



## Briefing Paper 3

# India's rapid transition: The Modi government's climate change and development plan

November 2015

This paper is part of a series of briefing papers that examine the climate change policies of the countries key to a global agreement at the United Nations Framework Convention on Climate Change (UNFCCC) negotiations in Paris in December this year, and its effective and ongoing implementation.

### Executive Summary

---

The Government of India, under Prime Minister Narendra Modi, is currently undertaking a rapid transition in its electricity, agriculture, and cities and urban transport sectors in order to reduce greenhouse gas pollution and enhance climate resilience while at the same time, stimulate social and economic development.

This briefing paper argues that the Modi government and major industrialised countries have a shared interest in fast-tracking India's low-pollution and climate-resilient development plan (operationalised in the above sectors) and therefore, a shared interest in negotiating and implementing a strong global agreement to reduce greenhouse gas emissions.

#### Key findings:

- India's cities, villages and rural areas are highly vulnerable to the physical impacts of climate change, including increasingly frequent floods, droughts, and heatwaves, all of which have the potential to cause significant food shortages and major health crises.
- The Modi government's low-pollution and climate-resilient development plan can reduce the impacts of climate change in India while also delivering many social, economic and environmental benefits, for instance electrifying the homes of the poor, creating rural employment opportunities for young people, and averting premature deaths from acute respiratory infections from indoor and outdoor air pollution.
- India's actions are very important in moving forward a strong agreement in Paris and avoiding dangerous global climate change.
- India's Intended Nationally Determined Contribution lodged to the UNFCCC in October 2015 estimates that more than \$US2.5 trillion (at 2014-15 prices) will be required to meet India's low-pollution and climate-resilient development plan between now and 2030. Industrialised countries can help India meet and enhance its commitments by providing strong public and private sector finance and technology.

## Introduction

The election victory of the Bharatiya Janata Party (BJP) in May 2014, under the leadership of Narendra Modi, presents a transformative moment in India's history. The charismatic Modi sees his overarching task as to construct a new 'modern' identity for India – or as he describes it, to 'refine, rebuild and transform the national character'. The Prime Minister's modernising agenda encompasses eradicating poverty within India's territory, educating and up-skilling India's massive youth population, connecting all households to reliable (and ideally clean) electricity, encouraging India's farmers to embrace scientific methods, and building new cities and urban transport networks. For Modi, India must no longer be known as a country that is 'poor', 'old', 'unhealthy', 'unskilled', 'filthy', and 'underdeveloped'. A modern India, he explains, is 'the aspiration of the masses'.<sup>1</sup>

Since winning office, the Modi government has pursued a range of policies and campaigns that have sought to give credence to this new identity. For example: 'Make in India' (encouraging foreign investment and small business entrepreneurialism in high-tech manufacturing), 'Skilled India' (skilling youth – which Modi sees as India's competitive advantage), 'Smart Cities' (renovating established cities and building new ones), 'Clean India' (a campaign on sanitary issues), 'Solar Missions' (a five-times expansion of India's solar capacity), 'Model Villages' (each state has to exhibit more and more villages that are healthy, clean, green, and friendly), among many others.

Climate change is also a key concern for the Modi government, and justifiably so. The threats posed by unmitigated global warming are becoming acute in India, and will only get worse. Indeed, India is highly vulnerable to the physical impacts of global warming. These impacts include increasingly frequent floods, droughts, and widespread food shortages and major health crises from heatwaves.<sup>2</sup> Sea-level rise is also a major concern, for example, the greater city of Kolkata, home to more than 14 million people, is considered the most at risk urban population in the world to sea-level rise, while Mumbai, home to more than 11 million, is second.<sup>3</sup>

To help tackle these challenges, the Government of India has played an active role in the UNFCCC negotia-

tions, as well as cultivating bilateral relations on climate change. In previous UN negotiations, India has rightly emphasised the obligation on the part of developed countries to lead in mitigation in accordance with the principle of common but differentiated responsibilities. This, however, may be changing. Indeed, Modi has signalled that India may assume some kind of leadership role at the Paris negotiations, explaining: 'India will set the agenda for the upcoming Conference of Parties'.<sup>4</sup> On the bilateral front, Modi has managed to secure billions of dollars from the US government to fund India's clean energy projects, released a memorandum of understanding with China committing to the UNFCCC process as a top priority to avoid dangerous warming,<sup>5</sup> and has sought to cultivate a coalition of 50 nations committed to developing solar electricity to try to further reduce the costs of producing this technology.<sup>6</sup>

The UNFCCC, for its part, is urging nations to commit to radically transform their domestic economies to ensure low-carbon growth. As the UNFCCC executive secretary, Christiana Figueres, explained in her opening address at the Twentieth Conference of the Parties (COP 20) in Lima:

The time has come to leave incremental change behind and to courageously steer the world toward a profound and fundamental transformation. Ambitious decisions, leading to ambitious actions on climate change, will transform growth – opening opportunity instead of propagating poverty.<sup>7</sup>

The Modi government's modernisation agenda is answering this call. In the electricity sector, Modi is steering India away from old polluting technologies such as coal, towards the clean technology of the future, such as solar. In the agricultural sector, he is urging farmers to abandon traditional farming practices such as flooding fields to grow crops, and embrace modern techniques, such as drip irrigation. And in the urban environment, he is seeking to renovate India's existing cities and build new low-polluting cities and transport networks.

In short, Modi's vision of a 'modern' India is largely compatible with the UNFCCC's 'action on climate change' narrative. Indeed, they are interlinked. Modi requires international support from industrialised countries to

fulfil his modernisation agenda and at the same time, the UNFCCC – along with key advocates for action on climate change such as the US, UK and Europe – require India to modernise cleanly to avoid dangerous global warming. The climate change negotiations in Paris this December – and its implementation phase next year – provide a window of opportunity where these interests will align.

The briefing paper is divided into three sections. The first examines India's electricity sector transition. The second examines India's agriculture sector transition. The third examines India's cities and urban transport sector transition.

## India's solar electricity future

India has traditionally relied on coal for its electricity supply. Currently, coal fires more than half of India's power stations. And in the future (out to 2019), Coal India Ltd, India's state-owned coal enterprise, aims to double coal production to 1 billion tonnes per year. A distinct shift, however, is occurring in India's electricity mix.

As recently as 17 June this year, the Modi government approved a five-fold increase in India's solar electricity target – up from 20 gigawatts to 100 gigawatts by 2022.<sup>8</sup> This is a hugely ambitious target and achieving it would see India surpass Germany as the world leader in solar. Modi foretold of a shift in India's electricity mix while on the campaign trail last year: 'The time has arrived for a saffron revolution,' he declared, 'and the colour of energy is saffron'.<sup>9</sup> The language of transition was reiterated soon after the BJP won office, Narendra Taneja, convener of the BJP's energy division, asserting: 'We look upon solar as having the potential to completely transform the way we look at the energy space'.<sup>10</sup>

We begin with a brief policy narrative outlining what Modi has achieved on solar so far.

### a) Modi's solar story

On 10 July last year, the newly elected BJP government delivered its first budget. In his budget speech, Minister for Finance, Arun Jaitley, explained 'India has decisively voted for a change... [and] as a high priority, we pro-

pose to take-up ultra mega solar power plant projects in Rajasthan, Gujarat, Tamil Nadu, and Ladakh, and Jammu & Kashmir'.<sup>11</sup> The Minister explained that these solar parks would help provide nation-wide access to electricity, create jobs and reduce emissions. Modi described the budget as a 'modern vision' that signals the 'dawn of a prosperous future'.<sup>12</sup>

"The time has arrived for a saffron revolution... and the colour of energy is saffron"

Prime Minister Modi, Feb 2014

In September of that year the Modi cabinet approved the first 'ultra-mega' solar park. When completed, the Charanka Park in Modi's home state of Gujarat will be the biggest in Asia covering more than 5000 acres.<sup>13</sup>

Soon after this announcement Modi flew to Washington DC for talks with US President Barack Obama. As a top priority, Modi wanted to secure funding for India's solar expansion.<sup>14</sup> He succeeded. To get the ball rolling, the US Export-Import Bank entered into an agreement with the Indian Renewable Energy Development Agency (IREDA) offering \$1 billion in low-cost loans for solar activities. A critical feature of this deal was to off-set the cost of shipping renewable technology from the US to India.

With funding secured, in December, the Cabinet Committee on Economic Affairs (CCEA), chaired by the Prime Minister, approved several other solar power projects, including the installation of more than 300 megawatts of grid and off-grid projects in defence establishments.

On 25 January this year, President Obama visited India. Again, the planned expansion of India's renewable sector was a top agenda item. Speaking at a joint press conference in New Delhi, Modi explained:

For President Obama and me, clean and renewable energy is a personal and national priority. We discussed our ambitious national efforts and goal to increase the use of clean and renewable energy. We also agreed to further enhance our excellent and

innovative partnership in this area. I asked him to lead international efforts in making renewable energy more accessible and affordable to the world.<sup>15</sup>

In response, Obama explained:

I'm pleased that we agreed to a number of important steps to promote clean energy and to confront climate change. We very much support India's ambitious goal for solar energy, and stand ready to speed this expansion with additional financing...no country is going to be more important in moving forward a strong agreement [in Paris] than India.<sup>16</sup>

The Obama Administration pledged \$US2 billion in the form of loans to be leveraged through the US Trade and Development Agency. In addition, the Overseas Private Investment Corporation, the US government's development finance institution, committed a further \$US227 million.<sup>17</sup>

On 15 February, the inaugural Renewable Energy Global Investors Meet and Expo (RE-Invest) was held in New Delhi. RE-Invest's rationale was two-fold: to showcase the government's renewable energy commitments; and to help attract more large-scale investment in renewables.<sup>18</sup> Modi explained that expanding this sector will 'lighten the homes of the poor and bring a change in

their lives'; and generate high-tech employment as part of the Make in India initiative.<sup>19</sup> At the end of the conference, Piyush Goyal, Minister for Power, Coal, New and Renewable Energy, predicted that India would become the 'renewable energy capital of the world'.<sup>20</sup>

On 17 June, the Modi cabinet gave its formal approval to increase India's solar power capacity target under the Jawaharlal Nehru National Solar Mission (JNNSM) five-fold, reaching 100,000 MW (100 GW) by 2022. The target would source 40 GW from rooftop solar and 60 GW from large and medium-scale solar plants.<sup>21</sup> The target planned to raise India's solar capacity from 0.5% to 9%. Foreshadowing this massive increase, Modi explained: 'When we talk of energy we usually talk about megawatts, today we're talking about gigawatts. This is a big thing'.<sup>22</sup>

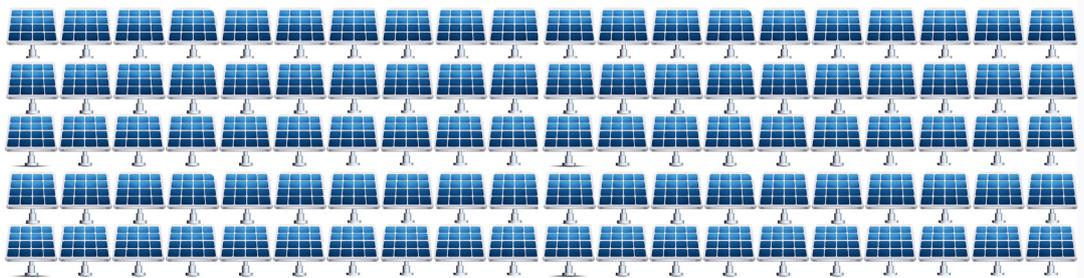
Soon after, the Prime Minister's renewable electricity aspirations received a major boost when Japan's SoftBank announced a \$US20 billion joint venture with Indian conglomerate Bharti Enterprises and Taiwan's Foxconn Technology Group. The new group planned to not only build solar plants, but provide complete integrated power solutions at scale, including infrastructure.<sup>23</sup> Softbank's CEO, Masayoshi Son, explained that the low labour, land and construction costs in India made in-

# INDIA REVISES UP SOLAR TARGET FIVE-FOLD 5x

Previous solar target 20GW



New solar target 100GW



India's revision of cumulative targets under National Solar Mission from 20,000 MW by 2021-22 to 1,00,000 MW

vestment in solar projects very attractive for Japanese companies.<sup>24</sup>

As a demonstration of the export potential (and strategic and climate change mitigation benefits) of expanding India's solar industry, in August, Modi announced that India would provide solar electricity to thousands of homes in the Pacific region.<sup>25</sup> This was soon followed by the energy minister of the central Indian state of Madhya Pradesh, Rajendra Shukla, announcing plans to construct a 750 MW solar power plant – this will be the world's largest solar plant, he claimed, and it will be up and running by early 2017.<sup>26</sup>

On 1 October, the Government of India submitted its long-awaited Intended Nationally Determined Contribution (INDC) – the climate action plan a nation intends to take under a new UN agreement to be negotiated in Paris this December – to the UNFCCC. India stated it intended to reduce emissions intensity of its GDP by 33-35% by 2030 from the 2005 levels, and aims to achieve 40% cumulative electric power-installed capacity from non-fossil fuel-based energy resources in the same timeframe.<sup>27</sup> The statement continued:

While this would evolve over time, a preliminary estimate suggests that at least \$US2.5 trillion (at 2014-15 prices) will be required for meeting India's climate change actions between now and 2030.<sup>28</sup>

On 12 November, Modi delivered an Address to the British parliament. A key message was about the importance of strong action on climate change:

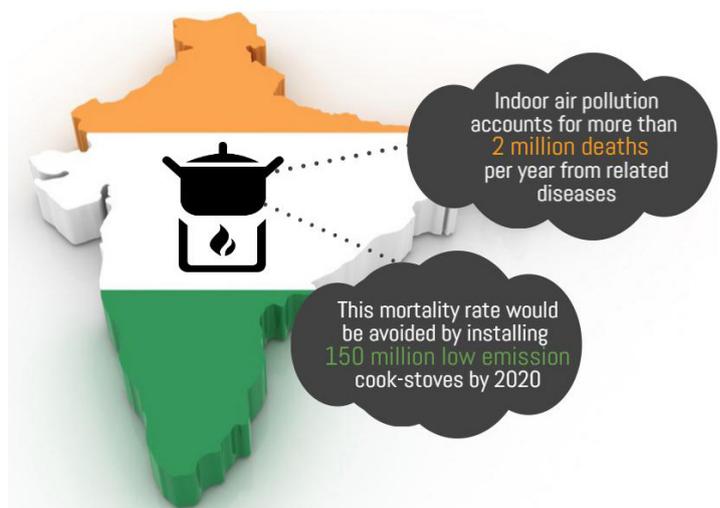
We must also cooperate to launch a low carbon age for a sustainable future for our planet. This is a global responsibility that we must assume in Paris later this month... Those who have the means and the know-how must help meet the universal aspiration of humanity for clean energy and a healthy environment. And, when we speak of restraint, we must not only think of curbing fossil fuels, but also moderating our lifestyles... I propose to launch during the COP 21 meeting an International Solar Alliance to make solar energy an integral part of our lives, even in the most unconnected villages.<sup>29</sup>

In the next section we unpack the social, economic and environmental benefits for India associated with an expansion of its solar electricity sector.

## b) Solar electricity - a triple 'win'

A top priority of the Modi government is to ensure universal electrification by 2019. Basic electrification is defined as two bulbs, a cooker, and a television. Currently about 300 million Indians – about one-quarter of the population – do not have access to basic electricity.<sup>30</sup> This is particularly acute in the rural areas with roughly 20 000 of India's 576 400 villages un-electrified. Solar can help solve this problem. Off-grid solar panels can be installed in remote villages much faster and cheaper than the time it takes to erect pylons across the country linking villages to a centralised power source.<sup>31</sup>

Connecting India's households to electricity has the added social dividend of reduced 'household air pollution', which is largely produced by burning biomass for cooking and heating purposes. As it stands, this issue is a major health problem in India. It is estimated that biomass fuels cause between 400 000 to 550 000 premature deaths in India each year. The related period of illnesses as a result of household air pollution (which may result in recovery or death) can have broader social impacts than the mortality itself, such as loss of family income and required care. This places household air pollution as a major health risk that can be largely solved by electrification. Installing 150 million low-emissions household cook-stoves in India over 10 years would, by 2020, avert more than 240 000 premature deaths from acute respiratory infections in children, and more than 1.8 million premature adult deaths from heart disease and chronic pulmonary disease.<sup>32</sup>



*Indoor air pollution in India is mostly caused by cooking over coal, wood & biomass stoves.*

The economic advantages of India's solar transition abound. First, the Modi government's solar target is expected to require about \$US100 billion in investment over the next seven years. This opens up space for foreign investors from the US, Japan, China, and Germany (the current leaders in solar technology) – boosting India's economic growth rate.<sup>33</sup>

Second, India's shift to clean electricity will create many thousands of jobs. India's solar and wind energy markets have already created nearly 70 000 domestic jobs.<sup>34</sup> This is set to increase as expanding clean energy industries in India requires highly skilled clean energy engineers, currently in short supply, as well as a workforce to help build large-scale projects, renovate existing transmission infrastructure, and install rooftop solar, which is labour-intensive.

Third, boosting solar capacity can reduce stress on traditional electricity sources in cities, which struggle with rolling blackouts, particularly when temperatures soar and air conditioning is ramped up. These power outages pose a significant drag on economic growth. A World Bank Enterprise Survey found that one-third of India's companies saw power shortages as the single most important constraint on growth.<sup>35</sup>

Fourth, solar reduces India's dependency on coal imports, which decreases India's exposure to international coal price volatility and provides some degree of energy security. The recently established National Institution for Transforming India (Niti Aayog) renewable electricity roadmap of 2015 shows that reaching an electricity mix with 20% renewable sources by 2022 will considerably reduce India's coal import bill.<sup>36</sup>

Fifth, solar can provide a boost to local small-scale manufacturing and assist entrepreneurial activity. Here, India has an opportunity under the government's 'Make in India' and 'Skilled India' programs to manufacture the high-tech clean energy componentry required to drive the world's transition to a low-pollution future as well as its own.<sup>37</sup>

India's solar transition can generate direct and indirect environmental benefits. The key direct advantage from increasing solar's share in India's electricity mix to 9% (100 GW) by 2022, displacing fossil fuels, is that it is

expected to abate more than 170 million tonnes of CO<sub>2</sub> over its life cycle.<sup>38</sup> The indirect advantage of lower emissions associated with the growth of solar capacity in India is that it buffers existing electricity generators, and their associated infrastructure, from the impacts of climate change. For example, thermal fossil fuel power plants (which rely on a steady supply of water), operating in regions with diminishing water supply may find it increasingly difficult to source this critical component, causing reduced electricity output and temporary shut-downs.<sup>39</sup> By contrast, open-cut coal mines operating in regions of increasing frequent severe storms and rainfall risk extensive infrastructure damage from floods and landslides. Other transmission infrastructure such as powerlines and pipelines also risk damage from heavy rains, floods, strong winds, large forest fires, landslides, and sea-level rise.

In what follows we examine the key areas where international support could be directed to help India achieve its solar goals faster.

### c) How India could expand its solar capacity

There are five key areas where international help could potentially increase India's solar capacity: up-front project capital, grid infrastructure investment, land acquisition, energy storage capacity, and subsidy redirection.

First, India's aim to generate 60GW from medium to large-scale solar plants by 2022 will require about \$US40 billion of investment. The majority of this debt is planned to come from international sources such as the World Bank as well as investments by international companies from the US, China, Japan and Germany.<sup>40</sup> Piyush Goyal, among many others, has warned that securing up-front capital at affordable interest rates, and clean energy finance, will be central to the Paris negotiations. International financial support is critical to ensure India meets its solar target.

Second, in 2011 India's electricity output – transition and distribution – loss was estimated at 21%. This compares with 6-7% in the US and China. This loss is caused by, first, 'technical losses', which refer to electricity that is generated but lost in transit due to poor electricity infrastructure and maintenance; and second, 'commercial losses', which refer to electricity that is delivered

and consumed but for which the power companies are underpaid because of theft and inefficiencies in billing and collection.<sup>41</sup> Financial assistance from abroad could be used to help repair existing electricity transmission infrastructure and modernise administrative processes, mitigating these losses.

Third, solar power plants require large parcels of land. That presents a considerable difficulty in India, as the land needed for a project is often dispersed among several small land-owning families. The resulting negotiations typically lead to delays and cost overruns, raising the cost of projects making them economically unviable. The Modi government's land acquisition bill, which is designed to speed up the process by which companies can acquire land, remains stalled in the Indian parliament and is unlikely to have an easy ride.<sup>42</sup> This hold-up poses a significant challenge to the government achieving its solar targets.<sup>43</sup>

Fourth, the availability of reliable battery storage capacity is another vital issue. Solar doesn't produce power when cloudy or at night, therefore it needs to be accompanied by storage capacity. While new batteries are quickly coming onto the market, for India it is a question of cost. The 'Powerwall', produced by the company Tesla, the world leader in battery technology, is currently available to installers at R2.23 (\$US3500) for 10kWh and R1.91 (\$US3000) for 7kWh, excluding inverter and installation costs – India's norm is R5 per kWh.<sup>44</sup> The international community could help bridge these costs on what is an essential item of technology to ensure India's solar targets are met. Realising this, in September, Modi met Tesla CEO Elon Musk in California to discuss the technology.<sup>45</sup>

Fifth, the Indian government could consider redirecting subsidies in the electricity sector. Fossil fuels still receive more than \$US40 billion in subsidies every year in India. Yet even so, state-owned electricity boards and distribution companies are largely insolvent. Solar, too, receives government subsidies. In India, however, the cost of solar electricity generation has come down by 65% over the past three years.<sup>46</sup> This puts it on the edge of beating coal and gas on price. Parity is predicted somewhere between 2018 and 2020.<sup>47</sup> This means that solar subsidies will be abolished around 2019, at which point it is expected to become cheaper than imported coal-based

power.<sup>48</sup> As Pranav Mehta, the chairman of India's peak solar body, the National Solar Energy Federation of India notes: 'you give me a fraction of that \$40 billion and I will make solar affordable and available everywhere'.<sup>49</sup> The international community could support government efforts to reform subsidies.

## The second agricultural revolution

India is largely an agrarian society. The agricultural sector employs about half of the national workforce, provides a livelihood for about two-thirds of the population, and contributes about 14% to national economic output.

Of great concern to national policymakers is that this vitally important sector to India's economic and social well-being is highly vulnerable to the physical impacts of climate change, including increasingly frequent droughts, heatwaves, severe storms, and floods. While damaging on their own, these climatic events can also have a ripple effect on rural economies, for instance, a poor monsoon (drier conditions) can have a negative effect on the income of farmers and subsequently their purchasing capacity in the local and regional community.

In light of this, the Modi government has vowed to 'transform agriculture into an ecologically sustainable climate-resilient production system', while at the same time, boosting productivity to ensure: food security, equitable access to food, livelihoods, and economic stability at a national level.<sup>50</sup> Such importance is placed on this transition, that in June this year Modi called for 'a second agriculture revolution', which requires, according to Modi, 'changing the conventional and traditional way of farming... and making it more modern and scientific'.<sup>51</sup>

India needs to change 'the conventional and traditional way of farming... making it more modern and scientific'

Prime Minister Modi, June 2015

Let's begin with a brief policy narrative outlining what Modi has achieved in agriculture.

### **a) Modi's agri-transition story**

The Modi government's first budget of July 2014 flagged a transition in India's agricultural sector. In his budget speech, Minister for Finance, Arun Jaitley, thanked the agricultural sector for feeding India's growing population to date, but explained that:

To make farming competitive and profitable [in the future] there is an urgent need to step up investment in agro-technology development, and modernise existing agri-business infrastructure.<sup>52</sup>

In the budget, the Minister announced that two new agriculture-specific research institutes would be established in the states of Assam and Jharkhand – accompanying the Pusa Institute, and several small-scale agricultural research centres. The government believed that a research-based approach to agriculture would help guard against the 'vagaries of climate change', provide skilled employment, encourage entrepreneurship, alleviate poverty, ensure food security and contribute to economic stability.

As a part of this modernisation agenda, on 18 February 2015, Modi launched the national Soil Health Card scheme. The 'card', to be distributed to farmers, would convey recommendations about soil additives such as fertilisers and minerals that would help improve crop productivity. At the launch, Modi explained that 'farmers need to do away with traditional farming techniques and adopt scientific methods of agriculture to raise crop yields', and this scheme is a step in that direction. This scheme should also encourage local soil testing businesses to open, he added.<sup>53</sup>

On 3 June, the India Meteorological Department (IMD) revised India's monsoon (which runs from June to September) forecast down to 88% of average rainfall from 93% previously forecast in April. The IMD predicted that in July and August, months critical for agriculture, the expected rain deficit would be between 8-15%. In response, Ramesh Chand, the director of the National Institute of Agricultural Economics and Policy, expressed concern that the drier conditions would 'depress the agriculture sector and economy'.

To combat the predicted lower rainfall, on 8 June, Modi announced a new range of water conservation meas-

ures. The 'challenge' of ongoing water deficits should be converted into an 'opportunity', he explained. For example, we should look at creating 'farm ponds' as well as a mix of 'modern and micro irrigations systems such as drip and sprinkler irrigation'. This modern approach contrasts with traditional irrigation methods such as flooding fields, he concluded.<sup>54</sup> Young researchers from universities should help plan and implement our modern irrigation policy, he added.

On 28 June, Modi laid the foundation stone at the soon-to-be-built Indian Agriculture Research Institute (IARI) in Hazaribagh, Jharkhand. The stated purpose of the 1000-acre Institute was to achieve inclusive agricultural growth through integrated farming systems (IFS), improved soil health, and water use efficiency and management. Speaking to the massive crowd that had gathered at the site, Modi declared: 'There is an immediate need of Green Revolution in the country... there is a need to change the conventional and traditional way of farming and do more research... Through government policies, through training, we can make agriculture modern and scientific.' There is also a need, Modi continued, for farmers to adopt a more progressive attitude towards farming, traditional attitudes have held India back, he explained, so while farmers the world over have made progress, in India they are still lagging behind.<sup>55</sup>

In what follows we unpack why Modi's agricultural transformation is important on social, economic and environmental grounds.

### **b) Transforming agriculture - a triple 'win'**

Climate change is already wreaking havoc on India's agricultural sector, and causing multiple associated social and economic hardships. For example, in the north of the country, unseasonal rains and hailstorms ruined crops and many livelihoods, causing increased rates of mental health problems and a spike in rural suicides.<sup>56</sup> To address this issue, on 29 April this year, the Modi cabinet announced a series of relief measures for farmers facing crop damage from extreme storms, such as providing direct financial compensation, expanding the eligibility for compensation, and calling on banks to restructure agricultural loans.<sup>57</sup> Further, in June, the government adopted an insurance scheme for farmers

whereby farmers would be paid out if their income fell below a certain minimum. If extended, this scheme would become increasingly expensive for the government because at present only 10% of India's 263 million farmers are covered.

Unseasonal rain and hailstorms are also causing food security problems. Earlier this year, the production of lentils – a staple food in Indian cooking – was decimated because of severe storms in the states of Maharashtra and Madhya Pradesh. This caused the production of lentils in 2014-15 to fall to 17.38 million tonnes from 19.25 million tonnes the previous year. This shortage has caused lentil prices in India to increase 64% from the previous twelve months. To stabilise prices, on 10 June, the government approved a massive increase in the importation of lentils. 'We need to focus on enhancing food grain production,' Modi said, and that can be achieved 'by embracing modern scientific methods in farming and working collectively towards achieving the target of producing enough lentils'.

In other parts of the country, heatwaves and droughts are causing social and economic disasters. For example, in May and June this year, a three-week heatwave caused more than 2500 deaths in India. This was the second-deadliest heatwave on record in India, and the fifth-deadliest in the world. In this instance, temperatures averaged 10C hotter than usual over the period, and in some locations reached 47.8C. In terms of its impact on food production, during this event, more than 17 million chickens perished causing egg prices to soar from Rs 260 (\$US3) per 100, to Rs 327 (\$US5) – rendering this product unaffordable for many. As India's agricultural sector currently stands, periods of prolonged drought are also likely to significantly damage India's food supply, causing increasing rates of malnutrition, which will mostly impact on India's poor.<sup>58</sup> Sadly, the UN Food and Agriculture Organisation (FAO) finds that about 194 million Indians are currently undernourished – 15% of the population.<sup>59</sup> Put another way, the World Food Programme finds, India is home to a quarter of all undernourished people worldwide.<sup>60</sup> The Prime Minister is aware of this and has stressed that modernising India's farming practices will facilitate the judicious use of water:

Farmers practising traditional farming believe that

unless their field is filled with water they cannot get good crops, but this may not be scientifically true because drip irrigation, irrigation through sprinklers are more effective and reduces of water and nutrients.<sup>61</sup>

Sustained temperature rise will cause severe economic damage to India's agriculture sector. It is estimated that a 3.25C increase in temperature (by 2100) will cause agricultural production losses in India in the order of \$US57 to \$US208 billion by 2050, and up to \$US113 to \$US367 billion by 2100.<sup>62</sup> A warmer climate will significantly decrease agricultural yields, damage the incomes of farmers, and reduce the number of ongoing employment opportunities in the sector. For example, in the state of Maharashtra, two-thirds of inhabitants depend on agriculture. In a 'high' climate change scenario, drought-related losses in agriculture are predicted to be about \$US570 million by 2030, compared to \$US370 million if temperatures were to remain at current levels accompanied by existing rainfall patterns.<sup>63</sup> Income and employment will naturally follow suit.

Modi's plans have sought to inspire growth in the agricultural jobs of the future. For instance, the soil health card, he explains, will encourage 'private individuals to set up and own laboratories to test soil – which will lead to job creation'. Also, the Modi government has reopened fertiliser plants and established new ones to 'generate further youth employment'. And the new research institutes, Modi explains, will attract the best post-graduate and doctoral students from all over India and abroad.

India's agricultural GHG emissions profile is dominated by CH<sub>4</sub> (mainly methane from livestock) and N<sub>2</sub>O (the application of nitrogen fertiliser). In 2007, India's agriculture sector emitted 334.41 million tonnes of CO<sub>2</sub> equivalent, of which 13.76 million tonnes was CH<sub>4</sub> and 0.15 million tonnes was N<sub>2</sub>O.<sup>64</sup> The agricultural sector roughly constitutes 30% of India's total GHG emissions. Over the past decade, India has officially opposed mitigation targets for agriculture in global climate negotiations, as it considers the potential implications for livelihoods and food security. As this suggests, the major problem with India's agricultural transition, from a climate change perspective, is that India is more focused on adaptation in agriculture rather than mitigation. This is despite

India's agricultural sector being extremely vulnerable to the impacts of climate change, as stressed above. However, any suggested action should seek to emphasise a reduction in emissions intensity – rather than aggregate emissions – in agriculture so that India can meet its growing demand for food.

The Ganges, a global natural icon and holy place for many Indians is largely rain-fed, making it highly vulnerable to climate-induced changes in precipitation patterns. The Ganges basin supports 300 million people in India and already faces challenges from water overuse and high levels of pollution from domestic waste, untreated industrial effluent, cremation grounds and agricultural pesticides and fertilisers.<sup>65</sup> The International Water Resource Management Institute estimates that water demand in India will increase 32% by 2050, and with ongoing land use changes and changes in precipitation associated with global warming, there is a risk that more parts of the Ganges basin will run dry more frequently.<sup>66</sup> In an effort to save the Ganges, in May 2015 the Modi cabinet approved the Namami Gange project.<sup>67</sup> This centrally funded project seeks to clean and protect the holy river, which is crucial for India's future drinking water supply, agricultural industry and food security as well as the government's rural transport and SmartCities projects.

In the following section we examine the four key areas where international support could hasten India's transition towards a climate-resilient agricultural sector.

### **c) Fast-tracking India's agri-transition**

First, international finance could be deployed to help upgrade India's food supply chain. According to the UN FAO about 40% of India's fresh fruit and vegetables – worth about \$US8.3 billion annually – perishes before it reaches consumers. About 21 million tonnes of wheat rots in India each year because of inadequate storage and distribution systems.<sup>68</sup> Upgrading India's food supply chain means less food, and GHG emissions therefore, is required to feed India's growing population. The Modi government has already begun to tackle this issue, for example, the government's Warehouse Infrastructure Fund seeks to increase warehousing capacity to increase the shelf-life of agricultural products. International help

to finance food supply chain infrastructure upgrades and its associated logistics would have the added benefit of creating jobs.<sup>69</sup>

Second, international finance could help roll out drip-irrigation systems across the drier areas of country. Substantial cuts in water demand could be achieved with the adoption of efficient drip and sprinkler-irrigation technology, and extending and enhancing the surface irrigation network. Sustained rainwater harvesting and groundwater recharge initiatives, combined with better irrigation pump efficiency, could also contribute. These initiatives will increase resilience to looming water scarcity without compromising productivity, with co-benefits that include reduced energy consumption and lower methane emissions from flood irrigation. As mentioned above, Modi is already moving in this direction. Also, the current subsidy on ground water pumps, without policy to regulate extraction, is leading to dramatic declines in groundwater levels. Policy change is critical here.

Third, the international community could encourage India to redirect subsidies towards expanding R&D programmes. In 2011-12, subsidies for agriculture totalled \$US28 billion, comprising \$US13.7 billion for fertiliser, \$US6.5 billion for power, \$US4.7 billion for irrigation, and \$US2.5 billion for credit.<sup>70</sup> All of these areas are failing to recoup the money spent, and thus constitute a bad investment for the government.<sup>71</sup> Only about 0.7% goes to agricultural R&D.<sup>72</sup> However, these subsidies generate at least a seven-fold return. There is an opportunity to improve the effectiveness of public expenditure by reallocating spending from low-yielding subsidies towards R&D. For example, current subsidies for nitrogen fertiliser lead to its overuse, which causes increased N<sub>2</sub>O emissions. Redirecting these subsidies from N<sub>2</sub>O fertiliser towards R&D can improve nitrogen-use efficiency, which will help reduce emissions, especially from rice and irrigated crops.

On a related issue, the Government of India and foreign governments could provide direct funding to connect Indian scientists with those in more developed agricultural economies, specifically those advanced in climate-ready systems. For example, through the Australian-Indian Strategic Research Fund (AISRF), or Global Research Alliance on Agricultural Greenhouse Gases, and the Global

Alliance on Climate Smart Agriculture. If any country needs to plan for climate change impacts on their food security, it will be India. Increased R&D funding and transnational learning is critical.

Fourth, international support could help promote livestock productivity. India has the largest livestock herds in the world (some of which can't be 'touched' for religious reasons), which account for about 40% of its emissions from agriculture. The high-cellulose diet of livestock increases emissions. Helping to improve livestock diets can increase yields (i.e. milk produced), while reducing emissions. Also, modern approaches to reproduction management can help control herd size, and increase the proportion of healthy and productive animals. Estimates suggest that the reforms and initiatives in agriculture and livestock discussed have the potential to reduce GHG emissions by around 105 million metric tons of carbon dioxide equivalent (MtCO<sub>2</sub>e) in ten years and perhaps 165 (MtCO<sub>2</sub>e) in 20 years.<sup>73</sup>

## Transforming cities and urban transport

Indians are rapidly migrating from the villages to the cities. Currently, about 31% of India's population lives in a city – roughly 377 million people. By 2040, it is expected that this figure will increase to about 40% – 540 million people.<sup>74</sup> And by 2050, India's urban centres are expected to hold roughly 50% of the population – 840 million people. This rapid rate of urbanisation challenges a legacy that dates to Mahatma Gandhi's refrain that 'India lives in its villages'.

In light of this shift, soon after winning office in May last year, Modi announced his vision to radically renovate 500 cities across the country and build 100 new 'smart cities' from the ground up.<sup>75</sup> These 'clean and sustainable' urban spaces, the government explains, will be connected by grids in which water, electricity, waste removal, traffic, hospitals and schools are seamlessly integrated with information technology. This urban transition is a core part of Modi's plans for a modern India: 'Cities in the past were built on riverbanks,' he explains, 'but in the future, they will be built based on availability of optic fibre networks and next-generation infrastructure'.<sup>76</sup>

Transport is a critical feature of the government's urban renewal and smart cities program. Big spends are expected on low-pollution transport such as rail, trams, waterways, walkways, and bicycle tracks, as well as infrastructure builds for electric and hybrid vehicles. Ultimately we want to get people off the roads, Modi insists, indeed India must shift from highways to 'l-ways', he says.

Let's begin with a brief policy narrative about India's urban and transport transition.

### a) Modi's urban transformation story

The Finance Minister, Arun Jaitley, announced the 'smart cities' and urban renewal programme during his first budget speech on 10 July 2014. In the speech, he described the programme as 'critical' because of India's increasing urban migration from rural areas, and the importance of satisfying the increasing demands for better living standards by India's burgeoning urban neo-middle class. 'The Prime Minister has a vision,' the Finance Minister told the parliament, 'to modernise India's existing mid-sized cities, and develop 100 new Smart Cities'.<sup>77</sup> The Minister announced an initial budget allocation of \$US1.2 billion in 2014-15, which would be accompanied by a further \$US1 billion in 2015-16.<sup>78</sup>

The initial allocation was principally designed to leverage funding from the private sector in India and abroad to invest in a range of smart solutions, such as renewable energy and energy storage, smart grids and smart meters, water management and green transport and railways, energy-efficient building and smart IT and communications. It was expected this investment would kick-start a twenty-year investment process of more than \$US1 trillion.<sup>79</sup>

As the government expected, foreign investors were eager to be involved. For example, in June 2014, prior to the budget speech, the Government of Japan was approved to take a 26% stake in the \$US100 billion Delhi-Mumbai industrial corridor (DMIC), which planned to establish several smart 'eco-friendly' cities in the six states along its route.<sup>80</sup> The following month, during a five-day visit to India, an impressed K Shanmugam, Singapore's Foreign Minister, offered to build one smart city. This was soon followed by British Chancellor, George Osborne, extending a £1 billion credit line to help UK

‘Cities in the past were built on riverbanks...  
but in the future, they will be built based  
on availability of optic fibre networks  
and next-generation infrastructure’

Prime Minister Modi, June 2015

companies invest in Indian infrastructure projects.<sup>81</sup> In August, Japan signed a memorandum of understanding with India to develop Varanasi into a ‘smart city’. In September, a US-India roadmap was announced to develop smart cities in Ajmer (Rajasthan), Visakhapatnam (Andhra Pradesh) and Allahabad (Uttar Pradesh).<sup>82</sup> In December, Canada agreed to help build smart cities. In January this year, Germany signed up to develop three more smart cities. And on 10 April, the President of France, Francois Hollande, announced that France will invest €2 billion in India and help develop three smart cities.<sup>83</sup>

Two weeks later, on 29 April, the Modi cabinet approved the 100 smart cities project and the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) for 500 cities.<sup>84</sup>

On 25 June, Modi officially launched the smart cities programme. He explained that these urban centres would have clean water, a reliable and efficient electricity supply, and new low-emissions transportation networks. India’s Urban Development Minister, Venkaiah Naidu, echoed these claims. Furthermore, both agreed that India’s urbanisation plans should be treated as an opportunity to generate employment and better living standards.<sup>85</sup>

Soon after, US companies IBM and Oracle, among several others, met in Ajmer to discuss using smart technology to solve some of the city’s challenging water, traffic and waste problems.<sup>86</sup>

In the following section we examine the social, economic and environmental benefits associated with Modi’s plans to transform India’s urban environment.

### **b) Cleaning-up urban spaces - a triple ‘win’**

The implementation of Modi’s programme will deliver

significant health benefits for India. The World Health Organisation (WHO) finds that ‘outdoor air pollution’ in India – which includes particulate matter (PM10 and PM2.5), Ozone, Nitrogen dioxide, Carbon monoxide, and Sulphur dioxide – is the fifth leading cause of death domestically. Combined, indoor and outdoor pollution causes about 620 000 premature deaths each year in India.<sup>87</sup> The Lancet commission of 2015, comprising the world’s pre-eminent medical professionals, suggests that reducing fossil fuel emissions from India’s transport and energy sectors will significantly reduce this figure.<sup>88</sup>

Modi’s urbanisation plans and green transport initiatives are also good for India’s economy and jobs growth. The massive amounts of foreign investment required to drive India’s ‘futuristic growth’, as it has been called, will help lift large sections of the population out of poverty, and boost employment. Renovating and building cities will create vast numbers of skilled and unskilled jobs – from teams of engineers to labourers. In addition, the government’s ‘Make in India’ initiative is well placed to design and manufacture the high-tech componentry to run these technologically sophisticated low-pollution urban areas. As for transport, Minister for Transport, Nitin Gadkari, says it best: ‘We would like to convert the transportation system into electric and bio-fuel so as to reduce pollution and accomplish the ‘Make in India’ dream’.<sup>89</sup>

Modi’s plans also present opportunities to significantly reduce greenhouse gases and tackle climate change. Changes to India’s urban transport sector would be particularly useful in this endeavour. In 2007, India’s transport sector emitted 142.04 MtCO<sub>2</sub>e – mostly generated in urban areas.<sup>90</sup> Prioritising planning and infrastructure that encourages non-motorised transport, and restricts car travel, not only reduces emissions, but also lowers congestion, reduces road-traffic accidents, and limits energy consumption. Indeed, comparative studies show that based on current trends, Mumbai, which has an efficient public transport system, will consume 60% less transport fuel than Delhi, which doesn’t.<sup>91</sup>

In the following section we present four key areas where international support could hasten Modi’s modernisation plans for India’s urban spaces.



*India's Smart City Mission is attracting strong interest from foreign investors*

### c) How India can do more

First, urban governance could be improved. As the Minister for Urban Development, Housing and Urban Poverty Alleviation and Parliamentary Affairs, Venkaiah Naidu, has said: 'effective urban governance should aim at prudent utilisation of natural resources, minimum waste generation, recycling, water harvesting and efficient energy use'.<sup>92</sup> Improvements may also be required to infrastructure provision, pollution laws, and renewable energy provision.

Second, a big challenge is figuring out where the funding for the programme will come from. Most city corporations in the country are severely cash-strapped. Modi wants Indian and foreign companies to invest in the

programme, but there is no final estimate as yet.<sup>93</sup>

Third, one of the greatest problems associated with Modi's urban plans is to convince Indians of the benefits. This is because some cities that have been identified as potentials for transformation suffer from very basic problems. For example, in the ancient city of Ajmer, which Modi has identified as the futuristic trailblazer, running water is available for just two hours every two days. Only 130 of 125 000 homes in the city are connected to the sewerage system. Dirty water flows in open drains in cramped neighbourhoods. Stepwells and lakes have become garbage dumps. Illegal buildings and slums dot the city.<sup>94</sup> This type of situation leads some to doubt whether India, where many people live without

basic infrastructure, should be focused on sci-fiesque designs.<sup>95</sup> Other critics have dismissed the plans because they have the potential to create social apartheid, where poor people are locked out of the 'rich-only' new areas and cities.

Fourth, in terms of transport, the government has identified a combination of measures to reduce emissions from transport including improving motorised vehicle efficiency, increasing the use of alternative fuels, and increasing the share of public transport. The rapid construction and upgrade of India's metro rail is proving a great success on a number of levels, for instance, the Delhi metro has significantly reduced the number of cars on the road, petrol consumption (which India largely imports), road accidents and deaths, and pollution. Delhi's success has sparked metro rail construction in more than 10 other Indian cities (Ahmadabad, Bangalore, Chennai, Jaipur, Kochi, Kolkata, Lucknow, and Pune, among others).<sup>96</sup> Some projects have only been recently approved, while others are partially complete. These projects would benefit from funding and resources from abroad.

## Conclusion

This briefing paper argued that the Government of India, led by Prime Minister Narendra Modi, and major industrialised countries have a shared interest in fast-tracking India's transition towards a low-pollution and climate-resilient future. And hence, both parties have a shared interest in negotiating a strong global agreement to reduce greenhouse gas emissions at the UN climate change negotiations in Paris this year and its effective and ongoing implementation thereafter.

Section one examined the Modi government's transition in the electricity sector – towards boosting solar capacity. Section two examined the Modi government's transition in the agricultural sector – towards sustainable farming practices and water conservation techniques. Section three examined the Modi government's transition in India's cities and urban transport sector – towards clean eco-friendly urban spaces and infrastructure. This transition has the potential to produce strong social (health), economic (jobs and investment) and environmental (lower GHG emissions) dividends for India. The international community can help fast-track these benefits by providing financial and technical support, among other things.

India's multi-sectorial transition is also a part of the Prime Minister's dream to construct a new 'modern' identity for India, which is significantly compatible with the broader international 'action on climate change' narrative, readily deployed by leaders of industrialised countries such as US President Barack Obama as well as the UNFCCC.

In short, there is a distinct overlap of identities and interests here. Modi requires support from industrialised countries to achieve his 'dream' of a modern India. And at the same time, major industrialised countries want this dream to come to pass because it means low-emissions development in India. This overlap is positive news for advocates of a strong global agreement in Paris.

## References

1. Narendra Modi, Address, '68th Independence Day', Red Fort, Delhi, 15 August 2014.
2. Yasuaki Hijioka et al., 'Asia', *Intergovernmental Panel on Climate Change, Fifth Assessment Report, Working Group 2, 2014, 1327-1370*. See also, 'Assessing the Costs of Climate Change and Adaptation in South Asia', *Asian Development Bank*, June 2014.
3. Organisation for Economic Co-operation and Development, Environment Working Papers, Number 1 (2008), in 'Protecting Coastal Cities From Rising Seas', *Carnegie Endowment for International Peace*, May 2013.
4. 'Paris Climate Meet: India to Market its Action Plan for Achieving Emission Targets', *The Times of India*, 4 July 2015.
5. 'Joint Statement on Climate Change between India and China during Prime Minister's visit to China', Press Release, *Government of India*, 15 May 2015.
6. 'India to Create a Federation of 50 Solar Power-rich Nations: Piyush Goyal', *The Times of India*, 17 February 2015.
7. Christiana Figueres, Opening Address, Twentieth Session of the Conference of the Parties (COP20), Lima, 9 December 2014.
8. 'India Just Upped its Solar Target five-fold, will Install More Solar Power this Year than Germany', *Climate Progress*, 17 June 2015.
9. Rupa Subramayna, 'Is India Ready to be a Solar Power Leader?', *Foreign Policy Magazine*, 1 July 2015.
10. 'Modi to Use Solar to Bring Power to Every Home by 2019', *Bloomberg*, 19 May 2015.
11. Arun Jaitley, Speech, 'Union Budget, 2014-2015', Parliament House, Delhi, 10 July 2014.
12. 'Budget Pragmatic, will Re-ignite Growth, says Modi', *The Hindu*, 28 February 2015.
13. 'Can Narendra Modi Bring the Solar Power Revolution to India?', *The Guardian*, 30 September 2015.
14. 'Modi To Seek US Funds For 100 GW Each of Solar & Wind', *Clean Technica*, 26 September 2014.
15. Narendra Modi, 'Statements by President Obama and Prime Minister Modi of the Republic of India', Hyderabad House, New Delhi, 25 January 2015.
16. Barack Obama, 'Statements by President Obama and Prime Minister Modi of the Republic of India', Hyderabad House, New Delhi, 25 January 2015.
17. Subramayna, 'Is India Ready'.
18. Subramayna, 'Is India Ready'.
19. 'PM Modi Calls for Innovation in Renewable Energy for Affordable Power', *NDTV*, 15 February 2015.
20. 'India to Create a Federation'.
21. 'Revision of Cumulative Targets under National Solar Mission from 20,000 MW by 2021-22 to 100,000 MW: India Surging Ahead in the Field of Green Energy - 100 GW Solar Scale-Up plan', Press Release, *Government of India*, 17 June 2015.
22. 'Watch: PM Narendra Modi at First Renewable Energy Global Investors Meet', *DNA-TV*, 15 February 2015.
23. 'Softbank's US\$20 billion Solar Investment 'Game Changer' for India', *PV Tech*, 23 June 2015.
24. 'Japan's SoftBank Invests in India Solar Project', *BBC News*, 23 June 2015.
25. 'Indian PM Narendra Modi Offers Solar Power to Pacific Island Nations during Summit', *ABC News*, 22 August 2015.
26. 'World's Largest Solar Power Station to come up in Madhya Pradesh', *The Times of India*, 23 August 2015.
27. 'India Submits INDC, Pledging to Reduce Emissions Intensity up to 35% by 2030', *The Climate Group*, 1 October 2015.

28. 'India's Intended Nationally Determined Contribution: Working Towards Climate Justice', *United Nations framework Convention on Climate Change*, October 2015, 31.
29. Narendra Modi, Address, British Parliament, 12 November 2015.
30. 'Energy Access Database', *International Energy Agency*, 2014.
31. Pranav Mehta, Chair, *National Solar Energy Federation of India* in 'Can Narendra Modi Bring the Solar Power Revolution'.
32. Sharon Friel et al., 'Climate Change, Non communicable Diseases, and Development: The Relationships and Common Policy Opportunities', *Annual Review of Public Health*, November 2011, 139.
33. 'Can India Achieve its 100 GW Solar Target?', *Business Standard*, 8 March 2015.
34. 'Clean Energy Powers Local Job Creation in India', Interim Report, National Resource Defense Council, February 2015. See also 'The Business Case for Off-Grid Energy in India', Report, *The Climate Group*, February 2015.
35. 'India: Pathways to Sustaining Rapid Development in a New Climate Economy', Conference Draft, *The New Climate Economy*, 2014, 20.
36. 'Report on India's Renewable Electricity Roadmap 2030: Toward Accelerated Renewable Electricity Deployment', *Government of India*, February 2015, 12.
37. Arunabha Ghosh and Karthik Ganesan, 'Policy: Rethinking India's Energy Strategy', *Nature*, 521 (May 2015), 157.
38. 'Revision of Cumulative Targets', *Government of India*.
39. 'Climate Change: Implications for the Energy Sector, Key Findings from the Intergovernmental Panel on Climate Change, Fifth Assessment Report', University of Cambridge and World Energy Council, 2014, 6 & 8.
40. 'India Just Upped its Solar Target'.
41. 'Pathways to Sustaining Rapid Development', *The New Climate Economy*, 19.
42. Subramayna, 'Is India Ready'.
43. 'India Solar Handbook, 2015', *Bridge to India*.
44. 'India Could Tap Tesla for Solar Battery Solution', *EE Times*, 28 September 2015.
45. 'Indian Prime Minister tours Tesla Factory, talks Batteries & Solar with Elon Musk', *Fortune*, 27 September 2015.
46. 'Pathways to Sustaining Rapid Development', *The New Climate Economy*, 25.
47. 'Solar, Wind to Beat Coal on Costs in China, India by 2020', *Renew Economy*, 14 July 2014.
48. 'Reaching India's Renewable Energy Targets Cost-Effectively', Report, *Climate Policy Initiative*, April 2015.
49. 'Can Narendra Modi Bring the Solar Power Revolution'.
50. 'India's progress in Combating Climate Change: Briefing Paper for UNFCCC COP 20 Lima, PERU', *Government of India*, December 2014, 8.
51. Narendra Modi, Speech, 'Opening of the Indian Agricultural Research Institute', Hazaribagh, 28 June 2015.
52. Arun Jaitley, 'Union Budget, 2014-2015'.
53. 'Set up Expert Panel to Boost Agriculture, says PM', *DNA*, 19 February 2015.
54. 'Monsoon Forecast at 88% poses a Challenge for PM Narendra Modi', *The Times of India*, 3 June 2015; 'Modi on Monsoon: Convert Challenge into an Opportunity', *The Hindu*, 8 June 2015.
55. 'Second Green Revolution needed, says Modi', *The Times of India*, 28 June 2015; 'East should lead next Green Revolution: Modi', *The Hindu*, 28 June 2015; 'PM Narendra Modi Urges Farmers to Use Scientific Methods to Enhance Production', *NDTV*, 28 June 2015.

56. 'Heavy Unseasonal Rain Destroys Farmers' Spirits', *The Times of India*, 16 March 2015; For more information about links between climate change and NCDs see, Jessica G Fritze et al., 'Hope, Despair and Transformation: Climate Change and the Promotion of Mental Health and Wellbeing', *International Journal of Mental Health Systems*, 2:13 (2008).
57. 'PM Modi Announces Higher Aid for Farmers hit by Unseasonal Rains and Hailstorm', *DNA*, 8 April 2015.
58. Hijioaka et al., 'Asia', *Intergovernmental Panel on Climate Change*.
59. 'The State of Food Insecurity in the World, 2015', *Food and Agriculture Organisation of the United Nations*.
60. 'India: Overview, 2015', *United Nations World Food Programme*.
61. 'PM Narendra Modi Lays Foundation Stone of Indian Agriculture Research Institute (IARI) at Barhi in Hazaribagh', *The Times of India*, 28 June 2015.
62. Vaibhav Chaturvedi, 'The Costs of Climate Change Impacts for India: A Preliminary Analysis', *Council on Energy, Environment and Water*, Working Paper, 2015, 9.
63. 'Economics of Climate Change Adaptation – Shaping Climate-Resilient Development: A Framework for Decision-making', *Swiss Reinsurance Company*, 2011, 2.
64. 'India: Greenhouse Gas Emissions 2007, Indian Network for Climate Change Assessment', *Government of India*, 2010, 22.
65. 'India's Polluted Ganges River Threatens People's Livelihoods', *Deutsche Welle*, 2013.
66. Paul Whitehead et al., 'Impacts of Climate Change and Socio-Economic Scenarios on Flow and Water Quality of the Ganges, Brahmaputra and Meghna (GBM) River Systems: Low Flow and Flood Statistics', *Environmental Science: Process & Impacts*, February 2015.
67. 'Namami Gange: In the Name of the Ganga', *The Indian Express*, 18 May 2015.
68. 'India Tackles Supply Chain to Cut Food Waste', *Financial Times*, 21 April 2014.
69. 'Modi Needs a Farm Fix', *Bloomberg*, 2 April 2015.
70. Anwarul Hoda and Ashok Gulati, 'India's Agricultural Trade Policy and Sustainable Development', *International Centre for Trade and Sustainable Development*, Issue Paper 49, September 2013, 1.
71. Shenggen Fan, Ashok Gulati, and Sukhdeo Thorat, 'Investment, Subsidies and Pro-poor Growth in Rural India', *International Food Policy Research Institute*, Discussion Paper, September 2007.
72. Alka Singh, 'The Changing Landscape of Public Expenditure and Investments in Indian Agriculture', *Indian Journal of Agricultural Economics*, 66:3 (2011), 301-313.
73. 'Pathways to Sustaining Rapid Development', *The New Climate Economy*, 33.
74. 'India's Urban Awakening: Building Inclusive Cities, Sustaining Economic Growth', *McKinsey Global Institute*, April 2010; Meenu Tewari et al., 'Reimagining India's Urban Future: A Framework for Securing High-Growth, Low-Carbon, Climate-Resilient Urban Development in India', *Indian Council for Research on International Economic Relations*, Working Paper 306, August 2015.
75. 'PM Narendra Modi's Pet 100 Smart Cities project gets Cabinet's approval', *The Times of India*, 29 April 2015; '100 Smart Cities: Cabinet clears Smart Cities Mission with outlay of Rs48000', *The Indian Express*, 30 April 2015.
76. Narendra Modi, Speech, Prime Minister's Residence, New Delhi, 8 June 2014.
77. Arun Jaitley, Speech, 'Union Budget, 2014-2015'; 'Union Cabinet clears 100 Smart City Projects', *India TV*, 29 April 2015.
78. 'Cities of the Future? Indian PM Pushes Plan for 100 'Smart Cities'', *CNN*, 18 July 2014.
79. 'India Builds First 'Smart' City as Urban Population Swells', *Reuters*, 15 April 2015.
80. 'Japan Govt to get 26% Stake in DMIC Project', *The Hindu*, 18 June 2012.
81. 'Cities of the Future?'

82. 'US-India Joint Statement', The White House, 30 September 2014; 'US-India Business Council Hosts First Major Smart Cities Conclave for Ajmer', Press Release, *US-India Business Council*, 29 May 2015; 'Ancient Indian City of Ajmer Awaits its 'Smart' Makeover', *The Guardian*, 5 July 2015.
83. 'Timeline: How Countries lined up to Partner Modi's '100 Smart City' Project', *The Times of India*, 29 April 2015.
84. 'PM Narendra Modi's Pet 100 Smart Cities Project'.
85. 'PM's Remarks at the Launch of AMRUT, Smart Cities Mission and Housing for All (Urban)', Press Release, *Government of India*, 25 June 2015.
86. 'Ancient Indian City of Ajmer'.
87. 'Global Burden of Disease, Estimates for 2000-2012', Report, *World Health Organisation*.
88. Nick Watts et al., 'Health and Climate Change: Policy Responses to Protect Public Health', *The Lancet Commission*, June 2015, 1 & 24.
89. 'Gadkari Promises Digitalized, Eco-friendly Roadways', *The Times of India*, 7 January 2015.
90. 'Low Carbon Strategies for Inclusive Growth: An Interim Report', *Government of India*, May 2011, 17.
91. Jun Li, 'Decoupling Urban Transport from GHG Emissions in Indian Cities', *Energy Policy*, 39:6 (2011), 3512.
92. Venkaiah Naidu, 'Smart Leaders, Smart People can Only make Smart Cities', Press Release, *Government of India*, 14 September 2014.
93. 'Ancient Indian City of Ajmer'.
94. 'Ancient Indian City of Ajmer'.
95. 'Cities of the Future?'.
96. 'India's Great Metro-Rail Opportunity', *Business Standard*, 20 January 2015.

\* A note on reference style: to ensure clarity and presentation consistency with the *Briefing Paper* style, full web URL's are not included in the reference list. Readers wishing this information should contact Production Editor, Claire Denby [cdenby@unimelb.edu.au](mailto:cdenby@unimelb.edu.au)

Authors: Research Fellow Ben Parr and Public Policy Fellow Don Henry, Melbourne Sustainable Society Institute (MSSI)

MSSI at the University of Melbourne aims to provide concise, accessible briefings on topical sustainability issues in the Briefing Papers series. Each paper explores a topic country or area of concern and contention in a way that informs the general reader about the opportunities, challenges, and hopes for action. The papers translate sustainability research findings to provide the reader with information that is reliable and current.

Acknowledgements: The authors are very grateful to the following people for their comments and suggestions on earlier drafts of the paper: Grant Blashki, Roger Dargaville, Richard Eckard, Lawrence Molloy, and Aditya Pundir. Thanks also to Cathy Alexander, Peter Christoff, Claire Denby, Robyn Eckersley, Brendan Gleeson, Anne Steinemann, Leyla Stender, and John Wiseman for their support. This project was partly funded by a grant provided by the University of Melbourne's International Research and Research Training Fund.

Melbourne Sustainable Society Institute  
Level 3, Melbourne School of Design  
University of Melbourne  
VIC, Australia

[www.sustainable.unimelb.edu.au/briefing-papers](http://www.sustainable.unimelb.edu.au/briefing-papers)

@MSSIMelb

Briefing Paper 3

October 2015

Published by the  
University of Melbourne

The views and opinions contained within this publication are solely those of the author/s and do not reflect those held by MSSI of the University of Melbourne or any other relevant party.