Institute for Advanced Sustainability Studies (IASS)

# IASS

## ACTIVITIES 2012–2013

IASS POTSDAM


The stunning satellite images used throughout this report are taken from the illustrated book **one earth — Limited Edition** (ISBN 978-3-902834-16-4), which is published by eoVision (www.eovision.at). **one earth** shows the beauty and diversity of our world, but also its vulnerability. The editors aim to increase awareness of the need to treat our environment in a responsible manner and to promote the sustainable use of resources.

# IASS

## ACTIVITIES 2012–2013

SCIENCE FOR SUSTAINABILITY

IASS
POTSDAM

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# EDITORIAL

## "How should we address the environmental changes and challenges of the twenty-first century?"

The concept for the IASS was inspired by the Nobel Laureate Symposium "Global Sustainability – A Nobel Cause", held in Potsdam in 2007. The symposium addressed the problem of rising $CO_2$ emissions and climate change, a global trend that continues to prevail despite the international efforts made over the last couple of decades. If anything, the challenge has become even greater. The term 'Anthropocene' has been introduced to describe this new geological era, in which Earth is being influenced and increasingly transformed by collective human action. There is an urgent need to act to meet the challenges posed by the Anthropocene. The symposium recognised this and produced a document entitled *The Potsdam Memorandum*, which described the situation:

> "humanity is acting now as a quasi-geological force on a planetary scale that will qualitatively and irreversibly alter the natural Earth System mode of operation – should business as usual be pursued."

'Business as usual' does not just refer to our current unsustainable economic and lifestyle habits. It also refers to what Albert Einstein pointed out by saying: "The great challenges of our time cannot be solved by applying the same mindset as that which created these problems." Despite increasing knowledge, too often a gulf exists between knowledge and action, between the science, civil society and policy communities. Therefore, the *Potsdam Memorandum* calls for a new contract between science and society. Such a contract presupposes cooperation on an unprecedented scale between the scientific community and civil society. The IASS was created to foster this pioneering approach and, in the words of the *Potsdam Memorandum*, to "tap all sources of ingenuity and cooperation to meet the environment and development challenges of the twenty-first century and beyond." For the IASS, bridging this gap demands a new quality of interaction between the typically separated realms of science and society to identify obstacles to transformation towards sustainability and generate the knowledge needed to initiate purposeful action.

As researchers at an institute for curiosity-driven advanced studies, we work in interdisciplinary research teams that apply transdisciplinary approaches to unlock the critical potential for transformations towards sustainability and engage in strategic dialogues with partners from the civil society and policy communities:

### Our Vision

is a just and peaceful world in which the Earth System, as well as social and economic systems, are understood and governed in a way that enables sustainable development for all. We envision the IASS as a forerunner of a new form of research that empowers societies to face the challenges of the Anthropocene.

### Our Mission

is to develop transformative knowledge that is needed to pave the way towards sustainable societies. Our research is transdisciplinary, conducted together with scientific, political and societal partners, in order to develop solutions for urgent sustainability challenges and to support national and international decision-making processes.

**FROM LEFT TO RIGHT: Klaus Töpfer, Carlo Rubbia, Mark Lawrence**

Source: IASS/Agentur StandArt

The IASS was founded in 2009 as a joint initiative of the German Science Alliance, the German Federal Government and the Federal State of Brandenburg. Potsdam was chosen as the location for the institute partly due to its proximity to the German capital, and also because of the concentration of research organisations in Potsdam focussed on various aspects of global change. Operations commenced with the start of our first financing period in 2010, and the first two years were devoted to recruiting staff and developing our research programme. Our work has been in full swing since 2012.

The IASS focuses on the overarching question of how transformations towards more sustainable pathways can be achieved. Two of our main research areas, the transformation of energy systems (see chapter 1) and understanding and governing the Earth system and its resources (see chapter 2), relate directly to the priorities identified in the *Potsdam Memorandum:* how can we provide sustainable energy for all, be that by technological means or by changing policy and market structures? And how should we address the environmental changes and challenges of the twenty-first century?

In a third research area, we have chosen to reflect on different cultural and economic perspectives on sustainability (see chapter 3). Here, we investigate how patterns of unsustainable development have emerged historically and why they continue to be reproduced. More specifically, we ask why current approaches to problem-solving rarely address cultural differences and cultural definitions of 'development' and continue to view cultural diversity as an obstacle to sustainability rather than something that could promote it.

Since the inception of the IASS, we have implemented about 40 research projects in these three research areas, which form the institute's research agenda on sustainability transitions. We have involved stakeholders from society and government in our work from the very beginning and we have gathered together an interdisciplinary and international group of researchers, including physicists, biologists, chemists and engineers, as well as economists, historians, political scientists, sociologists, lawyers, psychologists and philosophers. Through our fellowship system, we also invite individuals from a wide range of disciplines and areas of expertise, within and beyond academia, to join us for a limited time so that we can benefit from their insights into current scientific and societal trends and issues. Our fellows include people with various levels of experience, from former directors of research institutes and former ministers to early career researchers. Our fellowship system has allowed us to address sustainability issues in a comprehensive way and develop a global partner network.

This first IASS Activity Report provides an overview of our work and achievements over the course of the institute's first two fully operational years, 2012 and 2013, and offers an outlook on the year 2014 and beyond. The ultimate quality criterion for our transdisciplinary work is how we contribute in concrete ways to transformations towards sustainable development. Below, we cite just three examples of our work, in which we have built bridges between science and societal needs, engaged in strategic dialogue, and unlocked potentials for change:

- With the creation of the Global Soil Forum (see pages 40–45), we have established a unique platform that brings together a broad coalition of stakeholders from science, policy and civil society to address an urgent, yet often neglected topic: the loss of soils and its negative consequences for sustainable development. Together with our partners, we are driving the debate forward and have successfully integrated scientific knowledge on soil governance into ongoing policy processes at European and global level. For example, the German Federal Ministry for Food and Agriculture requested that we jointly address the topic of soils in preparation for the negotiation of Sustainable Development Goals at the United Nations in 2015.

- Energy runs like a common thread through the institute's work. We are convinced that only a coherent energy policy that relies on innovative technologies will help to address the energy – and development – challenges of today and tomorrow. New energy options have to respond to an evolving energy system with the aim of identifying practical $CO_2$ emissions mitigation strategies as well as guiding transformations towards renewable energy scenarios across the globe. In this respect, our cutting-edge research on superconducting electric lines (see page 29) has taken path-breaking steps towards meeting the requirements of the future electricity grid and integrating renewables. Recent progress in the field of methane combustion without $CO_2$ emissions can also be highlighted and exemplifies the character of an institute for advanced studies.

- In Southern Asia, where air pollution and climate change are among the most pressing environmental concerns, we have developed a network of research organisations, governmental agencies, civil society groups, religious leaders and business associations (see page 48). Our work centres on Nepal, the gateway to the Himalayas, where regional pollution can negatively affect one of the major water sources for Central and Southern Asia. In a first step in 2012 and 2013, we organised the second largest air pollution measurement campaign ever in Southern Asia, in order to identify the main sources of air pollutants, an important first step towards designing effective mitigation strategies. In the next phase from 2014 onwards, we will jointly develop and test feasible mitigation options with our partners.

We consider these cases to be good examples of our multifaceted work. These and many other aspects of our work and plans underwent a first evaluation by the German Science Council in 2014. As the evaluation process affirmed the potential of the IASS and its globally unique concept to add value at the interface of science and policy, we are continuing to develop our new approach to science that aims to combine the best qualities of a research organisation and a science-policy platform.

Potsdam, 2014

Prof. Dr Klaus Töpfer
Executive Director

Prof. Dr Carlo Rubbia
Scientific Director

Prof. Dr Mark Lawrence
Scientific Director

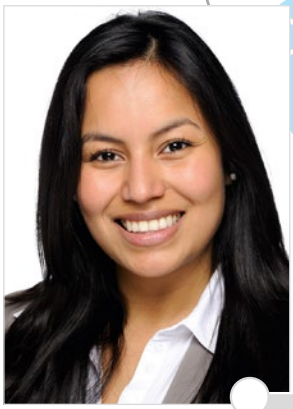
# OUR GLOBAL NETWORK FOR SUSTAINABILITY

The IASS builds a platform for visiting scientists and provides a setting in which cutting-edge science can take place. We draw on the expertise and innovation potential of qualified fellows – ranging from outstanding young scientists at the beginning of their careers to renowned scientists – and strive for scientific exchange at the highest international level. We have established networks and partnerships with national and international research institutions all over the world.

“I am working to enhance transdisciplinary research that supports more effective mutual learning and decision-making processes that lead to more sustainable and equitable futures. This is central to the new Future Earth approach to global change challenges and a critical area of development for the IASS.”

**PROF. ILAN CHABAY**
USA
IASS Senior Fellow since February 2012
**Research topic:** Understanding decision-making and behavioural change

“Connecting science and policy demands innovative ways of conducting research that translates into political language and motivates stakeholders to take action. At the IASS, I work together with partners from the European Commission, the United Nations, NGOs, national governments and many more in order to develop strategies for the sustainable management of soils and their inclusion in global sustainability agendas.”



**IVONNE LOBOS ALVA**
Guatemala
IASS Fellow since April 2012
**Research topic:** Sustainability governance for soil and land resources

“The role of the IASS as a bridge between science and policy is a fascinating one, and I feel privileged to have been a part of that. I enjoyed the opportunity to conduct research on the highly political project of the Energiewende. The transdisciplinary nature of the institute was a real eye-opener and has changed how I view the world. I’m now working as a policy planner for the Finnish Foreign Ministry.”

**PETRI HAKKARAINEN**
**Finland**
**IASS Senior Fellow from June 2012 to August 2013**
**Research topic:**
**Renewable energy**

“The IASS is a very unique centre for transdisciplinary and transformative research and thought. I enjoyed working with international researchers from different disciplines to investigate how solutions can best be implemented globally. The friendly interactions in a beautiful setting between two lakes has been inspiring.”

**PROF. CHING CHUEN CHAN**
**Hong Kong, China**
**IASS Senior Fellow from July to September in 2012, 2013 and 2014**
**Research topic:**
**Electric vehicles, energy and information**

“I chose the IASS mainly because it offered an opportunity to be at the interface of different disciplines. I found the interdisciplinary approach an innovative way of radically changing the way we deliver sustainability solutions. I am now working as a consultant for UNEP in Nairobi on green economy legislation for African countries.”

**YVONNE WAWERU**
**Kenya**
**Alexander von Humboldt Fellow at the IASS from September 2012 to November 2013**
**Research topic:**
**Renewable energy**

“I enjoyed the working environment at the IASS. My stay was very productive: I managed to publish one peer-reviewed research paper and one book chapter. Now back in my usual position as professor at the Asian Institute of Technology in Thailand, I am still in close contact with my IASS colleagues to continue research collaborations.”

**PROF. NGUYEN THI KIM OANH**
**Vietnam**
**IASS Fellow from July to September 2012**
**Research topic: Short-lived climate-forcing pollutants**

Source (all photos): IASS

# CALENDAR 2012 – 2013

## 2012

### 7 MARCH 2012

**The IASS launches the "Transdisciplinary Panel on Energy Change" (TPEC)**


Source: IASS

The TPEC team in 2012 with Project Leader Kathrin Goldammer (second row, third from the left)

### 8 – 21 JULY 2012

**Global Sustainability Summer School**

Source: PIK, Christine Bounama

Participants in the first Global Sustainability Summer School in Potsdam discuss the nature of human-environment interactions.

### 18 – 22 NOVEMBER 2012

**First Global Soil Week Berlin**


Source: IASS/Agentur StandArt

Live cookery demonstration at the Global Soil Week, where star chef Sarah Wiener prepared vegetarian, regional and seasonal food with the assistance of IASS Executive Director Klaus Töpfer.

# 2013

## 20 – 21 MARCH 2013

**First workshop on "Oceans in the Anthropocene: Advancing Governance of the High Seas"**


The then Minister for the Environment Peter Altmaier (centre), IDDRI Director Laurence Tubiana and IASS Executive Director Klaus Töpfer discuss options for better protection of the oceans.

## 27 – 31 OCTOBER 2013

**Second Global Soil Week**


IASS Director Klaus Töpfer and Environmental Activist Vandana Shiva symbolically deseal Potsdamer Platz by planting a bush at the opening of the GSW.

## 21 – 23 AUGUST 2013

**Open Discussion Workshop about Climate Engineering: Perspectives from Pacific Small Island States in Suva, Fiji**


Group photo after the opening ceremony with (front row, from left to right) Prof. Elisabeth Holland (Director of the Pacific Centre for the Environment and Sustainable Development PaCE-SD at USP), Prof. John Bythell (USP Pro-Vice Chancellor), Esala Nayasi (Director Political and Treaties/Climate Change Unit, Fijian Ministry of Foreign Affairs), Prof. Mark Lawrence (Scientific Director, IASS), Achim Maas (IASS) and Katharina Beyerl (IASS).

## 19 – 20 NOVEMBER 2013

**IASS Workshop on Sustainable Fuels from Renewable Energies**


Workshop Participants: Prof. Rubbia, Scientific Director, IASS (front, third from the right), Dr Harry Lehmann, Director of the Environmental Planning and Sustainability Strategies Division, German Federal Environmental Agency (back, first from the left), Prof. G.K. Surya Prakash, Loker Hydrocarbon Research Institute (front, second from the left).

# ‘Advanced’ means always moving forward

Developing concepts for integrating society and science and fostering a new type of transdisciplinary researcher are key tasks for the IASS

As our wealth of knowledge increases, the idea of linking isolated disciplinary research islands and involving the ‘end users’ of scientific evidence has gained momentum. In the field of biomedical research, where I am based, basic researchers already work side-by-side with clinical doctors in order to translate scientific knowledge into medical benefits and vice versa. By bringing bed and bench together, new options for diagnosis, therapy and prevention can be developed. The creation of the Berlin Institute of Health (BIH) in 2013 as a centre for translational medicine pays tribute to this new paradigm.

Similarly, the mission of the IASS is to create stronger ties between science and society in order to find ‘cures’ for some of the most pressing challenges humanity faces today, like ensuring water, food and energy security and coping with the impacts of climate change. To facilitate the translation of sustainability research into sustainable practices, and socially and politically relevant questions into science, the IASS was created – inspired by the Potsdam Memorandum – as a unique combination of an Institute for Advanced Studies, a think tank, and a platform for engaging stakeholders from politics, the economy, and civil society.

Source: Tom Maelsa/Berlin Institute of Health

## Prof. Ernst Rietschel

Professor Ernst Th. Rietschel has been chairman of the IASS General Assembly since 2009. He studied chemistry in Munich and Freiburg and was appointed director of the Leibniz-Center for Medicine and Biosciences in Borstel near Hamburg in 1980. From 2005 to 2010, he was president of the Leibniz Association. Ernst Th. Rietschel has been the chairman of the Directorate of the newly founded Berlin Institute of Health (BIH) since 2013.

Since its foundation in 2009, the IASS has made significant progress in fulfilling this mission, something to which this Activity Report bears witness. However, being an Institute for Advanced Studies means never resting on one’s laurels. The IASS is engaged in a constant process of renewal and reflection both within and outside the institute. I would, therefore, like to venture an outlook on its future development. The need for guidance to bridge the gap between science and society is great, as is the need for researchers who feel at home in both worlds. With its particular set-up as an Institute for Advanced Studies that attracts fellows from leading international scientific institutions, the IASS is not only in a position to contribute to the advancement of truly transdisciplinary research. In cooperation with and complementary to universities, it can also play a role in training young scientists who are eager to transcend disciplinary boundaries.

Given the dedication and excellence of the institute’s researchers and its strong network of partners in Potsdam, Germany, Europe and the rest of the world, I am convinced that the IASS will continue to evolve as an outstanding institution for sustainability research in Germany and beyond.

# IASS PUBLICATIONS


In 2013, the IASS launched its own publication series with different formats – Policy Briefs, Working Papers, Studies, and Thematic Brochures – geared to different target groups. The series aims to stimulate discussion on aspects of sustainable development and inform a wide audience about new research results and proposed solutions.

## IASS SERIES

### Policy Briefs


Policy Briefs (8–12 pages) present options and recommend courses of action with regard to an aspect of sustainable development relevant to current policy-making.
**Target Groups:** Policy-makers, NGOs, scientists

### Fact Sheets


Fact Sheets (4–6 pages) give a concise overview of the most important facts and the state of research with regard to an aspect of sustainable development relevant to current policy-making.
**Target Groups:** Policy-makers, civil society actors, the media, industry

### Studies


Studies present research findings and are subject to a review process before publication.
**Target Groups:** Scientists, policy-makers, NGOs, the media, industry

### Working Papers


Working Papers present the initial results of ongoing research projects before they are published in peer-reviewed journals. They aim to stimulate discussion and involve stakeholders in the debate.
**Target Groups:** Scientists, policy-makers, NGOs, the media, industry

## FURTHER PUBLICATIONS

### Image Brochures


Image Brochures present the main thematic areas and research projects of the IASS in brief to a broad readership.
**Target Groups:** Policy-makers, scientists, civil society actors

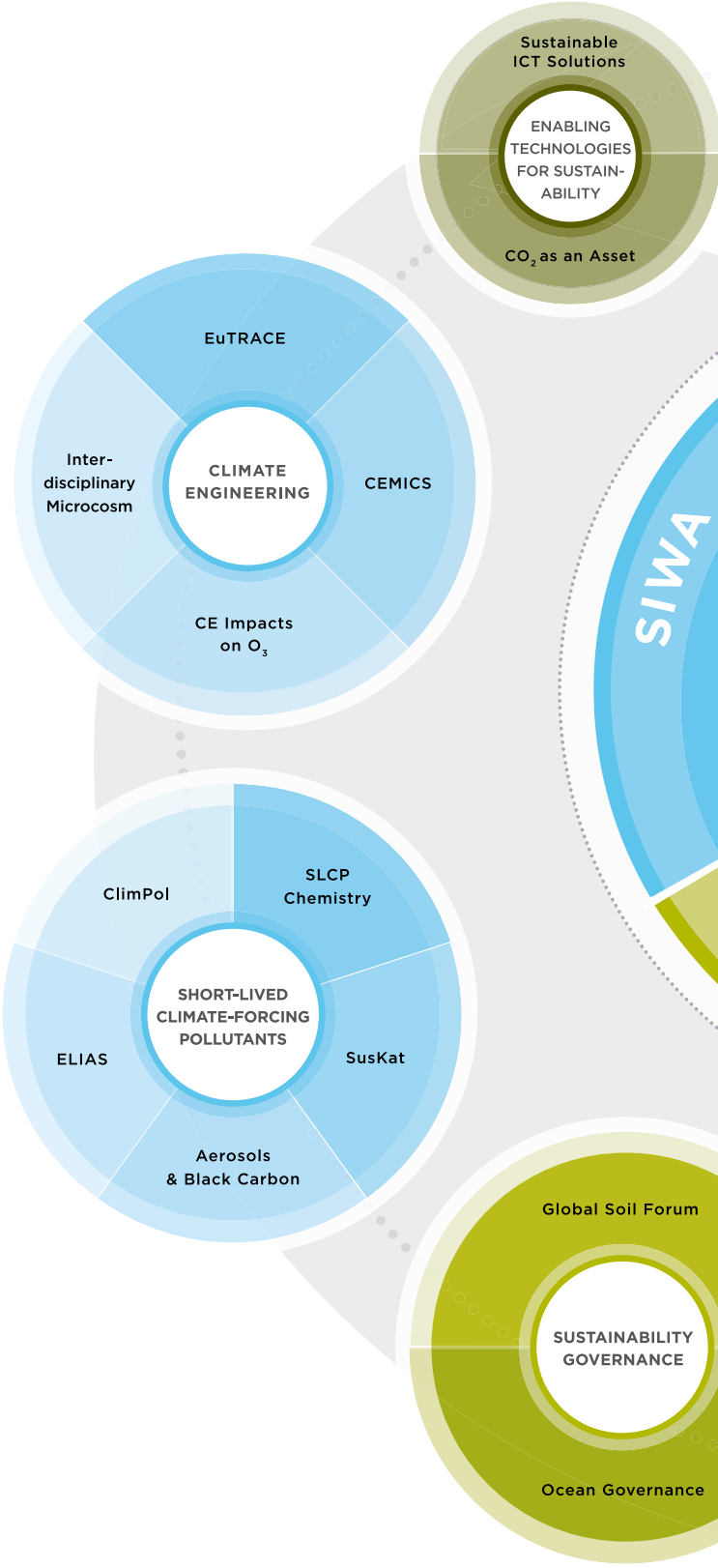
### Thematic Brochures


Thematic Brochures present a topical sustainability theme in an understandable and engaging way. They provide context and point to possible solutions and courses of action.
**Target Groups:** Interested members of the general public, policy-makers, NGOs

# THE IASS AT A GLANCE

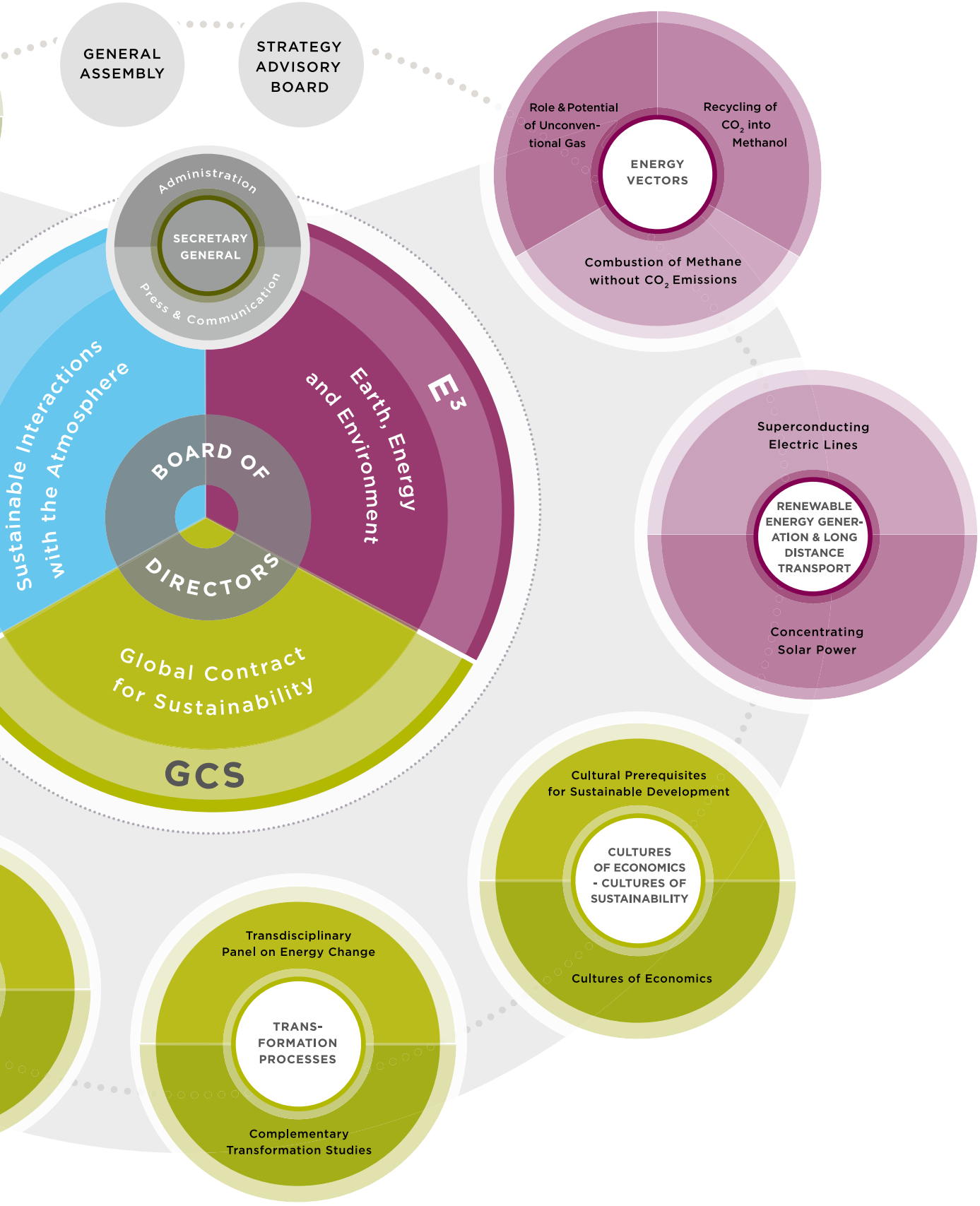
The sustainability research programme at the IASS is organised around three interlinked thematic clusters: *Global Contract for Sustainability* (GCS), led by Executive Director **Prof. Klaus Töpfer**; *Earth, Energy and Environment* ($E^3$), led by Scientific Director **Prof. Carlo Rubbia**; and *Sustainable Interactions with the Atmosphere* (SIWA), led by Scientific Director **Prof. Mark Lawrence**. They are complemented by the platform *Enabling Technologies for Sustainability* (ETS).

Our various research projects benefit from interdisciplinary teams and cross-cluster activities. For example, the SIWA and GCS clusters collaborate in our *Anthropocene* project and in our *Sustainable Maritime Arctic Transformation* project. SIWA and ETS teams cooperate on assessing *Carbon Capture and Utilisation*; and researchers from $E^3$ and GCS cooperate on investigating the transformation of our energy system.




**Legend**

- Board of Directors
- Secretary General
- Sustainable Interactions with the Atmosphere (SIWA)
- Earth, Energy and Environment ($E^3$)
- Global Contract for Sustainability (GCS)
- Enabling Technologies for Sustainability (ETS)


GENERAL ASSEMBLY
STRATEGY ADVISORY BOARD
Administration
SECRETARY GENERAL
Press & Communication
BOARD OF DIRECTORS
Sustainable Interactions with the Atmosphere
Earth, Energy and Environment
E3
Global Contract for Sustainability
GCS
Role & Potential of Unconventional Gas
Recycling of $CO_2$ into Methanol
ENERGY VECTORS
Combustion of Methane without $CO_2$ Emissions
Superconducting Electric Lines
RENEWABLE ENERGY GENERATION & LONG DISTANCE TRANSPORT
Concentrating Solar Power
Cultural Prerequisites for Sustainable Development
CULTURES OF ECONOMICS - CULTURES OF SUSTAINABILITY
Cultures of Economics
Transdisciplinary Panel on Energy Change
TRANSFORMATION PROCESSES
Complementary Transformation Studies

# SCIENTISTS FOR SUSTAINABILITY

More than one hundred scientists from over thirty countries are working together in interdisciplinary research groups that cover a broad spectrum of areas in the natural and social sciences as well as the humanities. At the IASS, they are part of a significant transformation in the way scientists work on sustainability challenges: we actively involve societal stakeholders not only in the initial scoping and development of research topics but also in the research and peer-review processes. With this approach, we want to ensure that the scientific knowledge we generate is action-oriented and usable for society.

**LORENZO CREMONESE,** Geoscience, **MARIANNE PASCALE FLYNN,** Geoscience, **ALEXANDER GUSEV,** Political Science, **NICOLA LORENZ,** Geoscience (from left to right)

Our Project: **The Role and Potential of Unconventional Gas**

We are aiming to gain a better understanding of gas hydrate, shale gas and coal-bed methane reservoirs and their respective production techniques. To date, the main focus of our research group has been on shale gas developments worldwide. In a first step, we are analysing the potential of shale gas in Germany from a geological and an economic point of view. We are also exploring the possible implications of shale gas development for our society, taking highly controversial environmental issues such as hydraulic fracturing (fracking) and the envisaged economic and geopolitical repercussions into consideration.

Source (all photos): IASS/Agentur StandArt

**DR ALBERTO VARONE,** Physics

My Project: **$CO_2$ Recycling for Sustainable Fuels Production**

The combination of recycled $CO_2$ with electricity generated from renewables could help to reduce anthropogenic greenhouse gas emissions and foster intermittent renewable sources of energy, thereby lowering our use of fossil fuels. In my research, I try to assess the technological and economic sustainability of Power-to-Liquid and Power-to-Gas processes in the energy transition.

**ANNA-MARIA HUBERT,**
International Law

My Project: **Climate Engineering Microcosm**

Proposals for deliberate, planetary-scale interventions in the environment to offset some of the effects of climate change raise the prospect of global environmental management at Earth systems level in the future. Yet already today, there is a need for anticipatory, reflexive and transparent governance over the research and development of controversial climate engineering technologies. My interest lies in the question of how the existing international legal system can effectively respond to these novel challenges.

**DR HEIKO THOMAS,** Physics

My Project: **Long-distance Energy Transport with Superconducting Transmission Lines**

Future electricity grids will require innovative technologies to ensure an energy supply based primarily on renewables. I'm particularly interested in superconducting transmission lines because of the clear advantages they have over standard technologies such as greater efficiency, smaller size, and perhaps even lower costs. This makes them an ideal candidate to meet the many challenges of supplying sustainable and affordable energy with a high level of public acceptance.

**MATHEUS ALVES ZANELLA,** Geography, and **JUDITH ROSENDAHL,** Sociology

Our Project: **Global Soil Forum**

Many rural populations depend on natural resources for their livelihoods and are vulnerable to global changes such as rises in food prices and climate change. We look at how the governance of natural resources can be improved to reduce this vulnerability. We believe that the people who work closely with the rural poor have the best ideas about how to tackle this challenge, and for that reason we collaborate with local civil society organisations to document this knowledge.

Source (all photos): IASS/Agentur StandArt

**DR MAHESWAR RUPAKHETI,** and **DR JULIA SCHMALE,** both Atmospheric Sciences

Our Project: **Sustainable Interactions with the Atmosphere**

We both started our academic careers by investigating small particles in the air to increase our understanding of atmospheric chemistry. At the IASS, we now use this knowledge to learn more about the causes and implications of air pollution in Kathmandu, Berlin and Kyrgyzstan. With this knowledge and together with our local partners, we aim to develop strategies to mitigate adverse effects on public health, ecosystems and the climate. Currently, air pollution consisting of small particles is the largest environmental cause of premature deaths and illness.

**DR HARALD STELZER,** Philosophy

My Projects: **Climate Engineering Microcosm and EuTRACE**

As a philosopher, I took this opportunity to work in an interdisciplinary team on climate engineering. From the perspective of applied ethics and justice, climate engineering poses many troubling but also very interesting questions in respect to our relationship to others, to future generations and to non-human nature. The search for answers to these questions with colleagues at the IASS will also advance the debate about global environmental problems in the Anthropocene.


**MANUEL RIVERA,** Sociology

My Project: **Cultures of Economics**

In different ways, my research at the IASS deals with the conditions that allow sustainability to resonate with different regions, groups, or cultures. Among others, I explore the following questions: will Global Sustainability Development Goals (SDGs) fall on fertile ground in the place (Bogotá) where they came from – and if so, why? What do German Members of Parliament think about alternative growth concepts, and what influences the formation of their opinions? The diversity of my work is inevitable – and challenging.

**JEFF ARDRON,**
Environmental Policy, and
**KATHERINE HOUGHTON,**
International Law

Our Project: **Ocean Governance**

Long 'out of sight, out of mind', the deep ocean and high seas are now seen by many countries as the last frontier of economic development. Our interest lies in improving the governance and protection of what covers almost half the surface of the planet, so that the sorts of economic and environmental tragedies we have seen in the past are not repeated. We are looking at legal principles, better use of existing institutions, and improved transparency.

Source (all photos): IASS/Agentur StandArt

**DR BARBARA OLFE-KRÄUTLEIN,**
Media and Communication Studies

My Project: **$CO_2$ as an Asset (CCU) – Potentials & Challenges for Society**

How can unconventional ideas convince a hypercritical public? The communication of complex technical issues in the industrial sector was the focus of my work for years. Here at the IASS, I carry out research on a subject that presents an even greater communication challenge: while the utilisation of $CO_2$ in foams or plastics is a potentially sustainable option, the products themselves remain practically unaltered and are thus far from 'ecological'. On our way to a more sustainable lifestyle, we will need to deal with paradoxes like this.

**PROFESSOR DR MARTIN JÄNICKE,** Political Science

My Project: **Horizontal and Vertical Dynamics in the Global System of Multi-level Climate Governance**

For sustainable energy on a global scale, new clean energy technologies need to be developed and rapidly disseminated. From my research, I am convinced that such an ambitious strategy can only be implemented in the context of a multi-level system of global governance.

**Renewable energy is generated from Concentrated Solar Power in a solar park near Seville, Spain.**

# CONTRIBUTING TO SUSTAINABLE ENERGY FOR ALL

A modern and efficient energy supply constitutes a basic requirement for development. But the current, fossil-based energy system is the source of two thirds of all anthropogenic $CO_2$ emissions. It is also wasteful and expensive and has failed to provide universal energy access. How can we move forward with sustainably transforming the energy system and break existing path dependencies? What are the available technological options and the political and social prerequisites for them? How can we share innovations and lessons learned on an international level?

The inhabitants of the small coastal community of Friedrich-Wilhelm-Luebke-Koog in Germany's North Friesland region know all about turning nature to their advantage. In the early 1990s, these 'energy pioneers' were the first citizens in Germany to found a *'Bürgerwindpark'*, a community-owned wind farm. And in recent years, the amount of energy generated per capita with solar panels in this community has also topped the ranks in Germany's renewable energy league repeatedly. Success is contagious, and the whole of North Friesland has since become a model region of Germany's energy transition – the Energiewende. By harnessing the abundant wind and sunshine on the north-west German coast, North Frieslanders have turned their locality into a multi-million euro business region for renewable energy in just a few decades. Today, the flat, expansive countryside is dotted with 679 wind turbines.

One of the most surprising aspects of this accomplishment is that

**95%**

**of the renewable energy sources in Friedrich-Wilhelm-Luebke-Koog are owned by regular citizens.**

For this to work, local people were included in the energy transition from the outset. Their participation has been continuous and intensive. Locals played an active part in financing, planning, and implementing the project, and are even involved in plant management.

This community-led initiative is one of countless examples in Germany's Energiewende: nationwide, almost 87 per cent of the 53 GW installed renewable energy capacity is owned by non-utility actors. Almost half of that capacity is in the hands of private households, farmers and cooperatives. The rest is divided among small businesses, independent project developers, and investment funds and banks.

**The radical diversification of actors and energy sources in the German energy system is unique in the world and it raises many challenging questions.**

How can we govern a future energy market with so many different actors and high levels of public participation? How should we deal with the myriad of technological issues that arise when the electricity mix of an entire country is largely based on decentralised, fluctuating renewable energy sources, such as wind and photovoltaics? What new technological advances can help to make our current highly wasteful fossil-based energy system more sustainable? What kind of electricity market is needed to satisfy a supply system based on renewable energies?

Our research accompanies and strives to contribute to this transformation process. We examine questions and solutions in relation to the political, environmental and social design of energy systems on the one hand and technological innovations for a future with renewable energy on the other.

## The Road to the German Energiewende

**1970s**

The oil crisis triggers the search for alternative energy sources. Nuclear power is considered as an alternative by the German government. Anti-nuclear and grassroots alternative energy movements begin to form in civil society.

## TRANSFORMATION AS A COLLABORATIVE ENDEAVOUR: THE GERMAN ENERGIEWENDE

Transforming energy systems towards sustainability is one of the biggest challenges of our time. In September 2011 UN Secretary-General Ban Ki-moon called for steps to be taken to make a world with sustainable energy for all a reality by 2030: provide universal access to modern energy services; double the global rate of improvement in energy efficiency; and double the share of renewable energy in the world's energy mix. Inspired by this vision, we founded our ***Transdisciplinary Panel on Energy Change*** (TPEC) in March 2012. As part of the ***Global Contract for Sustainability*** (GCS) cluster led by Klaus Töpfer, the panel aims to provide scientific guidance for the ongoing national and international energy transition.

One of the fundamental premises of TPEC's work was suggested by the Ethics Commission for a Safe Energy Supply. This commission, which was established in 2011 by Chancellor Angela Merkel and co-chaired by our Executive Director Klaus Töpfer, set the course for the German Energiewende. It emphasised that a profound transformation of the world's energy supply towards sustainability can only be achieved if this is a collaborative endeavour – in German, a *Gemeinschaftswerk*. After all, energy systems are much more than technological structures. The Energiewende is a socio-economic and political transformation process that encompasses technological change and requires innovation in all fields.

That is why TPEC was consciously set up as a 'platform' that connects experts from science, politics, industry, and society. True to the transdisciplinary approach to scientific research that is the hallmark of the IASS, we involve a wide range of stakeholders in all stages of our projects. We select research topics, develop recommendations and disseminate results in cooperation with policy-makers, practitioners from the energy sector, and civil society organisations. We also address public concerns from the very start of the process, not as an afterthought. In this way, we hope to generate knowledge and solutions for an energy transition that is sustainable in terms of environmental impact (emissions, pollution), cost efficiency, and societal participation.

Our interdisciplinary team reviews recent data and trends in the development of renewable and conventional energies. On that basis, we elaborate technological and socio-economic alternatives to the current energy system. In addition to contributing to the scientific discussion, we aim to stimulate a broad public debate on the following questions: what financing mechanisms could be feasible for renewable electricity in the future? How do we as a society want to carry the costs of the Energiewende? What is our vision of a sustainable energy system? And how can we achieve a sustainable transformation of our energy system that is socially acceptable and can serve as role model for other societies?

**Debates on the future of energy are often characterised by controversy and it can be hard to reconcile a multitude of stakeholders with very different perspectives.**

With this in mind, we have organised several workshops and other events on the Energiewende in Germany with the participation of experts from Europe and further afield. These events have given rise to books, IASS studies,

**1980s**

Anti-nuclear protests continue to increase. The Green Party enters the German Parliament for the first time, putting environmental issues onto the national agenda.

**1982**

The Öko-Institut in Germany publishes a roadmap for the replacement of nuclear power and fossil fuels by renewable sources. The vision it sets forth is called the 'Energiewende'.

Source: euroluftbild.de/F1online

**A shift from fossil fuels to renewables is crucial to reducing $CO_2$ Emissions.**

## 1986

A core meltdown of one of the four nuclear reactors at the Chernobyl (Ukraine) power station occurs. Only weeks later, the Federal Ministry of the Environment, Nature Conservation, and Nuclear Safety is founded.

and policy briefs with recommendations for decision-makers, all of which are available on our website. At the political level, we have discussed the various implications of the energy transition with the Federal State of Brandenburg and the Chancellery of the Republic of Poland.

### Rethinking electricity markets

The question of energy market design has dominated the German energy debate in the last two years. The energy transition entails an increase in the share of fluctuating electricity sources such as wind and solar energy, which have limited capacity to react to price signals from the electricity market. These renewables incur considerable costs in the run-up to production (capital costs) but virtually no production or marginal costs. We need, therefore, to rethink the basic premises of the current electricity market. Together with the TPEC working group ***Market System for Renewable Energies***, which is made up of stakeholders affiliated with universities, consumer groups, energy companies, foundations and government agencies, our team developed a proposal for a market design for the transition (see IASS Study, April 2014). This design facilitates the continued expansion of renewables by ensuring a high level of flexibility in the energy system so that fluctuating energy sources like wind and photovoltaics are preferred. Already today, these renewables are generating electricity at costs comparable to those incurred by new conventional power plants.

The issue of demand response is crucial to making the energy system more flexible. This is the process of balancing the supply of electricity on the grid with demand. The higher the percentage of fluctuating, renewable energy sources in the total energy mix, the more urgent this issue becomes. The IASS has worked intensively on demand response, integrating the expertise of a wide range of stakeholders at national and international level. With funding from the Transatlantic Climate Bridge, we met with experts from the United States and learned from their experience of demand response. The results of this work have also been published in IASS working papers.

In recent years, 'energy poverty' has been a highly controversial subject in Germany. Due to a rise in energy prices as a result of the renewable energy surcharge (*EEG-Umlage*), low-income households have had to spend an increasing share of their income on electricity. Together with experts from the Wuppertal Institute, the European Institute for Energy Research, and the German Federal Environmental Agency (Umweltbundesamt), we have provided insightful analyses of this issue. More importantly, we have actively engaged with representatives from societal groups affected by the currently imperfect energy market, such as the German Tenants' Association (Mieterbund). Our publication *Beiträge zur sozialen Bilanzierung der Energiewende* was a constructive contribution to the discussion of energy poverty.

### Our proposal for financing renewables

As a possible financing model for long-lasting assets and infrastructures, an 'Innovation Fund' for renewable energies proposed by IASS Executive Director Klaus Töpfer and TPEC has been attracting considerable interest. But what benefits would such a fund bring and how would it work in practice? So far, the costs of developing renewable energy technologies in Germany have mainly been borne by electricity consumers via the surcharge for renewable energies foreseen for a twenty-year period from the date a renewable generation site is put into service. Since it was introduced, technological

**1990**

Germany commits itself to a nationwide 25% reduction of $CO_2$ by 2005 (compared to 1990).

**1991**

The Electricity Feed-In Act (*Stromeinspeisegesetz*) comes into force in Germany. It sets feed-in tariffs for electricity produced from renewable energies and stipulates that green power should be prioritised over conventional energy sources.

innovations have led to a considerable reduction in the cost of producing energy from solar and wind. Yet this has not translated into lower electricity bills for consumers because the twenty-year surcharge period still applies to older, more expensive systems. Hence, there is a lingering perception that generating electricity from renewables is still comparatively expensive. The proposed fund would transfer the cost of technological 'innovation' from the consumer to a designated fund. In this way, the costs of the energy transition would be distributed more equitably. More importantly, the adoption of such a fund would also signal to other countries that solar and wind power systems can already compete in terms of price with conventional power plants.

### The more renewables, the more $CO_2$ emissions?

The steady increase in the share of renewables has been accompanied by a paradox: even though more than a thousand new wind turbines are being built annually, the levels of $CO_2$ emitted in the German power sector have not decreased in the past two years. On the contrary, greenhouse gas emissions in Germany rose by 1.2 per cent in 2013. This is due to the low price of coal on the one hand, and carbon prices that are not high enough on the other.

**Without additional measures, Germany will fail to reach its goal of reducing emissions by 40% in comparison to 1990 levels by 2020.**

We analysed how an internationally tested instrument – $CO_2$ emission limits for power plants – could be implemented in Germany and looked into its political and legal ramifications. Together with the German Institute for Economic Research (DIW Berlin) and the Technical University Berlin (TU Berlin), we presented a proposal based on this work to representatives from politics, the energy industry, manufacturing, environmental protection groups and research institutes. This has given new impetus to the public debate on the transformation of the energy system and the future of coal-fired power plants in Germany.

### A knowledge network

Collaboration with other national research platforms on the subject of energy is integral to our work. We set up the Forschungsforum Energiewende with the Federal Ministry of Education and Research (BMBF), the German Academy of Science and Engineering (acatech) and the Max Planck Society. As well as being a board member of the Energy Systems of the Future project initiated by the National Academy of Sciences, Professor Klaus Töpfer heads the advisory board of the Agora Energy Transition, a joint initiative of the Mercator Foundation and the European Climate Foundation. As part of this network, we have the opportunity to integrate the best available practical and scientific knowledge for the energy transition.

**1990s**

Local people take the initiative in decentralising the power supply: a first *'Bürgerwindpark'* starts operations in northern Germany and the citizens of Schönau in the Black Forest purchase the local power grid, becoming one of Germany's first green electricity suppliers.

**1997**

Within the framework of the Kyoto Protocol, Germany commits itself to a 21% reduction in greenhouse gases by 2012 (compared to 1990).

# CARRYING ELECTRICITY OVER LONG DISTANCES

Often, the places where energy consumption is the greatest are hundreds, if not thousands, of kilometres away from the places were the production of renewable energy is most economical, such as sun-drenched deserts for solar energy or the open sea for offshore wind. At such distances, electrical resistance takes a heavy toll: 2 to 5 per cent of the electricity transported along a 1,000-km HVDC overhead line is lost due to resistivity. Ohmic losses are even higher in the case of standard HVDC underground cables (up to 10 per cent). Moreover, the construction of new overhead lines is often met with strong public opposition. And while conventional underground cables may be less visible, they are prohibitively expensive.

Led by Professor Carlo Rubbia, researchers in our $E^3$ cluster have made substantial progress in developing an alternative solution: superconducting electric cables, which transmit electricity with zero losses. In a purpose-built test station at CERN in Geneva, we have been conducting experiments on progressively longer cables at varying temperatures and current ranges. In February 2014, a major breakthrough was made when a 20m-long prototype cable carried a current of 20 000 amperes – a world record for a superconductor. The dimensions of this cable – 16 cm in diameter – were just as impressive as the amount of current it transported. Superconducting cables take advantage of the fundamental change that occurs in some electrical conductors when their temperature goes below a certain threshold. This phenomenon was first discovered over a century ago, when mercury was shown to be superconductive at 4.2 Kelvin (-268°C). Since then, superconductivity has found many applications, from particle accelerators to medical imaging equipment.

In the last three decades, new discoveries have paved the way to exploiting superconductivity for electricity transport. Materials with higher 'critical temperatures' have been found, thus making it easier and cheaper to reach the state of zero resistance. For instance, so-called high-temperature superconductors (HTS) can be cooled down to 77 Kelvin (-197°C) using liquid nitrogen. However, HTS are ceramic materials that are relatively expensive and cannot be manufactured into flexible wires. In collaboration with CERN and the Karlsruhe Institute of Technology (KIT), the IASS is investigating the use of a more recently discovered superconducting material: magnesium diboride, or $MgB_2$. The operational temperature of $MgB_2$ is a low 15–20 Kelvin (-253 to -258°C), which means that instead of – or in addition to – liquid nitrogen, either liquid helium or liquid hydrogen is needed to cool it down sufficiently. But $MgB_2$ is nevertheless a strong contender for long-distance power transport, because it is a simple chemical compound based on raw materials that are abundant in nature. It is therefore easy and cheap to produce in bulk, and it is also suitable for the manufacture of round wires. As such, $MgB_2$ might well represent the breakthrough needed to make superconducting lines a practical and affordable option for electricity transport.

To maintain its cool operating temperature, a superconducting cable needs to be housed in an insulating envelope filled with cryogenic fluid. For this reason, it is best installed underground. Thus, compared to overhead lines, the visual impact of superconducting lines would be negligible. Underground cables are also not vulnerable to natural weather phenomena; they do not emit noise and require much less land use.

Moreover, superconducting cables offer specific benefits that set them apart from existing power lines. In addition to incurring less resistive losses, these cables would generate very little heat. This gives them a clear advantage over standard HVDC cables, which are prone to heat leakages that can adversely affect soils. Their comparatively compact size is also a plus: we expect that the whole installation for a 4 GW 800-km $MgB_2$ cable would have a diameter of 30 cm, which is much smaller than a conventional HVDC cable with a similar capacity, and vastly smaller than the corridor width needed for an overhead line.

Our superconducting cable is also attractive from an economic point of view. At this stage in the development process, costs cannot be assessed with complete accuracy. However, the first estimates conducted by the IASS show that $MgB_2$ cables would be several times cheaper than standard HVDC cables and could possibly compete with HVDC overhead lines.

Our research can lift superconducting cables out of the realm of prototypes. We have established contacts with industry and transmission partners interested in developing this technology. It is our vision that 'lossless' transport of electricity across long distances will be routine in the next decade by exploiting the potential of superconductivity.

## TECHNOLOGICAL OPTIONS FOR THE FUTURE OF ENERGY

The success story of renewable energies in Germany illustrated by the example of North Friesland has created new issues: in order to transport renewable power from the windy north to the energy-hungry south, Germany's electricity grid has to expand considerably in the next decade. By 2023, around 4,900 kilometres of new lines have to be rolled out and capacity needs to increase by 16 GW, all at an estimated cost of EUR 20 billion. Four new north-south 'electricity highways' are currently being planned.

**However, the construction of new overhead power lines has been met with growing public protest, motivated by concerns regarding their impact on the landscape and the environment.**

These lines are massive constructions that demand extensive land use and property acquisition; they permanently alter the landscape and have a significant ecological footprint. The envisaged new power lines will cross biosphere reserves and urban areas. Transmission towers will be built close to people's homes, fuelling concerns about noise and the effects of electromagnetic fields. Apart from their environmental impact, conventional HVDC (High Voltage Direct Current) lines incur electrical losses that increase with the length of the line, making them ill-suited to form the new 'electricity highways'. Everywhere in the country concerned citizens, municipalities and conservation organisations are calling for alternative solutions.

### Large amounts of energy going underground

One such solution is currently being developed by our research staff in the ***Earth, Energy and Environment*** ($E^3$) cluster led by our Scientific Director and Nobel laureate Carlo Rubbia. Our programme ***Long-distance energy transport through superconducting electric lines*** investigates the possibility of replacing standard HVDC overhead lines and cables with DC superconducting cables based on the superconducting material magnesium diboride ($MgB_2$).

The main advantage of these cables is obvious: superconductivity permits the transport of large amounts of power without resistive losses. Moreover, the ecological footprint of a superconducting power line would be much smaller than that of standard technologies (see Text Box, p. 29). In collaboration with the European Organization for Nuclear Research (CERN) and the Karlsruhe Institute of Technology (KIT), our prototype superconducting cable was designed and tested in a laboratory setting with promising results. In the future, we expect that these superconducting cables will have capacities of 2 to 10 GW, or possibly even more. By comparison, a typical nuclear power plant has a generating capacity of 1 GW.

In 2013, following intensive contacts with industries and utilities, a working group submitted a proposal under the EU's Seventh Framework Programme for Research (FP7-ENERGY-2013-2) for the development of a prototype superconducting power line in partnership with European manufacturers and transmission operators. The proposal, which aims to carry out a real-world operational demonstration of the technology, was favourably evaluated by the European Commission and work began in the autumn of 2014.

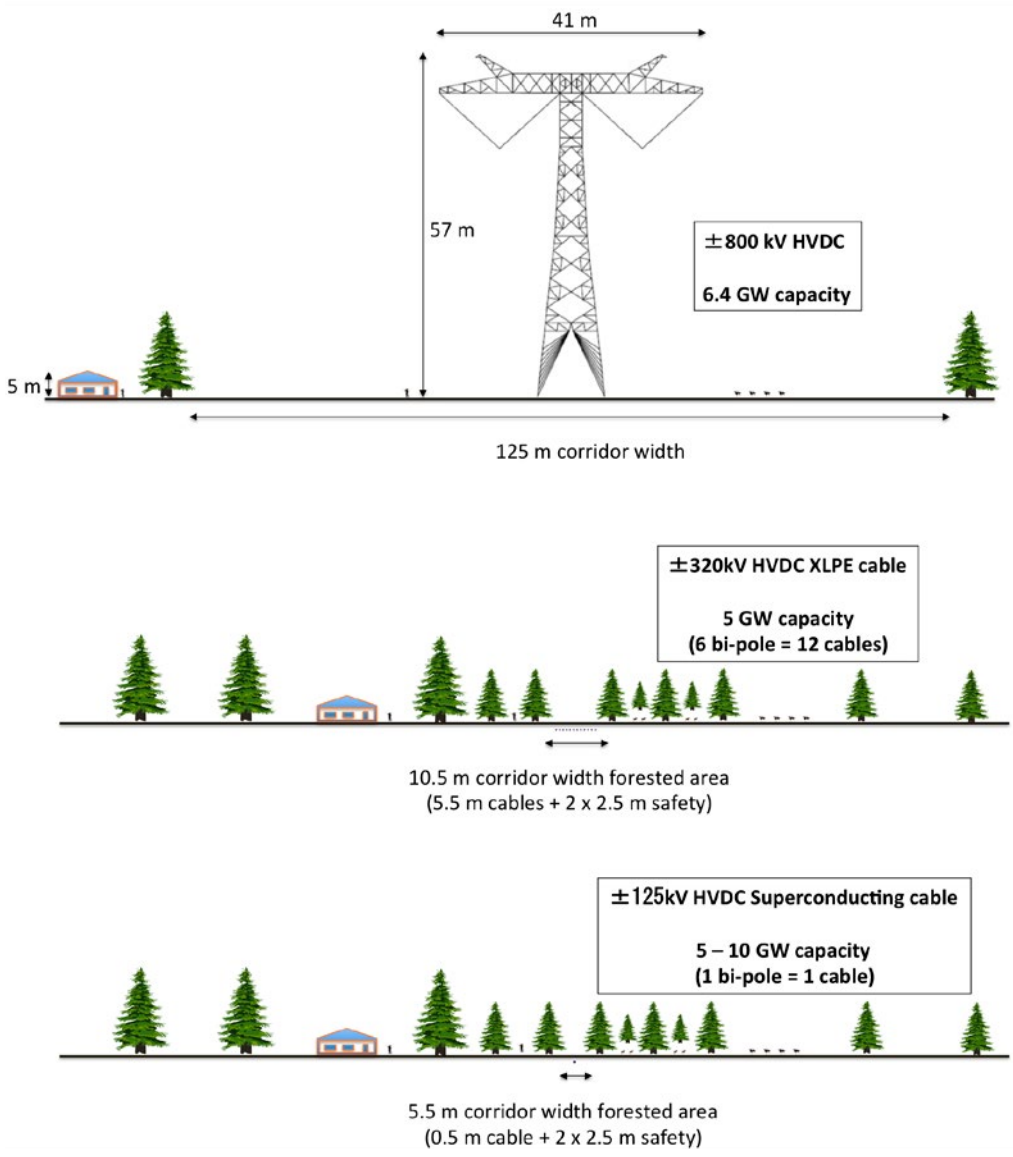
**2000**

A coalition government of Social Democrats and Greens enacts the Renewable Energy Act (*Erneuerbare-Energien-Gesetz*) as the successor to the Electricity Feed-In Act. The high level of investment security due to fixed feed-in tariffs, priority feed-in and purchase obligations for renewable energies leads to an increase in their share in electricity consumption.

The government negotiates an agreement with nuclear operators in Germany to phase out nuclear power. In 2002, this agreement is transposed into the Atomic Energy Act (*Atomgesetz*), marking the beginning of the organised phase-out of nuclear energy in the country by 2021.

## Visual and environmental impacts of different energy transmission options

Source: IASS/Heiko Thomas




The illustration shows the necessary installations and visual impacts of different types of power lines. Standard overhead lines (top) require 50- to 90-metre high pylons at 400-metre intervals and with corridor widths of up to 250 metres. For standard underground cables (centre), 12 single cables are usually needed, resulting in a trench width of at least 5.5 metres as opposed to the few decimetres required for superconducting cables (bottom). In both cases, additional protective zones (2.5 metres) are required on either side in forested areas. Superconducting transmission lines produce no electric stray fields and potentially no magnetic stray fields.

**2005**

The European Union launches a 'cap and trade' emissions trading scheme, covering gas- and coal-fired power plants and large parts of the energy-intensive industries in all EU member states.

**2007**

The European Union sets the '20-20-20' targets for 2020: a 20% reduction in greenhouse gas emission levels compared to 1990; 20% of energy consumption from renewable energies; and a 20% improvement in energy efficiency. Germany commits itself to reducing $CO_2$ emissions by 40% by 2020 compared to 1990.

# HARVESTING THE POWER OF SUNLIGHT

While solar panels are gracing ever more roofs in more and more countries, in the world's deserts another way of harnessing the sun's rays is more popular: CSP, or Concentrated Solar Power. In installations as large as conventional power plants, sunlight is concentrated by mirrors to produce great heat, which can then be converted into electricity through a steam turbine. The flexibility in energy output that this allows is a great asset. Unlike photovoltaics, CSP can be used directly to power applications that require either thermal energy or a combination of heat and electricity, for example, water desalination facilities. More importantly, CSP allows us to store part of the heat generated to produce electricity at a later time. In the case of photovoltaics, electricity can only be generated when the sun shines, and storage methods are expensive and inefficient. The ability to minimise power generation intermittency is the main advantage of CSP. This could make renewable energy a more attractive option than fossil fuels.

The different CSP technologies vary according to the type and the configuration of the solar field. The most common technology uses parabolic mirrors. However, in our research we focus on linear Fresnel reflectors. In this system, the same effect is achieved not by one large parabolic mirror but by a row of smaller flat mirrors, each angled to focus rays on the right spot (a receiver tube with heat carrier fluid). Thanks to their flat mirrors, large Fresnel systems are very flexible and much easier and cheaper to produce, install and maintain than large parabolic mirrors. This might make them winners in the competition for the most efficient form of renewable energy generation.

To date, our efforts have been concentrated on making Fresnel reflectors – and CSP as a whole – more cost-efficient and reliable. In 2013, in collaboration with the Technical University of Madrid, we presented a report analysing various technical options for the optimisation of Fresnel reflectors with multi-tube receivers, including systems for heat storage. The report details the results for different heat-carrying fluids, including water/steam, inert gas and molten salts, and compares the different thermodynamic processes that could be used to convert heat into mechanical work in the turbine. It also includes a theoretical model to help operators decide what would be the best design for them. One of the main findings was that the necessary investment for a Fresnel plant could be brought down to EUR 2,000/kW, with a corresponding electricity cost of between EUR 0.07 and EUR 0.09/kWh. More affordable CSP plants that can generate energy continuously could turn out to be a real game changer for renewables.

**The world's largest linear Fresnel power plant in Puerto Errado, Spain. Here, 300 000 m² of solar mirrors provide 50 million kWh of electricity per year.**

Source: istock

**While we are confident that these cables will make an important contribution to solving the grid expansion challenge, we are aware that no single technological innovation can resolve complex energy issues on its own.**

For that reason, alongside our technology development activities we have begun to thoroughly evaluate the wider context in which our superconducting cable could enter the energy playing field. This evaluation is being carried out by an interdisciplinary team of researchers and will present a socio-economic overview of the issues at stake as well as concrete proposals for policymakers and industry leaders.

Adapting the electricity grid to accommodate a rising share of renewable energy sources (RES) is only one aspect of a multifaceted endeavour to foster RES in Germany and beyond. TPEC's activities in relation to financing mechanisms, electricity market design, demand response, and the regulatory framework represent another crucial component. But we also believe that there is room for improving the technologies behind some renewable energy sources in order to make them more cost- and energy-efficient and increase their competitiveness vis-à-vis fossil fuels. And what if solutions could be found to mitigate intermittency, one of the main drawbacks of renewables?

### Sun in the mirror: solar power for Latin America

At the IASS, we have chosen to focus our efforts on solar power – currently the fastest growing RES – and more specifically on Concentrated Solar Power (CSP), a technology that we believe has not yet been exploited to its full potential. The basic principle of CSP is simple: mirrors are arranged to reflect and concentrate sunlight onto a receiver, thereby generating high levels of heat. This thermal energy can be utilised directly, or converted into electricity, for instance using a conventional steam turbine. Heat is much easier to store than electricity, and therefore the addition of thermal storage systems could help CSP plants to produce energy continually. This feature distinguishes CSP from renewable sources that generate electricity directly, like wind and photovoltaics.

Some CSP technologies, like parabolic mirrors, are already being deployed in many parts of the world. But the existing CSP plants are often quite expensive and difficult to maintain. That's why the $E^3$ cluster is carrying out research on linear Fresnel reflectors, a different CSP technology that promises significant opportunities for cost reduction and greater efficiency (see Text Box, p. 32).

As with our other research projects, we combine work on developing this new technology with research on the broader prerequisites for its implementation. We leverage our scientific and technical knowledge to reach out to stakeholders with concrete proposals. This means that our institute is in a unique position to provide solutions that can be put into practice. For instance, in cooperation with the UN Economic Commission for Latin America and the Caribbean (UN ECLAC) and the Chilean Government, we founded a Latin American Solar Task Force (LASTF) composed of scientists and experts from Chile and Brazil. In a presentation of its work to UN ECLAC and the Chilean Ministry of Energy, it demonstrated the considerable potential of CSP in Latin America and helped to shape Chile's national solar power strategy. In particular, the Task Force proposed

**2010**

With the Energy Concept 2010, the new government led by Chancellor Angela Merkel sets long-term goals for the transformation of the energy system: an 80% share of renewable energies and greenhouse gas reductions of 80–95% (compared to 1990) by 2050.

The government rolls back the 2002 nuclear phase-out by extending the lifetime of Germany's remaining 17 nuclear plants until 2038. Nuclear power is to act as a bridging technology.

the creation of a Latin American Solar Energy Research Center (CELES), which is now being envisaged. Furthermore, the Chilean Economic Development Agency has launched a programme for the installation of at least 10 MW of CSP systems in northern Chile with loans supported by the Inter-American Development Bank, the German KfW Bank and the European Commission.

### Decarbonising our energy supply

Fixing the world's climate problem is a relay race. Everybody knows the goal – to switch to renewable energy sources that generate far less greenhouse gas (GHG) emissions while reducing global energy consumption. Our work on CSP and superconducting electricity lines proceeds from this vision. This is a long-term goal: at least for the next decades, fossil fuels will continue to be used extensively in many sectors. Left unchecked, GHG emissions from the combustion of fossil fuels might well jeopardise our global warming mitigation targets. That is, unless we figure out how to use fossil fuels in a way that renders them less harmful to the environment, or better still, prepares us for the new energy system to follow. That is what one of our $E^3$ projects is helping to achieve. It concerns a fossil fuel that is giving coal and oil a run for their money: methane, the main component of natural gas.

Worldwide production of natural gas is rising fast, thanks in part to the increased exploitation of unconventional reserves, for instance in the USA.

**Global gas consumption amounts to 3.4 trillion cubic metres per year and is set to increase by**

**30%**

**in the next twenty years according to the International Energy Agency.**

When used conventionally, methane is a 'cleaner' source of energy than coal or oil. Instead of their long chains of carbon atoms with hydrogen attached, methane has just one carbon atom for every four hydrogen atoms. That means that its combustion releases less $CO_2$ per unit of energy. But what if the energy potential of natural gas could be tapped while eschewing $CO_2$ emissions altogether?

Instead of burning methane, its atomic components, hydrogen and carbon, can be separated without generating $CO_2$ in a process called 'methane cracking'. The first product of this reaction, hydrogen, is a clean fuel: its combustion does not release any harmful emissions. As such, hydrogen is often seen as the key to decarbonising our energy system. Indeed, in visions of a 'hydrogen economy', it would become the main energy carrier, replacing fossil fuels in power generation and transport. The extent of hydrogen's role in our future energy system will depend on how we meet the economic and technical challenges of building a hydrogen infrastructure, among other factors. But even today, developing a $CO_2$-free source of hydrogen would help to cut emissions from industrial processes like ammonia production (currently 0.3 gigatons of $CO_2$ per year).

**2011**

In March, an earthquake and tsunami in Japan leads to the meltdown of three reactors at the Fukushima Daiichi nuclear power complex. The German government commissions a safety study of all 17 nuclear plants in Germany and announces the immediate closure of the eight oldest plants.

The Ethics Commission for a Safe Energy Supply emphasises that a profound transformation of the world's energy supply towards sustainability can only be achieved if this is a collaborative endeavour. On 30 June, the phase-out of nuclear power in Germany by 2022 is decided in an all-party agreement.

The second product of the methane cracking process is pure carbon in solid form, which can be safely and easily stored. Here in particular, methane cracking has a distinctive advantage over other $CO_2$ emissions mitigation strategies, such as Carbon Capture and Storage (CCS). CCS denotes the storage of $CO_2$ in underground or submarine geological formations, which is far from being risk-free. Moreover, the carbon that derives from methane cracking can be sold for use in the manufacture of car tyres, structural materials, etc., thereby adding to the economic profitability of this technology.

In theory, cracking methane is easy enough. The bonds between carbon and hydrogen will start to snap when the temperature reaches about 550°C. Our research group at the IASS is investigating ways of improving this technology, building upon previous research and experimenting with an innovative design that could overcome obstacles such as clogging of the system. We have developed a column reactor that is filled with liquid metal (tin) at temperatures of between 800 and 1,000°C: methane is injected at the bottom in the form of bubbles that migrate to the top and progressively split into carbon and hydrogen. Due to differences in density, carbon is likely to accumulate at the surface. This makes it easier to remove and allows the reactor to operate stably.

We have taken up this engineering challenge together with the Karlsruhe Institute for Technology (KIT). Since we started in late 2012, we have successfully produced hydrogen and gained valuable insights in the course of several experiments. At present, we are working on optimising several aspects of the process, from the selection of materials to bubble dynamics and carbon removal systems. The ultimate goal is to develop an economical and efficient device that is ready for industrial upscaling.

**Our research on methane cracking exemplifies our approach to the energy transition: finding innovative yet practical solutions to help us to reduce $CO_2$ emissions right away.**

The replacement of gas, coal and oil with renewables in power generation is a key target, but it does not address the use of fossil fuels in other sectors like the transport sector. In this context, there is a clear need for alternative energy carriers that could satisfy the diverse energy requirements of a modern economy yet avoid GHG emissions and work in tandem with renewables.

### Replacing fossil fuels in transportation

This is the starting point for our research project on the ***Recovery of $CO_2$ for the production of methanol***. Through catalytic processes, $CO_2$ can be used in the production of methanol and other synthetic fuels (e.g. synthetic methane). We focus on methanol because it holds the greatest potential for replacing fossil fuels in many sectors. The case for methanol was originally made by Nobel laureate George Olah, who developed the concept of a 'methanol economy'. Owing to its properties, methanol is an excellent fuel for conventional internal combustion engines and requires only minor modifications to be integrated into our cars. In some countries, such as China, it is already being used in blends with gasoline. Beyond the transport sector, methanol can be converted into all the compounds that the petrochemical industry currently produces from fossil feedstocks. It can also be used in novel applications such as Direct Methanol Fuel Cells (DMFC).

**2013**

The share of renewable energy sources in electricity consumption increased from 6.4% in 2000 to 25.2% in 2013. Citizens are the drivers of the Energiewende: 46% of installed renewable energy capacity is owned by private households, farmers and cooperatives and only 12% is in the hands of utilities. The rest is owned by small businesses, independent project developers, and investment funds and banks.

The hydrogen and energy required for the production of methanol and other synthetic fuels from captured $CO_2$ could be provided directly or indirectly from renewable energy sources (e.g. via water electrolysis). This combination of $CO_2$ with renewable energy to produce fuels is a great opportunity. First and foremost, it could lead to significant reductions in overall GHG emissions. The combustion of synthetic fuels releases $CO_2$, but since an equal amount is consumed in the synthesis process, the whole cycle can become carbon neutral. The required $CO_2$ could be obtained from large emitters like fossil power plants, and, in the future, through atmospheric capture. This approach to $CO_2$ as an asset rather than a liability links our work to the institute's other activities on ***Carbon Capture and Utilisation (CCU).*** Furthermore, synthetic fuels produced in this way offer a means of storing surplus renewable electricity in the more convenient form of a liquid or gas. So-called 'power-to-liquid' (PtL) and 'power-to-gas' (PtG) options have recently been attracting more and more interest as a possible solution to the intermittency problem.

In our research we examine the potential of existing and emerging technologies for the fuel synthesis process with the intention of delineating the best pathways to the renewable production of methanol. At the same time, we assess the wider technological, economic and political preconditions for the success of methanol and synthetic fuels. To this end, we bring together various stakeholders to exchange the latest information on research, industrial prototypes, and legislative issues. For instance, marine transport companies have been demonstrating interest in methanol as an alternative fuel. This is particularly the case with those operating in the North Sea, where regulations on marine engine emissions are becoming more stringent. Success in this area could be a catalyst for advances in other sectors, such as road transport.

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## OUTLOOK

With our technological know-how and our profound insights into the German Energiewende, we are in a privileged position to develop real alternatives and new visions for the energy revolution that is required on a global scale. In a world where 1.6 billion people still have no access to electricity, there is a great need for the combination of technical expertise and social analysis that characterises IASS projects. That's why our focus will increasingly shift from the national to the global context in the coming years.

What opportunities exist to globalise renewables 'made in Germany'? How can the world benefit from our experiences of the German Energiewende? What implications do the falling costs of renewable energies have for the world energy market? What model projects for the energy transition in developing countries can we identify and participate in?

We aim to contribute to the massive transformation that is underway towards the goal of sustainable energy sources for all.

2014

Looking ahead: the energy transition is entering a new phase as renewable energies gain system relevance. Reform of the power market design and market integration of high shares of variable renewable energies are high on the political agenda. As renewable energies leave the domain of niche regulations, economic incentives need to be adapted to allow renewable energies to play a leading role in tomorrow's energy system.

## OVERVIEW OF IASS PROJECTS

# TRANSFORMING ENERGY SYSTEMS

**Long-distance Energy Transport through Superconducting Electric Lines**
Since 2011

**Advanced Concepts of Concentrating Solar Energy Systems**
2011–2013

**Combustion of Methane without $CO_2$ Emissions**
Since 2011

**Recovery of $CO_2$ for the Production of Methanol**
Since 2011

**TransGov: Transgovernance – The Quest for Governance of Sustainable Development**
July 2010–December 2011

**Transdisciplinary Panel on Energy Change/Plattform Energiewende**
Since October 2011

**DemoEnergy**
June 2013–May 2016

**The Energy Change in Germany – the NIMBY Phenomenon**
October 2011–September 2012

**Demographic Shrinking and Infrastructures: Technical and Social Supply Systems of the Future**
February 2011–September 2013

**Closed Cycles, Open City**
November 2011–December 2013

**The Role of Narratives and Models for Transformation Processes**
Since 2012

**Options for the Rehabilitation of Fukushima**
2011–2012

**The terraces on the Loess Plateau in Northern China were built over centuries by persevering farmers.**

# TRANSFORMING OUR INTERACTIONS WITH THE ENVIRONMENT

Rapidly growing populations and unsustainable consumption patterns have put unprecedented pressure on our natural systems and resources. For example, the atmosphere in most urban regions and over 40 per cent of the world's oceans are severely affected by humanity. And each year, 24 billion tons of soils disappear. Human activities and emissions are drastically altering the global carbon cycle. This is undermining the ability of our Earth systems to provide functions and services that are crucial to human livelihoods and sustainable development for all. What governance options can foster a sustainable interaction with the environment and safeguard the Earth's resources? How can we trigger action?

In June 2012, twenty years after the first Earth Summit in Rio de Janeiro, thousands of delegates from governments, the private sector, NGOs and other interest groups came together in the same city for the United Nations Conference on Sustainable Development. They sought to reach agreement on a range of measures that can reduce poverty while promoting decent jobs, clean energy, and a more sustainable and equitable use of resources. Among other issues, the conference addressed the following questions: how is it possible to develop a green economy and lift people out of poverty at the same time? What green paths to development could developing countries take? And how can we improve the international coordination of sustainable development? Many new proposals for practical measures emerged from the conference. But fundamental gaps remain between research, practice and policy.

**With our research on the governance of Earth systems and resources, we aim to bridge these gaps and address the environmental, social and economic aspects of transformations towards sustainability.**

We concentrate on four interrelated environmental issues: soil, oceans, the atmosphere, and resources. Our aim is to investigate these areas in an integrated way, combining our knowledge about them and actively involving decision-makers from industry, politics and civil society in the research process. Our work is driven by a desire to promote problem-oriented science that is directly usable for decision-makers. We also strive to provide knowledge for civil society. Hence, quite some effort at our institute goes into building knowledge-sharing communities and stimulating dialogue among researchers, policy-makers and society at large.

## GAINING BACK LOST GROUND

*If you want to go fast, go alone.*
*If you want to go far, go together.*
(African proverb)

We are living in an ever more populated world. The question of how humanity can feed itself in the coming century is becoming increasingly urgent. While projections suggest that a 70 per cent rise in food production is necessary, little attention has been paid to the basis for more than 90 per cent of our food: soils. This is a dangerous omission. Let's take a look at India, a country of 1.2 billion people with a projected average annual rate of population growth of 1.2 per cent from 2010 to 2015. For all its economic progress, the Global Hunger Index still paints a gloomy picture for India: calculations suggest that the country's food security situation is alarming. Fertile soils are scarce and more than 50 per cent of the total land area is degraded. The problem is compounded by social barriers to accessing fertile soils. Caste matters. Evidence from West Bengal shows that landlessness has risen by 20 per cent since the late 1970s. Today, 57 per cent of the region's population has no access to land. How can we ensure food security and tackle malnutrition if the power to determine how soils are used (or abused) is in the hands of a privileged few?

But soil degradation is not only a threat to sustainable development in the Global South. It is a global issue. In the European Union, for example, an area equivalent to the size of Berlin is swallowed every year due to urban sprawl and infrastructure development. Half of that area is sealed, that is, lost to agriculture and other uses. Soil degradation is, however, not only about food production. Fertile soils are also important for the replenishment of groundwater and carbon storage. Soils store about ten times more carbon than the world's forests, so they play a crucial role in mitigating climate change. Moreover, soil biodiversity is impressive, and mankind is only beginning to understand it.

**Soils are not only essential, they are also non-renewable in human lifetimes: it takes two millennia to produce just 10 cm of soil.**

For all these reasons, changing development pathways towards more sustainable soil management is of the essence.

Knowledge about sustainable soil management already exists. Agricultural practices to increase soil fertility are well documented. There are also technologies and management schemes for limiting soil sealing and rehabilitating degraded land. The benefits of a more equitable distribution of land – including decreased livelihood vulnerability and higher economic growth – are universally acknowledged. Why then is this knowledge not applied in a more systematic way? More importantly, how can we generate usable knowledge on sustainable soil management and responsible land governance? And how can we transmit this knowledge to decision-makers at the centres of power?

There are other challenges with regard to knowledge about sustainable soil management and responsible land governance. Not all types of knowledge receive equal attention in global policy fora. More often than not, traditional knowledge is not heeded. Science is also not without its flaws. Despite their claims to the contrary, researchers on different aspects of soil often work in splendid isolation from each other. Hence, there is a real need to establish knowledge platforms that lay the basis for inclusive dialogue and negotiation.

To respond to this need, the IASS ***Global Soil Forum*** was founded in 2011 in consultation with a broad stakeholder group. We strive to create inclusive processes that link local knowledge to global policy debates. We provide a knowledge platform that bridges different types of knowledge – as generated by science, civil society and the political sphere – and different scientific disciplines. Our objective is to drive transformations towards sustainable soil management and responsible land governance worldwide. To that end, we support policy processes with the aim of identifying windows of opportunity for knowledge-based transformation.

### Giving the poor a voice in land governance

In 2012 and 2013, the ***Global Soil Forum*** worked together with partners in six countries in Africa, Asia and Latin America on a project to identify workable climate change adaptation options, which was funded by the International Fund for Agricultural Development. The partners ranged from small civil society organisations in Burkina Faso to BRAC in Bangladesh, arguably one of the largest NGOs worldwide. Our objective was to develop strategies for responsible land governance that would work in otherwise unfavourable policy contexts. Together with our partners, we documented the often implicit knowledge on how to overcome barriers to transformation. The participation of these local partners at every stage of the research process, from study design through data collection to analysis, was the hallmark of the project. According to our partners, this research approach enhanced their capacity to make their voices heard in policy contexts that were previously difficult for them to penetrate. Detailed case study findings were subsequently discussed with senior policy staff of the International Fund for Agricultural Development and brought to the attention of the participants of the ***Global Soil Week***, a knowledge platform and inclusive learning process on sustainable soil management and responsible land governance hosted by the ***Global Soil Forum*** every two years (see Text Box, p. 43).

### Addressing 'land-grabbing' through dialogue

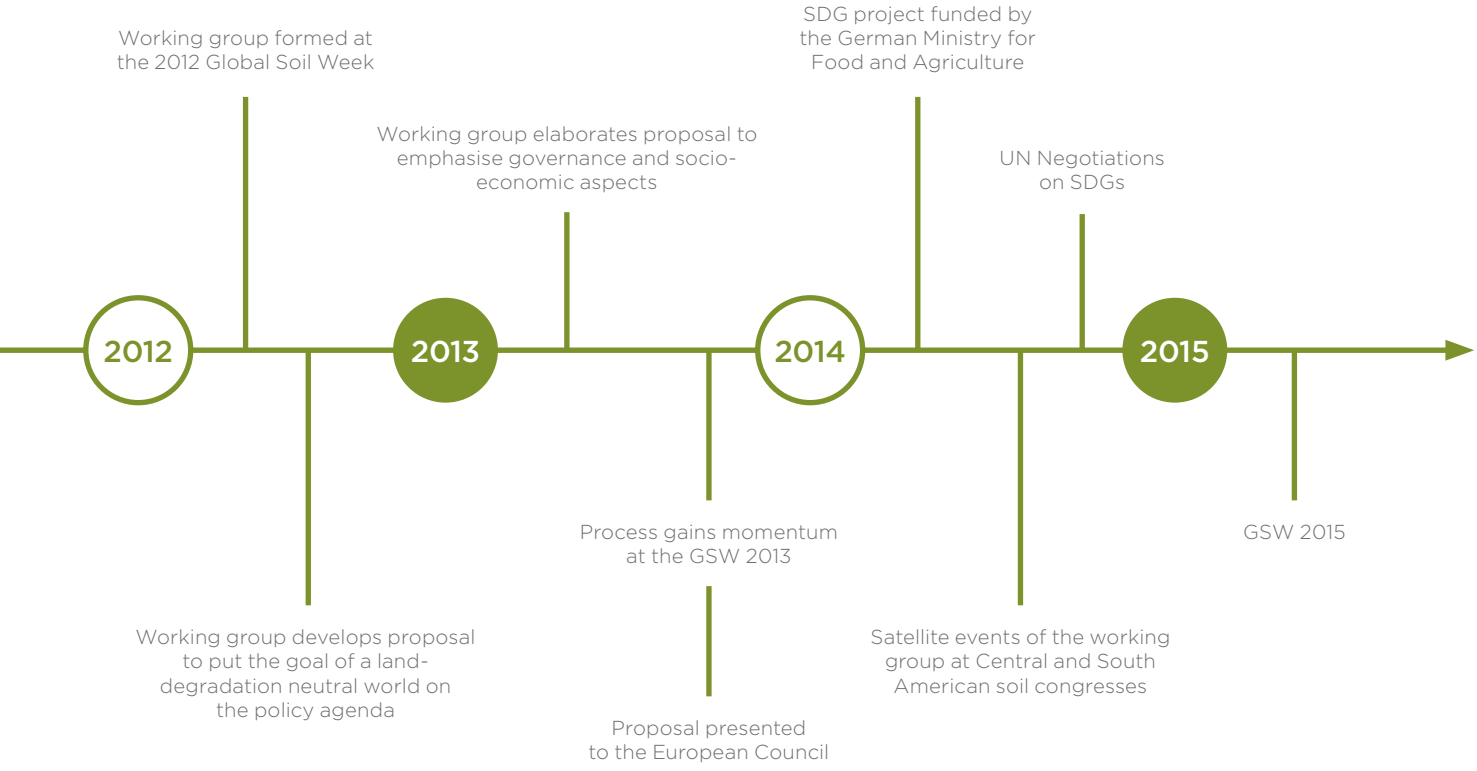
The food crisis of 2008 whetted investors' appetite for land. A decision by Madagascar's then President Marc Ravalomanana to lease 1.3 million hectares to the South Korean company Daewoo in 2009 led to a popular uprising. Ravalomanana resigned shortly thereafter. Due to their detrimental social effects, the Madagascar deal and others like it were soon dubbed 'land-grabbing'. After the 'Madagascar case', land-grabbing became a hotly debated issue in the international media.

The ensuing policy debate was characterised by precious little dialogue and a lot of talking at cross purposes. Some people highlighted the

need for increased investments in agriculture in developing countries. Yet those opposed to such investments drew attention to mounting evidence that regulation was often no guarantee that they would actually benefit vulnerable groups. In fact, comparative studies have shown that investors prefer weak governance contexts. At the beginning of 2013, information began to trickle down that the G8 would take steps to increase the transparency of land investments in recipient countries. This focus on transparency, civil society claimed, neglected other principles of responsible investment such as equality, gender and environmental concerns. Thus it was hardly a surprise that these plans were met with fierce opposition.

In partnership with the German Institute for Human Rights, the IASS invited representatives of the German Government, scientists and civil society actors to exchange views on this contentious matter. After analysing both sides of the debate, the IASS facilitated an exchange of views on the G8 land transparency initiative. While the participants did not stray far from their positions, they did make active use of the space for dialogue. Similar discussions took place at the same time in the United Kingdom. At the end of the negotiations in June 2013, the final text approved by the G8 reflected many of the recommendations made at the IASS earlier that year.

## Sustainability in Action: our work on a *Land-Degradation Neutral World* as a collective process at the Global Soil Week



# THE GLOBAL SOIL WEEK: BRIDGING KNOWLEDGE, EMPOWERING TRANSFORMATION

Imagine soil scientists from the USA and Russia, farmers from Europe and China, politicians from Malawi and Brussels, environmental activists from India, a sociologist from Brazil and businessmen from South Africa and the United Kingdom coming together for a whole week to collectively address the problem of losing the ground beneath our feet. With our Global Soil Weeks in 2012 and 2013, we established an international event that bridges different kinds of knowledge and provides a collaborative platform for farmers, the policy-makers who regulate soil use, people whose businesses depend on soil ecosystem services, and civil society actors, including artists. We aim to close the gap between knowledge and action. To do so, we believe it is necessary to integrate scientific knowledge with practical and traditional knowledge. In the autumn of 2013, our second Global Soil Week in Berlin attracted over 450 participants from 71 countries. Together with our partners – the European Commission, the Food and Agriculture Organisation of the United Nations (FAO), the United Nations Convention to Combat Desertification (UNCCD), the United Nations Environment Programme (UNEP), the German Federal Ministry for Economic Cooperation and Development, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), and the German Federal Environmental Agency – we also raised awareness of more sustainable soil management practices among policy-makers.

One example of the Global Soil Week's contribution to political processes towards soil protection (see timeline) is our work on a Land-Degradation Neutral World (LDNW). The loss of fertile soils has devastating consequences: reduced land productivity and related socio-economic problems, including food insecurity, migration, limited development, and damage to ecosystems. We picked up the work thread leading up to the United Nations Conference on Sustainable Development in 2012 (Rio+20), whose principle outcome was a mandate for a new set of Sustainable Development Goals (SDGs). These SDGs represent an important instrument to anchor the issues of soil and land in the international political arena. The IASS co-hosted a side event at Rio+20 to ensure that the goal of a Land-Degradation Neutral World was included in the final declaration of the conference. Four months later at the first Global Soil Week in 2012, a dialogue session on Global Land and Soil Degradation was organised in collaboration with the United Nations Convention to Combat Desertification and the Deutsche Gesellschaft für Internationale Zusammenarbeit. This session led to the establishment of a working group comprising representatives of government (e.g. the German Federal Environmental Agency and the European Commission), science (e.g. the International Center for Tropical Agriculture), and civil society (e.g. Oxfam) under the auspices of the Global Soil Forum. Throughout 2013, it developed a proposal for Land-Degradation Neutrality targets. By including a diverse range of stakeholders in the process, we were able to integrate governance and socio-economic aspects that were previously absent from the debate on soils. The collaborative process continued at the second Global Soil Week in 2013, where 100 dedicated stakeholders forged an agreement on the working group's proposed Land-Degradation Neutrality targets. Only a few weeks later, this document informed the European Council's negotiations on the topic. The process will continue at the Latin American Congress of Soil Science in 2014, the Brazilian Soil Seminar in 2015, and, of course, at our Global Soil Week 2015. Our leadership of a project on renewables and the Sustainable Development Goals funded by the German Federal Ministry of Food and Agriculture builds on these achievements.

Source: Piero Chiussi/Agentur StandArt

Fertile soils are the basis for 90% of the world's food production.

Source: Flickr/Utilitarian

40% of the world's ocean's are severely affected by humans.

Source: istock

Emissions of greenhouse gases and pollutants are dramatically changing the atmosphere and our climate.

Source: istock

Due to global warming, polar ice is melting, leading to rising sea levels and further climate change.

Source: IASS/Karsten Häcker

### A question of human rights

It is now widely recognised that secure rights to land encourage the uptake of sustainable soil management practices. While secure tenure rights do not automatically lead to sound soil use, the latter is unlikely to come about without the former. However, the issues of responsible land governance and sustainable soil use continue to be discussed in different policy and scholarly contexts. The people involved publish in different journals and do not attend the same conferences. As a result, the scope for joint action and learning across disciplines is not exploited to its full potential. The IASS cooperates with and encourages dialogue among three different research communities: soil scientists, people who study responsible land governance, and people engaged in research on land degradation and desertification. The task of bridging the gap between the scientific community and practitioners outside of academia is even more challenging. To facilitate such an exchange, a space for dialogue must be created.

We need to build on these insights when addressing emerging issues such as soil rehabilitation and ways to achieve a 'Land-Degradation Neutral World' (see Text Box, p. 43) – a core outcome of the Rio+20 conference. If we fail to do so, technical solutions might not benefit those who are most in need of them. The pathways towards responsible land governance and sustainable soil management should therefore be merged.

## HIGH SEAS — DEEP CHALLENGES

The inhabitants of Sointula, a fishing village on the west coast of Canada, could not believe their ears. The representative of the Department of Fisheries and Oceans was explaining that the most lucrative fishery on the coast would stay closed that year due to depleted fish stocks. It was unbelievable, and yet it happened. In this village and others like it up and down the coast, and indeed across the world, fishing boats have stayed tied up to the dock since the early 1990s, slowly falling into disrepair. Jeff Ardron, now a senior fellow in the IASS Oceans Governance group, lived as a fisherman in Sointula and experienced these closures at first hand. No one, and everyone, was to blame: it was not the failing of any single group or government, but the failing of the entire governance system that had led to this state of affairs. Policy-makers, managers, scientists, and stakeholders all had their role to play.

As part of its work on sustainability governance, the IASS analyses key challenges in relation to sustainability in the ocean and develops strategies for governance reform. Here, the aim is to identify options for improving the protection and sustainable use of marine areas and fostering dialogue among scientists, policy-makers and stakeholders.

**The ocean — which covers almost**

**70%**

**of the Earth's surface — is a critical pillar of global transformation processes towards sustainability.**

Marine ecosystems and biodiversity perform critical functions in the natural cycle and support life on Earth. And billions of people around the world depend on them for their livelihoods. The pressing need to put the oceans high on the political agenda was highlighted at Rio+20. There, states committed themselves to deciding on an international instrument under the UN Convention on the Law of the Sea by August 2015. Such a global agreement would improve the governance of marine areas beyond national jurisdiction (ABNJ) – the high seas – and ensure the conservation and sustainable use of marine biological diversity in these areas.

# The IASS – Creativity in Science and Transformation

Demographic growth across the globe and a change in consumer behaviour prompted by increasing wealth in industrial, emerging and developing nations are increasing pressure on natural resources.

In this context, human activities result in higher emissions of climate-relevant gases into the atmosphere, a reduction in the availability of fertile soils, clean water and high-value foodstuffs, as well as ecosystem degradation due to the use of mineral and fossil resources, which is often accompanied by adverse effects on biodiversity. In contrast to the pre-industrial era, mankind is, today, increasingly intervening in the natural processes of the Earth system and has itself become a geological factor. The reciprocal feedback effects provoked by these anthropogenic interventions are not yet sufficiently understood. In accordance with the precautionary principle, efforts must be made at national and international level to ensure that our natural resources are extracted in an environmentally friendly way, used efficiently, and reclaimed and conserved as far as possible.

As the first institute of its kind, the IASS develops innovative approaches with the aim of combining the analysis of scientific knowledge with the transfer of the knowledge gained to society at large. Together with the GFZ, the German Research Centre for Geosciences, the IASS has contributed to this often neglected transfer of knowledge at the interface of politics, society and science, most notably within the framework of the Global Soil Week and the 2014 Potsdam Summer School on the Arctic in the Anthropocene. In efforts to improve the global governance of central sustainability issues, this combination of transdisciplinarity, transfer to society, and internationality is the unique selling point of the IASS. It offers a blueprint for attaining a global consensus on the sustainable development of the Earth system (Global Contract for Sustainability) in spite of cultural and economic differences. For that reason, the IASS must remain committed to developing this knowledge-based and scientific approach as a progressive paradigm of political and societal action at international level. The national and global networking and reputation of the institute, its wide-ranging expertise in the humanities and the natural sciences, as well as the cooperation of young and experienced IASS researchers on overarching research questions will allow it to blaze new trails in developing solutions to existing problems and map out visions for the future development of human civilisation. To this end, the methodological challenges that persist in the international field of transformation research need to be met in a comprehensive way. In this respect the IASS benefits from intensive collaboration, in particular with research institutes in the metropolitan region of Berlin-Brandenburg, and has become a hub and thus an integrating force in the field of transdisciplinary research.


Source: GFZ

## Prof. Reinhard Hüttl

Professor Dr Reinhard F. Hüttl is chairman of the Board of the German Research Centre for Geosciences, president of the National Academy of Science and Engineering (acatech) and chairman of the IASS Strategy Advisory Board. After studies in Germany and the USA, he held the chair of Soil Protection and Recultivation at Brandenburg Technical University in Cottbus. He holds the Order of Merit of the Federal Republic of Germany. (*Bundesverdienstkreuz*).

### Navigating towards better protection of the oceans

In 2012 and 2013, the IASS cooperated with partners from science, politics and civil society to support this process. Leading international experts from the fields of maritime law, marine policy and the marine sciences joined representatives of government, civil society and international organisations at a workshop organised by the Institut du développement durable et des relations internationales (IDDRI) – a French think tank based in Paris – and the IASS from 20 to 21 March 2013 in Potsdam. This workshop, which was titled "Oceans in the Anthropocene: Advancing the Governance of the High Seas", aimed to identify options and overarching principles for the protection of marine areas beyond national jurisdiction.

In the presence of German Environment Minister Peter Altmaier and Jean-Pierre Thébault, the French Ambassador for the Environment, participants discussed the potential content of a new agreement on the conservation and sustainable use of biological diversity in areas beyond national jurisdiction. They also debated ways of ensuring better protection of the high seas through existing global and regional instruments and explored general principles for ocean governance.

At the end of the workshop, there was overall consensus on the need to launch negotiations towards a new global agreement. At the same time, it was stressed that regional initiatives aimed at ensuring better governance of the high seas must be advanced. The key messages of this workshop were published in IASS Policy Brief 1/2013: Advancing Governance of the High Seas. They were also published in a special section of the Marine Policy Journal in 2014, which was guest-edited by the IASS and IDDRI.

We were invited to present the key conclusions of our research on ocean governance to delegates at intersessional workshops at the UN in New York from 7 to 8 May 2013. The results of these workshops fed directly into relevant international processes and inspired debate, for example at the UN General Assembly's Working Group on areas beyond national jurisdiction (7–8 May and 19–23 August), the Global Meeting of UNEP Regional Seas Conventions and Action Plans (Montego Bay, 30 September–1 October), and the International Marine Protected Areas Congress (Marseille, 21–27 October). Furthermore, in an effort to engage with civil society, scientists, and decision-makers in Germany, the IASS hosted a dialogue meeting in January 2014 – together with the Helmholtz Centre for Ocean Research Kiel (GEOMAR) and the Cluster of Excellence "The Future Ocean" at the University of Kiel – to ensure informed discussions on ocean governance issues, such as the establishment of a new regime for the high seas, a Sustainable Development Goal for oceans and coasts, and the reform of existing ocean governance mechanisms.

Both institutes, the IASS and IDDRI, are committed to working together and cooperating with other key partners such as UNEP to further a global discussion that should lead to a decision on a new agreement. To that end, a second Potsdam Ocean Governance Workshop was held in the autumn of 2014.

## FOR SUSTAINABLE INTERACTIONS WITH THE ATMOSPHERE

In 2001, Professor Veerabhadran Ramanathan, a leading researcher at the Scripps Institute of Oceanography in La Jolla, California, and Professor Paul Crutzen, a Nobel Prize-winning climate scientist, took the then Executive Director of the United Nations Environment Programme (UNEP) Klaus Töpfer on a flight along the foothills of the Himalayas. What Töpfer saw was literally breathtaking: layers of brown clouds or regional-scale plumes of air pollution lapping at the edges of the mountain range.

From that day on, UNEP has taken a keen interest in the atmosphere. The 'atmospheric brown clouds' that Töpfer saw are composed of aerosol particles that are small enough to float in the air together with gases such as ozone. These clouds are not only harmful to human health and crops; they also have a significant impact on the climate. Some aerosols, such as black carbon,

# A CLEAR VIEW FOR KATHMANDU

On a clear day, you have beautiful views of the snow-capped peaks of the Himalayas from the Nepalese capital. Unfortunately, most days in the Kathmandu Valley are not clear, and even the nearby hills are often not visible. But that is not the worst consequence of air pollution here: the gases and aerosols are hazardous to the health of the valley's 3.5 million inhabitants and its numerous visitors. In the city centre, the air quality is so bad that Nepal's own air quality standards are only met on about 40 days of the year; the rest of the year, particulate matter exceeds the limits considered harmful.

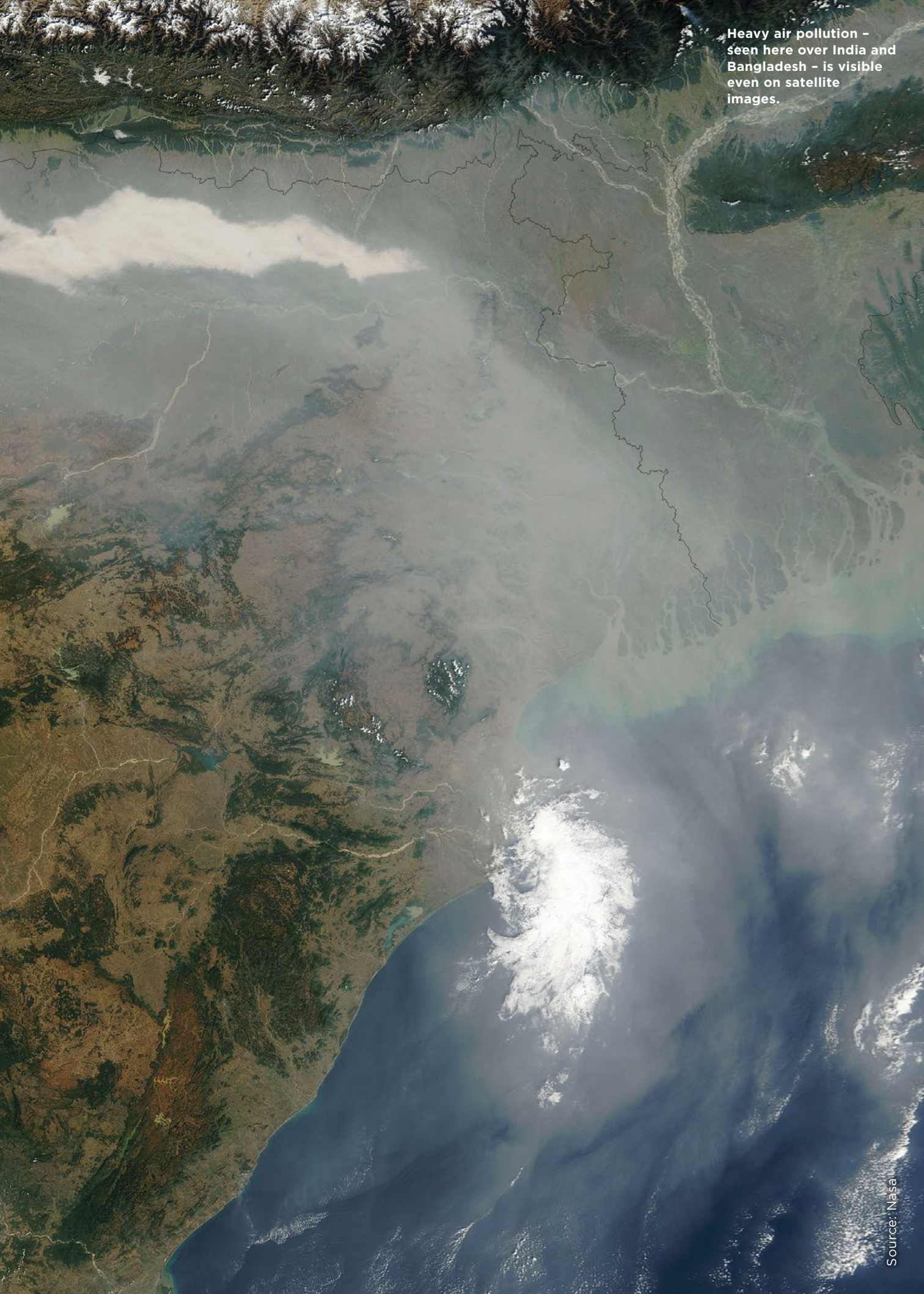
If air pollution were just a matter of physics and chemistry, the problem would perhaps be easy to solve. But air pollution is a product of society: people cause emissions. While the pollutants are harmful to those who emit them and others nearby, there are good reasons for activities that cause the emissions, like cooking food, transporting goods, and generating electricity. This complex web of phenomena is what must be understood if polluted areas are to be made cleaner. The core aim of our activities lies in transcending science to understand the socio-cultural aspects of air pollution and support the implementation of mitigation measures in one of the most polluted areas in the world: the Kathmandu Valley.

The emissions that sully the valley's air have many different sources: exhaust fumes from cars and trucks, smoke from brick kilns, dust from badly maintained roads and soot and other aerosol particles from burning waste. These sources are not confined to the city itself, but can also be found in the surrounding countryside. Furthermore, the bowl-shaped rim of the Kathmandu Valley helps to trap pollution in the valley.

With the project SusKat, *A Sustainable Atmosphere for the Kathmandu Valley*, we have taken the initiative to tackle this pollution in a systematic and holistic way. In the first phase of this project, from mid-2012 to mid-2014, we organised and led a measurement campaign to understand the details of the pollution. We were joined by over 20 local and international research groups, making it the second largest international air pollution measurement campaign ever carried out in Southern Asia. Our analysis of these measurements is complemented by studies using computer models.

In the second phase of SusKat, from mid-2014 to mid-2016, we will focus on possible mitigation options. Again, at a technical level, this might seem relatively easy. Is home cooking a major source? Introduce modern, clean-burning stoves or solar cookers. Are buses leaving dirty smoke plumes in their wake? Retrofit them with diesel particle filters or replace them with new buses. Are brick kilns to blame? Replace them with modern, cleaner-burning ones. But here too, social processes are crucial to understanding which mitigations options are feasible in the local context. If the identified options prove promising on small scales, future phases of the project will try to scale them up. At every stage of the project, we have involved key stakeholders, including governmental agencies, business associations, community groups, religious leaders, the private sector, the media, and even popular figures such as movie stars.

SusKat is already reaping rewards for Kathmandu by raising awareness of the amount and the harmful impact of air pollution and showing that there are ways to reduce it. But there are more reasons why we are putting so much effort into this project. There are many cities in the developing world that are in dire need of relief from air pollution. If SusKat can help to make the snow-capped Himalayas visible from Kathmandu on more days of the year, we will also have developed a template for tackling extreme air pollution in other cities in the developing world.



**Heavy air pollution – seen here over India and Bangladesh – is visible even on satellite images.**

Source: Nasa

contribute to global warming, while others have a cooling effect. Since they do not remain in the atmosphere for very long – from days to years – compared to a residence time of centuries for $CO_2$, the pollutants that make up brown clouds are often called 'short-lived climate-forcing pollutants' (SLCPs).

### The many faces of air pollution

According to the World Health Organisation (WHO), air pollution leads to approximately 7 million premature deaths per year. In Europe alone, despite high air quality standards, it is estimated that poor air quality lowers life expectancy on average by about half a year. It also causes substantial damage to ecosystems and agriculture.

**Moreover, at present SLCPs collectively contribute about as much as $CO_2$ to global warming.**

Thus a reduction in SLCPs would help to lower air pollution-related disease and premature deaths, as well as minimising damage to ecosystems. Furthermore, lowering SLCP concentrations could slow down the rate of global warming. With regard to long-term climate change, however, the focus for mitigation still needs to be on long-lived greenhouse gases such as $CO_2$.

In the past two years, our IASS research cluster ***Sustainable Interactions With the Atmosphere*** (SIWA) headed by Professor Mark Lawrence has developed a comprehensive research programme on SLCPs. The SIWA research groups and projects address a broad spectrum of issues related to air pollution. In addition to carrying out basic research, they explore mitigation and governance options, focusing in particular on Southern Asia, Europe and the Arctic. The cluster's researchers measure and model the chemistry of air pollutants and trace their dispersal and removal on local to global scales. Other researchers work on identifying promising mitigation measures that fit to local/national contexts and improving the regulation of SLCP sources.

Despite considerable progress in research on all of these areas, many questions remain unanswered. Especially in the cases of tropospheric ozone and black carbon aerosol particles, we are far from fully understanding observed global and regional distributions and trends. Several SIWA projects are contributing to filling this knowledge gap over a range of spatial scales. On the global scale, we are applying global chemistry-climate model, the Community Earth System Model (CESM), to investigate global tropospheric background ozone as well as the long-range transport of ozone and its precursors. We are also employing the Weather Research and Forecast model (WRF) for local- to regional-scale studies. SIWA's modelling projects aim to:

- investigate how various urban planning strategies such as urban greening contribute to the formation of SLCPs;
- analyse the underlying processes and production pathways of tropospheric ozone;
- determine the influence of black carbon emissions from many different activities such as transportation, industrial processes, power generation, residential biofuel burning, and forest and savannah burning;
- understand black carbon's contribution to poor air quality in the Kathmandu Valley and the greater Southern Asian region and develop possible mitigation strategies;
- examine black carbon's climate-forcing role, seen, for example, in its absorption of sunlight.

In addition to our work with numerical computer models, we have also been conducting measurements of air pollution in Nepal, especially in the Kathmandu Valley (see Text Box, p. 48), and in the Berlin-Potsdam metropolitan region. These measurements are providing further insights into the nature and sources of SLCPs in these regions and will be a valuable baseline for evaluating the success of any mitigation measures in future.

A robust scientific understanding of SLCPs forms the backbone of other SIWA projects that

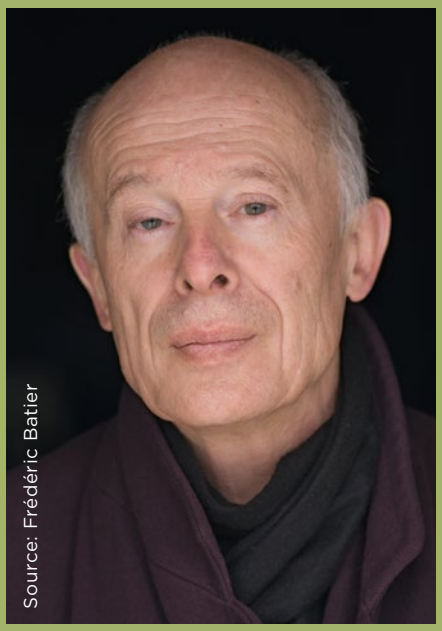
# Sustainability Science – A Success Story

The foundation of the IASS can be perceived as a landmark in the quest for transdisciplinarity. The multifaceted research carried out there is of paramount importance for advancing our knowledge about the contemporary world. This is key to designing possible solutions to anthropogenic climate change, demographic transition, and resource depletion.

Back in 2001, I had the honour of authoring – together with a number of eminent colleagues – an article for the journal Science (Kates et al. 2001). Actually, that very article gave birth to the now thriving field of 'sustainability science'. The Proceedings of the National Academy of Sciences (PNAS) have since dedicated an entire section of the journal to the question of how complex socio-ecological systems can be steered through the challenges and risks of global change.

Six years later, I was able to initiate – again with the support of outstanding personalities – the Nobel Laureate Symposium Series on Global Sustainability, which is perhaps the most conspicuous international outlet for sustainability science today. The next event in that series, focussing on "4C: Changing Climate, Changing Cities", is due to be held in Hong Kong.

The first event in Potsdam in 2007 culminated in the so-called Potsdam Memorandum, which was signed by numerous Nobel laureates, internationally renowned experts, and public intellectuals. Incidentally, the production process of the Memorandum was overseen by Klaus Töpfer.


Source: Frédéric Batier

## Prof. Hans Joachim Schellnhuber

Professor Hans Joachim Schellnhuber is deputy chairman of the IASS Strategy Advisory Board. He has been the director of the Potsdam Institute for Climate Impact Research (PIK) since he founded the institute in 1992. He is Professor of Theoretical Physics at the University of Potsdam and external professor at the Santa Fe Institute, USA. He is also co-chair of the German Advisory Council on Global Change (WBGU).

> "The Memorandum underlined the necessity of at last setting sail to energetically pursue the transition to sustainability through a new global contract between science and society."

One of the direct impacts of this wake-up call was the establishment of the Institute for Advanced Sustainability Studies (IASS) in 2009 by the German Government with the broad support of the German Science Alliance.

The foundation of the IASS can be perceived as a landmark in the modern quest for transdisciplinarity. The multifaceted research carried out there is of paramount importance for advancing our knowledge about the contemporary world. This is key to designing possible solutions to anthropogenic climate change, demographic transition, and resource depletion. Managing the complexities of today and tomorrow requires the IASS and many sister institutes.

focus on the science-society interface and strive to develop appropriate policy frameworks to support SLCP mitigation. Rather than merely providing end-of-pipe solutions, we aim to fully understand societal dynamics on global and local scales in order to support more sustainable interactions with the atmosphere. Our ClimPol project (***Short-lived Climate-forcing Pollutants: Research Needs and Pathways to Policy Implementation***) follows a transdisciplinary research approach by collaborating with stakeholders from politics, science and society. Our cooperation with the City of Potsdam is just one example of ClimPol's work.

**Together with the city authorities, we developed a new multi-criteria assessment method for an integrated evaluation of the impact of traffic measures on air quality, climate change, noise pollution, road safety, eco-mobility, and quality of life.**

Complementary to this, we have organised workshops to discuss the challenges and opportunities presented by integrated strategies for air pollution and climate change mitigation at European level in Copenhagen, Brussels and London.

### Integrating policies on air quality and climate

An appropriate legal framework is a prerequisite for implementing sound measures. If we are to interact sustainably with the atmosphere, we need good governance as well as progressive and well-designed laws to protect the environment. Our research project on ***Environmental Law and Institutions with a Focus on Air and Sea*** (ELIAS) complements our strengths in the natural sciences by addressing the international law and politics of SLCPs. ELIAS focuses on emerging and rapidly evolving governance regimes, such as the Climate and Clean Air Coalition (CCAC), an international effort to maximise the health, agricultural and climate benefits of swift action on short-lived climate-forcing pollutants (SCLPs) recently launched by UNEP. It also analyses how air quality and climate policies could be better linked to or incorporated into the existing international legal framework of multilateral environmental agreements (MEA).

Our transdisciplinary research project ***Sustainable Modes of Arctic-Resource-driven Transformations*** (SMART) is closely linked to ELIAS. SMART analyses the effects of changes in the Arctic that are driven by climate change and increasing economic activity in the region. Regional warming in the Arctic – which is twice that of lower latitudes – is significantly influenced by SLCPs, especially black carbon. While SLCPs from sources outside the Arctic contribute most to this warming, the impact of SLCPs generated in the Arctic from domestic heating, gas flaring, and maritime transportation, is significant. SMART tries to contribute to the sustainable development of the Arctic by furthering scientific understanding and developing participatory governance.

As part of our outreach work, we have initiated several innovative communication projects such as the short animated film "Outlaws in Air City" on the sources and consequences of SLCPs and possible mitigation options. A second SIWA film, "Engineering the climate?", critically engages with the opportunities and risks associated with climate engineering, our second research focus in SIWA (see Text Box, p. 53).

## MITIGATING EFFECTS OF RESOURCE USAGE

Our research activities on soils, the oceans and the atmosphere all aim to support more sustainable interactions with Earth systems. In pursuing this goal, we also need to consider the resources contained in these systems and how they are used. That is why, in line with the Rio+20 recommendations on the sustainable management of natural resources, we investigate ways of reconciling resource usage and environmental protection in a number of targeted sectors. As well as analysing the technical solutions

# MODIFYING OUR MODIFIED PLANET?

Given the limited success of mitigation measures to date, options for directly intervening in the climate system are being considered by scientists, policy-makers and other stakeholders. These options are often subsumed under the umbrella term 'climate engineering', but they actually encompass a multitude of very different methods, from fertilising the oceans to capturing $CO_2$ from the air or injecting aerosols into the atmosphere.

In the context of ongoing efforts to reduce air pollution, it seems paradoxical that the injection of climate-forcing air pollutants (sulphate aerosols) into the stratosphere is one of the most widely discussed options for engineering the climate. By reflecting sunlight away from Earth, this would have a cooling effect, similar to the impact of the stratospheric aerosol particles produced by large volcanic eruptions. It is estimated that only a fraction of the amount of aerosols that are currently being emitted as air pollution would be needed to cool down the planet.

Proponents of this technique – known as Stratospheric Aerosol Injections (SAI) – claim that the costs of such an intervention in the global climate would be relatively low. Yet the Earth system is complex: while SAI would have a cooling effect on global average temperatures, its impact on regional temperatures would vary greatly. Precipitation patterns would also be affected, with possible negative consequences for vegetation and agriculture.

Investigating the possible effects and risks of climate engineering is, therefore, an extremely complex challenge. Many risks and uncertainties remain, particularly given the largely hypothetical nature of the different approaches. Key governance questions are unresolved, and there is no consensus as to whether it is at all desirable to seriously engage in such activities. To examine these and other questions from different perspectives, we set up an ***Interdisciplinary Microcosm on Climate Engineering Research***, which brings together researchers from a wide array of disciplines.

One of the many complex issues we investigate is the question of liability, which is particularly important. Can states that conduct large-scale climate interventions be held liable for possible side effects and/or be required to provide compensation? Our atmospheric physicists and legal researchers explore whether and to what extent various effects could be attributed to climate engineering, whether current public international law is equipped to handle such interventions in non-linear systems, and what the legal consequences might be. In line with the institute's transdisciplinary framework, our work focuses on questions that have been identified as particularly relevant to dialogue processes with various civil society organisations. Here, the IASS serves as a link between science, politics and civil society and connects scientific insights to concrete societal issues.

**Various climate engineering measures**

that could make more efficient and environmentally friendly use of resources possible, we try to formulate pathways to more sustainable lifestyles.

Our research in the field of electronic waste, carbon dioxide utilisation and unconventional gas is driven by the following questions: how can we raise awareness of a more sustainable use of resources? And how can we close resource cycles? Whether we're advocating mobile phone recycling or assessing the many risks of unconventional gas exploitation, our activities are always grounded in an evaluation of products and technologies across their entire lifecycle. This approach often leads us to re-think the conventional distinction between 'waste' and 'asset' and discover opportunities for closing product cycles.

## Our wasteful lifestyles

The resource-intensity of our lifestyles is an important but often rather abstract issue, especially for young people. To make it more tangible, the ***Enabling Technologies for Sustainability*** (ETS) platform headed by Mario Tobias established a research and communication project on mobile phones in 2012. The project, which was developed in close collaboration with the Wuppertal Institute under the auspices of the Federal Ministry of Education and Research (BMBF), aimed to sensitise consumers, in particular teenagers, to the resource intensity of our information and communication technologies-(ICT-)driven lifestyles.

With around 6.4 billion active mobile phone accounts worldwide, mobile phones make up a considerable part of the ICT sector. As consumers, we often succumb to the temptation to update: in Germany alone, an estimated 100 million mobile phones are sitting in drawers.

**Mobile phones contain more than 30 different metals, some of which are rare and expensive.**

Most of them, including palladium, indium and rare earth elements, need to be imported to the European Union. As part of the BMBF Science Year 2012, we developed a Raw Materials Expedition and created a Mobile Phone Resource Box for use in schools. This box contains a disassembled mobile phone and nine samples of the mineral resources used to manufacture it. Although the primary aim of this project was to raise awareness of our resource-intense lifestyles, the resource box is also a useful tool for informing young people about the origin of various raw materials, the social and environmental problems created by mining, and the importance of recycling. Since they were launched, over 350 schools, museums and other educational institutions have used the boxes.

The question to what extent secondary resources extracted from electronic waste can contribute to more sustainable resource management in the Anthropocene demands innovative answers. With the above campaign, we sought to transmit a clear message: we need to rethink Waste Electrical and Electronic Equipment (WEEE) as a valuable resource. This idea can only prevail if different stakeholders, including telecommunications providers, manufacturers, NGOs, recyclers and scientists, interact and contribute to finding solutions. The IASS conference "Mobile Phones, Resources and Sustainability – Conflict or Vision for the Future?" in 2013 brought many different stakeholders together to discuss recommendations for further action and research. Together with Professor Martin Faulstich, head of the German Advisory Council on the Environment (SRU) and senior fellow at the IASS in 2012, we engaged with partners from governmental agencies, companies and research institutes across Germany on possible inter- and transdisciplinary approaches to further sustainable e-waste management ('WEEE Mining') and stimulate discussion on this subject.

### $CO_2$ as an asset

If electronics can be recycled, what about $CO_2$ emissions? The project ***$CO_2$ as an asset – potentials and challenges for society*** views $CO_2$ not only as a harmful waste product and greenhouse gas, but also as a carbon feedstock that can be used in the manufacture of fuels, plastics and chemicals. Recent breakthroughs in Carbon Capture and Utilisation (CCU) technologies have helped this idea to gain momentum. The potential of CCU seems obvious: fossil raw material consumption and $CO_2$ emissions could both be reduced. However, the use of carbon dioxide in chemical processes worldwide would not be sufficient to tackle climate change. Nevertheless, CCU technologies could be one way of achieving the overall goal of a zero-waste and zero-emission society.

**And using waste carbon dioxide emissions as a basis for products could contribute to the development of a closed-cycle economy in the long run.**

Together with our partners at the RWTH Aachen, we are evaluating the environmental effects of CCU technologies in a lifecycle assessment. We are also measuring the environmental side effects of capture technologies via atmospheric modelling in cooperation with the SIWA cluster. As part of our assessment of the possible economic benefits of CCU technologies, we have prepared an overview of the current 'CCU economy' and future CCU markets. A case study carried out together with our industry partner Bayer Material Science analyses the economic impact of polyurethane foams made using $CO_2$. As a complement to our research activities, we are working on analysing the societal acceptance of products made with $CO_2$ and communicating such complex new technologies to a general audience.

### Unconventional gas: a bridging resource or a dead end?

In addition to conducting research on the utilisation of carbon dioxide and innovative, $CO_2$-free ways of producing natural gas,[>>] we try to answer a pressing question in today's energy debate: can gas from shale and other unconventional reservoirs be compatible with efforts to make our energy system more sustainable? Could gas from these reserves act as a bridging resource to sustainable scenarios? Or would it just perpetuate our reliance on fossil fuels and delay the deployment of renewables and climate change mitigation measures?

>> See page 34–36

Reservoirs of unconventional gas (e.g. shale gas, coalbed methane and methane clathrates) differ from conventional reservoirs in terms of their geological characteristics and the technologies needed for their exploitation. Our research programme on the ***Role and Potential of Unconventional Gas*** in the $E^3$ cluster evaluates developments in this area and promotes evidence-based dialogue among the stakeholders involved. As well as capitalising on the different scientific disciplines and backgrounds of the people in this research group, we integrate knowledge generated by other research institutes, industry and NGOs. Our main focus lies on shale gas in Europe and we pay particular attention to the German context.

In the past decade, the exploitation of unconventional natural gas reserves has become technically and economically feasible. This has prompted growing interest on the part of governments and industry all over the world, while also generating controversy. In the USA, the use of hydraulic fracturing ('fracking') in particular has grown rapidly in recent years, leading to a significant increase in domestic gas production. In Europe, some countries have undertaken initial steps towards exploration, but others remain cautious.

In the current public and scientific debate, some people claim that gas production from these reservoirs could compensate for diminishing conventional reserves, as well as improving energy security and providing a range of economic benefits. In the power generation sector, an increase in the share of gas and a corresponding

reduction in the share of coal would result in a decrease in $CO_2$ emissions, as natural gas generates half as much $CO_2$ since coal per unit of energy produced. Given the flexibility of gas-fired power plants, gas could also represent a suitable back-up capacity for renewables.

**Yet concerns have been raised regarding the environmental risks of hydraulic fracturing and the fact that unconventional gas exploitation could undermine climate policies that seek to phase out fossil fuels altogether.**

The issues that underlie the unconventional gas debate are often very complex and transcend the purely technical to encompass economic, social and geopolitical aspects. Furthermore, many uncertainties have not yet been elucidated: how large are the recoverable reserves? How well can we mitigate the environmental risks? Do the potential benefits outweigh the risks? Our interdisciplinary team is carrying out a scientific assessment of the risks and opportunities associated with unconventional natural gas reservoirs.

## OUTLOOK

A growing human population combined with unsustainable consumption patterns and production methods have put the Earth under unprecedented pressure. The climate, air quality, soils and oceans are all changing because of our actions, and the question remains: what are sustainable pathways for a world with 9 billion people?

The period from 2014 to 2015 offers several opportunities to address some of the most pressing issues on the sustainability agenda. Over the course of these two years, the global community aims to reach agreement on the post-2015 development agenda, set new Sustainable Development Goals, design an international framework for collective action on climate change at the Paris Climate Conference in 2015, and negotiate a new international system to protect areas beyond national jurisdiction (the high seas). Each of these issues merits thorough consideration across a range of disciplines.

Furthermore, scientific knowledge should be complemented by knowledge generated by decision-makers and civil society to deepen our understanding of sustainable development pathways and the challenges ahead. With this goal in mind, we are trying to diversify the sustainability debate and connect stakeholders around the world. We aim to provide a platform for dialogue on all these issues and develop new sources of knowledge to support policy changes.

## OVERVIEW OF IASS PROJECTS

# EARTH SYSTEMS & RESOURCES

**Role and Potential of Unconventional Gas**
Since 2011

**Global Soil Forum**
Since September 2011

**Global Soil Week**
November 2012, October 2013, April 2015

**Pro-poor Resource Governance under Changing Climates**
September 2012–September 2013

**Making Land and Soil Governance Work for Food Security**
2012 und 2013

**Renewable Resources and the Sustainable Development Goals Forum**
December 2013–November 2016

**Interdisciplinary Microcosm on Climate Engineering Research**
Since March 2013

**Policy against Hunger**
2013

**Soils in the Nexus – Sustainable Farming**
September 2013–March 2014

**Ocean Governance**
Since September 2012

**The Chemistry of Short-Lived Climate-Forcing Pollutants (SLCP Chemistry)**
Since December 2011

**Sustainable ICT Solutions**
Since October 2012

**$CO_2$ as an Asset**
Since 2013

**Advancing the Governance of Areas Beyond National Jurisdiction**
Since 2013

**The Impact of Black Carbon on Air Quality and Climate and its Role in Global Warming**
Since December 2012

**Regional Focus: A Sustainable Atmosphere for the Kathmandu Valley (SusKat)**
Since May 2012

**Short-lived Climate-forcing Pollutants: Research Needs and Pathways to Policy Implementation (ClimPol)**
Since May 2012

**Environmental Law and Institutions for Air and Sea (ELIAS)**
Since March 2013

**European Transdisciplinary Assessment of Climate Engineering (EuTRACE)**
June 2012–September 2014

**Investigation and Assessment of Geoengineering Approaches that Affect the Composition of the Atmosphere**
June 2012–January 2014

**Contextualising Climate Engineering and Mitigation: Illusion, Complement or Substitute? (CEMICS)**
January 2014–December 2016

**Across the globe, people are forming their own landscapes. In Qatar, luxury properties are being built on human-made islands.**

# UNDERSTANDING SUSTAINABILITY DRIVERS AND HURDLES

What will enable us to respond adequately to global sustainability challenges? How can the gap between knowledge and action be overcome? And what form should transformation governance take? It is our goal at the IASS to understand the mechanisms underlying the forces that drive and hinder sustainability. We analyse how unsustainable development paths have emerged from the structures and interplay of our economic and financial systems. And we look for opportunities to transform those systems for the sake of sustainability. The scope of the challenges we face today requires thinking outside the box and beyond existing disciplinary and sectoral boundaries.

In January 1945, the then American President Franklin D. Roosevelt told Congress that a country involved in a global war needed precise statistical information. This information would have to reflect business activities and markets, employment and unemployment, incomes, expenditure, and savings. Such data, he said, "is urgently needed as a guide for economic policies during the remainder of the war and during the reconversion and post-war periods. [...] Business, agriculture, labor, and the Government need to know the basic economic facts, if each is to play its role with maximum effectiveness during the months and years ahead." This was the first time a politician called for a figure that is now known as 'gross domestic product' (GDP). Since then, promoting GDP growth has remained the primary national policy goal of almost every country in the world.

**However, gross domestic product has turned out to be a misleading measure of national success. Our preoccupation with it fuels unsustainable policies.**

GDP measures market transactions, but it ignores all kinds of non-monetary benefits and costs. It reflects neither environmental impacts nor income inequality. If a business used GDP-style accounting, it would aim to maximise gross revenue – even at the expense of profitability, efficiency or flexibility. That is hardly smart – or sustainable.

## UNSUSTAINABLE SOCIETIES: THE ROLE OF ECONOMIC IDEAS

Our obsession with GDP is a good example of the success of a specific 'culture of economics', a set of strategies we have come to rely on when addressing economic issues. While such strategies have undoubtedly contributed to material and social progress, they are also responsible for unsustainable lifestyles and policies and, as events in recent years have shown, the global financial architecture is far from sustainable. For these reasons, the IASS research group ***Cultures of Economics – Cultures of Sustainability*** has begun to subject the dominant economic culture to critical analysis. We study its concepts and norms, particularly in terms of their replicability and translatability, and investigate how they become established. At the same time, we assess existing alternative, sustainable approaches, as proposed by scientists and others. In the past two years, we have set up an interdisciplinary team comprising economists, philosophers, historians and sociologists. The economists focus on the history of economic ideas. Their research has given rise to several studies, including a monograph on the enduring power of GDP, *Die Macht der einen Zahl. Eine politische Geschichte des Bruttoinlandsprodukts* (The Power of a Single Number. A Political History of GDP), which was published by Suhrkamp. Work on the history of other statistical concepts and credit is under way.

### Looking back to go forward

Analysing the processes by which economic knowledge is generated and mediated to politics and society can reveal how certain economic concepts manage to become dominant. If we understand how this happens, we may be in a better position to identify ways of making our current cultures of economics more sustainable. In a case study on the Berlin-born economist Albert O. Hirschman (1915), we investigated the role of the 'economic expert' in this kind of knowledge transfer. Hirschman helped to establish economic schemata that still prevail today, such as the assumed need for unlimited growth. He also laid the foundation for powerful narratives about social change that have been shaping modern economic thought ever since.

We also ask how concepts such as 'sustainability' and 'development' are formed and legitimised in the present. In a society where activities and decisions in all areas of life are based on knowledge, it is essential to understand the mechanisms that underlie knowledge-based transformation (see Text Box on Knowledge Democracy). How might specific forms of

research promote or prevent sustainable strategies in the way they acquire, use and disseminate knowledge? In December 2013, we organised an interdisciplinary workshop on this subject titled "Political Economy – Translating Economic Knowledge into Politics". The heads of economic research institutes in Germany as well as a number of eminent economists attended and investigated how economic knowledge and the results of economic research are 'translated' in the political sphere.

### The opportunities of a financial crisis

The Great Recession of 2008 and 2009 prompted critical reflection on the world's economic and financial systems in many quarters. And this reflection was by no means confined to anti-globalisation forums. In 2009, for example, the governor of the Chinese Central Bank, Zhou Xiaochuan, questioned the financial system's dependence on the dollar as the main reserve currency and explored some alternatives.

We have picked up on these controversial ideas. In 2012, we began work on a paper on "Sustainability, Finance, and a Proposal from China", which was subsequently presented at high-level panels in Brussels and Stockholm. As set out in this paper, our vision can be summarised as follows:

**The present international financial architecture is not sustainable. It highlights a key problem of our global civilisation: the tendency to postpone risks so that they are all but ignored by the decision-makers who create them.**

It is time to understand the global economy as an integrated, holistic entity in which capital flows, labour, consumer markets, national governments and environmental issues interact in a complex way. The economy is not merely linked to sustainability issues. Rather, we hold that economies in crisis can be revitalised by broadening their scope to include the energy and climate challenges they face. In other words, the double crisis of the environment and economy could in fact be a double opportunity. For example, the large-scale investments needed for the transition to a low-carbon economy could offer an exit from the vicious circle of sluggish economic dynamics, high unemployment, and mounting debts currently experienced by many OECD countries.

The magnitude of the challenge is of course enormous. It would basically mean rebuilding world capital stocks from the ground up, and there are no easy recipes for such a task. Yet, in our view, it is essential to be open for new ideas, such as those of Zhou Xiaochuan. Because such radically new approaches have the potential to put an end to the decoupling of the financial sphere from the real economy. This could be a crucial step on the way to making the financial system – and society as a whole – more sustainable.

### Rethinking our financial architecture

We are motivated by the desire to create new 'cultures of sustainability'. It is clear that the transition to sustainable development will require new forms of transformative governance, but it is not at all clear how such governance can deal with the financial markets. Therefore, it is essential to connect economic research to work on sustainable development, because the issues addressed by both fields are inextricably linked. The question of how to reform the current system of reserve currencies raised by the governor of the Chinese Central Bank is not just a 'technical' issue, but needs to be integrated into sustainability research. To facilitate this process, we have created opportunities for more exchange among a variety of actors from the financial world and the sustainability research community. In the past two years, we have organised several high-profile workshops on the subject of cultures of sustainability with participants from international research institutes, NGOs and businesses. In the autumn of 2013, for example, we explored the potential role of the International


How can growing cities like Hong Kong develop in a sustainable way?

Source: istock

Monetary Fund (IMF) and the World Bank in a form of sustainability governance that would be capable of dealing with the tensions between political institutions and market dynamics. We found that the IMF and the World Bank have already embarked on a learning process, and a lot will depend on the degree to which both institutions continue along this path to sustainable development.

## The ecology-economy interface

We are also investigating another theme at the interface of economics, society and the environment: Payments for Ecosystem Services (PES). PES are financial incentives offered, for example, to farmers or landowners in exchange for managing their land to provide ecological services that serve human well-being. The Millennium Ecosystem Assessment, a 2005 report on the state of the world's ecosystems initiated by the United Nations Environment Programme (UNEP), distinguishes between several kinds of ecological services, including climate change mitigation, watershed services, biodiversity conservation, and preservation of natural beauty. In addition to private schemes, there are many government-funded PES projects that involve partners such as NGOs. In the existing literature, PES are often presented as a means of preventing further ecosystem degradation and biodiversity loss that also offer local communities opportunities for economic development. But is this really the case? And if so, what conditions must be fulfilled to really reap environmental rewards? We seek answers to these questions from the perspective of ecological economics, a field of economics that deals with sustainable development. Our analysis combines theoretical and empirical approaches to PES. We study the ecology-economy interface and appraise economic policy instruments for the transition towards sustain-

able development. In surveys and experiments, this project also investigates the behavioural dimension of the success or failure of policy instruments such as PES using insights gained from behavioural economics and incentive-based policy instruments.

### Sustainability goals for cities

The majority of the world's population currently lives in cities and the proportion of city dwellers is set to rise: by 2050, an estimated 64 per cent of people in the developing world and 86 per cent of people in the developed world will live in an urban environment. In 2013, we started work on a project to investigate how the proposed Sustainable Development Goals (SDGs) might play a role in the political decision-making processes that shape urban planning. Our decision to locate this project in Bogotá was deliberate.

**Columbia is a vociferous promoter of SDGs and a country where debates about social and environmental issues have become heated in the context of economic growth.**

To evaluate the resonance of SDGs on the ground in real-life settings, we began to cooperate with the research centre of the Botanical Garden in Bogotá two years ago. This gave us the opportunity to answer some of our questions concerning SDGs, for example, how can global sustainability targets work at local level? And are our assumptions about the disputed status of economic growth and the national-regional divide in Latin America – a subject the IASS has already researched in depth – valid? We organised five participatory urban development dialogues, in which politicians and members of civil society discussed important aspects of sustainable urban transformation, including water management, energy, etc. This allowed us to investigate how governmental processes can be nudged in a more sustainable direction. Given that the project focussed on a large city as a unit of analysis for transition processes, cultural diversity played a crucial role in our considerations. On the basis of our research in Bogotá, we concluded that there is a need for a stand-alone SDG on urban areas and outlined our vision in IASS Policy Brief 3/2013 "Establishing a Sustainable Development Goal on Cities".

Further research on urbanisation at the IASS gave rise to a study on "Closed Cycles, Open City". It comes to the surprising conclusion that neither population density nor urbanisation is at the root of unsustainable urban development. Rather, the availability of cheap energy and the use of resources in the urban systems we have created are to blame. We also found that sustainable urban development is not secured by technological fixes alone. The most elaborate plans for cities with a limited environmental impact and a population committed to minimising its consumption of energy, water and food and its outputs of waste will not bear fruit if we neglect two crucial factors.

**To find more sustainable solutions, we need to understand the mechanisms underlying urban development and change the governance of urban space.**

### Shrinking populations – a chance for sustainability?

In the age of urbanisation, we also consider the other side of the coin in a project on demographic shrinkage in rural areas, which we developed together with the Berlin Institute for Population and Development. This project looks at how demographic changes in the countryside affect a range of societal and technological structures. Because it is not only population growth that influences sustainability: less people means less services, higher costs, and higher per capita burdens on the environment. However, demographic shrinkage may also be an opportunity to foster the sustainable development of regional infrastructures so that they can react to global crises. In 2011, we began to investigate the consequences of current German demographic trends for renewable energy sources. We subsequently

# THE GLOBAL SUSTAINABILITY SUMMER SCHOOL

To ensure that our efforts towards a more sustainable world bear fruit, we also engage with the next generation of experts and opinion leaders who are not all involved in research but still do a lot of thinking about sustainability. The 2012 Global Sustainability Summer School, which was organised jointly by the IASS and the Potsdam Institute for Climate Impact Research (PIK) in collaboration with the Santa Fe Institute (SFI), facilitated such a meeting of minds. For the 2013 Summer School, forty young professionals and academics from around the world came to Potsdam to reflect on the theme of "Complex(c)ity – Urbanization and Energy Transitions in a Changing Climate" with renowned experts.

We chose this theme for the 2013 Summer School because it is cities – or rather, city administrations and the designers of cities – that will determine just how sustainable the living arrangements of most of the world's population will be in the future. The participants had the opportunity to hear inspiring lectures on the future of cities and options for making them more sustainable. Doyne Farmer, a professor at Oxford University's Institute for New Economic Thinking, presented a critique of the now famous paper "The Death of Environmentalism: Global Warming Politics in a Post-Environmental World", in which Ted Nordhaus and Michael Shellenberger argued that 'environmentalism' as it is typically conceived is incapable of solving urgent policy problems such as climate change. And Bert de Vries from Utrecht University in the Netherlands presented his analysis of the interplay between the kind of 'objective' science that policy-makers demand from experts and the values and ideas that inevitably shape the reception and implementation of scientific results.

But lectures accounted for just a small part of the Summer School. For much of the time, the participants themselves played a more active role in workshops. There, people with very different cultural and professional backgrounds got together in small groups to design research projects, policy papers and business plans in the realm of urban planning and sustainability. For example, Blanca Fernandez from Spain and Mario Ríos from Mexico developed a proposal for a study on sustainable low-cost housing options in medium-sized cities in Latin America. As it is very difficult to change the infrastructure of megacities, they reasoned that more could be gained from ensuring that medium-sized cities, which are experiencing phenomenal population growth, chose the most sustainable paths possible.

What factors influence the transplantation of sustainability projects from one context to another? Fred Kodzo Ayifli from Ghana and Thibaud Henin from Canada used the Summer School to design a research project to find out why sustainability initiatives that seem to work in one country are adopted – or rejected – by other countries. In their conceptual model, geographical proximity, linguistic similarities and the strength of the personal and economic networks connecting any two countries all play a role here.

In terms of their languages and countries of origin, the Summer School participants were a very diverse group. But in just two weeks, they had formed a large network of scientists and young professionals with a common set of tools for making cities more sustainable.

**Participants at the Global Sustainability Summer School gather in the IASS garden.**

Source (all photos): PIK, Christine Bounama

**Excursion to the unique Pilot Site at Ketzin, where research on the geological storage of $CO_2$ is ongoing**

**Summer School participants enjoying a summer's evening and building networks by a lake in Potsdam**

The smaller workshop format is conducive to developing new ideas.

Panel discussion at the University of Potsdam on the challenges presented by changes in the Arctic

expanded our research to cover the issues of water, mobility and social infrastructures. As part of the German "Science Year 2013 – the Demographic Opportunity", an expert workshop on our research took place in May 2013. The results of our collaboration with the Berlin Institute were published in the same year in the *Allowing Diversity* study, which attracted a lot of media coverage. Notably, the study prompted an intense public debate on the different living conditions in different parts of our country. While there seems to be a general consensus that diversity may ultimately be a catalyst for good living conditions across the country, in practice current planning and mentalities are still wary of diversity and experimentation.

## THE QUEST FOR GOVERNANCE OF SUSTAINABLE DEVELOPMENT

The spheres of culture and economics as well as concrete issue areas such as energy, the atmosphere and soils require effective governance for transitions to sustainability. But how can we turn available knowledge into action? And what kind of governance could make the sustainable development of societies possible? To answer these central questions at the IASS, we started by analysing processes of transformation governance in our ***Global Contract for Sustainability*** cluster. In 2010, we began work on the first fully-fledged IASS research project, which gave rise to the term 'transgovernance' and laid the theoretical foundations for subsequent research projects. The term transgovernance underlines that transformation governance has to go beyond classic governance approaches and styles, for example, the dominant focus on the nation state or intergovernmental approaches at global level. While they may still have a role in meeting sustainability challenges such as climate change, resource depletion, or unsustainable economic systems, they are increasingly unable to tackle the problems we face. In addressing 'knowledge democracy' (Roel in't Veld, see Text Box, p. 67) as a building block of the transgovernance project, we have focused particularly on the gap between knowledge and action. This has become a pillar of our transdisciplinary research approach and determines how we conduct research at the IASS. The groundbreaking IASS publication *Veränderung durch Wissen* (Change Through Knowledge) is just one spin-off of this project.

Transgovernance uses knowledge itself as a governance instrument, for example, to understand and foster interaction between science, civil society, government and media for the sake of transformation. This transformative role of knowledge is also implied in our motto "transformation through transdisciplinarity". In analysing the prerequisites for complex transformation processes, our transgovernance research agenda was to some extent global in reach. Yet, transgovernance is not about imposing ideas in a top-down manner. We do not understand transformation processes as blueprints. Instead, we are critical of the often unquestioned assumptions of the blessings of holistic, global solutions, because they typically neglect the specifics of local cultures or regional issues and exclude a multiplicity of actors from the process.

**In our view, participation is the cornerstone of transgovernance: people – and their increasingly advanced knowledge-based capacities – are the key to sustainability solutions.**

Transgovernance avoids 'either-or' thinking about governance. Instead, it advocates a meta-governance approach that calls for contributions from all levels of governance: from global and national institutions to cities and individual actors. It seeks legally binding treaties where possible and bottom-up processes where necessary, taking account of the different interests and existing power structures.

The transgovernance project was completed in 2011, but many current cross-cutting IASS projects continue to build on the insights gained into governance processes. For example, transgovernance ideas are central to the ***Transdisciplinary***

# KNOWLEDGE DEMOCRACY

How can people influence the policies made by those who govern? Ideally, they should do so by democratic means, a belief cherished by humanity ever since the Enlightenment. But the meaning of 'democracy' has undergone many changes over time, and it is worth taking stock of how it has developed more recently. Following Professor Roel in 't Veld – a former member of the steering group of our Transgovernance project at the IASS – we call the emerging, modern form of citizen participation 'knowledge democracy'. The cardinal difference between knowledge democracy and classical democracy is the role information plays in public debate: not only does it flow in directions other than those we have come to expect; it is also generated and consumed by different actors.

A few decades ago, public life was still dominated by a limited number of institutions that acted more or less independently of each other. The government governed, hopefully in the way its citizens had mandated it to in the last elections. Scientists added to existing knowledge and enjoyed a great degree of autonomy in their research. And the media reported on all these goings-on with a great deal of freedom to determine what issues merited coverage. Of course, these segments of society interacted, but the overall structure of the system was quite straightforward. Nowadays, this system no longer exists.

Instead, there is a kind of free-for-all within each of these domains. Governments have to deal not only with elected politicians and their parties, but also with all kinds of ad hoc citizens' groups. The emergence of such groups is helped in no small measure by a splintering media landscape, where various new outlets for news and opinions are being formed and individual citizens can create their own media brand. Scientists, for their part, continue to pursue their research in separate disciplines, but they increasingly acknowledge that some problems can only be understood, let alone solved, by combining the ideas and methods of several disciplines. Moreover, they are now starting to work in a transdisciplinary way, allowing governments and ordinary citizens to shape what research questions are asked, how the answers to those questions are interpreted, and what concrete solutions are implemented.

These shifts are what constitutes knowledge democracy, a new way of managing the interaction between what people want, what people know and what people do. And such a democracy is a vital element of the new art of governing that the world needs for a sustainable future: transgovernance.

Source: Georg Lukas, KWI

**The joint DemoEnergy Project (IASS and KWI) explored ways of increasing participation in the energy transition.**

***Panel on Energy Change*** (TPEC). With its strong emphasis on the science policy platform and process (Global Soil Week), the ***Global Soil Forum*** is also informed by the findings of transgovernance. Work on governance challenges in relation to the high seas has also benefited from transgovernance ideas. And transgovernance has contributed to the development of ideas concerning the global financial system and its governance, which are urgently needed to finance sustainability transformations but still remain part of the problem rather than the solution. Currently, we are reflecting on and synthesising the insights gained into these specific issues and will develop our thinking further in IASS contributions to the most important overarching research agenda on sustainability: transformation governance.

## OUTLOOK

Research on the interrelationship of governance, economics and culture will continue to be a key component of our agenda, because without these three dimensions, research on energy, the atmosphere and natural resources is incomplete. Moreover, governance-related questions as well as questions on economics and culture will also be studied as projects in their own right, with a focus on perceptions of 'growth', better investment schemes and market designs for sustainability transitions, as well as an expanded research agenda on cultures of sustainability. Combined with the projects presented in chapters 01 and 02, this research agenda will address a question that informs all IASS research: what transformation governance options aimed at sustainability exist in the Anthropocene?

Conceptually and methodologically, the future research agenda will also investigate three underlying assumptions: firstly, if the Anthropocene blurs the border between nature and humankind, any research on sustainability challenges has to address ex ante the societal foundations of its research objectives. Secondly, transdisciplinarity is the right approach to this research if we want to understand and support action based on our insights into such multifaceted sustainability challenges. Thirdly, transdisciplinarity is a knowledge-driven way of achieving transformations. While we are aware of other drivers or hindrances to transformation towards sustainability such as power or specific interests, it is high time that we understood and embraced the transformative power of transdisciplinary research.

## OVERVIEW OF IASS PROJECTS

# PERSPECTIVES ON DEVELOPMENT

**Cultures of Economics – Cultures of Sustainability**
Since August 2012

**Cultural Prerequisites for Sustainable Development: Latin American Experiences**
2011–2012, book release in 2013

**Ecological Economics of Payments for Ecosystem Services**
Since 2012

**Sustainable Development Goals II**
December 2013 – November 2016

**Sustainable Development Goals I**
September 2012–February 2013

**The Role of Experts and Transmission of Knowledge**
Since 2012

**Sustainable Global Financial System**
Since 2012

**Sustainable Modes of Arctic Resource-driven Transformations (SMART)**
Since 2013

**SLCPs – Research Needs and Pathways to Policy Implementation (ClimPol)**
May 2012–April 2016

# IASS

# FACTS AND FIGURES

The IASS cooperates with over **241** partners in **33** countries, including **14** international organisations and initiatives.

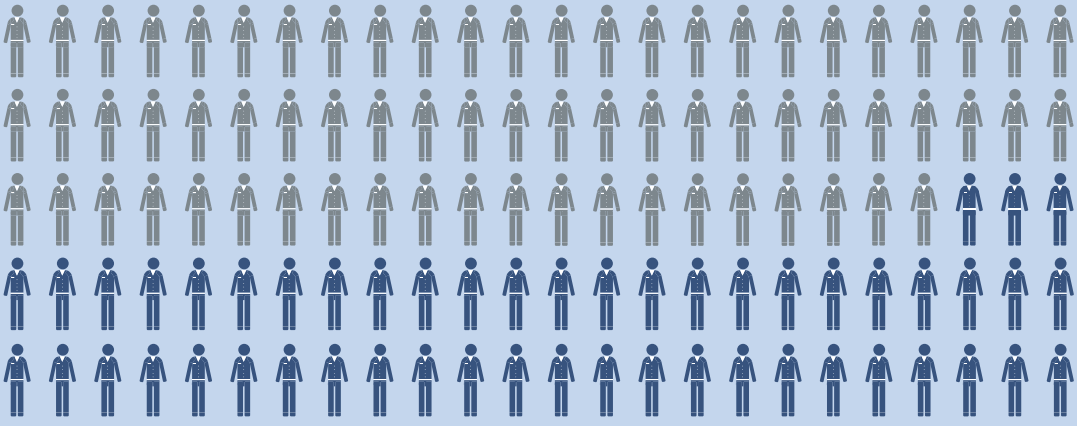
Around **50** events are organised by the IASS every year, from expert discussions and workshops with (scientific) partners to international conferences. In addition to internationally renowned researchers in relevant fields, we also invite practitioners from outside academia to participate to ensure that these events have a direct impact on societal developments.

As a member of the **Albert Einstein Science Park** in Potsdam (along with the AWI, the GFZ and PIK), the IASS has access to 14 000 scientific journals and can avail of all the services provided by the common library.

# DEVELOPMENT OF IASS STAFF

IASS employee numbers rose from **14** in 2010 (10 employees and 4 fellows)

to **120** in 2013 (69 employees and 51 fellows).



Our IASS fellows come from **33** different countries.

**53 %**
international

**47 %**
national

The average age of IASS employees was **37** years in 2013.

The ratio of male to female researchers at the IASS: **43 ♀ / 57 ♂**

# INTERDISCIPLINARITY AT THE IASS

Scientists from **28** different disciplines work together closely in more than **30** projects.

# STRUCTURES AND BODIES*

## MANAGEMENT BOARD

The IASS's central decision-making body is the Management Board, which comprises the three directors and ex officio the Secretary-General. The Management Board makes decisions on administrative questions and discusses issues related to the content and strategy of the research programme.

Executive Director
**Professor Klaus Töpfer**

Scientific Director
**Professor Carlo Rubbia**

Scientific Director
**Professor Mark Lawrence**

Secretary-General
**Dr Mario Tobias** (**2011–2014**)
**Alexander Müller** (**acting Secretary-General since September 2014**)

Head of Administration
**Wolfgang Hadlich**

## GENERAL ASSEMBLY

The General Assembly is the main governing body of the IASS. It is composed of representatives of the institute's two funding bodies, the Federal Ministry of Education and Research (BMBF) and the Federal State of Brandenburg, as well as the major German academic and research institutions and eminent scientists. Professor Dr Ernst Theodor Rietschel is the current chairman of the General Assembly.

The General Assembly defines guidelines for the institute's work, reviews its scientific programme, approves the annual budget and audited annual balance, and elects the Secretary-General as well as the members of the Management Board and the Strategy Advisory Board. The General Assembly also evaluates the IASS's work. The members of the General Assembly include:

- **Prof. Dr Ernst Theodor Rietschel** (Chair), Berlin Institute of Health
- **acatech – German Academy of Science and Engineering** (represented by Dr Bernd Pischetsrieder)
- **Federal Ministry of Education and Research** (represented by Dr Karl Eugen Huthmacher)
- **Prof. Dr Jörg Hacker,** Leopoldina, National Academy of Sciences
- **Helmholtz Association** (represented by Prof. Dr Jürgen Mlynek)
- **Dr Johann Komusiewicz** (former State Secretary)
- **Leibniz Association** (represented by Prof. Dr Matthias Kleiner)
- **Prof. Dr Karin Lochte,** Alfred Wegener Institute
- **Max Planck Society** (represented by Prof. Dr Martin Stratmann)
- **Ministry of Science, Education and Culture of the Federal State of Brandenburg** (represented by Martin Gorholt)
- **University of Potsdam** (represented by Prof. Dr Oliver Günther)

## STRATEGY ADVISORY BOARD (SAB)

The Strategy Advisory Board advises the Management Board and the General Assembly on the institute's activities. In particular, it sets guidelines for the institute's thematic orientation,

*as of November 2014

strategic and mid-term research programme and planned research projects. It is also responsible for fellows and determining the orientation of the strategic dialogue.
The chairman of the Strategy Advisory Board is Professor Dr Reinhard F. J. Hüttl.

### Members of the SAB

- **Prof. Dr Reinhard F. J. Hüttl** (Chair), German Research Centre for Geosciences (GFZ)
- **Prof. Dr Hans Joachim Schellnhuber CBE** (Deputy Chair), Potsdam Institute for Climate Impact Research (PIK)
- **Prof. Dr Wolfgang Huber,** retired Bishop of the Protestant Church in Berlin-Brandenburg and Silesian Upper Lusatia
- **Prof. Dr Robert Klapisch,** Sharing Knowledge Foundation, Geneva
- **Prof. Dr Hans Müller-Steinhagen,** Technische Universität Dresden
- **Prof. Dr Lucia Cavalho Pinto de Melo,** Fundação Joaquim Nabuco, Recife
- **Prof. Dr Veerabhadran Ramanathan,** Scripps Institution of Oceanography, University of California, San Diego
- **Prof. Dr. Ferdi Schüth,** Max-Planck Institut für Kohlenforschung
- **Prof. Dr Laurence Tubiana,** Institut du développement durable et des relations internationales (IDDRI), Paris
- **Prof. Dr Alexander J.B. Zehnder,** Alberta Water Research Institute, Alberta

## FINANCES

In 2012 and 2013, IASS funding from the Federal Government (85 per cent) and the Federal State of Brandenburg (15 per cent) amounted to EUR 8.9 million per annum. The institute also attracted a total of EUR 3,694,000 in third-party funding in the period from 2012 to 2013.

## IASS MEMBERSHIPS*

■ **Aerosols & Climate Cluster** | A coalition of three projects with combined funding of EUR 35 million from the European Commission under the Seventh Framework Programme with project terms up to 2017/2018.

■ **Climate and Clean Air Coalition** (**CCAC**) | An international effort to maximise the health, agricultural and climate benefits of swift action on short-lived climate-forcing pollutants (SLCPs)

■ **Earth System Research Partnership** | A coalition composed mainly of non-university research institutes that focus on research on Earth systems

■ **Geo.X** | A geoscience network of excellence with eight partner institutes in Berlin and Potsdam

■ **Klimanavigator** (**climate navigator**) | A platform to provide information on climate change, which is coordinated by the Climate Service Centre in Hamburg

■ **NaWis** | An association for sustainable science composed of universities and non-university research institutes that are active in the field of transdisciplinary sustainability research

■ **PEARLS – Potsdam Research Network** | A network of research institutes in Potsdam, Brandenburg and Berlin for the purpose of initiating and supporting research projects and fostering young researchers

■ **ProWissen e.V.** | A coalition of universities and research institutes in Potsdam and surroundings for the purpose of raising public awareness of scientific insights in the Potsdam area

■ **Sustainable Development Solutions Network** (**SDSN**) **Germany** | Part of the UN's global SDSN initiative, the German SDSN Chapter fosters debate on sustainable development within German academia, society and politics.

# SELECTED EVENTS 2012 – 2013

## SELECTED EVENTS 2012

### National and international events with up to 500 participants

| Date | Event |
|---|---|
| 27.09. | Soot, Ozone, Methane: Underestimated Climate Drivers and their Effects on Climate, Health and the Economy (organised jointly with the campaign "Rußfrei fürs Klima" in Berlin) |
| 15–16.10. | The Energiewende – Is there a Nordic Way? (conference organised jointly with the Nordic Embassies in Berlin) |
| 18–22.11. | First Global Soil Week, Berlin |

### National and international events with up to 50 participants

| Date | Event |
|---|---|
| 25–27.01. | A different Kind of Development. Perspectives from Latin America – The Importance of the Anthropological-Cultural Dimension for Economic and Political Development – New Paradigms of Sustainability in Latin America |
| 07.03. | Kick-off event to launch the Transdisciplinary Panel on Energy Change (TPEC) |
| 14–15.03. | Water infrastructures of the future. Socially and ecologically sustainable solutions for a shrinking population |
| 26–27.03. | Potsdam SLCP Workshop |
| 26.04. | Sustainable Business Leadership: Knowing Costs – Enjoying Benefits (ideas contest organised by the German Council for Sustainable Development in collaboration with the IASS) |
| 14–15.05. | Resources & WEEE mining – Workshop 1 |
| 13–14.06. | On the move in the countryside. Mobility concepts for rural areas with a shrinking population: the future of technical and social supply systems |
| 28.06. | Public meeting with TPEC experts: "The Energiewende: What have we achieved? What still needs to be done?" (organised together with acatech and the Max Planck Society) |
| 02.07. | TPEC working group 3 "The Social Dimension of the Energiewende" |
| 05.07. | TPEC working groups 1+2 "Market System for Renewable Energies– the Path to Revising the Law on Renewable Energies" and "The Energiewende and $CO_2$ – the Role of Fossil Power Plants" |
| 08–21.07. | Global Sustainability Summer School (organised jointly with PIK) |
| 03–06.09. | Soil Governance and Food Security |
| 10.09. | TPEC working group 2 "The Energiewende and $CO_2$ – the Role of Fossil Power Plants" |
| 11.09. | TPEC working group 1 "Market System for Renewable Energies – the Path to Revising the Law on Renewable Energies" |
| 27.09. | Demand Response as a Component of the Energiewende – Business Case |
| 01–02.10. | Renewable Energy Perspectives in Latin America in the International Context |

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| **25.10.** | TPEC working group 3 "The Social Dimension of the Energiewende" |
| **29.10.** | The Complexity of Cleaner Cookers |
| **05–6.11.** | Workshop on Recycling and Resource management (WEEE mining) |
| **6.11.** | EuTRACE Opening Debate in Brussels, Belgium |
| **8.11.** | Expert meeting on Ocean Iron Fertilisation |
| **12–13.11.** | Infrastructures of the future. Socially and ecologically sustainable solutions for a shrinking population |
| **15–16.11.** | Public lecture and workshop "Why do we need Sustainable Development Goals? The Columbian Perspective(s)" |
| **22.11.** | TPEC working group 2 "The Energiewende and $CO_2$ – the Role of Fossil Power Plants" |
| **22.11.** | An Opportunity to Integrate Atmospheric Pollution Control and Climate Change Adaptation and Mitigation in Nepal (organised jointly with ICIMOD in Kathmandu, Nepal) |
| **23.11.** | The Demand Response Potential of Cold Storage Systems in the Food Retail Sector |
| **28–29.11.** | Carbon Capture – a Bridge to a Low Carbon Economy? |
| **30.11.** | TPEC working group 2 "The Energiewende and $CO_2$ – the Role of Fossil Power Plants" |
| **30.11.** | The Science and Policy of Short-Lived Climate-Forcing Pollutants (a combination of a webinar and a side event at the World Climate Summit Doha, with the participation of the University of Oxford and Victoria University) |
| **03.12.** | Innovation in Large-volume $CO_2$-Recycling – Policy, Environment and Business Opportunities |
| **07.12.** | Review meeting "Closed Cycles, Open City" |
| **08.12.** | Sense (and Nonsense) of a Sustainable Development Goal on Cities |
| **8–10.12.** | Towards a Sustainable Global Financial System – Assessing the Perspective of Special Drawing Rights Linked to Commodity Buffer Stocks |
| **11.12.** | Nice View: A Life without Yesterday? (organised jointly with the Research Alliance for Cultural Heritage) |
| **13–15.12.** | Inaugural Meeting of the Interdisciplinary Global Working Group on Air Quality and Climate |
| **17.12.** | NaWis (an association for sustainable science) networking meeting |

# SELECTED EVENTS 2012 – 2013

## SELECTED EVENTS 2013

### National and international events with up to 500 participants

| Date | Event |
|---|---|
| 21.02. | Water Governance Conference, the first in a series of workshops on local and global sustainability (organised jointly with the Botanic Garden of Bogotá, Columbia) |
| 18.04. | Energy and Transportation Conference, the second in a series of workshops on local and global sustainability (organised jointly with the Botanic Garden of Bogotá, Columbia) |
| 19–20.06. | Soil and Nutrition Conference, the third in a series of workshops on local and global sustainability (organised jointly with the Botanic Garden of Bogotá, Columbia) |
| 22.08. | Sustainable City Conference, the fourth in a series of workshops on local and global sustainability (organised jointly with the Botanic Garden of Bogotá, Columbia) |
| 27–31.10. | Second Global Soil Week |

### National and international events with up to 50 participants

| Date | Event |
|---|---|
| 22.01. | IASS – UPM – DLR Workshop: Concentrating Solar Power for electricity generation. Assessing alternatives, opening new ways |
| 23.01. | Raw Materials Expedition dialogue forum: "What's in your mobile phone?" |
| 23.01. | Rethinking Franco-German cooperation in the context of energy transitions – expert dialogue on energy efficiency: how to combine incentives and regulations? (organised jointly with IDDRI/SciencesPo) |
| 24.01. | TPEC working group 3 "Contributing to the Social Accountability of the Energiewende" |
| 24.01. | WRF-CHEM Modeller workshop |
| 31.01. | TPEC working group 1 "Market System for Renewable Energies – the Path to Revising the Law on Renewable Energies" |
| 08.02. | WEEE-Mining: Material cycles in the age of the Anthropocene |
| 19.02. | TPEC working group 2 "The Energiewende and $CO_2$ – the Role of Fossil Power Plants" |
| 15.03. | Renewable Energies and Electricity Market Design – Squaring the Circle?, TPEC-British Bilaterals |
| 18–19.03. | UNESCO World Heritage Working Group |
| 20–22.03. | Oceans in the Anthropocene: Advancing Governance of the High seas |
| 15–16.04. | Geo-engineering Model Intercomparison Project (GeoMIP) Workshop |
| 16.04. | The Arctic Hub – Regional and Global Perspectives (as part of the Arctic Science Summer Week in Cracow, Poland) |
| 22.04. | Conference on "Mobile Phones, Ressources and Sustainability – A Contradiction in Terms or a Vision for the Future?" |

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|---|---|
| **23.04.** | Expert dialogue on the possibilities and limits of strengthening responsible land governance through transparency |
| **24–26.04.** | Religious and Spiritual Perspectives on Climate Engineering |
| **13.05.** | Workshop on "What about growth when everything is shrinking?" |
| **15–17.05.** | Potential Biodiversity and Ecosystem Impacts of Geo-engineering: an Agenda for Research |
| **21.05.** | Workshop with a Kogi Indian delegation on the cultural dimensions of sustainability |
| **21.05.** | Air Quality and Climate Change Policies – Separate or Joint Challenges? (organised jointly with the European Environmental Bureau in Brussels, Belgium) |
| **22–24.05.** | The Ethical Challenges of Climate Engineering |
| **31.05.** | Seminar on Life Cycle Assessment |
| **04–05.06.** | Putting Soils and Land on the SDG Agenda: Defining Potential Indicators |
| **06–07.06.** | Soil protocol |
| **07.06.** | Panel discussion on "Pro-poor Resource Governance under Changing Climates" (organised jointly with the University of Bern at the 14th Global Conference of the International Association for the Study of the Commons in 2013 at Mount Fuji, Japan) |
| **11.06.** | Workshop on "Governing Land Responsibly – Institutions and Actors" as part of the 2013 Policies against Hunger Conference "Land ahead! Applying the Voluntary Guidelines on the Responsible Governance of Tenure of Land, Fisheries and Forests" organised by the Federal Ministry of Food and Agriculture in Berlin |
| **17.06.** | Soils in the Nexus |
| **20.06.** | Sneakers made of $CO_2$? $CO_2$ – from a 'climate killer' to an asset (organised as part of the German Sustainability Week) |
| **1–12.07.** | Global Sustainability Summer School (in collaboration with PIK) |
| **2.07.** | An impulse for Europe – green growth (in collaboration with the German Ministry for the Environment (BMU) and Germanwatch) |
| **16.07.** | Buen Vivir and the Search for Alternatives to Development |
| **21–23.08.** | First Open Discussion Workshop on Climate Engineering (organised jointly with the University of the South Pacific in Suva, Fiji) |
| **27–29.08.** | SusKat Data Analysis Workshop (organised jointly with ICIMOD in Kathmandu, Nepal) |
| **27.08.** | Expert discussion on "Responsible Land Governance: what conclusions can be drawn from the G8 resolutions on land governance in Lough Erne?" (organised jointly with the German Institute for Human Rights) |
| **02.09.** | Climate policy after Doha: what are the alternatives for a successful climate policy? |

## FACTS & FIGURES

| | |
|---|---|
| **05–06.09.** | EuTRACE Scenario Workshop |
| **17.09.** | GeoEd: Geoscientific Teaching and Learning Module and Teacher-training Concept |
| **19–20.09.** | Decision-making under Uncertainty and Normative Aspects of Climate Engineering |
| **23–25.09.** | Closing workshop of the IFAD-IASS research project "Pro-poor Resource Governance under Changing Climates" in Rome, Italy |
| **02.10.** | Global Soil Forum – Steering Committee Meeting |
| **02–04.10.** | Towards a stress testing methodology for SLCP metrics – lessons learned, policy resilience, and current developments (a workshop organised jointly with University College London) |
| **09–10.10.** | Workshop on "Integrating air quality and climate change mitigation – is there a need for new metrics to support decision-making?" (organised jointly with the European Environment Agency in Copenhagen, Denmark) |
| **15.10.** | TPEC workshop on "The Regulatory Framework for Demand Response in California and Germany" (organised jointly with the German Consulate General in San Francisco, USA) |
| **22–23.10.** | Urban Productivity and Resilience: a Case for Global Sustainability Goals, the fifth in a series of workshops on local and global sustainability, organised jointly with the Botanic Garten of Bogotá, Columbia (The first four workshops took place in Bogotá with around 400 participants at each workshop.) |
| **06.11.** | Meeting of German users of the WRF-Chem (Weather Research and Forecasting model) and related models |
| **13.11.** | Sustainability Transitions, Past and Present |
| **13.11.** | Material Cultures of Energy |
| **18.11.** | Short-Lived Climate Pollutants (SLCPs) in South Asia – current Scientific knowledge and ways forward to develop tailored policy recommendations (a side event at the climate negotiations in Warsaw, Poland, organised jointly with the Climate and Clean Air Coalition, the Federal Environmental Agency and ICIMOD) |
| **18–19.11.** | WEEE-Mining: Material Cycles in the Age of the Anthropocene |
| **19–20.11.** | Sustainable Fuels from Renewable Energies |
| **04.12.** | Political Economics – The Translation of Economic Knowledge in Politics |
| **09–10.12.** | Arctic Horizon 2030 |
| **13–14.12.** | 2nd Workshop on Sustainable Global Financial Systems |
| **18.12.** | Research approaches to Carbon Capture and Utilisation – a discussion round with Climate KIC |

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