



ANNUAL REPORT | 2017-18





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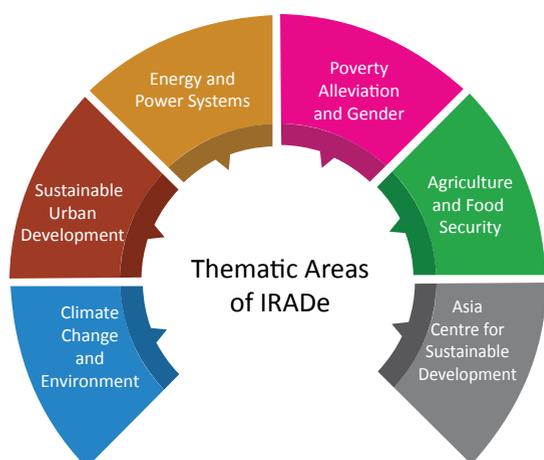
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About IRADe

IRADe is an independent advanced research institute which aims to conduct research and policy analysis to engage stakeholders such as government, non-governmental organisations, corporations, academic and financial institutions. Energy, climate change, urban development, poverty, gender equity, agriculture and food security are some of the challenges faced in the 21st century, IRADe's research covers these issues, as well as the policies that affect them. IRADe's focus is effective action through multi-disciplinary and multi-stakeholder research, to arrive at implementable solutions for sustainable development and policy research that accounts for the effective governance of techno-economic and socio-cultural issues.



IRADe was established under the Society's Act, in 2002 at New Delhi. It is certified as a Research & Development Organisation by the Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology (MoST), Government of India. It has also been selected as a Centre of Excellence by the Ministry of Urban Development (MoUD), Government of India for urban development and climate change. In addition, it provides expertise to other ministries, national and international institutions and partners with other reputed organisations.

Our Vision

To be a leading Global independent policy research Think Tank that provides and enables implementable policy solutions for sustainable and inclusive development.



Our Mission

To carry out policy analysis from multi-stakeholder and multi-disciplinary perspectives for decision makers and vulnerable groups in thematic areas of climate change and environment; energy and power systems; sustainable urban development; agriculture and food security; poverty alleviation and gender. Using policy research and analysis, consensus building and dialogues, capacity building, monitoring and evaluation.

Our Objectives

Integrate multi-disciplinary and multi-stakeholder perspectives concerning issues of development.

- Promote wider consensus, through research and analysis, on effective policies.
- Engage and work at local, district, state, national, South Asia regional and global levels.
- Provide research support to developing countries for development and for negotiation process for international agreements.
- Carry out policy research that accounts for the political economy of the society and effectiveness of governance.

IRADe's activities in the above areas have cross-cutting themes such as technology assessment and policy reforms. The key activities are:

1. Policy Dialogues and Dissemination
2. Training and Capacity Building
3. Research and Analysis for Decision Support
4. Research in Action, Monitoring and Evaluation Projects

Preface

IRADe Annual Report is a vehicle to conclude the year through report and to reflect on the work completed or to be launched. This year marked the completion of our work on assessment of coal technologies for power generation through scenarios till 2050 in collaboration with three IIT's viz. Delhi, Bombay and Madras in a DST project.

Shakti Sustainable Energy Foundation (SSEF) sponsored project which asked why should there be a difference in the prices of diesel and petrol? By a meticulous analysis of all stakeholders we suggested that the government can equalize prices and this is happening gradually as the report was released by Minister Shri Dharmendra Pradhan. The other collaborative projects funded by SSEF are on transport models and on Food-Energy -Water nexus.

South Asia Regional Initiative (SARI) project of USAID is at an advanced stage completed with 75 events, 23 reports, as can be seen in the event section. During August 2018, a major regional conference will be held.

We carried out modelling work and also engaged in energy access work, we carried out considerable amount of field work, especially about the views on LPG and electric cooking.

The most interesting part is the five new projects we got in the Urban theme covering issues in the disaster resilience, vulnerability Index, Dengue, air pollution and urban Heat Stress. Each, a major problem and same requiring considerable collaborations and new methodologies.

I take this opportunity to express my sincere gratitude to all our sponsors, collaborators, the Governing Council of IRADe and our well-wishers for their continued support and encouragement. I express my sincere appreciation to the IRADe's staff and thank them for their cooperation and dedication to work.

My special thanks to Ms. Ananya Bhatia, Research Associate, IRADe for completing the task of preparing this report.

We hope you enjoy this report as much as we did preparing it.

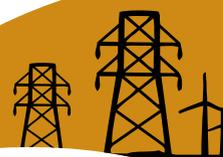


Professor Jyoti Parikh, PhD
Executive Director, IRADe

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1. Energy & Environment



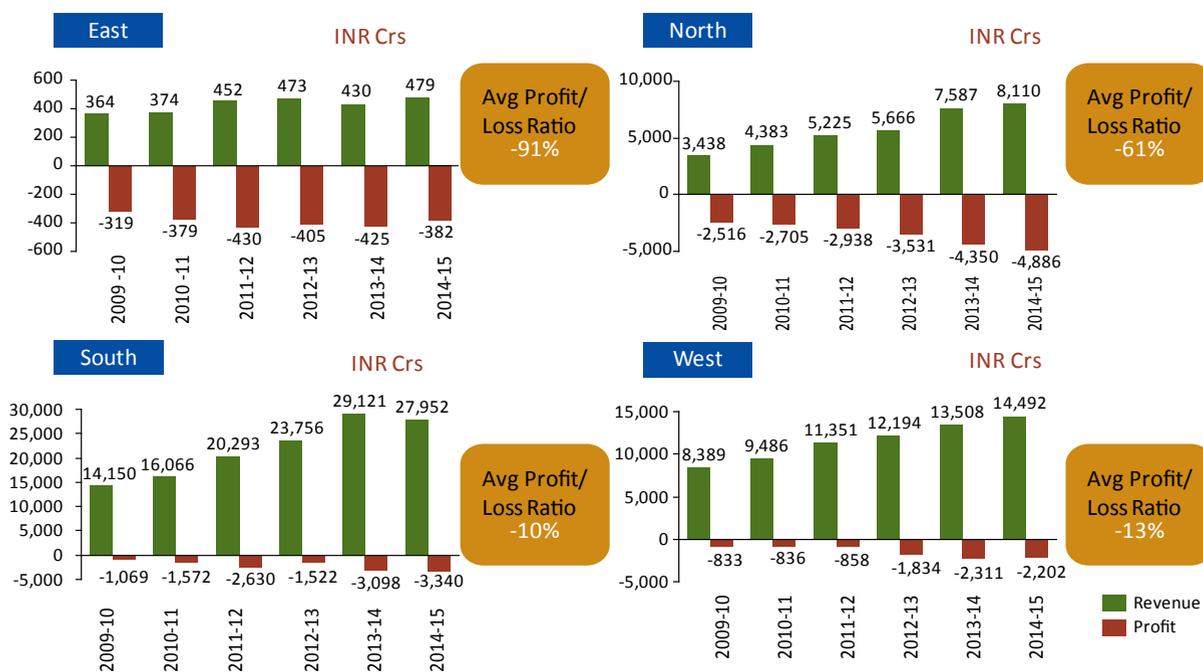
1.1. Diesel Price Rationalization

The key objective of this study is to analyse the impact of diesel price rationalization by removing price distortions between diesel and petrol. The Central Government imposes different excise duties which are specific on petrol and diesel. The State Governments impose VAT on excise inclusive cost. The VAT rates are ad valorem and are in general different for Petrol and Diesel and also vary from state to state. In India, diesel has the largest share (40 percent) in petroleum product consumption; in the year 2015-16 it was 40 percent. Petrol accounted for 12 percent and was the second most consumed petroleum product in the country. The share of diesel consumption is expected to rise to approximately 45 percent and that of petrol marginally to 13 percent by volume.

Consumption of petrol is almost entirely done by the transport sector, two wheelers (61 percent) and cars

(34 percent) and balance being consumed by three wheelers. While Diesel consumption is spread across sectors, the truck sector consumes around 28 percent, the agriculture and private car sector consumes around 13 percent each, and the bus sector consumes around 10 percent of India's total diesel consumption. Below is the all India zone wise performance analysis of State Road Transport Undertakings (SRTUs) of bus sector for 2014-15.

In this study, our objective was to assess the impact of removing the distortion in Diesel and Petrol prices due to differential taxation on state finances, transport sector (70 percent share in consumption) and agriculture (13 percent share in consumption) as well as compare the price difference with other developed and developing nations for developing recommendations for the 'National Petroleum Pricing Policy'.



STRU Zone Wise Revenue and Profitability Analysis

Three scenarios of petrol and diesel prices by nationalizing central excise taxes were considered in a way that maintains the total revenue from diesel and Petrol excise at the same level under 10 percent, 20 percent and 30 percent increase in crude prices.

When Central excise is rationalized, the price of diesel increases and that of Petrol goes down. Thus, since diesel consumption in almost all states is much larger than that of petrol, with ad Valorem VAT rates, States Revenue go up. When Crude price goes up in the world market, one would expect state revenues to increase also. However, the higher prices reduce demand and this leads to loss in a State's revenue.

Impact on Car Manufacturers

When price of diesel increases relative to that of Petrol, Diesel can become less attractive. However, even with Central excise rationalization, a number of smaller models of diesel cars remain economically attractive.

The demand for larger diesel vehicles falls but there will be a corresponding increase in Petrol driven vehicles. With reducing the cost of diesel cars, manufacturers may still be able to retain demand for them.

Impact on SRTU and Bus Travellers

Buses and State Transport Undertakings (SRTU) account for 9.55 per cent of the diesel consumption share by volume at a pan India level. Our approach was therefore to assess the diesel price impact at two levels:

Overall revenues of SRTUs went up by 35 percent from 2011-12 to 2013-14 but the profitability was down by 48 per cent, as the SRTUs did not pass on the increased cost of diesel to customers.

Based on the analysis of Six years' data for 49 SRTUs in the bus sector, covering the whole country, we concluded that there is significant scope for absorption of the higher cost of diesel by efficiency improvement.

Impact on Farmers

Higher diesel price will lead to 2% increase in cost of farm products. Also cost of diesel is passed through in setting up Minimum Support Price (MSP) by Commission of Agricultural Costs and Pricing (CACP). However, farmers

who rely solely on diesel pumps may need to be provided with some relief through Direct Benefit Transfer.

Impact on Truckers

The impact on freight rate was estimated to be just 1% and many inefficiencies that truckers face, lost time at octroi posts, lack of a system to find return load and wait time involved to get it, etc., impose much higher costs. The introduction of GST has already benefitted truckers significantly.

The upshot of the analysis was that rationalizing diesel and petrol prices and reducing the difference between the two has many advantages and puts only marginal burdens on various stakeholders.

The state level impact reflected a two per cent increase in fuel cost, and 1% to 12 % fall in profitability across states.

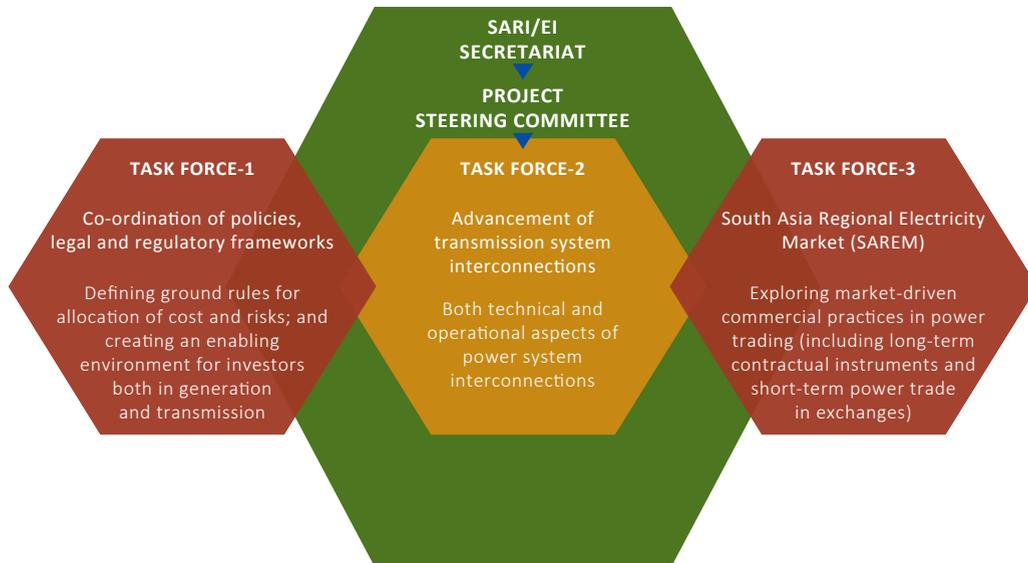
1.2. South Asia Regional Initiative for Energy Integration (SARI/EI), USAID/India

Integrated Research and Action for Development (IRADe) is the implementing partner for the fourth and final phase of USAID's South Asia Regional Initiative for Energy Integration (SARI/EI) programme for advancing regional energy integration and Cross-Border Electricity Trade (CBET). The three task forces comprise of various representatives from South Asian countries.

1.2.1 Various studies carried out under SARI/EI during 2017-2018 are described below:

Formulation of Model Electricity Regulations for Implementation of The SAARC Framework Agreement for Energy (Electricity) Cooperation (SFAEC) and for Advancing Electricity Trade in the SAARC Countries.

SAARC Framework Agreement for Energy (Electricity) Cooperation (SFAEC) was signed by the SAARC Member States during the 18th SAARC Summit held at Kathmandu, Nepal on 26-27 November, 2014. This historic agreement has paved the way for greater cooperation in energy (electricity) among member countries. This agreement has various articles related to the regulatory aspects of cross-border trade of electricity. For initiating and sustaining regional power



interconnections and trade in South Asia, providing an enabling regulatory environment is critical. In the second meeting of the SAARC Energy Regulators, held on February 2016 in Colombo, the members decided to establish the SAARC Council of Experts of Energy Regulators-Electricity (CEERE). Overall, the aim of the CEERE is to provide enabling regulatory environment for materializing SAARC Energy Ring through the implementation of SAARC Framework for Energy Cooperation (Electricity). During the Second Meeting of the SAARC CEERE held in Islamabad on 24-25th October 2017, the council approved the engagement of SARI/EI/IRADe to provide technical support to assess and review the suitability of a set of electricity regulations for implementation of the SAARC Framework Agreement. The South Asia Compendium of Regulations and Model Regulations are under advance stage of completion.

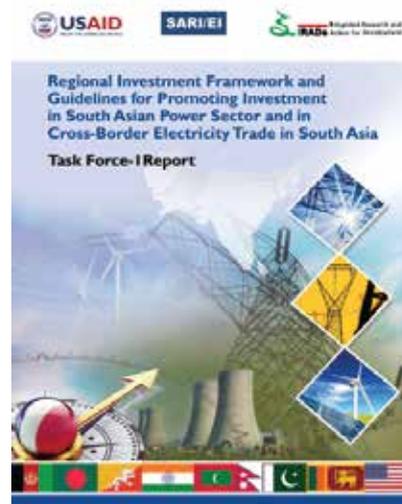
Sector in South Asia

Since Power Sector is capital intensive, investment framework, including prevailing FDI policies, in South Asian Countries was reviewed to suggest a framework to promote investment in the Power Sector. It recommends changes and amendments in the existing investment framework to promote investments in the sector and CBET infrastructure in the region. The study has recommended to establish a Regional Energy Investment Facilitation/Promotion Forum (REIFF) to coordinate and manage the cross border investment in energy and also to create an eco-system to promote regional investment in the electricity sector in the SAARC region.

Learning from Cross Border Power Exchange: Products, Evolution and Governance Including Indian Power Exchanges

This report informs on the evolution of regional power exchanges, their products and governance structure. The objective of this report was to provide national regulators/empowered entities of the South Asian countries a direction for short-term power market particularly power exchange.

Regional Investment Framework and Policy Guidelines for Promoting Investments in Power



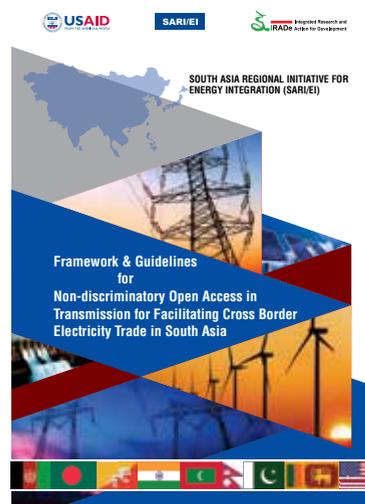
Model Power Purchase Agreement (PPA) & Model Transmission Service Agreement (TSA)

The model Agreement has been developed to enhance transparency and provide clarity to investors & developers and boost cross-border trade. Various key clauses related Term, Tariff, Structure, Incentive & Damages, Billing, Payment-terms including rebate & surcharge Payment Security Mechanism and Dispute Resolution has been worked out for Cross-Border Electricity Trade. Electricity Trade.



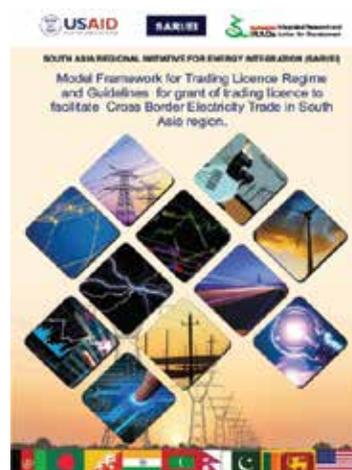
Model Framework and Guidelines For Non-Discriminatory Open Access Regime In Transmission and Grant Of Open Access to Initiate Power Trading and Facilitate CBET In South Asia.

The study covers prevailing framework and regulations, procedures for grant of open access, international experience, model framework for open access etc. and to be published. The model framework with four basic elements covering a) Legal & Regulations b) Market c) institutions and d) operational framework has been recommended to form the basis for deriving guidelines for Non-Discriminatory OA in SACs. The guidelines recommend a) enabling provisions for OA b) features and eligibility criteria for connectivity and OA c) Fixation of OA charges d) Terms and conditions, and information system for OA e) Procedure for grant of connectivity and OA f) Establishing the operational and commercial mechanisms and g) - regional mechanisms for coordination in CBET.



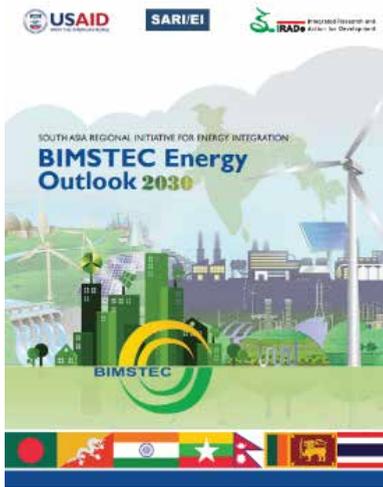
Model Framework for Trading Licence Regime and Guidelines For Grant of Trading Licence to Facilitate Cross Border Electricity Trade In South Asia Region.

Trading acts as a bridge, which facilitates commercial interactions between electricity suppliers and consumers. Considering above, the study covers the existing scenario in South Asian Countries pertaining to power trading, international experiences with a goal of developing model framework and guidelines for trading licence regime and grant of trading licence to initiate regional power trade. The guidelines addresses the thorny aspects of power trading and recommends - a) Operationalization of legal and regulatory framework for trading licensees b) Extending / applying the trading licence framework in the context of cross border trade c) Categories of trading licensees and qualification criteria d) Grant and revocation of trading licence e) Terms, conditions and obligations of trading licensees and f) Market development.



Report on BIMSTEC energy Outlook-2030

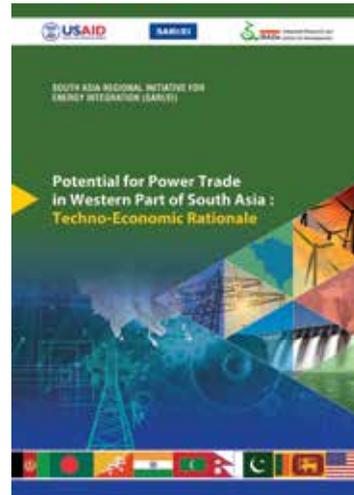
To promote energy integration in the Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) region, a detailed comprehensive study was undertaken to develop BIMSTEC Energy Outlook - 2030. It covers Substantial Country level Energy - data, regional economic and Energy analysis, investment requirements, demand-supply projections up to 2030,- institutional structure and energy security considerations related to energy/electricity covering all the BIMSTEC countries. The report also covers comprehensively all the energy interconnection data in BIMSTEC region for Oil, Gas and Electricity. The report will not only help in improving the energy literacy among BIMSTEC member states but also will bring more cohesion and sustenance about the Energy/Electricity cooperation initiatives among BIMSTEC member states over a long period of time.



Potential of Power Trade in the Western Part of South Asia: Techno-Economic Rationale

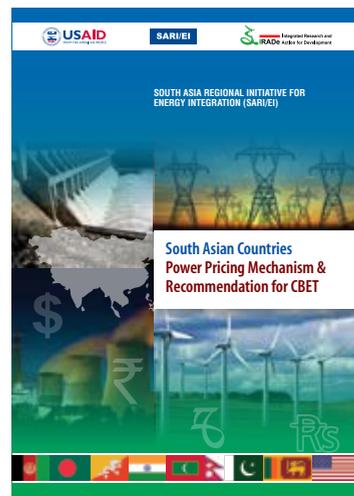
This Study is an endeavour to complement the increasing acceptance of CBET in South Asian region for sustainable development of power sector. Within South Asia, there have been several successful initiatives for interconnection on the eastern side, involving India, Bhutan, Bangladesh and now Nepal. A truly integrated South Asian regional power grid will be realised once there is connectivity on the western side of the South Asia involving India, Pakistan and Afghanistan. This will be an important step in the direction of

advancing/accelerating CBET in this Region. This report evaluates the profiles/options for power transmission interconnection and power trading opportunities among the western part of SACs in the changing context and provides conclusions on the potential for power trade based on the techno-economic rationale of the possible alternatives.



South Asia Countries Power Pricing Mechanism & Recommendations for CBET:

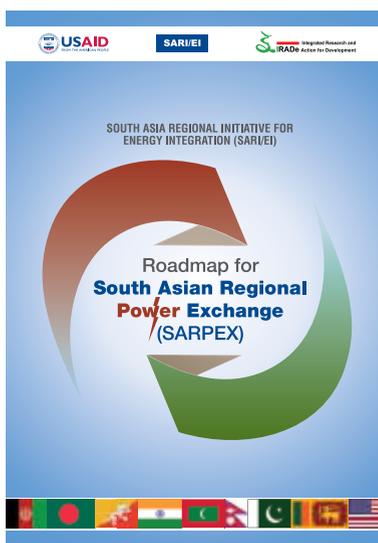
The report on power pricing mechanism imparts understanding about the tariff mechanism and procurement strategy in South Asian countries. Its objective is to provide the national regulators/empowered entities of SACs an input about reforming the tariff mechanism and developing a course of action that can be referred to for decision making on CBET in their respective countries to ensure consistency in the CBET transactions.



1.2.2 Pilot Market/Mock Exercise of SARPEX (South Asian Regional Power Exchange)

The main objective of this exercise was to explore the feasibility of a Regional Power Exchange in the South Asia, develop the draft market rules and design for the regional market as well as build the capacity of the participating nations in working on an exchange platform. The draft design and market rules were discussed and finalized with the TF members and Market Advisory Committee (MAC). The workshops in Bangladesh, Nepal and Bhutan were conducted to present the initial findings and sensitize them about the concept.

Currently countries in South Asia have long and medium term power trade through bilateral agreements. However, to extract the full benefit of regional power trade of day ahead nature, a regional power exchange is essential. In line with the above, SARI/EI, IRADe has developed a Roadmap of Asian Regional Power Exchange (SARPEX).



Stakeholder consultations workshops and meetings have been held in Bangladesh, Nepal, Sri- Lanka and Bhutan. In India, meetings were held with Central Electricity Authority (CEA), Central Electricity Regulatory Commission (CERC) and Power System Operation Corporation Limited (POSOCO) for the same.

Under the SARI/EI project, IRADe has completed the SARPEX Mock Exercise and developed and published the report on the Roadmap for South Asian Regional Power Exchange (SARPEX). The report presents the case for Day

Ahead Market in South Asian region. Two reports viz. "South Asian Regional Power Exchange- Market Design and Rules", "SARPEX Mock Exercise-Key Findings" has been completed.

1. South Asian Regional Power Exchange- Market Design and Rules: The report covers the key recommendations for setting up and operating a Regional Power Exchange between India, Bangladesh, Bhutan and Nepal. Key aspects covered in the report include – Recommended operating modes, currency, timelines, transmission charges and losses, deviation settlement mechanism etc.
2. SARPEX Mock Exercise-Key Findings: The report discusses the key results of the Mock Exercise for assessing the feasibility of a Power Exchange for India, Bangladesh, Bhutan and Nepal. The simulations were carried out for 71 days of FY16 and were based on the actual bid data extracted from IEX and bids submitted by the neighboring countries. These were then extrapolated for the entire year. The report discusses impact on day ahead prices, volumes, consumer and producers surplus etc.

1.2.3 SARI/EI Analytical Studies

Under the USAID's SARI/EI programme IRADe is undertaking comprehensive analytical macroeconomic studies to critically assess the need for CBET among countries such as Bangladesh, Bhutan, India and Nepal.

The study involves multi-country analysis and brings out the economic (macro and micro) importance of power trade besides other benefits. The study is being implemented in two steps. In the first step, power system models quantify the trade potential and tradable electricity price. Taking these inputs, in the second step, macro-economic models quantify the macro-economic benefits accrued to both the countries. An overview of the methodology adopted for the analytical study is given below.

Four sub models are developed for each pair of countries chosen for the study:

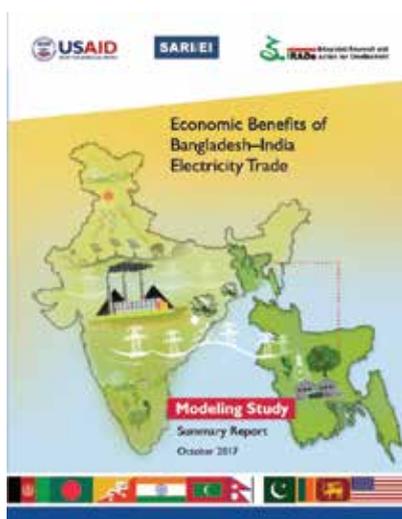
- a. A macro model and detailed power technology model for each country, which balances power demand-supply on an hourly basis with limited or expanded trade.

- b. Iterations between Macro and Technology Models are undertaken that give consistent results such as resources to invest, impact on growth, electricity demand, surplus for trade etc.

As part of consensus building, the study brought together different stakeholders of the power sector, especially energy experts, financial and diplomatic communities. The study meticulously estimates the benefits of providing information to all three task forces of SARI/EI and paves the path for development of sustainable regional energy markets to foster the region's economic growth.

Macroeconomic and analytical study on the benefits of electricity trade between Bangladesh –India

Given the scarcity and complexity around domestic resources for power generation, Bangladesh faces serious problem in meeting its burgeoning electricity demand to fuel its much-needed economic growth. A small quantity of imports (600 MW) from India has resulted in some temporary relief in dealing with the acute power shortage that causes economic losses and difficulties in daily life. We explore the different scenarios of future expansion of Bangladesh's power sector, the role of power trade in its future power supply challenges and its macro-economic benefits as it would help to achieve high economic growth with lower investment in the power sector as well as in the development of fuel import infrastructure. The study's primary objective was to share the information needed for socio-political dialogues and negotiation across and within countries to promote and enhance CBET.



The study analysed three different scenarios of Bangladesh's long-term power strategy: Business as usual (BAU) in which Bangladesh makes own investments to satisfy its demand profile (REF), Power Sector Master Plan (PSMP) 2015-45, and Trade-30. Key results from the study are highlighted below:

Gains to Bangladesh:

- The PSMP scenario provides a higher GDP with lower welfare (household consumption) at the cost of a higher economy of total investments.
- The TRADE-30 scenario provides a lower GDP with higher welfare (consumption) at the cost of a lower economy of total investments.
- The PSMP scenario limits the import (interconnection) capacity to 5 GW in 2030 and 9 GW in 2040 and beyond, the TRADE-30 scenario offers a potential import capacity of 7 GW in 2030, 18 GW in 2040, and 25 GW in 2045.
- The PSMP scenario has a lower investment (CAPEX) requirement than the TRADE-30 scenario, but a higher import bill. Thus, the question for Bangladesh is how much reliance on foreign exchange is worth the diversification of energy supply sources.
- Enhanced electricity trade reduces fuel import for power generation, in particular that of gas, which has a more volatile market, thus enhancing energy security. It also reduces the fuel import bill. The saved foreign currency can be used for activities with higher socio-economic benefits.

Gains to India:

- Electricity trade with Bangladesh causes some beneficial impacts although not highly visible because of the size of India's power system and its economy.
- Export to Bangladesh is projected as 17 TWh and 56 TWh in the PSMP scenario in 2030 and 2045. In the TRADE- 30 scenario, the figures are 28 TWh and 104 TWh, respectively.
- The power generation capacity need is projected as 606 GW and 1,616 GW for 2030 and 2045. The additional capacity need is not more than 1-1.5 percent to cater to the export in both the scenarios.
- Export revenue earning makes Indian households gain in the form of increased consumption, which is higher when trade is higher.

- Export demand and earning contribute to a higher investment in the power sector as well as to the entire economy and subsequently the GDP increases in the higher trade scenario.

1.2.4 Think-Tank Forum

SARI/EI as a part of its outreach and stakeholder engagement consensus building is engaged with four Think Tanks, one each from Bangladesh, India, Nepal, and Sri Lanka for activities related to research/impact studies, stakeholder engagement and media engagement as follows:

Implementation of NDCs for Renewable Energy in Sri Lanka: Addressing Gaps in Policies & Regulation

The study was carried out by Slycan Trust in Sri Lanka. National level consultations were done involving representatives from Ministry of Energy, Ministry of Science and Technology, Climate Change Secretariat, private sector and civil society. The research report highlighted the opportunities for developing energy sector in Sri Lanka and the opportunities for enhancing renewable generation in the country and the links it provides for promoting



| Name of union | Area (acre) | Population | | Literacy rate (%) |
|---------------|-------------|------------|--------|-------------------|
| | | Male | Female | |
| Ramkrishnapur | 12360 | 13737 | 12685 | 37.46 |
| Chilmari | 12307 | 11044 | 10666 | 22.89 |

regional co-operation. The research provided recommendations on private public partnerships for

enhancing renewable energy potential at the national and regional level.

Cross border Electricity Trade mapping-

Independent University, Bangladesh, was contracted for the above mentioned assignment. In order to track the socio- economic impacts of electricity trade, a village under Ramkrishnapur union, which is in the same upazila as Bheramara (where the substation importing power from India is situated) was selected for study. This union received electricity after the 500 MW of electricity was imported from India and its location being close to Bheramara substation. The union is also one of the areas covered by the transmission line.

As a control village, a village without any electricity, in the same Upazila (Daulatpur Chilmari) was selected for comparative analysis purposes.

Assessment of Impact of CBET on Livelihoods and Gender Concerns: Case Study Approach and Regional workshop for boosting CBET in BBIN region.

CUTS initiated a Case Study on the Impact of Cross Border Electricity Trade on Livelihoods and Gender Concerns (focussing on India, Bhutan and Nepal) and shared findings of the study through a regional energy workshop. The questionnaire, designed for the field survey, covered the household income, land holding, nature of economic activities, consumption, fuel usage, impact on their health, say of the women in the decision making, among others. Field work in Nepal was completed in June in 2017 and in Bhutan in July 2017.

A regional workshop was organized on 19 January 2018 in which 25-30 representatives from the private sector, relevant government departments, regulators, local communities, Civil Society Organisations, media, subject experts and academia from the BBIN nations took part. Its objective was to share the study findings and use the platform for a dialogue among the state and non-state actors to give a push for greater cooperation, coordination and integration of energy infrastructure, technology, investments and human capital among South Asian Region, with focus on Bangladesh-Bhutan-India-Nepal (BBIN).

Media Engagement for Creating Awareness on Benefits of CBET between Nepal and India

IIDS, Nepal is the Think Tank Partner for media engagement for creating awareness on the benefits of CBET for India and Nepal. Translation of executive summary of the analytical study on the benefits of CBET to Nepal has been completed. As part of media engagement, IIDS published an article in the leading newspaper of Nepal - The Himalayan Times. The article can be accessed at (<http://epaper.thehimalayantimes.com/detailimageviewer.php?id=2487&boxid=3275&cid=3&mod=1&pagenum=1&pagedate1> on 25 June 2017)

1.3. Global Technology Watch Group (GTWG) on Advanced Coal Technologies (ACT) for Power Generation, Department of Science & Technology

IRADe is a member of the Global Technology Watch Group, a consortia comprising of 3 IIT's (Madras, Bombay and Delhi), for monitoring of advanced coal technologies in context of India's needs, their evaluation for use in India, and to facilitate the development of a road map of Advanced Coal Technologies for Sustainable Power Generation.

COAL ROAD MAP FOR INDIA

Final Report Prepared BY
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Mr. Vinay K. Saini (IRADe, New Delhi)
Dr. Kirit S. Parikh (IRADe, New Delhi)

March 2018



IRADe aimed at a detailed analysis of the country's energy sector, its resources particularly coal, coal policies, coal based power generation scenario, efficiencies for different thermal power generation technologies, namely sub-critical, super critical and ultra-super critical technologies. IRADe critically examined the various technologies in power generation, beneficiation and mining and developed a technology index based on multiple evaluation criteria such as capital cost, O&M cost, CO₂ and other emissions, socio-economic and water foot print evaluation.

The group finalized selected coal power generation technologies for India including estimates of reductions in CO₂ emission intensity (in terms of g/kWh of energy produced from a coal power plant) possible through improvements in steam parameters in pulverized coal boilers, gas turbine inlet temperatures in IGCC and through oxy-fuel combustion-based CCS in PC boilers and IGCC.

Also, some environmental control technologies for the power plants that would help to meet norms for Carbon emissions (SO_x, NO_x, PM, Hg, Fly ash control) though desulfurization, selective catalytic and non-catalytic reduction, ESP and bag filters, activated carbon, etc. were also identified.

IRADe analysed sub-critical, super critical and ultra-super critical technologies with eight different technology scenarios ranging from addition of environmental control technologies like ESP, FGD, SCR and super critical power generation technologies with Carbon capture and storage (CCS) technologies. While in case of environmental control technologies, excluding CCS, there is an energy penalty of around Rs.1/kWh in case of CCS it goes up to Rs.4-5/kWh. IRADe incorporated the capital cost fuel cost and operating cost assumptions for the eight technologies in its Energy economy integrated model and constructed four scenarios, DAU, PM SO_x NO_x, CB156 and CB133 to assess the long term future of these technologies up to 2050. The DAU (Dynamics as usual scenario) was an unconstrained scenario where the choice of coal technology was purely on the basis of economic considerations and thus opted for super critical and ultra-super critical coal technology. The PM SO_x NO_x enforced choice of super critical and ultra-supercritical technologies with additional environmental

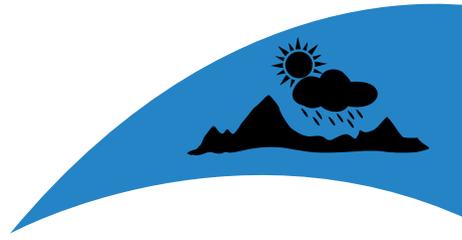
cost technologies like ESP, FGD, SCR for controlling particulate matter (PM), Sox and NOx emissions leading to higher cost and lower GDP. CB156 and CB133 scenarios imposed a carbon budget constraint of 156 GT and 133 GT from 2010 to 2050 on the model and thus the choice of technology depended on which technology was the most economic choice to meet the stringent carbon budget requirement. The CB156 and CB133 scenarios showed that in a climate change scenario too coal has a significant future through CCS technologies assuming adequate availability for safe and long term

storage. This suggests that India should explore CCS options, assess potential storage sites and consider plants locations nearby. Broad recommendations have been made by IRADe which is shared with the GTWG group for finalization of the road map for the country and presenting the final report to DST.

The project is completed as on 31.03.2018 with a final report

(Supported by Department of Science & Technology)

2. Climate Change & Environment



2.1 Inter-model comparisons of different transportation sector policies in India in support of NDC Implementation

The Sustainable Growth Working Group (SGWG) was formed under the US-India Energy dialogue in which the NITI Aayog is representing the Government of India. NITI Aayog has set up an Advisory Board on transportation and air quality. It had representatives of relevant ministries including the Ministry of Environment, Forest and Climate Change, several transportation ministries, Bureau of Energy Efficiency and others. The project team comprises of four Indian modelling teams: Integrated Research and Action for Development (IRADe), Centre for Study of Science, Technology and Policy (CSTEP), Council on Energy, Environment and Water (CEEW) and The Energy Research Institute (TERI). This project was set up to use a set of models to explore a set of technology and policy options to reduce energy consumption and emissions, increase access and solve mobility issues in the transport sector. This will also help to evolve a roadmap for the transport sector in the light of the Nationally Determined Contribution (NDCs). The policy scenarios to be modelled will be in consultation with the Advisory Board. This modelling exercise will result in initiating a dialogue between various ministries to understand the implication of a policy scenario or a combination of multiple policy scenarios.

The purpose of bringing together the four Indian teams and US team is to bring out some robust policy analysis and suggestions for the Government of India to reduce air pollution caused by road transportation.

India has committed through its NDC to reduce CO₂ intensity by 33-35 percent by 2030 as compared to 2005 levels. As India's per capita income grows, ownership of motorised vehicles will expand rapidly. India's transport sector contributed to 14 percent (75 Mtoe) of final energy consumption as of 2013. The road transport sector consumes 90 percent of the total transport sector

fuel and passenger transport contributes to 60 percent of the total fuel consumed by road transport (68 Mtoe, 2013). India's transport sector contributes about 10 percent of Greenhouse Gas (GHG) emissions in 2013. Of the total emission of 188 MT of CO₂ equivalents, road transport sector contributes to 87 percent of the total transport emissions. The development of the road transport sector will have implications for energy and GHG emissions from the transportation sector. The problem of worsening air quality, particularly in Indian cities has received much attention recently. Modelling would be helpful in understanding the linkages between air quality and transportation and designing policies to mitigate the adverse health impact and economic impacts of the ever-expanding transport sector.

Policymakers in the U.S., Asia and Europe increasingly rely on inter model comparisons because it helps simultaneously build modelling capacity and capacity for integrating modelling results into planning. Modelling of identical policy problems on different platforms and tools is the gold standard for model development because it yields a more robust consideration of likely impacts than those available from one model. It also allows for focused vetting and peer review. Vetted results, in turn, help policymakers understand why different models present different results, and the range of results increases the robustness of the findings. Different models typically can answer different aspects of a question. Recognizing the importance of energy modelling in effective policy making for low-carbon growth, the Governments of India and the United States have formed a Sustainable Growth Working Group (SGWG) as a part of the bilateral energy dialogue. The proposed research effort builds on technical collaboration and relationships established over the past few years through energy modelling and analysis between Indian and U.S. Government partners and modelling teams under the SGWG. The modelling teams are engaged in a multi-year research collaboration seeking to build on this foundation to assist in decision making through analysis on the critical issue of transport and air quality.

Status: The work on this project is in progress. IRADe has contributed to a joint paper by the four teams on transport sector modelling which has now been published in the Journal Energy policy (“A Multi-Model Assessment of Energy and Emissions for India’s Transport Sector through 2050”, Anantha Lakshmi. P et al, page 10-18, vol-116, Energy Policy(2018)) which is based on the comparative analysis of the Business as usual scenario projections by the teams. Currently the teams have sought a No Cost extension for the project up to July 2018. IRADe has submitted its first set of results for comparison across the four models. The teams met various transport nodal ministries and department representatives to discuss various assumptions and scenario constructions and IRADe participated in the meetings with each ministry organised by NITI Aayog. Following the meetings, the Teams agreed upon a common modelling protocol (CMP) which detailed the assumptions across various scenarios for all teams to follow. IRADe has submitted its scenarios for report writing after two rounds of modification and updation following comparison with other teams.

Duration: 12 months (1.10.2016 to 30.09.2017; extended till 31.07.2018. The project is supported by Shakti Sustainable Energy Foundation

2.2 Framing the Debate on Climate Change

The overall goal of this project was to raise climate change awareness among eight North Indian Universities students across seven states through holding lectures and debates. The program was envisaged such that first two days of the symposium held lecture sessions followed by the debate competition among the selected students on 3rd day. This project is a major step forward to raise climate awareness involving the youth, the most vibrant and motivated community who will propagate the knowledge across society. While the lectures cover areas ranging from the drivers of climate change, its indicators to impact on environment, society, lifestyle in one hand, on the other, it also addresses issues such as climate change policies in India, mitigation and adaptive measures, global frameworks on combating climate change etc. The debate was competitive in nature and selected a regional winner testing the general awareness of students as well as the learning from lectures. A national winner was chosen among the regional winners in a final round of debate at the New Delhi U.S Embassy.

University level programme has been conducted in seven University campuses starting with Kurukshetra University at Kurukshetra and followed by Central University of Rajasthan at Ajmer, Chandigarh University at Chandigarh, Kumaun University, SSJ Campus at Almora, Himachal Pradesh University at Shimla, Banaras Hindu University at Varanasi and University of Allahabad at Allahabad. Across 7 Universities, altogether 760 students, 50 research scholars and nearly 50 faculty members participated in the symposia. The eighth symposia were held at Jamia Millia Islamia University, Delhi. Final event in which winners from each University campuses took place in American Centre, New Delhi. This event had participation of University winners from each of the campuses where programme was conducted initially.

The overall objective of the project was to raise awareness about the ongoing complex conversations on climate change issues while preparing young leaders to participate in these discussions in an informed manner. To inspire youth in taking up the cause of climate change and become torchbearer for climate change awareness mission and practical solutions in India for tomorrow.

(Supported by U.S. Mission India Public Diplomacy Grants Programme)

2.3 Developing Disaster Resilient Action Plan through GIS & prioritising actions for natural disaster risk reduction in urban agglomerations of Shillong and Gangtok

Himalayan cities are particularly vulnerable to disasters and extreme events such as earthquakes, landslides, flash floods, thunderstorms, cold waves etc. The magnitude of extreme events in this region may be manifold depending on the risk and exposure of the city. Besides, the rapid urbanization and climate change cause unpredictable stress on the environment. There is thus a need for systematic review of the region’s risks and vulnerability to natural disasters. IRADe with the support from Ministry of Environment, Forests & Climate Change (MoEFCC) under National Mission on

Himalayan Studies (NMHS) aims to develop Disaster Resilience Action Plans for Shillong and Gangtok cities. To do this, IRADe will develop hazard/vulnerability index of Shillong and Gangtok urban agglomerations,

their cadastral maps at the scale of 1:4000, and conduct ground surveys to identify critical infrastructure at risk in the two cities. Based on this, IRADe will prioritize actions for disaster risk reduction through multi-stakeholder consultations. The project will lead to capacity building of the citizens and the administrative authorities at the city and district level.



Meeting with Shri Shakti Singh Choudhary,
Gangtok city Mayor

IRADe has developed a background paper on the project and city profile for Gangtok and Shillong for rapid vulnerability assessment after a thorough review of the studies and plans prepared by the State Disaster Management Authorities and Urban Local Bodies (CDPs, CDMPs, GIS maps). Collaboration with the State and City level stakeholders was established following the project team's meeting with the Chief Minister of Meghalaya, Dr. Mukul Sangma on August 2017.

Inception Workshop for the stakeholders was conducted at NESAC (North Eastern Space Applications Centre),

Shillong, on 25 August 2017. Field visit to Gangtok, Sikkim was conducted in October 2017, where the project team interacted and collaborated with the stakeholders including Gangtok City Mayor and Municipal Commissioner.

IRADe in collaboration with NESAC Meghalaya and GBPNIHESD (G.B. Pant National Institute of Himalayan Environment & Sustainable Development) organized stakeholders workshop on 6 February 2018 at the Sikkim Regional Centre, Summit Denzong, Gangtok. The workshop brought together city-level stakeholders to share with them the project goals and establish synchronous working among various stakeholders for risk reduction in the urban areas of the North East Region of India.

The workshop was attended by Mr Shakti Singh Choudhary, Mayor, Gangtok Municipal Corporation Mr Alok Kumar Srivastava, IAS, Chief Secretary, Govt. of Sikkim, Prof. Ajit Tyagi, former Director General of IMD & Senior Advisor, IRADe and Dr. Jyoti Parikh, Executive Director, IRADe. The other participants included officials from Gangtok Municipal Corporation, Land Revenue and Disaster Management Department, Govt. of Sikkim;; Geological Survey of India, Sikkim Unit; Met Centre, Gangtok; Urban Development and Housing Department, Govt. of Sikkim; United Nations Development Programme; Save the Hills; and Department of Geology and Department of Geography, Sikkim University.

Duration: 3 years (March 2017 – March 2020)

(Supported by MoEF&CC/NMHS)

2.4 Developing the urban climate vulnerability index and assess the vulnerability of 5 selected cities using the vulnerability index

Most Indian cities are vulnerable to climate induced natural hazards that may lead to disruption of basic urban services like drinking water supply, sewerage and drainage, solid waste management and communication networks etc. along with loss of human life. Cities, therefore, need the preparedness (resilience) for quick response, recovery and risk reduction to check the loss to life and property in case of adverse events. IRADe with the support from Ministry of Environment, Forest & Climate Change (MoEFCC) has undertaken a research project to develop Vulnerability Index for Climate Resilient Urban Planning and Assessing Climate Vulnerabilities and Risks.

Under this project, IRADe will develop Urban Vulnerability Index to identify and target climate vulnerable regions, populations and raise awareness. It will also contribute to developing a monitoring strategy and serve as a decision support system to the Government of India for devising climate change adaptation and mitigation strategies for urban areas. The objective is to design a framework, define sub-indices/indicators to assess urban climate vulnerability of the cities and bring forth the areas of adaptation which the cities should prioritize for improving its resilience and integrate it with their developmental initiatives.

Literature review of the existing methodologies of Disaster Vulnerability Index Assessments, calculations, ranking & scoring is completed and vulnerable cities, locations, populations and ecosystem types (coastal region, Hilly region & arid regions) identified. The shortlisted cities are Delhi, Rajkot, Shillong, Bangalore, Chennai, Mumbai and Srinagar. A list of vulnerability indicators and sub-indicators is being developed with due consideration to various aspects of climate change.

An Expert Consultation meeting of Executive Director of IRADe, Prof. Jyoti Parikh, Chairman of IRADe, Dr. Kirit Parikh, Former Secretary of Ministry of Urban Development, Government of India, Dr. Sudhir Krishna, former Secretary, Mr. Ajay Shankar, former President of IMD, Prof. Ajit Tyagi, and former Commissioner of Srinagar

Municipal Corporation, Dr. G.N Qasba, was held on 23 January 2018 at IRADe's New Delhi office. The meeting discussed the vulnerability indicators and finalized the ranking / scoring methodology. Based on this a pilot survey and vulnerability assessment of the cities will be conducted.

Duration: 1 year (October 2017 – October 2018)

(Supported by MoEFCC)

2.5 Climate Adaptive Action Plans to Manage Heat Stress in Indian Cities

Heat stress related deaths in India are rising at a rapid pace. With climate change, average temperatures and the frequency and severity of heat waves are predicted to increase. Heat waves than many other effects of climate change, are likely to cause more deaths; people



Inception Workshop, IIC, Delhi

in cities are particularly vulnerable. There is little understanding and quantification of how heat stress affects health, work productivity and livelihoods of the economically and socially marginalized populations. Such understanding requires multi-disciplinary research and is critical for formulating Heat Stress Action Plan (HSAP). IRADe, with support from International Development Research Centre, Government of Canada, will undertake inter-disciplinary research for developing gender sensitive HSAPs for the cities of Delhi, Bhubaneswar and Rajkot in partnership with the consortium members including Municipal Corporations of Rajkot, Delhi and Bhubaneswar, Indian Institute of Public Health (Gandhinagar and Bhubneswar) and Odisha State Disaster Management Agency.

The project, a first of its kind, will improve management of urban heat stress risks in India. HSAPs developed will serve to support India's medium term development planning, especially in prioritizing and integrating adaptive resilience within the agenda of climate resilient smart cities. The objective of the study is to spatially identify the vulnerability of populations and map the impacts of extreme heat events on their health, work productivity and livelihoods, and recommend appropriate, innovative and affordable climate adaptation measures for improving their health and livelihood resilience with due consideration to the cost effectiveness of the mitigation strategy.

Literature review of heat stress scenarios across Asia, South Asia and India is under process and heat stress impact on health, livelihoods and economy are being documented along with case studies. IRADe has done the stakeholder mapping and is managing the coordination and collaboration among them.

A pre-inception meeting of the partners was held on 31 January 2018, and Inception Workshop on 1 February 2018 in New Delhi collaboration with IDRC. The workshop

provided a platform for the partners and city stakeholders to effectively understand the aim and objective of the project. The participants and partner organizations were formally introduced and briefed on the current situation and actions taken in their cities to deal with heat stress. The workshop was attended by

IRADe Executive Director, Prof. Jyoti Parikh, IDRC Asia Director, Dr. Anindya Chatterjee, Sr. Program Manager, IDRC, Dr.

Melanie Robertson, Medical Officer, Rajkot Municipal Corporation, Dr. Milan Pandya, Associate Professor, Indian Institute of Public Health-Bhubaneswar, Dr. Ambarish Dutta, Additional Professor, Indian Institute of Public Health-Gandhinagar, Dr. Parthasarathi Ganguly, and Chief General Manager, Odisha State Disaster Management Authority, Dr. Pradeep K Nayak.

At the inception workshop, detailed survey questionnaire and survey checklist were developed and a presentation made using thermal/ temperature maps of the project cities to underscore the frequency and duration

of excessive heat events. These were discussed in detail at the Methodology workshop on 19 March at IRADe office. The workshop was attended by IRADe Executive Director, Dr. J. Parikh, and project team from IRADe including Dr. A. Tyagi, Mr. R. Magotra, Mr. Harish Chandra, and Dr. P. Ghosh, and Dr. L. Nanda from IIPH-Bhubaneswar, Dr. A. Dutta from IIPH- Bhubaneswar and Dr. P. Ganguly from IIPH-Gandhinagar.

The workshop discussed research methodology, GIS tools and procedure for field surveys. It also discussed and finalised Ethical Guidelines and framework for conducting surveys.

Duration: 3 years (Nov 2017- Nov 2020)

(supported by International Development Research Centre, Canada)



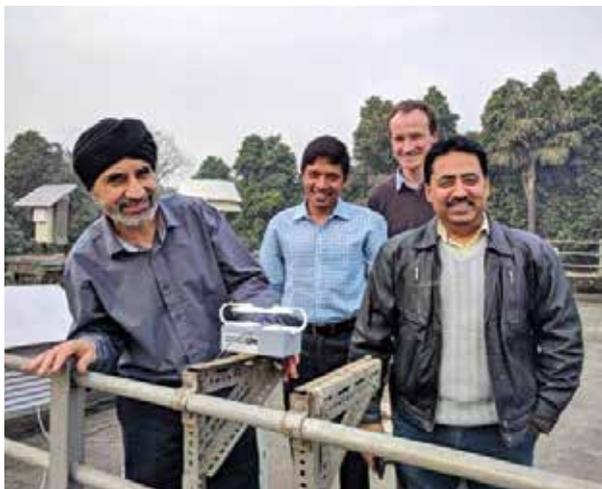
Methodology Workshop, IRADe, Delhi

3. Sustainable Urban Development



3.1 Process, analysis, observations and modelling Integrated solutions for cleaner air for Delhi, PROMOTE

PROMOTE is a collaborative project between UK and Indian research institutes which aims to reduce the ambiguities in air quality predictions and forecasting for Delhi. It is based on process oriented observational and modelling analyses of concentrations of air pollutants and available emission controls. This new knowledge will be critical for formulating an effective mitigation strategy for reducing air pollution in and around Delhi.



Installation of Aerosol Monitor at IMD, New Delhi

The project will inform how local and regional [Long Range Transport (LRT)] sources of air pollution affect Delhi's air quality. IRADe's role will be crucial for informing air pollution mitigation strategies for Delhi, which will be based on detailed sensitivity analysis to quantify the response of air pollution to local and regional emission controls for current as well as for future (2030/2050). IRADe will do the socio-economic analysis of air pollution to prioritize mitigation measures on the merit of cost-effectiveness, feasibility, ease of implementation and political acceptability.

As a part of the project, four UH (University of Hertfordshire) Aerosol monitors were installed at two sites in Delhi: IRADe office in Malviya Nagar and The Mother's International School at Sri Aurobindo Marg, Hauzkhas.

Duration: 4 years (Oct. 2017 to Sept., 2021)

The Project is supported by MoES- NERC

3.2 Prediction of Dengue with Climate Change for Delhi and Rajkot: A statistical analysis and development of warning system

Dengue, one of the major vector-borne diseases, has shown a rapid increase in its incidence across India in the recent years. It is very important to understand the relation between Dengue incidence, local climatic factors and demographic parameters in order to predict its spread in the future and develop a robust warning system as a part of the mitigation measures. IRADe with support from Department of Science & Technology, Government of India, will undertake an inter-disciplinary research connecting meteorology, statistical modelling and geo-spatial mapping to develop the warning system.

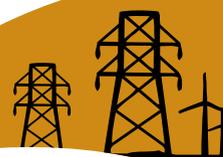
The study will establish the co-relation between climatic factors and Dengue incidence and distribution at municipal ward level and predict the future scenarios/warning system based on the statistical model.

City Level Stakeholders for Rajkot and Delhi are identified and detailed literature review of vector borne diseases and dengue occurrences and relation to climate change Completed. Data sources for spatial mapping and modelling of climate change and dengue occurrences will be identified during the field visits.

Duration: 2.5 years (August, 2017- Jan, 2020)

(The project is Supported by Department of Science & Technology, Government of India)

4. Poverty & Gender



4.1 Energy Sector Reforms in India

The study aims to provide gender-based evidence in an effort to bridge the policy gap that exists between clean cooking energy access to LPG (Liquefied Petroleum Gas- assumed to be the clean and convenient cooking fuel in India) for cooking and its impact on the role of women. The scoping report comprehensively covers the available literature on the subject and draws upon research methodology extensively. It also identifies the research issues that need to be explored.



To explore the impact of cooking fuel use-change on women, the impact was categorised across the three broad groups, ‘welfare’, ‘productivity’ and ‘empowerment’. Indicators were developed to collect household level data across each theme from sample households in Raipur- Chhattisgarh and Ranchi- Jharkhand. The primary survey of households using structured questionnaires and focus group discussions at selected villages in these two districts is also complete.

This study carried out an extensive survey on cooking energy consumption and related attributes of 810 households, in two states of India- Chhattisgarh and Jharkhand. The study finds that biomass is a dominant source of cooking energy and women have the skewed burden of biomass collection, processing and cooking with it. Apart from income criteria and LPG access,

several other factors like education level, years of use, door-step delivery, intrahousehold women availability etc. seems to be responsible for LPG usage. Improving the LPG supply infrastructure and door-step delivery in rural area will increase LPG usage. The availability of freely collected biomass and local cooking practices also affects the choice of cooking fuel. In terms of “final useful energy” for cooking, LPG costs less as compared to purchased biomass and coal. However, several households including less well-off continue to purchase biomass and coal for cooking due lack of availability and lump sum amount required for LPG cylinder refill. The capital subsidy for LPG kit under PMUY scheme had promoted LPG usage and therefore women wellbeing in poor households. Among the LPG consumer households in our sample, 14 %, revealed they will stop using LPG if subsidy is removed and switch back to biomass. On the other hand, 86 % LPG consumer households revealed that they will continue to using LPG; though 39 % said they would reduce its usage. Increasing usage of LPG for cooking reduces “time poverty” of women, hardship associated with biomass collection and processing and health hazards.

Duration: 4 Years (1. May 2015 – 31 Dec 2018).

(Supported by DFID/ENERGIA)

4.2 Electricity as a clean cooking option for rural areas

This study explore the possibilities of using electric cooking an alternative to provide clean cooking access to rural areas through an induction cooker intervention in Alwar and Jaipur districts of Rajasthan and Raipur and Balodabazar districts of Chhattisgarh. Intervention households were identified based on a set of predetermined criteria listed below.

1. A metered electricity connection
2. Willingness to use the electric cooktop

3. Ability to pay for the additional electric bill due to electric cooking
4. Ability and willingness to purchase induction cooktop and compatible utensils

To gather information about households in the selected districts we conducted a survey of 200 households using a structured questionnaire. The survey gathered information on the socioeconomic conditions, energy-use patterns, and willingness to adapt to clean cooking, status of electricity supply etc. The selected 40 intervention households were provided with induction cooktop and a set of compatible utensils to capture their cooking experience through cooking sessions and monitoring schedule which comprising 2-4 cooking sessions a day to study practical aspects of its usability. Therefore, 15 days monitoring schedule was prepared to record observations on experience of cooking with induction cooktop for each beneficiary's households. The purpose was to analyse the problems with respect to operation of the induction cooker, namely ease of operation, compatibility of cooking utensils, food preparation, taste satisfaction and comparison of Induction cooktop vis-à-vis LPG and biomass cook stoves. Before the observation period in technical collaboration with M/S TTK Prestige, we trained the beneficiaries in induction cooking method and essential user know-how and briefed them on health, environmental and cost

benefits. Further to check, the ability and willingness to purchase induction cooktop and compatible utensils a token sum of Rs.500 were collected from households.

The pilot study though limited in scope, points out that induction cooktop can be a promising solution for clean cooking even in rural areas, peri-urban and urban areas. The potential seen was encouraging with time can overcome psychological barriers and technical barriers. One woman even found a way to cook even chapatis. It reduces LPG or biomass consumption substantially. The pilot study encountered a widespread misconception that electric cooktops are not adaptable to Indian cooking. The study successfully quashed those misconceptions with live demonstrations. In general, following conclusions emerges from the study:

- Induction cooktop is comparable option in terms of efficiency and operating costs as LPG.
- Taste of food, cooking patterns and safety-related aspects were found to be good as compared to other devices.
- Induction cooktop addresses the problems of health, cleanliness of kitchen, safety, long preparation time involved in cooking with biomass etc.

Duration: 06 months (25 Jan 2017 to 15 December 2017)

(Supported by NABARD)

5. Agriculture & Food Security

5.1 Assessment of Climate Change Impact on Food Security and Livelihoods in Uttar Pradesh, Himachal Pradesh and Odisha

Food security is attained when all people, at all times, have physical, social and economic access to sufficient, safe and nutritious food to meet their dietary needs and food preferences for an active and healthy life. The four pillars of food security are availability, access, utilisation and stability. The nutritional dimension is integral to the concept of food security. Availability refers to the total food stock of a country/region (macro level) or within a given population or household (micro level); 'a measure of food that is, and will be, physically available in the relevant vicinity of a population during a given period'. Apart from other factors, availability may be limited by climatic factors such as droughts, floods, rising temperature etc. Climatic changes and increasing climatic variability are likely to aggravate the problem of future food security by exerting pressure on agriculture. The agriculture sector is sensitive to short-term changes in weather and to seasonal, annual and longer-term variations in climate.

The present study aims to assess the impacts of climate change on food security and associated livelihoods in three states namely Himachal Pradesh, Uttar Pradesh and Odisha. The broad objectives of the study are as follows:

- To assess the vulnerability of food security and livelihoods due to socio-economic and other environmental stresses in the current climate and its likely exacerbation due to climate change for a short, medium and long term time period
- To devise the adaptation options and prioritise the same
- To develop a framework for adaptation.

This is an ongoing project and IRADe team has estimated impact of climate change on yield consequently production of major agriculture crop at district level in the selected states for 2030, 2050 and 2080. To estimate the impact on yield we used CORDEX model

data for climate parameters for baseline as well as for the future period. These data sets are provided by IITM, Pune and we used data for future emission scenario's 4.5. Climatological mean of the variables over six years around the year of interest, which is the best representative of climatic pattern of that period than any specific year, is estimated. Agriculture data for area, production and yield for different crops are used from directorate of economic and statistics, Department of Agriculture. This study uses crop sensitivity to climate parameters from the available peer reviewed studies for India for different crops. Based on the impact on production of major crop at district levels adaptation options will be developed and prioritized.

Duration: 2 years (November, 2016 to October, 2018)
(Supported by MoEFCC)

5.2 Energy, Food and Water Nexus – Analysis in a Macroeconomic Consistency Framework

The project supported by NITI Aayog, was a part of the technical collaboration through energy modelling and analysis between Indian and U.S. Government partners and modelling teams under the SGWG. This project by IRADe is a part of the multi team effort to address the issue of energy, food and water nexus under the SGWG. The modelling teams are engaged in a multi-year research collaboration seeking to build on this foundation to assist in decision making through analysis on the critical issue of Energy, Food and Water nexus. Objective of the study was to assess if given the increasing foot print of water in power sector, there is a case for a trade-off between food production, energy production and water use in future in the context of a likely scarcity of water in India.

Water demand from the power sector has been increasing owing to the increase in thermal power generation capacity in recent years. Water for cooling requirements in thermal power generation technologies like coal based sub critical, super critical, ultra-super critical and IGCC (Integrated Gasification Combined Cycle), gas based

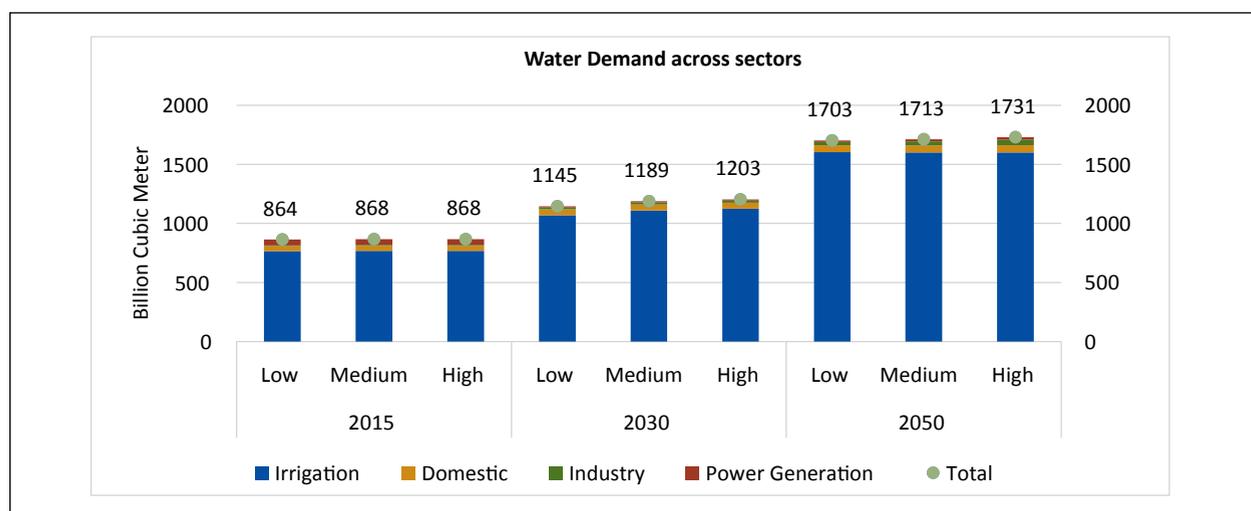
thermal generation, solar thermal and nuclear have significant water requirements. The demand for power would increase with growth, which would be also accompanied by an expansion of the agricultural sector, industrial sector and urbanisation led water demand from the affluent households. Water requirements in Agriculture sectors is also likely to change in future up to 2050 due to changing cropping patterns because of changing food consumption patterns and urbanisation. However, the availability of water remains constant based on historical levels of precipitation and might decrease due to the impact of climate change. This makes water a scarce commodity whose requirement in the production process is very critical and therefore imposes a major constraint on growth.

Individual water consumption sectors when projected separately may not be computed in consistency with growth in other sectors. The use of multi sector input output models over comes these disadvantages and all sectors are forecasted simultaneously and consistent with the growth rate in the aggregate economy. We use IRADe’s input-output based multi sectoral model to make a simultaneous projection of the growth of all water consuming sectors in the economy which is consistent with future economic growth of India and also satisfies macroeconomic relations and production linkages. This makes the projection of the growth of individual water consuming sectors and water demand from the plausible, viable and economically feasible.

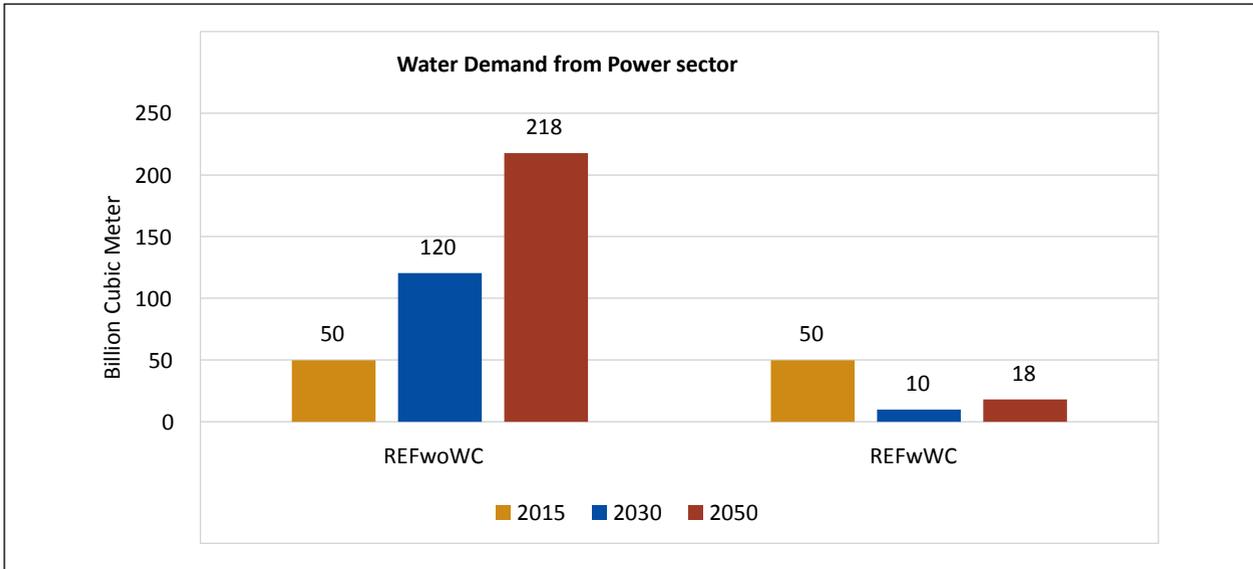
The IRADe team has contributed to a joint research paper that has now been published in the journal Applied Energy (“Water for electricity in India: A multi-model study of future challenges and linkages to climate change mitigation”, Srinivasan Shweta et al, Applied Energy, 2017)

We analyse 6 scenarios of which 3 scenarios are economic growth scenarios of varying GDP growth from 2011-47 (Low: 5.8%, Medium: 6.7% and High: 7.4%), two scenario of low carbon pathways and one scenario of non-implementation of water conservation policies of MOEFCC in power sector.

The results of the project show that aggregate water demand in the three different Growth scenarios varies from 1703 bcm in low growth, 1713 bcm in medium growth and 1731 bcm in High growth scenario in 2050. Irrigation demand from Agriculture is the biggest sector in terms of water demand where the water demand is nearly 1600 bcm in 2050 in all the scenarios. The water demand projection is higher due to 100% irrigation coverage by 2050 on the basis of Government’s slogan of ‘har khetme paani’ which increases water demand. Use of sprinkler and drip irrigation would reduce the water requirement for irrigation by 30 %. This underlines the importance of water conservation policies in agriculture and other non-power sectors. Given the severe water crisis faced by Cape Town and similar ones staring in the face of other cities, such as Bengaluru, underscores the



Economy wide water demand



Water demand in the power sector for Reference scenario (medium Growth) without Water Coefficient (REFwoWC) and with water coefficient (REFwWC)

need for water conservation in households and cities with modern water conservation technologies. Ambitious actions of low carbon pathways in power sector reduces the water foot print in the power sector by half compared to the medium growth rate scenario, however the reduction is insignificant at the national scale. Non implementation of water conservation policies in the power sector increases water consumption in power sector by 200 bcm compared to the medium growth scenario to 1913 bcm in 2050. Implementing MOEFCC guidelines for water conservation would secure future power generation from uncertainties related to water availability.

India's estimated annual precipitation including snowfall is 4000 bcm. The estimated annual average potential in rivers is 1869 bcm. The utilizable water is estimated to be around 1123 bcm. Climate change is likely to further reduce the utilizable water availability. Ministry of water resources (1447bcm) and the scenarios in this report project higher water demand (around 1700 bcm) than the estimated utilisable water. This further highlights the importance of water conservation in major sectors like irrigation and industry.

Duration: 12 months (September, 2016 to August, 2017)
– No cost extension had been sought from the NITI Aayog.
The project has been finally completed in January 2018.

6. Conferences, Workshops and Meetings

Consultation Meetings

6.1 Stakeholder Consultation Workshop on 'South Asian Regional Power Exchange (SARPEX) - Mock Exercise' 11 April 2017 and One-on-one meetings with stakeholders on 12 April 2017, Kathmandu, Nepal



The workshop covered SARPEX exercise objectives, mode of operations, power exchange operation and participation. Dr. Kirit Parikh, Chairman, IRADe, addressed the stakeholders on SARPEX objectives and relevance in the cross border electricity trade. An overview of the power trading scenario in the South Asian Region, the need of a regional power exchange and to initiate the discussion on the Basics of Power Exchange and the activities of SARPEX Mock Exercise was presented. Mr. Anil Rajbhandary of Nepal Electricity Authority (NEA) presented the relevance of Mock Exercise, role and responsibility of core team members and underlying assumption for creating the bids for mock exercise. The one on one meeting was conducted at the Load Dispatch Centre of Nepal's Ministry of Energy, Kathmandu. The participants were receptive and encouraged the mock exercise.

6.2 Stakeholders' consultation workshop on 'Economic Benefits from Bangladesh-India Electricity Trade' –17 May 2017, Dhaka, Bangladesh

At the workshop IRADe gave two detailed presentations: 'Overview of SARI-EI Programme, Progress and Key findings and Way forward' and 'Macro-economic benefits of India-Bangladesh electricity trade'. The presentations were followed by a panel discussion on power demand, concerns about cost of power imports and its reliability. Dr Kirit Parikh moderated the discussion. Overall, the panellists favoured creation of power market that facilitates electricity imports from India, Nepal and Bhutan.



6.3 Stakeholder Consultation Meeting with Bangladesh Energy Regulatory Commission (BERC) on 'Model Framework and Guidelines for 'Open Access Regime in Transmission' and 'Trading License' to facilitate power trade in the South Asia Region, 18 May 2017, BERC, Dhaka, Bangladesh

The objective of the consultations was to discuss the key findings of the SARI/EI proposed 'Model Framework and Guidelines for Open Access Regime in Transmission and Trading Licence' to facilitate power trade in the South Asia Region. IRADe presented the key findings of its study on 'Open Access Regime in Transmission' and 'Trading License' to facilitate power trade in the South Asia Region". The presentation covered existing framework, regulations and procedures relating to Open Access and Trading Licence regimes, gap analysis, prevailing institutional structure/arrangements in SA countries, Open Access and Trading Licence case study

of India, and international experience in the context of Bangladesh.

6.4 SARPEX Mock Exercise 29 June 2017, and One-on-one meetings with stakeholders on 30 June 2017, Thimpu, Bhutan

For the Stakeholders in Bhutan, SARPEX-Mock Exercise was held. It included a presentation on the basics of power exchange, the activities of SARPEX Mock Exercise, and preliminary results of SARPEX mock exercise for four months. The context of the workshop was presented to give the participants an overview of the power-trading scenario in the South Asian Region, the need of a regional power exchange and to initiate the discussion. On Behalf of the core team members, Mr. Karma Namgyal, Ministry of Economic Affairs, Government of Bhutan, presented the relevance of mock exercise, role and responsibility of the core team and underlying assumption for creating the bids for mock exercise. The one-on-one meeting was conducted in Ministry of Economic Affairs (MoEA), Druk Green Power Corporation (DGPC), Bhutan Power Corporation (BPC), Druk Holding & Investment etc.

6.5 Stakeholder consultations, 18 July, 2018 in Kathmandu Nepal



Workshops on “Developing Framework and Guidelines for Non- Discriminatory Open Access Regime in Transmission for Cross Border Electricity Trade (CBET)” and “Developing Model Framework for Trading License regime to facilitate CBET” in the South Asian Countries were conducted. Open access in transmission and trading licence regime are important for power trade and development of power market. SARI/EI/IRADe presented the key findings of the study on open access and trading licence to stakeholders in Nepal. More than 30 stakeholders representing the Ministry of Energy, Nepal, NEA, ADB, and private sector participated in the workshop.

6.6 Stakeholder consultation workshop on ‘South Asian Regional Power Exchange (SARPEX) - Mock Exercise’, 09 August 2017, Dhaka, Bangladesh



The stakeholder consultation workshop on SARPEX-Mock Exercise covered various aspects of SARPEX, including objective, mode of operations and power trade. Mr. S. K. Ray, Technical Specialist, IRADe and Ms. Suruchi, KPMG gave a presentation on the Basics of Power Exchange and the Activities of SARPEX Mock Exercise and the preliminary results of 4-month long SARPEX mock exercise. The workshop was attended by more than 40 participants from different organisations.

6.7 Expert Group Consultation Meeting on Macro-economic benefits of Bangladesh-India Electricity Trade, 31 August 2017, New Delhi, India

The Stakeholder Consultation meeting was chaired by Mr. Ravindra Kumar Verma, Chairman, CEA. The participants included representatives from POSOCO, Powergrid, IEX, CERC, NITI Ayog and CEA. Dr. Anjana Das, Dr. Probal Ghosh and Mr. Vinay Saini presented the key results of the study, which was followed by panel discussions on the results. The concerns and points raised at the meeting were taken note off for inclusion in the report.

6.8 Stakeholder Consultation for SARPEX was held on 17th January, 2018, Colombo, Sri Lanka

Dr. B.M.S. Batagoda, Secretary to the Ministry of Power & Energy, Sri Lanka, joined as the Chief Guest and provided the key note address. Representative from Public Utilities Commission Sri Lanka, Lanka Electricity Board, Ceylon Electricity board, Department of National

Planning, Power Ministry etc joined the workshop. The SARPEX concept along with the process of conducting the SARPEX mock exercise and its results were discussed in detail. The participants and Dr Batagoda, appreciated the contents and on the suggestion of Mr Batagoda, the participants agreed to explore the use of the same in context of Sri Lankan domestic market. They were assured of all support by the SARI/EI team. Members appreciated the activities carried out and approved the SARPEX Mock Exercise draft reports



Task Force Meetings

6.9 6th Meeting on Coordination of Policy, Legal and Regulatory Framework, 19-20 July 2017, Pokhara, Nepal



The Task Force members from South Asian countries and representatives from IRADe and USAID attended the meeting. Country policy updates and legal, regulatory frameworks for promoting/ advancing Cross border electricity trade were presented by the members. In the two-day meeting, the delegates presented and discussed the key findings of the SARI/EI studies on a) Regional Investment Framework and Policy Guidelines for Promoting Investment in SA Power Sector and in CBET b) Developing the Framework and Guidelines for Non-discriminatory Open Access Regime in Power

Transmission and Trade to Facilitate CBET in the South Asia region, and C) Developing Model Framework for Trading Licence Regime and Guidelines for the Grant of Trading Licence to initiate/advance power trading in SA countries.

6.10 5th Meeting of TASK FORCE-3 conducted on 16th January, 2018, Colombo, Sri Lanka

Task Force 3 members from various South Asian countries along with representatives from KPMG and SARI/EI Project Secretariat, IRADe attended the meeting. Members representing Sri Lanka, Bangladesh, Bhutan, India and Nepal participated in the meeting along with the IRADe team and representative from KPMG. Honourable Chairman, PUCSL, Sri Lanka, Mr. Saliya Mathew, joined as Chief Guest and also released the model PPA and TSA report prepared by the Task Force-3 team.

Members noted that all the items in the TOR and deliverables of TF-3 has been completed except or those which are to be completed along with the other TFs and AS or the renewable energy part being addressed to in a separate USAID project.

SARPEX mock exercise results and report was presented and discussed in detail. Member were appreciative of the mock exercise and member noted that the choice of mode of operation for SARPEX doesn't have a big bearing for BBN. What is more necessary is the introduction of exchange based trading in the South Asian Region. The final Model PPA and Model TSA released in Sri Lanka during the Task Force-3 meeting. The action plan and strategy for engaging the country governments and ensuring buy-in of the country governments for the pilot market including stakeholder consultation was discussed.

Report Release Workshops

6.11 Release of Report On 'Harmonization of Grid Codes, Operating Procedures and Standards to Facilitate Cross-Border Electricity Trade in the SA Region', 30 August 2017, Kathmandu, Nepal

In an effort to boost cross-border electricity trade in the South Asia region, SARI/EI programme unveiled a new study on better grid planning and system operations

and using grid code framework guidelines. Mr. Haider Ali Altaf, Director of Energy, Transport, Science and Technology Division in SAARC Secretariat, Nepal, and Mr. Purusotam Acharya, Deputy Director General, Government of Nepal, jointly released the study. While lauding the efforts of SARI/EI programme, Mr. Altaf, Director, SAARC Secretariat, said: “A safe and secure integrated grid in South Asia will help in enhancing power trade and long-term sustainability in the region.”



6.12 Report Release Workshop on the “Converging the Divergence between Diesel and Petrol Prices on 30th August, 2017, New Delhi



Shri Dharmendra Pradhan, Honorable Minister of Petroleum and Natural gas and Minister of Skill Development and Entrepreneurship inaugurated the conference. The report presented a persuasive case for the Indian Government to further rationalize the pricing of petroleum products, in particular to eliminate the gap between the price of diesel and petrol, through revisions in the structure of central and state tax levies.

In this workshop IRADe had analysed the impact of a revenue-neutral rationalisation of the central excise duty applicable on diesel and petrol, on private and public transportation, truck freight, agriculture and state finances, road transport corporations and passengers and found that a rationalisation of the excise tax to further reduce petrol and diesel price differential does not pose a major cost hurdle to diesel users, but can lead to the elimination of perverse incentives that currently exist in the Indian economy.

6.13 Release of Report on “Harmonization of Grid Codes, Operating Procedures and Standards to facilitate/promote Cross-Border Electricity Trade in the South Asia Region,” 4th October 2017, Bhutan



SARI/EI released a new study on better grid planning and system operation using grid code framework guidelines. The Report was released in Bhutan by Mr. Sonam Wangdi, DG, DHPs, Ministry of Economic Affairs, Bhutan on 4th October 2017, Hotel Druk, Thimphu, Bhutan. The study has recommended a Framework Grid Code Guidelines (FGCG), which though non-binding, will provide a consistent regional framework for system planning, transmission connections and operational rules and responsibilities to be followed by grid users and other stakeholders.

6.14 Report Release Workshop on the “Economic Benefits of Bangladesh - India Power Trade” to promote South Asia Electricity Trade on 11 January 2018, New Delhi

The meeting was chaired by Dr. Rajiv Kumar, Vice Chairman, Niti Aayog and addressed by Ms. Ramona El Hamzaoui, Deputy Mission Director, USAID/India and Mr. Sayed Muazzem Ali, Bangladesh High Commissioner

to India. Dr. Probal Ghosh and Mr. Vinay Saini presented the key results of the study, which was followed by panel discussions. The panelist for the meeting included representatives from Asian Development Bank, POSOCO, The Asia Foundation and Energy Infratech Private Limited.

6.15 Report Release Workshop on the “Economic Benefits of Bangladesh - India Power Trade” to promote South Asia Electricity Trade on 26th February 2018, Dhaka



Dr. Gowher Rizvi, Adviser to the Prime Minister, International Affairs, Government of Bangladesh, inaugurated the workshop and release of the report Along with Mr. Harsh V. Shringla, High Commissioner of India to Bangladesh; Dr. Kerry Reeves, Deputy Director, Environment and Economic Growth Office, USAID-Bangladesh; Mr. Farooq Sobhan, President, Bangladesh Enterprise Institute and Dr. Kirit Parikh Chairman, IRADe. The panellist for the event included representatives from Power Cell/Power Division, Ministry of Power, Energy & Mineral Resources; Centre for Policy Dialogue (Bangladesh); PWC Bangladesh and Energy & Power. The closing address for the event was delivered by Mr. Nasrul Hamid, State Minister of Power, Energy and Mineral Resources, Government of Bangladesh.

The event was attended by people from Minister of Power, Energy and Mineral Resources, BPDB, Power Division, BERC, Asian Development Bank, USAID, High Commission of India, Royal Bhutanese Embassy, Bangladesh Enterprise Institute, PWC, Dhaka Tribune, Centre for Policy Dialogue, Energy & Power, Elite Group, Easy Watts UK and BEXIMO among others.

Outreach Workshops

6.16 SARI/EI Participation in the HAPUA-ASEAN-UNESCAP Workshop on ASEAN Electricity Exchange (AEE): An International Perspective, 17 -19 April 2017, Jakarta, Indonesia

The workshop was convened to provide an opportunity to ASEAN Power Grid Special Task Force to exchange knowledge with the experts, and learn about the regional power integration models around the world. Experts from the region presented an overview of the benefits from regional power integration around the world, notably in the European Union (E.U.), Nordic countries (Nord Pool), the United States (U.S.), Central America (SEIPAC) and Southern Africa (SAPP).

6.17 SARI/EI Participation in SAFIR steering Committee and Executive Committee meeting, 12 May 2017, New Delhi



On the request of SAFIR (South Asia Forum for Infrastructure Regulation) Steering Committee and Executive Committee, a presentation on ‘Mechanism for Regulatory Cooperation to Facilitate Knowledge Sharing, Addressing Regulatory Issues and Capacity Building in South Asia’ was given. It covered suggestions on creating working groups (instead of independent South Asia Forum of Electricity Regulators) under SAFIR for coordinating knowledge exchange, capacity building and addressing regulatory issues.

6.18 SARI/EI participation in the SAARC Investment Forum & Trade Fair, 6-9 September, 2017, Colombo, Sri Lanka

Mr. V.K.Kharbanda, Project Director of SARI/EI, IRADe participated as a panellist in the session on investment

for South Asia at the SAARC Investment Forum & Trade Fair from 6-9 September 2017 in Colombo, Sri Lanka.

6.19 Round-Table consultation workshop On “Developing Framework and Guidelines for Non-discriminatory Open Access Regime in Transmission and Model Framework for Trading Licence Regime” for facilitating CBET in South Asia, 4 Oct 2017, Thimphu, Bhutan

More than 30 participants from Bhutan’s Ministry of Economic Affairs, Department of Hydropower & Power Systems (DHPS), Department of Renewable Energy, Bhutan Electricity Authority, Druk Green Power Corporation Limited, Druk Holdings & Investments participated. Mr. Sonam P. Wangdi, Director General, DHPS, MoEA, delivered the Keynote address and said that open access and trading licence are very important for promoting CBET in the region. He said that Bhutan is a pioneer in CBET and expected to double its capacity for power trade in the future. He also commended various initiatives taken under SARI/EI to promote CBET in the region. The key findings of the study were discussed.

6.20 Stakeholder Consultation Meeting with BIMSTEC Secretariat on BIMSTEC Energy Outlook (BEO) -2030, 14 Nov 2017, Dhaka, Bangladesh



IRADe in partnership with Deloitte met BIMSTEC officials. The meeting was chaired by Mr. S.M. Nazmul Hasan. SARI/EI Consultant presented the key findings of the “BIMSTEC Energy Outlook (BEO) -2030”, which is the first of its kind of study on the region. Mr. Hasan appreciated the work done by SARI/EI. “BIMSTEC Energy Outlook” study aims to improve the energy literacy among the BIMSTEC member states and cohesion and sustenance in energy/electricity cooperation initiatives among the BIMSTEC

member states. The study presents energy outlook of all BIMSTEC member countries until 2030.

6.21 Workshop on Regional Co-operation for Power Trade: Nepal-India Perspective held on 1st December, 2017, Kathmandu, Nepal



IRADe, SARI/EI in partnership with the Institute for Integrated Development Studies (IIDS), Nepal organized the national level roundtable discussion. The event had the participation of more than 30 high level participants which included policy makers, diplomats, private sector, civil society organization, media, research institutes, banking sector and academia. Executive Summary of the report on Economic Benefits from Nepal-India Electricity Trade in Nepali language was released by Mr. Jeebachh Mandal, Joint Secretary, Ministry of Energy, GoN & Mr. Manjeev Singh Puri, Indian Ambassador to Nepal.

6.22 SARI/EI Think Tank Forum for South Asia Regional Co-operation Regional Dialogue on Cross Border Energy Co-operation in the Bay of Bengal Region

Regional Dialogue on Cross Border Energy Co-operation in the Bay of Bengal Region was organised by CUTS International under Think Tank Forum initiative of SARI/EI/IRADe at India Habitat Centre, New Delhi on 19th January, 2018. The event had participation of 60 plus participants.

6.23 Framing the Debate on Climate Change at 8 Universities in North India

To increase climate change awareness among the University graduates and elevate the level of conversation on this topic, IRADe with the support of North India Public Affairs Section of U.S. Embassy, New Delhi, successfully organized Climate Change symposia followed by debate competitions at 8 universities. They were:



1. 6-8 April 2018 – Department of Geography, Jamia Millia Islamia University, New Delhi
2. 3-5 February 2018 – K. Banerjee Centre of Atmospheric and Ocean Studies, Allahabad University, Allahabad, Uttar Pradesh
3. 11-13 November 2017-Department of Sociology, Banaras Hindu University, Varanasi, Uttar Pradesh
4. 27-29 October 2017- Department of Geography, H.P.University Shimla, Himachal Pradesh
5. 12-14 October 2017- Botany Department, Kumaun University, Almora, Uttarakhand
6. 5 -7 October 2017-Department of Civil Engineering, Chandigarh University, Punjab
7. 21-23 September- 2017- School of Earth Sciences, Central University of Rajasthan, Ajmer, Rajasthan
8. 13-15 September2017- Institute of Environmental Studies, Kurukshetra University, Kurukshetra, Haryana

7. Professional Activities

Dr. Jyoti Parikh, Executive Director

- Panelist “City Planning” at Opening Ceremony of Smart Cities Conference and Expo., 10 May 2017, New Delhi.
- Panelist Energia /LCEDN Workshop; Loughborough University, 13th May, 2017; Loughborough, UK
- Attended T-20/G-20 Summit; 29th May, 2017; Berlin, Germany
- Moderated session “Financing Energy Transitions in Emerging Economics”. At India Think Tank Forum. Organized by Global Think Tank and ORF. 21st June, 2017; New Delhi.
- “Climate Change & its impact” on the occasion of Bihar Earth Day. Organized by DFID, ACT; 9th August, 2017; Patna, Bihar, attended by the Chief Minister and Deputy Chief minister of Bihar.
- Speaker on “Growing Crisis in the Thermal Power Sector, Public funded Bail outs and the NPAs crisis.” At National Seminar on India’s Thermal Power, Trends, cost & mounting financial stress.; 23rd August, 2017; New Delhi.
- Speaker at LCEDN Annual Conference 2017: Equity & Energy Justice; Durham University; 9th September, 2017; Durham, UK
- Panelist at the Opening session; Policy, Planning Implementation and support schemes at “The Resilience Continuum: Comprehensive Risk Management in the Face of Climate Change”; Organized by Global Development Network; 15th September, 2017; New Delhi
- Panelist Second BRICS Forum on SPE Reform & Governances. Organized by State Grid Corporation of China; 20th September, 2017; Beijing, China.
- Panelist and Speaker at the Web Summit, 2017; Organized by The Forum; 6th November, 2017; Lisbon, Portugal.

- Panelist at Panel Discussion on “Mountain Cities- Disaster in the making?” Organized by WWF and Integrated Mountain Initiative; 12th February, 2018; New Delhi.
- Panelist on Smart Cities session at World CSR day; 17th February, 2018; Mumbai
- Panel speaker on co-benefits approach at cities IPCC; 5th March, 2018; Edmonton, Canada
- Keynote Speaker on agriculture & food security at GDN Annual Conference. 22nd March, 2018; New Delhi
- Expert Dialogue on Modelling for Low Carbon Economy. Organized by EU; 23rd March, 2018; New Delhi.
- Attended Workshop on Market Mechanisms under Article 6 of Paris Climate Agreement.
- Organized by MoEFCC; 24th March, 2018; New Delhi

Rohit Magotra

- Discussant at Brainstorming workshop on National Mission on Himalayan Studies(NMHS) organized by MoEF&CC and GBPNIHESD, 6th July 2017, New Delhi
- Discussant at Consultation on the Review of ADB’s Public Communications Policy, 18 July 2017, New Delhi
- Panelist in World Sustainable Development Summit, 15-17 February, 2018, Vigyan Bhawan , New Delhi

Rajiv Ratna Panda

- Speaker at the SAARC Training Workshop on “System Operation and Settlement Mechanism, Cross Border Trade/Regional Power Market in South Asia” 10-11 December, 2017, Dhaka, Bangladesh.
- Speaker at 2nd Meeting of SAARC Council of Experts of Energy Regulators-24 October 2017, Islamabad, Pakistan.

8. List of Publications

Papers Published in Journals

- Ghosh, Probal & Parikh, Jyoti & Parikh, Kirit. (2018). Can India grow and live within a 1.5 degree CO2 emissions budget?. *Energy Policy*. 120. 10.1016/j.enpol.2018.05.014.
- Anantha Lakshmi Paladugula, Nazar Kholod, Vaibhav Chaturvedi, Probal Pratap Ghosh, Sarbojit Pal, Leon Clarke, Meredydd Evans, Page Kyle, Poonam Nagar Koti, Kirit Parikh, Sharif Qamar and Sangeetha Ann Wilson (2018): "A Multi-Model Assessment of Energy and Emissions for India's Transport Sector through 2050", *Energy Policy*, Vol-116, pp 10-18, 2018.
- Kirit Parikh, Jyoti Parikh and Mohit Kumar (2017) "Vulnerability of Surat, Gujarat to Flooding from Tapi River: A Climate Change Impact Assessment". *Vayu Mandal: Bulletin of Indian Meteorological Society*, Volume 43, Number 2, pp 123-132.
- Mohit Kumar, Rohit Magotra, Jyoti Parikh and A.S. Rajawat (2017) "Changing Landscape of Marine National Park and Sanctuary, Gulf of Kachchh: Ecological Assessment of Mangroves and Coral Reefs". *Proceedings of National Academy of Sciences, India Section A Physical Sciences Special Issue on Remote Sensing*, Volume 87, Issue 4, pp 889-900, <https://doi.org/10.1007/s40010-017-0457-3>.
- Kirit S. Parikh, Probal P. Ghosh, Alwin D'Souza and Hans P Binswanger-Mkhize (2016): "Consumer Demand System for Long Term Projections", *Indian Journal of Agricultural Economics*; Apr-Jun 2016; Vol 71, No 2; pp 113-136. (Awarded the D. K Desai Prize for 2016)

IRADe in NEWS

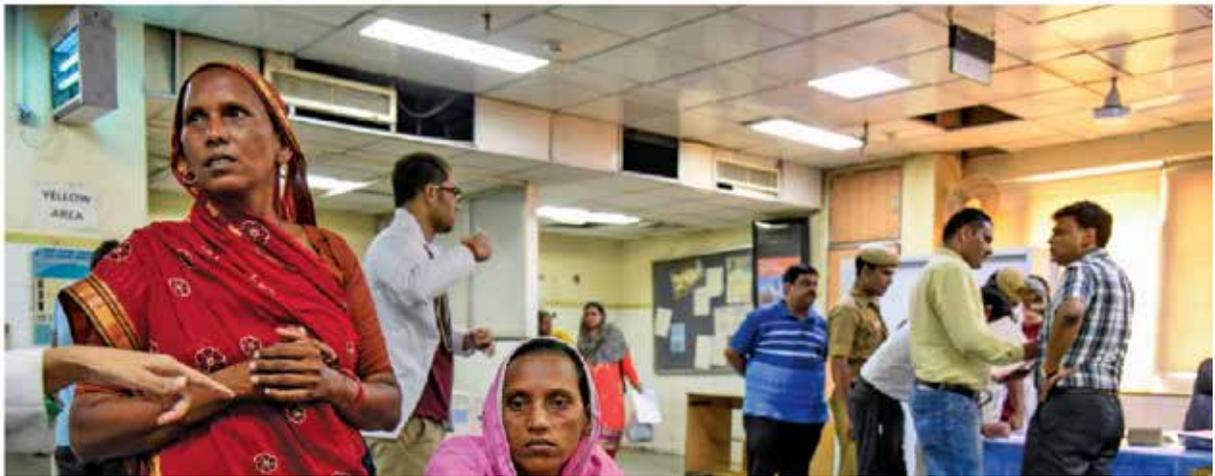
In India Summer Heat May Soon Be Literally Unbearable



By Somini Sengupta

Web link: <https://www.nytimes.com/2014/07/23/india/india-heat-wave-summer.html>

NEW DELHI — On a sweltering Wednesday in June, a rail-thin woman named Rehmani gripped the doctor's table with both hands. She could hardly hold herself upright, the pain in her stomach was so intense.



REnewable ENERGY

RE is the driver of the new global energy dynamics

The solar and wind sector eventually should become for most independent of the government and be based on the business model led by private sector, says Prof. Jyoti Parikh, Director, Integrated Research & Action for Development in an interview with **Focus Asia**.

Q How has the Renewable Energy (RE) changed the global energy scenario?

A The global energy scenario has changed significantly. The use of renewable energy is increasing rapidly. This is due to the fact that renewable energy is becoming more cost-effective and is being supported by governments. The solar and wind sector is becoming increasingly important. It is becoming more independent of the government and is based on the business model led by private sector. This is a significant change in the global energy dynamics.

Energy sector can afford to invest in R&D

Energy sector can afford to invest in R&D in foreign market

2

The energy sector can afford to invest in R&D in foreign market. This is because the energy sector is becoming more globalized and is looking for new opportunities for investment. The energy sector can afford to invest in R&D in foreign market because it is becoming more globalized and is looking for new opportunities for investment.

THE ECONOMIC TIMES

Why an effective ban on cow slaughter may soon banish the cow flout

The economic consequences of a ban on cow slaughter are significant. It will lead to a significant increase in the price of cow slaughter. This is because the supply of cow slaughter will be significantly reduced. This will lead to a significant increase in the price of cow slaughter.

The ban on cow slaughter will lead to a significant increase in the price of cow slaughter. This is because the supply of cow slaughter will be significantly reduced. This will lead to a significant increase in the price of cow slaughter.

9. Lists of Projects- 2017-2018

| S. No. | Title | Funding Agency | Status |
|--------|--|--------------------------------------|-----------|
| 01. | Inter-model Comparisons of Different Transportation Sector Policies in India | Shakti Sustainable Energy Foundation | Ongoing |
| 02. | Developing Urban Climate Vulnerability Index | MoEFCC | Ongoing |
| 03. | South Asian Regional Initiative for Energy Integration (SARI/EI) | USAID | Ongoing |
| 04. | Diesel Price Rationalization: Converging the divergence between Diesel and Petrol Pricing | Shakti Sustainable Energy Foundation | Ongoing |
| 05. | Advanced Coal Technologies for Power Generation | DST/GTWG | Ongoing |
| 06. | Gender & Energy Sector Reforms in India | DFID/ENERGIA | Ongoing |
| 07. | Electricity as a Clean Cooking Option for Rapid Scale Cooking | NABARD | Completed |
| 08. | Assessment of Food Security & Livelihoods due to climate change in UP,HP & Odisha | MoEFCC | Ongoing |
| 09. | Analysis of Energy, Food and Water Nexus in a Macroeconomic Consistency Framework | NITI Aayog | Ongoing |
| 10. | Developing Disaster Resilience Action plan through GIS and prioritizing actions for National Disaster Risk Reduction in Urban Agglomerations of Shillong & Gangtok | MoEFCC | Ongoing |
| 11. | Prediction of Dengue with climate change over Delhi | DST | Ongoing |
| 12. | Framing the Debate on Climate Change | US Embassy | Ongoing |
| 13. | Process Analysis, observations and modeling – Integrated solutions for cleaner air for Delhi (PROMOTE) | MoES-NERC | Ongoing |
| 14. | Climate Adaptive Action Plans to Manage Heat Stress in Indian Cities | IDRC | Ongoing |
| 15. | Partnerships for Skill Development LCEDN Program | Loughborough University | Ongoing |

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