



Approaches to low carbon development in China and India

Shailly KEDIA^{a,b,*}

^a The Energy and Resources Institute, New Delhi 110003, India

^b Jawaharlal Nehru University, New Delhi 110067, India

Received 17 June 2016; revised 15 October 2016; accepted 28 November 2016

Abstract

Low carbon development has gained policy prominence and is a concern of both environment and development policy globally and in China and India. This paper discusses the role of China and India as important global actors in light of development imperatives in the two countries. The article then looks at emerging approaches in the two countries related to financing, science, technology & innovation policy, and sub-national actions. The objective is to review efforts in China and India for contributing to learning experiences for other countries. The final section discussed the ways forward in terms of examining the role of China and India in terms of national policy strengthening as well as in global agenda setting. Implementation of sub-national initiatives in both countries faces challenges due to lack of adequate financing as well as knowledge such as greenhouse gas inventories and disaggregated resource and socio-economic assessments. Both India and China are making efforts in technology and innovation domains to set foot on a trajectory of low carbon development with varying degrees of success. In finance, both China and India have experimented with various instruments—the key difference is that China has taken the support of regulation more while India has leaned on to market based instruments. Both China and India are moving on an encouraging track regarding low carbon development with fairly well-designed domestic policies and consistent international engagement.

Keywords: Low carbon development; China; India; Sustainable development; Climate change

1. Introduction

In an era where climate change has been acknowledged by the scientific community (IPCC, 2014), low carbon development has gained policy prominence and is a concern of both environment and development policy. The European Union (EU) was an early advocate of ‘low carbon economy’. A 2003 white paper titled, ‘UK energy white paper: Our energy future—creating a low carbon economy’ by the Department of Environment, Food and Rural Affairs (DEFRA), was

presented to the Parliament by the Secretary of State for Trade and Industry by Command of Her Majesty. The paper describes ‘low carbon economy’ as being characterized by higher resource productivity—producing more with fewer natural resources and less pollution—and contributing to higher living standards and a better quality of life (DEFRA, 2003). In climate change negotiations, the EU advocated the concept of ‘low carbon pathways’ to growth with an implied peaking point for carbon emissions.

China and India as developing countries have redefined the low carbon approach with the view of emphasizing harmony with the over-riding priority of poverty eradication and sustainable development. In China, the National Development and Reform Commission (NDRC) describes low carbon development as the development of the socio-economic system that can realize low carbon emissions. India's National Action Plan on Climate Change (NAPCC) highlights the co-benefit approach for low carbon activities that could in turn ensure energy security, reduced local pollution, and increased

* The Energy and Resources Institute, New Delhi 110003, India.

E-mail address: shailly.kedia@gmail.com.

Peer review under responsibility of National Climate Center (China Meteorological Administration).



Production and Hosting by Elsevier on behalf of KeAi

<http://dx.doi.org/10.1016/j.accre.2016.11.001>

1674-9278/Copyright © 2016, National Climate Center (China Meteorological Administration). Production and hosting by Elsevier B.V. on behalf of KeAi. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

access to energy through distributed and decentralized forms of energy systems (GoI, 2008).

This paper will first discuss the role of China and India as important global actors. The paper will then look at emerging approaches in the two countries related to financing, science, technology & innovation policy, and sub-national actions. The objective is to review efforts in China and India as these contribute to learning experiences for other countries around the world. The final section will discuss the ways forward in terms of examining the role of China and India in terms of post-2015 climate and development actions.

2. China and India as important global actors

The sustainability of development patterns followed by India and China has significant socio-economic and environmental implications for the two countries (CAEP-TERI, 2011). India and China, which together account for about 36% of the world's population, are responsible for more than 1/4 of the world's demand for primary energy, and about 1/3 of the world's CO₂ emissions. Both these countries are also witnessing structural shifts in their economies with an increasing share of Gross Domestic Product (GDP) coming from the services and manufacturing sectors. With India and China staying on their impressive economic growth trajectories, respectively, seen in recent years, their energy demand and CO₂ emissions will continue to grow, and the two countries together will account for more than 50% of the world's incremental energy demand and CO₂ emissions over the next two decades. Hence, in order to stabilize greenhouse gas (GHG) concentrations and achieve the 1.5–2 °C target globally, low carbon transitions in both countries are of significant importance to global efforts on tackling climate change and achieving sustainable development.

Though China's per capita income levels and human development performance is better than India, the two countries still have much ground to cover in terms of their development indicators as compared to the developed countries. Table 1 depicts key socio-economic development indicators for China and India and also shows the performance of the two countries when compared to the EU or Organisation for Economic Co-operation and Development (OECD). In terms of access to electricity, it is seen that China has achieved access to electricity while India still has to make progress with regard to ensuring electricity access to its population. Another area is with regard to non-solid fuel for household energy

usages where both China and India have higher reliance to solid fuels when compared to the EU. China and India have both performed better in terms of improved water source for household. With regard to CO₂ emissions per capita, it is seen that both China and India have lower emissions per capita when compared to the OECD total.

Currently, at the aggregate level, China and India consume about 23.0% and 4.9% of the world's primary energy, respectively. China's primary energy consumption has risen at a compound annual growth rate (CAGR) of 6.3% in 1990–2014 and stands at 2792 Mtoe and was the largest energy consumer in the world in 2014. India's primary energy consumption has risen at a CAGR of 5.4% in 1990–2014 and stands at 638 Mtoe in 2014. In contrast, the world primary energy consumption increased at a rate of 1.94% during the same period (BP, 2015). As can be seen from Table 2, both China and India have high dependency on coal. Both China and India have also seen a high rate in growth of renewables in 1990–2014. It is also important to note that OECD has seen decline in coal and nuclear in 1990–2014.

India's NAPCC was adopted in 2008. NAPCC outlines policies directed at climate change mitigation and adaptation. China's National Climate Change Programme was approved in 2007 and includes measures to strengthen the energy legal system.

In the Twelfth Five-Year Plan, China has, for the first time, set for itself, a carbon-intensity reduction target of 17% by 2015. Similarly, the Government of India, in its Twelfth Five-Year Plan, recognized low carbon development and inclusive growth. Table 3 lists the policy objectives related to low carbon growth in China and India. It is seen that China and India have taken similar approaches at the multilateral foras as well as in domestic areas of action.

For both China and India, issues such as urbanization and industrial policy will continue to be relevant areas of low carbon development policies. The common areas for China

Table 2
CAGR according to fuel consumption (1990–2014)(unit: %).

| | Renewable | Hydro | Nuclear | Coal | Gas | Oil |
|-------------|-----------|-------|---------|-------|-------|------|
| China | 58.07 | 9.27 | 3.91 | 5.65 | 10.82 | 6.57 |
| India | 32.87 | 2.87 | 5.79 | 5.69 | 6.16 | 4.85 |
| OECD | 9.75 | 0.62 | −0.86 | −0.22 | 1.93 | 0.19 |
| Total world | 10.50 | 2.47 | −0.13 | 2.33 | 2.32 | 1.20 |

Note: For nuclear, CAGR is considering the period 2000–2014.

Sources: Based on data from BP (2015).

Table 1
Key socio-economic indicators: China and India.

| Indicator | India | China | Benchmark | Year | Notes |
|---|-------|-------|-----------|------|---------------------------|
| GDP per capita, PPP (constant 2011 international \$) | 5439 | 12599 | 34771 | 2014 | EU as benchmark |
| Human Development Index (HDI) value | 0.61 | 0.73 | 0.88 | 2014 | OECD is used as benchmark |
| Access to electricity (% of population) | 79 | 100 | 100 | 2012 | EU as benchmark |
| Access to non-solid fuel (% of population) | 36 | 55 | 99 | 2012 | EU as benchmark |
| Improved water source (% of population with access) | 94 | 96 | 100 | 2015 | EU as benchmark |
| CO ₂ per capita (t CO ₂ per capita) | 1.49 | 6.60 | 9.55 | 2013 | OECD is used as benchmark |

Sources: World Development Indicators, World Bank, data.worldbank.org; UNDP HDR indicators, <http://hdr.undp.org/en/data>; International Energy Agency, <http://www.iea.org/statistics/statisticssearch/>.

Table 3
Policy objectives and low carbon development in China and India.

| Theme | China | India |
|---|--|--|
| Copenhagen accord target | 40%–45% by 2020 in comparison to 2005 levels | 20%–25% by 2020 in comparison to 2005 levels |
| INDC target (emission intensity) | 60%–65% by 2030 in comparison to 2005 levels | 33%–35% by 2030 in comparison to 2005 levels |
| INDC: peaking | 2030 or earlier | — |
| INDC: non-fossil fuel | Non-fossil fuels in primary energy consumption to be around 20% by 2030 | To achieve 40% cumulative electric power installed capacity from non-fossil fuel based energy resources by 2030 |
| INDC: forestry and land use | To increase the forest stock volume by around 4.5 billion m ³ on the 2005 level by 2030 | Create additional carbon sink of 2.5–3 billion tonnes of CO ₂ equivalent through additional forest and tree cover by 2030 |
| INDC: financing needs | — | US\$ 2.5 trillion (at 2014–2015 prices) will be required for meeting India's climate change actions between now and 2030 |
| National climate policy | China's Policies and Actions on Climate Change (2014) | National Action Plan on Climate Change (2008) |
| Key national agency coordinating climate change | National Strategy for Climate Adaptation The National Development and Reform Commission | National Adaptation Fund Ministry of Environment, Forest and Climate Change |
| Sub-national initiatives | Low carbon Pilot Projects in Provinces and Cities | State Action Plan on Climate Change |
| Emissions/energy trading | Carbon Emissions Trading Pilot Program | Energy Saving Certificate and Renewable Energy Certificates |
| Technology development | China's Science and Technology Actions on Climate Change | Climate Change Centres in states |
| South–South cooperation | Fund for South–South Cooperation on Climate Change | International Solar Alliance |

and India, as clearly communicated in their national policies include renewable energy, energy efficiency in industry, energy efficiency in buildings, transportation and urban development. It is also important to make distinction between countries whose emissions have peaked and performance is assessed in terms of absolute emissions reductions and countries where emissions have yet to peak where performance will be measured through different indicators. Performance of developing and developed countries also takes into account their different capacity and levels of developments, which have already been achieved by developed countries. China and India both being developing countries, like other developing countries, have expressed intention not in terms of absolute emission targets but in terms of their development trajectories. China, with an ageing population, has expressed targets in terms of emission peaking and emission intensity of GDP. India, on the other hand, with a young workforce has expressed targets in terms of emission intensity of GDP.

Apart from similar stances at the domestic and multilateral policy levels, China and India have reaffirmed their commitment to work together on climate change at the bilateral level also. Climate change figured as an important element at high-level bilateral talks during the Chinese President's visit to India in September 2014 and during Prime Minister Modi's visit to China in May 2015. To strengthen the bilateral ties between the two countries the Indian government has set the goal of “INCH (India–China) towards MILES (Millennium of Exceptional Synergy)”.¹ In May 2015, the two countries issued a Joint Statement on Climate Change between the Government of India and the Government of China, promoting

bilateral partnership on climate change and reaffirming their commitment to engage through the UNFCCC process.

In November 2014, United States and China had a joint announcement on climate change which the two countries expressed their intention to reduce emissions in a time-bound manner. United States expressed intention to achieve an economy-wide target of reducing its emissions by 26%–28% below its 2005 level in 2025 and to make best efforts to reduce its emissions by 28%. China intends to achieve the peaking of CO₂ emissions around 2030 and to make best efforts to peak early and intends to increase the share of non-fossil fuels in primary energy consumption to around 20% by 2030. It is observed that, while the United States had emissions reduction target in terms of absolute emissions, China had emission peaking targets as well as targets for enhancing share of renewable energy in the overall energy mix. India on the other hand has also had bilateral agreements with both China and the United States which emphasize on addressing the issue of climate change. Given India's priorities of commercial and other international issues, India's joint agreements have mainly focused on commercial aspects (including commercial aspects of addressing climate change) with China and the United States; India has also focused on international issues such as ‘terrorism’, an example is the “United States–India Joint Declaration on Combatting Terrorism” signed in September 2015. India communicated quantitative targets through the multilateral process of the UNFCCC involving intended nationally determined contributions. It is however clear that both China and India, through bilateral and multilateral forums, have communicated their intention to address the global issue of climate change.

3. Innovative financing mechanisms

The Addis Ababa Action Agenda of the Third International Conference on Financing for Development recognizes that

¹ Transcript of Prime Minister's Interaction with Chinese media organizations, September 16, 2014, Media Briefings, Ministry of External Affairs, Government of India. Available at www.mea.gov.in.

Table 4
Examples of innovative financing mechanisms in India.

| | | |
|---------------------------------------|--|---|
| Public finance and fiscal Instruments | Tax revenue | Coal cess (indirect tax) |
| | Budgetary allocations and fiscal transfers | Annual budgetary allocations, centre-state fiscal transfers |
| Financing platforms | Subsidies | Example include subsidies on solar heaters, electric vehicles, energy efficient appliances |
| | Fiscal instruments | Property tax rebates on green buildings |
| | Special funds/institutions | National Clean Energy Fund, state energy conservation fund, IREDA, sub-national funds |
| | Markets innovations | Indices such as Greenex and Carbonex for Bombay Stock Exchange (BSE) |
| | Traditional market instruments | Green bonds for renewable energy, energy efficiency and green infrastructure projects |
| Risk management | Climate/energy market instruments | Clean Development Mechanism, Renewable Energy Certificates, Energy Saving Certificates |
| | Banking provisions | Special provisions for MSME, priority sector lending norms by the Reserve Bank of India for renewable energy |
| | Risk management mechanisms | The Partial Risk Guarantee Fund under the National Mission on Enhanced Energy Efficiency, Credit Guarantee Fund Trust for Micro and Small Enterprises |
| International sources | Grants | Bilateral and multilateral sources |
| | International climate finance | Green Climate Fund, Adaptation Fund |

Source: Based on Kedia and Jain (2015).

“funding from all sources, including through public and private, bilateral and multilateral, as well as alternative sources of finance, will need to be stepped up for investments in many areas including for low carbon and climate resilient development”. Finance is a very multi-faceted topic in low carbon development which encompasses public finance, banking, and market instruments. In the low carbon development space, financing is arguably the most critical challenge which has been greatly augmented in the wake of serious global macro-economic imbalances. While macro-economic decisions, including banking come from the policy side, finance decisions come from the investment side. Synchronization of macro-economic policy and finance mechanisms for sustainable development has become fairly arduous due conflicting interests. Macro-economic and banking regulations are moving towards safety while there are greater risks² attributed to sustainability projects. This section will discuss emerging practices related to finance in China and India.

3.1. Emerging practices in China

Following the global economic crisis in 2008, many governments announced stimulus measures for their respective governments. These included sets of policies to stimulate the private sector, boost consumer demand for goods and services, and provide greater public investment in various sectors. China's NDRC announced a variety of green stimulus measures. Over one-third of the massive Chinese stimulus package and nearly 27% of the 2009 budget was allocated to green themes, mostly rail, grids, and water infrastructure, along with spending on environmental improvement (Barbier, 2010).

The Chinese government announced its intent to establish domestic emissions trading markets in 2011, and moved quickly to establish seven regional emissions trading schemes: in the provinces of Guangdong and Hubei, and the cities of

Beijing, Tianjin, Shanghai, Chongqing and Shenzhen. The pilot emission trading scheme (ETS) aimed to cover ~700 Mt of CO₂ emissions, which could make China the second-largest carbon trading market in the world. After one year's operation, all pilots basically run smoothly, but still have problems, such as the allowance allocation and the liquidity. Liquidity is another inherent challenge and future of the market is not optimistic. The price ranges between CN¥ 20–90 per ton, the high transaction concentration since most transaction occur in the last month for compliance and the lack of liquidity due to market structure, the scale and the participants' risk appetite are seen as the major challenges.

According to NDRC, a nationwide China ETS would test run was to in 2016, which may be postponed to 2018–2019. At present, China is at an initial stage, learning from pilots. To promote a “top-down” and “bottom-up” dual path, NDRC will set up ETS infrastructure cap setting, allowance allocation, trading infrastructure and a regulatory framework. Some challenges of the sub-national ETS market include lack of historical emission data at an enterprise level, need for third party verification, low market efficiency due to fluctuating prices, and limited³ legal binding force.

As the key intermediary agents of indirect financing, banks are powerful forces to guide economic restructuring in China. China is the first country to establish the green credit policy system. Since 2007, China Banking Regulatory Commission has successively promulgated “Instructions to Energy Saving and Emission Reducing Credit Work” (2007), “Guidance to Green Credit” (2012) and “Instructions on Green Credit Work” (2013), which made rules for the credit extension for energy saving and emission reduction, and policy boundaries, managing styles, institutional arrangement, capacity building, procedure management, internal control, information disclosure and regulatory policies of green credit. These documents put forward not only the definition and key supporting industries of green credit, but also cautious loans to energy

² Also renewable energy or energy efficiency projects can have high initial capital costs which are usually offset by lower operations and maintenance costs.

³ Shenzhen, Beijing and Chongqing passed legislations that fine defaulters. Others do not have a binding legal instrument, rely on government regulations.

intensive and highly polluting enterprises. The policies encourage the establishment and improvement of environment and social risk assessment systems, and the measurement, reporting and verification (MRV) of green credits.

However, green credit still has broad room for development. According to statistics from China Banking Regulatory Commission, in terms of loans, green credits accounted for about 7.2% of the total amount loaned. There is need to further clarify the responsibility of different institutions related to environmental protection, financial regulators and profit-oriented banking institutions in the implementation of green credit policy. Currently the green credit policy is voluntary and market participation need to be enhanced for ensuring binding role of regulations alongside capacity building and internal incentives for banks.

3.2. *Emerging practices in India*

The report of the Expert Group on Low Carbon Strategies for Inclusive Growth by the erstwhile Planning Commission of India in 2014 noted that the shift to low carbon inclusive growth will require an additional investment equivalent to 1.5% of GDP over twenty years from 2011 to 2030, over and above the Baseline Inclusive Growth scenario. It is important to look at various financial mechanisms and the underlying policy environment for low carbon development in India. According to a stakeholder engagement by The Energy and Resources Institute, high cost of financing is the major bottleneck for financing sustainability projects. Also, inadequate subsidies, inadequate mechanisms for supporting low carbon development by financial institutions along with lack of awareness of low carbon projects impede the financial space for low carbon development.

There are various financial mechanisms for low carbon development in India including public finance, traditional finance, risk management instruments, market based tradable instruments, and international sources (Table 4). While there is no domestic carbon market developed in India, instruments such as renewable energy certificates are traded at the Power Exchange India Limited.

Public finance, including greater budgetary allocations, will be crucial in helping stimulate investments for low carbon development in India. Measures by the Reserve Bank of India such as sustainability guidelines for banking will be important. The Reserve Bank of India can play a role for spreading awareness regarding priority sector lending norms relevant to low carbon development among various stakeholders concerned. Also, sectors other than renewable energy which can also contribute potentially towards environmental sustainability, such as buildings, transport, agriculture, industry, waste and forestry should be given due consideration under the banking norms.

4. Science, technology & innovation

Science, technology and innovation (STI) does not follow a linear path that begins with research, moves through the

processes of development, design, engineering, production, and ends with the successful introduction of new products and processes into the market, rather, it is an interactive (and cumulative) process that involves continuous feedback loops between the different stages. Innovation can push the frontier outward and help to decouple growth from the natural resource degradation. Innovation is thus key to developing the low carbon technologies required for transition to a low carbon economy, and make it affordable and accessible. Research and Development (R&D) and innovation activities in many low carbon development related technologies especially related to environment are characterized by low investment and slow diffusion. Incentives for low carbon innovation are further weakened by real and perceived uncertainties about lack of clear direction and policy instruments. It is thus important to understand emerging practices in China and India related to STI.

4.1. *Emerging practices in China*

The Ministry of Science and Technology (MOST) is responsible for R&D in China and is the major funder of public R&D. In 2006, MOST published the National Medium- and Long-Term Science and Technology Development plan⁴ that sets out China's direction for R&D over the period 2006–2020. The plan included the specific target of investing 2.5% of GDP in R&D by 2020 in which developing technologies related to energy and environmental protection were among the top priorities including the development of efficient, clean and near-zero emissions fossil energy and Carbon Capture, Utilization and Storage, as well as other low carbon technologies. Examples of initiatives by MOST related to climate change include National Basic Research Programme on climate change and Global Change Research. Apart from MOST, other key organizations in China that have been promoting and financing basic research and applied research related to climate change include the National Science Foundation of China (directly affiliated to the State Council) and the Chinese Academy of Sciences.

Key policies that guide China's science technology and innovation systems include:

- National Medium- and Long-Term Program for Science and Technology Development (2006–2020) by State Council, 2006
- China's scientific actions on climate change, by MOST, 2007
- Twelfth National Scientific and Technological Plan on Climate Change by MOST, May 2012
- Work plan for Twelfth Five-Year National GHG Control by State Council, 2012
- S&T roadmap of China's CCUS development by MOST/ACCA21, 2011

⁴ See http://english.gov.cn/2006-02/09/content_183426.htm.

Table 5
Batches for low carbon pilots in China.

| Batch | Year | Province | City |
|---------|------|---|--|
| Batch 1 | 2010 | Guangdong, Liaoning, Hubei, Shaanxi, Yunnan | Tianjin, Chongqing, Shenzhen, Xiamen, Hangzhou, Nanchang, Guiyang, Baoding |
| Batch 2 | 2012 | Hainan | Beijing, Shanghai, Shijiazhuang, Qinhuangdao, Jincheng, Hulunbuir, Jilin, Daxing'anling, Suzhou, Huai'an, Zhenjiang, Ningbo, Wenzhou, Chizhou, Nanping, Jingdezhen, Ganzhou, Qingdao, Jiuyuan, Wuhan, Guangzhou, Guilin, Guangyuan, Zunyi, Kunming, Yan'an, Jinchang, Urumqi |

- Special Plan for CCUS technology development by MOST, 2013

Some specific projects related to R&D in low carbon development include industrial energy-saving technologies and equipment for key industries, renewable energy and new energy development and utilization of technology, technologies of the smart grid, and low carbon economy of industrial development model and the integrated application of key technologies. Examples of dedicated initiatives in China on low carbon technology demonstration and deployment are also in place.

An example of an initiative in market based demonstration and deployment is for electric vehicles, LED bulbs and photovoltaic industry. “10 Cities, 1000 Vehicles” initiative is for energy-saving and new energy vehicle demonstration and extension of the pilot has been increased to 25 in 2010. “10 Cities, 10000 Lamps” is for LEDs and in the year 2010, there are more than 1.6 million LED lamps light applied in 21 pilot cities, saving more than 164 million kWh. “Golden Sun” initiative involves using a combination of financial assistance, technology support, and market driven approach to accelerate the development of photovoltaic industry.

The government in China is currently undertaking reforms of its STI systems to increase efficiency of input and maximize the use of funds. A council—with representatives from agencies such as MOST, MOF, NDRC—will be established to oversee fund allocation, aiming to increase communication among government sections.

4.2. Emerging practices in India

The Science, Technology and Innovation Policy of India, 2013 prepared by the Ministry of Science & Technology (MST), recognizes the role of STI system in the NAPCC. The document states that the STI system will “serve as a source of strategic knowledge to cope with the challenges of climate variability and change as well as to meet equity-based differentiated and shared responsibilities of India”.

According to the stakeholder consultation by TERI, adaptation of imported technology to suit the local conditions emerged as an important aspect with regard to the transport, building and waste sector. Indigenous R&D and technology development was considered to be crucial for low carbon development in the agriculture sector. Technology demonstration has been perceived as the most important in the renewable energy, industry and non-renewable energy sector.

The Department of Science & Technology, Ministry of Science & Technology has been entrusted with the responsibility of coordinating two out of eight national missions launched under the NAPCC. These are National Mission for Sustaining Himalayan Ecosystem (NMSHE) and National Mission on Strategic Knowledge for Climate Change (NMSKCC). A brief description⁵ of mission objectives is now discussed.

The NMSKCC has been launched with the broad objectives of mapping of the knowledge and data resources relevant to climate change and positioning of a data sharing policy framework for building strategic knowledge among the various arms of the Government. The mission envisages international cooperation on S&T for climate change agenda through strategic alliances and assistance to the formulation of policies within a responsive climate change framework and inputs to the Ministry of Environment and Forests and Ministry of External Affairs. Various arms of the Government have already earmarked large resources for climate change related actions leading to the development of strategic knowledge. Within the Ministry of Science and Technology and Earth Sciences such allocations are estimated over INR 2500 crores.

The broad objectives of NMSHE include understanding of the complex processes affecting the Himalayan Ecosystem and evolve suitable management and policy measures for sustaining and safeguarding the Himalayan ecosystem, creating and building capacities in different domains, networking of knowledge institutions engaged in research and development of a coherent data management systems. The government has created a fund of approximately INR 1650 crores for developing capacities for Sustaining Himalayan Ecosystem to serve the activities during the Eleventh and Twelfth Plan periods.

Linkages between different ministries such as human resource development, environment and finance among others, segments of the decision making fraternity of STI policy within India is lacking and needs to be established for low carbon development and innovation. Moreover there is a need to strengthen programmes related to demonstration and deployment. Transition to a sustainable development pathway could be accelerated by incentives through a national directive for R&D in low carbon development, setting up of low carbon technology incubation centres with strong industry—academia—government linkages, facilitation of technology

⁵ Climate Change Programme, Department of Science & Technology; Available from <http://www.dst.gov.in/climate-change-programme>.

transfer through existing and new technology transfer offices, a focus on low carbon innovations in the informal sector, among others. A clear vision and prioritization for R&D for development of low carbon technology need to be determined through structured analysis. This could be facilitated by using the tools of technology foresight, technology road-mapping, technology assessment and evaluation.

5. Sub-national actions

According to UNDP (2010), around 50%–80% of the investments for GHG mitigation (and up to 100% for climate change adaptation) happen at the sub-national and local levels. Regional and local governments lead the implementation of policies, programmes and fiscal instruments ‘in the areas of generation, supply and distribution of electricity, the regulation of the built environment, waste management, transport and land-use planning’. Engaging sub-national and local actors in climate action could promote cross-sector policy interventions and create ‘role models’ which could be replicated/up-scaled at the domestic and global levels. Further, in light of the wide socio-economic and climate-geographic variations across different regions, the relevance of active involvement of sub-national regions in policy formulation increases manifold. Sub-national regions can also differ in terms of mitigation potential and capacity, making it imperative in both China and India, that a more decentralized, bottom-up climate policy making, resulting in actions customized to local contexts and needs, drives national responses to climate change.

5.1. Emerging practices in China

In July 2010, the NDRC initiated a low carbon pilot province and city program including five provinces (Yunnan, Guangdong, Hubei, Shaanxi, and Liaoning) and eight cities (Tianjin, Baoding, Hangzhou, Chongqing, Nanchang, Guiyang, Xiamen and Shenzhen) across the country. In November 2012, another 29 provinces and cities have been selected as the second batch of low carbon pilots. All these pilot cities and provinces occupy 57% of China's GDP, 42% of China's population and 56% of energy related CO₂ emissions. Table 5 shows the two batches for low carbon pilots in China.

The pilot cities and provinces were expected to develop and propose a low carbon development plan, formulate supportive policies for low carbon green growth, establish low carbon industrial systems, establishing GHG emission statistics and data management systems, and encourage low carbon lifestyle and consumption patterns. Provinces/cities are given flexibility in setting sectoral priorities as well as target setting in terms of carbon emission target, carbon intensity, energy intensity, or peaking.

According to the performance evaluation conducted by the NDRC in 2013 of the target responsibility system for curbing the GHG emissions in 2012, the carbon intensity in the 10 pilot provinces and cities dropped by nearly 9.2% in 2012 compared with 2010, higher than the decline on the national

level (NDRC, 2014). In addition, Guangdong, Hubei, Beijing, Tianjin, Shanghai and Yunnan provinces have surpassed their target in 2012 and the cumulative amount prescribed in the Twelfth Five-Year Plan. Other pilot regions have performed better in reducing carbon intensity than regions without similar conditions. While there is need for further strengthening of decision-support systems and financial systems, China's low carbon pilots are an important step in the right direction for integrating low carbon development planning at sub-national levels in accordance with local conditions to enable technological leap-frogging along with sustainable development.

5.2. Emerging practices in India

In June 2008, India launched its NAPCC that encompasses a multi-pronged, long-term and integrated framework for addressing climate change as a core development issue. In its eight missions, the NAPCC proposes an extensive range of measures focussing on renewable energy, energy efficiency, clean technologies, public transport, resource efficiency, afforestation/reforestation, tax incentives and research, and generation of strategic knowledge. As a corollary to NAPCC, in August 2009, the Prime Minister of India directed all the states to formulate their respective State Action Plan on Climate Change (SAPCC), guided by and consistent with the structure and strategies of the NAPCC. The individual SAPCCs should lay out sector-specific as well as cross-sector time-bound priority actions in light of state-specific risks, impacts and opportunities besides prioritizing areas for research and policy action in response to current and future vulnerabilities and projected impacts. The SAPCCs should also list indicative budgetary requirements, supplemented with details of the necessary institutional and policy infrastructure to support the operationalization of actions.

As of March 2016, the Ministry of Environment, Forests and Climate Change (MoEFCC) has endorsed 30 state action plans. As the next step, the SAPCCs endorsed by the National Steering Committee on Climate Change (NSCC) will be considered for integration in the respective state annual development plans and will seek financial support through various sources such as the Niti Ayog, MoEFCC and other national ministries and agencies.

Generally, the preparation of SAPCCs in India has witnessed line departments providing primary inputs to the nodal department (often the environment department), which in consultation with technical experts has sought to develop a coherent policy document. Cross-department integration of strategies has been attempted in varying ways: while in some states, presentation of the SAPCC before a high-level Committee of Secretaries has enabled quick iteration and consensus-building, in others, the process has been tedious and often superficial due to lack of funding.

In the state-specific SAPCCs, each state has come out with its own agenda of activities to address issues related to climate change in specific sectors in a manner that these activities also align with the eight missions listed under the NAPCC.

However, the implementation of the SAPCCs is still in early stages—it is perceived that the progress of states towards achieving the goals listed in SAPCCs is likely to face challenges due to lack of adequate financing available for specific targets.

For strengthening the implementation of the State Action Plan on climate change data management systems around GHG inventories will need to be strengthened. To be better able to implement the SAPCCs, synergies between central expenditure and state finances and actions needs to be explored. The lack of adequate financing for the well-written SAPCCs also highlights the need for appropriate institutional mechanisms which can support centre-state disbursements of public funds. Especially for sectors like improving energy efficiency and promoting renewable energy, involvement of private sector funding needs to be encouraged. Most importantly, given the cross-cutting cross-sectoral nature of climate actions, it is essential to have a powerful coordinating government agency (perhaps associated with the Chief Minister's Office or Chief Secretary's Office), which can coordinate across different line departments.

6. Discussion

Globally, there is an increasing awareness of the need to move away from a carbon-intensive development model. This, however, requires fundamental policy changes in key sectors of the economy including, but not restricted to, the energy sector. For China and India, beyond the energy sector, factors such as overall level of development, governance structure and vulnerability to climate change will also determine a country's targets and strategies. There is no single low carbon development blueprint that can be universally applicable.

From the examples discussed in the preceding sections, it is clear that China and India have taken efforts to operationalize low carbon development strategies in areas of finance, innovation policy and sub-national actions.

In finance, both China and India have experimented with various instruments such as guidelines, regulation, special funds and market based instruments—thus offering a rich experience to other countries who are now formulating initiatives for low carbon development. The key difference in approach is that China has taken the support of regulation along with market transformation while India has leaned on to mainly market based instruments. Both countries have also used fiscal instruments and public finance allocation. In future, China and India will both have to play a leadership role to push the sustainable development community as a whole to recognize the importance of engaging with global financial regulatory frameworks such as the Bank for International Settlements, International Monetary Fund and International Accounting Standards Board. Moreover, China and India will both have to voice for a more effective international finance architecture. While international climate finance has sought to leverage and attract private finance, according to Climate Funds Update, as of the beginning of 2012, globally, for every US\$ 1 spent between 2010 and 2012, only US\$ 0.25 of private

finance had been drawn (ODI, 2013). Green Climate Fund should be able to boost this gap.

In terms of innovation policy, differences between developed and emerging world markets are leading to reinvention of products and reduction of costs and have fostered innovation in distribution, commercialization, and marketing chains in countries like India and China. Both India and China are making efforts in technology and innovation domains to set foot on a trajectory of low carbon development with varying degrees of success. According to the Paris Climate Agreement,⁶ global technology mechanisms and the Climate Technology Centre and Network will need to be further strengthened to further work relating to technology research, development and demonstration, and for enhancement of endogenous capacities and technologies. To further climate actions in the post-2015 climate and development agendas, it will be vital that China and India, based on domestic experiences, play a role in global agenda shaping. China and India can give impetus to through national directives for R&D in low carbon development, setting up of low carbon technology incubation centres with strong industry–academia–government linkages, facilitation of technology transfer through existing and new technology transfer offices (TTOs), a focus on low carbon innovations in the informal sector, among others.

In terms of sub-national actions, both China and India have experimented with different implementation frameworks—low carbon pilots for China and the SAPCCs in case of India. However, the implementation of sub-national initiatives in both countries face challenges due to lack of adequate financing as well as knowledge such as GHG inventories and disaggregated resource and socio-economic assessments. The scientific basis of sub-national actions in both China and India need strengthening. With regard to policies for incubation and knowledge sharing, there are learning for other countries from the experiences of China and India. In terms of implementation, it will not be exaggerating to say that climate actions at sub-national (local, state/province, agro climatic regions) will contribute to climate change mitigation and adaptation. In the post-2015 climate and development agendas, the main theatre of actions will be at sub-national and local levels. It will be crucial to see how China and India strengthen engagement and capacity at all levels—global, national and sub-national.

Both China and India are moving on the right track regarding low carbon development with strong political willingness, fairly well-designed domestic policies, and consistent international engagement. The key to China's and India's low carbon technology future is through innovation, development, and commercialization of new technologies and focusing on indigenous solutions. In addition, technology transfer from developed countries and joint R&D with developed countries can also help the two countries leapfrog to cleaner development patterns and become leaders in rapidly emerging economic sectors like renewable energy. However, both China and

⁶ Para 67 of FCCC/CP/2015/L.9/Rev.1.

India need to overcome a series of social and economic barriers in order to achieve a low carbon future. For instance, meeting poverty reduction needs, expanding energy services, ensuring energy security, maintaining and increasing employment rate, reducing environmental pollution, protecting biodiversity, have to be kept in mind while moving down a low carbon development path.

Difficulties for both China and India, as emerging economies, in developing, deploying, and adopting low carbon technologies is mostly due to the additional cost associated with it and in some cases technical barriers to implementation. Besides, collaboration and open stakeholder involvement from various sectors including government, industry, academic, and civil society between the two countries is essential in framing and coordinating policies and measures, so that low carbon development policies can be implemented to promote sustainable development, spur innovative business, and meet the over-riding priority of poverty eradication in the two largest developing countries in the world.

Acknowledgment

Contents in this article has majorly drawn on the outputs of the project “Collaborative Initiative on Low Carbon Development for China and India” supported by Shakti Sustainable Energy Foundation (Ref No 121100545). The seed funding for the project was provided by the United Nations Development Programme. The implementing partners include The Energy and Resources Institute, National Centre for Climate Change Strategy and International Cooperation, Central University of Finance and Economics, and Zhejiang University. The China component was coordinated under the guidance of the National Development and Reform Commission. The collaborative study on low carbon development for China and India is directed towards developing specific strategies for low carbon development

in crosscutting areas such as financing, technology and innovation policy, and subnational initiatives. The intended outcome of the collaborative project on low carbon development for China and India is supporting policy development by facilitating south–south cooperation, creating relevant knowledge and building capacities through exchange of experiences and ideas. Project webpage: <http://www.teriin.org/projects/loci/>

References

- Barbier, E.B., 2010. *A Global Green New Deal: Rethinking the Economic Recovery*. Cambridge University Press, Cambridge and New York.
- BP, 2015. *BP Statistical Review of World Energy*. British Petroleum.
- CAEP-TERI, 2011. *Environment and Development: China and India*. Joint Study by the Chinese Academy for Environmental Planning (CAEP) and the Energy and Resources Institute (TERI), Commissioned by the CCICED and ICSD. TERI Press, New Delhi.
- DEFRA, 2003. *Our Energy Future: Creating a Low Carbon Economy*. Department for Environment, Food and Rural Affairs European Environmental Agency.
- GoI, 2008. *National Action Plan on Climate Change*. Government of India, New Delhi.
- IPCC, 2014. *Climate Change 2014: Synthesis Report*. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge and New York.
- Kedia, S., Jain, N., 2015. Financing for low carbon development in India (policy brief). http://www.teriin.org/projects/loci/pdf/res/Policy_Brief_LCD_Finance.pdf.
- NDRC, 2014. *China's Policies and Actions on Climate Change (2014)*. The National Development and Reform Commission, China.
- ODI, 2013. *Ten Things to Know About Climate Finance in 2013*. Overseas Development Institute. <http://www.odi.org/ten-things-know-climate-finance-2013>.
- UNDP, 2010. *Down to earth: a territorial approach to climate change, low carbon and climate resilient strategies at the sub-national level*. http://www.nrg4sd.org/sites/default/files/default/files/content/public/29-climatechange/background/tacc/down_to_earth_donor_proposal-version_1_mars_2010.pdf.