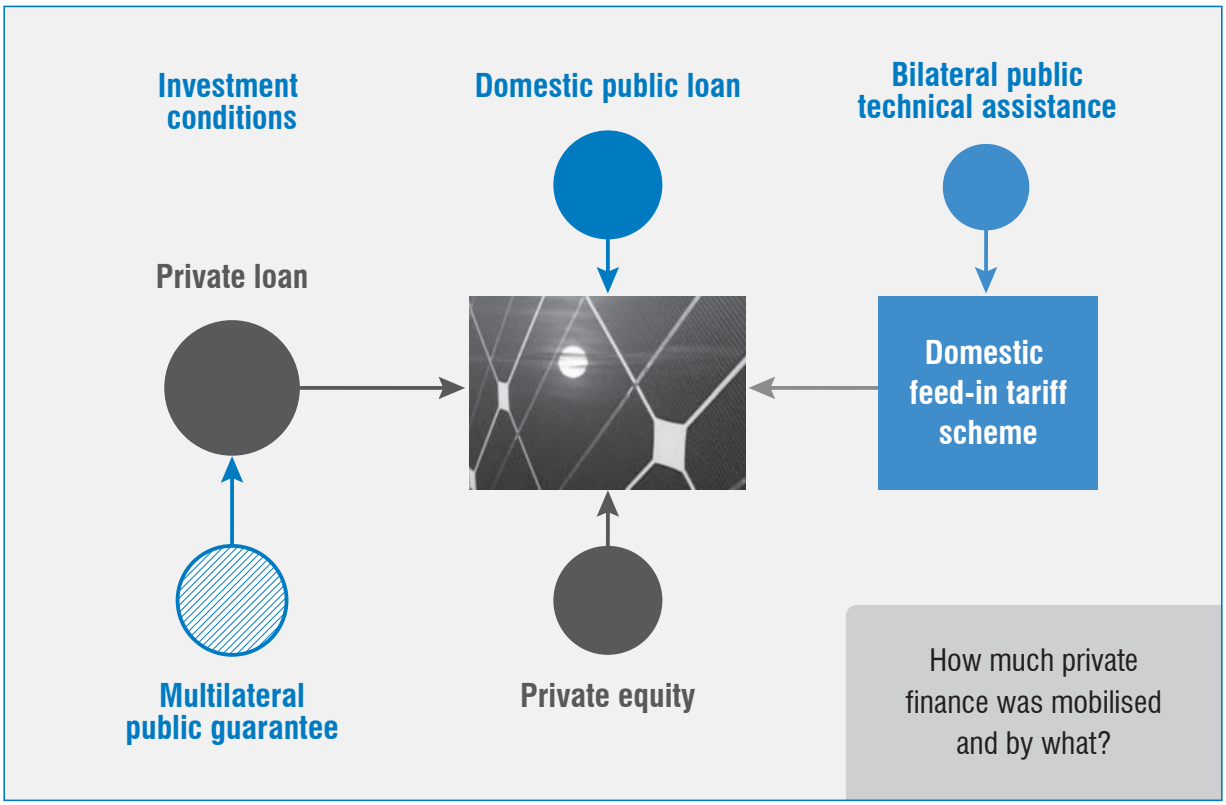
The last presentation, by Christine Wörlen, summarised her study on lessons from climate finance. First, she highlighted differences in the definition of climate finance: for some it means all financing related to climate-relevant purposes, and for others it means financing towards the commitments of Annex II Parties to the UNFCCC. She pointed out several challenges in climate financing, such as limited "Readiness"; the difference in time cycle in which project preparation required long timeframes and achievements/ results are expected within short timeframes; lack of accepted projects, programmes and best practices; differences in counterparts (Ministry of Environment vs Ministry of Planning/ Ministry of Finance); risk aversion and resistance to innovation in conventional industries. Such challenges also make it difficult to link Low Carbon Development Strategy with finance. Wörlen also highlighted some activities that are financially relevant but not recognised as climate finance, such as portfolio decarbonisation and the fossil fuel divestment campaign. In addition, matters on the time dimension of investments were also highlighted. Financial institutions do not necessarily recognise the risk of "Stranded assets", and mainly finance climate-proofing infrastructure as adaptation finance. Thus, the capacity of both financiers and recipients needs to be developed.

Summary and key findings of the session

- Mobilising and tracking of climate finance are not easy tasks. Even if climate actions by state and non-state actors are increased, financing of such actions is a further challenge.
- Governance of finance is one of several critical barriers. Risk sharing and derisking are useful instruments to mobilise climate finance; however, financial institutions may not be conversant with either climate risks or risks to assets (including stranded asset risk). Further, recipients need to strengthen their absorptive capacity ('readiness').
- Investment in technological transformation is one of several effective means, in which public policy should play a key role. Linking low carbon development strategies (LCDS) with finance is critical to enabling public policy to play a catalysing role to enhance investment in transformation of technologies towards low carbon society.

Concrete/practical steps for low carbon transformation

- Further collection and study of best practices and dissemination of study results to policymakers and practitioners is necessary.
- Capacity needs development for governance and management of climate finance for financial institutions and recipients, as well as policymakers.
- Effectiveness of investments in technological transformation needs analysing.



Source: OECD Research Collaborative on Tracking Private Climate Finance (2016)

Session Reports

Plenary Session 2.3:
Panel discussion: How could a “new deal” for green growth be designed and achieved?

Chair: Sergio La Motta, ENEA
Rapporteur: Rahul Pandey, Integrated General Systems Analysis Laboratories

Panelists:
Jean Charles Hourcade, CIRED
Thomas Wyns, VUB
Alfredo Sirkis, Centro Brasil no Clima

This panel discussion saw some valuable ideas put forth about how investments for green growth could be achieved in reality, and what role public funding could play.

Alfredo Sirkis began by stating that unlike the original “new deal”, we cannot solve the climate change crisis by direct public investment alone, since major governments are in debt and public funds are limited. The climate mitigation target could, however, be met by a combination of strategies, including introduction of a positive carbon removal price in line with the COP21 principle that recognises the intrinsic value of mitigation, backed with government-funded guarantees and implemented under leadership of the G20 and/or UN. Towards this direction a practical measure that can be implemented immediately is quantitative easing targeted at carbon reduction actions.

Thomas Wyns stressed the need to revive the role of the public sector and government funding to foster innovations for green growth. He recalled that although the public sector played similar roles in kick-starting some of the major innovations and industries in the past, in recent times such role has diminished, resulting in a loss of capacity to innovate and a large proportion of populations feeling disenfranchised in the new economy. The roles of the state and public sector therefore need to be resurrected in order to catalyse decarbonised growth. Initial signs of this happening can be found, for instance, in the increased funding of UNFCCC and EU infrastructure, although such funding needs to be steered in the green direction.

Jean Charles Hourcade spoke about the importance of launching a process aimed at such “new deal”, and which must address and mitigate the North-South distrust with respect to funding and other crucial issues. Removal of this distrust would result in several positive outcomes—for instance in developing countries possibly committing public guarantees for funding in green investments.

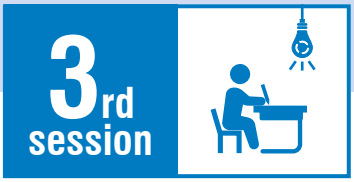
During the Q&A session it was also pointed out that while carbon pricing is an important instrument, there is a need for clear signals not linked with economic instruments to trigger hard actions, such as shutting down coal power facilities. Further, innovations are the key as climate change mitigation cannot be a zero-sum game. Low carbon and green products/services must be win-win solutions that overcome apparent trade-offs between the environment, cost, growth and user comfort.

Summary and key findings of the session

- Role of state and public funding towards triggering major industrial/market innovations needs to be resurrected.
- Innovation is the key to low carbon transition. Sustained innovations for a decarbonised, 'green growth' world in turn require a paradigm shift.

Concrete/practical steps for low carbon transformation

- Value placed on carbon removal must be estimated based on both economic and cultural aspects.
- An effective way of using public money must be found in order to funnel much larger funds in private markets into green and low carbon investments.
- Certain hard actions, such as shutting down coal power facilities, must be taken independently of economic instruments, which may require public funds to ensure smooth implementation and resolve any accompanying conflicts.



Session Reports

Plenary Session 3:

How to explore and exploit the synergies between the Sustainable Development Goals (SDGs) and low carbon societies?

Chair: Antonio Navarra, CMCC
Rapporteur: Rahul Pandey, Integrated General Systems Analysis Laboratories

Speakers:
Henri Waisman, IDDRI
Timur Gül, IEA

The session delved into methodologies that explicitly consider both sustainable development and climate mitigation goals.

Henri Waisman described the methodology of the DDPP project and drew some interesting lessons from it. The articulation of objectives to reflect both climate mitigation and sustainable development goals was an important starting point. Each country's research team had the flexibility to use its own modeling framework and focus on its domestic development priorities as well as common deep decarbonisation goals. The framework adopted by national teams generally comprised a model as well as a mix of varied assessment methods that reflected multiple developmental concerns and ground realities facing each country. Multiple scenarios were explored in order to explore resilient transformation pathways under uncertainties. Common but broad guidelines (for example, to build consistent, bottom-up national perspectives that consider both deep decarbonisation and domestic sustainable development priorities) and standard reporting templates helped to synergise the results of different countries and make these useful tools for communication to decision-makers.

Such country-level assessment methodologies that articulate both climate mitigation and domestic development using common templates could assist in identifying areas where actions must be accelerated on mitigation and development, in planning short-term domestic changes required to meet both climate and development goals, and in revising NDCs with more ambitious mitigation targets consistent with domestic capacity and sustainable development.

International collaborative processes and platforms such as DDPP and LCS-RNet that consider climate mitigation together with bottom-up, country-specific developmental goals could inform both domestic development policy and international climate policy. In addition, they could offer varied domestic perspectives to IPCC's and help it achieve complementarity between top-down and bottom-up results. DDPP and LCS-RNet could thus act as the essential bridge between national and global research and policy processes.

Timur Gül established the link between solving the air pollution problem in various countries, especially developing countries, and mitigating CO_2 emissions, thus highlighting the synergy between strategies to address an important domestic environmental problem and climate change.

While the countries in Asia (including China and India) and Africa presently face the severest health impacts of air pollution (both indoor and outdoor), many other countries (including Europe) have not resolved the problem completely. The chief cause is energy, particularly coal, oil and biomass

use. Although present and future decarbonisation policies will be partially successful in decoupling air pollution from growth in energy demand, they cannot solve the problem. Therefore, an explicit Clean Air Strategy is needed.

IEA's Clean Air Strategy scenario could cut air pollution and related premature deaths by about half, while only requiring a 7% increase in investment. This scenario, based on existing technologies and tailored to local conditions, comprises actions in three areas: (i) a long-term air quality goal, (ii) a package of clean air measures such as greater energy efficiency, renewable energy, and widespread use of advanced pollution controls, and (iii) stricter monitoring and enforcement and effective communication. A well-designed air quality strategy will also have major co-benefits such as improving energy access, meeting the SDG targets of renewable energy and energy efficiency by 2030, lowering the energy import bill, and leading to a peak in CO_2 by 2020. However, while the Clean Air Strategy will reduce energy related CO_2 emissions, more efforts will be needed to achieve the 2 degrees target.

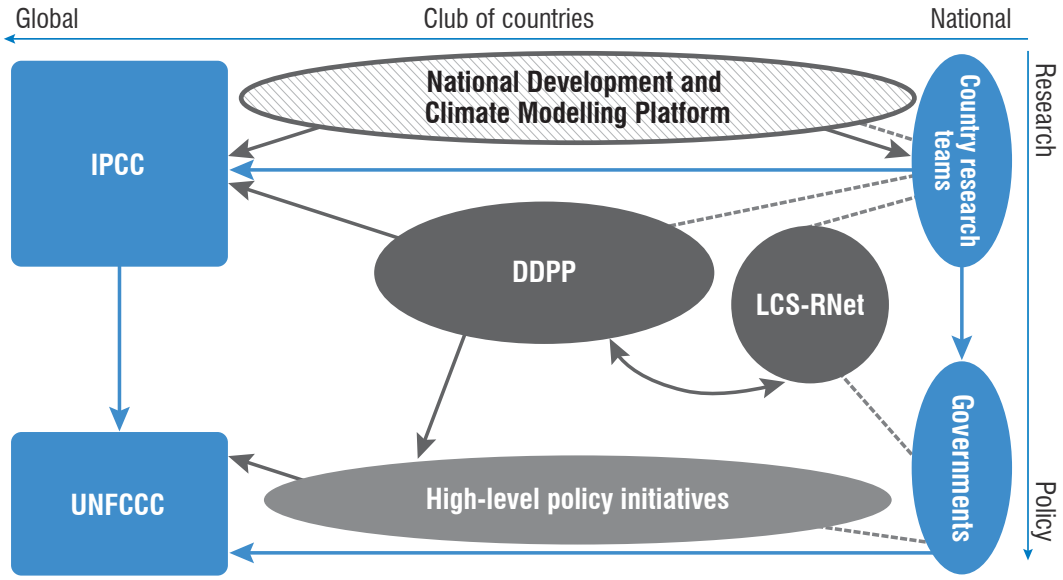
Summary and key findings of the session

- Experience of DDPP suggests that an effective way to achieve synergy between SDGs and low carbon societies is to adopt a flexible methodology that facilitates active collaboration among different countries, articulates objectives to reflect both climate mitigation and sustainable development goals, permits use of a mix of assessment methods that reflect multiple domestic developmental concerns specific to each country, and uses common templates for reporting and effective communication.
- International collaborative processes/platforms such as DDPP and LCS-RNet that consider climate mitigation together with bottom-up, country-specific developmental goals could act as bridge between, and inform, national and global research and policy processes.
- The majority of countries in Asia and Africa are facing severe health impacts of rising air pollution, primarily due to fossil fuel and biomass energy use. Although decarbonisation policies will be partially successful in decoupling air pollution from growth in energy demand, they cannot solve the problem. Therefore, a Clean Air Strategy is needed to directly solve air pollution problems with co-benefits for energy-related CO_2 reduction. Such a strategy can effectively meet the twin goals of sustainable development and climate change mitigation.

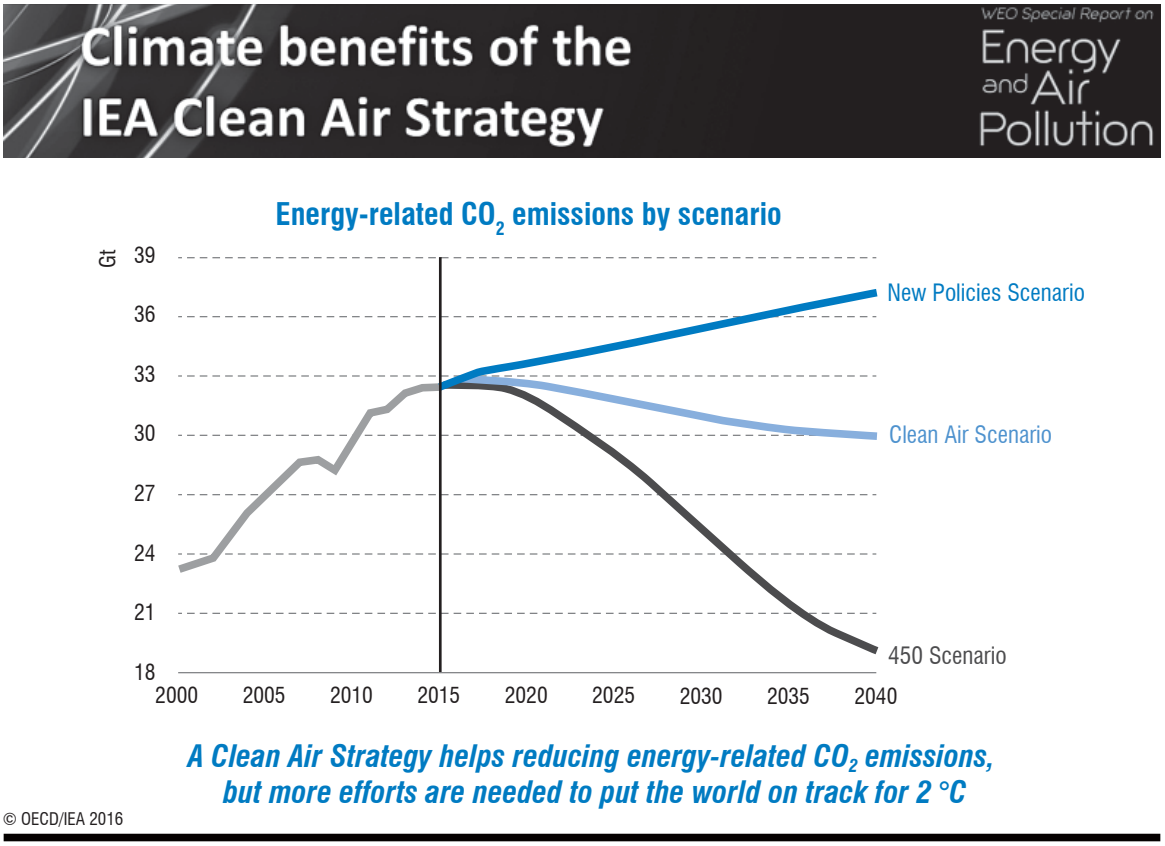
Concrete/practical steps for low carbon transformation

- There is a need to further strengthen and spread processes such as DDPP and LCS-RNet that articulate both sustainable development and decarbonisation goals and adopt a flexible process that facilitates active collaboration among different countries' researchers and policymakers while also permitting use of multiple assessment methods to reflect the diverse domestic developmental priorities of different countries.
- A Clean Air Strategy needs to be designed to control air pollution and its health impacts together as well as offer significant co-benefits of enhanced energy access and mitigated CO_2 emissions.

Articulating research and decision making



Source: Presentation by Henri Waisman



Source: Presentation by Timur Gül

Session Reports

Parallel Session 3.1:
Technology concepts and ambitions of carbon-neutral or 100% renewable societies

Chair: Stefan Lechtenböhmer, WI
Rapporteur: Rahul Pandey, Integrated General Systems Analysis Laboratories

Speakers:
Mikiko Kainuma, IGES and NIES
Harry Lehmann, UBA

This session introduced global, Japan's and Germany's scenarios corresponding to a very low carbon or carbon-neutral world that nears the 1.5 degrees target, and the implications thereof for technology and policy.

Mikiko Kainuma presented GHG mitigation and climate change impact scenarios, and demonstrated that scenario analysis is useful in assessing options to achieve low carbon or carbon-neutral futures, to inform policymaking, and to raise awareness among various stakeholders.

Global and Japanese scenarios were assessed by the AIM modelling team of Japan. First, four global mitigation scenarios were assessed. All four use the shared socioeconomic pathway-2 (SSP2), i.e.,middle-of-the-road world facing moderate mitigation and adaptation challenges, as a reference, but vary from implementing only the INDCs until 2030 to meeting the 2.6 W/m^2 radiative forcing and 1.5 degrees targets.

Results show that while the 1.5 degrees target is feasible, certain obligations must be met:

- Starting GHG reduction early at the global level is essential; negative emissions options contribute little.
- Share of renewables needs to be increased drastically, which is more feasible after 2030.
- Pre-2030 primary energy use needs reducing via efficiency improvements due to limitations on early ramp-up of renewables.
- Impacts on water-stressed populations and assets exposed to flooding in various regions are mitigated in the 1.5 degrees scenario. The tipping point temperature that destabilises the Greenland ice sheet is likely to be avoided in this century in the 1.5 degrees scenario. Economic benefits of such mitigated impacts could compensate for the GDP loss.

Second, mitigation scenarios analysed for Japan indicate that achieving an approx. 25% reduction in 2030 and 80% in 2050 (compared to 2005) is technically feasible even without nuclear power. However, rapid reduction is essential after 2030. Besides energy efficiency and renewable energies, innovative technologies such as CCS will be important options. End-use will be significantly electrified after 2030 and electricity will be almost fully decarbonised by 2050. While NDCs are meaningful, much more effort will be needed after 2030.

Key challenges to implement these options for 80% reduction by 2050 are: (i) Integration of variable renewable energy after 2030, (ii) Technologies such as back-up energy systems, efficient, high capacity batteries, and reliable grids, (iii) Policies such as carbon pricing, feed-in tariff, emissions trading, regulations linked to best available technologies, and policies to increase employment with low carbon systems, and (iv) increasing public awareness through dialogue among stakeholders and international collaboration.

Harry Lehmann provided an overview of a very low carbon scenario for Germany using a cross-sectoral approach and holistic scenario analysis, but without considering CCS, nuclear and expansion of bioenergy. Germany's goals of 40% GHG reduction in 2020 and 80–95% reduction in 2050 (95% is in line with 1.5 degrees global target and analysed in the scenario presented) imply a GHG-neutral German economy in 2050 with 80–100% share of renewable energy in electricity, halving of final energy use by 2050, resource-efficient economy, and 1 tonne CO_2 emission per capita.

Some major characteristics of this GHG neutral pathway are:

- 100% renewable energy in power, heat, transport and industry;
- Intensive deployment of technological measures for GHG reduction in all sectors;
- Ecological and sustainable agriculture and change in lifestyle and food habits, especially meat consumption;
- High recycling rate and use of secondary materials, and major reductions along entire value chains.

This is feasible provided the following challenges are met: (i) suitable energy policy changes are undertaken, for example with respect to importing of electricity, triggering changes in major sectors such as air transport, buildings and industry, co-location of energy-complementary industries, support for new technologies including a range of renewable electricity generation routes, and achieving the right balance between decentralised and centralised energy systems; (ii) a range of storage technologies are explored such as electric vehicles, gravitational storage, pumped storage, power-to-liquid, power-to-gas and gas grid; (iii) development plans that enable cross-sector coupling will permit a greater efficiency of energy (and material) production and end-use chains, for instance by co-locating energy-and-material complementary industries; establishing new industries whose energy (and material) needs are complementary to existing ones; and by using multiple conversion-storage methods such as power-to-gas and power-to-liquid; and (iv) a system for managing waste generated from renewable energy and other low-carbon technologies.

Summary and key findings of the session

- While meeting the 1.5 degree global target and drastic GHG reduction targets by 2050 for Japan and Germany are feasible, starting reduction early is essential. End-use energy efficiency improvement, renewable energy and several technology innovations will be the major contributors. Simultaneously, a range of policies and public awareness measures are crucial.
- Dramatic reduction in final energy use, rapid acceleration in electrification, and almost complete decarbonisation of electricity by 2050 are common characteristics of all GHG neutral scenarios.
- A cross-sectoral assessment and policy is important to explore a wide range of options and synergies, such as through co-locating energy- and material-complementary industries, reducing resource use and increasing recycling and reuse throughout entire cross-industry and cross-sector value chains, and harnessing multiple energy conversion-storage options.

Concrete/practical steps for low carbon transformation

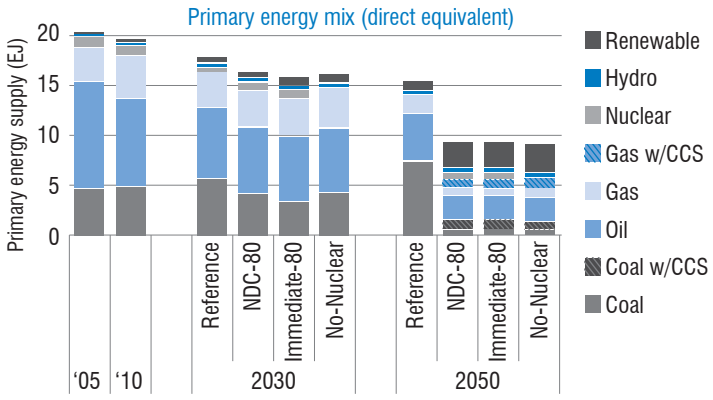
- Development and diffusion of key technological innovations that will help in rapid decarbonisation must be accelerated, such as end-use energy efficiency improvements in the immediate-term; integration of

variable renewable energy, reliable grids, back-up energy systems, power-to-gas and power-to-liquid, efficient, high capacity batteries, and multiple energy conversion-storage options by 2030; and possibly CCS as well as other break-through technologies for material processing industries during 2030–2050.

- A highly comprehensive mix of policies must be introduced such as carbon price, feed-in tariff, emission trading, regulations linked to best available technology, and policies to increase employment with low carbon systems.
- Policy and development plans must enable cross-sector coupling that will permit a greater efficiency of resource (both energy and material) use across entire value chains, for instance by co-locating energy-and-material complementary industries and by using multiple conversion-storage methods such as power-to-gas and power-to-liquid.
- Programmes must be taken up to increase public awareness and lifestyle changes (including food habits) through dialogue among stakeholders and international collaboration.

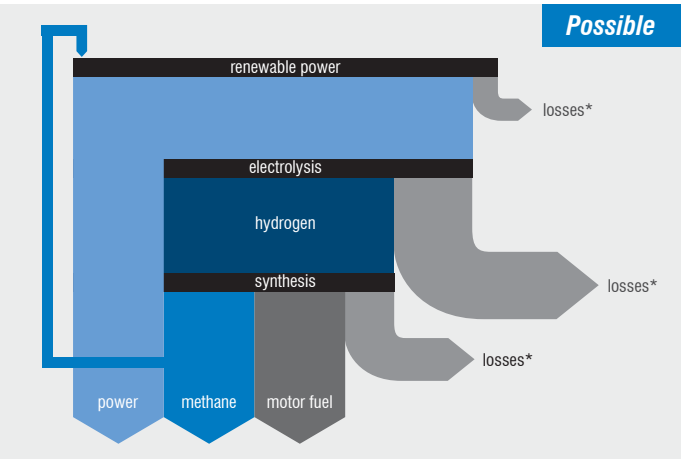
Results: Primary energy mix

- Energy efficiency and low-carbon energies are key options
- Share of low-carbon energies (NDC-80):
  - ➢ 12% in 2030, 59% in 2050
- Innovative technologies such as CCS could be important options by 2050

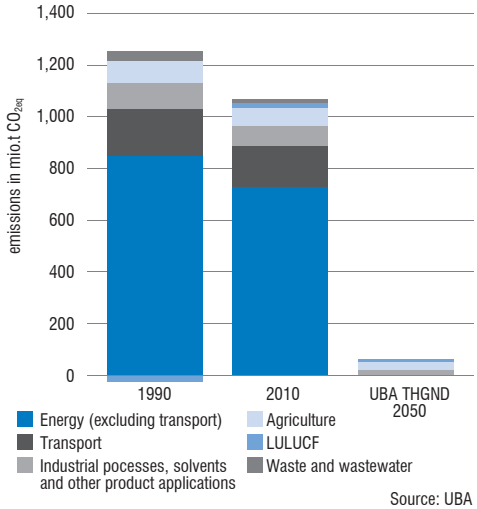


Source: Presentation by Mikiko Kainuma

UBA-Study: GHG-neutral Germany in 2050



Qualitative representation of the energy flow in the UBA THGND 2050 Scenario



Source: UBA

Source: Presentation by Harry Lehmann

Session Reports

Parallel Session 3.2:
Cities as places for transition and hotspots for future sustainable developments (including productive interaction with rural regions)

Chair: Ralf Schüle, WI
Rapporteur: Marie-Christine Gröne, WI

Speakers:
Nicola Tollin, RESURBE / RECENT Recycling City Network
Johannes Venjakob, WI
Damasa B. Magcale-Macandog, University of the Philippines Los Baños

This session explored the role of cities as places of transition and hotspots for future sustainable development. Each of the three different presentations highlighted other aspects of the topic: the importance of open spaces for urban resilience, participatory watershed land-use management and strategies for climate neutral urban development. The common thread was the emphasis on the myriad benefits generated by integrating different goals of urban planning.

In the first presentation, Nicola Tollin explained the triple dividend of urban resilience transition, i.e., a) adaptation & mitigation to react to climate change challenges, b) sustainable development with a focus on economic and social aspects and c) the ability to address specific local challenges. In the second part of the presentation, Tollin delved into two successful case studies from Colombia. Important lessons learned include: the participatory character of the project leads to re-appropriation of the territory by the community; conflict potential might arise due to knowledge gaps as well as time and space conflict.

The second presentation, by Damasa Magcale-Macandog, set out in detail the case study of Silang-Santa Rosa Subwatershed, Philippines. Massive land use changes in past decades have resulted in increased damage from flooding, environmental degradation, pollution and waste. A participatory watershed land-use management project was conducted to increase adaptation and mitigation strategies in the region, and comprised a four step process:

- A participatory GIS based scenario process to reveal future development and land use
- Risk assessment by mapping current and modelled future flooding areas
- Participatory climate change measure development (CCMD) including the definition of priority measures
- Active dissemination of the results of climate sensitive land-use into the population, civil society and local planning authorities

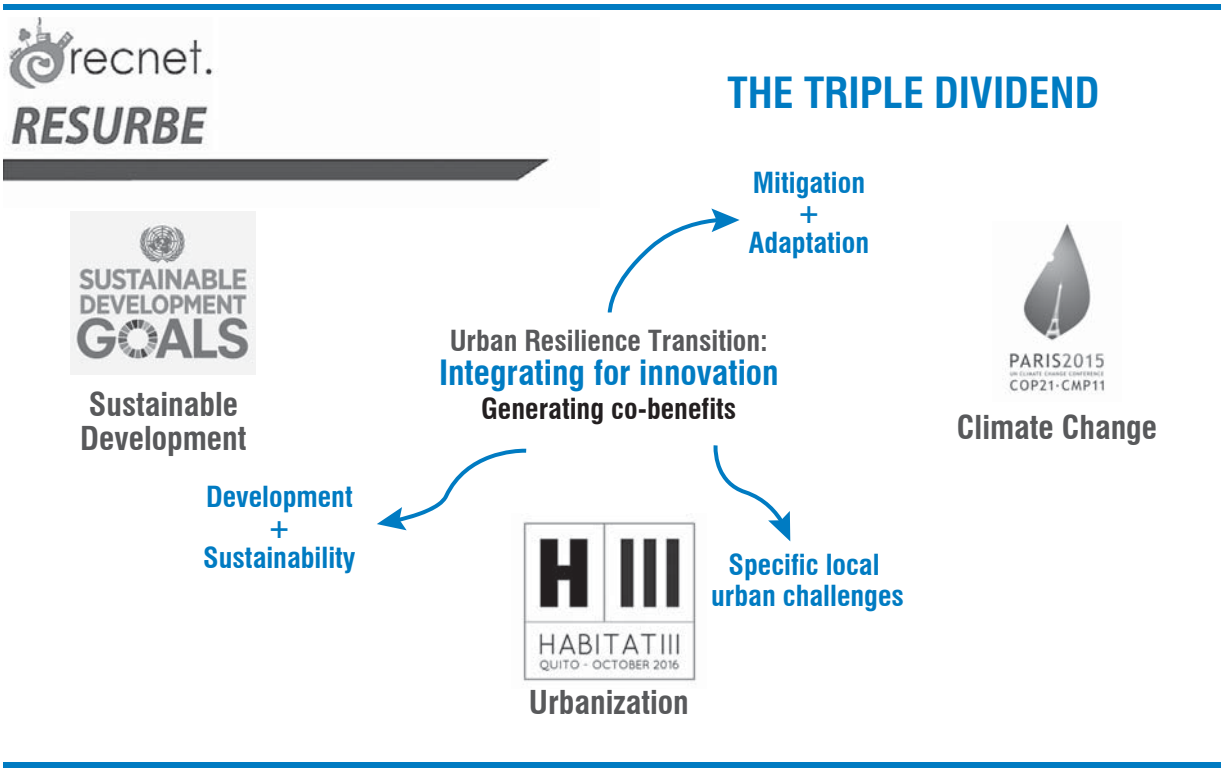
Johannes Venjakob provided an in-depth case study, Innovation City Ruhr (ICR), a bottom-up project that aims at reducing the CO_2 emissions of a Model City, Bottrop, Germany, by 50% between 2010 and 2020. He explained how cities can serve as laboratories for climate mitigation, and that the ICR-Management Association, together with multiple local and regional stakeholders, has already implemented over 300 projects in this area. Fields of action comprise living/neighbourhood development, work, energy/power supply and systems, mobility, and sustainable cities and location development, which together had already realised a 37.5% reduction in CO_2 emissions by 2015. The project "Innovation city roll out" identified 20 other quarters in 17 cities in the Ruhr area for which Bottrop serves as a blueprint.

Summary and key findings of the session

- The city level offers interesting preconditions for bottom-up and participatory transition approaches.
- Mitigation in combination with adaptation measures offers a variety of co-benefits (i.e., employment opportunities, decreased exposure to natural hazards, upgrading of neighbourhoods).
- Lessons learned and up-scaling play a crucial role when cities serve as laboratories.

Concrete/practical steps for low carbon transformation

- Since low carbon development is a cornerstone of sustainable urban development, co-benefits have to be communicated in local projects.
- Institutional capacity building should be pursued to combine the urban level with low carbon development goals on other levels (national, international).
- Transfer of knowledge and up-scaling should become an integral part of urban low carbon projects.



Source: Presentation by Nicola Tollin

Session Reports

Parallel Session 3.3:
Low carbon energy-intensive industries

Chair: Joyashree Roy, Jadavpur University & Manfred Fischedick, WI
Rapporteur: Ioanna Ketsopoulou, UKERC

Speakers:
Lars Nilsson, Lund University
Joyashree Roy, Jadavpur University
Arturo Castillo Castillo, Imperial College London
Caroline Kroes, Port of Rotterdam

This session explored the case for decarbonisation of energy-intensive industries that produce steel, aluminum, plastics, cement, glass, and paper, the current segmentation in terms of differences in industrial sectors and global regions, and what mitigation options are available.

The first presentation, by Nilsson, provided the general background and some examples from Sweden. He set out the key ways in which decarbonisation can be achieved in the industry and materials sectors: through service demand reduction, product-service efficiency, material efficiency in manufacturing and product design, and energy and emissions efficiency. Emphasis was placed on how change can take place in such slow-moving sectors which are highly capital intensive and in strong international competition. In order to move forward, a higher level of interaction and specific policies targeted at energy intensive processing industrie is needed between industry and government.

The presentation by Roy set out India's perspective. Particularly from 2000 onwards, a decoupling between industrial growth and emissions is observed. India's industry has been investing in a number of ways to minimise emissions and while most of the cheaper options have been adopted, some higher cost measures could be explored. In the future, policies will need to not only focus on energy-intensive industry but also address how the segmentation within it is changing. Existing policies should be expanded to include non-energy intensive industries.

The third presentation, by Castillo, focused on the opportunities for carbon capture and CO_2 reuse value chains. It highlighted findings from the enCO_2re project and explored the links between different value chain stages, from the source and capture to the transport and end use stage. The importance of considering trade-offs in each case was highlighted, as well as the fact that costs can usually be shared between different value chain participants.

The final presentation, by Kroes, provided a corporate strategy perspective and covered a case study of the port of Rotterdam. This port is a hub for transport, logistics and industrial activity, and is highly carbon intensive. However, in collaboration with the Wuppertal Institute, a series of pathways have been developed that enable future emissions reductions of up to 98%. A key requirement therefore will be to create collaborative relations between the different actors operating in the port.

Summary and key findings of the session

- Different actors in the industrial sector have different motivations; therefore a targeted policy approach is needed.
- Zero emissions requires fundamental technology shifts in the energy intensive processing industries.
- Strategies are needed and steps have to be taken to facilitate pilot plants, demonstrations, up-scaling and co-evolution with energy systems in the next 30-50 years.
- Significant institutional capacity and expertise is required at governmental levels, in order to effectively manage the transition.
- Industry decarbonisation has significant implications for the power sector.

Concrete/practical steps for low carbon transformation

- The policy focus should be set much more on the specific challenges of energy intensive processing industries but also expand to non-energy intensive industries.
- As a pre-requisite, the power sector needs to be decarbonised.
- A higher level of cross-sectoral collaboration should be developed between government and industry, as well as between different industrial actors.

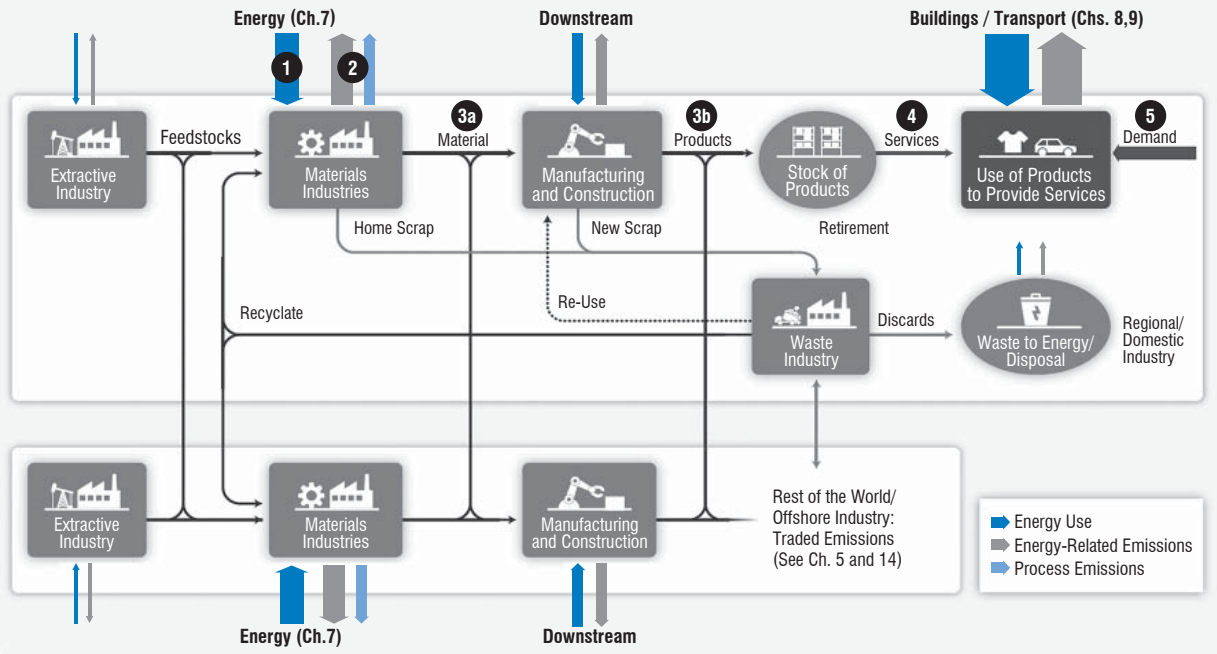
Which GHG mitigation options do we have?

Wuppertal Institut

Industry emissions decomposition - five main options for reducing GHG emissions in the industry

$$G = \frac{G}{E} \times \frac{E}{M} \times \frac{M}{P} \times \frac{P}{S} \times S$$

Emissions | Emissions Intensity | Energy Intensity | Material Intensity | Product-Service Intensity | Service Demand



Source: IPCC AR 5 2015

Source: Presentation by Manfred Fischedick and Joyashree Roy

Session Reports

Parallel Session 3.4:
Sustainable production and consumption as core fields of transition

Chair: Julia Nordmann, WI
Rapporteur: Sarah Reddig, WI

Speakers:
Yasuhiko Hotta, IGES
Laura Cutaia, ENEA
Shabbir Gheewala, JGSEE
Carolin Baedeker, WI

The first presentation, given by Yasuhiko Hotta, dealt with the rise in SCP practices in Asia. Asian economies show a growing need for energy, and also consume more than 50% of the world's resources, expressing the need for sustainable production and consumption. Examples given show that initiatives encouraging SCP did not generally start out as sustainable practices, but altered course in desirable directions. By reframing existing approaches, schemes such as the Canola Flower Project, which went from solving the issue of water pollution to the local production of rapeseed, rose to success. Using concurrent initiatives to tackle different challenges also proved to be successful: for example, inhabitants of Higashi-Omi, Japan, connected initiatives concerning goods supply, land use, and energy supply in order to make the most of their resources. By establishing local loops employing various forms of participation, frames, and synergies, individual local challenges can be overcome.

In the second presentation, Laura Cutaia introduced her research on industrial symbiosis in Italy focusing on company waste disposal. Its aim was to look into the potential uses and treatment of waste as raw materials by building a tool that allows easier ways for companies to collaborate. A national industrial symbiosis platform was created to simplify the process of identifying synergies between companies. Recent years have witnessed three national projects triggered by the need for sustainability in the tourism sector (Sicily Region), demand for cross-relations and industrial research (Emilia-Romagna Region) and green development of an industrial cluster (ASI Rieti). The projects eventuated in a reduction in landfilling, reduced consumption of raw materials as well as reduced goods shipping and an increase in collaboration between companies. However, getting companies to work together and share resources is still a challenge.

Life Cycle Thinking in Thailand was the topic of the third presentation, held by Shabbir Gheewala. His proposition is that Life Cycle Assessment is the only way to establish whether a product is in fact green. Single stages of production or consumption may vary significantly in their emission intensity; therefore, looking only at sections of a product's life cycle proves to be unrewarding. Beginning with the implementation of the Green label in 1990, Life Cycle Thinking in Thailand has since been recognised for its implications for SCP and receives substantial support from the government. Research, however, shows that despite employing different LCA-based labels, consumer awareness is still lacking. Accordingly, tools are available for helping consumers to reduce carbon emissions in everyday activities. Also, via community-based approaches like the low carbon goals of the Thai city of Muangklang, communities have demonstrated willingness to lower their carbon emissions by saving energy, promoting greener transportation,

utilising urban green spaces to grow crops, and change how waste is managed. Reducing stress factors such as emissions, however, must not lead to an increase in other negative aspects or stressors (e.g., social impacts, eutrophication). Life Cycle Thinking therefore prevents problem shifting.

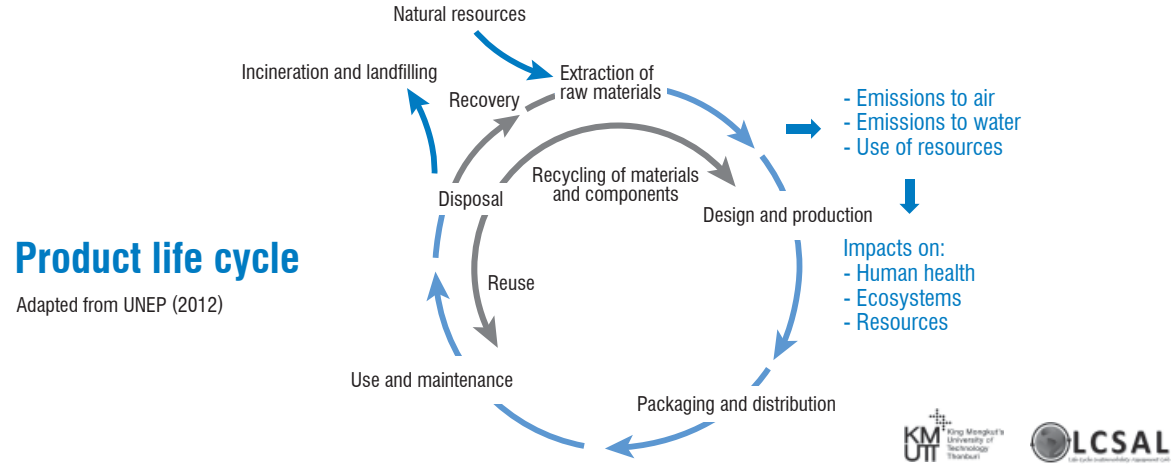
The fourth presentation was given by Carolin Baedeker, who presented tools and outcomes of the SusLabNRW research on heating in private homes in Germany. The research is based on the LivingLab approach that looks into the everyday life of real users in order to discern resource intensive behaviours and aims at behaviour change towards a more sustainable lifestyle as well as higher receptivity to sustainable innovations in daily life. The SusLab research consisted of three phases. Initially, the minutiae of each household were observed by calculating material and carbon footprints, and measuring and recording of action patterns. During the phase of prototyping, devices were built and tested. In the field-testing phase, improved prototypes were used by the participating households. The most notable finding in the field of heating was that users simply did not know how to heat in a sustainable way and that using smart home systems could help reduce one's energy consumption.

Summary and key findings of the session

- Examples show that local economical or social issues can often be solved by increased sustainable practices.
- Industrial symbiosis proves to be very beneficial for companies as well as the environment.
- The environmental impact of a product can only be determined by looking at its overall life cycle.
- Lack of knowledge proves to be a key cause of wasted energy.

Concrete/practical steps for low carbon transformation

- By collaborating, companies can save on resources, transport paths and the cost of waste disposal while at the same time cutting back on emissions and input of raw materials.
- Life Cycle Thinking enables us to improve products and services according to their environmental impact while simultaneously avoiding transference of other stressors.
- Looking into real households helps detect sources of waste, which can be removed by customised consultations and introducing smart technology.



Source: Presentation by Shabbir Gheewala

4th session

Session Reports

Plenary Session 4:
The role of science in the context of SDGs and climate policy post-Paris

Chair: Sergio La Motta, ENEA & Maja Göpel, WI
Rapporteur: Rahul Pandey, Integrated General Systems Analysis Laboratories

Speakers:
Sergio La Motta, ENEA
Volkmar Dietz, BMBF
Antonio Navarra, CMCC
Roland Scholz, ETH Zurich
Hironori Hamanaka, IGES
Uwe Schneidewind, WI

The session began with a video message from Jim Skea, Co-Chairman of IPCC Working Group-III, who also spoke on behalf of the other Co-Chairman, P. R. Shukla. Skea expressed his wish for obtaining useful outputs from LCS-RNet's annual meeting; specifically, he desired new and broader approaches to address climate change. He spoke about the importance of a "solutions-based agenda" and stressed the following three themes in order to address climate change in a comprehensive, pragmatic manner:

- The need to adopt a comprehensive set of various assessment methodologies. In particular, it is important to blend top-down with bottom-up approaches, technology with non-technology measures, and analytical modelling with case-study oriented methods.
- The importance of engaging a wider range of disciplines, i.e., social sciences study of lifestyles, consumption and behaviour, in addition to natural sciences, economics, engineering and technology.
- The need to better link climate mitigation with sustainable development goals, placing the former firmly in the context of the latter.

Antonio Navarra emphasised that SDG is a process that has emerged in parallel with climate change/IPCC and climate change mitigation is one of the SDGs, and that there is a need to ensure the two sets of policies are consistent.

In this light these are the challenges for science and research:

- To explore synergies between climate change and sustainable development, and therefore between quantitative-based methods (adopted by climate change researchers) and social science oriented/qualitative methods (adopted by SDG researchers).
- To adopt an interdisciplinary methodology and process, owing to the complexity of societal problems. This will require researchers and policy analysts to break away from the bounds of traditional academic organisations, which are based on watertight, specialist disciplines and traditional scientific methods that operate on the reductionist paradigm, and instead aim at convergence between multiple and differing disciplines together with evolving a trans-disciplinary process. Climate science is the new candidate for such a convergence.

Sergio La Motta also spoke about the importance of SDGs along with climate mitigation. Towards this end he emphasised the role of various technology mechanisms, such as the UN task team and CTCN, which provide support for the desired innovations and assistance and transfer of technology to developing countries. There is a need for targeted financing of such mechanisms and integration of the myriad disciplines.

Roland Scholz stated that there has been a paradigm shift since COP21, and underscored the urgency of adopting trans-disciplinary processes to address the climate change crisis. He distinguished between "normal scientific methods" and "interactive scientific practice" as follows: While normal scientific methods use conventional tools and approaches that are not fit for assessing complex, non-linear systems and problems such as climate change and sustainability, interactive scientific practice adopts transdisciplinarity and has the potential to comprehensively assess such problems.

"Transdisciplinarity" emphasises three main processes: (i) Targeted interdisciplinary process, that combines multiple and varied disciplines and adopts a synthetic approach; (ii) Multi-stakeholder process, that engages different stakeholders (such as scientists, policymakers, citizens) in an interactive and iterative manner; and (iii) a process that links (i) and (ii). Such a trans-disciplinary process would be based on the principle of mutual learning (among various stakeholders and disciplines). It would be coordinated and guided by the principle of "co-leadership", i.e. multiple leaderships representing multiple stakeholders working together, rather than a single, centralised, monolithic leadership.

Underlying the transdisciplinary process is the perspective of "science as public good that serves all values in a society" rather than science as the principal agent of profound transition.

Volkmar Dietz introduced Germany's sustainability strategy, which focuses on 34 sustainability indicators covering all areas of sustainable development. There is a need for a scientific platform for SDG implementation that studies the connections among SDGs (rather than individual SDGs in isolation), resolves the contradictions between different goals through transformative processes, provides a science-policy interface and explores innovative technological solutions to achieve ambitious targets (such as increasing resource productivity by a significant factor). FONA, the German research programme on sustainability, is a response to this need, and focuses on societal changes, inter- and trans-disciplinary research, and international networks in order to achieve SDG implementation. Three flagship initiatives of this programme are Green Economy, City of the Future, and Transformation of Energy System.

Hironori Hamanaka, Chair of the Board of Directors of IGES, noted that the Paris Agreement has paved the way for full transition to low carbon society involving all stakeholders, and science has to play a strong role in this transition. This is the backdrop to the reality that we only have about 30 years before the carbon budget for the 2 degrees target will be fully used up, and hence transition to low carbon society needs to be accelerated with commitment by most countries to stringent mitigation targets and deeper sharing of knowledge.

Therefore, the LCS-RNet network is expected to play an even more important role in this process. The Ministry of Environment, Japan is actively promoting collaborative research on mitigation through MoUs between Japan and France and Japan and Germany, and through platforms that facilitate continuous interactions among key stakeholders such as policymakers, researchers, private sector, financing organisations and NGOs.

DDPP and other similar international collaborative projects have highlighted three pillars for low carbon pathways: (i) energy efficiency and conservation, (ii) decarbonised electricity, and (iii)

switching of end-use to low carbon means. This implies that electricity must become carbon-free by 2050, which in effect implies an energy system transformation.

Therefore the next steps and challenges of low carbon transition are as follows:

- To assess and implement ways to achieve fundamental transformation of the energy system.
- To develop a national vision, goals and strategies which integrate climate mitigation and domestic goals.
- To promote public acceptance of deep decarbonisation pathways.
- To develop a policy framework to create an enabling environment. This requires both designing of effective policies (such as carbon price) and engaging stakeholders in the process.

Uwe Schneidewind, President of Wuppertal Institute, once again reminded us about the clash of two modes of science (normal and transformative)—a point made previously by Roland Scholz. He said that since the role of science is to inform on better policy decisions, adopting an inter-disciplinary process and integrated approach is both desirable and essential for climate change and sustainability researchers.

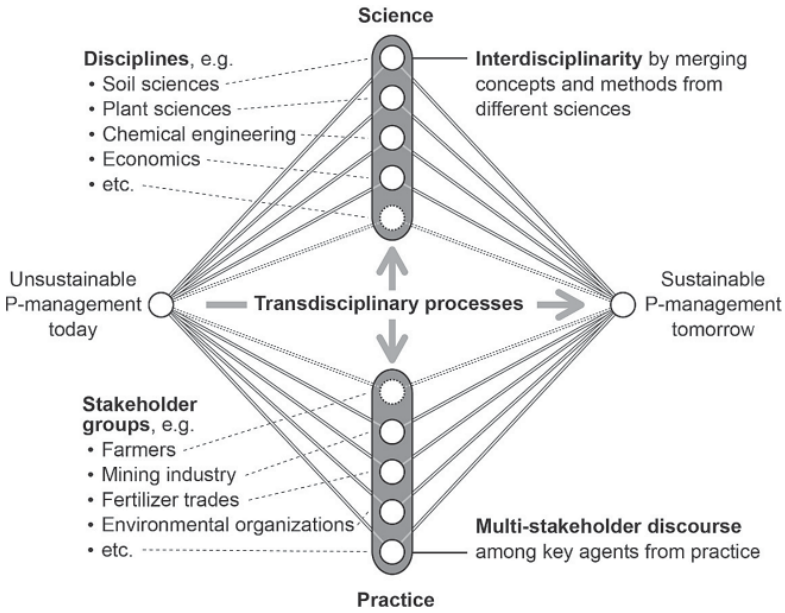
Summary and key findings of the session

- COP21 paved the way for full transition to low carbon society involving all stakeholders, and science has a strong role to play in this transition. With only about 30 years remaining before the carbon budget for the 2 degrees target evaporates, transition to low carbon society needs to be accelerated with commitment by most countries to stringent mitigation targets and deeper sharing of knowledge.
- Integrating climate mitigation and national sustainable development goals has emerged as a need since COP21. This requires a transdisciplinary scientific process that includes multiple disciplines, engages multiple stakeholders, promotes public acceptance of decarbonisation pathways, and follows the principles of mutual learning and co-leadership.

Concrete/practical steps for low carbon transformation

- Climate scientists and researchers need to achieve consistency between decarbonisation and sustainable development goals.
- Climate change and sustainability researchers need to adopt a transdisciplinary process, engaging multiple varied disciplines (for instance, natural sciences, engineering, economics, social and behavioural sciences), multiple methodologies, and involving multiple stakeholders (policymakers, citizens, private sector, financial organisations, NGOs).
- Climate change and sustainability research must achieve a synthesis of top-down and bottom-up approaches, of technology and non-technology measures, and of analytical modelling and case-study oriented methods, in order to assess the problems and solutions holistically.

There are three main processes in a (Mode 2) transdisciplinary process on sustainable transitioning



i. A targeted interdisciplinary process

iii. A facilitated td-process relating 1. and 2.

ii. A facilitated Multi-stakeholder discourse

Scholz, R. W., & Steiner, G. (2015). The real type and the ideal type of transdisciplinary processes. Part I - theoretical foundations. ***Sustainability Science***, **10**(4), 527-544.

Source: Presentation by Roland Scholz

What does COP 21 change?

Various Articles define "tasks for Td-processes"

- A global social contract/quantitative goals (Art 2(a))
- Request for national assessment for mitigation (Art 4.9)
- Regional economic organizations and (negotiation) processes among the parties are … "responsible for its emission level" (Art 4.18)
- "Intencitivize and facilitate participation ..." (Art 6(b))

The call for transdisciplinary processes is given in Art 7.5

- Parties acknowledge that adaptation action should follow a country-driven, gender-responsive, participatory and fully transparent approach, taking into consideration vulnerable groups, communities and ecosystems, and should be based on and guided by the best available science and, as appropriate, traditional knowledge, knowledge of indigenous peoples and local knowledge systems, with a view to integrating adaptation into relevant socioeconomic and environmental policies and actions, where appropriate.

Source: Presentation by Roland Scholz

Universities have departments, society has problems

- Traditional reductionist model insufficient

- Stresses from the world have pushed scientist to consider messy, multidimensional problems.
- Emergence of new technologies that have the potential to empower many different fields
- Pressure against traditional disciplinary barriers is increasing

Source: Presentation by Antonio Navarra


4th
session

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	Uwe Schneidewind (President and Chief Research Executive, WI, Germany)
	Martin Weiß (Representatives of BMUB as gvtl. focal point, Germany)
	Akio Takemoto (Director, Research and Information Office / Climate Change Adaptation Office, Ministry of the Environment, Japan)
	Shuzo Nishioka (IGES, Japan / Secretary-General, LCS-RNet)
	Stefan Lechtenböhmer (WI, Conference Co-Chair and Steering Group member, Germany)
Plenary Session 1: How to trigger the non-linear transformation towards full decarbonisation (by 2050) as targeted by G7 (Elmau) and COP21 (Paris)? Chair: Jim Watson (UKERC, UK)	
KS_1	**What disruptions are we facing in the areas of environment, energy, geopolicy and what could be strategies to counter them?** Karen Smith Stegen (Jacobs Univ. Bremen, Germany)
KS_2	**Energy Futures 2040: A positive vision or calculated optimism?** Jens Burgtorf (GIZ, Germany)
Parallel session 1.1: How to deal with non-linear and disruptive developments (long-term scenarios, modeling, innovation, structural change) Chair: Toshihiko Masui (NIES, Japan)	
PS1.1_1	**Recent development in scenario analysis** Detlef van Vuuren (PBL, Univ. Utrecht, Netherlands)
PS1.1_2	**Governance levels, scientific paradigms and policy instruments for Deep Decarbonization Pathways** Patrick Criqui (University of Grenoble Alpes and CNRS, France)
PS1.1_3	**Low-carbon scenarios after Paris: Ambition, transition and communication -a policy perspective** Martin Weiß (BMUB, Germany)
Parallel session 1.2: What are the potential contributions of non-state actors (including cities and finance industries) and how to better involve them? Chair: Giulia Gallucio (CMCC/FEEM, Italy)	
PS1.2_1	**Visions for post carbon cities** Margaretha Breil (CMCC/FEEM, Italy)
PS1.2_2	**Industries and companies as non-state actors? The case of the Paris Agreement** Noriko Fujiwara (CEPS, Belgium)
PS1.2_3	**GJETC - German - Japanese Energy Transition Council as good practice for international cooperation on energy transformation** Maike Venjakob (WI) and Stefan Thomas (WI), Germany
PS1.2_4	**Small-scale energy projects in the global South - Can they contribute to decarbonisation?** Julia Terrapon-Pfaff (WI, Germany)
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PL1.3_1	**Germany's Energiewende as a model for change? Problems, disruptions and policies** Peter Hennicke (WI, Germany)
PL1.3_2	**Energiewende: a challenge for energy companies but also a chance?** Stephan Ramesohl (E.ON Research, Germany)
PL1.3_3	**Japan's historical transitions** Shuichi Ashina (NIES, Japan)

Plenary Session 2: How could a "new deal" for green growth be designed and achieved? Jean Charles Hourcade (CIRED, France)	
PL2	**A new deal for Green Growth? Hedging against the risks of "secular stagnation"** Jean Charles Hourcade (CIRED, France)
Parallel Session 2.1: Carbon pricing and redesign of financial instruments as a lever for change Chair: Christophe Cassen (CIRED, France)	
PS2.1_1	**Climate systemic risk and how climate finance can help avoid it** Etienne Espagne (CEPII, France)
PS2.1_2	**Moving the trillions: decarbonization and carbon reduction are the "new gold"** Alfredo Sirkis (Centro Brazil no Clima, Brazil)
PS2.1_3	**Using carbon pricing revenues to finance sustainable development goals** Michael Jakob (MCC, Germany)
Parallel Session 2.2: Climate financing (lessons learned from financial instruments already implemented) Chair: Tomonori Sudo (Ritsumeikan Asia Pacific Univ., Japan)	
PS2.2_1	**Climate finance: An OECD perspective** Simon Buckle (OECD Environment Directorate)
PS2.2_2	**Financing urban climate action: Is the issue really creditworthiness?** Peter B. Meyer (Univ. of Louisville / The E.P. Systems Group, Inc., US)
PS2.2_3	**Decarbonising Europe's energy intensive industries** **The final frontier** Thomas Wyns (VUB, Belgium)
PS2.2_4	**Lessons from climate finance** Christine Wörlen (AREPO, Germany)
Plenary 2.3: Panel Discussion: How could a "new deal" for green growth be designed and achieved? Chair: Sergio La Motta (ENEA, Italy)	
PL2.3	Panelists: Jean Charles Hourcade (CIRED, France) Thomas Wyns (VUB, Belgium) Alfredo Sirkis (Centro Brasil no Clima, Brasil)
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Plenary Session 3: How to explore and exploit the synergies between the Sustainable Development Goals (SDGs) and low carbon societies? Chair: Antonio Navarra (CMCC, Italy)	
KS_1	**How to explore and exploit the synergies between SDGs and low carbon societies?** **Methodological lessons from the DDPP and research perspectives** Henri Waisman (IDDRI, France)
KS_2	**Energy and air pollution** Timur Gül (IEA)
Parallel Session 3.1: Technology concepts and ambitions of carbon-neutral or 100% renewable societies Chair: Stefan Lechtenböhmer (WI, Germany)	
PS3.1_1	**Modelling 1.5°C scenarios: Scientific challenges and consequences for policy making** Mikiko Kainuma (IGES/NIES, Japan)
PS3.1_2	**For our environment: Decarbonization through cross sectoral supply with renewable energies** **Goals 40 - 100 - 100plus - GHG N- RTD policy** Harry Lehmann (UBA, Germany)
Parallel Session 3.2: Cities as places for transition and hot spots of future sustainable developments (including productive interaction with rural regions) Chair: Ralf Schuele (WI, Germany)	
PS3.2_1	**The triple dividend of urban resilience transition** **Sustainable development, mitigation, and adaptation** Nicola Tollin (RESURBE)
PS3.2_2	**Innovation city Ruhr as an example for a transformative approach** Johannes Venjakob (WI, Germany)
PS3.2_3	**Approach to low-carbon and climate-resilient cities in the Philippines** Damasa B. Magcale-Macandog (UPLB, Philippines)

Parallel Session 3.3: Low carbon energy intensive industries Chair: Joyashree Roy (Jadavpur Univ., India) & Manfred Fischedick (WI, Germany)	
PS3.3_1	**Rethinking basic materials - The GIST research programme and more** Lars J. Nilsson (Lund University, Sweden)
PS3.3_2	**Deep decarbonization in industries – What does it mean for India?** Joyashree Roy (Javadpur Univ., India)
PS3.3_3	**Enabling CO_2 reuse value chains** Arturo Castillo Castillo (ICL, UK)
PS3.3_4	**Decarbonisation and the Port of Rotterdam: Challenges & opportunities** Caroline Kroes (Port of Rotterdam, Netherlands)
Parallel Session 3.4: Sustainable production and consumption as core fields of transition Chair: Julia Nordmann (WI, Germany)	
PS3.4_1	**Sustainable production and consumption in low carbon communities – an Asian perspective** Yasuhiko Hotta (IGES, Japan)
PS3.4_2	**An outlook at an Italian experience in the implementation of circular economy at industrial level Opportunities and concerns** Laura Cutaia (ENEA, Italy)
PS3.4_3	**Life cycle thinking for sustainable consumption and production** Shabbir Gheewala (JGSEE, Thailand)
PS3.4_4	**Transition towards sustainable production and consumption: Contributions of LivingLab research** Carolin Baedeker (WI, Germany)
Plenary Session 4: The role of science in the context of the SDGs and climate policy after Paris – together with IST 2016 Conference Chair: Sergio La Motta (ENEA, Italy) & Maja Göpel (WI, Germany)	
PL4_V	**Video message** Jim Skea (Co-Chair WGIII IPCC)
PL4_1	**A new scientific paradigm for SDGs?** Antonio Navarra (CMCC, Italy)
PL4_2	**The role of science in SDGs** **The technology mechanisms** Sergio La Motta (ENEA, Italy)
PL4_3	**The role/potential of transdisciplinary processes after the Paris 2016 agreement** Roland Scholz (ETH Zürich, Switzerland)
PL4_4	**SDG's, sustainability strategy and research in Germany** Volkmar Dietz (Federal Ministry of Education and Research, Germany)
PL4_5	**Roundtable (Interviewer: Maja Göpel, WI)** Hironori Hamanaka (IGES, Japan), Roland Scholz (ETH Zürich, Switzerland), Uwe Schneidewind (WI, Germany), Antonio Navarra (CMCC, Italy)
Introduction and invitation to next year's Annual Meeting to be hosted by UKERC and Closing of the conference	
	Stefan Lechtenböhmer (WI, Germany) and Ioanna Ketsopoulou (UKERC, UK)

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This Synthesis Report was developed with the aim of highlighting cross-cutting conclusions that emerged through panel discussions held during the eighth annual meeting of the LCS-RNet, Wuppertal, Germany, on 6th and 7th September, 2016.

This network was established based on Japan's proposal at the G8 summit held in Japan in 2008. The original concept was that, to realise the creation of "low-carbon societies" as proposed by then Prime Minister Mr. Fukuda, we have to bring together policymakers and researchers for an exchange of wisdom.

At the G7 Environmental Ministers' Meeting (G7 EMM) held in May 2016 in Toyama, Japan, and with reference to "long-term low-carbon emission development strategies" raised as a common challenge at the Paris Agreement, the meeting acknowledged the importance of "developing and communicating our strategies to the UNFCCC Secretariat, as soon as possible and well within the schedule provided by COP21". The communiqué of the G7 EMM also highlighted that "taking the lead in communicating these strategies will send strong signals to the private sector and other countries for the necessary transition towards a low-carbon society." This recognises the importance of the far-reaching actions taken by LCS-RNet to date.

The G7 Environmental Ministers' communiqué also stated, "For developing these long-term low GHG emission development strategies, and cooperating with other countries, we acknowledge the importance of research on future scenarios, strategies, and targets of each country, as well as knowledge sharing through researchers' networks. We commit to deepen our exchange in this regard from this year on." This reinforces the aim of the LCS-RNet, as it gathers knowledge and wisdom on exactly these issues from all over the world.

With this in mind we feel fully justified in asserting, with a sense of pride, that it was our network that paved the way to Paris ahead of time, and that our present mission, post-Paris, is to now lay a new path, with the deep conviction that it is the right path.

Finally, I would like to express gratitude to all of the chairs at the Wuppertal meeting, as well as to those who have contributed to this report. I would like to express my heartfelt thanks to the governments of the steering group member countries—France, Germany, Italy, Japan and UK—for their continued support of the network's activities. The steering group members extolled great efforts in initiating the programme, which has led us here to the current activities under the strong leadership of this meeting's co-chairs: Dr. Stefan Lechtenböhmer of WI and Dr. Jim Watson of UKERC. I would also like to thank all of the participants at the meeting in Wuppertal for their contributions.

Shuzo Nishioka

Secretary General
LCS-RNet Secretariat

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