# India's 2050 low-carbon pathways – *outcomes from workshop held in New Delhi on 10 June 2013*

## AVOID:

Avoiding dangerous climate change

AVOID is a DECC/Defra funded research programme led by the Met Office in a consortium with the Walker Institute, Tyndall Centre and Grantham Institute

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# India’s 2050 low-carbon pathways

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## Context and background to the workshop

AVOID[1] is a UK-government funded research programme which addresses three questions:

1. What levels of climate change are potentially dangerous?

2. What emissions pathways will avoid dangerous climate change?

3. What is the feasibility of such pathways?

The programme has produced several studies on the basis for, and implications of, a range of climate targets, and potentially dangerous regional impacts and feasible emissions reductions more generally. As part of analysing the third question on the feasibility of pathways, the Grantham Institute for Climate Change at Imperial College London, in partnership with University College London’s Energy Institute, undertook a study[2] in 2012 to examine India’s potential low-carbon energy system transition to 2050.

The Grantham Institute and The Energy and Resources Institute (TERI) of India subsequently co-hosted a workshop in New Delhi on 10th June 2013, attended by about 50 people representing businesses, NGOs, academic institutes and government. The workshop was used to present different research groups’ analysis on long-term low-carbon pathways in India, and to draw out key issues for future research. All material from the workshop, including background reading, presentations and a note of the discussions, has been made available online[3] and disseminated to attendees. This short note summarises the main presentation and discussion points, and proposed research directions that follow from these.

## Summary of workshop presentations and discussion

### Session 1: Introduction and context-setting

Dr Dan Bernie of the UK Met Office, and a scientist on the AVOID programme, presented a summary of the programme’s key findings, which highlighted that an increase in global average surface temperature of around 4°C will lead to large impacts on people, infrastructure and natural systems, though precise numbers remain uncertain. The benefits of mitigation can be quantified, indicating that a sizeable fraction of impacts can be avoided. In addition, for those impacts not avoided, mitigation effort provides the added benefit of extra time to adapt. Limiting global warming to 2°C is possible from a climate system perspective – it requires early peaking of emissions and rapid emissions reductions. However, it appears extremely challenging from a technological, economic and political perspective, requiring a portfolio of technologies with RD&D in key areas, including carbon capture and storage (CCS), low-carbon vehicles, advanced fuels, energy storage, and potentially also negative emissions technologies (such as bio energy with CCS). The AVOID programme has analysed the specific potential climate impacts in India, as part of its series of country reports, compiled for the 17th Conference of the Parties at Durban, in 2011[4].

Dr Jan Kiso of the UK’s Department of Energy and Climate Change (DECC), presented an overview of the DECC 2050 Pathways calculator[5], setting out the ways in which this tool has helped make more transparent the energy choices available to the UK in the face of its commitment to meet an 80% reduction in greenhouse gas (GHG) emissions by 2050. The tool considers the energy system to 2050 because many energy assets (e.g. power stations) have lifetimes of many decades, and therefore if they are built today, they could still be operating by 2050. Hence, a long-term perspective is required. A number of other countries have developed – or begun developing – their own calculator, including China, Belgium, South Africa and India, and this sort of transparent analysis is becoming an increasingly prominent tool to help increase public engagement and aid decision-making.

### Session 2: India's low-carbon pathways to 2050

Dr Amir Bazaz of the Indian Institute of Management (IIM), Ahmedabad, Mr Ajay Gambhir of the Grantham Institute for Climate Change, Imperial College London, and a scientist on the AVOID programme, and Dr Atul Kumar of TERI presented on their institutes' studies on the potential for India to significantly decarbonise its energy system to 2050. The studies all used the MARKAL-TIMES family of energy-technology models, which incorporate socio-economic and energy technology cost assumptions to calculate the cost-optimal energy technology mix across the energy supply and demand sectors, given specified future emissions levels. The studies used a range of growth rate assumptions, technology cost estimates and future emissions levels. Nevertheless, all of the studies indicated that – in order that India's future energy demand can be met in a low-carbon way - there would be a central role for the decarbonisation of the electricity sector, in conjunction with increased electrification of industrial and residential heat and transport. The studies also highlighted the critical role for energy efficiency across all sectors of the economy.

Electricity decarbonisation would come from switching away from coal-fired power generation towards a broad mix of technologies which include renewables (wind, solar, hydro, bioenergy), nuclear, and in some scenarios carbon capture and storage (CCS). All of the studies indicated a much smaller role for fossil fuels in the future energy mix, which could benefit energy security. In addition, the TERI and IIM Ahmedabad studies showed the additional benefits to local air pollution of switching away from fossil fuel technologies. All presentations highlighted the need for further research and consideration of policy frameworks including how to support and deploy the low-carbon technologies, as well as further consideration of infrastructure, land use, water, planning and developmental issues.

### Session 3: Panel discussion on India's low-carbon opportunities and challenges

This session saw a panel discussion, with representatives from the Indian Planning Commission, TERI, Tata, the National Institute of Advanced Studies (NIAS) and Schneider Electric discussing key challenges and opportunities for India in moving towards a low-carbon development pathway. The major discussion points have been grouped into four broad areas worthy of further, more detailed research:

*Urban development and planning:*

- A significant quantity of new buildings and infrastructure will be required in India's development, which means there is a big opportunity for low-carbon infrastructure.
- Major urban developments already underway (such as around the Delhi-Agra superhighway and the Mumbai-Bangalore corridor) create a danger that unplanned, rapidly developing cities and towns have a large environmental impact. There is a need for careful planning of low-carbon urban developments.
- Planning should include a consideration of how land is used effectively given competing demands for agriculture, bio energy, and water usage.

*Effective integration of new, variable output renewable electricity generation sources:*

- If India has large penetrations of renewable electricity generation sources (as indicated by all low-carbon scenarios presented), then there will need to be adequate transmission and distribution to connect them to the grid, and/or storage in order to help match supply with demand. For example, in Karnataka, there is insufficient renewable capacity to meet the demand for electricity, whilst in neighbouring Tamil Nadu, there is a large capacity of wind not connected to the grid.
- Pumped hydro provides a possible solution in terms of storage, but this technology has the same environmental hurdles as other hydro power, and the economics are questionable.
- The large potential for solar, which is a prominent source of power generation in all low-carbon scenarios presented in the 2050 pathways session, needs to be supported by adequate storage in off-grid settings. Battery storage is still a cottage industry, and the government doesn't have a national programme targeting the development of storage, with no major R&D effort. By contrast, China is now forging ahead with MWh-scale storage. In addition, India is in danger of failing to develop a successful indigenous programme of solar PV module manufacturing, given competition from overseas (especially China).
- There is a large potential for providing off-grid electricity access using other means than solar – for example there are 4.5 million biogas plants but the potential for much more.
- Smart meters and grids could be implemented, with appropriate infrastructure (including net metering) and also a strong commercial signal, which is difficult at a time of subsidised electricity prices. There is currently no framework to recognise the value of "negawatts" as in the USA.

*Water, land use and energy planning interdependencies:*

- Many new energy plants are sited in increasingly water stressed areas. Land is another limiting issue - there have been examples where nuclear power stations have seen the size of their exclusion zones halve as a result of land pressure.
- Site selection procedures do take water and land resources into account, but given the length of power plant lifetimes, it is important to consider how these resources will change over many years.
- It is complex but necessary to optimise plant siting, taking into account the length and cost of transmission, factors such as proximity to imported fuel (e.g. coal), and the availability of water.
- Water is a key issue for concentrated solar power (CSP), which has a relatively high level of water consumption per MWh generated, compared to other power generation technologies. This could cause barriers to deployment in states such as Rajasthan, which has abundant solar resource but where water is scarce.

*Policy design:*

- There are a number of national missions covering many energy areas. However, several areas lack adequate policy support (for example R&D into storage).
- It is important to consider the impact of low-carbon energy costs on consumer prices, especially given poverty levels and the need to achieve commercial competitiveness.
- There are many challenges to realising low-carbon energy including financing low-carbon technologies which are currently more expensive than fossil fuel alternatives, and designing policies to overcome behavioural barriers to energy efficiency (especially when many people's electricity costs are subsidised).

## Proposed further research directions

As a result of the presentations and discussions described above, it is apparent that India faces a number of opportunities and challenges in developing and deploying low-carbon technologies and measures. Future research to better understand how to address these includes:

- Planning of new urban infrastructure, to ensure that rapid urbanisation occurs without lock-in to a high carbon transport, buildings and industrial system. This will require the modelling and design of best-practice urban formats to maximise public transportation, low-carbon vehicle infrastructure (such as electric charging points), energy efficient buildings using low-carbon heating, and industrial plant positioning in order to maximise re-use of waste heat (in either district heating or other industrial processes). Such planning should also take into account the availability of land, water, and other resources that will impact on the appropriate choice of energy technologies and infrastructure deployed.
- Research into how to manage the intermittency of renewable energy generation to optimise supply-demand matching, considering the costs and benefits of grid/off-grid power generation sources, storage, smart metering and smart grid solutions. This research requires specific spatial and temporal modelling of different electricity supply and demand configurations, projections of power generation and storage technology costs, and consideration of future daily and seasonal electricity demand profiles in different (urban and rural) areas.
- Detailed research at the sub-national (e.g. state) level into the choice of appropriate low-carbon energy technologies to meet future energy demand whilst taking into account current and future availability of water, land and other resources. This will be a particularly important consideration for bio energy, where planning around the water, land and transport infrastructure needs will be critical.
- Choice and design of policies which effectively incentivise the development and deployment of low-carbon energy technologies, with a view to minimising costs (e.g. by driving down technology costs and by maximising energy efficiency) and realising co-benefits such as increased energy access, reduced energy imports, and reduced local air pollution.

## Endnotes

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[1] Details of the AVOID programme and outputs available at: www.avoid.uk.net

[2] Gambhir, A., Anandarajah, G., Napp, T., Emmott, C., 2012. *India's $CO_2$ Pathways to 2050*. AVOID report WS2D1R41.available online at: http://www.metoffice.gov.uk/media/pdf/0/c/AVOID_WS2_D1_41_India_2050_30-10-2012.pdf

[3] Web link to the workshop description and background material at: http://www3.imperial.ac.uk/newsandeventspggrp/imperialcollege/naturalsciences/climatechange/newssummary/news_20-6-2013-13-36-23

[4] Links to all country reports available at: http://www.metoffice.gov.uk/climate-change/policy-relevant/obs-projections-impacts

[5] More information on the DECC 2050 Pathways calculator available at: https://www.gov.uk/2050-pathways-analysis