

GREEN GROWTH KNOWLEDGE PLATFORM  
ANNUAL CONFERENCE 2017

# SUSTAINABLE INFRASTRUCTURE

CONFERENCE REPORT



[www.ggkp.org/event/conference2017](http://www.ggkp.org/event/conference2017)



## Overview

Ensuring affordable and reliable access to infrastructure remains a major challenge in developing countries, one that is further complicated by both a changing climate and changing climate policies. Central to the infrastructure challenge is the balancing act across the social, economic, and environmental dimensions of sustainability. These issues can and have been addressed from different scientific perspectives. However, despite a clear move of the academic community towards interdisciplinary projects, researchers working on specific aspects of the infrastructure agenda are not systematically interacting with each other.

To address these challenges, the Fifth Green Growth Knowledge Platform Annual Conference was convened by the World Bank on the topic of Sustainable Infrastructure. Taking place in Washington D.C., from the 27<sup>th</sup> to the 28<sup>th</sup> of November 2017, this two-day conference brought together the best researchers in the field, both from the academic world and from more policy-oriented backgrounds, to take stock of recent advances and challenges around the infrastructure agenda.

To generate research on the topic, the GGKP and the World Bank issued a call for papers. A total of 173 papers were submitted in response to the call. Papers were reviewed by the GGKP Research Committee on Sustainable Infrastructure and the Annual Conference Scientific Committee. A total of 44 papers were presented at the conference.

In recognition of outstanding research presented at the conference, three awards were presented. The winners of the awards were determined based on voting by conference participants. The award for Best Paper Overall was presented to Jörg Peters, RWI- Leibniz Institute for Economic Research and University of Passau for his paper “Demand for Off-grid Solar Electricity: Experimental Evidence from Rwanda”. The award for Most Impactful Research was presented to Catherine Wolfram, Haas School of Business at the University of California, Berkeley for her research on “Energy and Development”. The award for Best Presentation was presented to the three speakers in the Water Plenary – Mushfiq Mobarak, Edward Glaeser and Richard Damania.

The following report provides an overview of each of the conference’s individual sessions.

All papers, presentations, photos and videos from the conference can be found at: <http://www.greengrowthknowledge.org/event/conference2017>

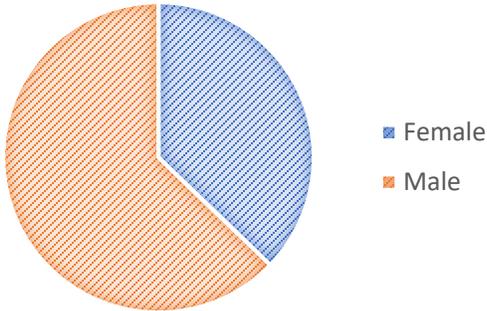


## Conference Statistics

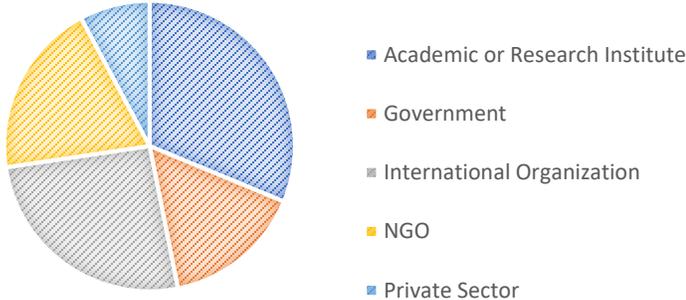
- 2** Keynotes
- 4** Plenary sessions
- 12** Parallel sessions
- 24** GGKP partners
- 44** Papers presented
- 83** Speakers
- 200** Participants



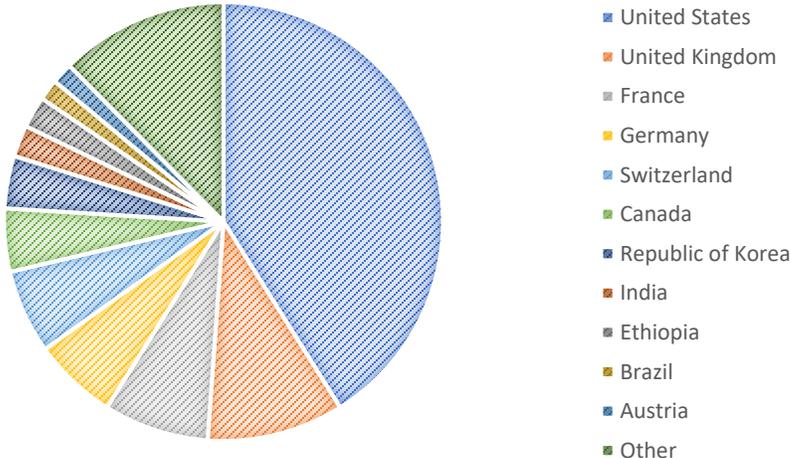
### Gender Breakdown

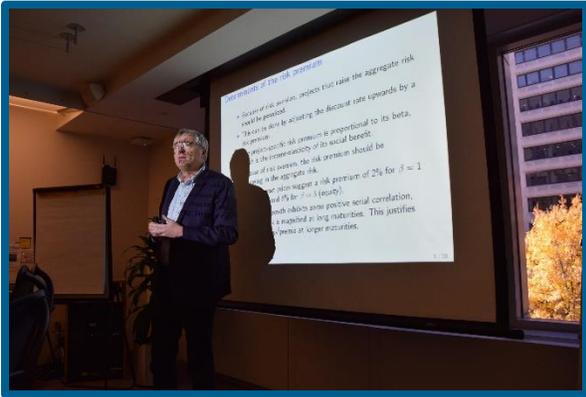


### Industry Breakdown



### Country Breakdown





## Conference Program at a Glance

### Day 1: November 27, 2017

- 09:00 – 09:15 Welcome and Opening Remarks
- 09:15 – 10:00 Keynote | Large Scale Renewables: Successes and Challenges
- 10:00 – 11:00 Plenary | Powering a Sustainable Future: Understanding Energy Infrastructure Needs
- 11:30 – 13:00 Parallel Sessions A
- Transport and Low Carbon Pathways
  - Rural Electrification
  - Infrastructure for Disaster Risk Management: Overcoming Barriers to Scaling up Nature-based Solutions
- 14:00 – 15:30 Parallel Sessions B
- Energy, Infrastructure and Low Carbon Pathways
  - Transport and Structural Transformation
  - A Sustainable Look at the Belt and Road Initiative
- 16:00 – 17:30 Plenary | Going with the Flow: Water Infrastructure and Sustainable Development

### Day 2: November 28, 2017

- 09:00 – 09:45 Keynote | Energy and Development
- 09:45 – 11:00 Plenary | Regulation for Sustainable Infrastructure
- 11:30 – 13:00 Parallel Sessions C
- Roads, Deforestation and Agricultural Productivity
  - Adaptation and Long Term Decision-Making
  - Assessing the Sustainability and Resource Requirements of Infrastructure Strategies
- 14:00 – 15:30 Parallel Sessions D
- Mitigation and Long Term Decision-Making
  - Adaptation and Flooding
  - Implementing Sustainable Infrastructure
- 16:00 – 17:30 Plenary | Sustainable Finance & Viable Investments: Where the Twain Shall Meet
- 17:30 – 17:45 Closing Remarks

## Keynote

### Large Scale Renewables: Successes and Challenges



**Mar Reguant**, Associate Professor at Northwestern University, delivered the opening keynote presentation, taking stock of the current state of large scale renewables and lessons for their expansion in developing countries – focusing namely on the operational and political economy challenges.

#### Session Highlights

- In developed countries, large scale renewables play a strong role in increasing renewable energy in the energy mix, but there exists significant potential from small-scale renewables in developing countries.
- Scholars debate whether wind and solar can ensure a transition to 100% renewable energy. A recent study suggested that these, together with hydro, would be enough, but controversy has emerged around whether the assumptions are false. This is complicated by the fact that economics has been good at explaining the past but poor at predicting the future.
- The rising penetration of renewables into national energy mixes raises operational challenges to achieving 100% penetration. As penetration increases, the costs of integrating renewables are likely to increase. For instance, wind tends to reduce market prices for energy but also to increase adjustment costs. Overall, the increased wind in the energy mix increases intermittency costs steadily but not exponentially.
- It is difficult to extrapolate these results and understand the impact of 100% renewable energy on operational costs. Reducing uncertainty through better forecasts and reducing volatility in wind supplies through better storage would help bring intermittency costs down.
- The rising penetration of renewables into national energy mixes also raises political economy challenges to achieving 100% penetration. As penetration increases, policy support for integrating renewables is likely to decrease due to tensions between residential and industrial use, distributional effects between income groups, and political opposition by and support to traditional energy generators.
- Alternative pricing schemes may help attenuate tensions between residential and industrial use as renewable energy penetration increases. It may be the most efficient to tax the least responsive group. For instance, Ramsey prices, which charges residential consumers more than industrial ones, may be best if industry fails to respond to taxation by lowering emissions. However, this solution may itself be politically untenable.

## Plenary

# Powering a Sustainable Future: Understanding Energy Infrastructure Needs

### Session Details

Chair:	<b>Paul Ekins</b> , University College London
Presenters:	<b>Keywan Riahi</b> , International Institute for Applied Systems Analysis <i>Investment Portfolios for Deep Transformation Scenarios</i> <b>Alejandro Moreno</b> , Director, US Department of Energy <i>Charting the Diffusion of Power Sector Reform in the Developing World</i>
Discussant:	<b>Najib Saab</b> , Arab Forum for Environment and Development

### Session Highlights

- Nationally Determined Contributions (NDCs) will not be sufficient to meet the long-term goals set by the Paris Agreement. The gap between the current and required policy stringency is enormous. Overall, an increase of 20-30% absolute investment is required to achieve a 2-degree climate scenario.
- Both investment and disinvestment are needed to achieve either the 2- or 1.5-degree goals. Investment is needed in energy efficiency, renewable energy, nuclear energy, carbon capture and storage and energy transmission, distribution and storage. Disinvestment is needed in fossil fuel extraction and power generation. Greater investments and disinvestments including negative emissions are needed to achieve a 1.5-degree scenario.
- Climate investment and disinvestment have implications not only for energy and climate SDGs, but also for SDGs relating to food, water, land, air and social equity. Additional investments are needed to ensure that changes in the energy sector improve energy access, clean cooking and particularly food and water security for the poor. Additional investments may be needed to ensure the protection of biodiversity and increase of natural capital.
- Developing country power sector reform is lagging substantially behind OECD countries, where full reform is far from being universal, and has been running out of steam for the last decade. These results are strongly affected by country characteristics such as income level and region.
- Developing countries have often cherry-picked relatively easy reforms, such as establishing a regulator while deeper reforms, such as full restructuring, private sector participation and competition, have lagged.
- Developing country reforms have been characterized by delays or gaps between reform announcement and implementation. They have also been packaged and sequenced in ways unrelated to the original logic, leaving many countries stuck in intermediate stages of reform. In some cases reforms have been reversed, particularly in the case of private sector participation.
- There is significant debate about whether the original reforms under the “Washington Consensus” were correct to begin with or rather need to be revised. It may be that countries are not “lagging” or “leading”, but rather that the benchmark itself needs rethinking.

## Parallel Session A1

### Transport and Low Carbon Pathways

#### Session Details

Chair:	<b>Maria Marcela Silva</b> , Transport and ICT Global Practice, World Bank
Presenters:	<b>Meriem Hamdi-Cherif</b> , CIRED <i>The Transportation Sector as a Lever for Reducing Long-term Mitigation Costs in China</i>
	<b>James Seong-Cheol Kang</b> , Global Green Growth Institute <i>Sustainable Transport through Provision of Electric Vehicle Taxis: A case study in Seoul</i>
	<b>Vivien Fisch</b> , CIRED <i>Investment Needs of Transport Infrastructure Along Low Carbon Pathways</i>
Discussant:	<b>Shomik Mehndiratta</b> , Transport and ICT Global Practice, World Bank

#### Session Highlights

- Emission reduction in the transport sector (accounting for 14% of global GHG emissions) is critical to achieve the Paris Climate Agreement and UN SDGs.
- To reduce GHG emissions in the transport session, additional policies are needed to push technological advancement, R&D and innovation. Supplementing carbon pricing with measures promoting a modal shift towards low carbon transport modes and a decoupling of economic activity from mobility needs, change the sectoral distribution of mitigation efforts and significantly reduce the macro-economic mitigation costs.
- Carbon pricing alone has limited impact in the transport sector. Structural issues need to be considered to avoid lock-ins.
- There is not a one-size-fits-all-solution to decarbonizing the transport sector. Innovative efforts to transform the sector are being piloted around the world. The city of Seoul, for instance, is gradually deploying electric vehicle taxis. Potential benefits include avoided environmental cost and an increase in public awareness. A cost-benefit analysis of the scheme finds it to be economically viable.
- In quantifying investment needs for transport infrastructure over time to reach both development and climate objectives, it is found that the expenditures needed for transport infrastructure are reduced along low carbon pathways compared to investment levels in baseline scenarios. The main decrease is observed in road and rail sectors. Climate policies tend to reduce cumulative investments needs in transport infrastructure with investments being reoriented due to a modal shift to low carbon transport modes and a reduction in transport activity.
- A key outstanding challenge is how to reorient carbon finance to implement these findings.

## Parallel Session A2

### Rural Electrification

#### Session Details

Chair:	<b>Jonathan Coony</b> , World Bank
Presenters:	<b>Jörg Peters</b> , RWI - Leibniz Institute for Economic Research <i>Demand for Off-grid Solar Electricity: Experimental evidence from Rwanda</i>
	<b>Fan Zhang</b> , World Bank <i>Benefits of Electrification and the Role of Reliability: Evidence from India</i>
	<b>Moussa Blimpo</b> , Africa Region, World Bank <i>The Demand for Rural Electrification in Africa</i>
Discussant:	<b>Haileselassie Medhin</b> , Ethiopian Development Research Institute

#### Session Highlights

- The SDG goal on rural electrification will be extremely challenging to meet, not because of a lack of political will, but simply because of the math. Only recently has the international development community begun to take off-grid solar seriously as a tool for rural electrification, but there may now be too much hype surrounding it as a solution.
- The willingness to pay for off-grid solar electricity of the poorest households has been found to be high. However, despite a strong desire for electrification, many energy systems remain out of their reach. Thus, subsidization is needed from the government to close the gaps and gain the wider social benefits of electrification.
- It is not sufficient to be connected to the electric grid but to ensure that the service is consistent. Low-quality electric service undermines household's trust in the government to the extent that households with poor electricity service feel more negatively toward the government, and less willing to pay taxes, than those with no service at all.
- Aggressive expansion of the electric grid in rural areas can cause lower reliability for existing customers. This is the case shown in some regions or rural India.
- Rural electrification requires many economic transformations at the same time to be successful.

## Parallel Session A3

# Infrastructure for Disaster Risk Management: Overcoming Barriers to Scaling up Nature-Based Solutions (Policy Session)

### Session Details

Chair:	<b>Stephane Hallegatte</b> , World Bank
Presenters:	<b>Bregje van Wesenbeeck</b> , Deltares <i>Implementing nature-based flood protection: Principles and implementation guidance</i> <b>Ugo Guarnacci</b> , European Commission <i>Co-design, co-development and co-implementation of Nature-Based Solutions for urban resilience: The EU perspective</i>
Discussants:	<b>Glenn-Marie Lange</b> , World Bank <b>Jonny Sadler</b> , Manchester Climate Change Agency

### Session Highlights

- Best practices for nature-based solutions include:
  - 1) taking a system-wide analysis of local conditions,
  - 2) doing a thorough assessment of the full range of possible solutions – including “gray” and “green”,
  - 3) testing selected solutions based on a standardized performance evaluation,
  - 4) carrying out adaptive management based on long-term monitoring, and
  - 5) using existing ecosystems, native species, and ecological restoration techniques.
- The construction of new infrastructure, which is often the first impulse following a natural disaster, is not always the best solution. Spatial planning, building codes, zoning and enforcing existing regulation are all equally important and potentially more effective.
- The European Union (EU) is responding to a range of new climate, water, meteorological and geophysical risks through nature-based solutions to achieve both benefits and co-benefits including through regional measures that mirror global agreements (e.g. SDGs, Paris Agreement, etc.).
- In the EU, Horizon 2020, an EUR 80 billion initiative over 2014-2020, supports several projects for nature-based solutions in European cities and abroad. The EU works with the Belmont Forum, Eklipse and other organizations to advance research and innovation around nature-based solutions.
- There is much interest in better applying nature-based solutions to help cities solve issues around health, well-being and the prevention of natural risks. There is a need to understand how to apply these techniques in developing contexts like Africa. Moreover, knowledge gaps remain about when nature-based solutions are cost-effective – more data is necessary. Finally, it is important to focus on scaling techniques – building coalitions, exploring broad policy areas (e.g. regulation, insurance) and making the business case at local and national levels.



## Parallel Session B1

### Energy, Infrastructure and Low Carbon Pathways

#### Session Details

Chair:	<b>Norbert Kurilla</b> , State Secretary in the Ministry of Environment, Slovakia
Presenters:	<b>Stefan Ambec</b> , Toulouse School of Economics <i>Decarbonizing Electricity Generation with Intermittent Sources of Energy</i>
	<b>Dina Subkhankulova</b> , University College London Energy Institute <i>Demand Side Management: A case for disruptive behaviour</i>
	<b>Prudence Dato</b> , Savoie Mont Blanc University <i>Investment in Energy Efficiency, Adoption of Renewable Energy and Household Behaviour: Evidence from OECD countries</i>
Discussant:	<b>Ron Benioff</b> , Low Emissions Development Strategies Global Partnership

#### Session Highlights

- Climate change mitigation requires the replacement of fossil-fuel energy with renewables such as wind and solar power. The intermittent nature of renewables, coupled with the lack of electricity consumers' responsiveness to short-term fluctuations in electricity provision, makes it necessary to back-up any new installation of intermittent energy facilities (e.g. new windmills) with reliable energy (e.g. coal-fuelled power plants). Intermittency also increases the cost of renewables due to the need to develop energy-storage technologies.
- Feed-in tariffs (FIT) in the renewables sector can result in excess energy production. FIT should be complemented by a tax on electricity consumption to reduce demand. Similarly, renewable portfolio standards should be complemented with a carbon tax to control fossil fuel burning and achieve the efficient energy mix.
- Rapid changes in the UK energy market (e.g. due to distributed generation, smart metering, and consumer storage) have made it complex to balance supply and demand in the grid. Competitive behaviour by electric utilities achieved by means of shifting consumer demand can lead to increased demand peaks in the system and thus higher electricity prices for certain periods during the year. Prices were highest when suppliers used cost minimizing demand-side management.
- Possible synergies exist between energy efficiency and renewable energy adoption. A study examining household decisions to invest in these technologies finds the two decisions are positively interrelated, possibly due to unobserved characteristics, e.g. environmental concerns. Incentives do not always align, e.g. landlord and tenant, as well as energy poverty problems. These findings can help to define incentive policies to advance the energy transition.

## Parallel Session B2

### Transport and Structural Transformation

#### Session Details

Chair:	<b>Cletus Springer</b> , Organization of American States
Presenters:	<b>Theophile Bougna</b> , World Bank <i>Roads and the Geography of Economic Activities in Mexico</i>
	<b>Sam Asher</b> , World Bank <i>The Ecological Footprint of Transportation Infrastructure</i>
	<b>Simon Alder</b> , University of North Carolina at Chapel Hill <i>The Effect of Transport Infrastructure on India's Urban and Rural Development</i>
Discussant:	<b>Nancy Lozano-Gracia</b> , World Bank

#### Session Highlights

- Transport infrastructure can have an important effect on local economic development outcomes. In the case of Mexico, where large investments in roads have been made over the past decades, road transport accounts for 57% of freight transport and is a vital component of the economy. A study looking at the impacts of road improvements in Mexico over the last three decades found that transportation improvement increased access to markets and had a positive effect on local employment and economic specialization. Heterogeneous effects are found across sectors and regions.
- Road construction is thought to result in forest loss, but causal identification has been elusive. Using multiple causal identification strategies, it has been found that India's rural road construction program, which built new feeder roads to over 100,000 villages and 100 million people, had precisely zero effect on local deforestation. In contrast, when 10,000 kilometers of India's national highway network were upgraded, there was substantial forest cover loss, driven by increased timber demand along the highway corridor. In terms of forests, last mile connectivity had a negligible environmental cost, while expansion of major corridors had important environmental impacts.
- To estimate the relationship between income and market access, a study in India exploits changes in transportation infrastructure that have led to reductions in travel times on the computed shortest path. The implied reduction in trade costs generates variation in the market access measures. This time variation allows the estimation of elasticity of income in each sector with respect to market access in their own and the other sector. The results suggest that both urban and rural market access are each individually strongly correlated with income, but they are empirically difficult to disentangle when estimating jointly.

## Parallel Session B3

### A Sustainable Look at the Belt and Road Initiative (Policy Session)

#### Session Details

Session Chair:	<b>Mustafa Moinuddin</b> , Institute for Global Environmental Strategies
Presenters:	<b>Kumi Kitamori</b> , Organisation for Economic Co-operation and Development <i>The Low Carbon Transition and Sustainable Infrastructure</i>
	<b>Fulai Sheng</b> , UN Environment <i>Belt and Road: Opportunity and Challenges for Sustainable Development</i>
	<b>Somik Lall</b> , World Bank <i>Who Wins, Who Loses: Articulating the Spatially Differentiated Impacts of BRI Investments</i>

#### Session Highlights

- The Belt and Road Initiative can be seen as “globalization 2.0”. Whereas in the past globalization was focused on removing policy barriers to trade, this initiative is more about removing physical barriers, i.e. building infrastructure links. “1.0” was more spontaneous and driven by market forces, whereas the Belt and Road is more planned and led by China. The BRI needs to draw lessons from experience and emphasize green development and inclusiveness.
- Large scale Belt and Road infrastructure investments can bring economic benefits and environmental challenges. The window to make the right choice on Belt and Road infrastructure is shrinking – the next 2-3 years will be crucial. If done right, it has huge potential to help meet the infrastructure gap for the SDGs.
- Choices about where to build infrastructure are as important as what type of infrastructure gets built. Spatial distribution has obvious links to environmental impacts (i.e. direct physical impacts to sensitive habitat), but also affects the spatial distribution of economic activity. Complementary policy packages (e.g. tax transfer, domestic infrastructure, governance) are needed to balance out the spatial effects.
- Investment choices need to go beyond “transit” infrastructure and ensure benefits to local populations, who will ultimately be paying for the infrastructure. This requires strategic, system-level planning of infrastructure development.
- Stakeholder buy-in is a key to the success of infrastructure projects. China and other Belt and Road country governments need to ensure stakeholder consultation and participation.

## Plenary

# Going with the Flow: Water Infrastructure and Sustainable Development

### Session Details

Session Chair: **Guang Zhe Chen**, Water Global Practice, World Bank

Presenters: **Ahmed Mushfiq Mobarak**, Yale University  
*No Sh\*t: Demand estimation with strategic complementarities with an application to sanitation in Bangladesh*

**Edward Glaeser**, Harvard University  
*Water, Health and Wealth*

**Richard Damania**, World Bank  
*Uncharted Waters: The economics of water scarcity and variability*

Discussant: **Jim Hall**, University of Oxford



### Session Highlights

- Sanitation adoption may be interdependent among households. Given this, optimal subsidy allocation is unclear. The benefit of subsidizing sanitation depends largely on the price elasticity and concentration of the target group. Landless and poorer households tend to have more price elasticity and therefore the subsidies lead to greater behavioral change. Sanitation subsidies should be targeted to the poor in population dense areas in a concentrated way. Subsidizing socially connected individuals does not lead to greater uptake in sanitation behaviors. Rather, behavioral change was more apparent if subsidies were provided to the poorest households. The change in behavior by these households creates a sense of shame in the wealthier households.
- History has shown that investment in water and sanitation is the most effective mechanism for improving overall health in a community. Whether to use subsidies or fines to create the behavior change depends on the relative strength of the judicial branch and executive branch in any given country. Fines are preferable if property rights are clear and enforcement is strong. Subsidies are preferable when property rights are less clear and enforcement is weak.
- There are considerable negative impacts caused by intermittent access to water and water service outages, including an increase in health concerns, such as diarrhea, typhoid, and respiratory disease.

In addition, the lack of access to water can have a disproportionately negative impact on girls as they spend more time on chores rather than at school. Finally, water outages also seem to decrease the number of financial transactions in African communities.

- A failure to act on water has been viewed as somewhat acceptable given an increase in the use of antibiotics which can be used to treat many water-borne illnesses. However, failing to address the lack of access to water could be creating graver threats than imagined by contributing to antibiotic resistant diseases. With a globally connected world we should not allow water-borne diseases to go unchecked because the risk is too great.
- There will be an increase in rainfall shocks due to climate change. Even moderate deviations from normal rainfall can cause large changes in crop yields. Although irrigation systems usually insulate agriculture from the negative effects of dry-shocks they can also exacerbate the risk by providing a false sense of water abundance which stimulates to use of water-intensive crops. Multi-policy instruments should be used to mitigate rainfall shocks and address water scarcity. These instruments need to be applied across the full chain of water extraction and use including: i) protecting water sources, ii) managing demand, iii) regulating utilities, iv) providing safety nets for shocks, and v) and reducing pollution and environmental degradation.



## Keynote

### Energy and Development

**Catherine Wolfram**, Professor at the Haas School of Business, University of California, Berkeley, delivered the keynote address on day two of the conference. Her presentation focused on energy in the developing world drawing on applications from her work in Kenya. **Moussa Blimpo** of the Africa Region at the World Bank served as discussant, reflecting on the implications of Professor Wolfram's work.



#### Session Highlights

- The developing world has now surpassed the developed in its demand for electricity. There is a strong link between income growth and energy consumption (with disagreement on whether growth leads to energy consumption or vice versa). Projections show that nearly all growth in energy consumption will come from the developing world. Moreover, projections from international organizations and the private sector have systematically underestimated energy demand in the developing world.
- Many households are living “under-grid”. In other words, the infrastructure exists, but socio-economic challenges hinder their connection to the grid. Moreover, households have a much higher willingness to pay for on-grid energy, rather than off-grid solutions. This is due to the higher-wattage services, such as ironing, which the households seek.
- Research was presented on how access to electricity impacts people's lives in Western Kenya. Through a randomized controlled trial (RCT), subsidies were offered to rural households to connect to the electrical grid. Results did not show a statistically significant improvement in a number of predefined household development indicators within 18 months of electrification. As a result, the development benefits from electrification may be overstated.

- Too narrow of a focus on rural electrification can lead to several challenges.
  - It leaves out the commercial and industrial sector, where more growth is expected.
  - Households that lack electricity also lack other basic services. Development outcomes need to be prioritized, and often electricity is not at the top of the list.
  - Rural electrification may divert resources from improving reliability on the existing grid.
- Key knowledge gaps for future research include the drivers of energy demand in the developing world; development of technological and policy solutions that work; and gauging of solutions based on their impacts in the developing world (e.g. China, India and Sub-Saharan Africa).
- The respondent pointed out that evidence shows electrification is a necessary, but not a sufficient measure for development. If a government can afford to electrify rural areas, it should.



## Plenary

### Regulation for Sustainable Development

#### Session Details

Chair:	<b>Bruno Oberle</b> , École polytechnique fédérale de Lausanne
Presenters:	<b>Emmanuelle Auriol</b> , Toulouse School of Economics <i>Infrastructure Regulation and Economic Integration</i>
	<b>Stephane Straub</b> , Toulouse School of Economics <i>Funding and Financing Regulated Infrastructure</i>
	<b>Michael Grubb</b> , University College London <i>The Policy and Regulation of UK Electricity Market Reform</i>
Discussant:	<b>Thomas Heller</b> , Climate Policy Initiative

#### Session Highlights

- The power of small government regulators is shrinking compared the major energy companies that often take on power projects in developing countries. Additionally, small developing countries have difficulty developing the capacity to effectively draft and enforce regulation.
- To compensate, a multinational energy regulation body may be a good solution to encourage the development of robust electricity systems. Such a body could result in increased capacity, increased accountability, increased commitment, and increased fiscal capacity. Africa's international power pools would be a good place to begin.
- Public-private partnerships (PPPs) may not be the best way to fund infrastructure in developing countries because the cost of regulating and auditing international firms can be so high that the government is better served by traditional procurement.
- The pricing model used by the UK government has been extremely successful in promoting renewable energy. The UK encourages new investment in electricity by holding auctions for a contracted price of electricity. Once the generation facility is online, the government acts as a guarantor of that agreed price, either paying or changing power provider depending on the prevailing market rate. This scheme has reduced the price of new renewable generating capacity by as much three percent, representing billions of dollars of savings over the course of replacing legacy fossil fuel generation with new renewable capacity.
- Countries around the world are working under multiple different growth models. There is no single model for infrastructure regulation that can be prescribed as each national system must be context dependent.



## Parallel Session C1

### Roads, Deforestation and Agricultural Productivity

#### Session Details

Chair:	<b>Karla Gonzalez Carvajal</b> , World Bank
Presenters:	<b>Juliano Assunção</b> , Climate Policy Initiative and PUC-Rio <i>Agricultural Productivity and Deforestation in Brazil</i>
	<b>David Kaczan</b> , World Bank <i>Can Roads Contribute to Forest Transitions?</i>
	<b>Eduardo Souza-Rodrigues</b> , University of Toronto <i>A Structural Dynamic Land Use Model for the Amazon Rainforest</i>
Discussant:	<b>Nicolas Gerber</b> , Center for Development Research, University of Bonn

#### Session Highlights

- In Brazil, electrification expansion has been found to have a positive correlation with agricultural productivity. Farmers subsequently both expand farming through frontier land conversion, but also shift away from land-intensive activities and into capital- and labor-intensive activities. The net effect depends on the county's land use prior to the increase in agricultural productivity, but it reduces deforestation in the typical country in the sample.
- A second study in Brazil found that paved and planned road development changes the share of deforestation, but the magnitude of the change is small. The study reveals that deforestation increases with output prices with an elasticity of 1 percent.
- In India, it has been tested that overall road construction does not contribute to forest cover loss but increases forest transition (defined as forest cover recovery). Reasons include: raising the relative productivity of labor in non-agricultural sectors, thereby reducing agricultural activity and encouraging substitution from locally collected fuelwood to other energy sources. However, in areas with untouched forest (generally rural areas) this conclusion does not hold true and road construction contributes to forest cover loss.



## Parallel Session C2

### Adaptation and Long Term Decision-Making

#### Session Details

Chair:	<b>Arame Tall</b> , Climate Change, World Bank
Presenters:	<b>Christian Gollier</b> , Toulouse School of Economics <i>Term Structures of Discount Rates: An international perspective</i>
	<b>Ki Han Song</b> , Korea Transport Institute <i>Application of DMDU (Decision-Making Under Uncertainty Methodology) on Korean Transportation Infrastructure Feasibility Study</i>
	<b>Raghav Pant</b> , Environmental Change Institute, University of Oxford <i>System-of-Systems Framework for Global Infrastructure Vulnerability Assessments</i>
Discussant:	<b>Joe Grice</b> , Office of National Statistics, United Kingdom

#### Session Highlights

- When a policy is evaluated, the rate at which future costs and benefits should be discounted depends upon their maturity and risk profile. When the shocks to the growth rate of consumption per capita are persistent, it is socially desirable to use a decreasing term structure of risk-free discount rates, and an increasing term structure of risk premia. Research shows that the efficient evaluation rules of long investment projects are heterogeneous across countries, stressing the need to use country-specific discount rates and the importance of estimating the risk profile of long-dated investment projects.
- In the South Korean transport sector, to deal with uncertainties and facilitate decision processes for investment infrastructure, decision making under uncertainty (DMU) methodology was applied. The model accounts for diversity in trends and highlights that complexity is growing. Through the DMU methodology, future uncertainties are included in the methodology.
- Infrastructure is often made up of large and spatially distributed systems involving complex interactions. It is important to understand systemic vulnerabilities and risks to infrastructure to address the challenges of population growth and the need to withstand human-induced and natural shocks. A 'system of systems framework' can be useful to study how global infrastructure vulnerability assessment can be generalized to provide useful insights for decision-making. For instance, hotspots resulting in vulnerabilities exist along the UK railway system. Focus on interrelations is crucial in prioritizing action in case of a disruption.



## Parallel Session C3

# Assessing the Sustainability and Resource Requirements of Infrastructure Strategies (Policy Session)

### Session Details

Chair:	<b>Raouf Dabbas</b> , Friends of Environment Jordan
Presenters:	<b>Anu Ramaswami</b> , University of Minnesota <i>The Weight of Cities: Resource requirements of future urbanisation</i>
	<b>Roy Brooke</b> , Municipal Natural Assets Initiative <i>Municipal Natural Asset Management as a Sustainable Infrastructure Strategy: The emerging evidence</i>
	<b>Oshani Perera</b> , International Institute for Sustainable Development <i>Sustainable Asset Valuation (SAVi) Tool</i>
	<b>Josh Sawislak</b> , AECOM and <b>Ryan Bartlett</b> , WWF <i>Assessing the Sustainability and Climate Resilience of Infrastructure to Catalyse Better Decisions</i>

### Session Highlights

- There are many different environmental sustainability screening and assessment tools for infrastructure projects that are used by international financial institutions and promoted by different organizations. Often climate risks are incorporated into the sustainability assessment tools, but stand-alone tools to assess climate risks should be developed. This is because the sustainability assessment tools work best on a single project basis, whereas climate risks should be assessed at an aggregated level (i.e. national or regional).
- There is also a need for better tools to value natural capital and natural assets, and how climate change will affect the value of the services that they provide, and incorporate those values into decisions.
- Urban development provides an opportunity to decouple growth from environmental impacts given the planned new infrastructure construction and the opportunity for pursuing a multi-sector, systems-level approach. Key pathways for urban decoupling include strategic densification, resource efficient infrastructure, and innovative modes of governance.
- Infrastructure should be thought of in terms of the service that it provides, not just as the hard infrastructure itself. In this view, natural assets (i.e. ecological infrastructure) can often provide key services at better costs than built infrastructure (e.g. water treatment, storm water control, shore protection). Focusing on the costs of service provision makes it easier to sell the benefits of investing in natural assets.
- Sustainable infrastructure cannot be promoted in the absence of a balance sheet discussion. Externalities that affect projects need to be incorporated into the cost of projects to show that increasing their sustainability can also increase their bankability.

## Parallel Session D1

### Mitigation and Long Term Decision-Making

#### Session Details

Chair:	<b>Kevin Urama</b> , African Development Bank
Presenters:	<b>Michael Grubb</b> , University College London <i>Innovation and Adaptability of Energy Systems: Some evidence and a mathematical exploration</i>
	<b>Jan Siegmeier</b> , Mercator Research Institute on Global Commons and Climate Change <i>Keeping Pigou on Tracks: Second-best carbon pricing and infrastructure provision</i>
	<b>Alexander Pfeiffer</b> , Institute for New Economic Thinking, Oxford <i>Dead on Arrival? Implicit stranded assets in Leading IAM scenarios</i>
Discussant:	<b>Nick Robins</b> , UN Environment Inquiry



#### Session Highlights

- The energy sector is “pliable” (adaptable): it responds well to price signals and learning-by-doing works well. Yet, the latter is often disregarded in economic models and policy recommendations.
- At the same time, this sector has high inertia because decisions to early-scrap infrastructure projects are not easy to make, and policy and fiscal reforms that would help the sector adapt are rarely made on time. Thus, economic models should include both dynamics to make better informed policy recommendations.
- A large volume of stranded assets will be created if we are to stabilize warming below 1.5°C (the number of stranded assets will be significant even for a 2 °C target). More importantly, stranded assets will not be limited to old and polluting infrastructure but will also include future capacity additions that are currently in the plans of investors. Thus, both investors and policy makers will need to reassess their investment plans. Extending the operating generators lifetime instead of investing in new plants to meet growing demand in the short term can help avoid carbon lock-in by new investments.
- Developing countries are unlikely to have the luxury to strand assets. Other technologies, such as carbon dioxide removal technologies, could be a solution to keep global warming under control while allowing developing countries to pursue their economic growth.

## Parallel Session D2

### Adaptation and Flooding

#### Session Details

Session Chair:	<b>K. Vijaya Lakshmi</b> , Development Alternatives
Presenters:	<b>Robert J. Nicholls</b> , University of Southampton <i>Global Investment Costs for Coastal Defense Through the 21st Century</i>
	<b>Xi Hu</b> , University of Oxford <i>The Spatial Exposure of China's Infrastructure System to Flooding Risks in the Context of Climate Change</i>
	<b>Xavier Espinet Alegre</b> , World Bank <i>Prioritization of Road Interventions in Nampula and Zambezia, Mozambique under Changing Flood Risk and Other Deep Uncertainties</i>
Discussant:	<b>Jaco Tavenier</b> , Organisation for Economic Co-operation and Development

#### Session Highlights

- The estimates of investment needs in coastal protection infrastructure keep increasing over time, as new assessments revise assumptions on costs and sea level rise. However, the total amount of money that will need to be spent on coastal protection infrastructure over the course of the 21st century is mostly driven by maintenance costs of current protection infrastructure rather than capital investment in new infrastructure – even if new infrastructure is of course needed for protecting developing countries against sea level rise. Governments need to, but often do not, put aside money to maintain sea walls on a yearly basis.
- Under a worst-case climate change scenario, most of China's existing infrastructure in secondary and tertiary cities, and connections between the cities, would be exposed to an increasing risk of flooding. This implies that the existing infrastructure needs to be better protected and that future infrastructure needs to consider flood risk in the preparation and design of the projects.
- In Mozambique, uncertainty is a major issue in the planning process for transport investments, because of climate change but also because of uncertain economic growth and agricultural and industrial development. To plan for more robust investments, new techniques that use network-level analysis and decision making under deep uncertainty can be used in the economic analysis of projects.
- The maintenance of infrastructure is clearly critical for resilience. There are new contracts, like Performance-Based Contracts, that can be used in situations where the client is not able to commit the necessary funding over time to maintain the infrastructure.
- In the face of uncertainty, it is important to adopt strategies that are adaptable and prevent lock-ins, and to focus on learning. For instance, hard infrastructure for coastal protection might not be a good solution because it creates a false impression of safety and a lock-in, which can increase coastal risk after 2100 when sea level keeps increasing to unmanageable levels.

## Parallel Session D3

### Implementing Sustainable Infrastructure (Policy Session)

#### Session Details

Session Chair	<b>Alexandra Oppermann</b> , Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH
Presenters	<b>Maria Cecilia Ramirez</b> , Inter-American Development Bank <i>Lessons from Four Decades of Infrastructure Project Related Conflicts in Latin America and the Caribbean</i>
	<b>Michael Mullan</b> , Organisation for Economic Co-operation and Development <i>Climate-Resilient Infrastructure: Getting the policies right</i>
	<b>Raffaello Cervigni</b> , World Bank <i>Enhancing the Climate Resilience of Africa's Infrastructure (Transport)</i>

#### Session Highlights

- Substantial regulation is required to ensure that infrastructure projects are climate resilient and environmentally and socially sustainable. This includes sectoral regulation, implementation of national and international regulatory frameworks and resiliency standards, and mechanisms for community engagement. Government regulatory capacities need to be developed through the provision of guidelines, training, technical support, and best practices for climate risk accounting and disclosure, community consultation, and integration of climate resilience into policy and infrastructure project design.
- Community support is key to implementation of sustainable infrastructure. To avoid conflict and ensure community support, governments should develop systems for community engagement and equitable project benefit distribution; developers should allocate time and resources to community consultation; investors should provide incentives for ensuring community engagement and support.
- Upstream planning is required to avoid project-related conflict and for the design and implementation of community-supported and effective climate resilient infrastructure projects; monitoring is required throughout the entire project life cycle.
- Investment flows drive sustainable infrastructure and can help avoid project-based conflict; investors have a key role to play in providing incentives for implementation of climate resilient, community-supported sustainable infrastructure projects.
- It is possible to make decisions under uncertainty, and several decision-support tools are currently available. Smart decisions around sustainable infrastructure implementation can deliver substantial social, economic and environmental benefits, including through avoided conflict and lower lifetime costs and down time.

## Plenary

# Sustainable Finance & Viable Investments: Where the Twain Shall Meet

### Session Details

Session Chair **Jordan Schwartz**, Infrastructure, PPPs and Guarantees, World Bank

Presenters **Maria Eduarda Gouvea Berto**, Secretary of Finance, Municipality of Rio de Janeiro, former Managing Director, Estruturadora Brasileira de Projetos (EBP)

**Nick Robins**, Co-Director, Inquiry into the Design of a Sustainable Financial System, UN Environment

**Leonardo Martínez-Díaz**, Global Director, Sustainable Finance Center, World Resources Institute

**Jim Hempstead**, Managing Director, Moody's Investors Services

**Sarah Slusser**, Managing Director at Point Reyes Energy Partners LLC



### Session Highlights

- Rating agencies like Moody's only consider "material risk factors" when assessing an issuer's credit worthiness. They think carefully about how to assess environmental, social, and governmental factors, and policy changes around carbon remain a significant risk for unregulated issuers. Climate-related and environmental risk factors are most likely to be material for companies that are directly impacted. For example, the US company Entergy New Orleans has very strong financials but, as a utility in a region prone to climate-related natural disasters, it is not rated highly. For other issuers, especially those that are not directly affected by climate or environmental factors and have a strong overall ability to adapt to new risks due to liquidity, sound management, credibility, underwriting,

and so on, then climate or environmental factors do not make a material difference to their credit worthiness. It is assumed that these issuers will be able to adapt to the long-term impacts of climate and environment-related risks. Rating agencies do not yet consider material the possibility of a catastrophic exit out of fossil fuels by a large number of institutional investors.

- Energy markets are showing very optimistic trends for investment in renewable energy in OECD and emerging economies. This is due to rapid innovation in the tech sector, successful structuring of utilities by governments, and low-cost financing from institutional investors for new renewable energy installations. Bid prices for new projects continue to fall each year. Challenges remain around intermittency and making these markets more attractive in developing countries.
- Despite optimistic trends in energy markets, there is widespread concern that they are not enough to meet the climate challenge or a number of other Sustainable Development Goals by 2030. Much greater investment and better policy support are needed. An effective carbon price is the first-best scenario, which could be accomplished most easily by levying a tax on the leading emitters and forging a political deal that returns the tax revenues in the form of rebates or compensation.
- In developing countries, rating agencies like Moody's generally downgrade utilities, municipalities, and state-owned enterprises due to a range of issues. As a result, financing is more expensive in the places where it is generally acknowledged to be most needed for combatting climate change and achieving sustainable development. To improve these ratings, a number of "ingredients" are needed: (1) sound regulatory microeconomic environments; (2) capacity-building in order to improve local credit markets; (3) concessional finance; and (4) de-risking or risk-sharing instruments. Some innovative companies are also designing new ways to leapfrog existing institutional infrastructure in order to provide lower cost distributed renewable energy where it is needed most.

## Contest winners

In recognition of outstanding research presented at the conference, three awards were presented. The winners of the awards were determined based on voting by conference participants.

The award for **Best Paper Overall** was presented to Jörg Peters, RWI-Leibniz Institute for Economic Research and University of Passau for his paper “Demand for Off-grid Solar Electricity: Experimental Evidence from Rwanda”.

The award for **Most Impactful Research** was presented to Catherine Wolfram, Haas School of Business at the University of California, Berkeley for her research on “Energy and Development”.



The award for **Best Presentation** was presented to the three speakers in the Water Plenary:

- Mushfiq Mobarak, Yale University, for his presentation of the paper “No Sh\*t: Demand Estimation with Strategic Complementarities with an Application to Sanitation in Bangladesh”
- Edward Glaeser, Harvard University, for his presentation of the paper “Water, Health and Wealth”
- Richard Damania, World Bank, for his presentation of the paper “Uncharted Waters: The economics of water scarcity and variability”.

