सत्यमेव जयते

नीति आयोग

National Institution for Transforming India

Knowledge Initiatives

National Conference on Energy: Data Management, Modeling and GIS Mapping

A Report by

Energy and International Cooperation Vertical

(NITI Aayog)

10th August, 2016

Conference Agenda

National Conference on Energy:
Data Management, Modeling and GIS Mapping

10th August, 2016

Venue- Juniper Hall, India Habitat Centre, New Delhi

9:00-10:00 Hrs	Registration
10:00-11:00 Hrs	Inaugural Session
10:00 - 10:10 Hrs 10:10 - 10:20 10:20 - 10:30 10:30 - 10:40 10:40 - 10:55 10:55 - 11.00	Opening Remarks by Shri Amitabh Kant, CEO NITI Aayog Address on collaboration between DECC and NITI Aayog by UK High Commissioner, Delhi Address on collaboration between USAID and NITI Aayog by Ambassador, US Embassy, Delhi Address by Shri Anil Madhav Dave, Hon'ble Minister –Environment, Forest and Climate Change Keynote Address by Dr. Arvind Panagariya, Vice Chairman, NITI Aayog Vote of Thanks by Shri Anil Kumar Jain, Adviser NITI Aayog
11:00-11:30 Hrs	*Tea Break*
11:30-13:00 Hrs	*Geospatial Analysis for Renewable Energy* *(Chair – Ms. Varhsa Joshi, Joint Secretary, MNRE)* *Panelist:* • *Anthony Lopez, NREL(15Min)* • *Gaurav Kapoor, CSTEP (15 min)* • *P.G. Diwakar, Scientific Secretary, ISRO (15 min)* • *K. Bhoopati, Additional Director, NIWE(15 min)* *Discussions- 30 min*
13:00-14:00 Hrs	*Lunch*
14:00- 15:30 Hrs	*Energy Data Management* (Chair: Dr. Arunabha Ghosh, CEEW) • *Rajnath Ram, NITI Aayog (15Min)* • *Geeta Singh Rathore, MOSPI (15Min)* • *Ashok Sreenivas, Prayas Energy Group(15Min)* • *Ajay Kansal, DGM, DGH (15Min)* *Discussions: 30 Min*
15:30-16:00 Hrs	*Tea Break*

16:00 - 17:30 Hrs	*Integrated Energy Modelling* *(Chair- Dr. Kirit S. Parikh, IRADe)* *Presentations followed by Panel Discussion:* • *Avik Sarkar, OSD, NITI Aayog (10 min)* • *Ritu Mathur, TERI (15 min)* • *Vaibhav Chaturvedi, CEEW (15 min)* • *Leone Clark, BNL (15 min)* • *Vaibhav Chowdhary, DFID (15 Min)* *Discussions: 20 Min*
17:30 - 18:00 Hrs	*Valedictory Session*
17:30 – 17:35	Welcome remarks by Shri Anil Kumar Jain, Adviser (Energy & IC), NITI Aayog
17:35 – 17:45	Address by Shri Dharmendra Pradhan, Hon'ble Minister – Petroleum and Natural Gas
17:45 - 17:55	Remarks by Dr. Arvind Panagariya, Vice Chairman, NITI Aayog
17:55 – 18:00	Closing Address by Shri Amitabh Kant, CEO, NITI Aayog
18:30 onwards	*Cocktails & Dinner (Venue-Magnolia, IHC)*

Preface

India's growth story is now the subject of global interest. To support this growth, energy will play a key role in multiple ways - to meet the rising fuel demand, to spur growth through investment, and raise the standard of living of our citizens. A directional pathway to achieve such ambitious goals of meeting the energy needs of 1.32 billion people of India, NITI Aayog, as the think tank of the Government of India, launched 2 versions of the energy planning tool – India Energy Security Scenarios, 2047. We continue to develop such tools and deploy them towards devising a robust energy policy.

This compilation, Knowledge Initiatives - A Report of Energy Division, is intended to put together in one place, the products of collaborative efforts of NITI Aayog and its national and international partners in the energy space. Over the years, the Energy Division of NITI Aayog has strived to harness the competencies of the best in class energy think-tanks in India and overseas abroad, towards devising a sustainable and secure energy pathway for the country. In the above pursuit, it has provided knowledge inputs to the line energy Ministries/Departments, both on the demand and supply sides.

In Government of India has recently conceived a transformational vision in the energy domain. The target for renewable energy capacity of 175 Gigawatt by 2022, provision of 24 X 7 power across the country by 2019, reducing crude oil import dependence substantially, and providing 5 crore rural poor with LPG connections, are unprecedented campaigns in the developmental history of India. These programmes call for coordination, long term planning and integration, a task which is being undertaken by NITI Aayog. The State Governments also have a key role to play in the energy agenda, and NITI Aayog is well placed to bring them on board. The launch of State calculators (on the lines of IESS, 2047) and a high-powered mechanism to address issues of integration of renewable energy are initiatives to seek the cooperation of the States.

As India increasingly confronts energy security and energy related climate change challenges, we have to respond with innovative knowledge based solutions. The Energy Division stands ready to fulfil these is expectations. There is a vast potential in our institutions, both in the government and private space, to support the transformational agenda of the country. We are also privileged to receive cooperation from our overseas partners from friendly countries. The contribution of US National Labs and DECC, UK stand out for special mention. NITI Aayog is ready and excited to play out its role in this national agenda.

Date: 2nd August, 2016

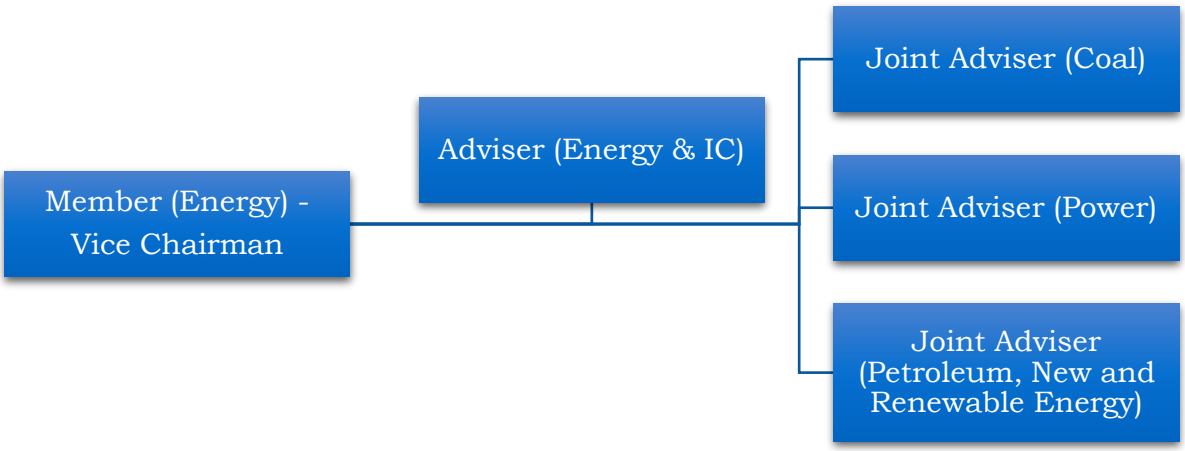
(Anil Kumar Jain)
Adviser (Energy & International Cooperation)

Executive Summary

Structure of the Vertical

The Energy and International Cooperation Vertical handles all aspects of the value chain of the energy sector. The areas of focus are sub-divided into Power, New & Renewable Energy, Coal, Gas, Nuclear and Petroleum. Overseas engagements in the space of Energy and Climate Change also form a part of the work profile of this vertical.

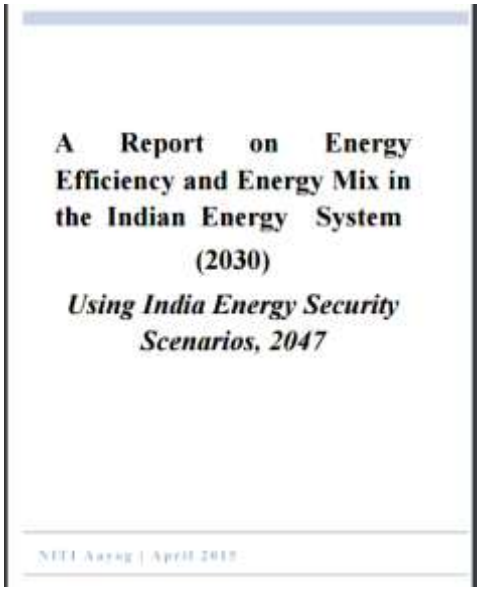
The structure of the personnel in the vertical is as follows:



In addition, the vertical is assisted by an Officer on Special Duty, two Senior Research Officers, a Research Officer, and three Young Professionals.

Energy Sector

1. NITI Aayog has been entrusted with task of framing the National Energy Policy (NEP). As the first step, NITI Aayog, with the help of its Knowledge Partners, carried out a series of consultations with Government departments, Industry, Academia, Regulatory Bodies and institutions for inputs on key thematic areas. These inputs were then woven into policy document, the draft of which was circulated to all line ministries in March 2015.


A Report on Energy Efficiency and Energy Mix in the Indian Energy System (2030)

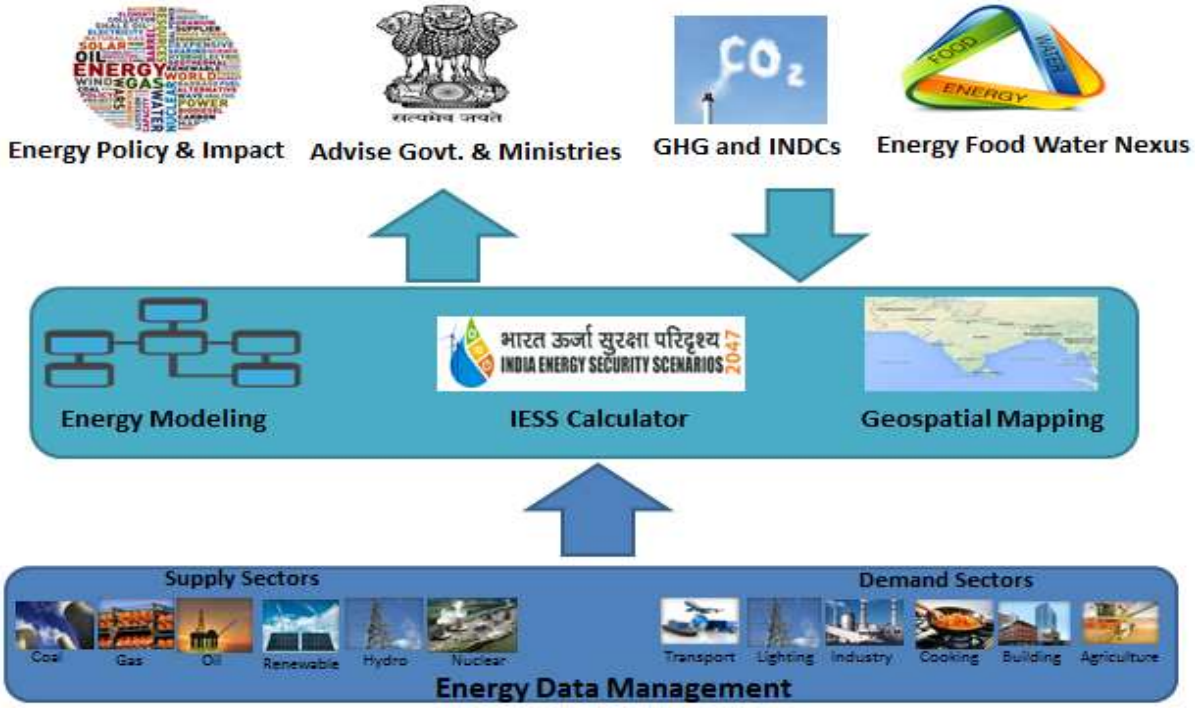
Using India Energy Security Scenarios, 2047

2. A sub-committee was constituted by Ministry of Power, and led by Adviser (Energy), NITI Aayog, for finalising India's possible energy mix till the year 2030 to provide inputs to the formulation of India's Intended Nationally Determined Contributions (INDC). The

electricity demand in 2030, along with various other parameters proposed from the IESS, 2047 were majorly incorporated by the Ministry of Environment, Forest and Climates Change while framing the final INDCs.

3. NITI Aayog, in collaboration with the International Energy Agency and TERI, organised a workshop titled 'India Energy Outlook' on April 13, 2015. The workshop was a part of the IEA's 2015 edition of the World Energy Outlook, which has an in-depth focus on India. The vertical was also instrumental in providing key inputs for the development of the same.

4. As a part of the Sustainable Growth Working Group (constituted under the India-US Energy Dialogue Framework), in the spirit of encouraging collaboration between the Indian and the US research communities, NITI Aayog has identified topics to conduct studies in areas of energy. The areas of collaboration are (i) Energy Data Management, (ii) Comparison of energy models and (iii) Geo-spatial mapping.



The above figure provides an overview of the various activities that the Energy vertical at NITI Aayog is involved.

- Advise and collaborate with the various Energy supply or demand ministries to evaluate energy needs and impact and suggest the optimal way forward e.g. National Energy Policy
- Develop an ecosystem for good quality energy data management in India
- Evaluate and study impact of various global and national scenarios by means of activities like energy modelling, model comparison and geospatial mapping
- Continue consultation with ministries on various scenarios using the IESS 2047 tool
- Facilitate and fund various research projects on energy use and impact with domestic and international partners
- Involve in review of the infrastructure projects/programs at the Prime Minister level
- Collaborate with National and International like-minded think tanks

कार्यक्रम

इंडिया एनर्जी सिक्योरिटी सिनेरियोज-2047 विषय पर राष्ट्र स्तरीय सेमिनार का आयोजन

'हमें एनर्जी को सिक्योर भी करना चाहिए'

विडिम हाईकमीशन के लोग भी आए

In 2014, the then Planning Commission developed the Government of India's first dynamic and interactive web based scenario building tools for the Indian energy sector, **India Energy Security Scenarios, 2047**. Keeping in mind the rapidly changing energy landscape of India, NITI Aayog developed a revamped version of the IESS, 2047, factoring in newer outputs, new technologies, and sectors that are gaining importance in the present scenario. To keep the tool relevant in the present policy space, the IESS V2.0 also builds in the recent development goals of the Government of India.

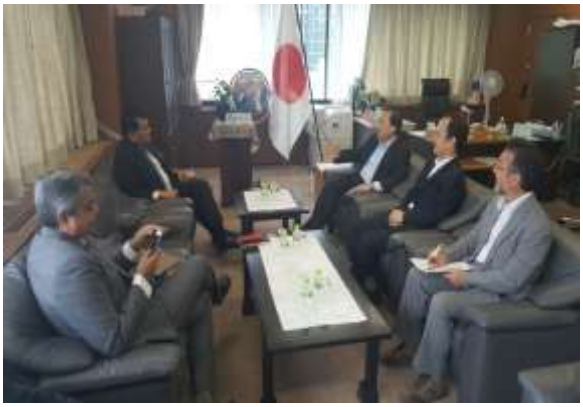
The IESS team conducted **nationwide outreach workshops** to

increase the usability of this tool in tier II cities, educational institutions *etc.*

The IESS has **recorded ~52000 visits till date**, and is being used as a platform for shaping the vision of the National Energy Policy.

Overseas Engagements in the Energy Space

1. NITI Aayog signed a Statement of Intent (SOI) with the International Energy Agency in March 2016. The SoI entails the exchange of ongoing joint research on relevant technologies, and analysis of global trends in pricing and supply of energy supplies, plus development of human resources development strategies for the energy sector.



2. NITI Aayog finalized cooperative frameworks with the Development Research Centre (People's Republic of China) and PEMANDU (Malaysia).

3. Adviser (Energy) as India's Principal Representative to the G-20 Energy Sustainability Working Group led discussions in Turkey in 2015, and continues to participate this year in China's leadership of G-20.

4. NITI Aayog has signed Statement of Intent with the Institute of Energy Economics, Japan (IEEJ) to promote co-operation for the purpose of analysing issues related to the Energy Sector.

5. Representatives from the vertical also participated in the Joint Working Group meeting on Sustainable Growth held at Washington DC, USA during September, 2015.

6. Subsequent to the signing of the finalization of the cooperative framework between NITI Aayog and Development Research Centre (DRC), of People's Republic of China, a dialogue was held at Beijing in November 2015. Discussions were also held with the top civic officials at Tianjin and Shenzhen in China.

Networking with Knowledge Partners

The Energy vertical collaborates actively with various national and international agencies, including industries, academia, think-tanks etc. for research inputs for different sectors in the energy value chain. Some of the agencies that collaborated with the energy vertical for the various projects in the year 2015 – 16 were the Prayas Energy Group, Center for Study of Science, Technology, and Environmental Policy (C-STEP), Integrated Research and Action for Development (IRADe), Centre for Policy Research, TERI, Council On Energy Environment and Water (CEEW), India Smart Grid Forum, FICCI, CII, Shakti Sustainable Energy Foundation, Petrofed, Alliance for an Energy Efficient Economy (AEEE) from India and international partners like National Renewable Energy Laboratory (NREL), Lawrence Berkeley National Laboratory (LBNL), UK Department of Energy and Climate Change (UK DECC), Pacific Northwest National Laboratory (PNNL), Brookhaven National Laboratory (BNL), USA among others.

Engendering debates on key energy issues – Contribution to NITI Blogs

The Energy Division has contributed to the intellectual discussions in the space of energy by contributing to the NITI Aayog Blogs. Blogs titled "Our Rising Energy Imports - What does it mean?", "Electricity and Clean Cooking Strategy for India", "NITI Aayog Collaborates with Top Global Energy Think-tanks", and "NITI's energy sector planning tool — IESS, 2047" have been contributed to engender debates on the current issues being faced by the Indian energy space.

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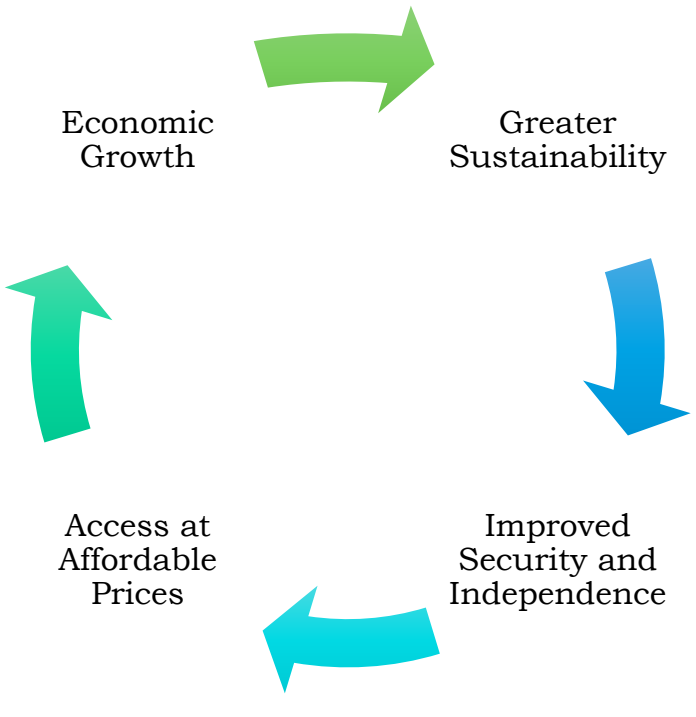
Energy Sector Activities

National Energy Policy

The President of India, in his address to both Houses of the Parliament on June 9, 2014 expressed the Government's decision of developing a new "comprehensive National Energy Policy" (NEP) for India. Consequently, the Prime Minister's Office delegated the responsibility of formulating this new policy to NITI Aayog.

The last omnibus policy statement for the Indian energy sector, the "Integrated Energy Policy" was launched in 2008. The energy scenario of India has witnessed many transitions since then. In 2014, India was the world's fourth largest primary commercial energy consumer. Additionally, while global energy demand growth slowed down, India's demand grew at 7% in 2014, the highest amongst the leading economies of the world. This changing landscape signals the need for a new vision – and therefore, the new energy policy, which focusses on a market based approach for achieving India's energy sector objectives, began to be conceptualized.

In view of the fact that energy is handled by different Ministries that have the primary responsibility of setting their own sectoral agenda, an omnibus policy is required to achieve the goal of energy security through coordination between these sources. This is also expected to mainstream emerging energy technologies, and provide different energy choices to the consumer. The new energy policy focusses on the four key objectives of Access at affordable prices, improved security and Independence, Greater Sustainability, and Economic Growth. The NEP proposes actions to meet these objectives in such a way that India's economy is 'energy ready' by the year 2040, the medium term. It builds on the achievements of the "Integrated Energy Policy", and sets the new agenda consistent with the redefined role of emerging developments in the world of energy.



Recognizing the need for making the new policy as inclusive and collaborative as possible by taking key energy sector stakeholders on board, NITI Aayog initiated the process of policy development by conducting a consultation with key think tanks working in the Indian energy space. Subsequently, to lay the foundation for conceptualizing the new policy, Vice Chairman (VC), NITI Aayog met a group of eminent economists of India on 25th August 2015. Following the same, a meeting between MOS (Power), MOS (Petroleum & Natural Gas), MOS (Environment, Forest & Climate Change) and VC, NITI Aayog was held on 15th September, 2015. In October and November 2015, 9 Stakeholder workshops hosted by NITI and partner think-tanks on an identified equal number of salient themes were held, which witnessed wide participation of State Governments, Central Electricity Authority, Bureau of Energy Efficiency, Central Electricity Regulatory Commission, line ministries, Public Sector Undertakings, the private sector and the academia. The themes for the consultation workshops and the partner agencies are enlisted below:

Consultation Workshop	Agencies
Coal and Gas based Thermal Power	Prayas Energy Group
Oil & Gas	Petrofed
Nuclear and Renewable Energy	Center for Study of Science, Technology and Environmental Policy
Energy Markets	Shakti Sustainable Energy Foundation
Demand Sectors and Energy Infrastructure	TERI
Industrial Framework and Energy Data Issues	Centre for Policy Research
Energy Access and Technology	Council on Energy, Environment and Water
Energy Efficiency	Lawrence Berkeley National Laboratory and FICCI
Air Quality/Emissions	IRADe

A draft version of the policy was then prepared in March 2016, and was circulated to the concerned line ministries for their comments. Following the same, two consultations were held with the MOS (Petroleum) and MOS (Power) respectively, in April and May 2016 in order to gather their views on the recommendations made by the policy.

Currently, the comments of the inter-ministerial consultations are being incorporated into the draft energy policy by NITI Aayog. The version so revised, is intended to be made open to the public for their comments.

Inputs to INDC

Ministry of Environment, Forests and Climate Change (MoEF &CC), Government of India requested the Ministry of Power (MoP) to provide inputs for determining India's Intended Nationally Determined Contributions (INDCs) for submission to COP-21 (Paris). To firm up the views of the Ministry with respect to the above communication, a meeting chaired by Special Secretary, MoP was held with participation from NITI Aayog, wherein NITI Aayog was requested to provide inputs on determining the INDCs via energy projections till the year 2030 with the help of India Energy Security Scenarios, 2047 (IESS).

As mentioned earlier, IESS 2047 enjoys the advantage of allowing sector specific projections to be made and yet aggregate the entire energy system. In the Indian setting, where different energy sources are planned separately (and often without synergy with others), it becomes important to identify sectoral targets and yet subject them to stress tests in an aggregate scenario. Accordingly, it was possible to adopt electricity projections for the year 2030 using IESS. The other forms of energy (solid and liquid) were generated using the same assumptions which were applied for electricity, thereby allowing estimations of energy efficiency and energy mix as well.

The above inputs were provided to the Ministry of Power, which served as one of the several inputs towards finalising the INDCs. As per the above exercise of NITI Aayog, India will be achieving a satisfactory energy sector transformation in the year 2030. The per capita energy consumption and electricity consumption will have grown at a CAGR of 3.6% and 5% respectively. The CAGR of energy supply will grow at 4.8% which will be able to support a GDP CAGR of 7.9% (keeping 0.61 elasticity of energy demand to GDP, an improvement from the present and 0.8 elasticity of electricity demand to GDP). As regards energy efficiency, the economy will have registered a drop in specific energy consumption across all consumption sectors other than transport and residential buildings at a rate which will be higher than the historical ones. In transport, due to a high growth rate in personal transport, the gains made by a higher share of public transport will get negated to some extent leading to a higher SEC. On the issue of energy security, due to high transport demand where alternative fuels are yet to set in, the share of oil will remain high in the energy mix and coupled with the fact that there is a poor domestic oil production; India's overall import dependency is expected to rise. However, the energy mix will move in favour of renewable energy as is evident from the fact that the share of renewable energy (excluding large hydro) in the electricity mix of the economy will rise to 14.3% in 2030 from 5.5% in 2012. But due to the large demand of energy requirement of the economy, and adequate availability of coal reserves, the share of coal in the energy mix is set to rise from 46% in 2012 to 52% in 2030. This will have a negative impact on emissions which are set to rise from 1.7 tons/capita 2012) to 4.2 tons/capita in the year 2030.

The above conclusions have been drawn by assuming Level-2 (determined effort) suitably modified as per recommendations of the MoP-led committee which factored in the present policies of the Government which will move in the positive direction

in the years to come. It was also acknowledged that if there was large fund availability, especially from OECD agencies including multilateral funding, India could easily move to the Level-3 (aggressive effort) which would have a salutary effect on raising energy efficiency level as well as de-carbonizing the Indian energy system. The energy demand sectors of the economy have been witnessing a near 1% rise in energy efficiency, and could register even yet higher increases if there were substantial investments in infrastructure. A comparative analysis with OECD countries would reveal, that a rising population and energy supply needs major investments in the energy which is not the case in OECD. The new infrastructure could be made more efficient and less carbon intensive, if substantial investments were to be made in public transport, renewable energy and other forms of low carbon energy supply, namely, bio-fuels and nuclear. These investments are massive and difficult to source in the present domestic and international policy framework, but are cost effective. Therefore, the constraint is not of economic viability, but of capital requirement. Technology is also expected to play a major role not only in demand sectors wherein it could reduce SEC, but also raise the share of sustainable sources of energy. At present, such technologies which have been developed in the West, are high priced and have not been factored in for high levels of penetration. In summation, the above exercise leads us to believe that India could ramp up to much needed high doses of energy in a more efficient and cleaner manner, if there was an international effort to help in transformation of the Indian energy system.

G20 Dialogue on Energy and International Cooperation

The G20 is an international forum for the Governments and Central Bank governors from 20 major economies. It includes the European Union (EU), which is represented by the European Commission and the European Central Bank, and 19 countries: Argentina, Australia, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, the Russian Federation, Saudi Arabia, South Africa, South Korea, Turkey, the UK and the US.

The Energy & International Cooperation Vertical of NITI Aayog participates in the G20 Energy Sustainability Working Group (ESWG) and Energy Ministerial Group. Adviser (Energy & IC) is India's Principal Representative to the ESWG and co-ordinates India's response to agenda issues across energy sub-sectors. Details on the various G20 Energy meetings held in China in 2016:

On January 28th 2016, first G20 Energy Sustainability Working Group Meeting hosted by the National Energy Administration of China (NEA) was held in Xiamen. About 150 delegates from G20 members, guest countries and relevant international organizations participated in the meeting. Delegates had initial discussion on topics including energy access, clean energy, energy efficiency, global energy governance, implementation of previous commitments, and agreed to work together towards further progress through this year's G20 energy agenda.

Building on the outcomes from the First G20 Energy and Sustainability Working Group meeting on 28thJanuary 2016 in Xiamen, China, G20 member countries discussed the advancement of energy efficiency, clean energy, energy access, and global interconnections, with a focus on the possible outcomes of the Second G20 Energy Ministerial Meeting.2nd G20 Energy Sustainability Working Group Meeting was held from 12th-14thApril 2016 in Shenzhen, China. Discussions were held over the period of 3 days comprising of working group sessions and side events. The working group was divided into 4 sessions for discussing the zero draft on G20 Energy Efficiency Leading Programme, G20 Renewable Energy Action Plan, Enhancing Energy Access in Asia and the Pacific: Key Challenges and G20 Action Plan and the G20 Energy Ministerial Meeting Beijing Communique. Sh. Surinder Singh Sur, Joint Adviser (Energy), NITI Aayog along with officials from MEA and MNRE represented India at the meeting.

The 3rd Energy Sustainability Working Group meeting was held on 28th June, 2016, Conference on Energy Access was held on 29th June, 2016 and Energy Ministerial Meeting was held on 30th June, 2016. G20 Natural Gas Day was also held on 29th June, 2016 in Beijing, China. Officials from 27 countries and relevant international organizations were gathered with the common goal to push forward global energy sustainable development. Shri Anil Kumar Jain, Adviser (Energy), NITI Aayog and Shri Surinder Singh Sur, Joint Adviser (Energy), NITI Aayog represented India at the meeting. As one of the specialized ministerial meeting before the G20 Hangzhou Summit, this meeting was themed *"Shaping a Low-carbon, Smart and Sharing Energy Future"*. In the two-day event, participants had in-depth discussion and reached broad consensus on topics including opportunities and challenges on global energy development, energy technology innovation, demand and current policy on energy access. The meeting adopted 4 outcome documents, including one major document, namely the G20 Energy Ministerial Meeting Beijing Communiqué, and 3 affiliated documents, namely Enhancing Energy Access in Asia and the Pacific: Key Challenges and G20 Voluntary Collaboration Action Plan, G20 Voluntary Action Plan on Renewable Energy and G20 Energy Efficiency Leading Programme.

New and Renewable Energy

1. Catering to a request of the Ministry of Finance, NITI Aayog constituted an Expert Group for proposing the financial options to meet the 175 GW target for renewable energy by 2022. The group made a bold assessment for moderate public funding and reinforced the need for robust non-monetary interventions to achieve this target.

2. NITI Aayog constructed a "Report on India's Renewable Electricity Roadmap 2030" which summarizes the opportunities and barriers to renewable Energy and the rationale as well as the benefits and costs of its adoption within the context of the Indian Power System. This was done by a comprehensive stakeholder-driven "roadmap" exercise. The report was launched in February, 2015 during RE-Invest-2015.

3. The theme Chapter on 'Renewable Energy Sector' of Appraisal Document of 12th Plan was contributed by the vertical.

RE Roadmap 2030

In November 2015, the NITI Aayog (erstwhile Planning Commission) initiated a stakeholder driven analysis of the opportunities and barriers to rapid deployment of renewable electricity. The process to arrive at the report entitled "Report on India's Renewable Electricity Roadmap 2030" was facilitated by NITI Aayog, in conjunction with its role of co-leading the 21st Century Power Partnership (21CPP), a multilateral effort of the Clean Energy Ministerial. The initiative was guided by a steering committee led the by then-Member (Energy), Planning Commission of India. Members of the committee included Secretaries from key Ministries (Power, New and Renewable Energy, Finance, Environment and Forests), Chairpersons from key central level agencies (Central Electricity Authority, Power Grid Corporation of India Limited), and Energy Secretaries from two representative states (Tamil Nadu and Rajasthan).

The NITI Aayog appointed CII as an operating agent for the 21Century Power Partnership (21st CPP), Shakti Sustainable Energy Foundation and Regulatory Assistance Project (RAP) engaged as knowledge partners constituted the RE Roadmap initiative team. The team implemented a comprehensive, stakeholder driven "Roadmap" exercise to answer the question: "How must the Indian power sector evolve if India chooses to put RE at the core of the future system, rather than at the periphery?"

The initiative team conducted extensive consultations with close to 250 stakeholders including the steering committee members, chairpersons, and senior staff central and state electricity regulatory commissions, Energy secretaries of states, managing directors of generation, transmission, and distribution companies, grid operators and managers, power planning agencies, civil society, industry, finance, developers, and bilateral and multilateral institutions in 12 states, and Delhi. The initiative's findings and subsequent recommendations in draft form were sent or presented to over 100 individuals, groups, and institutions, as well as international experts, for their responses.

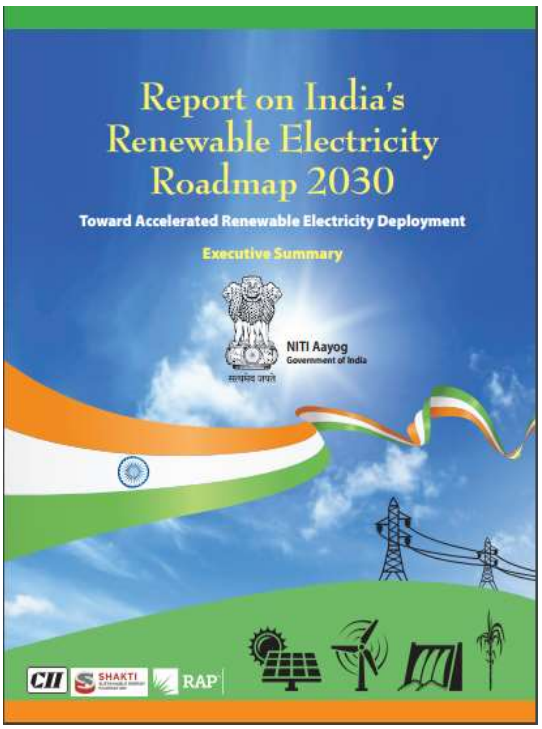
The report thus prepared was launched in February, 2015 during RE-Invest-2015. This report summarizes both the process and the results of the stakeholder exercise. It presents the opportunities and barriers to RE as reflected by stakeholder input and provides a summary of the rationale as well as the benefits and costs of RE within the context of the Indian power system. Then, drawn from

stakeholder input and international experience, the paper suggests a framework for an integrated policy strategy for rapid RE implementation that complements both the existing and planned conventional power projects. The framework includes:

- A new comprehensive National RE Law and/or Policy, and its components,
- Support mechanisms to ensure timely implementation,
- Grid reforms to ensure smooth integration of RE.

Phase II

Through the RE Roadmap 2030 report, it was recognized that achieving India's developmental goal of 175 GW of Renewable Electricity (RE) by 2022 will require new initiatives from Centre and state governments — beyond policy and programs currently in place — to support the engagement, participation, and new behaviours of power sector stakeholders.



In order to put in place a strong implementation machinery to aid the above electricity sector transformation, and carry out the recommendations of the aforementioned report, an implementation assembly with a two-tier structure has been constituted. This consists of an "Advisory Group", and a "Steering Committee".

NITI Aayog is being assisted by its knowledge partners- Shakti Sustainable Energy Foundation and Confederation of Indian Industry in driving this initiative. The Advisory Group is benefitted by the participation of Energy Ministers, and the Steering Committee by the presence of Energy Secretaries, in charge of the Renewable Energy departments from selected states. For the purpose of this exercise, 10 states, of differing resource potentials have been identified. These are namely, Rajasthan, Tamil Nadu, Madhya Pradesh, Gujarat, Andhra Pradesh, Telangana, Karnataka, Maharashtra, Assam and Punjab. NITI Aayog, CII, and Shakti Foundation aim to work very closely with these states to draw out individual State Action Plans for the implementation of the aforementioned report.

Expert Group on 175 GW RE by 2022

Today, India's 275 GW of installed electricity generating capacity is significantly higher than 140 GW of peak demand. In fact, India's coal generation capacity alone is higher than its peak demand.

Despite installed capacity exceeding power demand, some parts of the country face acute power shortages. The critical reasons are – coal supply shortages, high level of transmission and distribution losses, and poor financial health of utilities. Further, unlike domestic coal, the price of imported coal is unregulated; its price can be quite volatile. Imported coal in the recent past has been significantly more expensive than Indian coal. Distribution companies (DISCOMS) that buy electricity generated with imported coal face significant and unpredictable upward pressure on tariffs. Some utilities have tried to avoid these high costs by simply not buying power, even when the result is local shortages, rolling blackouts, and increase in fixed costs.

These fundamental problems in the power sector are hampering the efficient use of the existing system to even meet the grid-connected demand. On top of this, more than 400 million people in India are still waiting for access to electricity1. Rampant load-shedding and low-quality electricity supply forces people to resort to private, local, costly and dirty solutions such as diesel generators, which pose both health and environmental concerns. On top of this, estimates suggest that by 2021-22, India's electricity demand will be more than double the level in 2011 – 2012.

One of India's major advantages today and going forward is that its renewable energy (RE) potential is vast and largely untapped. Recent estimates show that India's solar potential is greater than 750 GW and its announced wind potential is 302 GW (actual could be higher than 1000 GW). India Energy Security Scenarios 2047 show a possibility of achieving a high of 410 GW of wind and 479 GW of solar PV by 2047[2]. The potential of biomass and small hydro is also significant. Thus, renewable energy has the potential to anchor the development of India's electricity sector.

The question that is still unanswered is the need to do RE. From a broad public policy perspective, the major benefit of a rapid transition to RE will be the positive effect on India's macroeconomic circumstances. Tapping into abundant indigenous renewable resources could avoid revenue outflows for expensive imported fuels. At the current time – without innovative policy changes – India is facing a rapidly rising and volatile imported coal bill far into the future. India's coal imports in 2014-15 were already at 212 million tonnes and over 1 lakh crore[3]. Economic principles might suggest that we should be able to find something to export – the facts on the ground suggest that it is not easy.

[1] http://energymap-scu.org/energy-in-india-spotlight/energy-access-introduction/
[2] http://www.indiaenergy.gov.in/docs/RE_Documentation.pdf
[3] http://indianexpress.com/article/business/business-others/fy15-coal-import-bill-spills-over-rs-1-l-crore/

From a pure macro-economic perspective, reaching 175 GW RE by 2022 could dramatically reduce the coal import bill in 2022. Then there are environmental benefits (less pollution), social benefits (local employment opportunities) and investment inflows, which may need to be monetized to assess the complete range of benefits. But, to capture the benefits of RE, India would need to make available the necessary capital, and get comfortable with managing the variability and uncertainty of RE generation in conjunction with the existing and planned fossil fuel-based and large power plants.

In April 2015, the Ministry of New and Renewable Energy (MNRE) had submitted proposals to the Expenditure Finance Committee (EFC), Government of India, for funds to support achievement of 100 GW solar by 2022. MNRE vide D.O. No. JS (NSM)/MNRE/2015 dated 22nd April, 2015 requested NITI Aayog to set up an Expert Group to look at various aspects connected with the scale up plan including the matter like availability of equipment, manpower, financial resources. Subsequently, a meeting was held between NITI and MNRE on 12.05.2015 to decide the modalities and expert group members. MNRE was of the view that the Group should look overall 175 GW of scale up plan and solar rooftop in particular, while Department of Expenditure vide O.M. No. 59(o6)/PFII/2009 (part) dated 12.05.2015 issues the minutes of Expenditure Finance Committee (EFC) which inter-alia asked "NITI Aayog to constitute a group of expert for exploring possibilities of Grid-Connected Rooftop system and various business models which can be implemented in the country". NITI Aayog formulated this Expert Group in June 2015. The Expert Group consists of –

- Chairman: Mr. Anil Jain, Advisor (Energy), NITI Aayog
- Convener: Mr. Rajnath Ram, Joint Advisor, NITI Aayog

Members –

- Mr. Ashwin Gambhir, Prayas Energy Group
- Dr. Anshu Bharadwaj, Center for Study of Science, Technology and Policy
- Mr. Deepak Gupta, Shakti Sustainable Energy Foundation

The Expert Group was assisted by Dr. Gireesh Shrimali, Climate Policy Initiative.

The Expert Group strongly felt that in the first place, all non-financial support options should be made available to RE e.g. project development, policy support, legislative enablers, and coordinated implementation ecosystem. Such interventions are critical to reach the 175GW RE targets. The ecosystems should also ensure that all direct and indirect incentives should get reflected in the tariff of RE at the procurement end. Further the incentive design and procurement mechanism should be specific to the characteristics of resource and technology under consideration.

Task Force Report on Solar and Wind

The Planning Commission vide its order dated 24th June, 2013 constituted a Task Force under the Chairmanship of Shri B.K. Chaturvedi, Member (Energy) to coordinate different activities relating to solar energy, integrate solar power in the electricity grid and provide marketing support to this power, and build solar sector considering the satisfactory progress made under the Jawaharlal Nehru National Solar Mission, even beyond the 13th Plan Period. Subsequently, it was also decided to consider issues being faced by the wind sector. It was felt that many concerns were similar to these two renewable energy sources, and could be addressed commonly.

The constitution of the Task Force was as follows –

1. Shri B.K. Chaturvedi, Member (Energy), Planning Commission, Chairman
2. Chief Economic Adviser, MoF, Member
3. Secretary, Power, Member
4. Secretary, MNRE, Member
5. Secretary, DIPP, Member
6. Secretary, DEITY, Member
7. Advisor, (Energy), Member
8. Secretary, CERC, Member
9. Chairman, SBI, Member
10. Director General, FICCI, Member
11. Director General, CII, Member
12. JS, Solar, MNRE, Member

The Task Force was authorised to co-opt officials from related organizations from time to time.

The Terms of Reference (TOR) of the Task Force was as follows –

- To suggest policy interventions for improving domestic manufacturing;
- To suggest measures to enhance availability of cost-effective finance;
- To ensure effective implementation/strengthening of the REC mechanism;
- To address issues related to evacuation of solar power and development of green corridors;
- To seek involvement of State Governments for solar capacity development.

To ensure that Government actions are aligned with the country's energy security goals, the Task Force was guided by the following overarching principles –

1. *Finance related recommendations*

1.1. Financial support to renewable energy

- Grant of subsidy/VGF for development of RE in the short term
- Ensure compliance of RPOs by DISCOMS
- Dedicate a percentage of National Clean Energy Fund for RE projects
- Increase the term loan period up to 25 years through DFIs
- GOI to provide hedging cover to the foreign exchange component of the debts raised for RE projects

1.2 Enhance availability of funds to the solar/wind sectors

- A separate exposure limit may be established for financing RE sector by banks
- Banks to come up with specific schemes to provide loans for off-grid solar RE projects
- Initiate measures to access foreign funds through a local financial institution.

1.3 Reduce perceived risk of banks.

- Creation of a fund to provide risk cover to a portion of bank finance
- Introduce a system of certification of solar equipment
- Train the bankers to assess the true viability of RE projects.

2. Manufacturing related recommendations

2.1 Support for up-gradation of technology
2.2 Remove duties on raw-material to reduce the cost of domestic manufacture
2.3 Provide assured market for domestic manufacturers through DCR
2.4 Introduce QC check for ensuring quality of imported materials.

3. Infrastructure related policy measures

3.1 Up-gradation of grid to facilitate integration of solar and wind energy
3.2 Up-gradation of transmission infrastructure
3.3 Establishment of solar parks

4. Regulatory Support

4.1 Granting statutory backing to RPOs
4.2 Modification of REC mechanism to make it more practical
4.3 Lower wheeling charges for renewable energy
4.4 Introduce nation-wide regulations to promote roof-top solar projects
4.5 Issue "must run" status for solar and wind power projects.

5. Support through GOI measures

5.1 Statutory measures:

- Amendment of Electricity Act.2003
- Enforce use of RE based products (provision for RPOs in the Electricity Act, 2003)
- 5.2 Issue policies for development of renewable energy by Government Departments/Organization
- All conventional energy companies to generate a fixed percentage of their generation through renewable energy (provision RGOs in the Electricity Act, 2003)
- Reduce taxes on RE products
- Support from State Governments/DISCOMS

6. *State Government related policies for encouragement of RE*

6.1 Issue policies for RE, including net-metering and grid-connectivity for roof-top solar PV
6.2 Development of transmission infrastructure
6.3 Allow use of Government land and facilitate change of land use for RE.

The above Task Force held three meetings, identified various issues which needed to be addressed and considered interventions of the Government. However, the recommendations could not be adopted by the Task Force during the currency of the erstwhile Planning Commission. During the deliberations, following broad suggestions were made by the members of the Task Force and participants at the meetings –

- Setting up of Ultra Mega Solar Projects and Roof-Top Solar Projects to meet the upscale solar target of 1,00,000 MW by 2020;
- Substituting kerosene for lighting and cooking purposes in rural areas with Solar Energy/Heating;
- Expediting the project "Green Corridor" for transmission of renewable power;
- Enforcement of RPO by all the States and taking action to amend the Electricity Act. 2003 to increase penalty for non-fulfilment of RPO, and make it mandatory;
- Bringing down the cost of equipment to make it help achieve grid parity;
- Support domestic market manufacturing through subsidy, to provide level playing field with imported solar equipment;
- Need for providing finance for the Wind Project developers for achieving the 12th Plan target of 15 GW and NAPCC target of 60 GW by 2022.
- Need for low interest rate loans from financial institutions and also encourage non-recourse financing in the future.
- Solar and Wind could be made amenable to decentralized distribution;
- SERCs need to show support for RE as per Electricity Act.2003
- Identify major reasons for low capacity expansion in the States and find ways to improve the sector.

Building Energy Efficiency

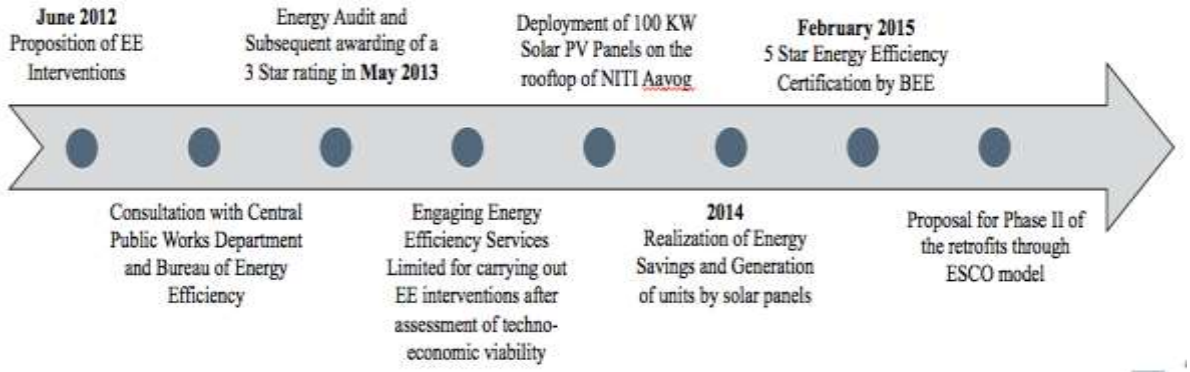
Energy consumption in buildings can be broadly categorized under heating, water heating, cooling, ventilation, lighting etc. Residential and Commercial sectors account for 29% of the total electricity consumption in India and this share is rising at a rate of 8% annually. A significant part of this percentage goes into meeting the energy demand from heating, cooling and lighting. The Indian commercial sector exhibits a massive savings potential on the demand side, through energy efficiency interventions. As per one estimate, there is going to be a rapid growth in buildings in India and the present building space will comprise only 30% of the likely covered area in 2030. Hence, buildings will continue to be a major energy guzzler in the Indian context. There is also an opportunity, which can be leveraged on the supply side by introducing renewable energy generation in buildings.

For the realization of the above, there is a need for tackling various gaps including the problem of information asymmetry through the propagation of project experiences and best practices and the issue of transactional barriers. While new buildings are already adopting efficient technologies, it is the existing stock of buildings which offer a challenge to the economy. It is little appreciated that energy efficiency is also a money-saver in a short period, and the ESCO model even obviates the need for the building owner to spend money, which is sometimes a vital concern in Government.

The Government at various levels from New Delhi to panchayats, is also a major energy consumer in its offices, hospitals, railway stations, PSUs and staff colonies. Energy efficiency measures in these existing facilities can save enormous quantities of energy and catalyse a new set of entrepreneurs as ESCOs and RESCOs. NITI Aayog (Erstwhile Planning Commission of India) has recently set a national precedent by initiating two types of energy efficiency interventions. The process of introducing energy efficiency in NITI Aayog started in June 2012. In close consultation with the CPWD and the Bureau of Energy Efficiency, two interventions were proposed:

- Facilitation of the applicability of energy efficiency retrofits in order to move towards securing a BEE 5 star rating for its office.
- Approaching the MNRE in parallel, for the assessment of the feasibility and subsequent deployment of Solar PV panels on the rooftop of NITI Aayog.

NITI Aayog undertook this exercise as a proof of concept for adoption of energy efficiency measures in buildings, particularly those of the Government. Undertaking this exercise helped scale the wall of the barriers for easy adoption of energy efficiency interventions in government buildings.



The exercise is being carried out in two phases. Following the completion of Phase I of the retrofits which targeted 60% of the building load, and the deployment of Solar PV panels on the rooftop of the office building, NITI Aayog has been awarded the 5 Star energy efficiency rating by the Bureau of Energy Efficiency in February 2015. It has also, with the help of the rooftop solar PV panels, started generating its own electricity, which feeds into the electricity grid and is available for use at a reduced tariff. Phase II of the exercise, which targets 30% of the building load not covered under phase I, is being undertaken through the ESCO model.

NITI Aayog, after receiving the **Five Star Energy Efficiency Rating** from the Bureau of Energy Efficiency in February 2015, became the first Government Building in India to achieve this rating by carrying out an energy efficiency retrofit. NITI Aayog also received the **National Energy Conservation Award 2015** for the same in December 2015. Backed by a successful evidence base, NITI Aayog was also able to bring about a policy change for the implementation of the ESCO model in all Government buildings in Delhi.

Energy Data Management, Modelling and GIS Mapping

Energy Data Management

Robust energy data is essential to formulate and analyse policies for promoting energy security and sustainable development; data is used by government policy makers and by the research community to explore likely implications of policies. A review of India's energy data management (EDM) was conducted and it revealed that the ministries collect data but some of most of the data are primarily collected for administrative purposes and the mandate to disseminate data is also weak. This review also revealed gaps in data collected, in particular, energy consumption data. Also, a review of international best practices of EDM was conducted, yielding insights for potential application to India. Based on these inputs, NITI Aayog led the development of a roadmap for improving energy data management in India. This roadmap charts out a path aimed at near-term improvements to targeted critical energy data and a longer-term vision of a nodal agency on EDM for India. Major accomplishments in Energy Data Management are:

- Report on the data gaps in the India Energy sector based on feedback from energy data users in the research, policy analysis and modelling communities as well as various ministries during a workshop held in September 2015 chaired by NITI Aayog and MoSPI.

- Energy Data Management Study tour on side-lines of the Indo-U.S. Energy Dialogue meetings in Washington D.C. during September 2015. The Indian delegation from NITI Aayog, Ministry of Statistics and Programme Implementation (MoSPI), Petroleum Planning and Analysis Cell of the Ministry of Petroleum and Natural Gas and Prayas Energy group meet with US - DOE's Energy Information Administration (EIA), U.S. Environmental Protection Agency, the U.S. Office of Management and Budget, and the Department of Transportation.

India's Energy Sector: Data Gaps & Opportunities

- Most significant gaps are in availability of data on energy consumption and decentralized small scale generation sources
- Energy supply data generally available; some gaps may be easily addressed through improving dissemination
- Data quality and accessibility may be improved by technology upgradation and process improvements
- Need for improved statistical and sectoral knowledge at data agencies
- Nodal agency needed to coordinate data collection, processing and dissemination across ministries

Energy Data Management initiatives coordinated by NITI Aayog under the India-US Sustainable Growth Working Group (SGWG) in collaboration with Prayas Energy Group, Ministry of Statistics and Programme Implementation (MoSPI), Director General of Hydrocarbons (DGH) and different energy ministries from India and US Department of Energy DOE's Energy Information Administration (EIA).

Energy Modelling

Models to assess the energy and environmental impacts of competing development pathways are critical to formulating policies to support energy security and low carbon growth. NITI Aayog has been involved in various energy modelling related activities over the past several years. These energy modelling activities can be classified as –

- IESS 2047 used for analysing various energy supply and consumption scenarios and their impact based on various choices in terms of economic growth, technology adoption, etc.
- Model comparison where different modelling groups work on a common objective and the modelling results across groups are compared and discussed on the following topics:
    - Mitigating Carbon Dioxide and Local Pollutant Emissions from India's Transportation Sector - Analysis within an Integrated Assessment Modelling Framework
    - Energy-Water Nexus and Efficient Water Cooling Technologies for Thermal Power Plants in India - Analysis within an Integrated Assessment Modelling Framework
- Setting up an Energy Modeling Unit at NITI Aayog for conducting cross-sector integrated energy modelling for policy making.

IESS 2047 and its applications

In view of the rising energy demand and sticky import dependency of India, and recognizing the need for long term energy planning, the erstwhile Planning Commission, now NITI Aayog, decided to undertake an energy scenario building exercise early in the year 2013, called the India Energy Security Scenarios, 2047 (IESS, 2047). The IESS, 2047 has been built as a knowledge portal, combining IT applications, behavioural aspects, energy related emissions, local resource endowments, all sources of energy supply and demand, technologies of global scale as and when they are inducted in the Indian system, and cost-time parameters.

The IESS, 2047 is expressly an energy scenario building tool. The guiding ambition of this is to develop energy pathways leading up to the year 2047, comprising of likely energy demand and supply scenarios. It has been developed on an Excel Format with a Web Tool front end, which allows user-friendly, dynamic, graphic representations of the chosen outputs of the energy demand and supply levels leading up to the selected terminal year. Energy security has been adopted as the major output of the exercise. The tool is amenable to adoption of other outputs as well, which can be further developed over the years.

Two versions of the tool have been worked upon. The first version of the tool integrated energy security, land and carbon dioxide emissions as its outputs, the second version incorporates cost as an implication as well and the future versions could incorporate other implications like water, labour etc. as outputs. The guiding ambition of this is to develop energy pathways leading up to the year 2047, comprising of likely energy demand and supply scenarios. The end demand and

supply numbers will be generated in light of the adoption of different combinations of energy efficiency measures and technology interventions on the demand side, and an increase in indigenous resource production of the country on the supply side. The tool has been so developed, that it can create hundreds of scenarios with different combinations of levels/efficiencies of energy demand and supply sectors. For each sector, four levels have been developed, these are:

- **Level 1 -** the 'Least Effort' scenario: This assumes that little or no effort is being made in terms of interventions on the demand and the supply side, and represents a pessimistic outlook.
- **Level 2** - the 'Determined Effort' scenario: This describes the level of effort, which is deemed most achievable by the implementation of current policies and programs of the government. It may be seen as the 'current policy' with autonomous improvements.
- **Level 3** - the 'Aggressive Effort' scenario: This describes the level of effort needing significant change, which is hard but deliverable.
- **Level 4** - the 'Heroic Effort' scenario: This considers extremely aggressive and ambitious changes that push towards the physical and technical limits of what can be achieved.

The tool has been built with the help of a wide pool of knowledge partners from the Government, Industry, Think Tanks, Non-Governmental organizations, International research agencies and the academia. The networking of top energy related think-tanks with energy Ministries, is a high water mark achieved in this exercise. This has added to the intellectual quality and transparency of the entire exercise. It is also a completely open-source tool and can be considered a one-of-a-kind data repository for energy sources in the country.

Version 1 of the IESS, 2047 was launched on 28th February, 2014. In order to improve the analytical ability of the exercise and factor in the fact that the energy scenario of India is rapidly changing, NITI Aayog worked towards developing the second version of this tool, with updated datasets, new technologies that are gaining importance in the Indian energy space and added implications to enable policymakers and the general populace to make better informed decisions. Version 2.0 of this tool was launched on 27th August 2015 and is accessible at www.indiaenergy.gov.in. The IESS has **recorded ~52000 visits till date**.

The IESS, 2047 can be summarized as follows –

I-1: Comprehensive database of all energy sources- The IESS, 2047 brings together all the demand and supply sources of energy in the economy and creates an integrated, open-source, database which does not exist till now. Additionally, the information database has a dynamic front end web tool which, using the data from the database, changes to reflect the choices of the user. The data for the base year 2012-13, independently provides a comprehensive energy data base for the first time, which can be used for current research.

I-2: Inclusion of all energy demand sectors - Earlier, the major focus was on analysing the supply side of the Indian energy sector. The IESS brings in all the energy demand sectors of the economy and focuses on demand side management and energy efficiency. It is also an Efficiency Calculator, providing the levels of energy efficiency for the different levels of inputs that the user picks.

I-3: Long term - The IESS, 2047, realizing the importance of long term energy planning, provides scenarios with the terminal year 2047, the 100th year of India's independence.

I-4: Technology - The IESS captures and incorporates all prevailing and anticipated technologies both in the energy demand and the supply sectors. (Electric Vehicles, Supercritical Power Plants, Shale gas, advanced bio fuels, Green Buildings, Solarisation of telecom towers etc.

I-5: Social media integration - The IESS, 2047 is being promoted vigorously though social media so as to reach out to more and more common people and involve them in the energy policy debates.

I-6: Interactive web tool - The IESS, 2047, for the first time, has brought about an interactive and dynamic web-tool which reflects the implications of the user's choices on energy security, land and emissions, in a turnaround time of less than 2 seconds.

Outreach activities of the IESS, 2047

NITI Aayog has in the past, and is also presently, in the process of conducting nation-wide outreach workshops to promote the usage of this tool and involve more people in the exercise for consensus building and creating awareness about energy policies. Workshops have been conducted in Government ministries and in different parts of the country, witnessing participation from the Industry, local academia, state governments etc. and industry bodies. For Version 2.0 of this exercise, workshops were also held in several Tier-II towns and cities including Coimbatore, Vadodara, Karnal, Agra etc.

Industrialists asked to adopt energy-saving technologies

TRIBUNE NEWS SERVICE

KARNAL, JANUARY 14

To discuss means for tackling energy crisis facing the country, the NITI Aayog on Wednesday held a state-level convention of the members of the Haryana Chamber of Commerce and Industry (HCCI). The convention, "India Energy Security Scenarios - 2047", was held in association with the Department of Energy and Climate Change (DECC), Government of United Kingdom (UK), and Federation of Indian Chambers of Commerce and Industry (FICCI) at the HCCI Bhawan in Sector 3 here.

Anita Usmani of the NITI Aayog said the meet aimed at sensitising the state industrialists to adopt energy-saving technologies. "The governments of both countries are collaborating to provide training, technical assistance, financial support, besides spreading awareness among people," she said.

Usmani told the media that the NITI Aayog had introduced a calculating tool — Indian Energy Security Scenarios (IESS) 2047 — to help meet Prime Minister Narendra Modi's goal of making India energy self-sufficient by 2047.

The Tribune Fri, 15 January 2016
epaper.tribuneindia.com/c/8122098

राष्ट्रीय

प्रदेश में भी बनाएं एनर्जी संरक्षण के लिए इको सिस्टम

Experiences on the use of IESS, 2047

Being the first of its kind tool of the Government for integrated energy planning, the IESS, 2047 has met with wide acceptance, both nationally and internationally. It has recorded considerable visits from countries like the United States of America, the United Kingdom, China, Germany, Australia, Singapore, France, Japan, Hong Kong, Indonesia and Canada, among others. Most of the spikes in the visits correspond with major international discussions taking place on the Indian energy sector, highlighting its wide popularity and acceptability. Several leading institutions have used the IESS platform in their analyses on a variety of energy issues.

- The IESS, 2047 has also being used in the curriculum of IIT Bombay and has also received personal commendation from the Secretary, MEA.
- The IESS, 2047 is also being used as a platform for generating scenarios underpinning the new National Energy Policy of the Government of India.
- A sub-committee was constituted by Ministry of Power, and led by Adviser (Energy), NITI Aayog, for finalising India's possible energy mix till the year 2030 to provide inputs to the formulation of India's Intended Nationally Determined Contributions. The electricity demand in 2030, along with various other parameters proposed from the IESS, 2047 were majorly incorporated by the Ministry of Environment, Forest and Climate Change while framing the final INDCs.
- A downscaled, state specific version of the IESS, 2047, named the Odisha Energy Security Scenarios, 2047 has already been developed with World Bank assistance for the Government of Odisha. The Government of Gujarat has also expressed its desire for developing a Gujarat specific energy scenario building tool on the lines of the IESS, 2047.
- The IESS, 2047 has also been used by various think-tanks and research institutions for conducting research. A brief synopsis of the research that the IESS has triggered is as follows:
  a. Quality of Life for All: A Sustainable Development Framework for India's Climate Policy, released by the Center for Study of Science, Technology and

Policy (CSTEP): The study provides detailed analyses showing that quality of life for everyone can improve along a pathway in which greenhouse gas emissions and energy intensity reduction are co-benefits.

b. An Approach to Sustainable Development Based Energy and Climate Policy by the Centre for Policy Research, Prayas Energy Group, and the Energy Research Centre, University of Cape Town: This study proposes a 'multi-criteria decision analysis' (MCDA) approach for operationalizing a multiple objective framework for development and climate policy, using illustrative examples from the buildings and cooking sectors.
c. A More Sustainable Energy Strategy for India by Shri Montek S Ahluwalia, Himanshu Gupta and Nicholas Stern: This study presents India's energy trajectory from 2012 to 2047 with a view to highlighting the implications for energy security (import dependence) and the trajectory of carbon emissions (sustainability).

Energy Modelling Unit

NITI Aayog has been involved in various activities related to energy modelling in terms of developing the IESS 2047 tool and model comparison activity in collaboration with SGWG. A lot of the energy modelling has been carried out by the partners in the past. The energy domain in India currently faces a range of conflicting views from both the demand and supply sector of energy like –

- India's ambitious target of 175 GW of Renewable energy capacity by 2022
- Targets for reducing oil imports in India
- Universal access to electricity and 24*7 electricity for all
- Increasing the domestic coal production
- Reducing carbon emissions as per the INDCs
- Interruption in renewable energy suuplies based on weather conditions
- Effect and cost of modernizing the power grids
- Possible reduction in PLF and profitability of the thermal and hydro power plants

The team at NITI Aayog would like to develop a better understanding and appreciation for energy modelling to deal with these conflicting views of the energy sector and decide the best way forward. Towards the same the energy modelling unit has been setup at NITI Aayog to carry out cross-sector integrated energy modelling. The team would engage in hands-on energy modelling activities using the MARKAL-TIMES energy modelling tool. The exact scenarios on which the modelling activities would be undertaken would in consultation with the "Advisory Committee" consisting of the Vice-Chairman of NITI Aayog along with the representatives from the ministries involved in supply and consumption of energy in India.

The following list has some of the broad modelling areas that energy modelling unit would engage over the next couple of years –

- Modelling and prediction of the key supply and consumption components in the India energy sector with some degree of certainty.
- Dealing with the complexly linked Indian Economy, Social Development and Energy Sector.
- Impact of INDCs on the Energy, transport, Industry Sectors and India's growth.
- Model the complex interaction of federal and state structure with respect to energy resource allocation.
- Economy-Energy interaction due to freer trade regime including energy commodities.

Geospatial Mapping and Analysis of Renewable Energy Sector

India is emerging as a global leader in renewable energy (RE) development. The Indian Government has set ambitious goals of 100 GW of solar and 60 GW of wind energy by 2022, and is developing programs and initiatives aimed at addressing the many challenges to achieving these goals. Fundamental to turning these goals into actual deployment of solar and wind installations are data and analysis to identify the geographic distribution of areas in India with the greatest potential for renewable energy.

To meet this need, the team developed an Enterprise Geospatial Toolkit (EGsT), aimed at providing spatial and spatiotemporal data, analysis tools, and interactive maps to display the data and analysis, in a user-friendly web-based platform. Broadening access to data, analysis and information and providing maps to help visualize multiple layers of data will help accelerate the speed of RE development in India through supporting national and state level policy makers, transmission planners, RE developers and the academic and NGO community. The EGsT offers a platform to conduct impactful visualization and analysis, and thereby supports quantifying opportunities in renewable energy and prioritizing development of these resources.

Geospatial Analysis Stakeholders: Needs and Opportunities

Policy makers and public sector managers at national and state levels

--Design targeted policies and incentives to encourage RE development in most productive areas for solar and wind energy
--Analytically-based state Renewable Purchase Obligations
--Grid integration analysis, including capacity expansion, regional electric system planning, production cost modeling and carbon mitigation

Central and state transmission planners

-- Transmission planning to site infrastructure to drive RE development in the most productive, cost-effective areas
--Renewable Energy Zones (REZ) screening to identify areas with high quality and highly concentrated RE resources, suitable topography and land-use, and strong developer interest

Indian and international RE project developers

--Quickly and easily identify and assess areas that look most cost-effective for further site-specific exploration

--A level playing field that supports market entry for potential developers

The tool currently allows analysis of both solar and wind technical potential along with solar site selection. Going forward the tool plans to incorporate economic potential along with mapping other key energy resources across India like transmission lines, plants (thermal, hydro, gas), etc. The work of the EGsT tool is in collaboration with National Renewal Energy Laboratory (NREL) from US and Center for Study of Science, Technology and Policy (CSTEP) in India. Further details of the same can be found in the attached SGWG report.

Collaboration Partners

Domestic Partners

1. Planning Commission (Now NITI Aayog) signed MOU with The Energy Research Institute (TERI) on analysing issues related to Energy Sector through the use of appropriate tolls and models and to provide inputs to Planning Commission for informed policy making during the 12th Five Year Plan period.. The MOU was singed on 20th June, 2013.
2. Planning Commission of India and Centre for Study of Science Technology and Policy (CSTEP), Bengaluru signed a Memorandum of Understanding (MoU) to develop an integrated energy planning system for India – Decision Analysis for research and Planning (DARPAN); which can also be used for other sectors such as infrastructure, transportation and emergency and disaster management. The MoU was signed on 24th June 2013
3. Statement of Intent between NITI Aayog and Health, Energy, Learning and Parenthood Prayas, Initiatives (Paryas), Pune was signed on 9th may 2016 on analysing issues related to the energy sector using the expertise and tools at Prayas and to thereby provide inputs to the NITI Aayog for informed energy-sector policy formulation. The SOI also includes –
    a. Regular exchange of information to improve mutual understanding the energy sector in India.
    b. Strengthening the framework for a coordinated Energy Data Management System in India by striving to improve the country's energy balance preparation, improve data collection and data coordination.
    c. Joint analysis and research projects, including energy policy analysis and energy sector and market analysis to address the issue of energy security, access, sustainability and affordability.
    d. Exchange of technical know – how, experience and information and dissemination of data, statistical methods and analytical techniques.
4. Statement of Intent between NITI Aayog and The Alliance for an Energy Efficient Economy, New Delhi signed on 16th May 2016. The SOI provides as a framework for cooperation between NITI Aayog and AEEE to collaborate for designing, developing and conducting consultative policy dialogue and business research to promote and enable high level energy efficiency policy formulation in India by jointly undertaking the following activities –
    a. To support mechanism for development and implementation of the broad national framework for energy efficiency with the goal to improve the energy intensity for Indian economy by helping set energy efficiency as a resource (MW) target at the national level, appraising the states for devising appropriate strategies for energy efficiency measures.
    b. To provide input framework for national energy policy both at the central and state government level on energy efficiency.
    c. To provide inputs and share best practices from India and around the world on energy services (ESCO) market development, including innovative energy efficiency financing, to enable a dynamic and vibrant

energy services (ESCO) sector to implement government policies and scale up programmes within validated energy savings.

d. To look at market mechanisms and policy options to promote energy efficiency in the residential sector with a specific focus on multi dwelling units in medium and high rise residential buildings.
e. To provide inputs in developing a roadmap for sustainable space cooling by balancing it against India's power generation including peak demand reduction requirements by encouraging best available technology through stringent codes and standards.
f. Collaboratively work to enhance the capacity of Indian states and put an objective evaluation framework to implement energy efficiency policies and scale up the implementation efforts in all states.
g. To help build a public-private platform for ongoing dialogue on energy efficiency policy to enable a transparent public process of policy making.
h. Collaboratively develop suitable outreach and communications material including energy efficiency market and policy briefs, newsletters and reports showcasing the progress made by Government of India in energy efficiency policy formulation and implementation.
i. Collaboratively designing, developing and conducting research to promote and enable high level energy efficiency policy formulation and implementation framework in India.

International Partners

1. Statement of Principle (SOP) on Collaboration on Sustainable Growth under Indo – US Energy dialogue was signed between Planning Commission and United State Agency for International Development (USAID) on 7th May, 2013 and has been renewed for continued cooperation.
2. Memorandum of Understanding between NITI Aayog of the Government of the Republic of India and the Development Research Centre of the State Council of the People's Republic of China signed on 15th May 2015. The MoU included the following cooperative activities –
    a. Exchange of policies and programs in the public domain;
    b. Exchange of research materials and information;
    c. Regular exchange of visits;
    d. Joint studies and research;
    e. Joint workshops and seminars etc.
3. Statement of Principle (SOP) signed between Planning Commission and United Kingdom Department of Climate Change (UKDECC) signed August, 2013. The Aim of the extended cooperation is to continue in-depth information exchange between energy and emissions modelling experts from both Governments in order to further strengthen and update their respective analysis. Open and in-depth information exchanges on the latest analysis methodologies can significantly improve mutual understanding, risk/opportunity assessments as well as the wider public debate around these challenges. Extending the cooperation between the IESS 2047 and the UK 2050 Calculator will provide mutual benefit in three critical areas:

a. Modelling Analysis
b. Communication
c. Policy

4. Memorandum of Understanding (MOU) between "The Regents of the University of California, as management and operating contractor for Lawrence Berkeley National Laboratory (LBNL) and Planning Commission of singed on September, 2013. The MoU included the following cooperative activities –
    a. Energy sector Planning - assessment of grid-connected and off-grid energy development models, policy/regulatory interventions needed for increasing energy access, role of emerging technologies (e.g. smart grid, energy storage, electric vehicles, technology etc.) in meeting Government of India objectives/targets, etc.
    b. Policy analysis - assessment of potential energy sector policy alternatives that would improve access, enhance exploitation of energy resources, increase affordability, enhance energy security, and meet environmental objectives; participating in activities such as conferences/workshops for dissemination of analysis results, seeking stakeholder/expert comments, and building long-term capacity for conducting policy analysis
    c. Energy modeling - development of comprehensive energy model for Indian energy supply perspective up to 2030 and 2050 covering an optimal mix of all energy supply sources, including required data/information collection - and its sustained enhancement to be able to quantitatively assess various energy sector policy alternatives; participating in activities such as conferences/workshops for building long-term capacity for energy modeling
    d. R&D and Human Resource development - assess the R&D capability and human resource requirement for research and management of energy sector, share technical know-how in development of R&D infrastructure and academic institutions to meet the growing needs of manpower in this sector
5. Statement of Intent between NITI Aayog and Institute of Energy Economic, Japan on –
    a. Exchange of information Conduct of joint research projects,
    b. Exchange visits of suitable personnel for participation in agreed joint activities,
    c. Organization of seminars and other meetings on agreed topics.
6. Statement of Intent between NITI Aayog and International Energy Agency was signed on 4th March 2016 to promote co-operation relating to energy sector analysis and planning, energy sector modelling and forecasting and seeking broader dissemination of best practices of energy sector analysis, modelling and forecasting techniques and a strategy towards development of human resource in the energy sector. The SOI also included –
    a. Regular exchange of information to improve mutual understanding of the functioning of energy markets in the world;
    b. Joint analysis and research projects, including energy policy analysis and energy sector and market analysis;

c. Exchange of technical know-how, experience and information concerning electronic gathering, processing and dissemination of statistical data, statistical methods, analytical techniques, and econometric models used to analyse energy sector trends and prepare scenarios and make future projections;

Research Studies

Energy-Water Nexus and Efficient Water Cooling Technologies for Thermal Power Plants in India: An Analysis within an Integrated Assessment Modelling Framework

Proposed by: *Council on Energy, Environment and Water*
Proposed Budget: *Rs 18,34,000/-*

India is increasingly facing water shortages. Agriculture is the largest consumer of water. However, water demand for cooling in thermal power plants is also increasing with high growth in power generation capacity. Cooling water is required for transferring waste heat generated in the power production process. There are mainly three different types of cooling technologies- once through, recirculating, and dry cooling. There are trade-offs between these technologies. The lesser the water withdrawal, the higher is the cost of the technology, as well as the efficiency penalty on power production. The proposed study seeks to understand if water could be a constraint to India's energy and climate policy objectives: Following are the key objectives of the study:

- To understand water consumption and withdrawals from India's power generation sector under the reference scenario.
- To understand the implications of water efficient technologies for water consumption and withdrawals for thermal cooling.
- To understand the implications of water efficient technologies for power production.
- To recommend policy interventions based on the insights from the research.

The Global Change Assessment Model, IIM Ahmedabad version (GCAM-IIM) will be used for our analysis. GCAM is a global energy-agriculture-emissions model that has been widely used in climate policy analysis. GCAM has a detailed power sector with representation of fossil and non-fossil power generation technologies. GCAM is a state of the art model and has been consistently used for IPCC related exercises, and has widely published and cited literature. GCAM runs till 2100 in five year time steps, and can model energy policies as well as climate policies like carbon markets and carbon taxes. Scenario analysis will be undertaken for analysing the research questions related to water energy nexus. Different scenarios will be modelled: Reference scenario, Climate Policy scenario, and Dry Cooling Technology scenario. GCAM is also being developed to incorporate a water supply module to understand water constraints on the energy and land use systems and this capability will be very useful for this project. Along with in-house capacity on GCAM-IIM, we will also engage closely with the Joint Global Change Research Institute (JGCRI, USA) where GCAM is developed and housed, for further capacity building on the model as and when required.
The study is highly relevant as it analyses India's two critical ambitions, water security and energy security, within the same framework. Understanding the water-energy nexus for the power sector will inform India's planning and policy

formulation process and hence will be a useful value add to the NITI Aayog and Government of India.

Energy, Food and Water Nexus – analysis in a Macroeconomic consistency framework

Proposed by: *IRADe*
Proposed Budget: *Rs 15,00, 800/-*

Higher economic growth would imply increasing and changing agricultural consumption patterns which in turn would imply a change in cropping pattern and therefore impacting the amount of water required for the agriculture sector to satisfy such a demand. At the same time higher economic growth would imply increasing power generation also resulting in rising water demand for cooling requirements. Climate change is likely to affect Rainwater frequency, intensity and distribution. Thus a sustainable economic growth path would require a sustainable use of water resources across sectors and by private households and this would require a model based analysis of projections water demand and supply.

The study by IRADe proposes to address this trade off by modelling the water and energy demand in agriculture, power sector in particular and there inter sectoral tradeoffs with the other sectors of the economy using the IRADe-IAM model. The IRADe-IAM model is an optimisation based macroeconomic model in an activity analysis framework. The model uses the Social accounting matrix for 2007-08 based on the Input-Output tables of 2007-08. The viability of this demand in the context of climate change is assessed by computing the availability of water to meet this demand using the GCAM model. The spatial distribution of water demand and availability is illustrated using GIS maps for generating various planning scenarios for decision making.

The study aims to address the following –

- To project the changing water requirement in to the future up to 2050 accounting for changing cropping patterns due to changing food consumption patterns
- To project the water demand due to urbanization and growing cities
- To incorporate the impact of climate change on water availability and hence increasing reliance on ground water irrigation
- To assess the water requirement by industry and power generation technology wise
- To assess the reduction in water use due to water conservation policies for the power generation sectors

The deliverables for this project would be a report on the following topics –

- Scenario on water requirement till 2050 under existing water use policies and trends
- Scenario on water needs from Power and agriculture sectors due to optimized water use policies
- Impact of climate change agenda on water availability and demand

- Macroeconomic impacts of the above scenario on Growth, Consumption and sectoral developments

Research Study Assessment of Water foot prints of India's Long-term Energy Scenarios

Proposed by: *TERI*
Proposed Budget: *Rs.12,84,924/-*

Water demand evolves over time, putting stress on energy-water-land system. In, India, in particular the Gangetic plains will emerge as one of the worst affected areas on the globe in terms of water shortage in the near to long term. Climate change mitigation policies, if not designed with careful attention to water resources, could increase the magnitude, spatial coverage and frequency of water deficits. The results challenge the general perception that mitigation, which aims at reducing warming, would directly alleviate water deficits in the future.

There are several critical issues related to water foot prints. In the context of our country, more than 70% of the water goes for agriculture; more than 50% area is irrigated by ground water; power subsidy has led to over exploitation, and many spatial blocks show excess use and lowering of water table etc. The Fossil-fuel based power plants account for the majority of water use in the power sector. More renewable energy for power would result in less water withdrawal which could potentially relieve the water scarcity situation in India, and shifts to water efficient technology foreseen in new Indian policies will reduce the relative impact of the power sector on water demand. But high levels of implementation of mitigation and adaptation policies are key factor in achieving this.

The Research study by TERI will focus on:

- Assessing the water footprint of India's long-term energy scenarios in energy demand and supply sectors as follows:
- Demand sectors: (a)Agriculture, (b)Industries, (c) Buildings
- Supply sectors: (a)Fossil based Power Generation, (b)coal washeries, (c)Nuclear power stations, (d)Renewable based bio-energy, (e)Oil & gas extraction including shale gas/oil development
- Water requirement for shale gas development based on international experiences; assessing the water requirement in India especially in the sedimentary bearing geological areas for shale gas development per well wise.
- The study will also investigate the potential for improving water efficiency in the sector and shall suggest various methods of efficient utilization of water in the above industries based on survey conducted by them and review of international literature.
- The study will evaluate the regional water requirement as the country experiences significant variability in rainfall and water availability. They should also consider the central/state level future plan of development of industries region-wise while carrying out the study.

The proposed study/survey shall also include at least three rich industry states in each of four regions of the country i.e. East, West, North & South (total 12 industry rich Sates).

Integrated Modelling Study of Energy-Water-Food Nexus in India

Proposed by: *TERI*
Proposed Budget: *Rs. 20,66,066/-*

Energy models are critical in conducting analysis and developing policies on issues of interest to decision makers within the Government. There is a need for taking a regional and national perspective on energy-water issue which is ably supported with substantial research on energy-water- food and land interactions. This research has to be driven by both policy and planning considerations, using integrated multiple modelling tools and data across multiple disciplines. Food habits impinge on agriculture, climate change impacts water availability and such developments impact water models.
There is a need for integrating GIS Models for Energy-Water-Food Nexus of water stress and energy related activities for deeper understanding of the complex inter-linkages of water usages. Given the significantly more advanced methodology of data collection, there is a clear opportunity for Indian institutions to learn the best practices of generating data on water usage and availability.

The Research study by TERI will attempt to focus on:

- Estimating the water consumption and water withdrawal in India in a BAU scenario using the TERI-MARKAL model for the time period 2001-2051.
- To calculate the water consumption and water withdrawal in India in a low carbon growth (GHG mitigation) scenario using the TERI-MARKAL model for the period 2001-2051.
- To calculate the water consumption and water withdrawal in India in a low water use intensity growth scenario using the TERI-MARKAL model for the time period 2001-2051.
- To estimate India-specific water-use coefficients of the various existing as well as expected technologies base on secondary data and possible consultants with specific user groups.
- To provide results for the inter-model comparison with modeling studies of other SGWG teams.
- To suggest policy based actions, technological changes and possible solutions through a policy brief.
- Dissemination of key findings to relevant Government Departments

Impact of Public Transport on Pollution Emissions

Proposed by: *C-STEP*
Proposed Budget: *Rs. 10,14,550/-*

India is the third largest Co2 embitter in the world and there is an critical need to develop information and computational tools for assessing strategies for meeting air, climate, and energy goals simultaneously, and, supporting air-climate-energy planning at various levels (national, regional & state).Transport sector which uses fossil fuel is a critical infrastructure for development .Adequate understanding of the emissions from this sector in terms of quality ,quantity and resource efficiency is essential.

There are large data gaps, particularly in transport fuel use, leading to differences in model assumptions. Filling these data gaps is an important priority to enable effective air pollution modelling. Continued comparison of modelling results will lead to methodological enhancements and refine understanding of policy impacts. Better data on vehicles in use and their activity will allow clearer understanding. Low carbon policy will not necessarily lead to decline in transportation sector local air quality pollutants, for which a targeted policy on vehicle emissions controls will be required

A mid to long-term scenario has to be evolved with projections of air-pollutant emissions from transportation under one or various shared socioeconomic pathways, developing gridded emissions profiles under reference and policy scenarios, co-benefits of CO2 mitigation, dispersion modeling and health-related impact analyses at the regional and local scale besides, impact of modal shifts and fuel economy standards etc.

The objective of this study is to evaluate the impact of public transport in reducing air pollution by 2050 using bottom up quantitative modelling of passenger transport scenarios.

The Research study by CSTEP will attempt to focus on –

- Detailed assessment and modal break-up of mode-wise passenger transport demand in the base year (2012) based on secondary data (MoRTH), MoPNG, ICCT database etc.)
- Projections of passenger transport demand based on macroeconomic variables (population, urbanization, incomes, etc.), and mode and sub-mode (modal) shares based on historical trends, international experience and domestic policy announcements.
- Identification of sources of air pollution within passenger transport and determination of coefficients (pollutants emitted per passenger or vehicle kilometre travelled or per unit of fuel used in each mode/sub-mode category based on secondary data)
- Modelling impact of behavioural choices on passenger and vehicular kilometres travelled, fuel consumed, and local pollutant emissions using transportation model.
- Construction of Business-as-Usual (BAU) and High Public Transport (HPT) scenarios and comparisons between the two scenarios on vehicular kilometres travelled, energy consumed and local air-pollution impact at the national level.
- Submission of a report or a policy brief on the exercised mentioned above with technical annexures to NITI Aayog, which can be peer-reviewed by experts and other modelling groups.
- Regular stakeholder consultation with NITI Aayog and other experts via meetings and webinars etc.

Impact of Power Sector Growth on Water Resources

Proposed by: *C-STEP*
Proposed Budget: *Rs.* 10, 14,550/-

The Fossil-fuel based power plants account for the majority of water use in the power sector. More renewable energy for power would result in less water withdrawal which could potentially relieve the water scarcity situation in India, and shifts to water efficient technology foreseen in new Indian policies will reduce the relative impact of the power sector on water demand. But high levels of understanding of key issues are important to achieving this.

Our choices for what kind of power plants we build can contribute to freshwater supply stress by committing an imbalanced share of the available water to power plant use and can affect water quality, by increasing water temperatures to levels that harm local ecosystems. Population growth and rising demand for water also promise to worsen water stress in many regions of the country already under stress from power plant and other uses. The power plant portfolios of companies have widely varying water-use and carbon profiles. Utilities with lower-water plants place less stress on local water sources. Utilities with carbon intensive power plants contribute to long-term water stress by exacerbating climate change. Power plants are designed to last for decades, and much of our existing infrastructure will continue operating for years. As such, our nation's precious freshwater resources will face ever more stress. The typically high cost of retrofitting power plants means that decisions on the water impact of today's plants should consider the risks they pose to freshwater resources and energy reliability throughout their expected lifetime.

The Research study by C-STEP will attempt to focus on –

- Assessing the impact of power sector growth on fresh and sea-water demand using systems optimisation model.
- Review available literature and assimilate data on the current and projected status of the power sector by 2050.
- Review available literature and policies on trends in water consumption and withdrawals in India's power sector for thermal power plants (cooling and ash water requirements) and other non-conventional sources of power (such as solar); review secondary literature and datasets for water coefficients developed in other countries.
- Identify suitable water coefficients to model impact of the growth power sector, estimate the reliance on fresh water and sea water. Explore the role of cooling technologies on water demands reduction in the sector under a Business-as-Usual (BAU) scenario.
- Model the growth of the power sector using the Integrated MARKAL-EFOM system (TIMES) model (a system optimisation model). Detailed technological profiles (plant level information, fuel characteristics and processes), cost curves and demand characteristics (linked to income, population and or other economic variables), and national and state policies will be used to obtain a future profile of fuel-wise installed capacity and electricity generation.

- Model technology-wise water consumption and withdrawal based on finalised coefficients from literature review. Estimate the share of fresh-water and sea-water use, and the role of technologies.
- Submit a report or a policy brief on the exercise mentioned above with technical annexures to NITI Aayog which can be peer-reviewed by experts and other modelling groups.
- Provide periodic updated on modelling and data to NITI Aayog via webinars, conferences, seminars etc.

Development of Energy Information Portal for India

Proposed by: *Prayas*
Proposed Budget: *Rs.* 12,38,980/-

India is the third largest economy in the world and it would be good to follow a balanced growth model for energy market. While emphasizing on the need for an effective energy management in the country it is important to consider a range of issues, which has to be futuristic, that takes into account all possible policy angles and addresses the issue of energy security, access and affordability. Therefore, for an effective and robust energy policy we would need to rely heavily on rigorous analysis of rapidly available, reliable accurate and comprehensive energy data. Considering the scenario of Renewable Energy sector for which an ambitious target of 175 GW by 2022 has been set by the Government, there is hardly any quantitative or qualitative data and information that is available to the policy makers. A comprehensive Energy Data Management will be very useful for an effective citizen engagement business strategy management and performance of energy sector programmes. An institutional mechanism has to be put in place for an effective management of energy data system in the country

Lack of accurate, comprehensive and consistent energy data in the public domain makes it difficult to analyze issues related to energy access, performance and efficiency, and increases investor risk. India is an investment destination with market dimension, therefore energy sector needs to be viewed from the market perspective to provide reliable and accurate data with real-time information. The need for a credible performance criterion which provides an on-line data, real time reporting with more efficient use of resources. Similarly, a comprehensive State wise data also has to be compiled and collected. Presently only MoSPI and NITI Aayog are in the process of generating the data. There is a widespread agreement that Energy data will help development agenda and needs to be promoted on the need for a nodal agency for data management system in the country.

Energy data related to the unorganized sector, consumption, access and latent demand either do not exist or are of poor quality with a long time lag, and hence need special attention. Survey based data takes time. Anticipated technological, policy and regulatory changes in the electricity sector are expected to give rise to new challenges, but also open opportunities to improve Energy Data Management by leveraging internet and communication technologies. In addition, financial data on the energy sector, particularly debt related data, is neither available in one place nor in a timely manner.

Immediate improvements can be undertaken by data agencies within supply-side line Ministries/Departments that can help improve data gaps in the demand and supply side management. Sector-wise research questions that are relevant to development needs of the country should be articulated through a consultation process and data requirements should be based on these research questions. In addition, the distinction between data and analysis should be carefully deliberated. Best practices around the world should be used as benchmarks against which India's Energy Data Management should be compared.

The Research study by Paryas will attempt to focus on creating an energy information portal that will collate and report energy data at a national and state level, through a user-friendly and interactive web interface.

India-U.S. Sustainable Growth Working Group – a Progress Report

Introduction

The Sustainable Growth Working Group (SGWG) is a joint Government of India (GOI) – U.S. Government (USG) initiative aimed at energizing analysis-based and data-driven policy making, infrastructure planning and renewable deployment to support India's low carbon growth. The SGWG was established in 2013 as a sixth working group under the Indo-U.S. Energy Dialogue and is co-led by the National Institution for Transforming India (NITI) Aayog for the GOI, and the U.S. Agency for International Development (USAID) for the USG. It brings together researchers at leading Indian technical institutes and national laboratories affiliated with the USG'S Department of Energy (DOE) to collaborate in three focal areas: energy data management, energy and environmental modelling, and geospatial analysis to support deployment of solar and wind energy. The collaboration brings cutting edge analytic tools and approaches to address the challenges that both India and the U.S. face in ensuring energy security and charting a low carbon development pathway.

BOX 1

KEY ACCOMPLISHMENTS

April 2015-July 2016

Energy Data Management

- Report on gaps in India's energy data and opportunities for improvement
- Expanded collaboration between GOI and USG's Energy Information Administration

Energy/Environmental Modelling

- Assessment of baseline energy and emission trends of the transportation sector
- Analysis of water implications of a decarbonized power sector

Geospatial Analysis for RE Deployment

- Development of core Enterprise Geospatial Toolkit framework for India
- Development of geospatial-based tool for assessing technical potential of solar and wind energy

NITI Aayog brings in the expertise of Indian think tanks, namely, Council on Energy Environment and Water (CEEW), Center for Study of Science, Technology & Policy (CSTEP), Integrated Research and Action for Development (IRADe), Prayas (Energy Group) and The Energy and Resources Institute (TERI); USAID brings in the expertise of the National Renewable Energy Laboratory (NREL) and the Pacific Northwest National Laboratory (PNNL).

Sustainable growth cuts across many ministries, and NITI Aayog recently established an Advisory Board to provide a forum for GOI ministries to discuss topics critical to sustainable growth, identify priorities, shape the analyses being carried out by the Working Group, and explore implications of the results of the analyses. This section covers SGWG activities and accomplishments over the past 15 months (April 2015 to July 2016) since the first SGWG Progress Report. Key accomplishments are noted in Box 1, and are detailed in subsequent sections.

Energy Data Management: Building Blocks to a Sustainable Future

Robust energy data is essential to formulating and analysing policies to promote energy security and sustainable development; data is used by government policy makers and by the research community to explore likely implications of policies. It is also critical for the private sector to plan its investments. During the first SGWG phase, a review of India's energy data management (EDM)4 was conducted and it revealed that GOI ministries collect energy data but primarily for administrative purposes and the mandate (and capacity) to disseminate data is weak. This review also revealed gaps in data collected, in particular, energy consumption data. Also during the first phase of SGWG, a review of international best practices of EDM was conducted, yielding insights for potential application to India. Based on these inputs, NITI Aayog led the development of a roadmap for improving energy data management in India. This roadmap charts out a path aimed at near-term improvements to targeted critical energy data and a longer-term vision of a nodal agency on EDM for India.

ACCOMPLISHMENTS

Energy Data Management Study Tour: On the side lines of the Indo-U.S. Energy Dialogue meetings in Washington D.C. during September 2015, a delegation of GOI officials from the NITI Aayog, the Ministry of Statistics and Programme Implementation (MoSPI), the Petroleum Planning and Analysis Cell of the Ministry of Petroleum and Natural Gas, and technical staff from Prayas met with USG agencies to discuss insights and lessons learned on EDM which may be applicable to India. The delegation met with DOE's Energy Information Administration (EIA) as well as the U.S. Environmental Protection Agency, the U.S. Office of Management and Budget, and the Department of Transportation. Through this study tour, which included webinars and discussions, the team determined that an ongoing engagement with EIA may offer perspectives useful to the GOI as it evaluates options for improving Indian EDM. An MOU between NITI Aayog, EIA and USAID has been drafted and is expected to be signed shortly.

BOX 2

India's Energy Sector: Data Gaps & Opportunities

- Most significant gaps are in availability of data on energy consumption and decentralized small scale generation sources
- Energy supply data generally available; some gaps may be easily addressed through improving dissemination
- Data quality and accessibility may be improved by technology upgradation and process improvements
- Need for improved statistical and sectoral knowledge at data agencies
- Nodal agency needed to coordinate data

Data gaps in India's energy sector. Based on the review of India's EDM developed during the first phase of the SGWG collaboration, Prayas researched and wrote a report on gaps in India's energy sector (Box 2).5 The report was informed by feedback received from energy data users in the research, policy analysis and modelling communities as well as various ministries during a workshop held in September 2015, co-chaired by NITI Aayog and MoSPI. The report highlights opportunities for improving data collection and dissemination, and proposes development of a nodal agency for EDM to coordinate data collection, processing and dissemination across ministries with responsibilities for energy sub-sectors. It

also identifies ways to strengthen the annual Energy Statistics report published by MoSPI.

UPCOMING ACTIVITIES

Annual Energy Statistics publication: The Central Statistical Office (CSO) under the MoSPI publishes a book "Energy Statistics" every year and the present one is the 22nd issue in the series. The SGWG EDM team will support CSO/MoSPI in improving this publication with respect to breadth of data included, data quality, and methodological issues. In particular, the major focus area in the coming months will involve resolving discrepancies in the energy statistics to develop an energy balance for inclusion in the publication. An accurate energy balance is critical for determining carbon inventories, which are fundamental to assessing India's carbon baseline. This will support better understanding of the impact of low carbon growth strategies on emissions in the energy sector.

Nodal agency for Indian EDM: Given the decentralized nature of India's energy data management among several ministries, the establishment of a nodal agency for EDM would address a key need for coordination of energy data. The SGWG team has proposed an outline of a nodal agency structure and composition, including organizational structure, staffing and skills, and coordination mechanisms between agencies, informed by international experiences and best practices, drawing on those of the USG's EIA in particular. This proposal is under consideration by GOI, and the SGWG EDM team will provide assistance to GOI as required to take this idea forward.

Oil and gas supply data: Oil and gas demand is growing rapidly in India, fueled by growth in the transportation sector and a desire for cleaner, more efficient fuel for power supply. Emissions from oil and gas production and combustion are also growing rapidly. Understanding these trends and having high-quality data is very important to making good policy decisions that lead to lower emissions trajectories. There is a possibility that the Directorate General of Hydrocarbons will initiate steps to develop a manual offering recommended guidelines for compiling statistics on oil and gas exploration and production. The SGWG EDM team will assist such an effort.

Energy Modelling: Understanding Impact of Policy Choices

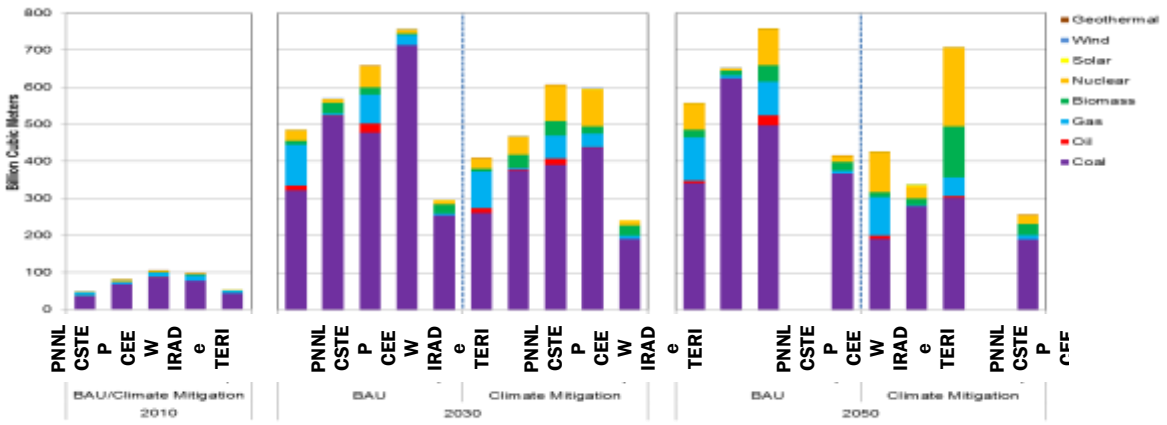
Models to assess the energy and environmental impacts of competing development pathways are critical to formulating policies to support energy security and low carbon growth. The objective of this SGWG focus area is to share methodologies, models, tools, and data to strengthen analytically-based policy-making. This collaboration builds on decades-long international experience in inter-model comparison6, in which teams come together to agree on an analysis question and then each of the teams conduct separate analysis using their own models, after agreement on basic assumptions. In a meeting with relevant ministries and other stakeholders, the results from the separate models are compared, and insights are gleaned from how the results align and vary among the models. Since the models used by the teams differ, the results typically differ as well, and the strength of the inter-model process is in understanding where the model results converge as well as the scale and trends of the impacts, which can be helpful to policy-makers in formulating policies. Exploring differences in results can also strengthen models and thereby improve future analysis results.

During the first round of inter-model comparison, the teams analysed the energy and greenhouse gas (GHG) emissions implications of decarbonizing India's power sector. At the annual SGWG meeting with GOI ministries in March 2015, the group agreed to focus next on two issues: the energy-water-food nexus, and the impact of transportation policies on air quality. NITI Aayog is coordinating with the SGWG Advisory Board to choose topics that are of specific relevance to India. Analyses are targeted to helping to identify likely impacts of policies aimed at addressing issues of critical importance to India's low carbon growth and energy security.

ACCOMPLISHMENTS

Energy-water-food nexus (EWFN) analysis: India is one of the most water-stressed nations in the world7 and as India's economic development continues, water needs will increase across the spectrum of water uses, including agriculture, electricity, other industrial uses, and households. This will put increasing pressure on local and national planners to develop long-term and forward-looking solutions. Building on the initial inter-model comparison exercise, in the second round the teams examined the implications of water use (withdrawals) in power generation under three scenarios: 50% decrease in carbon intensity of power production by 2050 (compared to 2010); low water consumption (based on recent regulations on water use in coal power plants); and a reference scenario which assumes no new relevant policies. Preliminary analysis revealed that fossil fuel-based power generation accounts for water use that can be avoided by a shift to water-efficient technologies and renewable-based power (Figure 1)

Figure 1. Total Water Withdrawals by Fuel across Models in the Reference and Climate Mitigation Scenarios



Air quality and transportation analysis: Concern about urban air quality is growing in India due to recognized health and economic impacts, and transportation is strongly linked with air quality. As India develops, conventional fuel (gasoline, diesel, and CNG) consumption in the transportation sector is projected to increase significantly. At the same time, policies offer opportunities to reduce emissions and potentially slow down the growth in conventional fuel consumption, contributing to India's energy security. As a first step, the teams explored varying assumptions in potential baseline trends in the transportation sector, and how base year data and other assumptions impact energy use and

emissions. The analysis revealed considerable differences between the models on fuel use in the transportation sector (Figure 2); filling data gaps on vehicle types and numbers, activity and fuel use is an important priority for enabling effective air pollution modelling.

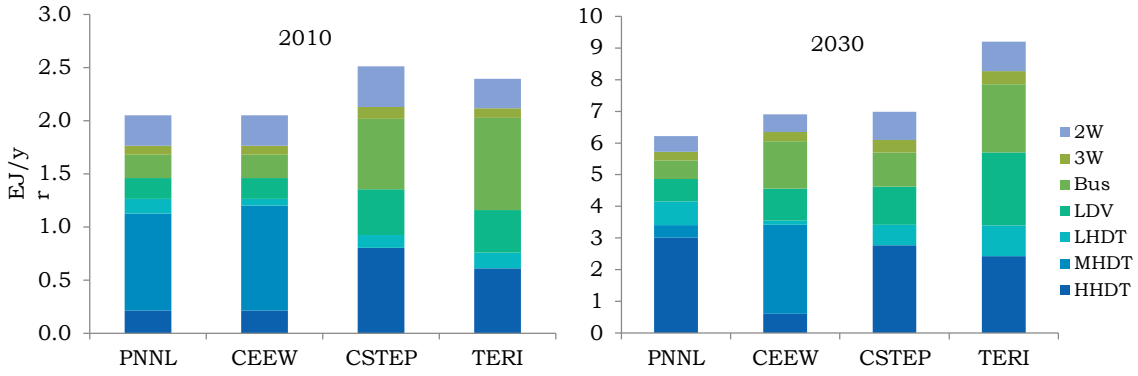


Figure 2. Comparison of Energy Consumption by Transportation Mode across Models, 2010 and 2030 (EJ per year)

The study also found that there is potential for substantial benefits by reducing energy demand and air emissions through transportation policies; however, the success of such policies depends on successful implementation. For example, auto efficiency standards have limited effect on particulate matter (PM) emissions due to the manner in which they are currently and typically constructed.8 In contrast, mandatory emissions control devices can substantially reduce PM emissions. These efforts highlight the value of inter-model comparison in exploring how competing approaches--such as fuel efficiency, fuel standards, and alternative fuels–may impact both energy use and air emissions. The results from the analysis of the energy-water-food nexus and the role of transportation in addressing air quality were shared at a workshop with relevant ministries in March 2016.

Energy-water-food nexus policy brief: To ensure that the analysis described above is available and easily accessible to GOI policy-makers, researchers and other stakeholders, the team prepared a brief report. This report summarizes the analysis and policy implications, and identifies key research questions for further investigation.

UPCOMING ACTIVITIES

Water supply model: The team will develop a detailed water supply model for India, based on updated publicly available supply data including data

BOX 3

Energy-Water-Food Nexus: Potential Topics for Analysis

- *How will India's water supply be affected by climate change?*
- *How will growing water demands affect India's ability to feed its people?*
- *How will water constrain India's fossil power development?*
- *What are the water demand implications of India's goals to develop the biofuels sector?*
- *Given current irrigation trends, what is the future trajectory of groundwater depletion assuming no policy changes?*
- *Will shifts to solar water pumps worsen water depletion and how can such programs be designed to minimize/reverse impacts on groundwater supplies, such as through BESCOM's Surya Raitha pilot?*
- *Where are the flashpoints for water scarcity in this nexus of energy, water and food?*

[8] **Automobile standards typically test vehicle fuel efficiency at fixed steady state conditions which do not accurately capture PM emissions that evolve as a result of field conditions (acceleration, deceleration, start-up conditions).**

on river flows, precipitation and ground water availability (from well data). The team will seek collaboration with partners to leverage related work on water. The resulting water supply model will be available to all teams and may be released publicly for wider application and broader impact.

Regional energy-water-food nexus analyses: The team will define and conduct basin and/or local-level analysis of EWFN issues**.** Box 3 includes issues that may be analyzed by the team; topic selection will be driven by the NITI Aayog-led Advisory Board of relevant ministries, and will seek to leverage related analyses underway at Indian partner institutions.

Energy-water-food nexus journal issue/series of issue papers: The team will prepare a journal issue or a series of issue papers developed from the EWFN analyses. This journal issue will include an overview article on the model inter-comparison and discussion papers on specific issues and analyses. The issue papers may draw from the regional analyses described above as well as related analyses conducted by team members. The SGWG team will encourage relevant ministries and other public sector partners to contribute to these papers, which will strengthen links between policy and analysis.

Air quality-transportation policy brief: With a similar objective as in the energy-water-food policy brief, the team will draft a short paper summarizing the results of the analysis conducted on air quality and transportation. This policy brief will provide policy-makers with clear results and explanations for differences as well as convergence on analysis results, to support policy-makers in understanding those results and integrating them into policy making. This paper will also highlight critical data needs and suggest topics for analysis to dig deeper into the impacts of alternative policy approaches to address air emissions from the transportation sector.

National and targeted air quality-transportation analyses: The team will model air pollutant emissions from India's transportation sector using harmonized assumptions and scenarios for several policy scenarios. These scenarios may examine potential impacts of various policies, such as an economy-wide carbon constraint, a fuel economy standard, model shift, and national level fuel standards. The particular scenarios to be analysed will be determined in close consultation with the Advisory Board, such that the scenarios will touch on relevant issues and incorporate and build on existing regulations and policies. The team may also conduct analyses of air pollutant emissions and impacts on air quality (air pollutant concentrations) at the local level to understand the benefits of national level and localized policies. Target cities and regions, approach and policy interventions to be analyzed will be determined in consultation with the Advisory Board. This work will build upon the work already conducted and underway by Indian researchers at IIT Kanpur, IIT Delhi and other institutions working on air quality issues.

Air quality-transportation journal/series of issue papers: Upon research completion the team will prepare a journal issue or series of papers on air quality-transportation analyses. This series will include an overview article on the model inter-comparison policy scenarios and discussion papers on specific issues and individual discussion papers.

Mapping the Future: Geospatial Analysis for Renewable Energy Deployment

India is emerging as a global leader in renewable energy (RE) development. The GOI has set ambitious goals of 100 GW of solar and 60 GW of wind energy by 2022, and is developing programs and initiatives aimed at addressing the many challenges to achieving these goals. Fundamental to turning these goals into actual deployment of solar and wind installations are data and analysis to identify the geographic distribution of areas in India with the greatest potential for renewable energy.

To meet this need, the SGWG team developed an Enterprise Geospatial Toolkit (EGsT), aimed at providing spatial and spatiotemporal data, analysis tools, and interactive maps to display the data and analysis, in a user-friendly web-based platform. Broadening access to data, analysis and information and providing maps to help visualize multiple layers of data will help accelerate the speed of RE development in India through supporting national and state level policy makers, transmission planners, RE developers and the academic and NGO community (Box 4).The EGsT offers a platform to conduct impactful visualization and analysis, and thereby supports quantifying opportunities in renewable energy and prioritizing development of these resources.

BOX 4

Geospatial Analysis Stakeholders: Needs and Opportunities

GOI policy makers and public sector managers at national and state levels

--Design targeted policies and incentives to encourage RE development in most productive areas for solar and wind energy

--Analytically-based state Renewable Purchase Obligations

--Grid integration analysis, including capacity expansion, regional electric system planning, production cost modeling and carbon mitigation

Central and state transmission planners

-- Transmission planning to site infrastructure to drive RE development in the most productive, cost-effective areas

--Renewable Energy Zones (REZ) screening to identify areas with high quality and highly concentrated RE resources, suitable topography and land-use, and strong developer interest

Indian and international RE project developers

--Quickly and easily identify and assess areas that look most cost-effective for further site-specific exploration

--A level playing field that supports market entry for potential developers

ACCOMPLISHMENTS

Core Enterprise Geospatial Toolkit framework: The team developed an initial web-based geospatial platform which allows users to view, explore, query, and download solar and wind resource data, transmission lines, roads, land use, land ownership and other spatial and spatiotemporal data (Figure 3). The EGsT includes data at a higher resolution than is currently available at no cost to all stakeholders. After refining the EGsT based on targeted stakeholder input and developing additional tools to support key analytic needs, the EGsT will be officially launched in late 2016.

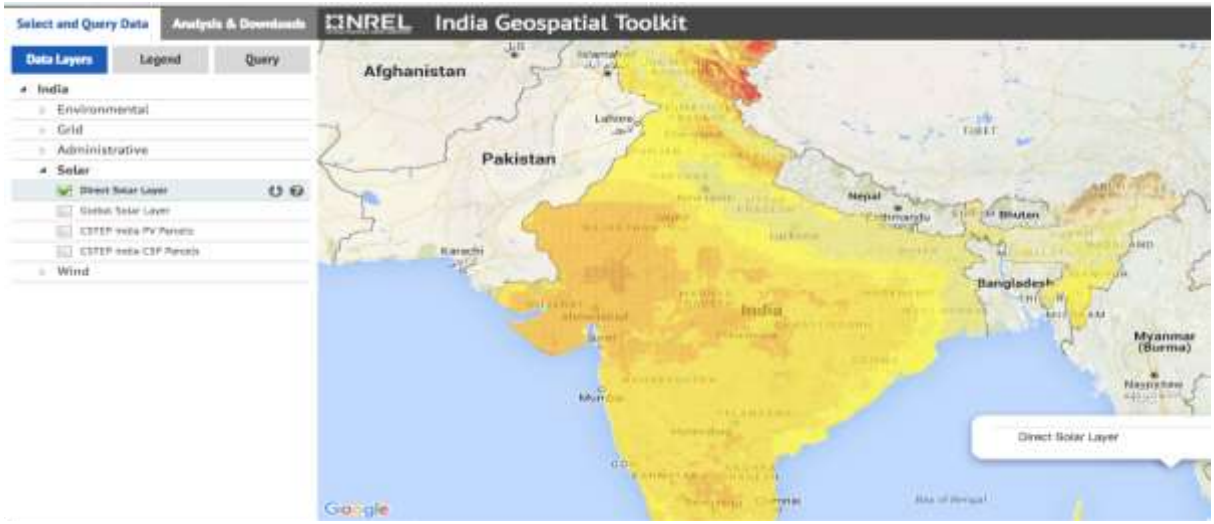


Figure 3. Enterprise Geospatial Toolkit for India

Solar site selection tool: Based on a concept developed at CSTEP, the EGsT team implemented a tool that allows users to determine the solar potential for specific land parcels based on set parameters. This analysis can serve as a baseline for solar technical potential as an initial step in identifying optimal areas for solar development (Figure 4).

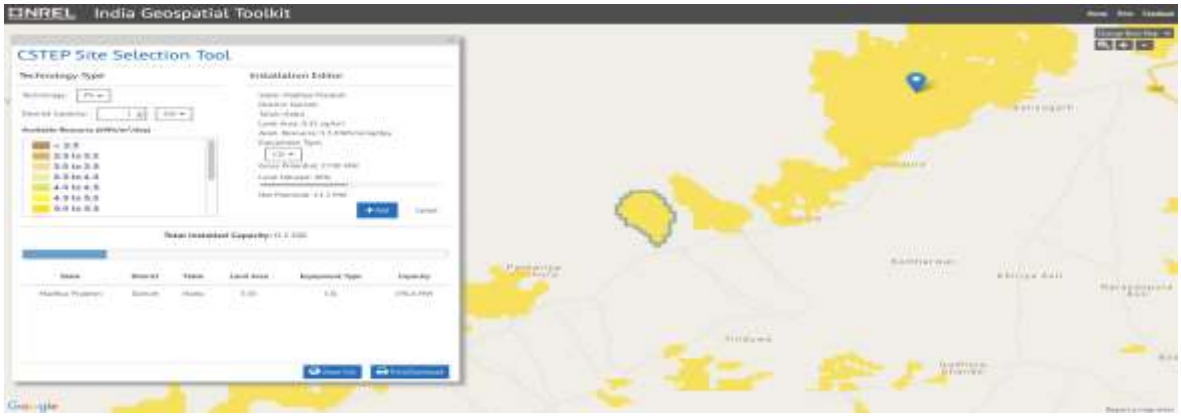


Figure 4. Solar Site Selection Tool

Technical potential tool: Technical potential is fundamental to identifying the areas and parcels of land that offer the greatest potential for solar and wind development, considering physical aspects of the land (slope, water bodies, etc.), proximity to roads and transmission infrastructure, and land ownership and current land-cover and land-use. The Technical Potential Tool (Figure 5) provides the maximum capacity and potential generation for solar and wind technologies within specific parcels**,** based on assumptions (e.g. resource class, density of installations, available land area, proximity to infrastructure, solar generator system) specified by the user.

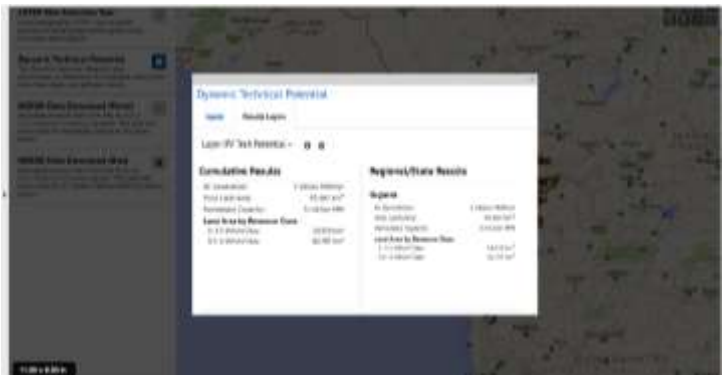


Figure 5. Solar and Wind Technical Potential Tool

Technical potential may subsequently be filtered down to economic potential, which quantifies the resource potential that meets a certain economic criteria, and finally to market potential, which is an even more narrow potential based on non-economic barriers. This analysis provides the fundamental data and information for policy makers, transmission planners, and solar and wind project developers to identify the areas with the greatest opportunity for RE development. Varying assumptions and running multiple scenarios allows stakeholders to explore the impacts of different assumptions and parameters. The data provided by the tool can be downloaded, supporting exogenous analysis.

UPCOMING ACTIVITIES

EGsT stakeholder workshop: The initial EGsT will be shared with stakeholders during a workshop in early August 2016 to gain input on how the EGsT can be enhanced to meet stakeholder needs. The full-day workshop will include a review of the EGsT, sample analyses of how the analysis tools and data can be used to tackle real-world questions, and hands-on experience in using the initial EGsT. Based on reactions from workshop participants and subsequent dialogues, the toolkit will be enhanced for improved targeted analysis functionality. In addition, tools to meet specific needs will be developed in the coming months (described below). The official launch of the EGsT is anticipated in late 2016.

Economic potential tool:. Economic potential in this context is defined as the subset of the available technical resource potential where the cost of generating electricity (which determines the minimum revenue requirements to develop the resource) is below a certain threshold. In one definition, the renewable resource must come at a cost that is below the conventional resource "avoided costs", including avoiding new capacity and energy. This tool will support solar and wind developers interested in analysing the economic merits of one or more proposed solar or wind plants. The tool will build on a set of technical potential scenarios, which will be run through algorithms to provide the levelised cost of energy9(LCOE) at thousands of sites (identified in the technical potential scenarios). The Economic Potential Tool will integrate the LCOEs for the different renewable resource scenarios and provide a mechanism for users to explore levelised avoided cost (LACE)10 and apply individual economic inputs onto the LCOE scenarios to calculate final economic potential of a specific location.

Renewable Energy Zones (REZ) support tool: REZ is an analytical framework aimed at building competition in RE energy project development and identifying corridors for new transmission development. Zones that are identified to have the greatest potential (through Technical Potential analysis) are shared with solar and

wind developers through the REZ Support Tool to get their feedback on which of these target zones are in fact the ones where they are most interested in developing solar and/or wind installations.

The EGsT REZ Support Tool will allow users to visualize, download, and interact with the target zones and also overlay zones with critical geospatial information for RE siting, including land-use/land-cover, transmission infrastructure, and environmentally sensitive lands. The tool will allow users to download high-resolution spatiotemporal solar and wind resource data for a given zone as well as selected ancillary data (e.g. land-cover). This will allow stakeholders to easily access the required high-resolution data to be able to further evaluate a zone's potential for development.

The REZ tool supports stakeholders assessing target zones that have the most desirable characteristics, including parcel availability, land-use type, and solar and wind spatial and temporal variability. By providing a tool to solar and wind developers to explore, developers can identify the zones of greatest interest to them. In response the GOI can target policies and incentives to support the subset of zones with demonstrated interest from developers.

Geospatial Grid Integration Support Tool: With greater penetration of RE into the grid, the operational implications of renewables becomes increasingly important. This scenario-based tool will incorporate key drivers (e.g., technical potential, RE supply curves, RE generator profiles) and generate the necessary inputs for conducting renewable integration studies (namely production simulation models). This dynamic tool will auto generate necessary data, allowing users to generate substation-based RE supply curves with associated class-based time-series power profiles through a combination of dynamic technical potential and generator energy modelling. The tool will allow analysts to control the supply curves input, generator characteristics, and spatial location of nodes, allowing analysts to quickly and robustly generate multiple scenarios for grid integration analysis. Output from this tool may be integrated into grid integration analysis tools (e.g., PLEXOS) for India. The benefit of this tool will be an automated and user-friendly process to generate data inputs for grid integration studies.

Looking Ahead

In the next phase, the SGWG team will build on the foundation established to date and collaborate on near-term improvements to energy data collection and dissemination, articulation of a longer-term plan for energy data management, analysis of critical issues in the Indian energy-water-food nexus and in the role of transportation in air quality, and in developing and sharing geospatial tools to support deployment of solar and wind energy in the most productive and economically favourable locations. The SGWG offers GOI decision-makers the opportunity to together engage in framing critical analysis questions, shaping the tools to tackle these issues and engaging on results from these analyses to support development and implementation of a trajectory that meets India's goals for sustainable and inclusive growth.

UK DECC (Department for Business, Energy & Industrial Strategy)

The UK and India's close collaboration and partnership on energy planning and modelling started in early 2013 with the signing of a Statement of Principles (SoP) between the UK Government and the former Planning Commission (now NITI Aayog), to deliver a long term energy pathway model for India based on the UK's 2050 Calculator approach. This was a first of its kind approach which gave users and policy makers the ability to get detailed projections of the impacts of specific energy supply and demand choices.

This partnership resulted in the development of the India Energy Security Scenarios 2047 tool (available at www.indiaenergy.gov.in) - the first energy pathways calculator developed by and for India. It highlights the long term impact of energy choices on India's energy security, land usage and emissions, and opens up this information to new audiences by making it available for free online.

Building on the successful and mutually beneficial achievement of the aims of the original Statement of Principles, both Governments were keen to extend, as well as widen and deepen, the original cooperation to increase the usefulness of the IESS and its reach.

This new phase in the partnership saw the UK providing further support on the technical capabilities of the model, and working with Indian partners to showcase India's IESS energy pathways model at international platforms. This second phase in the collaboration also facilitated the development of a global energy modelling community with the UK and India played leading roles. The close and detailed working also fed into revisions the UK was making to its own 2050 Calculator. Specific achievements during this phase include –

- Launch of Phase 2 of IESS including estimates of impacts on GDP;
- Creation of a knowledge exchange platform between DECC and NITI Aayog on energy pathways modelling and other approaches;
- Establishing a global energy modelling community with India as a key member;

- Outreach activities to showcase India's energy pathways model at international events in Taiwan, Mexico and Delhi (DSDS).

Over the last two years our two countries have worked very closely together to spread awareness and increase the outreach of the IESS to enable better integrated energy planning, particularly at state level. We have jointly –

- produced animation videos and media material;
- provided technical support to prepare reports and publication material;
- held steering group discussions with knowledge partners like Prayas, C-step, Teri, ISGF and other stakeholders;
- held regional, state and district level outreach activities using the IESS to demonstrate its value in energy planning.

This collaboration is now in its fourth year and growing ever stronger and adding new areas of scope. We are now focussing on building technical capacities, modelling analysis and communicating results to enable increased use of the tool for policy approaches in the energy and climate sectors. We are also exploring opportunities to work at state level.