

Energy and Environment Programme



NITI AAYOG-NIAS WORKSHOP

On

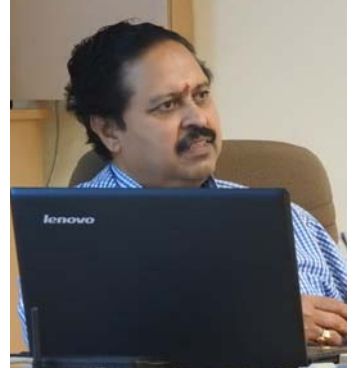
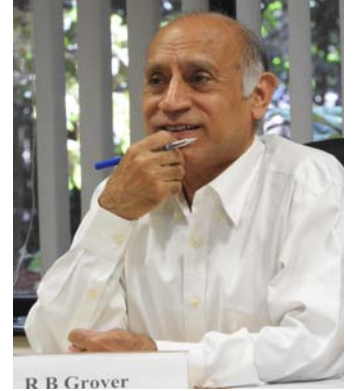
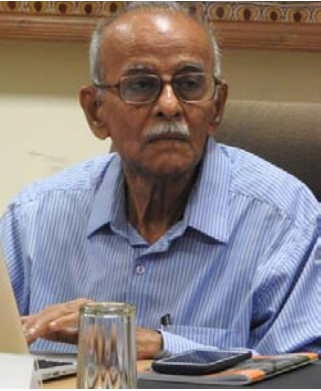
Optimal Electricity Mix for India – Glide Path for India's Power Sector

R Srikanth

December 2018

National Institute of Advanced Studies
Indian Institute of Science Campus
Bengaluru-560012

Workshop Gallery



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1. Introduction

The Energy and Environment Program (EEP) at the National Institute of Advanced Studies (NIAS) has recently secured a 3-year research grant from the Department of Science & Technology (DST) to carry out a Study to develop an “*An Integrated Approach to Development and Environment in the Power Sector.*” The over-arching goal of this Study is to find optimal technology and policy interventions to be implemented at the State and Central levels to meet the Southern Region’s growing needs for electricity by achieving the targets set out in Sustainable Development Goal (SDG) 7 (*‘to ensure access to affordable, reliable, sustainable, and modern energy for all’*), and realising the aspirations indicated in India’s Nationally Determined Contributions (NDCs).

This Study is an intensive analytical and policy-oriented project which aims to develop an optimal electricity mix for each state in the Southern Region. The Study also aims to incorporate inputs of various stakeholders in the power sector like Generation companies, Transmission utilities, DISCOMs, Electricity Regulators, Equipment manufacturers, Financiers, CEA, Government(s), and Civil Society. The final report of this Study will detail the State-wise, time-bound, transition plans in relation to the electricity sector, which will help achieve an optimal electricity mix for the States in the Southern Region during various time horizons (2022, 2027, and 2030).

In order to kick off this Study, on 20th November 2018, the NITI Aayog – NIAS Workshop on “Optimal Electricity Mix for India- Glide Path for India’s Power Sector” was conducted in the NIAS campus in Bengaluru. This Workshop chaired by Dr. V K Saraswat, member of NITI Aayog was conducted in three interactive sessions culminating in a panel discussion (Annexure). The concept note for this Workshop was the draft of an article published in *Energy Policy* recently (<https://www.sciencedirect.com/science/article/pii/S0301421518305792>). In addition to Dr. Saraswat, the key speakers during this Workshop were: Prof. P.S. Goel, Raja Ramanna Chair Professor and Ex-Secretary MOES, Mr. Sreenivasa Murthy IAS (Retd.), ex-Chairman of KERC, Prof R.B. Grover, Member of Atomic Energy Commission, Mr. Pankaj Batra, ex-Chairman of CEA, Mr. S.K. Soonee, Advisor to POSOCO, Mr. Vikas Agarwal, Director (Distribution) of UPERC, Mr. R Balasubramanian ED/Company Secretary of KPCL, Mr. Venkatakrishnan, ex-COO of Raichur Power Corporation, Mr. Nagamanikam, GM of BHEL, Dr. L.V. Krishnan of NIAS, Dr. Rahul Tongia, Fellow Brookings India, and Prof R Srikanth of NIAS.

2. Inaugural Session chaired by Dr. V K Saraswat

During his opening remarks, Dr. Saraswat reiterated the strong correlation (0.74) between GDP growth and per capita electricity consumption in India. He also highlighted the paradox in India with several million people being connected to the power grid for the first time but still not getting quality power for most of the day, while the Nation is facing an overall power-surplus situation. After touching on the poor state of most Government DISCOMs in India despite the ongoing UDAY program for DISCOM restructuring, Dr. Saraswat also emphasized promoting clean coal technologies like AUSC (Advanced Ultra Super Critical) and IGCC (Integrated Gasification Combined Cycle) for improving thermal power plants efficiency. He also stressed

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the need for self-reliance in the power sector, including in the area of modern renewable energy technologies.

3. Session I chaired by Professor P S Goel,

Mr. Pankaj Batra opened the technical session of the Workshop by making a presentation on the salient features of the National Electricity Plan (NEP) and asserted that India’s electricity demand is expected to grow at a rate of about 6% to 1566 TWh in FY 22 and 2047 TWh in 2027. Corresponding to the rise in power consumption, peak demand is projected to increase from the FY 18 level of 170 GW to 226 GW in FY 22 and further to 299 GW in FY 27. He asserted the urgent need to increase pumped storage capacity to 8000 MW to integrate higher proportions of intermittent power from RES (Renewable Energy Sources) without expensive storage.

In his presentation, Dr. Rahul Tongia indicated that power tariffs from Coal Power Plants (CPPs) have increased as Government levies (including, Coal Cess) and Railway Freight have been increasing much faster than the pithead price of coal. He stated that power from (Solar + Battery) is still not competitive with power from CPPs in India at this time since the overall battery cost is about 2.9 times the cost of the solar cell itself. Finally, he stated the urgency of DISCOM reforms.

The first session concluded with a talk by Prof Srikanth who explained why the current level of stressed power assets (about Rs.1.8 Trillion) is a cause of concern for India. The ‘twin balance sheet’ problem faced by India's power sector and the Public Sector Banks require policymakers to include the costs of stranded CPPs with other social costs of renewables. As India’s electricity requirements grow to meet the aspirations of 1.3 Bi people, he stressed the need for a policy framework that integrates all low-carbon energy technologies with coal in such a manner that the reliability, security, and affordability of electric supply are balanced with sustainable development.

4. Session II chaired by Professor R B Grover

During the second session, Mr. Soonee presented the achievements of India’s Power Grid (third largest in the World) which is operating as one Grid, while the US has three Grids and China has two Grids. However, he also stressed that the power market in India is bedeviled with multiple layers of intervention due to the absence of specialists in electricity market design. He explained the need for more stringent technical standards for grid connectivity. Mr. Soonee admitted the need for more transparent data sharing related to power system operation and focussed on the urgent requirement for increasing capacities in the areas of power system modeling and forecasting to enable the development of more accurate and flexible power system models. He also explained the need to develop a special tariff to recognize the ramping capability of hydel power (or that of other power sources) which is critical for RE integration. He concluded by summarising the current status of the enablers needed to integrate 175 GW of intermittent RE with the Grid.

Mr. Venkatakrishnan and Mr. Nagamanikam then explained the operation and design of modern super-critical power plants that are also fitted with modern pollution control equipment to comply with the current environment norms. In comparison with conventional sub-critical

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power plants, these CPPs are also capable of reducing specific coal consumption (lower heat rate) as well as specific water consumption while achieving a higher ramp rate. But, such CPPs are not being utilized to their full potential today either due to coal shortages or due to inadequate demand.

Mr. Nagamanikam explained how modern Electrostatic Precipitators (ESPs) can reduce Particulate Matter (PM) emissions from CPPs to meet the current emission standard of 30 mg/m³ applicable to all CPPs from December 2017. Similarly, Flue Gas Desulfurizers (FGDs) and Selective Catalytic Reduction (SCR) technology can be used to bring down the SO_x content and NO_x content of CPP stack emissions to comply with the environmental norms applicable from December 2017. Such modern pollution control equipment is now being manufactured in India to help CPPs meet the current environmental norms. However, retrofitting CPPs with these systems requires lengthy shutdowns (4 – 6 months for ESP, 24 – 30 months for FGD, and 2 – 3 months for SCR system) as well as incremental capital investments of Rs.7-10 million per MW of installed capacity. Operating such pollution control equipment also entails additional costs for CPPs. These additional capital investments and operating costs to comply with the revised standards will increase the tariffs of CPPs if no funds are available from the National Clean Energy and Environment Fund (NCEEF) which was originally intended to be funded by the coal cess.

Dr. LV Krishnan then spoke about load-following Nuclear Power Plants (NPPs) which are used in France and Germany to balance the intermittent power generated by RE sources. While NPPs can generate power on a 24x7 basis unlike solar and wind energy sources, they are expected to generate only 5% (up from 3% today) of the total electricity generated by utilities in India during FY 27 after the ongoing expansion program. He mentioned that, while China and India are not using NPPs for load balancing, all European countries (barring the United Kingdom) use Pressurised Water Reactors (PWRs) to enable NPPs to balance the intermittent power of RE sources.

5. Session III chaired by Mr. Sreenivasa Murthy

Mr. Sreenivasa Murthy laid the ground for the third session by delivering an erudite talk on the major challenges faced by India’s power sector today. He explained despite the dramatic growth in power generation capacity in India during the 12th Five Year Plan, latent demand is still unmet while several Independent Power Producers (IPPs) are unable to secure long-term Power Purchase Agreements (PPAs) with the DISCOMs. Further, the dues of DISCOMs to IPPs have now increased to nearly 18,000 Crores in June 2018, primarily because the Average Revenue Realised (ARR) of most DISCOMs is falling short of their Average Cost of Sales (ACS). He stressed that DISCOMs must ensure that 100% of the power supplied is billed. He concluded by stating that UDAY is the third bailout of the power sector and must not be allowed to fail.

The first special address in the third session was delivered by Mr. Vikas Agarwal, Director (Distribution) of Uttar Pradesh (UP) Electricity Regulatory Commission who detailed the year-on-year growth in share of electricity sold to domestic consumers while the proportion of electricity sold to industrial consumers is gradually decreasing. Due to these changes, the share of the unsubsidized category (industrial) is reducing while the share of the subsidized category

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(domestic) is increasing. He stressed the need for installing meters (preferably, pre-paid) for all electricity customers to reduce the gap between ARR and ACS (currently, Re. 0.48 per unit in UP) which is critical to control DISCOM losses. Finally, he stated that DISCOM reforms as envisaged in UDAY cannot be achieved unless the DISCOMs receive the wholehearted cooperation of the District Administration, the Government, the Electricity Regulator, and the public at large.

The second special address during this session was given by Mr. Balasubramanian of KPCL who presented the current operational and financial parameters of the power sector in Karnataka. He stated that Karnataka DISCOMs are providing free power for six hours a day for agriculture and about 20 hours a day to the residential sector in rural areas. The Government of Karnataka has been providing financial assistance to the DISCOMs to meet the burden of free electricity to farmers. Non-materialisation of projected demand increase of 4000 GWh in the Karnataka Grid has led to cannibalization between different sources of power instead of coexistence of thermal and RE power. Since power from RE sources is replacing thermal power during the day, the fixed charges (per unit) of KPCL are growing steadily thereby depriving the power consumers of a cheaper tariff. At this time, KPCL itself is not feeling a major impact since the State Government reimburses the fixed charges prescribed by the Regulator as per the PPA. Eventually, the PPA will become an albatross around the neck of KPCL as well as power consumers in Karnataka, and may even saddle the lenders with loan defaults if the State Government is unable to transfer (in a timely manner) an adequate amount of subsidies to KPCL for providing critical energy services.

6. Final panel discussion chaired by Dr. Saraswat

Prof Grover opened the panel discussion by explaining the key actions to be implemented by Government of India (GOI) in order for nuclear energy to play a major role in decarbonizing the power sector since intermittency of RE power can be compensated in a cost-effective manner only by conventional sources of power. Responding to some suggestions, he explained that NPPs are owned and operated by public sector companies in India, France, and Russia, while in USA, Japan, and the UK, private companies own and operate nuclear power plants. While both models are successful, if India has to open nuclear power plant operation to the private sector, three important issues namely safety, security, and safeguards need to be addressed. This would require amendments to the Atomic Energy Act, 1962 inter alia to place Atomic Energy Regulatory Board on a sound legal basis. This is also required to make it legally obligatory for an NPP operator to provide for fool-proof physical security for the NPPs and nuclear material, and also to provide timely and complete information to the Government regarding the accounting of nuclear material and equipment subject to safeguards.

Prof V S Ramamurthy indicated that microgrids using diverse sources of power (solar/wind, small hydro, biomass/biogas) may be best-suited for far-flung villages where the extension and maintenance of the Grid may become costlier (and less reliable) than a local microgrid. This is an extension of the decentralized renewable energy generation model whose salient features were presented by Mr. Vikas Agarwal with reference to a large, populous State like UP.

Finally, the conclusions and recommendations of the Workshop are summarised as follows:

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Thermal Power Plants

- Adoption of clean coal technologies in coal beneficiation and utilization must be expedited since coal will continue to be India's primary source of electricity at least till 2040 even as the country ramps up generation capacity of RE sources to comply with the NDCs.
- Due to the supply-demand mismatch in India today, surplus capacity in the Grid can be used to plug the gap caused by the closure of any of the older (+25 years), inefficient, and polluting CPPs that are not capable of meeting the environmental norms without major capital investments and extensive shutdowns. Therefore, the feasibility of retrofitting all CPPs to comply with the environmental norms should be examined carefully on a case-by-case basis, taking into account, the technical, commercial, and financial implications.
- India is witnessing an unprecedented growth of peak demand (177 GW in H1 of FY 19 compared to 164 GW in H1 of FY 18), partly due to the rapid implementation of the Saubhagya scheme in recent months. This has also led to a steep increase in the PLFs of CPPs leading to an overall shortage of coal stocks despite Coal India and Singareni Collieries Co Ltd (SCCL) increasing coal supplies to the power sector by about 9%. Therefore, GOI must implement commercial coal mining urgently (as permitted by existing statutes) to supplement CIL/SCCL.

Renewable Energy Sources

- There is an urgent need to promote indigenous manufacturing as well as R & D into new solar cell technologies in order to expand the use of solar energy in the long run.
- DISCOMs must find ways and means of enhancing the growth of rooftop solar power since utility-scale solar may be constrained by inadequate availability of land in future.
- Hydel power must be increased by removing the constraints inhibiting its growth since it is critical to integrate larger amounts of intermittent power from RE sources.
- The state-level technical and policy interventions required to integrate 160 GW of solar and wind power into the Grid must be accelerated to avoid stranded generation assets.
- Production cost simulation tools must be used by all stakeholders to evaluate the impact of different strategies in the power sector. Regulatory guidelines must be developed to make it mandatory for stakeholders to provide data required to perform power flow studies.
- Since Pumped Storage Systems (PSPs) with their fast ramping capabilities are critical for RE integration, GOI and the States must work together to incentivize growth of PSPs.

Nuclear Power

- Nuclear power is a safe, environment-friendly technology which can provide baseload power potentially at lower costs compared to CPPs which are based on imported coal. However, NPCIL must reduce project costs and the gestation period for ongoing projects to minimize interest during construction in the overall interest of achieving a competitive tariff.
- Since the Southern Region is also rich in intermittent RE sources, GOI must also expedite the construction of NPPs in time to replace CPPs saddled with high coal costs in the Southern Region when the capacity of RE progressively increases as per GOI's targets.

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- DAE must accelerate research on India’s own PWR (load-following type) which will be particularly useful in the Southern Region to balance the growth of RE generation.
- Small and Modular Reactors (SMRs) maximize the use of factory-built modules which can be built more efficiently to a higher quality than what can be achieved by on-site fabrication. Therefore, DAE can explore the feasibility of developing SMRs to reduce the total gestation period as well as the capital cost of NPPs in the interest of achieving a lower tariff.
- There is an urgent need for GOI to induct power-sector Maharatnas like NTPC and BHEL into nuclear power so that their financial and human resources, as well as experience in putting up greenfield power projects, can be harnessed to realize the potential for nuclear power in India.
- GOI must consider the amendment of the Atomic Energy Act to involve select private sector companies (having JVs with reputed international companies having proven experience in the construction and operation of NPPs) to put up and operate NPPs in India.
- Putting the Atomic Energy Regulatory Board on a sound legal footing is also necessary to win public acceptance, particularly when companies other than NPCIL are allowed to put up NPPs.

Way Forward for DISCOMs, Regulators, and Government

- Electricity Regulators must ensure that regular distribution system audits are conducted to separate distribution system losses from power theft which is a key reason for DISCOM losses.
- The Central and State Governments must implement Direct Benefit Transfer (DBT) of power subsidies to each consumer to ensure affordable power supply to the under-served without affecting the viability of the DISCOMs. This move will also yield other associated benefits in areas like energy conservation, energy efficiency, and groundwater conservation.
- The operational (and revenue collection) efficiencies of DISCOMs can be enhanced only with the help of suitable political will and administrative interventions.
- Each DISCOM must be adequately compensated (in a timely manner) for the power sold to each category of consumer, while the power subsidy is directly remitted to the beneficiary’s account by the Government. This is preferable over the current situation where the DISCOMs have to wait for the Government to compensate them for the costs already incurred by the DISCOMs to serve unserved/under-served consumers.
- The DISCOMs of UP are attempting to address issues related to billing and collection by appointing distribution franchisees whose scope and responsibility can be varied depending on the need and capability of the DISCOMs. This may be a middle path whose efficacy can be reviewed before going in for complete privatization of loss-making DISCOMs.

India’s electricity sector will continue to play a vital role in the attainment of India’s SDGs as well as the NDCs well before 2030. Therefore, all stakeholders in the power sector must enhance public communication in order to win public trust at a time of rapid transition in India’s energy sector.

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ANNEXURE

Agenda for National Workshop conducted at NIAS

On November 20, 2018

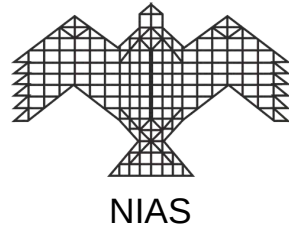
09.00–09.30	Registration
09.30–10.00	Inauguration Welcome – Professor P S Goel , Raja Ramanna Chair Professor, and ex-Secretary MOES Objectives and Purpose of the Workshop – Dr. R Srikanth , NIAS Opening Remarks - Dr. Saraswat , Member, NITI Aayog
10.00–10.30	Tea Break
10.30–12.00	Session I: India’s strategy to achieve Nationally Determined Contributions and Sustainable Development Goal 7 (Energy) Chairman: Professor P S Goel , Raja Ramanna Chair Professor, NIAS
Key Note Address (20 Min)	Recommendations of CEA related to Optimal Electricity Mix for India in 2022, 2027 and beyond. Mr. Pankaj Batra , Ex-Chairman, CEA
Talk–1 (15 Min)	RE versus Coal in India: A false framing as both have a role to play Dr. Rahul Tongia , Fellow, Brookings India
Talk–2 (15 Min)	India’s Sustainable Development Goals – Glide Path for India’s Power Sector Dr. R Srikanth , Professor & Head (Energy & Environment Research), NIAS
30 Minutes	Discussions/Recommendations
10 Minutes	Coffee/Tea Break
12.00–13.30	Session II: Role of Conventional Energy Sources to achieve India’s Sustainable Development Goals and Nationally Determined Contributions. Chairman: Professor R B Grover , Member, Atomic Energy Commission
Key Note Address (20 Min)	System Operation and Renewable Energy Integration Mr. S K Soonee , Advisor, POSOCO
Talk–1 (15 Min)	State-of-Art Super-Critical Power Plants – Experience & Challenges Mr. Venkatakrishnan , ex ED (BHEL) and COO of Raichur Power Corporation
Talk–2 (15 Min)	Techno-economic feasibility of retrofitting 200 – 600 MW capacity Coal Power Plants with FGDs and other pollution control equipment in the current Scenario Mr. Nagamanikam , GM, BHEL
Talk–3 (15 Min)	Role of Nuclear Power as a Balancing Source to integrate Renewable Energy Dr. L V Krishnan , formerly of IGCAR and Adjunct Professor, NIAS
25 Minutes	Discussions/Recommendations
13.30–14.30	Lunch
14.30–15.40	Session III: Viability of Power Sector and Regulatory Reforms Chairman: Mr. Sreenivasa Murthy , IAS, Ret’d Chairman of KERC
Keynote Address (20 Min)	Universal Electricity Access and Viability of DISCOMs – Way Forward Mr. Vikas Agarwal , Director Distribution, UP Electricity Regulatory Commission.
Special Address (20 Min)	Viability of State Gencos – Challenges and Way Forward Mr. R Balasubramanian , ED (Corporate Affairs) & Company Secretary, KPCL
30 Minutes	Discussions/Recommendations
15.40–16:00	Tea Break

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16.00–17:30	Session IV: Panel Discussion: Way Forward to integrate 175 GW of renewable power (70 GW in Southern Region) to achieve SDG 7 and the NDCs Chairman: Dr. V K Saraswat Professor V S Ramamurthy Mr. Pankaj Batra Professor R B Grover Mr. R Balasubramanian Dr. Rahul Tongia
17.30–17:50	Concluding Remarks and Way forward Dr. V K Saraswat
17:50 – 18:00	Vote of Thanks by Dr. Sheela Ramasesha, Principal Scientist, NIAS.



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