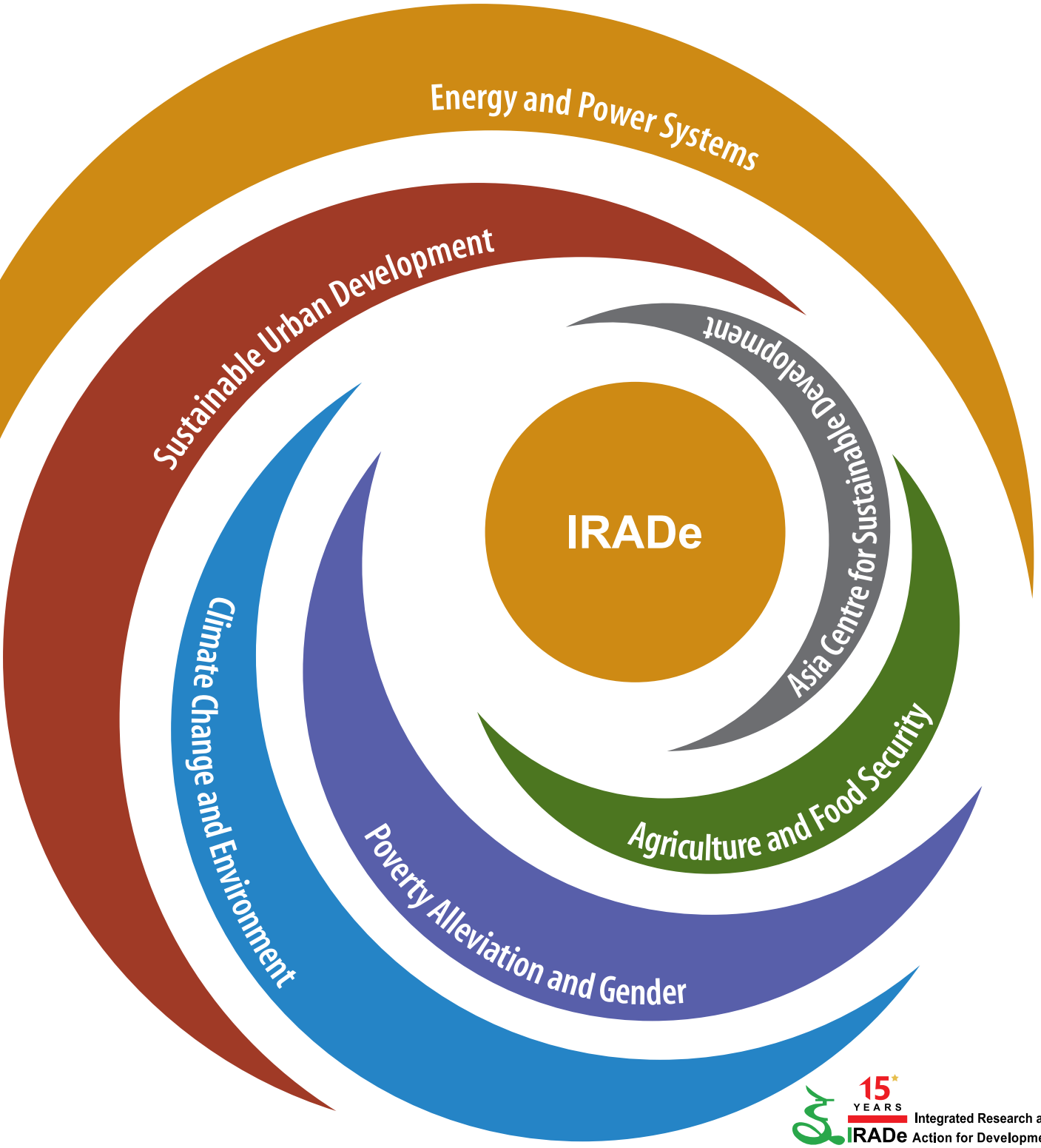
Integrated Research and Action for Development



15 YEARS
Integrated Research and Action for Development
IRADe

IRADe founding members (from left to right): Kirit Parikh, Shirish Patel, Manmohan Singh, Jyoti K. Parikh, R.A. Mashelkar and Adi Godrej

15 YEARS

IRADe Integrated Research and Action for Development

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About Us

IRADe is an independent advanced research institute which aims to conduct research and policy analysis to engage stakeholders such as government, non-governmental organizations, 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. Therefore, IRADe research covers these, as well as 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 and Development Organization by the Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology (MoST). It has also been selected as a Centre of Excellence by the Ministry of Urban Development (MoUD) for urban development and climate change. In addition, it provides expertise to other ministries, national and international institutions and partners with other reputed organizations.

Our Vision

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

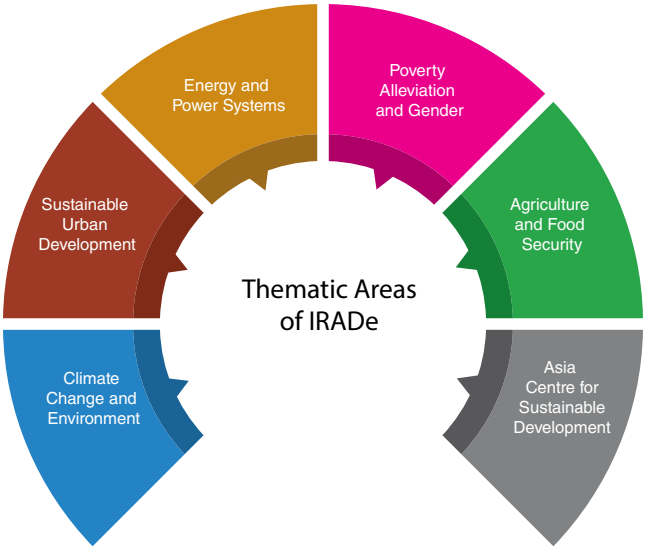
Our Mission

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.

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.

Thematic Areas of IRADe



IRADe 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

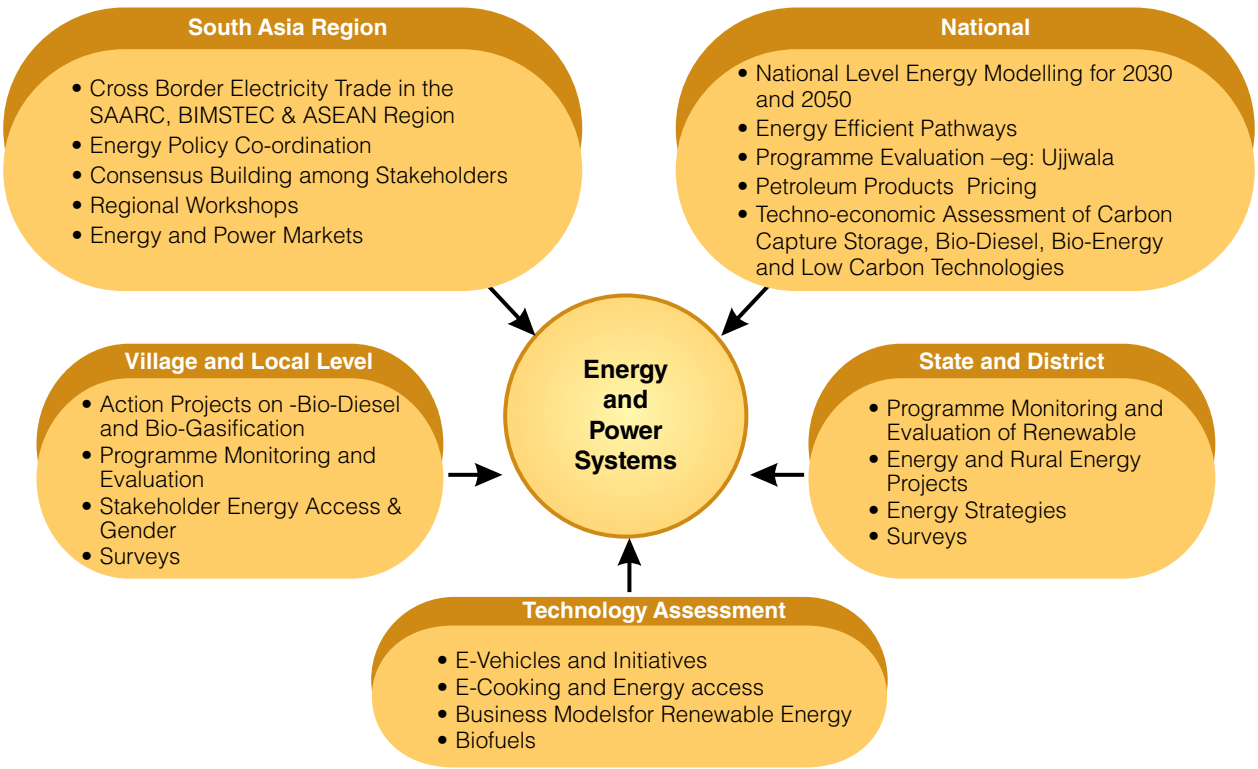
Our Partners in Development

Energy and Power Systems

IRADe has a strong presence in energy policy studies in India. These include energy needs of India in the context of global energy scenarios, pricing policy and reforms, technology assessment, energy access, programme evaluation, role of renewable energy trade and long-term (2050) perspectives on energy.

The analytical research included understanding the changes in trends of energy production, consumption, imports and exports of petroleum fuels and their contribution to the overall energy mix in India. Technology assessment exercises carried out include carbon capture and storage, biodiesel, renewable technologies and star-rated appliances. Fuel demand and specific sectors that impact energy consumption and energy transition till 2030 and 2050 are studied. Technology and Policy alternatives for transportation and business models for renewable energy are some of the latest programmes.

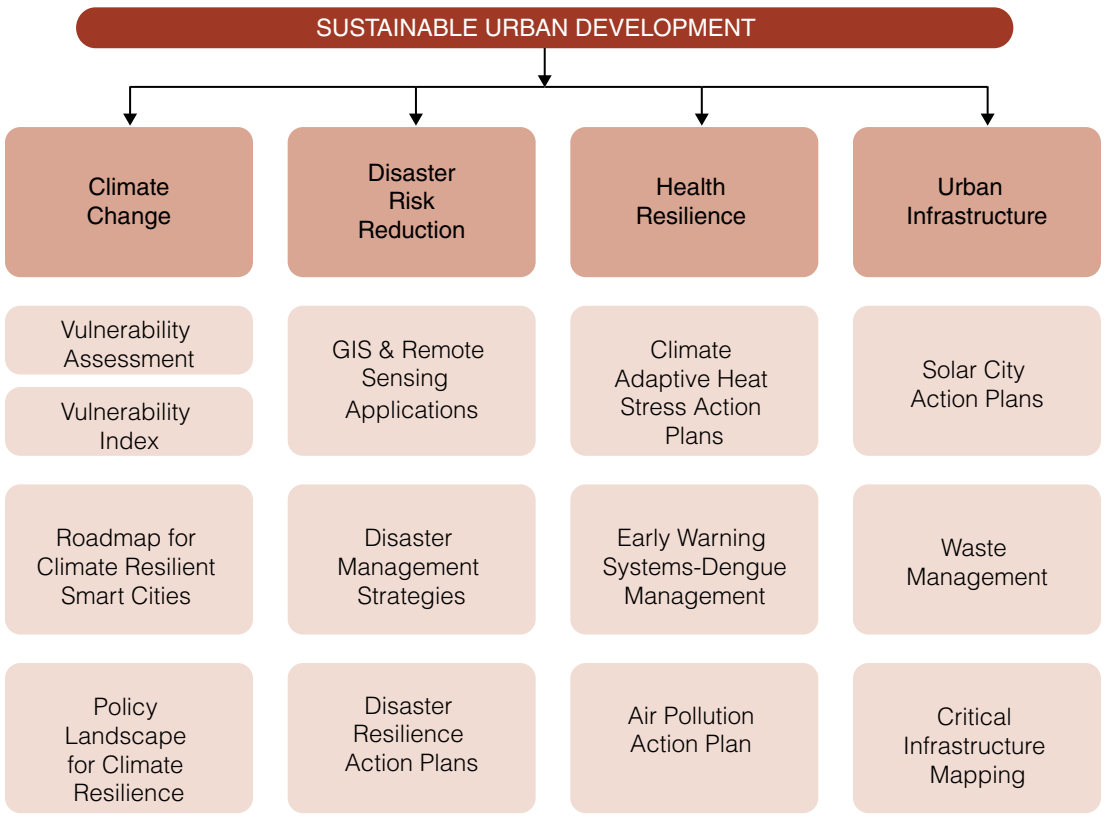
South Asia Regional Power trade is now a major project with duration of five years supported by SARI/ USAID. Access to modern energy for poor, especially for women, is a major concern always reflected in IRADe research and has undertaken several projects involving surveys and analysis. Our policy analysis cover areas related to pricing of and access to energy and also technology perspective for long term. These also explore issues linked with poverty and gender as well as climate change.



Sustainable Urban Development

IRADe is designated as Centre of Excellence (CoE), urban development and climate change by Ministry of Urban Development (MoUD), GOI. IRADe collaborates with national institutions, state urban departments, urban local bodies, development aid agencies for capacity building, promoting awareness, research and training in the area of climate resilient urban development, disaster risk reduction, health resilience and urban infrastructure. We have worked with 32 cities across 19 Indian states.

As the CoE, IRADe is furthering the agenda of integrating various urban development efforts and documenting best practices and policy level prescriptions. For addressing Climate Change issue in cities IRADe has carried out rapid vulnerability assessment of 20 cities, devised roadmap for mainstreaming climate and disaster resilience components in the smart city development plans of 10 cities, piloting urban climate vulnerability index. Using GIS and Remote Sensing tools hazard vulnerability and critical infrastructure maps have been developed for 12 cities to help planners and decision makers in devising city disaster management strategies and resilience action plans. For building health resilience within the cities the CoE has been actively working on developing climate adaptive heat stress action plans, early warning system for Dengue and air pollution action plans.

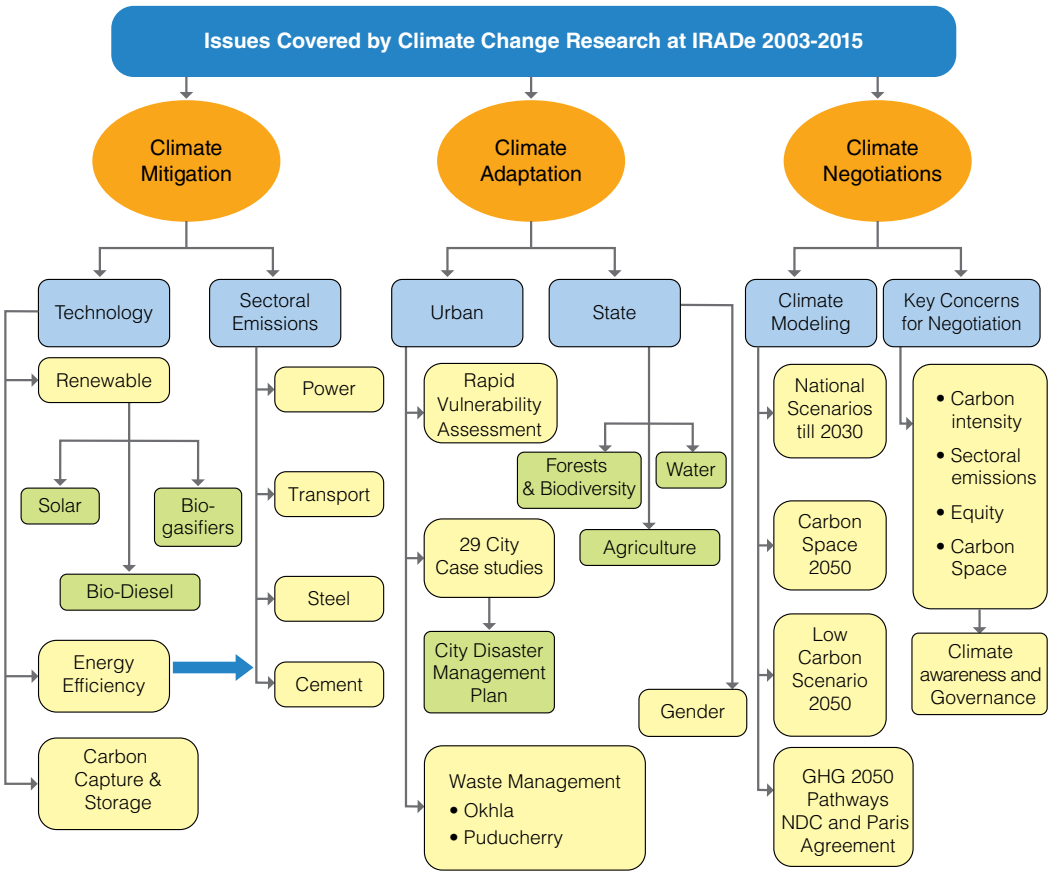


Climate Change and Environment

Local and global environmental issues, especially climate change, loom large with increasing risks. As the way forward, IRADe has adopted a multi-disciplinary approach and carries out national projects for both climate mitigation and adaptation in the country.

In climate change, IRADe intensively covers climate mitigation, adaptation and negotiations. Further, IRADe provides inputs using the activity analysis model in the area of low carbon pathways and nationally determined contributions until 2030 and 2050 for Climate Policies in India. As a member of NATCOM institutions and Indian Network on Climate Change Assessment (INCCA), IRADe assists in country reports and provides inputs on negotiating positions, arguments and policy suggestions to ensure equity principles. IRADe provided analytical support to the Ministry of Environment Forests and Climate Change (MoEFCC) for Paris Agreement

IRADe's environment project portfolios include environmental accounting and valuation for Goa and Andhra Pradesh with a focus on tourism, waste management, air and water pollution. Biodiversity and Ecosystem management for Marine National Parks are also addressed. IRADe recently organized climate debate in 8 Universities for Climate Change Awareness.

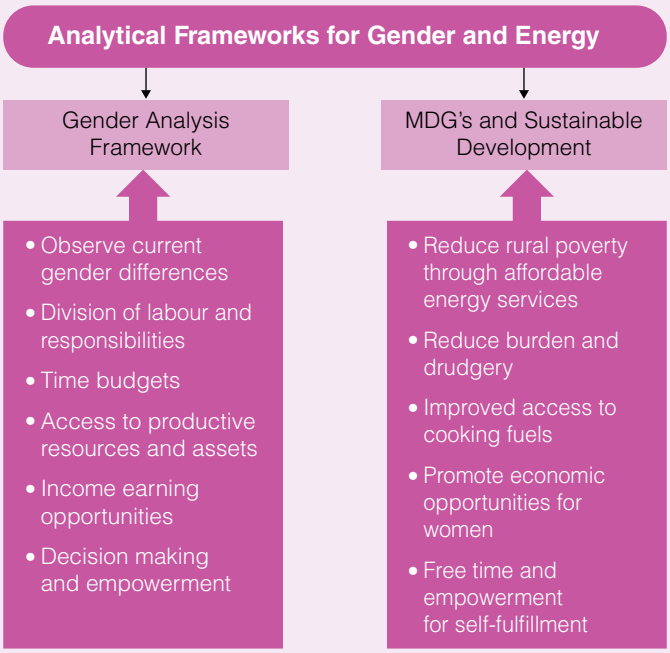


Poverty Alleviation and Gender

Unequal treatment of men and women, and their differentiated social and economic roles, have led to higher levels of poverty for women than for men. Therefore, achieving gender equity is an important consideration in improving the effectiveness of poverty alleviation programmes. In order to enhance capabilities of women, ensure their participation and decision making rights, thereby enabling them to exercise control over their own lives, IRADe has focused especially on poor women in the other thematic areas, while discussing energy, environment, climate change and food security.

In the energy sector, IRADe is advocating that more attention should be given to the problems associated with the non-commercial energy sector (fuel-wood). Clean and convenient energy sources are needed to reduce drudgery for women and increased access to cooking, and other household and productive purposes. This can have dramatic effects on women's levels of empowerment, education, literacy, nutrition, health, economic opportunities, and involvement in self development activities, including community participation.

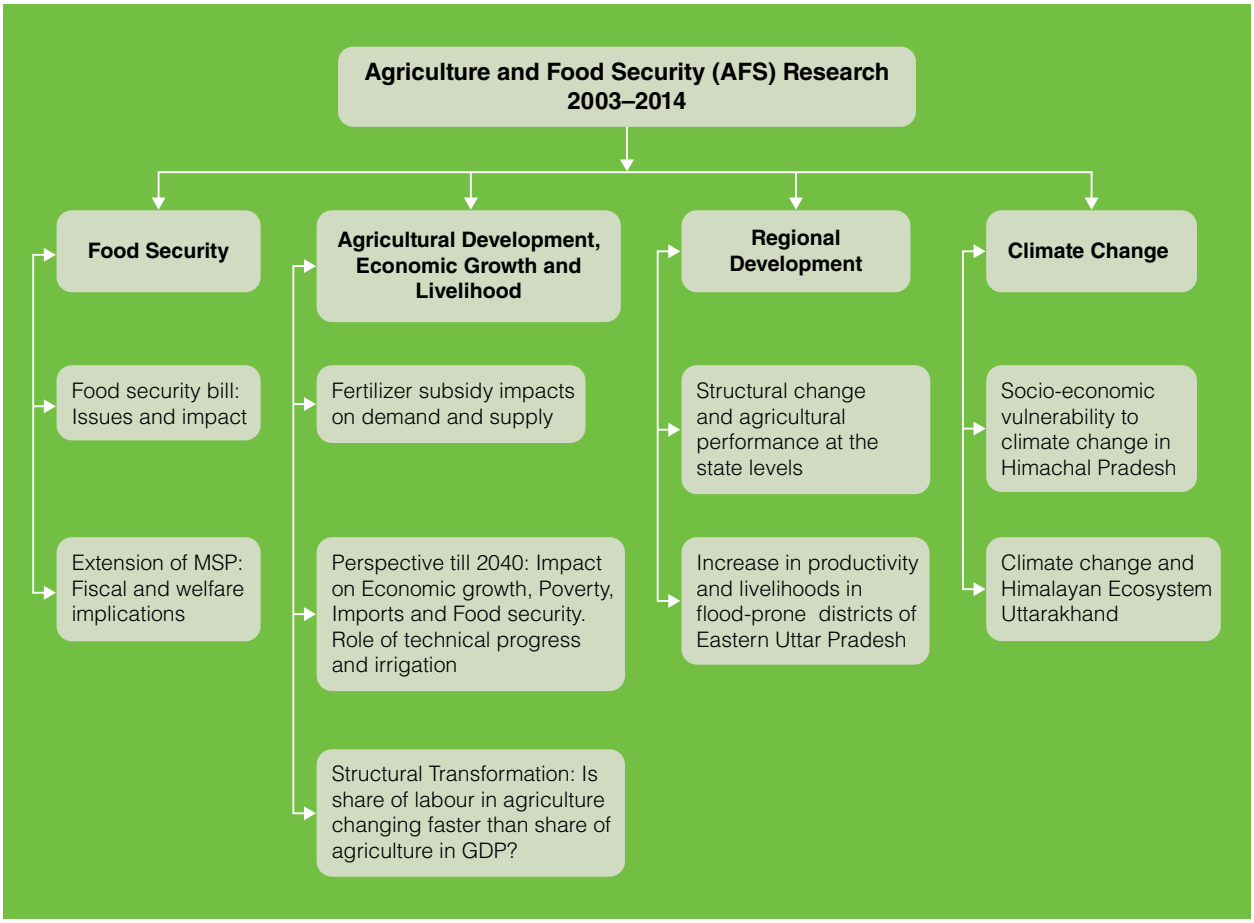
In the last few years, IRADe was involved in projects relating to mainstreaming gender in the process of energy sector reform and climate strategies; evaluation of government programmes to increase access to clean energy for women; the gender dimension of energy sector reforms and regulation.



Agriculture and Food Security

Food security issues now should also include climate change. To enhance food security, IRADe focuses on yield growth in agriculture, a rational development strategy for handling the issues of excess labour in agriculture sector, management of arable land in India, institutional approach for collective action and rational use of irrigation water etc. The domestic self-sufficiency ratio for food security needs to be optimized. IRADe has worked on the following projects related to the field of agriculture and food security.

IRADe has developed a general equilibrium model to explore the Indian agriculture over the next 30 years that will have profound implications for diversification for rural urban migration, for agricultural profitability and food security. In the past IRADe has conducted a study that entails estimation of demand for Natural Gas in the Indian Fertilizer Industry and analyze the fertilizer demand, to access the impact of various feedstock prices, to estimate the total subsidy for the fertilizer sector, to suggest range of policy alternatives, to recommend viable policy and reform options for policy-makers for India.



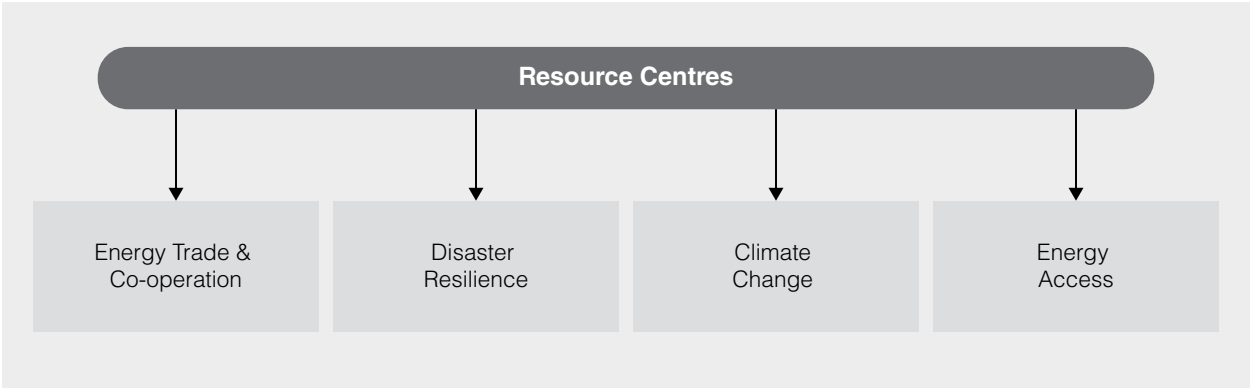
Asia Centre for Sustainable Development

15 YEARS IRADe

Asian countries share geography, history, arts, culture, natural resources and value systems. Regional co-operation amongst Asian Countries can generate synergy and additional benefits to each country for optimal use of resources. Asia needs connectivity, common infrastructures and co-operative mechanisms to achieve Sustainable Development Goals. Regional common perspectives require collaboration in several development areas like energy, infrastructure connectivity, climate change, agriculture, urban development, food security and disaster management.

IRADe is working on sustainable development issues in South Asian Countries. We carry out policy research and its implementation for enabling socio-economic growth and chart pathways for sustainable development. Since 2012, IRADe in partnership with USAID has successfully demonstrated implementation of South Asia Regional Initiative for Energy Integration to push energy trade in the South Asian region. We have been very successful in leveraging the collaboration with several regional forums like SAARC, BIMSTEC, SAFIR, ACCCRN, ASEAN in Asia on the sustainable development issues.

With this encouraging experience IRADe has set Asia Centre for Sustainable Development to extend our work in Asian countries and beyond to work on achieve Sustainable Development Goals.



IRADe's Sponsors Collaborators and Partners

IRADe networks with the government, ministries/departments, international organizations, public and private sectors, academic experts, NGOs, and consultants to work on projects awarded by them. IRADe provides decision support to eleven ministries that include Ministry of Environment and Forests and Climate Change, Ministry of New and Renewable Energy, Niti Aayog (formerly Planning Commission), Ministry of Power, Ministry of External Affairs, Ministry of Earth Sciences, Ministry of Urban Development, Department of Science and Technology, Central Statistical Organization under Ministry of Statistics and Programme Implementation, Technology Information, Forecasting and Assessment Council (TIFAC), etc. for many national level projects.

At the international level, IRADe has worked with bilateral and multilateral organization like the World Bank, Asian Development Bank (ADB), U.S. Agency for International Development (USAID); United Nations Development Programme (UNDP); United States Environmental Protection Agency (USEPA), Wuppertal Institute for Climate, Environment and Energy, (WISION) Germany; Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany; Rockfeller Foundation; International Institute for Applied Systems Analysis (IIASA), Austria; British High Commission (BHC), Centre for Clean Air Policy (CCAP), USA; International Institute for Sustainable Development (IISD), South South North Trust (SSNT) International Development Research Centre (IDRC), Canada etc.

IRADe has partnered with academic, private sectors, multinational organizations, think tanks and NGOs. These include Shakti Foundation, Indian Council of Social Science Research (ICSSR), SEWA, Petroleum Federation of India, Pricewater House Coopers, ICF International, Rockefeller Foundation, Institute for Social and Environmental Transition (ISET), Center for Clean Air Policy (CCAP), Indian Council for Research on International Economic Relations (ICRIER), InsPIRE Network for Environment, Stanford University, National Bank For Agriculture and Rural Development (NABARD) and World Wildlife Fund (WWF) Collaborations with IIT-B, IIT-Madras, IIT-Delhi, TERI, GB-Pant Institute of Himalayan environment and development, IIPH-Gandhinagar, IIPH-Bhubaneswar, North East Space Application Center (NESAC), NERC, US Embassy, LCEDN, DST/MoES, Pacific Northwest National Laboratory (PNNL), Council On Energy Environment and Water (CEEW), Center for Study of Science, Technology & Policy (CSTEP), The Energy and Resource Institute (TERI).

IRADe has also developed strategic partnerships and is part of global networks like the USAID's Low Emissions Asian Development (LEAD) program – ASIA-LEDS, ENERGIA-International Network for Gender and Sustainable Energy, Netherlands; Global Clean Cook Stoves Forum, UN Foundation; Asian Cities Climate Change Resilience Network (ACCCRN), Global Technology Watch Group (GTWG-DST), Climate Action Network South Asia (CANSA). State and City level senior officials have partnered with IRADe and supported us, when we have carried out some pioneering work in the field of state level energy planning, city level climate resilience planning, other climate change and livelihood studies.

We profusely thank all the sponsors whose logos are flagged overleaf, who have believed in us and supported us generously. Some of them have given so much feedback that we can consider them as partners as well. State and City level senior officials have partnered with IRADe and supported us, when we have carried out some pioneering work in the field of state level energy planning, city level climate resilience planning, other climate change and livelihood studies.

Our Supporters in Progress

ACCCRN
Brot für die Welt
CCAP
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DFID
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Ministry of Urban Development
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VISIONS
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WWF

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ANNUAL REPORT 2017-18

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About IRADe

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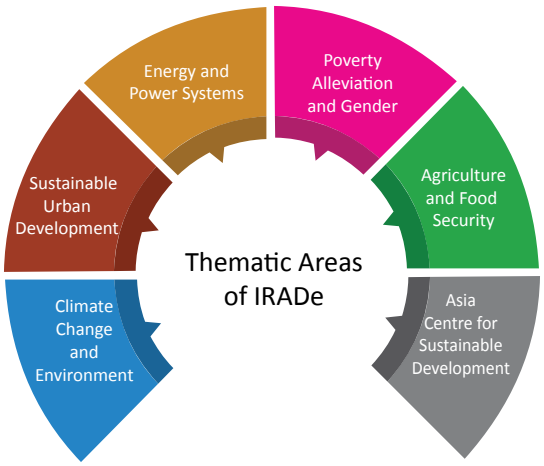

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Preface

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 cess 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.

Jyoti Parikh

Professor Jyoti Parikh, PhD
Executive Director, IRADe

Contents

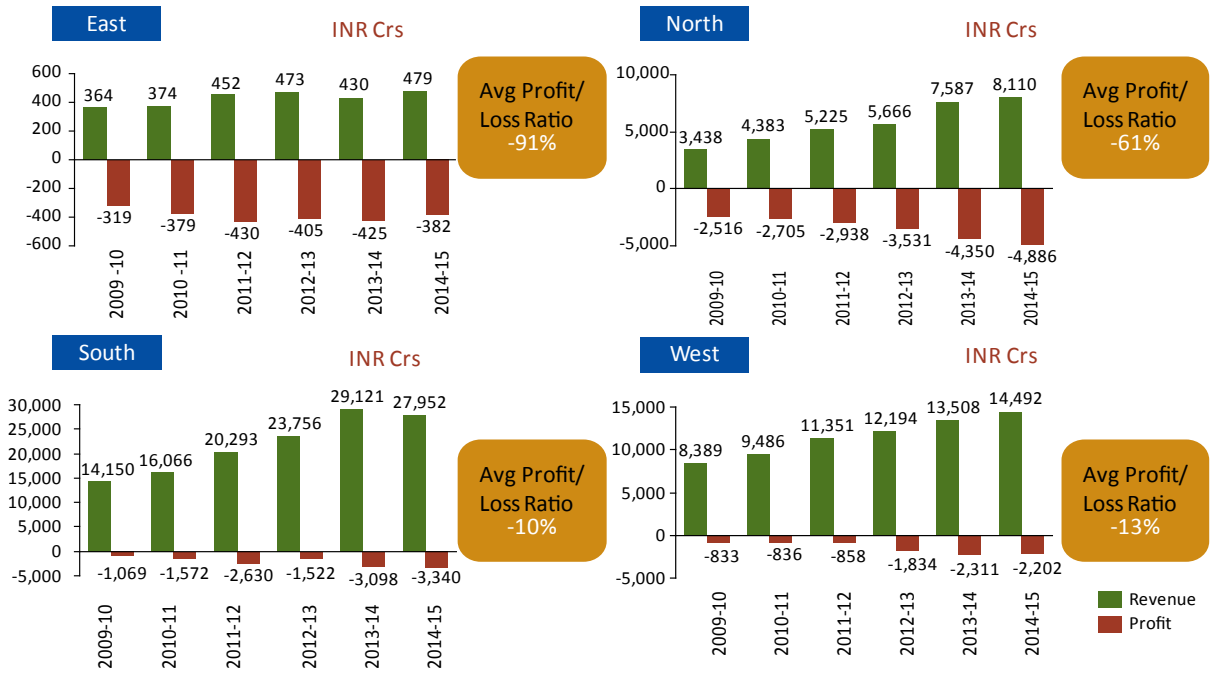
1. Energy & Environment

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.

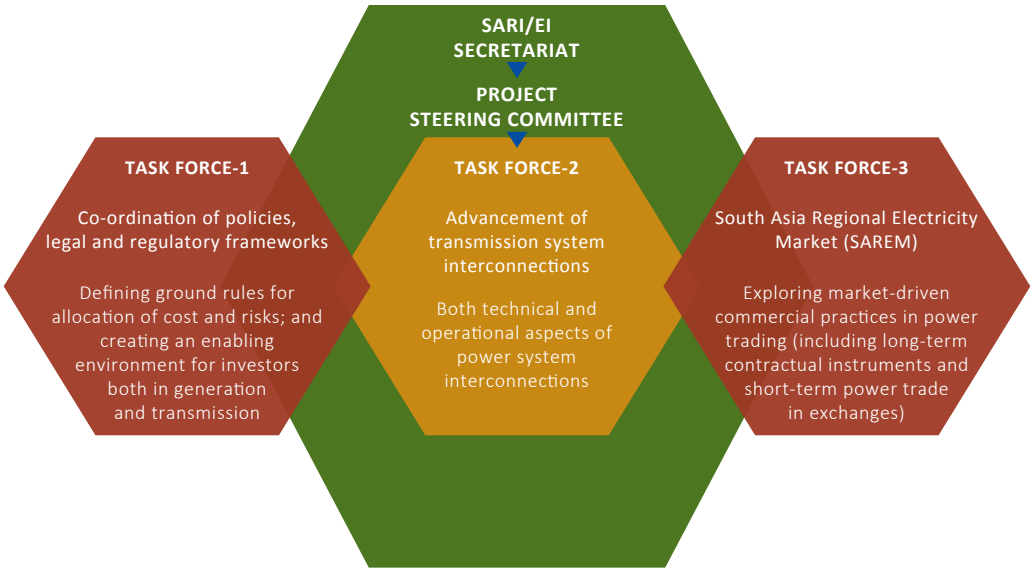
1.2. South Asia Regional Initiative for Energy Integration (SARI/EI), USAID/India

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



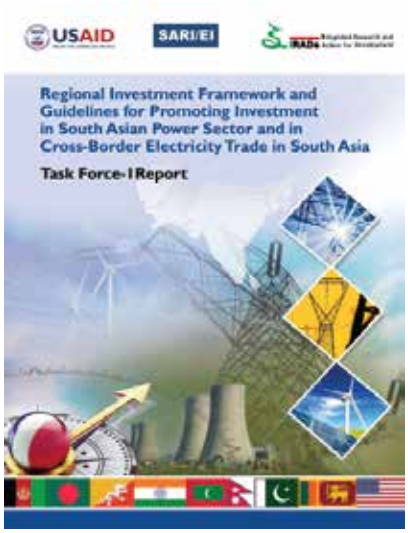
interconnections and trade in South Asia, providing an enabling regulatory environment is critical. In the second meeting of the SAARC Energy Regulators, held on February 2016 in Colombo, the members decided to establish the SAARC Council of Experts of Energy Regulators-Electricity (CEERE). Overall, 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.

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 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.

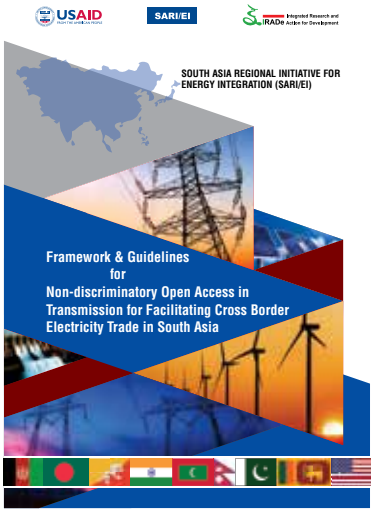


Model Power Purchase Agreement (PPA) &Model Transmission Service Agreement (TSA)

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.

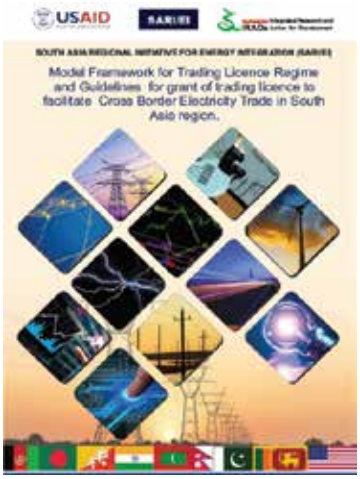
Model Framework and Guidelines For Non-Discriminatory Open Access Regime In Transmission and Grant Of Open Access to Initiate Power Trading and Facilitate CBET In South Asia.

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.



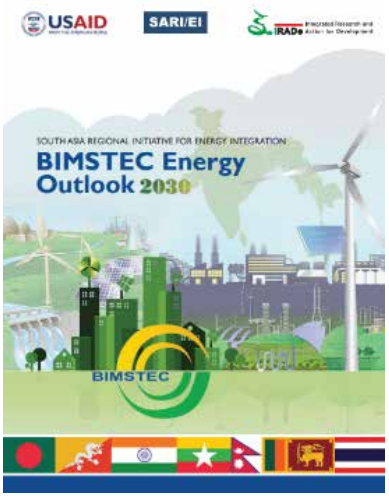
Model Framework for Trading Licence Regime and Guidelines For Grant of Trading Licence to Facilitate Cross Border Electricity Trade In South Asia Region.

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.



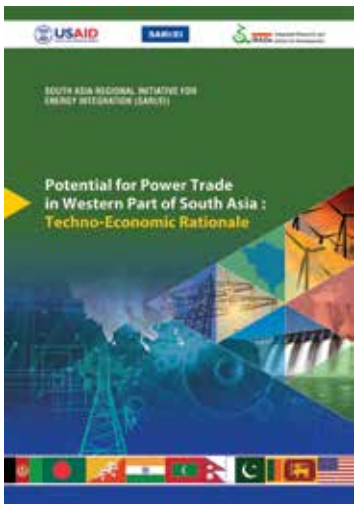
Report on BIMSTEC energy Outlook-2030

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.



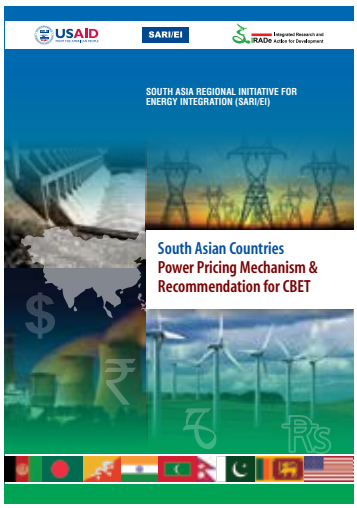
Potential of Power Trade in the Western Part of South Asia: Techno-Economic Rationale

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:

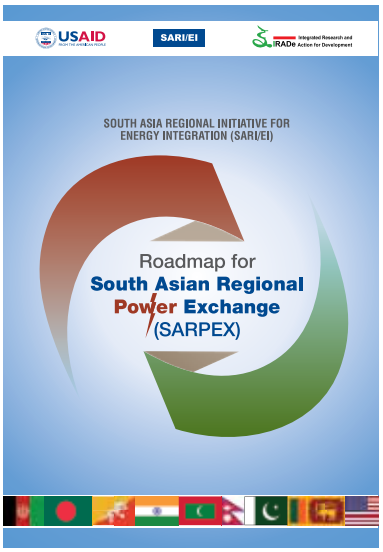
The report on power pricing mechanism imparts understanding about the tariff mechanism and procurement strategy in South Asian countries. Its objective is to provide the national regulators/ empowered entities of SACs an input about reforming the tariff mechanism and developing a course of action that 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

Global Technology Watch Group on Advanced Clean Coal Technologies

Dr. Sreenivas Jayanti (IIT Madras)
Dr. Anand B. Rao (IIT Bombay)
Dr. Sreedevi Updadhyayula (IIT Delhi)
Dr. Jyoti Parikh (IRADe, New Delhi)
Dr. Preeti Aghalayam (IIT Madras)
Dr. Munish Chandel (IIT Bombay)
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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 (SOx, NOx, 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 SOx Nox, 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 SOx NOx 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 Milia 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 25August 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 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, Bhubaneshwar 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 31January 2018, and Inception Workshop on 1February 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

Inception Workshop, IIC, Delhi

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-Bhubaneshwar, Dr. Ambarish Dutta, Additional Professor, Indian Institute of Public Health-Gandhinagar, Dr. Parthasarthi Ganguly, and Chief General Manager, Odisha State Disaster Management Authority, Dr. Pradeep K Nayak.

At the inception workshop, detailed survey questionnaire andsurvey 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 19March 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-Bhubaneshwar, Dr. A. Dutta from IIPH- Bhubaneshwar 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.

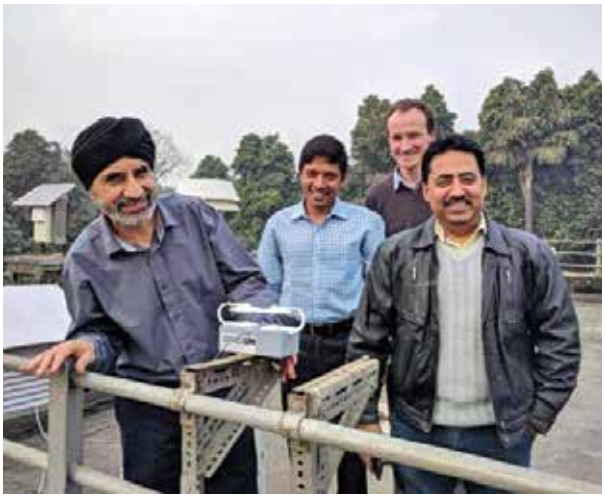
Duration: 3 years (Nov 2017- Nov 2020)
(supported by International Development Research Centre, Canada)

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 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

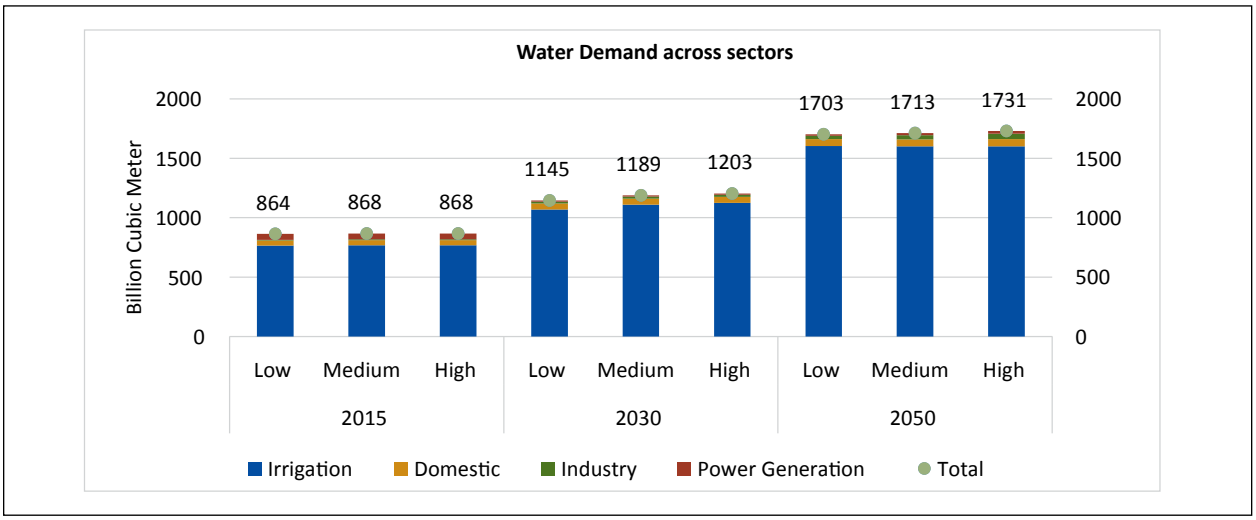
thermal generation, solar thermal and nuclear have significant water requirements. The demand for power would increase with growth, which would be also be accompanied by an expansion of the agricultural sector, industrial sector and urbanisation led water demand from the affluent households. Water requirements 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.

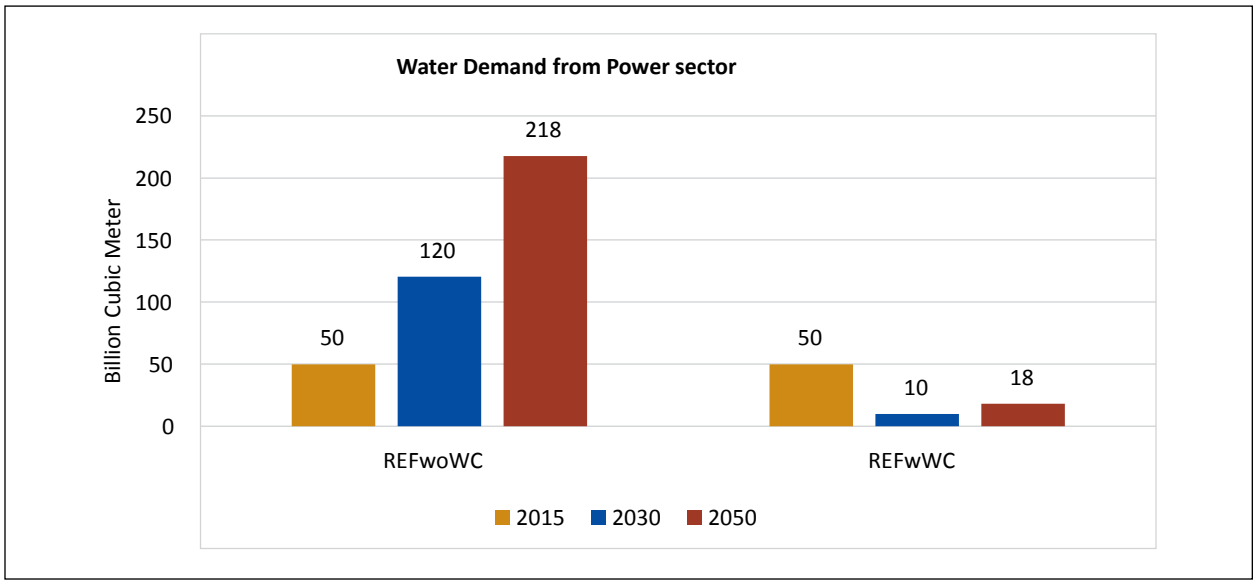
The IRADe team has contributed to a joint research paper that has now been published in the journal Applied Energy ("Water for electricity in India: A multi-model study of future challenges and linkages to climate change mitigation", Srinivasan Shweta et al, Applied Energy, 2017)

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)" ans "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', 09August 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 4t 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

NEW DELHI — On a sweltering Wednesday in June, a frail-thin woman named Rehmati 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 far more independent of the government and be based on the business models led by private sector, says *Prof. Iyoti Parikh*, Director, Integrated Research & Action for Development in an interview with *Fozia Yasmeen*.

THE ECONOMIC TIMES

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

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

Partners and Sponsors

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Integrated Research and Action for Development

IRADe

ANNUAL REPORT 2016-17

ANNUAL REPORT 2016-17

IRADe Integrated Research and Action for Development

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 promote development using 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 through policy research and analysis, consensus building & 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.

Thematic Areas of IRADe

Key Programme Areas or Thematic Area of IRADe are:

1. Climate Change and Environment
2. Sustainable Urban Development
3. Energy and Power System
4. Poverty Alleviation and Gender
5. Agriculture and Food Security

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

Our Partners in Development

Preface

I express great pleasure in presenting IRADe's Annual Report of the activities undertaken for the year 2016-17. This report highlights the research and development work, as well as the activities conducted for various projects of the organisation.

After contributing to the Paris Agreement Dialogue on Climate Change through IRADe modelling work, we discussed its implementation in a Conference with the representatives of private sector, public sector and Government officials. We were fortunate to have the dynamic ministers: Shri Prakash Javadekar, currently the Minister for Human Resource Development who spearheaded the negotiations in his capacity as the Minister for Environment, Forest and Climate Change; and Shri Suresh Prabhu, currently the Minister of Commerce & Industry, and IRADe Council member who addressed the valedictory session.

For IRADe, this year marked the completion of some old projects and many new beginnings. For example, we are working on addressing the problems of air pollution and the adverse impact on human health due to climate change. Our interest in technology assessment remains a strong and critical factor leading to work on electric vehicles, modernisation of railways, development of early warning system for dengue, electricity induced cooking and grid integration of renewable energy. Some of these key initiatives are in the exploratory stage, while we have received a pilot project from NABARD for cooking using electricity.

IRADe's flagship program *"South Asia Regional Initiative for Energy Integration (SARI/EI)"* is at its peak, culminating in many activities such as completion of reports, stakeholder consultations, consensus and consortia building. The Think Tank Forum (TTF) was initiated leading to cooperation and convergence among South Asian Think Tanks, interested in inter-state energy trade. The Nepal-India modelling exercise provided many insights around the macro-economic impact on South Asia power trade and the final report was released with praise for the state-of-the-art modelling approach used by IRADe. Meanwhile, the Government of India has come out with guidelines for South Asia power trade.

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 Mr. Mohit Kumar, Senior Research Associate, IRADe for completing the task of preparing this report.

Jyoti Parikh

Professor Jyoti Parikh, PhD
Executive Director, IRADe

Energy & Power Systems

Climate Change & Environment

Poverty Alleviation and Gender

Agriculture and Food Security

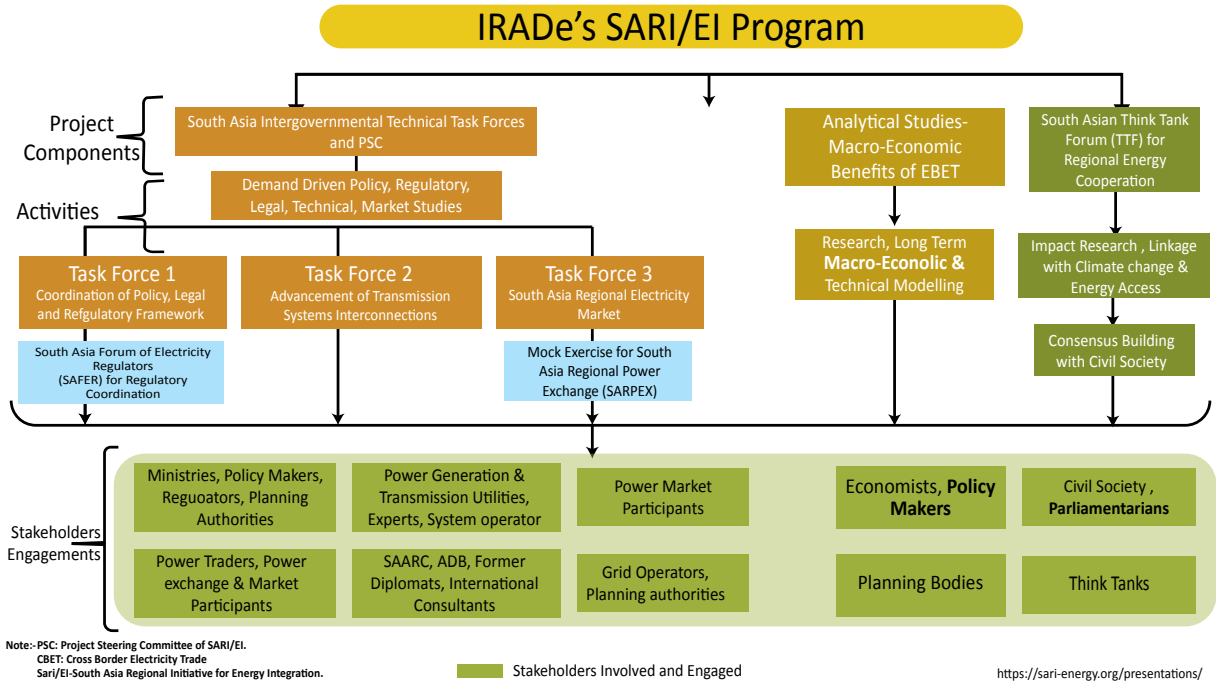
Contents

1 Energy & Power Systems

1.1 South Asian Regional Initiative for Energy Integration (SARI/EI)

Integrated Research and Action for Development (IRADe) is the implementing partner for the fourth phase of USAID's South Asia Regional Initiative for Energy Integration (SARI/EI) program for advancing regional energy integration and Cross Border Energy Trade (CBET) in eight South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Pakistan, Nepal, Sri Lanka and the Maldives).

The SARI/EI program critically plays the important role of advancing regional energy integration and thus increasing CBET through focus on (i) Coordination of Policies and Regulatory Mechanisms, (ii) Advancement of Transmission Interconnections and (iii) Establishment of South Asian Electricity Market. To this end, IRADe has constituted three inter-governmental Task Forces and a Project Steering Committee with representations from SAARC country governments, where in-depth analysis/studies are being completed with specific recommendations on policies/regulatory mechanisms, technical grid standards and market rules for promoting electricity trade between South Asian countries. The findings and outcomes are used towards gaining consensus and support from the key decision-makers and stakeholders. In addition to three inter-governmental task forces, last year analytical studies were added and this year the Think Tank Forum (TTF) was formed to engage with civil society institutions. The South Asia Regional Power Exchange (SARPEX) capacity building program for grid operation was also floated. Overall the SARI/EI approach framework is as follows:

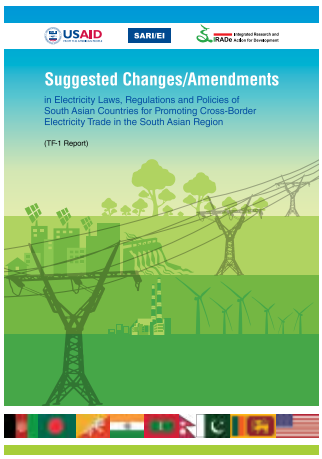


Various activities which were carried out are briefed as follows:

1.1.1 SARI/EI Task Force Activities

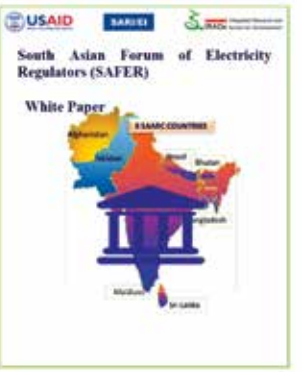
A. Task Force-1 Report on "Suggested changes/amendments clause/section wise in the existing electricity laws, regulation and policies of SA countries for promoting CBET in the South Asia Region"

IRADe had earlier published the Task Force-1 Report on "Regional Regulatory Guidelines (RRGs) to facilitate CBET in South Asia". To take forward the implementation of RRGs and for the coordination/harmonisation of electricity laws, regulation and policies of South Asian (SA) countries for promoting CBET, the Task Force-1 has come out with its 2nd report on "Suggested changes/amendments clause/section wise in the existing electricity laws, regulation and policies of SA countries for promoting CBET in South Asia Region". This report breaks new ground by suggesting changes/amendments in electricity laws, policies and regulation on the various aspects challenging cross-border trade by addressing issues such as trading licenses, non-discriminatory open access, transmission pricing, transmission planning, settling the imbalance by energy accounting and scheduling, harmonising of codes in the existing electricity laws, policies and regulation. The report has also come out with country wise proposed short, medium and long-term roadmaps for implementation.



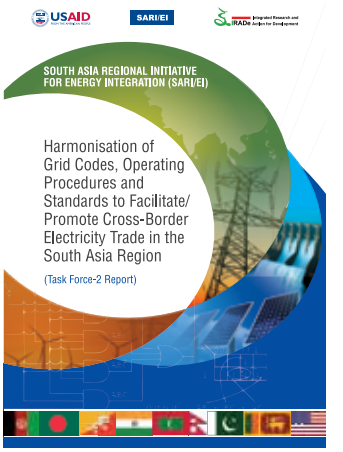
B. White Paper on South Asian Forum of Electricity Regulators (SAFER)

To address various policy, regulatory and legal issues with respect to CBET, under Task Force 1, SARI/EI has commissioned a demand driven study on "Review of Electricity Laws, Regulations, Policies and Legal Structure of South Asia countries (SACs) to identify areas that can hinder CBET and to recommend changes/amendments therein to promote CBET. The study has recommended a regional regulatory institutional mechanism i.e., the formation of South Asian Forum of Electricity Regulators (SAFER) to manage the process of harmonisation of regulations in close coordination with various regional bodies such as the SAARC Secretariat, technical committees, forums and other relevant SAARC entities. The proposed SAFER will be a neutral body and will be critical for the success of CBET and harmonisation/coordination of regulatory frameworks among SACs. A detailed White Paper on SAFER covering its role and responsibilities, functions etc. has been finalised after consultation with various stakeholders in each South Asian country. The study has also recommended that such a forum be initiated under the aegis of an existing regional forum /authority that has been working on a similar agenda in the South Asia region.



C. Task Force-2 Report on "Harmonisation of grid codes, operating procedures and standards to facilitate/promote cross-border electricity trade in the South Asia region: Framework grid code guidelines"

The SACs envisage a manifold increase in the quantum of CBET by the end of the next decade with several new transmission interconnections being proposed across SACs, which will enable greater integration of power systems. For the smooth, optimal, secure and reliable power system operation of CBET across the SA nations, the Study on harmonisation of grid code covering - power system operating procedures, protection code,



metering code, connection code, planning code, system security, scheduling and dispatch, frameworks, open access was undertaken. The Task Force-2 report on "Harmonisation of grid codes, operating procedures and standards to facilitate/promote CBET in the south Asia region has been finalised in three volumes. The Framework Grid Code Guidelines (FGCG) provides basic design criteria and operational rules and responsibilities to be followed by the generating stations, transmission utilities, distribution utilities, and traders. The study has recommended the creation of a Regional Technical Institution/Body such as the South Asia forum of transmission system utilities of SACs or South Asian Forum of Transmission Utility (SAFTU), which shall be mandated for coordinated, reliable and secure operation of the interconnected transmission network as well as for coordinated system planning and integrated system/ network development and grid code harmonisation.

D. Task Force-3 Study on assessment of commercial terms and conditions for CBET and suggested model of power exchange in South Asian region

The Task Force-3 Study on assessment of commercial terms and conditions for CBET and suggested model of power exchange in South Asian region has been completed and has recommended commercial terms and conditions, principles and procedures for the short term, medium-term and long-term CBET in the South Asian Regional Electricity Market. This report has come out with Model PPAs and TSAs, South Asia power Pricing Mechanism & Recommendations for CBET and will be released soon.

1.1.2 Ongoing Studies under South Asia Regional Initiative for Energy Integration (SARI/EI) program

- **Regional investment policy guidelines and regional investment framework for promoting investment in South Asian power sector and CBET:** The draft report of the study has been completed and stakeholder's consultation are being undertaken from different south Asian countries to get their views on the key findings of the study
- **Assessment of the Electricity Trading Potential of South Asian Countries:** The study on the assessment of trading potential covers the existing long term demand-supply projection scenarios of the participating countries and the expected developments in the next 20 years by the year 2034 by taking into account the CBET potential as a means to meet the additional demand for power by each country and/or by exporting surplus power through CBET to other South Asian Nations. The additional scope of study on the economic benefits and CO2 emission reduction of electricity trading among SACs is under progress.
- **BIMSTEC Energy Outlook:** The study is to prepare the BIMSTEC energy sector outlook covering seven countries that are part of BIMSTEC. The study will analyse mapping the past, present and future trends in the energy value chain including the generation and transmission sector. The study will also review and analyse the reforms in the energy sector in each of these countries.

1.1.3 Mock exercise of South Asian Regional Power Exchange (SARPEX) Project

Currently in the SA regional power market, there is long and medium term power trading 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, SAR/EI, IRADe has developed a Roadmap of South Asian Regional Power Exchange (SARPEX). Starting with an internally developed concept of SARPEX, the ultimate path to the establishment of SARPEX is dwelt upon. At present, Bangladesh, Bhutan, Nepal and India can participate in the exchange as they are grid connected. The market operates as a Day Ahead Spot Market.

One of the key feature of the concept is the two modes of operations of the exchange. In unified mode, the bids of the neighbouring countries are cleared along with the Indian bids. In the sequential or the residual mode, the bids of the neighbouring countries are cleared along with the Indian bids which are not cleared in the domestic exchanges. A mock exercise for SARPEX is currently being conducted. The results of the mock exercise shall be analysed in order to recommend a suitable mode of operation for SARPEX.

Stakeholder consultations workshops and meetings have been held in Bangladesh, Nepal and Bhutan. In

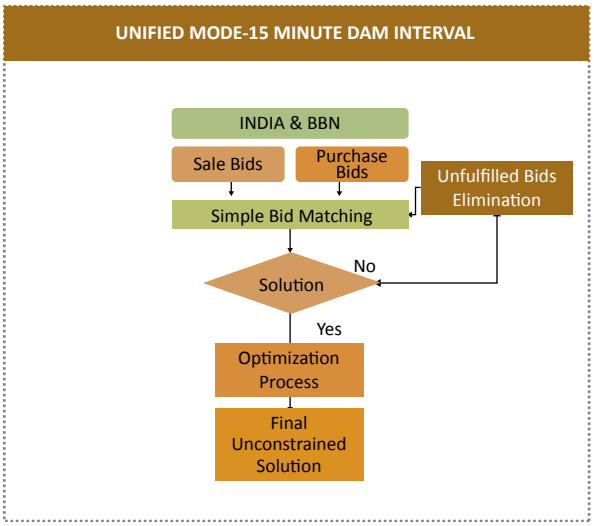


Figure: Unified mode of operation

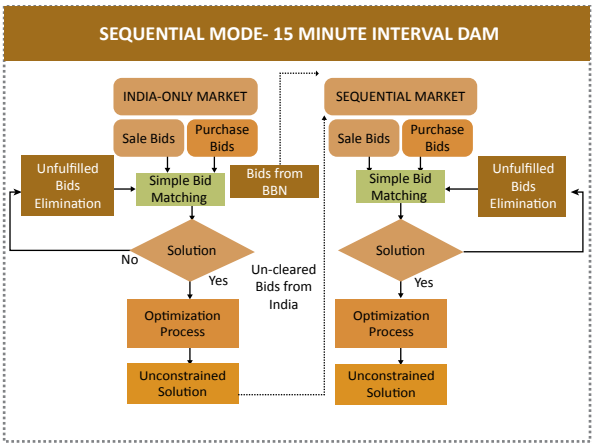


Figure: Sequential mode of operation

India also meetings were held with Central Electricity Authority (CEA), Central Electricity Regulatory Commission (CERC) and Power System Operation Corporation Limited (POSOCO) for the same. After the completion of the mock exercise, the benefits of such an exchange for each of the participating nation shall be quantified. Additionally, a draft market rule and design for SARPEX will be available for further developing the market rules and design for an actual SARPEX. The results of the mock exercise shall be disseminated among all stakeholders. It is felt that these activities will culminate in the establishment of an actual Regional Power Exchange in the South Asian Region.

Core teams from Bangladesh, Bhutan and Nepal governments have been nominated for participating in all

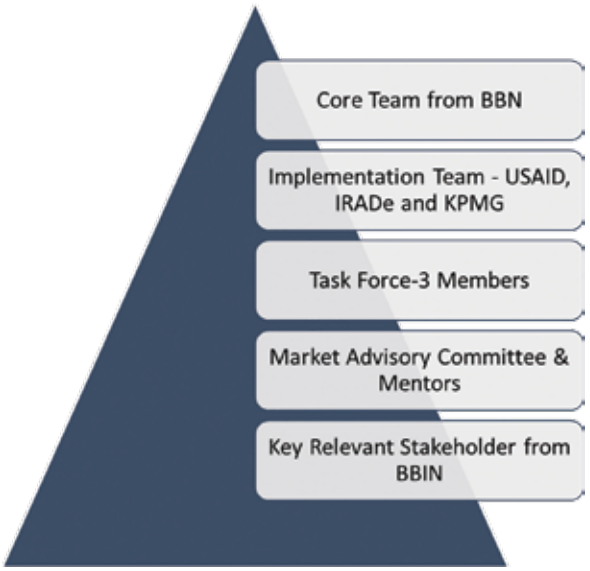
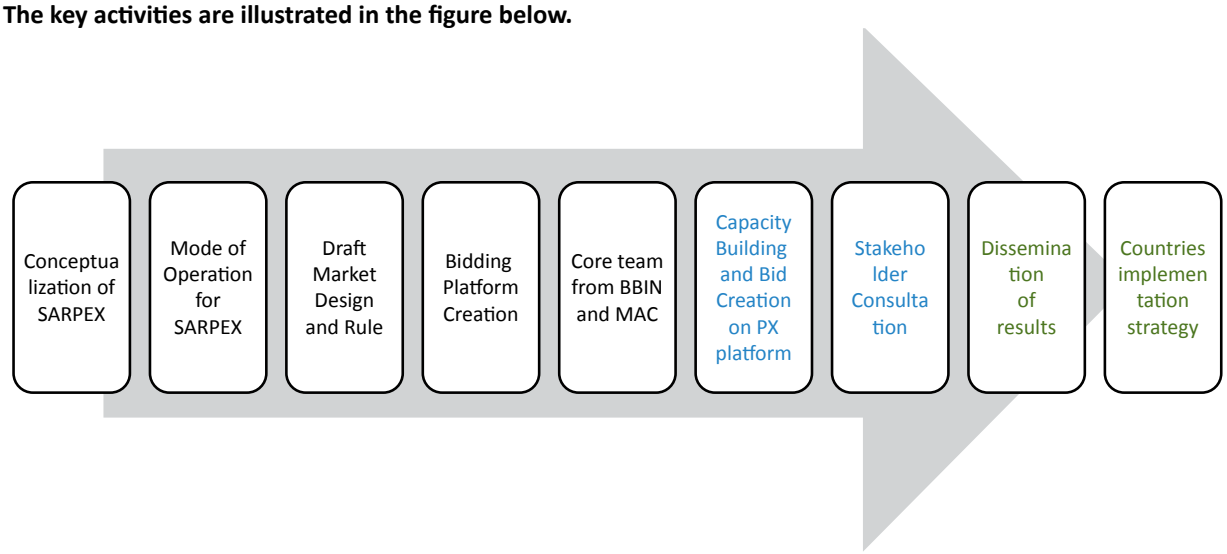


Figure: SARPEX Team for execution of exercise

The key activities are illustrated in the figure below.



the activities. A Market Advisory Committee (MAC) has been formed. Members of MAC are prominent persons from the power sector in India, Norway, Denmark and South Africa. MAC is providing guidance in all the activities in the key activities including the mock exercise.

SARI/EI, Task Force 3 works for the establishment of South Asian Regional Electricity Markets. All these activities are being conducted under the guidance of the TF-3, which will finally give recommendations on all regional market related activities including SARPEX.

1.1.4 SARI/EI Think Tank Forum for South Asia Regional Energy Co-operation

The SARI/EI Think Tank Forum, which is a network of leading Think Tanks in India, Pakistan, Sri Lanka, Butan, Bangladesh and Nepal, has been created for initiating a discourse on the role of CBET in addressing energy demands for economic development among the civil society community. The local Think Tanks are an important channel for positioning CBET in the national priorities of respective countries. They will play a key role in engaging politicians, government institutions, media and civil society, to engrave CBET's role in the realm of energy security and clean energy agendas of these nations.

SARI/EI as a part of its outreach and stakeholder engagement strategy commissioned short-term assignments with four Think Tanks in Bangladesh, India, Nepal and Sri Lanka for activities related to research/ impact studies, stakeholder engagement and media engagement which areas follows:

- Slycan Trust, Sri Lanka for Implementation of NDCs for Renewable Energy in Sri Lanka: Addressing Gaps in Policies & Regulation.
- Independent University, Bangladesh for Research/ Impact Research on CBET and National Events (meetings/workshop) for encouraging CBET.
- Institute for Integrated Development Studies (IIDS), Nepal for Media Engagement for Creating Awareness on Benefits of CBET between Nepal and India.
- CUTS International, India for Assessment of Impact of CBET on Livelihoods and Gender Concerns: Case Study Approach.

1.1.5 Analytical Studies

Under the USAID's SARI/EI program IRADe is undertaking comprehensive analytical macroeconomic studies to critically assess the need for CBET between countries such as Bangladesh, Bhutan, India and Nepal. However, before undertaking CBET a few points need to be considered, such as:

- Why do we need to trade? Are there economic benefits of electricity trade (adequate energy supply to achieve higher economic growth target, less investment on a country energy infrastructure)?

TTF Members

Nepal	Bangladesh	Sri Lanka	Bhutan	India
▪ Institute for Social and Environmental Transition Nepal (ISET) ▪ Institute for Integrated Development Studies (IIDS) ▪ International Center for Integrated Mountain Development (ICIMOD) ▪ Samriddhi Foundation ▪ Niti Foundation	▪ Bangladesh Centre for Advanced Studies (BCAS) ▪ Bangladesh Institute of Developmental Studies (BIDS) ▪ Bangladesh Enterprise Institute (BEI) ▪ International Centre for Climate Change and Development (ICCCAD)	▪ SLYCAN Trust ▪ University of Paradeniya ▪ Climate and Development Research, Munasinghe Institute for Development (MIND)	▪ QED Group ▪ Royal Society for Protection of Nature (RSPN)	▪ Consumer Unity & Trust Society (CUTS) ▪ Centre for Study of Science, Technology & Policy (CSTEP) ▪ Observer Research Foundation (ORF)

- What would be the quantity of hourly tradable electricity and a price agreeable to both buyer and seller?

The study helps to answer the above questions through quantification of the technical, economic, environmental and energy market benefits from cross border interconnections in the region. It is undertaken in phases with the first phase focusing on India- Nepal, which has been completed in the current fiscal year. India- Bangladesh is being considered in the second phase and is an ongoing study.

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. Whereas, taking them as inputs, macro-economic models in the second step quantify the macro-economic benefits accrued to both the countries. An overview of the methodology adopted for the analytical study is provided below.

Four sub models have been 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 and electricity demand, surplus for trade etc.

As part of consensus building activities carried out under this study, different stakeholders from the power sector, financial and diplomatic communities and other energy experts were brought together. 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 this region's economic growth.

A. Analytical Studies: Macroeconomic and analytical study focusing on benefits of electricity trade between Nepal-India

The study has been completed and a report titled Economic Benefits from Nepal-India Electricity Trade was released in Kathmandu, Nepal on January 19, 2017. The study used three scenarios for analysis. The BASE scenario assumes no increased interconnections across countries beyond what are currently in place (as in 2011–12). The Accelerated Power Trade (APT) scenario allows full potential of electricity trade. Third scenario was a Delayed Capacity Addition (DCA) scenario on delay in hydropower project implementation by five years in Nepal. The delay in projects may not only postpone the earning from exports, but may even increase the imports until the projects are implemented. Key results from the study are highlighted below:

Gains to Nepal

- GDP reaches a level of NPR 13,100 billion at 2007–08 prices in 2045 with APT, which is 39 percent higher than in the BASE

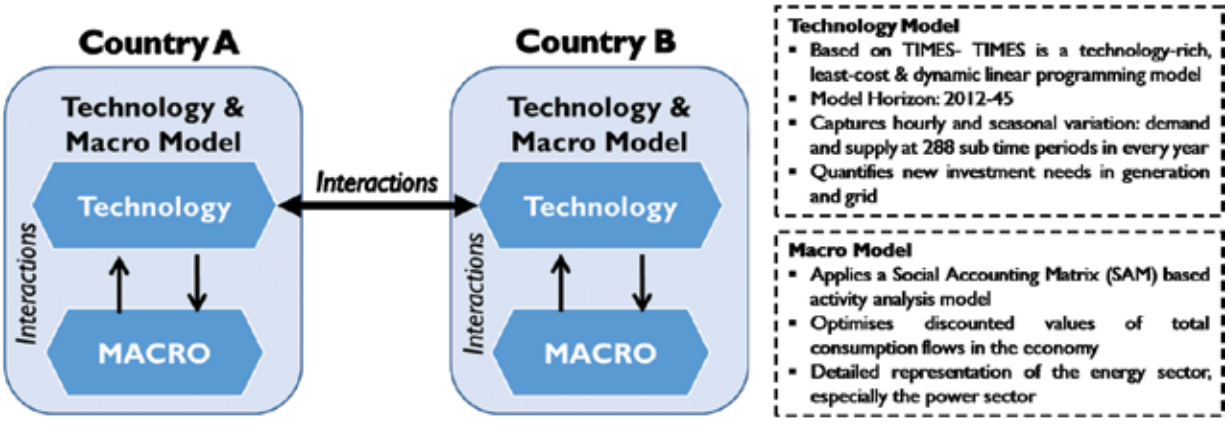


Figure: Approach and Methodology for Analytical Study

- APT leads to significant growth of household consumption, which increases by 23 percent over the BASE. Per capita consumption in 2045 reaches a level of NPR 2,84,000 at constant 2007–08 prices, as against just NPR 27,000 in 2012
- Per capita electricity consumption increases by 50 percent in APT (1500 kWh per capita) by 2045 compared to BASE (1010 kWh per capita)
- Nepal's power generation capacity increases to 34.4 GW in 2045 with APT compared to only 8.9 GW in BASE
- Net export revenues from electricity exports are 1,069 billion NPR in APT and 998 billion NPR in DCA scenario in 2045 (at 2011–12 prices).

Gains to India

- Trade reduces coal and gas-based generation and hence reduces the use of coal and gas in power generation resulting in a decrease in the production and import of these fuels.
- Reduction in fossil fuel use results in lower cumulated CO2 emissions from Indian power generation.
- Trade causes marginal increase in per capita consumption and decline in GDP, as investment and production decline due to imports.

B. Macroeconomic and analytic study focusing on benefits of electricity trade between Bangladesh -India

The second phase of the SARI Analytical Study focuses on India- Bangladesh in the current fiscal year. Given the scarcity and complexity around domestic resources for power generation, Bangladesh faces serious problem of meeting its burgeoning electricity demand to fuel its much needed economic growth. Already a small quantity of import (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. The analytical study applying mathematical

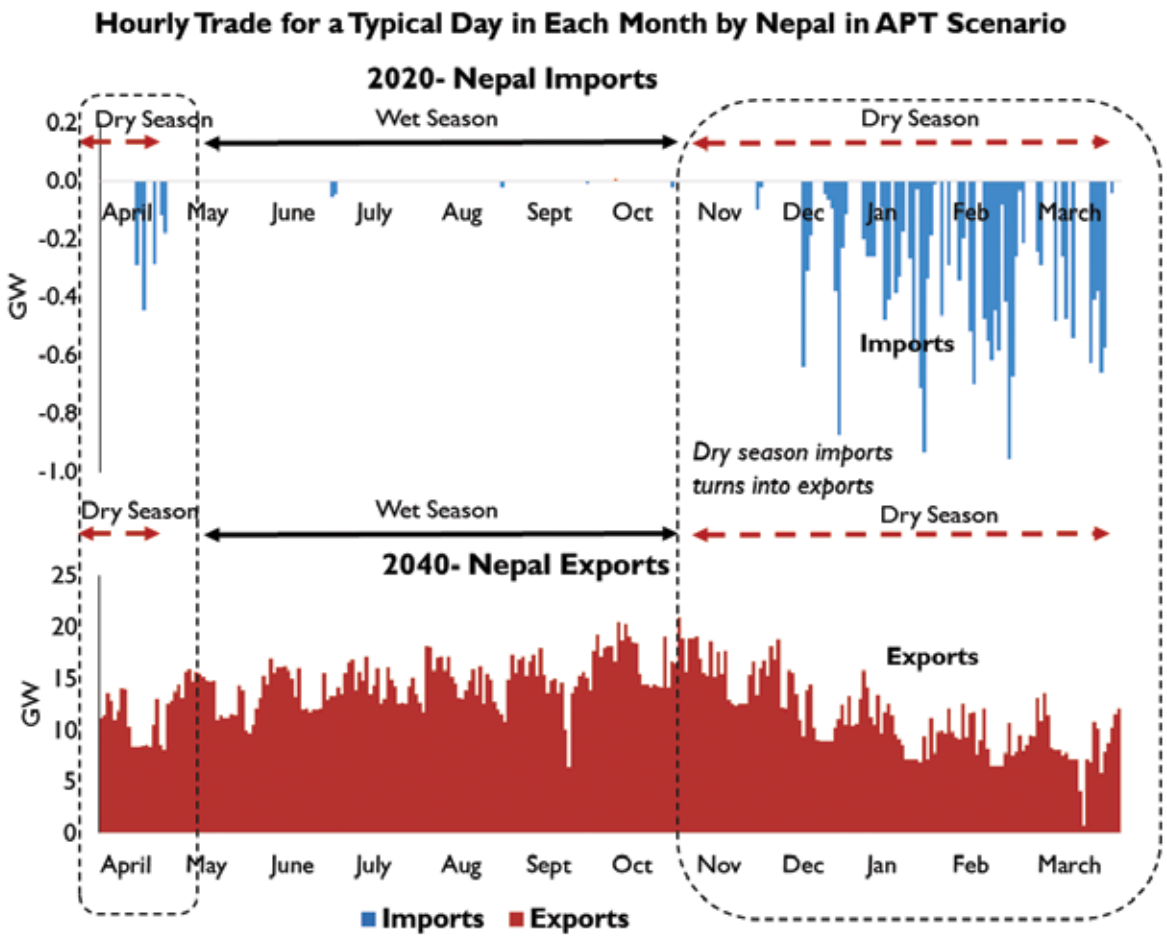


Figure: Hourly Trade for a Typical Day in Each Month by Nepal in APT Scenario

models, explores 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 is to produce the information needed for socio-political dialogues and negotiation across and within countries to promote and enhance CBET.

The present activities of the India- Bangladesh study include data collection, model development, model validation, scenario development and analyses. Work is carried out in close association with Bangladesh stakeholders. A stakeholder's consultation workshop involving policy makers, development institutions, and research organisations has been conducted where initial findings have been presented to get their feedback. That feedback has been incorporated and the remaining work is being carried out.

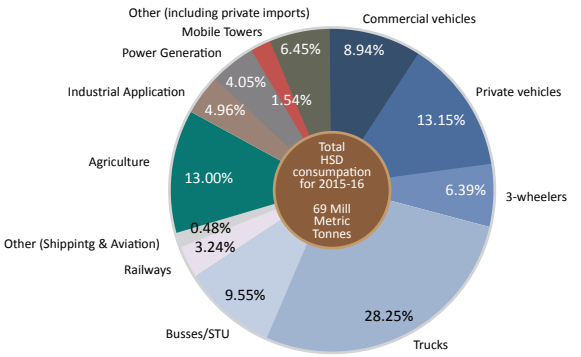
1.2 Converging the Divergence between Diesel and Petrol Pricing

The key objective of this study is to analyse the impacts on various stakeholders, if the price distortions between diesel and petrol were to be eliminated through revenue neutral policy level interventions.

In India, diesel accounted for the largest share (40%) in petroleum product consumption for the year 2015-16 while petrol accounted for 12 percent being the second largest. It is expected that the share of diesel consumption is going to rise to approximately 45 percent and that of petrol marginally to 13 percent.

In this study, our objective was to assess the impact on state finances, transport sector (70% share in consumption) and agriculture (13% share in consumption). Further, we have compared the price differentials existing in other developed and developing nations to provide recommendations for the 'National Petroleum Pricing Policy'.

Diagram below presents the all India sectoral end use analysis of diesel consumption for 2015-16:



Source: 2015-16 data from PPAC (Ready Reckoner - November, 2016)

Three scenarios of petrol and diesel price change that can occur due to price changes in crude oil are considered, viz, 10 percent, 20 percent and 30 percent increase in crude prices. Following were the key results:

1. Diesel Petrol Price Differential – Evolution & Analysis

Analysis of the diesel and petrol price build up reflected key issues, viz, taxes account for 52 percent of the total Retail Selling Price (RSP) in the case of petrol and 46 percent in the case of diesel. Excise duty and VAT contribute majorly (85%) to the price differences at the retail level, excise duty is the common cause of price difference across all the states while inconsistent VAT rates cause significant price differences across states.

2. Impact on State Finances

Taxes on petro products provide a major source of revenue for the states and Centre in India. This analysis is focused on excise duty, as VAT is a state subject.

- The corresponding drop in demand for diesel and petrol resulted in total excise revenue loss at four percent, eight percent and 11 eleven percent.
- Maintaining the revenue neutrality principle, the price difference between petrol and diesel at the given state VAT/Sales Tax rate, is minimised.
- Decline in excise revenue from petrol is compensated by an increase in excise revenue from diesel.
- Net increase in VAT/Sales Tax revenue at a pan India level for all the states together.

These price scenarios have been considered for conducting a further impact analysis of various stakeholders, to ensure a consistent approach.

3. Impact on Diesel Car Manufacturers

The trend of vehicular growth in India would impact the consumption of petrol and diesel. Earlier, petrol cars were preferred however today diesel cars are getting preference over petrol cars due to price differential between diesel and petrol. The preference of diesel cars would decrease when the gap between petrol and diesel price closes. Our analysis compares the discounted cost of buying and using a diesel car and a petrol car of same model. The costs are computed using data on initial costs of buying, annual fuel costs and salvage value of the cars. We use two different discount rates, three different annual kilometre use rates, three different values for life of a car and two sets of prices before and after excise duty equalisation. Our analysis indicates that the rationalisation of excise duty will not change the economics from the consumer's perspective in the selection of a diesel or petrol car. The current pricing of car manufacturers, particularly sedans and SUVs, already make the diesel models an economically unattractive choice. In the case of hatchback car, the sales of diesel vehicles would be only marginally affected by a rationalisation of excise duty. However even if diesel car sales reduce petrol car sales would increase and on the whole sales of cars would not reduce. The cost of controlling effectively carcinogenic emissions from diesel cars will make them even more expensive. Diesel car emissions are estimated to cause thousands of additional deaths. Thus diesel price rationalisation should not have much impact on the car demand.

4. Impact on State Transport Undertakings (SRTU) and Bus Travellers

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

Analysis 1 - Impact of deregulation of the diesel price: Overall revenues of SRTUs went up by 35 percent from 2011-12 to 2013-14 and the profitability was down by 48 percent, mainly due to the fact that the SRTUs were able to compensate for the increase in diesel price through the incremental revenue and reduction in operating costs, while some could not due to operational issues.

Analysis 2 - Comparative analysis of SRTU profitability at the base price level and revenue neutral scenario price: Six years' data for 49 SRTUs in the bus sector, covering the whole country was considered and both financial and physical parameters were calculated based on the SRTU financial performance reports. Based on these calculated parameters, a counter factual scenario for the year 2015-16 was created and this projected the revenue, costs and profitability for the year 2015-16.

The state level impact reflected a two percent incremental fuel cost, while a reduction in profitability was reflected in the range of one percent to 12 percent across states.

5. Impact on Farmers

The impact on farmers is a critical part of this study as the share of agriculture in diesel consumption at the pan India level is 13 percent (PPAC). In order to assess the diesel price impact in the key states, the impact on diesel cost for agriculture was calculated using constant quantity of diesel consumed for 2015-16, End Use Percentage Share in Agriculture (agriculture pump sets, agriculture implements and tractors) as per the PPAC Nielsen Report 2013 and base price and revenue neutral scenario price. Overall and state level impact reflected a two percent incremental cost.

6. Impact on Truckers

Road transport is an important sector of the Indian economy, contributing about 5% to the annual GDP. Trucking industry forms the backbone of this sector, accounting for 28 % of total diesel consumption by the sector. Specifically fuel costs constitute 55% of an average trucks total trip expenses when considered without overheads and about 50% when considered with overheads. With an increase in price of diesel of 2% when excise duties are rationalised, the impact on freight rate will be just 1%. This 1% increase in the freight rate is negligible compared to the many sources of inefficiencies in the trucking operations with much larger impact. Thus, this small increase should not raise much of opposition from the truckers particularly if other measures are taken to reduce trucking costs.

1.3 Advanced Coal Technologies (ACT) for Power Generation

IRADe is a member of the Global Technology Watch Group, a consortia comprising of IRADe and three IITs (Madras, Bombay and Delhi) for the continuous monitoring of the status of coal technology in India and abroad, its evaluation for use in India, and to facilitate the development of a road map for Advanced Coal Technologies for Sustainable Power Generation.

The group has had a series of meetings and has finalised some technology aspects for the country. The main purpose of the meeting was to arrive at a consensus on the evaluation of technologies and arriving at a draft coal road map and technology road map for coal utilisation in India. IIT-M reported on the recent estimates of reductions in CO2 emission intensity (in terms of g/kWh of energy produced from a coal power plant) possible through improvement in steam parameters in pulverised coal boilers, gas turbine inlet temperatures in IGCC and through oxy-fuel combustion based carbon capture and storage (CCS) in PC boilers and IGCC. Based on these calculations, IIT-M have suggested that one could analyse these with respect to sustainability including:

(a) Achievable measures on PC boilers (current power generation technology) providing up to 10 percent reduction in CO2 emission intensity without requiring CCS.

(b) Upto 25 percent reduction in CO2 emission intensity through IGCC, which is yet to be done on a large scale in India, again without requiring CCS.

(c) Upto 80 percent reduction in CO2 emission intensity possible with CCS coupled to PC boiler/IGCC based power generation.

IIT-B has suggested some environmental control technologies for the power plants that would be required to meet norms for CCS (SOx, NOx, PM, Hg, Fly ash control) though desulphurisation, selective catalytic and non-catalytic reduction, ESP and bag filters, activated carbon, etc.

Under the project,IRADe has undertaken 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 & other emissions, socio-economic and water food print evaluation and in meeting India's INDCs.

IRADe analysed sub-critical, super critical and ultra-super critical technologies with eight different technology scenarios ranging from the addition of environmental control technologies like electro static precipitator (ESP), Fluidized Gas Desulphurisation (FGD), Selective Catalytic Reduction (SCR) and super critical power generation technologies with CCS technologies.

While in the 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 has made broad recommendations, which have been shared with the GTWG group for the finalisation of the country's road map.

2 Climate Change & Environment

2.1 SAMANVAY: Synthesis of Traditional and Modern India's Approach to Sustainable Low-Carbon Development Pathways

Unsustainable consumption leads to pressure on natural resources and long-term impacts on the environment. While a section of the globe and society suffers from lack of basic necessities, the high consuming and unsustainable lifestyles of another section places immense stress on the environment. This imbalance in global consumption patterns is reflected in a situation where the richer sections over exploit the available resources, and the poorer segments are unable to even meet their food, health, housing and education needs.

During COP21 at Paris, the Honourable Prime Minister Shri Narendra Modi released the 'Parampara' catalogue showcasing India's traditional climate friendly practices. This project is a step in the direction of providing a glimpse of the consumption patterns, carbon emissions, efforts to balance rich heritage and modernity, roots of India's frugal lifestyle and future challenges. It focuses upon the possibilities of leapfrogging through which we can achieve the same level of development, prosperity and wellbeing without necessarily going down the path of reckless consumption. It does not mean that economies will suffer; it means that our economies will take on a different character.

In India, traditional practices that are sustainable and environment friendly continue to be a part of people's lives. India has a history of low carbon footprint and lifestyle. These need to be encouraged, rather than replaced by more modern but unsustainable practices and technologies. Changing our lifestyle and creating consciousness can help us deal with climate change and create a more balanced world.

2.2 Inter-model comparisons of different transportation sector policies in India

This project was supported by Shakti Foundation. 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) and involves building 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. This 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. Understanding the linkages between air quality and transportation and modelling would be helpful in designing policies to mitigate the health 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. Recognising 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.

The project involves building a set of technology and policy options to reduce energy consumption and emissions and 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 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 policy scenario or a combination of multiple policy scenarios.

The work on this project is in progress. IRADe has contributed to a joint paper by the four teams on transport sector modelling.

3 Sustainable Urban Development

3.1 Preparation of Solar City Master Plan for Ajmer

Ajmer is a city in Rajasthan rich in heritage and a favourable destination for tourists from around the world. Ajmer has qualified as a Smart City along with funding from MoUD's AMRUT and HRIDAY schemes. IRADe is preparing the Ajmer Solar City Master plan for the Ajmer Municipal Corporation, Rajasthan under the Solar City Programme of MNRE and MoUD's Smart City programme.

The Solar City Program aims at a minimum 10 percent reduction in projected demand for conventional energy at the end of five years for the city, which can be achieved through a combination of Demand Side Management (DSM) energy efficiency measures and enhancing the supply from renewable energy sources. The city's Solar City Master Plan includes the base line energy consumption, demand forecasting for the next five years, sector-wise (residential, commercial, institutional, industry) strategies and action plan for implementation of renewable energy projects like solar, wind, biomass, small hydro, waste to energy etc. that may be installed along with possible energy efficiency measures [LED (Light-emitting diode) bulbs, Star rated appliances, etc.] depending on the need and resource availability in the city, so as to mitigate the fossil fuel consumption and reduce the GHG emissions. The city has formed the Special Purpose Vehicle (SPV) for implementation of smart city projects and also replaced all the streetlights with energy efficient LED lights. Three field visits have been made to the city to meet the various stakeholders (Corporation, electricity, supply, statistics, development) and energy data collection from relevant departments has been completed. Data analysis is in progress and the report is likely to be submitted in March 2017.

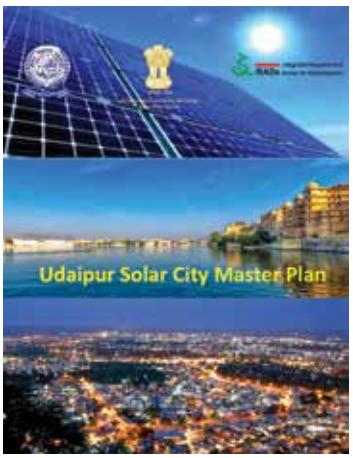
Ajmer Municipal Corporation Heritage Building

Solar Power Plant at AMC Office

3.2 Preparation of Solar City Master Plan for Udaipur

Udaipur the city of lakes and palaces is an important tourist destination in Rajasthan;it is surrounded by the Aravalli hills and dotted with lakes. IRADe has submitted the draft Udaipur Solar City Master Plan to Udaipur Municipal Corporation under the MNRE's Solar City Programme. IRADe submitted the Draft Report after undertaking extensive field surveys and meetings

with various stakeholders. Discussing the report requirements with Commissioner UMC and Additional Commissioner SPV (Special Purpose Vehicle) Solar City and city engineers. The energy requirements for the city were projected by IRADe for the next five and ten years and was able to reduce the energy requirements by five percent through energy efficiency, recommending EE (Energy Efficient) devices and it also recommended five percent renewable energy interventions through RE (Renewable Energy) devices. IRADe also recommended a few pilot projects that could be implemented in the city like the 8.5 MW Solar power plant at Tiger Hills, one MW WtE plant for MSW. The city has already formed its City Solar Cell that would oversee implementation of projects along with the SPV for the implementation of smart city projects. The next step is a stakeholder consultation meeting to discuss the draft report of the Solar City Master Plan. The final report will be submitted after receiving comments from the stakeholder consultation on the Draft Report.



Tiger Hill site for solar power plant

Fateh Sagar Lake, Udaipur

3.3 Development of Urban Climate Vulnerability Index

IRADe will develop an urban vulnerability index for five Indian cities, which will be selected based on the population, city location and ecosystem type (coastal region, hilly region & arid regions). The Urban Vulnerability Index may serve as a decision support system to the Government of India for devising adaptation and mitigation strategies for the urban sector in India. The objectives of the research study are: to design a framework for assessment of the cities' urban climate vulnerability and to prepare climate vulnerability profiles of the selected cities using identified indicators and bring forth the areas of adaptation which cities should prioritise for improving its resilience and integrate it in to their developmental initiatives.

The extent of climate vulnerability for the cities will be measured based on five principles viz., risks due to climate change, infrastructure status, governance, socio-economic condition and adaptive capacity. A replicable methodology for assessing urban vulnerability/climate resilience of the cities will be the major outcome of the project.

4 Poverty Alleviation & 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, which 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 (see Table below) 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 was also completed.

Gender impact and energy interventions

Gender goal	Types of needs/issues addressed	Possible energy intervention
Welfare Reduce drudgery associated with collection and use of biomass fuel Reduce health problems associated with biomass fuel	Practical need Health Quality of life	Improve access and affordability of clean cooking alternatives—possible link to energy subsidies Reduce time taken to collect fuel Reduce load to be carried
Productivity Free up women's time for income-generating activities Improve women's economic output and thereby incomes	Productive need Economic power	Free up women's time by improving access and affordability of energy related to time-intensive, non-economic and menial activities-possible link to energy subsidies Improve access and affordability of energy related to women's employment needs—possible link to energy subsidies
Empowerment Promote women having an equal voice in decision-making Promote women's ownership and/or control of assets Safeguard women from violence and harassment	Representation need Equality in governance Ownership	Introduce minimum requirements for female members of decision making bodies Provide capital or transfers related to energy use—possible link to energy subsidies Improve street lighting

Training for surveyors being conducted in Ranchi

4.2 Electricity as a clean cooking option for rapidscale cooking

The National Bank for Agriculture and Rural Development (NABARD) has given IRADe the work to explore the possibilities of using electricity for cooking as a way of providing access to clean cooking options in rural areas. Under this project IRADe would carry out studies in the States of Rajasthan and Chhattisgarh using field level surveys and technology demonstrations and monitoring of the households, which would be provided with electric induction cookers. The study will help to understand consumer/stakeholder behaviour towards the new technology/device, cooking habits and reasons for its adoption or otherwise. The project will involve a multi stakeholder approach to address all the issues and will work with the Ministries of Petroleum, Renewable Energy and the Electricity Departments. The project will help in meeting the UN's SDGs (Sustainable Development Goals) of access to clean energy and gender issues and suggest suitable policy recommendations so that the goals are achieved effectively.

5 Agriculture & Food Security

5.1 Assessment of food security and livelihoods due to climate change 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 in 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 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.

The project is supported by the Ministry of Environment, Forest and Climate Change (MoEFCC) of Government of India.

5.2 Analysis of Energy, Food & Water Nexus in a Macroeconomic Consistency Framework

Water demand from the power sector has been increasing owing to the increase in 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 accompanied by an expansion of the agricultural sector, industrial sector and urbanisation led water demand from the affluent households. 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. This project aims to see if India's stated climate goals in the power sector and its growth ambitions are impacted by the competing demands for water from all the sectors. The IRADe-IAM model developed under several projects for Government of India has been used to analyse the water use based trade-off between agriculture and energy in the long-term perspective up to 2050.

This project was supported by NITI Aayog.

Objectives of the research study

1) Projection of water demand scenario for the Power Sector up to 2050 under existing and optimised water use policies.

2) Projection of water demand scenario for agriculture and other sectors up to 2050 under existing and optimised water use policies.
3) Impact of the decrease in the water availability on energy food nexus.

Scope of the research study

1) To comprehensively assess the nexus between energy, food and water and provide policy based suggestions on the most optimal strategy for energy sector growth and water conservation and water use efficiency.
2) To project the changing water requirements in to the future up to 2050 accounting for changing cropping patterns due to changing food consumption patterns and urbanisation.
3) To incorporate the impact of climate change on water availability and hence increasing reliance on ground water irrigation.
4) To assess the water requirement of the industry and power generation technology wise.
5) To assess the reduction in water use due to water conservation policies for the power generation sectors.

The IRADe team has projected water demand in the power sector and analysed the impact of low carbon policies and water conservation policies on water demand from the agriculture, industry, household and power sectors to assess the trade-off between food, and energy due to water and the impact that climate change has on this nexus due to a reduction in water availability.

6 Conferences, Workshops and Meetings

6.1 "National Conference on Post Paris Climate Action", held in New Delhi, India on July 12th, 2016

At COP 21 in Paris, Parties to the UNFCCC reached a historic agreement to combat climate change and to accelerate and intensify the actions and investments needed for a sustainable low carbon future. The Paris Agreement requires all Parties to put forward their best efforts through "Nationally Determined Contributions" (NDCs) and to strengthen these efforts in the years ahead. Against this backdrop the "National Conference on Post Paris Climate Action" was organized by IRADe on July 12th, 2016 at New Delhi, India. Shri Prakash Javadekar, Hon'ble Minister for Human Resource Development, Government of India inaugurated the event and Shri Suresh Prabhu, the then Hon'ble Minister for Railways, Government of India chaired the valedictory session. Senior Government officials from Ministry of Power, Ministry of Environment, Forest and Climate Change, Ministry of New and Renewable Energy, Department of Science and Technology and Ministry of Finance, CMD's and Senior officials of public and private sector organisations participated and shared their insights. The purpose of the conference

Glimpses from "National Conference on Post Paris Climate Action", held in New Delhi, India

Glimpses from "National Conference on Post Paris Climate Action", held in New Delhi, India

was to discuss how to implement the INDC's, what are the obstacles and its requirements, what are the challenges of technology and availability of finance. The representatives discussed how to meet the two promises given at Paris viz; reducing Green House Gases (GHG) intensities by 35% by 2030 from 2005 values and 40% share of non-fossil energy sources in power capacity. The focus was on power sector, transport sector, especially railways. In addition to the Inaugural Session there were also four technical sessions. GAIL, NABARD, IREDA, PFC, NTPC, REC, and PTC India Limited were the partners for the support, cooperation and sponsorship of the event.

6.2 Launch of Task Force-1 report on "Suggested Changes/Amendments in Electricity Laws, Regulations and Policies of South Asian Countries for promoting Cross-Border Electricity Trade in the South Asian Region" at Dhaka, Bangladesh on 21 April 2016

Mr. Nasrul Hamid, Hon'ble State Minister, Ministry of Power, Energy and Mineral Resources (MPEMR), Government of Bangladesh released an important SARI/EI report on suggested changes/amendments in electricity laws, regulations and policies of SACs for

Release of report on "Suggested Changes/ Amendments in Electricity Laws, Regulations and Policies of South Asian Countries for Promoting CBET in the South Asian Region " by Mr. Nasrul Hamid,MP, Hon'ble State Minister, MPEMR, Govt. of Bangladesh on 21 April, 2016 at Dhaka.

promoting CBET in the South Asian region. The report is a first of its kind for South Asia and breaks new ground by suggesting changes/amendments in electricity laws, policies and regulation on tricky aspects challenging cross-border trade by addressing issues such as trading licenses, non-discriminatory open access, transmission pricing, transmission planning, settling the imbalance by energy accounting and scheduling, harmonising of codes in the existing electricity laws, policies and regulation. These suggested changes/amendments can be considered by the government of each SAC as a base for aligning the legal, policy and regulatory frameworks in their respective countries. The report also has come out with country wise proposed short, medium and long-term roadmaps for implementation.

6.3 Workshop on "Power Markets Development in India: Key Lessons Learnt", held at Mukti Hall, Bidyut Babhan (Power Cell premises, Power Division), Dhaka, Bangladesh on 21st April 2016

On the request of the Power Division (under MPEMR), a workshop on "Power Markets Development in India: Key Lessons Learnt" was held at Mukti Hall, Bidyut Babhan (Power Cell premises, Power Division), Dhaka, Bangladesh on 21st April 2016. The workshop shared the lessons and learnings from the evolution of the Indian Power Sector covering key laws, policies and regulations, besides the role of transmission agencies and power exchanges in the development of the Indian Power Market. Mr. Nasrul Hamid, Member of Parliament and Hon'ble State Minister, MPEMR, Government of Bangladesh, the Chief Guest, in his inaugural speech acknowledged the timely relevance of the workshop given the country's interest in developing a local power market and the significant energy opportunity it sees in regional markets. To this end, he stressed on the need for capacity building of power sector professionals and pointed out that this critical gap was of high priority. He also used the forum to share some of the key investments planned for CBET, like the USD one billion that Bangladesh would be investing in Bhutan for power-infrastructure development, along with India. He shared that Bangladesh plans to increase the import of electricity from India to 2,000 MW in the

Mr. Nasrul Hamid, MP, Hon'ble State Minister, Govt. of Bangladesh, graces as the chief guest of SARI/EI Workshop on Power Market Development in India: Key Lessons Learnt, at Dhaka on 21st April 2016.

coming years. The workshop concluded with a high-level panel discussion that brought forward the views on power market development and the importance of policies and regulations and the government's role. The panel unanimously recommended the benefits of a competitive power market for Bangladesh, which would strengthen the power sector and its entities.

6.4 Combined meeting of SARI/EI Task Force-2 and Task Force-3, Hotel Pan Pacific Sonargaon, Dhaka, 20th April 2016.

The combined meeting of Task Force-2 and Task Force-3 was held on 20th April 2016 in Dhaka, Bangladesh. The meeting was inaugurated by Mr. Masum-Al-Beruni, Managing Director, Power Grid Company of Bangladesh (PGCB). The meeting had members of Task Forces 2 and 3 from Bangladesh,

Combined meeting of SARI/EI Task Force-2 and Task Force-3, 20th April 2016, Dhaka, Bangladesh

Bhutan, Nepal, India, Sri Lanka, SAARC Energy Centre, Islamabad along with the SARI/EI team members and consultants. The SARI/EI Project Secretariat presented the objective and the key deliverables of the proposed "Pilot Market - Mock Exercise for South Asian Regional Power Exchange (SARPEX) and formation of Market Advisory Committee". The SARI/EI Project Secretariat also presented the terms of reference for the proposed "Model framework guidelines for non-discriminatory open access regime in transmission and on trading license regime and guidelines for grant of trading license in South Asian Countries (except India)" for deliberation by the members. Members appreciated the efforts being made by SARI/EI to promote CBET.

6.5 Workshop on "Regional Power Trade with special focus on Nepal – India" held in Kathmandu, Nepal, on 28th April, 2016.

A Workshop on "Regional Power Trade with special focus on Nepal – India" was organised on 28th April, 2016 at Hotel Radisson, Kathmandu wherein results of the Nepal-India Modelling study were presented to the stakeholders. The workshop was marked bythe presence of eminent people from Nepal such as Mr. Suman Prasad Sharma, Secretary, Ministry of Energy, Government of Nepal; Prof. Dr. Govind Nepal, Former Member, National Planning Commission, Nepal; Mr. Shankar Khagi, Environment and Energy Specialist, USAID Nepal; Mr. Jeebache Mandal, Joint Secretary, Water and Energy Commission Secretariat, Ministry of Energy, Nepal; Mr. Sher Sigh Bhat, Deputy Managing Director, Nepal Electricity Authority; Dr. Biswo Poudel, Assistant Professor, Kathmandu University; Dr. Bishnu Dev Pant, Executive Director of IIDS, Nepal; Mr. Surendra Raj Bhandari, Deputy Managing Director, NEA, Nepal; and energy economist, Mr. Devendra Adhikari. Representatives from IBN, ADB and World Bank were also present at the workshop.

Group photograph: Workshop on "Regional Power Trade with special focus on Nepal-India

6.6 Focus Group Discussion on "India TIMES Electricity Model" with Central Electricity Authority (CEA), India held at CEA, New Delhi, on 1 July 2016

A focus group discussion on "India TIMES Electricity Model" was held on 1 July 2016 at Central Electricity Authority, New Delhi, India. The participants were members of CEA- Mr. S.D. Dubey (Chairman), Mr. H.R. Arora (Director), Mr. Vikram Singh (Director), Ms. Sharda Prasad (Director HPP&I), Mr. J.S. Bawa (C.E.), Mr. Pankaj Kumar Verma, Mr. Raj Singh Tomar, Mr. Pawan Gupta, Mr. Joydeb Bandyopadhyay, Mr. S. Mandilwar, Mr. Pradeep Jindal (C.E.), Mr. Pankaj Batra (C.E.) and Ms. Shivani Sharma (Deputy Director). From IRADe, Dr.Kirit Parikh (Chairman) also participated in the focus group discussion and briefed the CEA members about SARI/EI. Mr. Vinay Saini (IRADe), gave the presentation on India TIMES Model prepared for the SARI/EI Nepal

Focus Group Discussion on "India TIMES Electricity Model" with Central Electricity Authority, India

India Analytical Study. He shared the key assumptions and outputs of India TIMES model with the CEA representatives.

6.7 Stakeholder Consultation for White Paper on Regional Regulatory Institutional Mechanism with Bhutan Stakeholders, Ministry of Economic Affairs, Royal Government of Bhutan, 14th July, 2016.

A stakeholder consultation meeting on the White Paper "South Asia Forum of Electricity Regulators" was held on 14th July, 2016 with Bhutan stakeholders on structure, functions, roles and responsibilities of the forum. Senior officials from the Ministry of Economic Affairs, Royal Government of Bhutan, BPC, DGOC, and BEA attended the meeting. The consultants Ernst & Young made a presentation to the gathering on the key findings of the White Paper focusing on the structure, functions, roles and responsibilities of the Forum of Electricity Regulators to get their inputs and suggestions for charting a roadmap with a clear action plan for the formation of the Regional Electricity Regulatory Institutional Mechanism: South Asia Forum of Electricity Regulators (SAFER).

6.8 Stakeholder Consultation on White Paper on Regional Regulatory Institutional Mechanism for South Asia Forum of Regulators with Nepal Stakeholders, Ministry of Energy, Government of Nepal, 16th September, 2016.

A Stakeholder Consultation on the White Paper on the South Asia Forum of Electricity Regulators was held with Nepal stakeholders on 16th September, 2016. The workshop was attended by senior officials from MOE, Nepal, NEA, Tariff Fixation Commission, and USAID Nepal. The presentation on the "Key findings of the white paper on structure, functions, roles and responsibilities of South Asia Forum of Electricity Regulators" was made by consultants Ernst & Young to the gathering to get inputs and suggestion from stakeholders to chart a roadmap with a clear action plan for formation of the Regional Electricity Regulatory Institutional Mechanism: SAFER.

6.9 Launch Workshop of SARI/EI Think Tank Forum for South Asia Regional Cooperation, Hotel Shangri-La, Kathmandu, Nepal, 16th September 2016.

IRADe organised the meeting of the Think Tank Forum on 16th September at Kathmandu. The Think Tank Forum is a network of leading Think Tanks for initiating a discourse on the role of CBET in addressing energy demands for economic development in each participating SAC. The local Think Tanks are an important channel for positioning CBET in the national priorities of the respective countries. There was a diverse and dynamic group of participants from 13 Think Tanks and six SACs namely, Bangladesh, Bhutan, Pakistan, Sri Lanka, Nepal and India. Representatives provided insights, as well as, actionable and practical suggestions, which would be considered for further evolving the Think Tank Forum.

Launch workshop of SARI/EI Think Tank Forum for South Asian Regional Cooperation, 16th September, 2016 at Kathmandu, Nepal

6.10 SAFER Stakeholder Consultation Meeting-White Paper on Regional Regulatory Institutional mechanism, Dhaka, Bangladesh, 19th October, 2016

The SAFER Stakeholder Consultation Meeting on the White Paper on Regional Regulatory Institutional mechanism was organised in Dhaka, Bangladesh. During the meeting key findings from the White Paper on Regional Regulatory Institutional mechanism on SAFER were deliberated upon and discussed with Bangladesh Energy Regulatory Commission (BERC). Valuable inputs and suggestions were made by BERC to chart a roadmap with a clear action plan for formation of the Regional

SAFER Stakeholder Consultation Meeting, Bangladesh Energy Regulatory Commission, Dhaka, Bangladesh

Electricity Regulatory Institutional Mechanism. Senior officials from BERC attended the meeting.

6.11 Meeting with Honourable Secretary General of Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC), BIMSTEC SECRETARIAT, Dhaka, Bangladesh, 20th October, 2016.

A meeting was held with Honourable Secretary General of Bay of Bengal Initiative for Multi-Sectoral Technical and Economic Cooperation (BIMSTEC) on 20th October, 2016 at the BIMSTEC Secretariat, Dhaka, Bangladesh. Mr. V.K. Kharbanda made a brief presentation on the Overview of SARI/EI Program Progress, Key Achievements and Way Forward. Various SARI/EI Task Force studies being conducted under SARI/EI were highlighted and discussed. How these studies can be useful to BIMSTEC was also discussed. Mr. Rajiv Ratna Panda, suggested that BIMSTEC may consider publishing a biennial flagship publication titled "BIMSTEC Energy Outlook" which would not only improve the energy literacy among BIMSTEC member states but also bring cohesion and sustenance about the energy cooperation initiatives among BIMSTEC member states over a long period of time. The idea of publishing the "BIMSTEC Energy Outlook" was considered positively by the BIMSTEC Secretariat.

Meeting with Honorable Secretary General, BIMSTEC SECRETARIAT, Dhaka, Bangladesh

6.12 Round Table Stakeholder Consultation on Regional Investment Framework in South Asia, Dhaka, Bangladesh, 20th October 2016.

SARI/EI organised a Round Table Stakeholder Consultation on Regional Investment Framework and Policy Guidelines for promoting investment in the South Asian Power Sector on 20th October, 2016 in Dhaka, Bangladesh. The meeting stressed on the need for an appropriate investment and policy framework to promote regional investments for CBET. The meeting reflected on the key concerns of investors, lenders, multilateral development banks (MDBs), and project developers for promoting investment. The objective behind this was to develop the Regional Investment Framework and Policy Guidelines for promoting investment in the South Asian Power Sector and in CBET in the region. Policymakers, investors, bankers, private development, senior officials of the Energy and Power Ministries, senior officials of the Investment Board of Bangladesh, Public Private Partnership Authority and Bangladesh Investment Development Authority participated in the event.

Round Table Stakeholder Consultation meeting, Regional Investment Framework and Policy Guidelines for promoting investment in South Asian Power Sector and in Cross-Border Electricity Trade (CBET) in South Asia, on 20th October 2016, Dhaka, Bangladesh

6.13 SARI/EI Think Tank Forum India Workshop for South Asia Regional Co-operation

SARI/EI Think Tank Forum India Workshop for South Asia Regional Co-operation was organised on 27th October, 2016 at Hotel Le Meridian, New Delhi, India. Representatives of four leading Think Tanks -- Observer Research Foundation (ORF), CUTS International (Consumer Unity & Trust Society), Centre for Study of Science, Technology & Policy (CSTEP) and the National Council of Applied Economic Research (NCAER) attended the workshop. The participants deliberated on ideas for engagement to promote the issue of power trade through the lens of economic development, climate change and energy security.

SARI/EI Think Tank Forum Workshop for South Asia Regional Co-operation, New Delhi, India

6.14 5th Meeting of Project Steering Committee-Maitland State Room Mount Lavinia Hotel, Colombo, Sri Lanka, 9th and 10th November, 2016

The 5th meeting of the Project Steering Committee (PSC) was held on 9th and 10th November, 2016 at Mount Lavinia Hotel, Colombo, Sri Lanka. Members of the PSC from various SACs along with representatives from IRADe and USAID attended the meeting. Dr. B.M.S Batagoda, Secretary, Ministry of Power and Renewable Energy, Government of Sri Lanka delivered the keynote address. Mr. V.K. Kharbanda, Project Director, SARI/EI, IRADe presented an overview of the South Asian Power Sector. Dr.Kirit Parikh, Chairman, IRADe, presented the analytical study on macroeconomic benefits of CBET between India and Nepal and updated the gathering on the Bangladesh Analytical Study. Mr. Rajiv Ratna

5th Meeting of Project Steering Committee, Colombo, Sri Lanka

Panda, Head-Technical SARI/EI, IRADe presented the "Annual Work Plan (AWP) for 2016-2017 and strategies for synthesis of SARI/EI Recommendations-Preparation of Combined Task Force Report". Members deliberated on the AWP 2016-17 and the members agreed that the implementation by SARI/EI/IRADe be carried on. Ms. Monali Zeya Hazra, Regional Energy Manager, USAID,India made a presentation on the role of SARI/EI in capacity building in South Asia for promoting CBET in the region. She highlighted various activities being conducted by the United States Energy Association (USEA) under the project to enhance capacity.

6.15 4th Meeting of Task Force-3, Kathmandu, Nepal, December 7th, 2016.

The 4th meeting of the Task Force-3 was held on 7th December 2016 at Kathmandu, Nepal. Mr. Michael Boyd, Senior Energy Advisor, USAID Nepal welcomed the participants. The inaugural session was addressed by Dr Kirit Parikh, Chairman, IRADe while the Chief Guest, Mr. Chiranjiwee Chataut, Joint Secretary, Ministry of Energy, Government of Nepal delivered the keynote address. The vote of thanks was given by Mr S.K Ray, Technical Specialist, SARI/EI. The meeting was attended by Task Force-3 members from different South Asian Nations and core team members from Nepal along with core team nodal officer from Bhutan. After the inaugural meeting, Ministry of Power (MoP) guidelines on CBET were discussed in detail by the country representatives.

The Task Force member's concurrence has been received on the SARPEX market rules, design and the selection of days based data sampling methodology.

4th Meeting of Task Force-3, Kathmandu, Nepal

The key recommendation of the first study and implementation plan has been discussed in detail and agreed on. The action plan and strategy for engaging the country governments and ensuring buy-in from governments for the pilot market including stakeholder consultation was discussed. Mr. Shankar Khagi, Environment & Energy Specialist, SEED Office, USAID/ Nepal delivered the vote of thanks.

6.16 Report Release for Nepal-India Analytical Study "Economic Benefits from Nepal-India Electricity Trade" held in Kathmandu, Nepal, on 19th January, 2017

A report titled Economic Benefits from Nepal-India Electricity Trade was released in Kathmandu, Nepal on January 19, 2017 by Michael Gonzales, Chargé d'Affaires, US Embassy, Dr. Swarnim Wagle, Member, National Planning Commission, Government of Nepal and Smt. Mala Narendra, Second Secretary, Indian Embassy, Nepal.

Report Release event for Nepal-India Analytical study "Economic Benefits from Nepal-India Electricity Trade" held in Kathmandu, Nepal

The report analyses the potential of CBET between Nepal and India, and its feasibility and impact on the economy, power systems and power infrastructure of both countries. The report was widely covered by Nepal's media in more than eight national newspapers.

6.17 Stakeholders' Consultation Workshop on the study "Economic Benefits of Bangladesh-India Electricity Trade" held in Dhaka, Bangladesh, February 2nd, 2017.

A Stakeholders' Consultation Workshop was organised at Dhaka on February 2, 2017. The workshop was inaugurated by Dr. Ahmad Kaikaus, Honourable Secretary, Power Division, Ministry of Power, Energy and Mineral Resources, Bangladesh. Some high-level participants included Mr. Nathan Sage, Deputy Director, Economic Growth Office, USAID, Bangladesh, Mr Mohammad Hossain, Director General, Power Cell, Mr. Abul Baser Khan, Member, Planning and Development, Bangladesh Power Development Board (BPDB), Mr. K. M. Abdus Salam, Member, Renewable Energy, Sustainable and Renewable Energy Development Authority (SREDA), Mr. Sk. Md. Abdul Ahad, Joint Chief, Power Division, Planning Commission, Mr Arun Kumar Saha, Chief Engineer, Project Monitoring, Power Grid Company of Bangladesh Ltd. A panel discussion chaired by Prof Kirit S. Parikh was held and some important points were raised.

Stakeholders' Consultation Workshop on Bangladesh-India electricity trade study, Dhaka, Bangladesh

7 Professional Activities

Dr. Jyoti Parikh, Executive Director

- Panelist in the session "GESI Enabling Policy, Regulatory and Institutional Environment" at ADB Sub-Regional Conference. Organised by Asian Developing Bank (ADB), on 11th April, 2016 at Jaipur, India.
- Distinguished Speaker at the 17th CONSTRUTECH India Conclave & Expo 2016. Topic "Smart City-Governance & Climate Change", Organised by India Tech Foundation, on 26th April, 2016 at Mumbai, India.
- Panelist on "Policy Talk-Food, Water, Energy and Communication" at Knowledge Forum on "Climate Resilient Development in Himalayan & Downstream Regions". Organised by ICIMOD, on 16th June, 2016 at New Delhi, India.
- Panelist on "Road to 2030". Organised by Asian Development Bank (ADB), on 2nd August, 2016 at New Delhi, India.
- Panelist on "Smart Urbanisation local solutions for local issues", at CII Conclave, Organised by CII, on 8th August, 2016 at New Delhi, India.
- Panelist at National Conference on "Energy Data, Energy Modelling and GEO Spatial Analysis." Organised NITI Aayog, on 10th August, 2016 at New Delhi, India
- Panelist at India Energy Access Summit, Organised by The Climate Group, on 11th August, 2016 at New Delhi, India.
- Panelist on "How to build on efficient technology framework under the Paris Agreement?", at Seminar on Technology Partnership after COP 21.Organised by French Embassy, on 9th September, 2016 at New Delhi, India.
- Panelist on "Financing Sustainable Development", at India Think Tank Dialogue on Rising Policies. Organised by ORF & RIS, on 19th September, 2016 at Goa, India.
- Panelist on "Trade, Investment & Regional Value chains" at Regional Consultations of the BIMSTEC Network of Policy Think Tanks (BNPTT). Organised by RIS, on 27th September, 2016 at New Delhi, India.
- Participation in BRICs Civil Forum. Organised by RIS, on 4th October, 2016 at New Delhi, India.
- Panelist on "The Regional Approach Emerging New Opportunities through Regional Initiatives.", at a Discussions on "Road Maps for Accelerating Nepal's Economic Progress, organised by IIPP, Chennai, on 11th November, 2016 at New Delhi, India.
- Panelist on "Poverty & Low Carbon Development Strategies" at Consultation on Energy titled "How is a Decarbonized & Decentralized Energy Future Possibility for India? The Energy Equity Work. Organised by INECC, on 30th November, 2016 at New Delhi, India.
- Panelist on "South Asia Power Trade: Benefits & Challenges" at Conference on Establishing the Research Platform for Energy Cooperation & Governance in Asia. Organised by Northeast Asia Research Institute, Beijing, on 7th December, 2016 in Beijing, China.
- Participation at T-20 Task Force, Preparation on Climate Policy & Finance/material and decisions for G-20.Organised by Mercator Research Institute on Global Commons and Climate Change, Berlin, Germany, on 27th February, 2017 in Berlin, Germany.

Dr Parikh speaking at the India Energy Access Summit

- Participation in World Energy Outlook 2017, High Level Workshop on Energy and Development. Organised by International Energy Agency (IEA), Paris, on 27th March, 2017 in Paris, France.

Mr. V. K. Kharbanda, Project Director

- Presented and Chaired the Session on "Opportunities through facilitating bilateral or multilateral cooperation" In the workshop organised by USAID-LEAD at Hanoi, Vietnam during 30th June-1st July 2016.
- Speaker for "Financial Consideration: Investment for Energy Cooperation in South Asia" and Panelist for Panel discussions on "Global Best Practices: Lessons for South Asia" organised by IPAG and ADBI at Hotel Raddisson, Dhaka, Bangladesh during 21st-22nd October2016.
- Speaker for "Regulatory Issues and Challenges in Cross Border Electricity Trade–Role of Regional Regulatory Guidelines & Way Forward" in the 3rd SAARC Energy Regulator meeting held at Islamabad, Pakistan during 22nd-23rd September 2016.

Mr. Rohit Magotra, Assistant Director

- Speaker in Session on "Emerging Prospects of Sustainable Development Goals and Climate change" at The Human Settlement Institute (HSMI) on 22nd Nov., 2016 at HSMI, New Delhi.
- Speaker in Session in ACCCRN Learning Forum 2016 on "Sharing Knowledge and Sustaining Partnerships for a More Resilient Urban Future" at Semarang, Indonesia on May, 23rd - May 25th 2016.
- Speaker at conference on Climate Change and Disaster Risk Management in Planning and Investment Projects organised by Asian Development Bank and Asia Pacific Adaptation Network on 28th June, 2016 in New Delhi, India

Mr. Sharad Verma, Assistant Director

- Speaker and presented IRADe activities at the 2nd India International Science Festival (IISF-2016), NGO Conclave at CSIR - National Physical Laboratory, New Delhi, 7-11 December 2016.

Mr. Rajiv Ratna Panda, Head-Technical

- Spoke on "Regional Energy Cooperation for Promoting Cross Border Electricity Trade(CBET)& Hydro Power Development in South Asia" -SAARC workshop- 9th-10th May, 2016 at Kathmandu, Nepal.
- Spoke on "South Asian power sector and CBET" Power gen India & Central Asia conference-18th -20th May, 2016-New Delhi-India.
- Spoke on "Accelerating the development of South Asian Power Sector through CBET", Nepal Power Investment Summit- May 31-June 3, 2016-Kathmandu, Nepal.
- Panelist on "Strengthen South Asia Power Grid Interconnection", Nepal Investment Summit -May 31-June 3, 2016-Kathmandu-Nepal.
- Spoke on "Harmonization of grid codes, operating procedures and standards to facilitate/promote CBET in south Asia ", 3rd Meeting of SAARC Energy Regulators- 21st -22nd September 2016- Islamabad, Pakistan.
- Spoke on "Harmonization of grid codes, operating procedures and standards to facilitate/promote CBET in south Asia region"-SAARC video conference- 18th and 19th October, 2016.
- Spoke on "Accelerating CBET and Hydro Power Development between Myanmar and South Asia" in the Myanmar Green Energy Summit- 15th -16th August, 2016-Yangon.

Ms. Asha Kaushik, Senior Research Associate

- Presented a paper titled "Integrating climate resilience in smart cities: case study of Ahmedabad city" at Smart City World Congress, held at Barcelona, Spain during 15-17 November 2016.

List of Publications

Papers in Journals

- Kirit Parikh and Jyoti Parikh (2017) Strengthening India's Position in Climate Change Negotiations. **Economic and Political Weekly.** Vol. 52, Issue No. 10.
- Shweta Srinivasan, Nazar Kholod, Vaibhav Chaturvedi, Probal Pratap Ghosh, Ritu Mathur, Leon Clarke, Meredydd Evans, Mohamad Hejazi, Amit Kanudia, Poonam Nagar Koti, Bo Liu, Kirit S. Parikh, Mohd. Sahil Ali and Kabir Sharma (2017) Water for electricity in India: A multi-model study of future challenges and linkages to climate change mitigation. **Applied Energy.** (DOI: http://dx.doi.org/10.1016/j.apenergy.2017.04.079).
- Kirit Parikh and Jyoti Parikh (2016) Paris Agreement: Differentiation without Historical Responsibility? **Economic and Political Weekly.** Vol. 51, Issue No. 15.
- Kirit Parikh and Jyoti Parikh (2016) Realizing Potential Savings of Energy and Emissions from Efficient Household Appliances in India. **Energy Policy.** Vol. 97.

Papers in Conferences

- Kirit Parikh, Jyoti Parikh and Mohit Kumar (2016). "Vulnerability of Surat, Gujarat to Flooding from Tapi River: A Climate Change Impact Assessment", TROPMET 2016 National Symposium on Tropical Meteorology: Climate Change and Coastal Vulnerability, held at Shiksha 'O' Anusandhan University, Bhubaneshwar, Odisha, India during 18-21 December 2016.
- Rohit Magotra, Jyoti Parikh, Asha Kaushik and Sonali Vyas (2016) Integrating Climate Resilience in Smart Cities: Case Study of Ahmedabad City. Smart City Expo World Congress, Barcelona,Spain 2016.

Newspaper and Magazine Articles

- Jyoti Parikh and Kirit Parikh (2016) Making odd-even work better. Business Standard, dated 10 April 2016.
- Jyoti Parikh and Kirit Parikh (2016) Still Up in the Air. Indian Express, dated 09 May 2016.
- Jyoti Parikh (2016) Constant Consultation is Key. Energy Next, July 2016.

Project Reports

- Jyoti Parikh, Rohit Magotra, Mohit Kumar, Pushkar Pandey, Asha Kaushik, Sonali Vyas and Mohit Kumar Gupta (2016) Review of Status of Marine National Park, Jamnagar: Evolving a vision statement for Management of MNP. Project Report. IRADe-PR-54(2017).
- IRADe (2017) Economic Benefits from Nepal-India Electricity Trade. Project Report. IRADe-SARI/EI-2017-01

Workshop Proceedings

- IRADe (2016) Launch of SARI/EI Think Tank Forum for South Asian Regional Energy Co-operation. Workshop Proceedings. IRADe-SARI/EI-2017-WP-01.
- IRADe (2016) SARI/EI Think Tank Forum India Workshop for South Asia Regional Energy Co-operation. Workshop Proceedings. IRADe-SARI/EI-2017-WP-02.

Paris Agreement

Differentiation without Historical Responsibility?

KIRIT S PARIKH, JYOTI K PARIKH

The Paris Agreement on Climate Change has reiterated the principle of Common but Differentiated Responsibilities and Respective Capabilities, but has not referred to historical responsibility. How important is historical responsibility and what does it imply? How is one going to differentiate without historical responsibility? What would

India submitted its Intended Nationally Determined Contributions on 1 October 2015 to the United Nations Framework Convention on Climate Change (UNFCCC) (Government of India 2015). Countries were asked to submit their own INDCs before the Conference of Parties (COP).

The process of INDC preparation involved modelling studies by different groups—Integrated Research and Action for Development (IRADE) and Energy and Resources Institute (T

Indian Express

Still up in the air

The odd-even programme is no long-term solution to pollution. It can only be the beginning of the search for one

JYOTI PARIKH AND KIRIT PARIKH

Even without the odd-even programme, congestion can be reduced by technological measures and economic incentives. A computerised and automated signalling system can move the traffic faster. Synchronised signals can also help. There is poor lane discipline in traffic and stricter enforcement of rules can reduce many gridlocks. Steep congestion charges can be introduced as has been done in Singapore and London. Parking fees should also be raised to reflect the scarcity of road space. Some important short-term options within Delhi government's ambit are the reducing of biomass burning, minimising road dust and controlling construction dust.

[EXPERT SPEAK]

'Constant consultation is key'

The Delhi Solar Power Policy 2016 is evoking mixed reactions. Although a welcome step, the Government will do well to ensure a foolproof mechanism by taking into confidence all the stakeholders, writes *Jyoti Parikh*.

[IN CONVERSATION]

'Solar cell efficiency is important'

If we want to push Make In India, we need to complement it with determined efforts in R&D, says *Kirit Parikh* in an interview with *Shitanshu Shekhar Shukla*.

Sunday Business Standard, 10 April 2016

Making odd-even work better

Even if pollution does not decline due to the odd-even rule, Delhi residents' exposure could decrease as a result of reduced congestion and travel time on the roads

JYOTI PARIKH & KIRIT PARIKH

IRADe's Outreach and Partners

IRADe networks with the government, ministries/ departments, international organisations, public and private sectors, academic experts, NGOs, and consultants to work on projects awarded by them. IRADe provides decision support to eleven ministries that include Ministry of Environment, Forests and Climate Change (MoEFCC), Ministry of New and Renewable Energy (MNRE), NitiAayog (formerly Planning Commission), Ministry of Power, Ministry of External Affairs, Ministry of Earth Sciences (MoES), Ministry of Urban Development (MoUD), Department of Science and Technology (DST), Central Statistical Organization under Ministry of Statistics and Programme Implementation, Technology Information, Forecasting and Assessment Council (TIFAC), etc. for many national level projects.

At the international level, IRADe has worked with bilateral and multilateral organisations like the World Bank, Asian Development Bank (ADB), U.S. Agency for International Development (USAID); United Nations Development Programme (UNDP); United States Environmental Protection Agency (USEPA), Wuppertal Institute for Climate, Environment and Energy Germany; Deutsche Gesellschaftfür Internationale Zusammenarbeit (GIZ), Germany; Rockfeller Foundation;International Institute for Applied Systems Analysis (IIASA), Austria; British High Commission (BHC), Department for International Development (DFID); Centre for Clean Air Policy (CCAP), USA; International Institute for Sustainable Development (IISD), South South North Trust (SSNT) etc. IRADe has partnered with academic, private and public sectors, multinational organisations, think tanks and NGOs. These include Shakti Foundation, Indian Council of Social Science Research (ICSSR), SEWA, Petroleum Federation of India, Gujarat Power Corporation Limited (GPCL), National Bank for Agriculture and Rural Development (NABARD), Pricewater House Coopers, ICF International, Rockefeller Foundation, Institute for Social and Environmental Transition (ISET), Center for Clean Air Policy (CCAP), Indian Council for Research on International Economic Relations (ICRIER), InsPIRE Network for Environment, Stanford University and Sir Dorabji Tata Trust (SDTT) among others.

IRADe has also developed strategic partnerships and is part of global networks like the USAID's Low Emissions Asian Development (LEAD) program - ASIA-LEDS, ENERGIA-International Network for Gender and Sustainable Energy, Netherlands; Global Clean Cook Stoves Forum, UN Foundation; Asian Cities Climate Change Resilience Network (ACCCRN), Global Technology Watch Group (GTWG-DST), Climate Action Network South Asia (CANSA).

IRADe has carried out some pioneering work in the field of state level energy planning, city level climate resilience planning, other climate change studies and livelihood studies.

List of Projects

Sr No.	Title of the Project	Funding Agency	Status
1	SAMANVAY: Synthesis of Traditional and Modern India's Approach to Sustainable Low-Carbon Development Pathways	MoEFCC	Completed
2	Inter-modal Comparisons of Different Transportation Sector Policies in India	Shakti Foundation	Ongoing
3	Preparation of Solar City Master Plan for Ajmer	Ajmer Municipal Corporation	Ongoing
4	Preparation of Solar City Master Plan for Udaipur	Udaipur Municipal Corporation	Completed
5	Developing Urban Climate Vulnerability Index	MoEFCC	Ongoing
6	South Asian Regional Initiative for Energy Integration (SARI/EI)	USAID	Ongoing
7	Diesel Price Rationalization: Converging the Divergence between Diesel and Petrol Pricing	Shakti Foundation	Ongoing
8	Advanced Coal Technologies for Power Generation	DST/GTWG	Ongoing
9	Energy Sector Reforms in India	DFID/ENERGIA	Ongoing
10	Electricity as a Clean Cooking Option for Rapid Scale Cooking	NABARD	Ongoing
11	Assessment of Food Security & Livelihoods due to Climate Change in UP, HP and Odisha	MoEFCC	Ongoing
12	Analysis of Energy, Food and Water Nexus in a Macroeconomic Consistency Framework	NITI Aayog	Ongoing

Partners and Sponsors

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ANNUAL REPORT
2015-16

Integrated Research and Action for Development
IRADe

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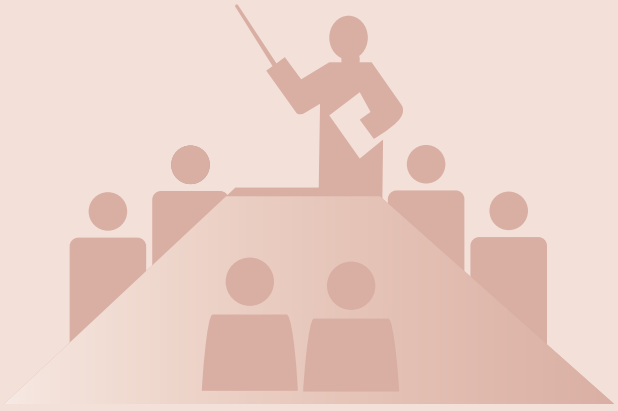

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Preface

It is my great pleasure to present the 2015-2016 Annual Report of the activities of IRADe. This Annual Report provides an opportunity to reflect on the significance of research and development that makes an impact on economic growth and sustainable development by IRADe. This year, IRADe has worked on nine projects of which four are successfully completed and five are in different stages of accomplishment.

IRADe was one of the two institutions that provided inputs for India's Intended Nationally Determined Contributions (INDCs) prior to Paris negotiation on Climate Change. We also organized two events with French embassy on "Climate Change and Cities" and "Climate Finance".

IRADe flagship programe on South Asia Regional Initiative for Energy Integration (SARI/EI) is reaching crescendo in multiple dimensions. Engagement with the power managers and policy makers in the seven countries through task forces and studies, detailed analytical studies and modeling studies for bilateral trade issues and how can countries transform economies, especially through Nepal-India trade as well as a beginning of a new forum of think tanks in these South Asian countries. Many events and studies are enriching our understanding. Do visit IRADe and SARI/EI websites (www.sari-energy.org).

Our continuing stress on energy access and gender leads to several activities including research and surveys on subsidies through Energia-DFID project in Chhattisgarh and Jharkhand.

We are happy to complete the final reports of our projects on Marine National Park, Sustainable Energy Strategies for Gujarat and Smart Climate Resilient Cities.

This year we brought out IRADe highlights 2002-2015 giving account of 13 years of our work.

I take this opportunity to express my sincere thanks to all our sponsors, well-wishers and Governing Council of IRADe for their continued support and encouragement. I express my sincere appreciation to the IRADe team and thank them for their cooperation and devotion to work.

We welcome your suggestions and request you to visit www.irade.org.

Professor Jyoti Parikh, PhD
Executive Director, IRADe

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 organizations, 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. Therefore, IRADe research covers these, as well as 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 and Development Organization by the Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology (MoST). It has also been selected as a Centre of Excellence by the Ministry of Urban Development (MoUD) for urban development and climate change. In addition, it provides expertise to other ministries, national and international institutions and partners with other reputed organizations.

Our Mission

To explore new opportunities and promote paradigm shifts to provide optimum solutions in sustainable development to include vulnerable groups in decision making process.

Our Vision

To be a leading independent policy research organization and think tank that suggests implementable policies to focus on poverty alleviation, gender equity and inclusive growth, with a focus on energy, environment and climate change using multi-disciplinary, multi-stakeholder framework so as to integrate various perspectives and field-level understanding.

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.

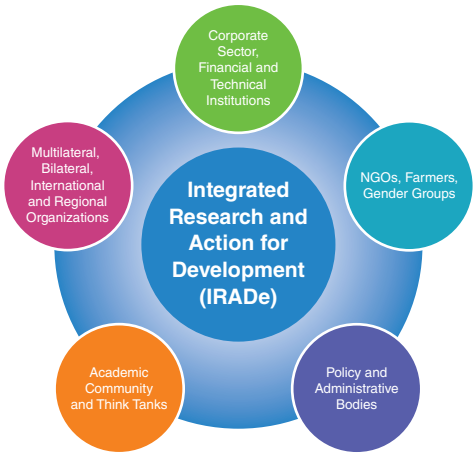
Thematic Areas of IRADe

Key Programme Areas or Thematic Area of IRADe are:

1. Climate Change and Environment
2. Sustainable Urban Development
3. Energy and Power System
4. Poverty Alleviation and Gender
5. Agriculture and Food Program

IRADe 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



Our Partners in Development

1 Climate Change and Environment

1.1. Modeling Studies on Greenhouse Gas Emissions (GHG) and Emission Intensity of Indian Economy

The Ministry of Environment, Forest and Climate Change (MoEF&CC) assigned the tasks to answer key questions relating to climate negotiations. The Project focused on key sectors such as energy and power, transport buildings, industries, agriculture, land use and land use change and forestry (LULUCF) and wastes among others. Further, the project also includes assessment of implications of various developmental pathways, structural shifts or technological changes on national Greenhouse Gas Emission (GHG) trajectories in the time frames 2007-2050. The project carried out analysis of the ongoing and planned policies and assessment of their impact on the GHG emission intensity of Indian economy, including the cost/ economic implications thereof.

To achieve the project objectives, IRADe developed a model version **IRADe-Neg-50** which is a dynamic multi-sectoral, inter-temporal, linear programming activity analysis model based on an input–output framework. The model incorporates interventions in these areas to achieve low carbon pathways. Further, the household consumption along with Government consumption is a part of the final sector final consumption in the economy. The growth rate of household consumption and its composition over time is what drives the economy. The model projects the changing demand structure of the economy till 2050 in a dynamic manner using a combination of log normal population distribution and expenditure class specific linear expenditure systems which are consistent along classes as they reflect an underlying non-linear demand system.

The project work was monitored by the ministry in consultations with the project steering committee (PSC). There were seven meetings through a course of two years during which various scenarios were run to assess the possible GHG emissions and emissions intensity for 2020, 2030, 2040 and 2050. IRADe assessed the GHG emissions and emissions intensity and associated energy and power generation mix under various socio-economic scenarios of growth, low carbon measures in power and transport sector, energy efficiency, and fall in costs of renewables. Currently available calculations were used with expected as cost reductions in future as well as current policy for e.g. no more sub-critical coal power plant should be constructed after 2016. Additionally, through the scenarios, the IRADe team showed that India would not peak under any of the envisaged socio-economic pathways even by 2050. In the run up to the Paris COP, IRADe team summarized possible range for GHG emissions and emissions intensity through three scenarios, Dynamics as Usual (DAU), Determined actions scenario (DETA) and Ambitious Actions scenario (AMBA). The DAU scenario incorporated current policies and programs as well as current trajectories in falling costs, renewable penetration and energy efficiency. The DETA scenario is about increasing efficiency and achievable technological intervention. The AMBA scenario on the other hand is **about Increased Rate of Capacity Creation, Cost reduction** of technologies, drastic lifestyle change, and energy conservation with Ambitious targets. The results from IRADe's analysis showed that the emissions intensity target in the INDC is nearly realized in the DAU scenario itself while the non-fossil fuel capacity is only 30% in DAU. However, in the DETA & AMBA scenario India achieves an emissions intensity reduction of 39% and 43% by 2030 and a non-fossil fuel capacity of 40% and 51% in DETA and AMBA respectively. In addition to these scenarios, the PSC requested IRADe team to also do a sensitivity analysis of various policies to test for the robustness of the result that with determined actions India would be able to reach its INDC targets by 2030 and also suggest possible INDC targets for 2050. The IRADe team showed that through aggressive nuclear or even the renewable energy program or a combination

of both, INDCs can be achieved even if one or some of the other targets for technological options in power, transport and energy efficiency are not reached. Some of the more important conclusions arrived at by the study are summarized as under:

- India can bring down its per capita GHG emissions to less than 6 tonnes by 2050 where non fossil electricity generation would be 47% and 60% in the two scenarios.
- INDC's announced by India are achievable.
- This will require support from international community on two fronts: Financial support for meeting the additional investment needed and access to technology or international co-operation in technology development.
- Financial support as well as low interest long term loans with interest payment moratorium for 20 years.
- Technology access at low reasonable costs to advances in solar, wind and other power sector technologies as the installed capacity for solar and wind becomes 829 GW and 1064 GW in DETA and AMBA in 2050. Of these solar with storage is 135 GW and 360 GW in 2050.
- Thus, access to technology becomes critical including that for storage technologies, smart grid, ICT technologies for promoting energy efficiency and energy efficient transport technologies etc.

Supported by: MOEF & CC, GoI

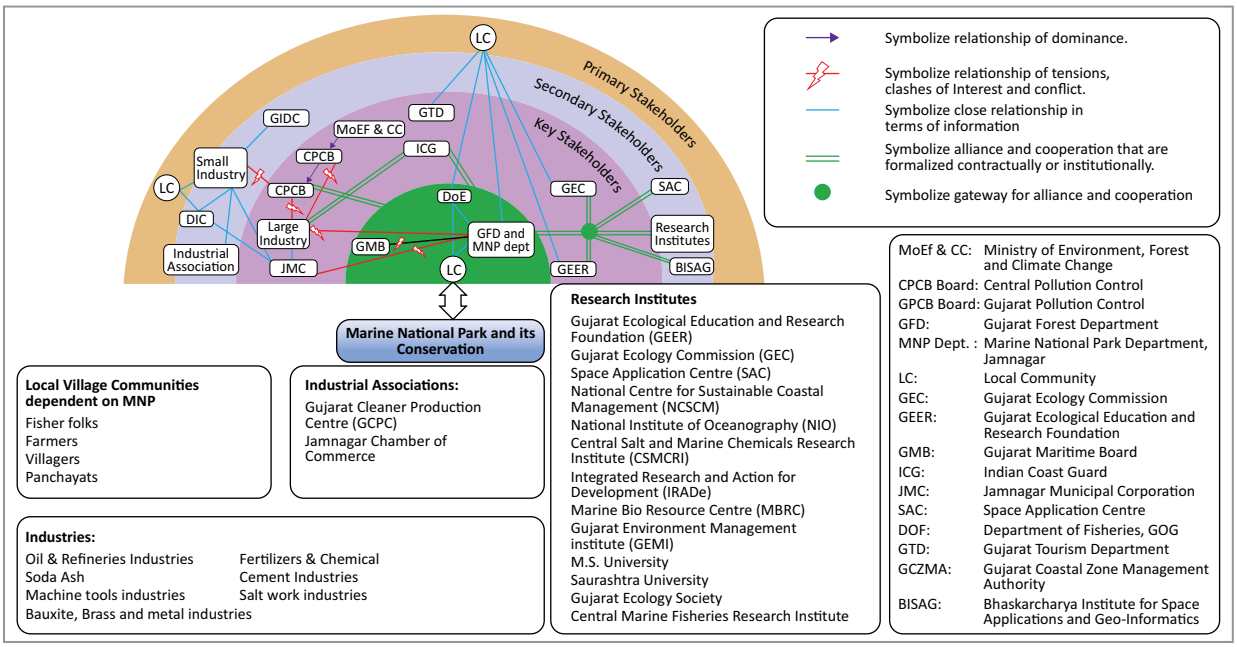
1.2. Review of Status of Marine National Park (MNP), Jamnagar and evolving vision statement for management of MNP

IRADe conducted a study for MoEF&CC to undertake macro assessment of the ecological status, governance structure, management plans of Marine National Park since its establishment in 1982 and the impacts of all the involved stakeholders by means of primary surveys, stakeholder consultations and mapping. Further focus of the study was to understand existing governance and management structure, review of the concerned policies, regulations and notifications and identification of the loopholes associated with MNP structure and policies.

Stakeholders perception survey

To identify the relevant actors and their relationships amongst each other, stakeholder mapping was done through extensive stakeholder's discussions and consultation. Stakeholders map below provides their relationship in diagrammatic form.

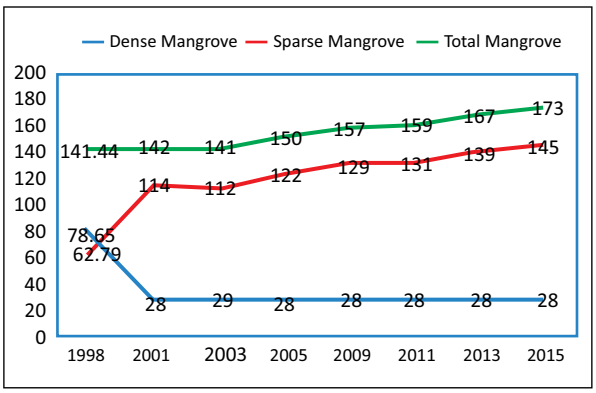
IRADe also conducted primary surveys to investigate perception of Local community (chiefly fisher folk) and to determine if the presence of well managed MNP has any positive effect on the adjacent fishing community. Fishermen at six sites (Sachana, Jodiya,



Stakeholder Map-Marine National Park, Jamnagar

Sikka, Salaya, Arambada and Bet Dwarka) were surveyed using structured questionnaires. Perception survey was conducted to investigate fisherfolk opinions and their acceptance of Marine Protected Areas in vicinity to fishing areas. Outcomes of the survey highlighted that the total fish catch has been observed to increase over the years, but there is a drop/decline noticed in total catch in recent years. Similarly, while the total fish catch data recorded an increasing trend, discussion with the fishermen revealed a sharp decline in 'catch per unit effort' in recent years. Fisherfolk from all the study sites show more of an interest and were keen to be involved in planning for conservation or management plan for MNP.

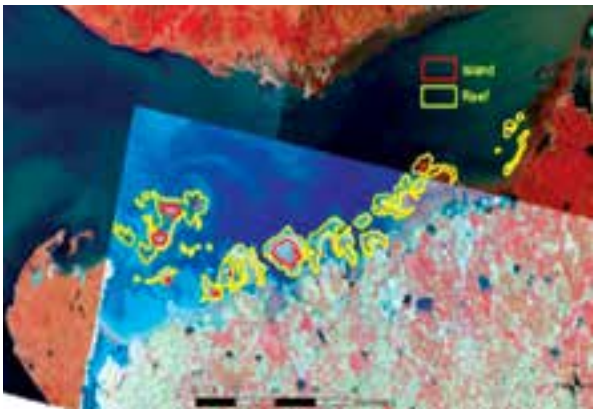
Collage of the biodiversity photographs, MNP, Jamnagar



Changes in mangrove (sq. km) cover in Jamnagar since 1998

The study found out that the mangrove cover has increased in MNP, but the diversity of mangroves has decreased. Mostly, the area comprises of Avicennia, with sporadic occurrences of Rhizophora and Ceriops.

The coral reefs have been subjected to intensive pressure of sedimentation, anthropogenic exploitation and climate change impacts.



Coral reef map of MNP, Jamnagar, Gulf of Kachchh, Gujarat for 2014

IRADe's team mapped the coral reefs along the Jamnagar coast using Landsat 8 Operational land Imager (OLI) data of 2014 and found the total area of reefs as 443.49 sq. km. In 2014, some of the coral colonies on Pirotan Island were found bleached. Increase in SST due to delay in onset of southwest monsoon and sedimentation were suggested to be the probable reasons for bleaching of coral colonies. Bleaching was also observed in some coral colonies of Narara reef when the team of researchers from IRADe visited the island in 2015.

Way Forwards and Recommendation

I. Management and Coordination

- Coordination: Role of all the authorities that are managing the protected area (Forest Department, MNP, GMB etc.) should be streamlined in order to avoid coordination issues and improve their accountability for the assigned responsibilities.
- Coastal governance mechanisms need to be strengthened through Gujarat State Coastal zone management authorities. Seascape approach should be designed for management along with a coordination mechanism among research groups working in Marine Protected Areas.

II. Monitoring, Regulation & Surveillance

- Monitoring and surveillance for protection – Base stations should be established at specified

islands such as Pirotan, Kalubar, Bural Chank, etc. for surveillance. Joint surveillance teams with involvement of forest department, navy, coastal guards, local communities need to be established.

- Urban Waste Management: There is need for improvement of trash and solid waste collection both in residential and industrial areas.
- Proper planning and regulation of the fishing activities. Monitoring mechanisms should be set to control the incidences of overfishing and illegal fishing in and around MNP.

III. Research

- Ensuring that scientific exercises are done for documenting the flora and fauna of Marine National Park. Assessment of the same would help to understand clearly the changes, associated reasons and devising measures for better management.
- Vulnerability assessment studies should be done for the Gulf of Kachchh region and Coastal Resilience Plan should be developed in wake of uncertainties arising due to climate change.

IV. Community Participation

- There is a need to increase the involvement of local communities and village Panchayats (assign them roles and responsibilities) in the management and conservation of framework of Marine Protected Areas.
- Alternate and sustainable livelihood options for local communities such as seaweed cultivation (involving endogenous species), aquaculture, mericulture and eco-tourism should be further explored in consultation with community should be promoted and supported.

Sponsored by Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH & Ministry of Environment Forests and Climate Change

2 Sustainable Urban Development

2.1. Policy Engagement for Developing Climate Resilient Smart Cities

IRADe, supported by the Rockefeller foundation has strived to position urban challenges in the larger policy framework provided by the state and national institutions. IRADe engaged decision makers and informed them on urban climate change resilience while integrating the concepts into wider planning discourses.

IRADe also proposed inclusion of climate resilience component in the recently landed smart city plans engagement at various levels in the Ministry of Urban Development, state and city level urban bodies for climate resilient smart city framework. IRADe engaged with two cities viz. Ahmedabad and Guwahati for integrating climate resilience in their smart city plans, the Ahmedabad Municipal Corporation welcomed IRADe's inputs and incorporated Climate Resilience component into their smart city plans. Also IRADe's Inputs for integrating disaster resilience in Master plans and Smart city plans were considered by 9 smart cities in India.

To put forth the importance of climate and disaster resilient urban development IRADe organized and participated in several events at city, national and international levels for building capacity of the related stakeholders and for stressing the mainstreaming of climate resilience in urban development, some of these are:

- **Roundtable in Ahmedabad:** With Ahmedabad Municipal Commissioner and other key city stakeholders at Ahmedabad Municipal Corporation (AMC), Ahmedabad on 22nd December 2015
- **Road to COP Dialogue: I -Cities Resilience to Climate Change;** in collaboration with the French Embassy in India on 30th October, 2015. Recommendations largely focused on the importance of mitigation technologies and adaptation which were largely attributed to sustainable planning for climate resilient infrastructure and thus addressed a significant issue in context of COP 21, Paris
- **Road to COP Dialogue: II -How can long-term and sustained financing be structured for mitigation and adaptation?** with French Embassy in India in collaboration with Integrated Research and Action for Development (IRADe) on 29th June, 2015
- **Session on Climate and Disaster Resilient Smart Cities -** in partnership with Technology, Information, Forecasting and Assessment Council (TIFAC), DST, GoI and International Society for Integrated Disaster Risk Management (IDRiM) on 28th October, 2015

Climate Resilient Smart City Reports have been prepared for city of Ahmedabad and Guwahati. The key recommendations of the study are:

- Master Plan/Development Planning and Town Planning Scheme mechanisms are instrumental for local level actions. To address climate change, urban resilience factor should also be incorporated in Smart Action Plans.
- Use of GIS and Remote Sensing for developing hazard assessment maps, spatial mapping of urban utilities/ critical support services and land use planning are essential tool for decision makers and should be used in prioritizing the City Climate Resilient Agenda and mobilizing the actions where needed
- Urban development must be inclusive, ecosystem based planning should be prioritized and Climate Resilience and Disaster Risk Reduction components should be essential components of city development plans and smart city plans
- **Prioritize a climate resilient agenda:** Cities need to identify priority activities that respond to their urgent needs for adaptation to climate change.
- **Rejuvenation of water bodies:** Restoration may also help overcome the growing water scarcity and also the risk of flooding can be reduced. Drought and floods can also be addressed simultaneously if cities look after urban lakes, ponds and wetlands.

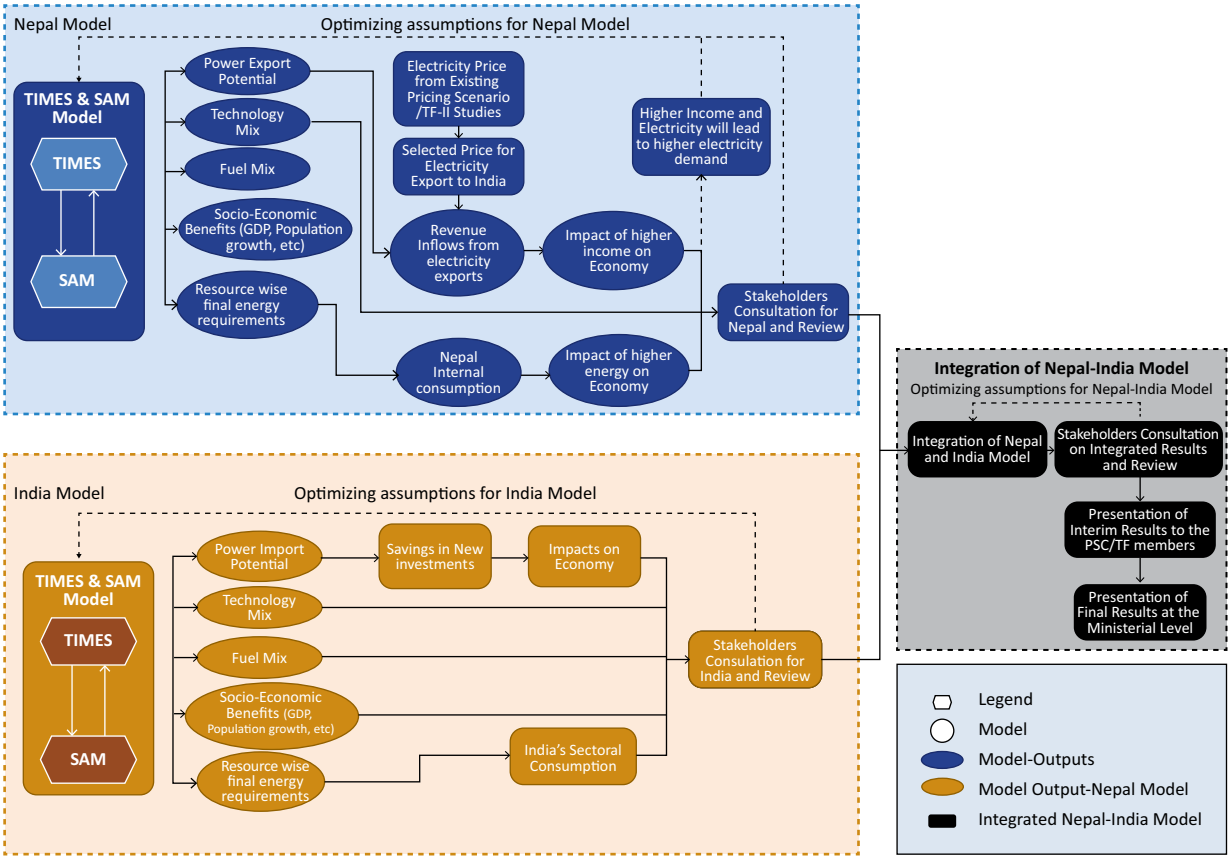
Sponsored by Rockefeller Foundation

3 Energy and Power Systems

3.1. South Asian Regional Initiative for Energy Integration (SARI/EI)

3.1.1. The macroeconomic and analytic study focusing on benefits of electricity trade between Nepal-India

Under the USAID SARI/EI program IRADe has commenced ***"The macroeconomic and analytic study focusing on benefits of electricity trade between Nepal-India"*** with the primary purpose to build the consensus for Cross-Border Electricity Trade (CBET). The objective of the study is to critically assess the need for CBET among the nations of the South Asia region through comprehensive analytical studies that quantify the technical, economic, environmental and energy market benefits of cross-border interconnection in the region. The study involves multi-country analysis and bringing out the economic (macro and micro) importance of power trade besides other country benefits. The consensus building activities undertaken under this study are bringing together stakeholders from power sector, financial and diplomatic communities and other energy experts. The outcome of the studies will rigorously form estimates of benefits to inform the discussion by all three Task Forces of the SARI/EI and pave the path to prepare and develop regional energy markets and make them sustainable in order to foster economic growth of this region.



Nepal-India Macroeconomic and Analytic Study Modelling

Progress made so far: In the month of May the study was awarded to IRADe and in June Inception meeting for the project providing key insights and details of the study was organised at IRADe. In the months of July to September, Dr. Anjana Das provided 7 days training on Answer-TIMES to IRADe SARI/EI team, which was spread over 50 days starting. In addition, a five-day visit to Nepal by Dr. Pradeep Kumar Dadhich and Dr. Probal Ghosh was undertaken between 31 August 2015 to 4 September 2015 to meet potential stakeholders and data agencies of Nepal such as ADB, Central Bureau of Statistics, Ministry of Finance, National Accounts Statistics, Nepal Rastra Bank, World Bank, UNDP, etc. In December, the Reference Energy System of Nepal and India in the Answer-TIMES model were completed. Initial Nepal results were generated at various exogenous export prices with standalone Nepal Model without considering the absorption capacity of India. Dr. Pradeep Dadhich and Dr. Probal Ghosh conducted a stakeholder consultation workshops on the 18th and 19th January 2016 in Kathmandu wherein the preliminary results from Nepal TIMES model and Nepal Macroeconomic model were shared.

Answer TIMES Training by Dr. Anjana Das (in Centre)

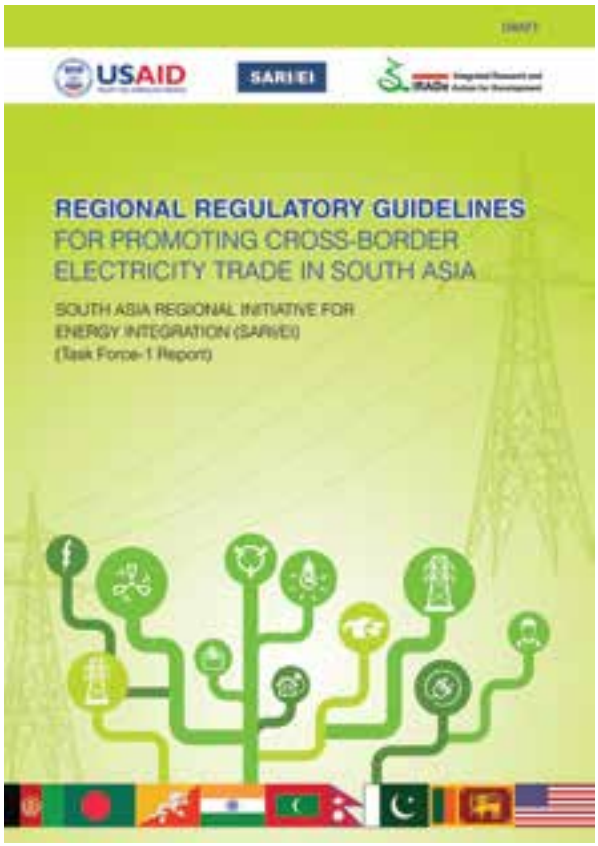
Subsequently same follow-up meetings with Ministry of Energy (MEA), Government of Nepal; Nepal Electricity Authority (NEA), Water and Electricity Commission Secretariat (WECS) and the World Bank were carried out. In the month of March, the integration of the two TIMEs model i.e. India and Nepal was successfully undertaken. This was followed by interaction between TIMES and macro-economic model of Nepal. The stakeholder consultation for India model and Nepal-India integrated model will be undertaken in the next financial year.

3.1.2. Regional Regulatory Guidelines for Promoting Cross-Border Electricity Trade in South Asia

IRADe is the implementing partner for USAID's South Asia Regional Initiative/Energy Integration (SARI/EI) program for advancing regional energy integration and Cross-Border Energy Trade (CBET) in eight South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Pakistan, Nepal, Sri Lanka and the Maldives). The SARI/EI program critically fills the important role of advancing regional energy integration and thus increasing CBET through focus on (i) Coordination of Policies and Regulatory Mechanisms, (ii) Advancement of Transmission Interconnection and (iii) The establishment of South Asian Electricity Market. To this end IRADe has constituted three inter-governmental Task Forces and a Project Steering Committee with representations of SAARC country governments where in-depth analysis/studies are being completed with specific recommendations on policies/regulatory mechanisms, technical grid standards and market rules for promoting electricity trade between South Asian countries. The findings and outcomes are used towards gaining consensus and support from the key decision-makers and stakeholders.

Key Achievements

IRADe published the Regional Regulatory Guidelines (RRGs) to facilitate CBET in South Asia. RRGs were developed to primarily aid the national electricity regulators of the South Asian countries for developing a regional regulatory framework and for decision making on CBET in the South Asian Region. RRGs were developed under the study on Review of Electricity Laws, Regulations, Policies and Legal structures of South Asian Countries, which identified the critical ingredients for CBET, reviewed international power pools and regional trade arrangements to understand the good practices around the world and brought out the RRGs. The RRGs are set of guidelines on common regulations, rules and protocols in technical, operational and legal matters for harmonization/coordinating of electricity regulation from the perspective of promoting CBET in South Asia.

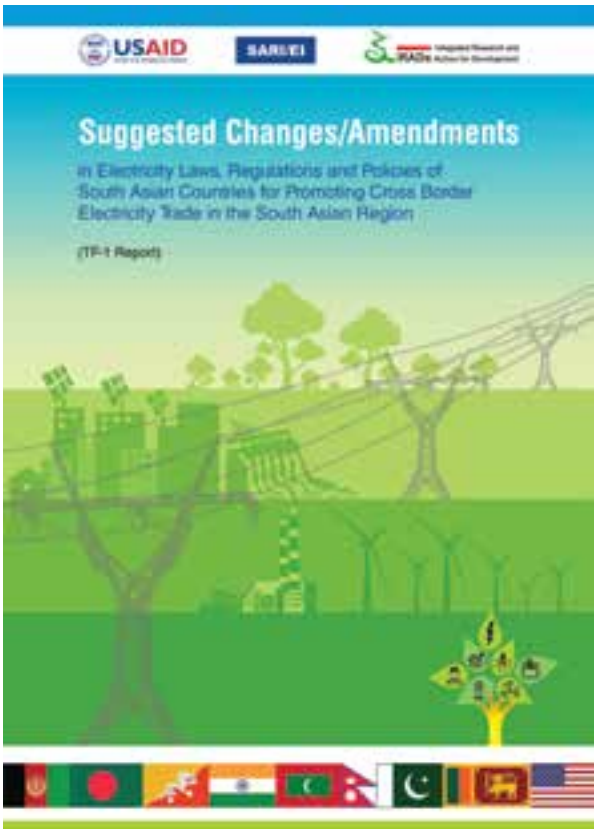


To take forward the implementation of RRGs and for coordination/harmonization of Electricity Laws, Regulation and policies of SA countries for promoting CBET, the study also came out with its 2nd report on **"Suggested changes/amendments clause/section wise in the existing Electricity Laws, Regulation and policies of SA countries for promoting CBET in South Asia Region across".**

These suggested changes/amendments can be considered by each South Asian Country Governments as a base for aligning the legal, policy and regulatory frameworks prevailing in each South Asian Countries for promoting CBET in the region. This report also covers country wise proposed long-, medium- and short-term roadmaps for implementation of these suggested changes and amendments.

Ongoing Studies

- **Investment friendly policy and investment framework for promoting investment in South Asian power sector and CBET:** The ongoing study reviews the prevailing investment friendly policies/ guidelines/frameworks/FDI regimes in each South Asian country and
- **Assessment of the Electricity Trading Potential of South Asian Countries:** The study now at its closure looks into the existing long term Demand-Supply projection scenarios of the participating countries and the expected developments in the next 10-20 years by taking into account the CBET potential as a means to meet the additional demand of power by each country and/or by exporting surplus power through CBET to other South Asian Nations.
- **Harmonization of grid codes, operating procedures and standards to facilitate/promote Cross-Border Electricity Trade in South Asia:** The almost completed study is identifying provisions in the Grid Codes and Operating Procedures that will have an impact on optimal, reliable and economic operation of CBET across the South Asian nations and developing recommendations for necessary changes or additions required in the operation procedures/ Grid codes/standards/institutional structure etc. in respective countries.
- **Assessment of commercial terms and conditions for CBET and suggested model of Power Exchange in South Asian region:** The study at the verge of its completion is assessing the preparedness of each South Asian country (Afghanistan, Bangladesh, Bhutan, India, Pakistan, Nepal, Sri Lanka and the Maldives) for CBET for selecting suitable models/ options a regional power exchange for the countries and to recommend commercial terms and conditions, principles and procedures for the short-term, medium-term and long-term CBET in the South Asian Regional Electricity Market.
- **Building consensus and developing a white paper on South Asian Forum of Electricity Regulators (SAFER)** is consulting stakeholders on initial feedbacks on SAFER.
- **Pilot Market Project - Mock exercise for South Asian Regional Power Exchange (SARPEX). A pilot market project has been conceptualized.** A mock exercise is planned towards establishing the desirability and the feasibility of a South Asian Regional Power Exchange (SARPEX). The project will bring out the benefits to various nations if SARPEX is established. The other objectives are developing a draft set of market rules and design of SARPEX and capacity building. The pilot project shall be run like a Day Ahead Spot Market.



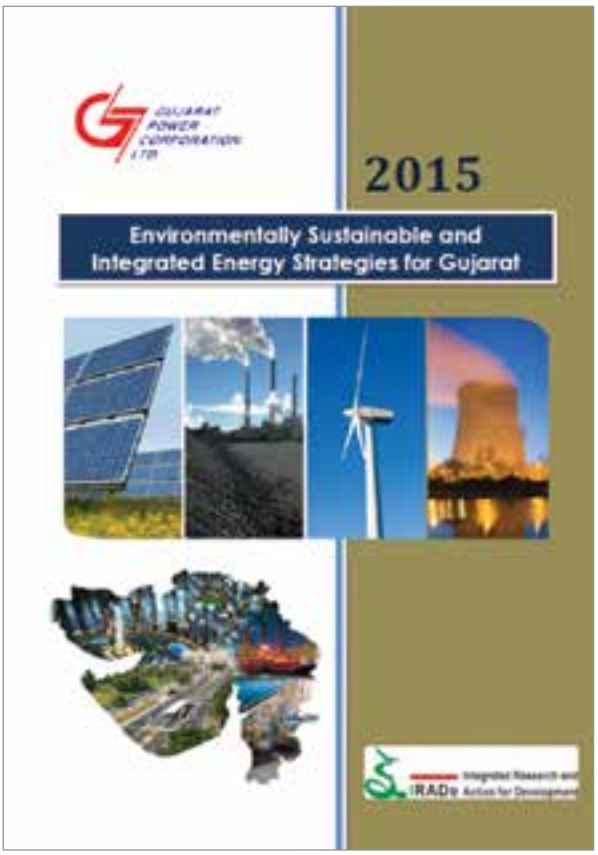
3.2. Sustainable Integrated Energy Plan for Gujarat

IRADe undertook the task of preparing the report on Environmentally Sustainable and Integrated Energy Strategies for Gujarat State. The report analyses the existing energy resources, energy supply and demand scenarios, environmental constraints, hazard risk vulnerability of the state's critical infrastructure, energy access issues and supply strategies to meet the energy security of the state with a perspective for the next two decades.

Under the project IRADe conducted three stakeholder meetings at Gandhi Nagar, Gujarat which were attended by around 100 participants from the entire energy and power sector of Gujarat. IRADe staff visited key power and energy sector installations to get a first-hand knowledge of issues in the state.

GTPS Ash Dyke, 1MW SPV Power Plant, Gandhinagar

Visits were made to all the major organizations in the energy, power, infrastructure sector in Gujarat to gather energy generation and consumption data and discuss critical issues being faced by these organizations in terms of fuel costs, fuel supply issues (coal, gas, lignite), environmental issues, fuel imports and costs, issues of grid stability on account of renewable energy. The draft report was circulated to all major power sector organizations and comments were received and incorporated in the final report.



Key Findings of the Project

Gujarat's energy sector is one of the most energetic in comparison to other Indian states. In 2011, over 90% of the households of the state were electrified and 38% had clean cooking fuels access whereas these figures were mere 67% and 28.5%, respectively for India. Per capita electricity consumption in 2013-14 was 1708 kWh in Gujarat compared to 957 kWh for all India despite the fact that there are limited energy resources in the state. The rural area also has 24x7 electricity

access. The state is very forward in terms of renewable energy and has one of the highest installations of solar power in India and among top three in wind energy.

Gujarat is the second highest coal consuming state in India, despite the fact that it has no domestic resources of coal. It handles 66% of the country's total imports of petroleum products, 98% imports of LNG; 77% of POL exports, 36% of imports of coal and 100% of coal exports pass through its ports. Vibrant Gujarat and other programmes have had an encouraging investment climate in the state, which would lead to further growth in energy demand.

It is thus challenging to develop scenarios for the future and make policy recommendations. In this context, IRADe has carried out a detailed analysis of energy demand for industry, agriculture and services sectors with perspectives up to 2035 and also suggested a supply strategy and made recommendations.

Energy projections have been made assuming 8% and 10% growth rates of the state GDP; it was also assumed in alternative scenarios that services and industry will lead the growth. It is noted that electricity requirement jumps from the present 68 bkWh to 243 and 324 bkWh in 2035 under the 8% and 10% growth rates with falling elasticity scenarios; the required installed capacity jumps to 3-4 times the present capacity of 21,500 MW. In the long run Gujarat will benefit from service led growth that will curtail demand for a state with meagre fossil fuel reserves and will also provide more jobs.

In terms of CO_2 emissions, the emission per unit generated is the highest in 8% growth scenario at 0.70 kg/kWh. Restricting supercritical coal to 20,000 MW lowers emissions to 0.39 kg/kWh even when natural gas is used as a balancing fuel. It is marginally lower at 0.38 kg/kWh when solar PV with storage is used.

- Peak electricity demand for the year 2035 will increase to 46,700 MW with 8% growth rate and to 69,000 MW with 10% growth, a margin of 48%. With Vibrant Gujarat mode of industry led 10% growth the peak demand will be 80,300 MW which is an increase of 16% due to change in the structure of the economy.
- With emphasis on renewable, mainly wind and solar, the share of renewable capacity can be 50% or more; 35,000 MW of wind and 60,000 MW of solar energy can be absorbed with gas based plants providing balancing power.
- Even when supercritical coal plants are restricted to 20,000 MW compared to 40,000 MW in other scenarios, Gujarat can meet its power requirement with some balancing by natural gas or solar PV with storage.
- Significant reduction of 30% in total power sector emissions is feasible, but with a 40% increase in the cost of electricity.
- Gujarat should push for the development of renewables. Its ability to restrict coal will depend on the availability of natural gas or development in electricity storage technology. It can adapt its strategy to evolving technology.
- If Gujarat is to progress as it aspires to and achieve double digit growth rate, led by industrial development, it faces a huge challenge to meet its energy needs.
- Gujarat's dependence on coal will continue for some time. Hence moving to more efficient supercritical and ultra-supercritical plants is necessary.
- Today Gujarat is paying more than what it should for coal because of the coal linkage and railway freight rate policies of the Government of India. It should strongly ask for tradable coal linkages and rationalisation of railway freight rates.
- With its limited resources of fossil fuels its emphasis must be on renewable power if it wants to restrict the level of energy imports.
- Gujarat has significant potential of wind and solar power as well as a good policy framework to attract investment in these areas.
- Model shows that it is possible to absorb significant amounts of solar and wind power by balancing with open cycle gas based plants. Also, if advancement in electricity storage technology brings down costs, solar PV with storage can provide the needed balancing power.
- While availability of natural gas is limited, coal gasification based on imported coal or in-situ gasification of lignite can provide gas.
- Apart from electricity, consumption of petroleum products has to be restrained. Here, development of mass transport, encouragement of non-motorised transport, discouragement of use of private vehicles

by providing the option of efficient and convenient public transport and imposing parking and congestion charges, are required.

- At the same time, increased fuel efficiency from vehicles, more stringent emission norms and facilitating electric vehicles by providing supporting public infrastructure are needed. Regular environmental impact studies, with modelling needs to be undertaken in major cities.
- While supply policies are important, demand side measures to promote energy efficiency are equally critical. The state should push hard for more efficient use of energy. Appropriate pricing of energy is a vital element of pushing energy efficiency. Education and encouragement for saving energy can be cost effective.
- With 24x7 electricity supply, Gujarat has come a long way in providing energy access to all its residents. Even then action is needed to provide clean cooking fuel to a large segment of the population. The spread of Gujarat gas grid to all urban areas should help replace LPG use in urban households with PNG. The freed cylinders and LPG should be used to provide them to rural households. With 24x7 electricity and significant expansion of solar power, it might be more practical to provide induction cookers where supplying LPG may be difficult or impracticable.
- We have also looked at the environmental consequences of energy use. With emphasis on energy efficiency, mass transport, efficient vehicles, stringent emission norms, promotion of electric vehicles and large thrust on renewable energy can provide a much cleaner environment.

To address the challenges arising from Gujarat's ambitious development plans, the report strongly recommends energy efficiency measures, aggressive efforts in renewable energy, clean coal technologies, time of day pricing, adopting ECBC more aggressively, while taking care of grid balancing and also at the same time providing energy access at affordable prices. In four of our projected scenarios, Gujarat would be able to meet or exceed India's INDC's commitments at the state level.

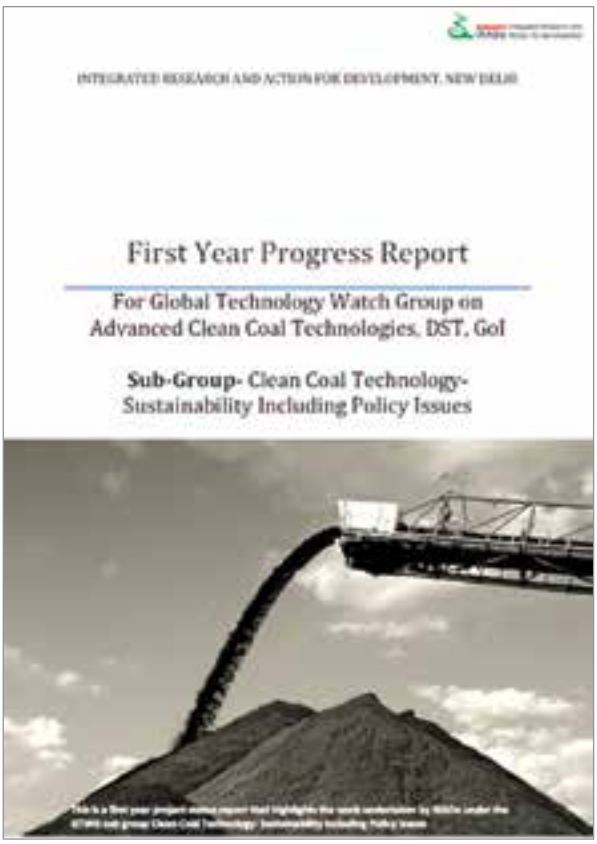
Supported by the Gujarat Energy and Petrochemicals Department and Gujarat Power Corporation Limited (GPCL)

3.3. Global Technology Watch Group (GTWG) on Advanced Coal Technologies (ACT) for Power Generation

Under the GTWG project IRADe is undertaking the sustainability issues of clean coal technologies that include power generation, mining and beneficiation and emissions. Sustainability issues with respect to cost-economics, social aspects and environment are being analysed for suitable technology options.

Under the project IRADe is a consortium partner along with IIT-Madras, IIT-Bombay and IIT-Delhi.

Coal plays an important role in electricity generation worldwide and its importance is even more pronounced in India, which relies heavily on coal. The present installed electricity generating capacity in India is around 300 GWe (as on 31 May 2016, CEA), of which coal accounts for about 61%. The power generation capacity is projected to increase to about 778 GWe by 2031-32, and a significant portion of the capacity addition is expected to come from coal.



Coal-fired power plants generate huge amounts of carbon dioxide (CO_2) which is widely considered as a major contributor to global warming and climate change. Other major areas of concern associated

with coal-fired power plants are other conventional pollutants such as Sulphur dioxide (SO_2), nitrogen oxides (NOx), particulate matter (PM), mercury (Hg), arsenic (As), flyash and other harmful elements. Another area of pollution is related with coal mining and beneficiation of the low grade Indian coal which contains a large amount of waste matter due to the drift origin of coal.

Though India's annual per capita CO_2 emission is only one-fourth of the world's average, India is the world's third largest CO_2 emitter, and there is tremendous pressure on India to reduce CO_2 emissions.

India has been operating lately very old power plants based on sub-critical technology, and only recently super-critical plants have started to get commissioned, these plants emissions are much less than the older plants. Recently globally lot of research work is going on in developing high efficiency low emissions technologies like Ultra-Super Critical, IGCC and CSS technologies to mitigate the impacts of GHG emissions from power sector.

Under this backdrop, the GTWG-ACT has discussed three scenarios for the country as mentioned below:

- Scenario 1 in which coal-based power generation continues with minimal changes in technology except for incorporation of already commercially-available technologies for removal of SOx, NOx, Hg and particulate emissions. This scenario is possible when new technological developments are not accessible or are prohibitively expensive and significant advances have been made in the induction of renewable energy sources (such as solar PV and wind) into the power generation.
- Scenario 2 in which a wide range of new and appropriate technologies delivering clean coal and high energy conversion efficiencies is implemented together with induction of control measures for conventional pollutants such as SOx, NOx, Hg and pollutants. Among the additional technologies envisaged in this scenario, compared to Scenario 1, would be for coal beneficiation technologies, ultra-supercritical steam parameters, coal gasification, IGCC and co-firing with biomass and other opportunity fuels. This scenario may unfold when induction of renewable energy sources is not as robust as anticipated and additional CO_2 mitigation is required through conventional power generation routes to meet with global warming obligations.
- Scenario 3 in which the full range of clean coal technologies, including carbon capture and sequestration (CCS), is brought into play to make a case for sustained use of coal for power generation. Among the additional technologies to be inducted in this scenario would be those related to pre-or post-combustion capture, oxyfuel and its supporting technologies, chemical looping and supporting technologies, coal-to-liquid fuels, coal-to-chemicals routes, mineral, biological sequestration of CO_2, reuse and recycling of CO_2, etc. This scenario is possible when steeper-than-anticipated reductions in CO_2 emissions become mandatory and the transition to hydrogen economy and electric vehicles does not happen to the extent needed.

The GTWG-ACT consortium comprising of IIT Madras, IIT Bombay, IIT Delhi and IRADe, New Delhi proposes to evaluate these technologies in terms of their feasibility and competitiveness in Indian context, and develop a viable Advanced Coal Technologies road map for sustainable, coal-based power generation within an appropriate policy framework.

The GTWG-ACT technology evaluation are categorized into four groups – Advanced Coal Mining and Beneficiation Technologies, Advanced Coal Utilization Technologies, Advanced Emission Control Technologies, Clean Coal Technology: Sustainability and Policy Issues – and are individually handled by IITD, IITM, IITB, and IRADe, respectively. The methodology being adopted for sustainability analysis is summarized schematically in Figure 1. The development and integration of assessment tools is under progress with specific reference to the following means of clean power generation using coal which offers the following:

- Oxyfuel combustion of pulverized coal in a tangentially-fired boiler.
- Powdered activated carbon injection for 90% removal of Hg.
- Operating on supercritical steam parameters
- Geological sequestration of CO_2
- Use seawater/wet-lime flue gas desulphurization for 95% removal of SO_2
- Compression, drying and low temperature flashing for CO_2 enrichment to 95% purity with 90% CO_2 capture.
- Selective catalytic reduction of NOx for 95% removal

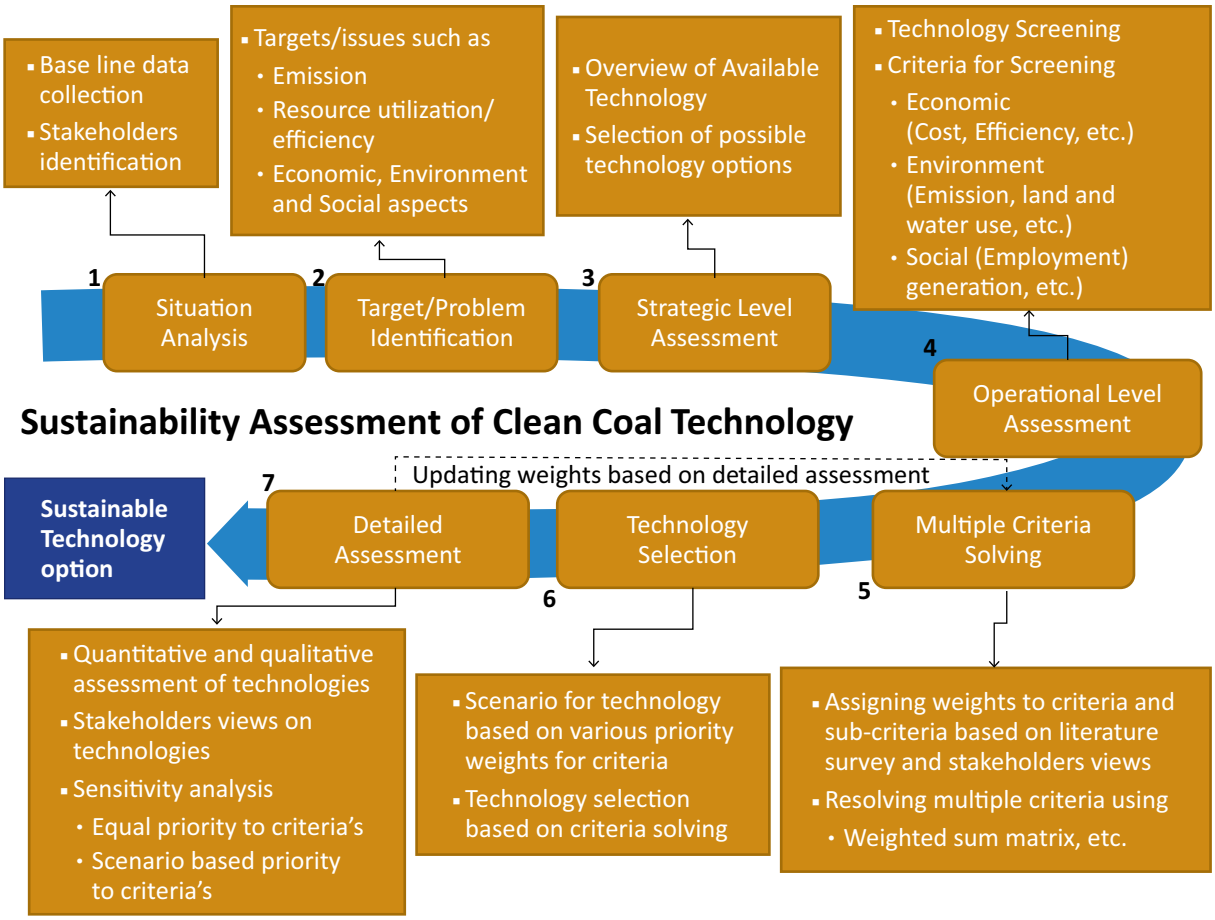


Figure 1: Schematic representation of the methodology for assessment

Under the project this year four review meetings were held this year among the project partners, on 13th June 2015 meeting was held at IIT-Mumbai, on 12th September 2015 at IIT-Delhi, on 25th February 2016 at IRADe and on 19th May 2016 a project review meeting was held at Delhi with DST, GoI. IRADe also organized the National Energy Policy Workshop on 6th November, 2015 in which project PI, IIT-Madras also participated along with other industry participants. IRADe has submitted its annual progress report to DST.

Supported by DST-SPLICE, GoI

3.4. Impact of Growth and Mitigation on Consumption Patterns and Sectoral Structure in Developing Countries: A Case Study of India

Developing countries need economic growth to take care of their human development deficit. Economic growth requires in these countries substantial development of infrastructure for electricity, roads, railways, ports for transport and airports, as also for providing services of water, health care and education. At the same time economic growth results in changed consumption patterns, which in turn affect the structure of production. Also developing countries cannot neglect the compulsion of climate change as the poorer persons and nations are most vulnerable as they have little capacities and means to deal with extreme events. They need to reduce their emission intensities as their economies grow. This calls for additional resources putting further stress on already scarce resources.

The issues that were addressed in this research projects were as follows:

- How would consumption patterns change with economic growth?
- What would be the impact on energy consumption both directly as energy and indirectly as embodied energy in the consumption basket?

- How does the energy ladder of the energy intensity of per capita real output evolve over time?
- How does the structure of value-added from different sectors such as agriculture, industry and services change over time?
- How would measures to reduce emissions intensity affect different sectors of the economy?

IRADe used the IRADe-IAM model to analyse the economic impacts of low carbon measure by comparing a Dynamics as usual scenario and a low carbon scenario up to 2050. The Report also analyses the Dynamics as usual scenario to illustrate the impacts of structural change in the economy on changing energy ladder of energy commodity intensities and patterns of energy consumption.

Supported by: Shell International

3.5. Udaipur Solar City Master Plan

IRADe is preparing Udaipur Solar City master plan for Udaipur Municipal Corporation under the Solar City Programe of MNRE. Urbanization and economic development are leading to a rapid rise in energy demand in urban areas leading to enhanced Green House Gas (GHG) emissions. The program aims at minimum 10% reduction in projected demand of conventional energy at the end of five years, which can be achieved through a combination of energy efficiency measures and enhancing supply from renewable energy sources.

The solar city master plan of the city will include the baseline for energy consumption during the baseline year, demand forecasting for the next five years, sector-wise strategies and action plan for implementation of renewable energy projects like solar, wind, biomass, small hydro, waste to energy etc. may be installed along with possible energy efficiency measures depending on the need and resource availability in the Udaipur city, so as to mitigate the fossil fuel consumption in the city and reduce the Green House Gas (GHG) emissions.

Fateh Sagar Lake, Udaipur

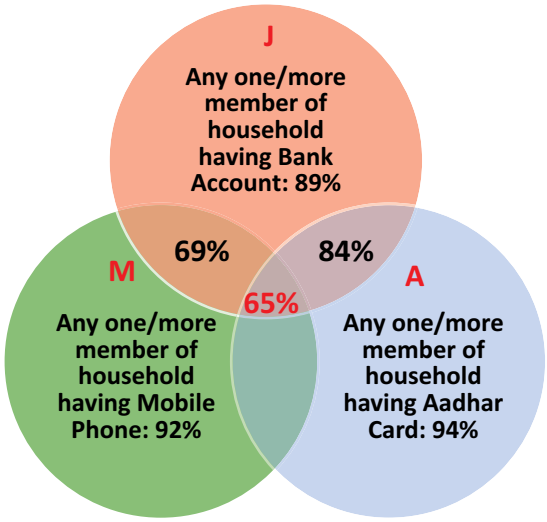
Supported by Udaipur Municipal Corporation, Government of Rajasthan

4 Poverty Alleviation and Gender

4.1. Providing Clean Cooking Fuel in India: Challenges and solutions

India has the largest concentration of population using biomass with inefficient stoves. When modern fuels are unavailable, women and children not only face health hazards due to smoke but also "time poverty". Freedom from smoke and the drudgery associated with biomass is the need of the hour to empower women and allow families to live purposeful lives. This report explored the issues and challenges of clean cooking in urban India through a case study of the Ghaziabad Municipal Corporation, Uttar Pradesh.

We conducted surveys of 250 households in Ghaziabad district using a structured household questionnaire that was delivered between August 5 and October 10, 2015. The detailed questionnaires included information on family structure, socio-economic conditions, energy-use patterns, housing characteristics, cooking behaviour, access to crucial infrastructure for subsidy transfer (JAM) and willingness to pay for liquid petroleum gas (LPG). The energy-use pattern included information on the consumption of solid fuels and commercial fuels for cooking, where cooking fuel is procured, the time and effort involved in procurement, the price at which it is procured, etc. Characteristics of housing and other assets included information on type of house and location of the kitchen. Further information was collected on cooking behaviour, including the number of meals cooked using different fuels in a day, hours of cooking, cooking involvement by male or female members of the household and type of involvement. Reasons for not using clean fuels, willingness to pay for an additional amount of clean fuel and desire to forego the subsidized kerosene quota were also captured.



Households can be reached through JAM

Source: IRADe household survey for LPG Ghaziabad, 2015

To receive benefits from the government under JAM, an individual member of the household has to have all three identities synced (bank account, mobile number and Aadhaar card). The survey in Ghaziabad

revealed that, though nearly 90% of the households had access to these three basic requirements, barely 65% households had at least one member with all three requirements in place that could access the JAM scheme. In some cases, it was possible that different members of the household had access to these three basic requirements, and any individual member of the household did not have these three mandatory things simultaneously in his/her name to qualify for benefits under JAM scheme.

To assess the choice between LPG and alternative cooking fuel by households a multinomial logit model (MNLM) is used. The response variable includes three distinct unordered alternatives: Traditional, mixed and modern cooking fuel. The goal of this model is to find the best fitting model to describe the relationship between outcome variables. Here the predictor variable is family size, highest year of female education in the family, gender composition (percentage of females in the family), monthly PCI, LPG price per MJ, household monthly energy demand and head of household.

The results suggest that increasing household size has a negative effect on household fuel choice, suggesting that increasing family size can result in the use of inferior quality fuel for cooking. Households with more years of female education are less likely to cook with traditional fuel. The household monthly per capita income also turns out to be an important determinant for fuel switching. The LPG price paid by the households is an important determinant of fuel switching. A one-unit increase in LPG price per MJ is associated with a 2.18 decrease in relative log odds of using mixed fuel versus traditional fuel. Similarly, a one-unit increase in LPG price per MJ is associated with a 2.93 decrease in relative log odds of using modern fuel versus traditional fuel.

The household energy demand improved fuel switching in GMC. The results suggest that a unit increase in log monthly household energy consumption is associated with a 3.23 increase in relative log odds of using mixed fuel versus traditional fuel. Moreover, a unit increase in log monthly household energy consumption is associated with a 2.06 increase in relative log odds of using modern fuel versus traditional fuel. The relative log odds of using mixed fuel versus traditional fuel will decrease by 0.34 if moving from male-headed households to female-headed households. Similarly, the relative log odds of using modern fuel versus traditional fuel will decrease by 0.67 if moving from male-headed households to female-headed households.

The recommendations largely focus on laying a path to eliminate unequal distribution of cooking fuels among the economically challenged and to further strengthen the availability and distribution to all, including those in the remote areas. We hope that the Government of India, oil companies, the state government and other related authorities will find the results and recommendations helpful in enhancing the access to clean energy for cooking, especially to poor households. The government can use this study to design a nationwide LPG distribution plan.

Sponsored by International Institute for Sustainable Development (IISD)

4.2. Gender and Energy Sector Reform

This research aims to look at the opportunities for and impacts from energy sector reform in India and the removal of fossil-fuel subsidies on gender, especially from the perspective of women and children. Research will be undertaken globally to identify examples of best practice of implementation of positive energy sector reform policies that have worked well for women, as well as those that have not worked well. The work will cover those research methods deployed to understand the impacts of energy sector reform on different sections of society and on the impacts of policy change on gender drawing from other sectors such as health and education. From this understanding a detailed national household level research will be undertaken in India.

This is a 4-year study starting from February 2015. As per the stated work plan scoping research report has been prepared and submitted to donor organization. The scoping report comprehensively cover the available literature on the subject and draw upon research methodology extensively. This study aims to provide gender based evidences in efforts to bridge the policy gap that exists between clean energy access and its impact on the role of women. For the purpose of this study, 2 streamlined research questions have been identified from scoping study to investigate in detail.

The research addresses following questions:

1. How do existing LPG subsidy policies affect the welfare, productivity and empowerment of women and girls in urban, peri-urban and rural low-income households in two districts—preliminarily identified as Ranchi (in the state of Jharkhand) and Raipur (in the state of Chhattisgarh)—taking into account
   - Impacts of the subsidy on LPG distribution?
   - The extent to which the subsidized price is actually reflected in LPG retail prices paid by consumers?
   - The extent to which lower LPG retail prices influence household fuel use?

2. How might the welfare, productivity and empowerment of women in low-income households change as a result of the following policy reforms:
   - Strengthening the existing LPG distribution network
   - EMI (earnest monthly instalment) facility for availing LPG connection
   - Implications of distribution of free LPG "connection" (registration and starter kit) to below poverty line (BPL) households

Two states—Jharkhand and Chhattisgarh—have been selected as locations to perform the case study. These are among the 4 most backward states of India in terms of access to clean cooking energy sources. Jharkhand and Chhattisgarh are two neighboring States with only 11.66% and 11.18% households using LPG as main cooking fuel and 86.90% and 87.74% households uses solid fuels for cooking. These states possess similar socio-economic characteristics but different policy and administrative environment. For instance, as per union government scheme any BPL category people wanting a new LPG official connection of 14.2 kg cylinder will be given a rebate of Rs. 1,600. The rebate includes Rs. 1,450 as security deposit for cylinder and Rs. 150 as cost of pressure regulator. This policy has been further enhanced in Jharkhand where the state government is providing an additional assistance of Rs. 918.50 per connection for other items (except hot plate), thus making the LPG startup cost virtually zero for the BPL families in Jharkhand.

The case study will be developed for two specific districts Ranchi from Jharkhand and Raipur from Chhattisgarh. Raipur (36% urban and 64% rural) and Ranchi (43% urban and 57% rural) represent a balanced mix of rural and urban population in the selected state will be useful to understand the major cooking fuel issues in both rural and urban areas. Moreover, 29.5% and 19.3% households use LPG as main source of cooking in Ranchi and Raipur district respectively (Census, 2011). Therefore, given the similar socio-economic characteristics and different level of LPG penetration in these 2 districts will be good case for a comparative study. The study will use combination of qualitative and quantitative approaches.

To collect gender disaggregated data household sample surveys will be conducted. The survey will be based on a stratified sampling design, using adequate sample size. With stratified sampling, the sample sizes within each stratum are controlled by the sampling technics rather than by a random determination through the sampling process. The study will collect information through one-on-one interviews with those who make or implement policy to understand their concerns. It will also help in defining a way to engage stakeholders, so that impact of research on policy can be maximised. Focus Group Discussions' (FGDs) of end-users to gauge energy access and supply status in the location and opinions on energy policy reforms and programs. Women stories will also be captured through FGD. This will provide an insightful understanding of complex issues and situations.

In the second year secondary data from various sources will be analyzed, and consultation will be carried out from stakeholders *inter alia* policy makers, decision makers and distributors.

Sponsored by ENERGIA, Department for International Development (DFID)

5 Events, Meetings and Workshops

5.1. COP 21 DIALOGUE – How can long term sustained financing be structured for mitigation and adaptation

The seminar on "How can long-term and sustained financing be structured for mitigation and adaptation" was organized by the French Embassy in India in collaboration with Integrated Research and Action for Development (IRADe) on 29th June, 2015. As events leading up to Paris, IRADe and the French Embassy held two dialogues to address significant issues in the context of COP 21. Seminar was held to provide greater visibility to the perspective of Indian stakeholders on issues pertinent to the global climate negotiations.

From L-R, Ms. Rajasree Ray, Mr. Dipak Dasgupta, Dr. Jyoti Parikh, Ms. Namita Vikas and Mr. K.S. Popli

COP 21 Dialogue: How can long-term and sustained financing be structured for mitigation and adaptation

The recommendations largely focused on the importance of mitigation technologies and adaptation which were raised during the Paris negotiations.

5.2. Stakeholder Dinner Meeting on "Catalysing Cross-Border Electricity Trade in South Asia: South Asia Forum of Electricity Regulators (SAFER)"

SARI/EI - IRADe organized a high-level meeting in New Delhi on August 5, 2015 to deliberate the role of the South Asia Forum of Electricity Regulators (SAFER). The meeting convened key stakeholders such as India's Central Electricity Regulatory Commission (CERC); South Asia Association for Regional Cooperation (SAARC), Energy Centre, Islamabad, Pakistan; Bangladesh Energy Regulatory Commission (BERC), Bangladesh, Ministry of Economic Affairs, Bhutan, Indian Renewable Energy Development Authority (IREDA), India; Power Trading Cooperation; India (PTC), Indian Energy Exchange (IEX); Power Finance Corporation, India (PFC); Rural Electrification Corporation (REC), India; National Hydro Electric Corporation Ltd. (NHPC), India; Power System Operation Corporation Ltd., India (POSOCO) among other dignitaries and guests.

From L-R Mr. Gireesh Pradhan, Dr. Jyoti Parikh, Ms. Monali Zeya Hazra and Mr. V.K. Kharbanda

Stakeholder Dialogue on "Catalyzing Cross-Border Electricity Trade in South Asia: SAFER", 5th August 2015, New Delhi

The meeting concluded with an agreement that emerged from the discussions that there is a need for a regional institutions to assume the role for regulatory coordination/harmonization for CBET.

5.3. The Combined Meeting of SARI/EI Task Forces, on 5-6 August, 2015 at New Delhi, India

IRADe convened all the three SARI/EI task forces, such that the 5th Meeting of Task Force-1 on Coordination

Combined Meeting of SARI/EI Task Forces, 5-6 August 2015, New Delhi

of Policy, Legal and Regulatory Framework, the 4th Meeting of Task Force-2 on Advancement of Transmission Systems Interconnections and the 2nd Meeting of Task Force-3 on South Asian Regional Electricity Market were held, creating a highly interactive meeting and deliberation of various aspects of CBET studies undertaken by SARI/EI-IRADe. The meeting also released the SARI/EI publication developed by IRADe, "Regional Regulator Guidelines".

(L-R) Dr. Jyoti Parikh, Dr. Kirit Parikh, Dr. Naeem Malik, Mr. Colin Dreizin, and Mr. V.K. Kharbanda

Launch of Regional Regulatory Guidelines

5.4. International Voluntary Leadership Program under the Theme of Climate Change

Dr. Probal Pratap Ghosh was selected by the US Government for visiting the United States of America under the International Voluntary leadership program under the theme of Climate Change in the background of the work that he has been doing in the field of climate change in the past few years. Dr. Ghosh was selected along with a group of 8 researchers working in the field of climate change to visit the US and interact with various organisations and researchers working in the field of climate change.

International Voluntary Leadership Program, USA

The tour took Dr. Ghosh and his colleagues to 5 different US cities spread across the country for 21 days from September 19, 2015 to October 20, 2015. The group was led during the tour by a liaison office appointed by the US state department with whom the group visited various researchers in Washington DC, Rhino Nevada, Los Angeles in California, Austin in Texas and finally to New York City. The Visit was organised by the State department of USA with help from the Graduate school, USA which did the coordination of the visits across different cities and overall administrative requirements for the visit.

5.5. "SAARC Perspective Workshop on the Past, Present and Future of High Voltage DC (HVDC) Power Transmission" at Lahore, Pakistan

SARI/EI delegation comprising Mr. V.K. Kharbanda, Project Director, SARI/EI, IRADe and Mr. Rajiv Ratna Panda, Senior Project Manager, SARI/EI, IRADe, participated as Resource Person in the SAARC Energy Centre's workshop titled "SAARC Perspective Workshop on the Past, Present and Future of High Voltage DC (HVDC) Power Transmission" held on 30th September - 01st October, 2015 at Lahore, Pakistan. The workshop

was inaugurated by Ch. Abid Sher Ali, Hon'ble Minister of State for Water and Power, Pakistan. The event was attended by around 70 participants from South Asian region. SARI/EI delegation made three paper presentations on following topics:

- South Asian Power Sector: Investment Prospects, Challenges and Issues
- Harmonization of Grid Codes, Standards and Operating Procedures for Transmission System Interconnections (both HVDC and HVAC) for facilitating/promoting CBET in South Asia Region.
- SARI/EI: Key Activities undertaken and the Way Forward.

5.6. Climate and Disaster Resilient Smart Cities

IRADe and ACCCRN in partnership with Technology, Information, Forecasting and Assessment Council (TIFAC), DST, GoI organized IDRiM TIFAC-2015 session on the theme "Climate and Disaster Resilient Smart Cities" under the 6th Conference of the International Society for Integrated Disaster Risk Management (IDRiM-TIFAC 2015) on "Disaster Risk Reduction: Challenges and Opportunities for Sustainable Growth" on 28th October, 2015.

From L-R, Mr. Ajit Kaliyath, Ms. Asha Kaushik, Mr. Rohit Magotra and Dr. Tomoko Okayama

IDRIM session on Climate and Disaster Resilient Smart Cities

The session aimed to bring together experts working in areas of Urban Resilience, Climate Change and Disaster Management for highlighting the issues related to mainstreaming climate change concerns into urban development planning framework for planning smart cities in India.

5.7. International Study to Nord Pool Power Market (Norway and Denmark), 12th – 16th October 2015

IRADe conducted an international study tour under the SARI/EI project to the Nord Pool Power Market from 12th October 2015 to 16th October 2015. The delegation that included government officials and other key energy sector entities were from Bangladesh, Bhutan, Nepal, and Sri Lanka as well as from India, besides SARI/EI-IRADe and USAID officials. The objective of this study tour was to give an insight to the members of the establishment, evolution, and growth etc. of the Regional power market so that the members can suitably apply the learnings to the growing Cross-Border Market in the South Asian Region. In the Nord Pool about 85% of all energy produced in the Nordic region is traded at the Nordic exchange.

SARI/EI delegates at Nord Pool Spot, Norway

The delegation visited the Nord Pool Spot market in Oslo, Norway and the Transmission System Operator (TSO) of Denmark, Energinet at Frederecia. Speakers from NASDAQ and Statekraft also addressed the delegates.

5.8. COP 21 DIALOGUE - Cities Resilience to Climate Change

The seminar on "Cities Resilience to Climate Change" was organized by the French Embassy in India in collaboration with Integrated Research and Action for Development (IRADe) and Asian Cities Climate Change Resilience Network (ACCCRN) on October 30th, 2015.

Event engaged with prominent experts including Ms. Thara, Municipal Commissioner of Ahmedabad

and Dr. Sudhir Krishna, Former Secretary, MoUD to share and direct discussions in the context of India's expectation aligned to the Paris text. These discussions were largely attributed to sustainable planning for climate resilient infrastructure. IRADe presented extensive work it has carried out on climate resilience in 20 cities.

Dr. Jyoti K. Parikh, Executive Director, IRADe concluded by saying that "If we are to meet future challenges with effective solutions and sufficient level of preparedness, we must begin today to devise mitigation and adaptation strategies for the cities which will lead way to development of climate resilient and low carbon cities''.

From L-R Mr. Mahesh Babu, Prof. Jagan Shah, Dr. Sudhir Krishna, Ms. D Thara, Mr. Rohit Magotra and Mr. François Richier

COP 21 Dialogue: Cities Resilience to Climate Change

5.9. National Stakeholder Consultation on New Energy Policy (NEP): Environment and Climate Change Perspectives

IRADe host a workshops/stakeholder consultation in partnership with NITI Aayog, Government of India on "Environment and Climate Change" themes to provide inputs to the National Energy Policy (NEP). on November 6, 2015 which served as a platform to gather and discuss their policy positions on various sectors including that of Energy and Climate Change, Transport and Air-Pollution and CAMPA. Following India's INDC submission to the UNFCCC for the Paris Climate Agreement 2015, this platform served as a discussion forum to plan further actions to achieve India's established INDC targets for 2030.

National Energy Policy Workshop

The main objective of the workshop was to understand the perspectives of various stakeholders for the NEP from the environment and climate change perspectives. The workshop provided an opportunity for a diverse group of stakeholders to come together and discuss inputs to the NEP which are futuristic, address the institutional mechanism to implement the policy and also cover issues of energy access, security and afford ability in the country. The findings of the workshop have wide-ranging implications for policy.

5.10. The 4th Meeting of Project Steering Committee, 9th December 2015, Mumbai, India

The 4th Project Steering Committee Meeting was held on 9th December 2015 at Mumbai, India. Members of the Project Steering Committee (PSC) from various South Asian countries along with representatives from IRADe, USAID attended the meeting. The PSC met to review the activities of SARI/EI in the year 2014-15 besides the key achievements and lessons learnt. The PSC discussed and finalized the Annual Work Plan for 2015-2016. SARI/EI reports on Regional Regulatory Guidelines and Regional Regulatory Institutional Mechanism were presented before the PSC.

The 4th meeting of SARI/EI Project Steering Committee

A detailed presentation on the updates and key findings of SARI/EI Demand Driven and Analytical Studies were held to seek the PSC's inputs. SARI/EI presented its consensus building agenda and took the Committee's inputs for SARI/EI outreach strategy. PSC Members including Mr. Dasho Yeshi Wangdi (Sec, MOEA, Bhutan), Dr. Sanjay Sarma (PSC Chair and Jt. Sec, MOE, Nepal), Mr. Major Singh (Member (Planning), CERC India), Mr. Vaqar Zakaria (MD, Hager Bailey, Pakistan), Dr. P.N. Fernando (Consultant, Sri Lanka) participated in the meeting. Mr. Colin Dreizin (Director, USAID), Ms. Monali Zeya Hazra (Regional Energy Manager, USAID), Ms. Vandana Vats (Acquisition Specialist, USAID), Dr. Jyoti Parikh (Exec Director, IRADe), Mr. V.K. Kharbanda (Proj. Director, SARI/EI-IRADe), Dr. Pradeep Dadhich (Dep. Director, IRADe), Mr. S.K. Ray (Tech Specialist, SARI/EI-IRADe), Ms. Reshmi Vasudevan (Project Coordinator, SARI/EI-IRADe), Mr. Rajiv Ratna Panda (Head Tech, SARI/EI-IRADe), Mr. Probal Gosh (Head Modelling, SARI/EI-IRADe) and Mr. Gaurav Jain (Sr. Research Associate, SARI/EI-IRADe) participated in the PSC meeting.

5.11. Sustainable Integrated Energy Strategies for Gujarat - Meeting with the Minister of Energy and other Stakeholders

From L-R, Sh. Govindbhai Patel, Shri Saurabhbhai Patel, and Sh.G.R. Aloria

Stakeholders meeting to present and discuss project report

A stakeholder meeting was organised by IRADe at Swarnim Sankul, Sachivalaya, Gandhinagar on December 21, 2016 in the auspicious presence of the Hon'ble Minister for Energy, Sh. Saurabhbhai Patel, Minister of State, Sh. Govindbhai Patel and Sh. G.R. Aloria, IAS, Chief Secretary, Gujarat. IRADe gave a detailed presentation on the energy plan prepared by it. Deliberations were held post presentation and suggestions were taken into consideration. Further the Minister thanked IRADe for their untiring efforts to prepare the plan and requested all the stakeholders to follow and implement the plan and the policies in line with Gujarat Government.

5.12. Workshop on Sustainable Development of Power Sector and Enhancement of Electricity Trade in the South Asian Region and the Way Forward: Policy, Regulatory Issues/Challenges

IRADe in association with the South Asia Forum of infrastructure Regulation (SAFIR) successfully organised a Workshop on "Sustainable Development of Power Sector and Enhancement of Electricity Trade in the South Asian Region: Policy, Regulatory Issues/ Challenges and the way forward" (under USAID's SARI/ EI Program), 15th January, 2016 in New Delhi, India.

Shri Pradeep K. Pudari, Secretary, Ministry of Power addresses the Workshop

The workshop discussed and deliberated on *inter alia*, key policy and regulatory frameworks, challenges and need for coordinated policies/regulation for sustainable development of regional energy resources and enhancement of CBET the South Asian region and lessons learnt from international experiences in power market development and Cross-Border Electricity Trade. The workshop was attended by regulators from all south Asian countries and the states of India, besides policy and decision makers, regulators, power utilities, private sector, MDBs, donor agencies, among others.

5.13. Gujarat Energy Strategies: Energy Report Release by Hon'ble Chief Minister of Gujarat Smt. Anandiben Patel

From L-R Dr. Jyoti Parikh, Smt. Anandiben Patel and Dr. Kirit Parikh

The final report on "Sustainable Integrated Energy Strategies for Gujarat" was released by Hon'ble Chief Minister of Gujarat, Smt. Anandiben Patel on 19th January 2016 at Gandhi Nagar, Gujarat along with Dr. Jyoti Parikh and Dr. Kirit Parikh. The report was discussed with the Chief Minister along with Principal Secretaries of energy, climate change and CM's secretariats.

5.14. Stakeholders Consultation Workshop: Review of Status of Marine National Park, Jamnagar and Evolving Vision Statement for Management of MNP, Jamnagar, Gujarat

A stakeholder's consultation workshop on "Review of status of Marine National Park, Jamnagar and Evolving vision statement for Management of MNP", was organized by IRADe on March 08th, 2016 at Jamnagar, Gujarat. The workshop was supported by GIZ (Gesellschaftfür Internationale Zusammenarbeit), Germany and coordinated by the Ministry of Environment, Forests and Climate Change (MoEFCC), Government of India (GoI).

The workshop, through the process of dialogue and knowledge sharing, is aimed at identifying the most suitable practices for the conservation of Marine National Park in harmony with sustainable development of community's dependent on it. It will also highlight the interventions needed from different stakeholders to ensure that these practices are actually streamlined into ground realities. The purpose of the workshop is to share the findings of the review and discuss with all the stakeholders the steps needed for the conservation of Marine National Park.

From L-R Mr. Bharat Pathak, Dr. Micheal Vakily, Dr. H.S. Singh, Mr. Shyamal Tikadar and Mr. Rohit Magotra

Marine National Park Stakeholders Consultation Workshop, Jamnagar, Gujarat

Ultimately, it was recognized that industrial activity do harm the environment however, industrial representatives were eager to support the conservation efforts towards sustaining the marine diversity. It was also recognized that proper management of Marine National Park require a seascape/landscape approach which will incorporate the study of impact of different activities in the entire Gulf on MNP.

5.15. Stakeholder Consultations for "Macroeconomic and Analytic Study Focusing on Benefits from Nepal-India Electricity Trade"

A Stakeholder's consultation was undertaken on 19-20 January 2016 in Kathmandu, Nepal with NEA, WECS, Ministry of Energy, Nepal Planning Commission, Nepal Rashtriya Bank, IBN, IIDS, ADB, World Bank representatives etc. for **"Macroeconomic and analytic study focusing on benefits from Nepal-India electricity trade"** under the South Asia Regional Initiative for Energy Integration (SARI/EI). Presentations on them were made to the various stakeholders.

The workshop primarily focused on consultation with the stakeholders to undertake:

- **Consultation on Key Inputs to Nepal TIMES Model and Macro Economic Model:** Initial results of Nepal Answer-TIMES and on multipliers showing the economic impact of injection of one unit of electricity in Nepal power system using the 2007 SAM matrix were discussed.
- **Consultation on Results from Preliminary Work:** Preliminary results such as energy generation, trade and shortages were shared with the participants. Supply curve that highlights the potential of various technologies at various export prices were also discussed during the workshop.

Stakeholder Consultations workshop in Kathmandu, Nepal

- **Inputs of Experts on Energy Scenarios:** For building various scenarios for Nepal Model, expert advice were taken through the stakeholder consultation.

Workshop concluded with stakeholder's suggestions on Nepal TIMES Model and Nepal's Macro Economic Model. They further suggested the integration of Nepal TIMES Model with India TIMES model.

5.16. SARI/EI Delegation to the 2nd Meeting of SAARC Energy Regulators, 8th February 2016, Colombo, Sri Lanka

The SAARC Secretariat, Nepal, invited SARI/EI in the Second Meeting of SAARC Energy Regulators held on 08th-09th February 2016 at Colombo, Sri Lanka. Key Findings of the SARI/EI Study on a) Harmonization of Grid Codes, Operating Procedures, Standards for promoting Cross-Border Electricity Trade (CBET) in South Asia Region and b) Regional Regulatory Guidelines (RRGs) were presented during the meeting. The SAARC Energy regulators and members acknowledged and appreciated the work being carried out by SARI/EI.

A delegation comprising of Mr. V.K. Kharbanda, Project Director, SARI/EI-IRADe and Mr. Rajiv Ratna Panda, Head-Technical, SARI/EI-IRADe participated in the workshop.

SARI/EI Delegation presented at the second meeting of Energy Regulators, 8th Feb 2016

6 Professional Activities

Dr. Jyoti Parikh

- Chaired the session "**Recent Initiatives on Climate Finance set up and what move needs to be done**" at the workshop on "Climate Change Finance in India", organized by Department of Economic Affairs of the Ministry of Finance and GIZ, 23rd April, 2015, New Delhi.
- Speaker at the 16th Annual India Tech Triple Expo 2015. Topic "**Disaster and Climate Resilient Planning for Smart Cities**", Organized by India Tech Foundation, 30th April, 2015, Mumbai.
- Speaker at Brainstorming session on Climate Change. Organized by National Academy of Sciences, India (NASI), 19th May, 2015, Jammu.
- Speaker at the Seminar on the theme "**Could Technology partnerships catalyse climate negotiations?**" Organized by French Embassy in preparation for COP 21 meeting at Paris, 21st May, 2015, New Delhi.
- Speaker at Think-20 Turkey Workshop. Organized by TEPAV G20 Studies, 12th June, 2015, in Izmir and Bodrum, Turkey.
- Attended the launch Ceremony of Flagship program on Smart cities by the Prime Minister Shri Narendra Modi. Organized by MoUD, 25th June, 2015, New Delhi.
- Speaker at 2nd Power Southeast Asia Conference and Exhibition, 14th September, 2015, Yangon, Myanmar.
- Panelist at Workshop on Growing Coal, Growing Renewables, Discom Realities and carbon implications. Organized by Brookings India, Sept, 2015, New Delhi.
- Attended Research Council Meeting of NEERI Organized by NEERI, 5th October, 2015, Nagpur.
- Participated in Summit on Global Agenda 2015. Invitation from World Economic Forum, 26th October, 2015, Abu Dhabi, UAE.
- Chaired the session on Climate Change Impacts on other Sectors. MoEFCC, 29th October, 2015, New Delhi.
- Speaker at Smart City Expo World Congress, 17th November, 2015, Barcelona, Spain.
- Lead Speaker at session III, EU-India Cooperation. Invitation from Delhi Policy Group, 22nd January, 2016, New Delhi.
- Participated in the event on "Empowering Women & Girls". Organized by Bill & Melinda Gates Foundation, 11th March, 2016, New Delhi.

Mr. Sharad Verma

- Participated in Sustainability Partnerships roundtable at SPA, New Delhi, organised by IIT-D, and Arizona State University, USA on 16th October, 2015.
- Attended the India-UK Technology Summit, Knowledge Expo at Le Meridien, New Delhi, organised by RCUK, UK Govt. on 9th December, 2015.

Dr. Probal Ghosh

- Participated in the India Modelling workshop at the NITI Aayog under US-India energy dialogue on June 2, 2015.
- Visited Nepal to meet government ministry representative and to establish contacts for data on Analytical studies for India Nepal Energy Trade from 31st August to 5th September.
- Participated in Stakeholder conference for India Nepal Analytical studies, 19-20th January, 2016 at Hotel Radisson, Kathmandu.
- Participated in a Workshop on "Regional Power Trade with special focus on Nepal-India" on 28th April, 2016 at Hotel Radisson, Kathmandu.

Mr. Rajiv Ratna Panda

- Presentation on "Harmonization of grid codes, operating procedures and standards to facilitate and promote CBET in the south Asia region "in the SAARC Perspective Workshop on the Past, Present and Future of High Voltage DC (HVDC) Power Transmission held on 30th September - 01st October, 2015 at Lahore, Pakistan organized by SAARC Energy Center.

Dr. Ashutosh Sharma

- Participated in CEEW-IISD National Dialogue on Subsidies for Energy Access on 4th May 2016 at Imperial Hotel New Delhi.

Mr. Chandrashekhar Singh

- Participated in India Clean cooking forum conference on 6th October 2015 at Sangri-La Hotel New Delhi.

IRADe's outreach and partners

IRADe networks with the government, ministries/departments, international organizations, public and private sectors, academic experts, NGOs, and consultants to work on projects awarded by them. IRADe provides decision support to eleven ministries include Ministry of Environment and Forests and Climate Change, Ministry of New and Renewable Energy, Niti Aayog (formerly Planning Commission), Ministry of Power, Ministry of External Affairs, Ministry of Earth Sciences, Ministry of Urban Development, Department of Science and Technology, Central Statistical Organization under Ministry of Statistics and Programme Implementation, Technology Information, Forecasting and Assessment Council (TIFAC), etc. for many national level projects.

At the international level, IRADe has worked with bilateral and multilateral organization like the World Bank, Asian Development Bank (ADB), U.S. Agency for International Development (USAID); United Nations Development Programme (UNDP); California and United States Environmental Protection Agency (USEPA), Wuppertal Institute for Climate, Environment and Energy, (WISION) Germany; Deutsche Gesellschaftfür Internationale Zusammenarbeit (GIZ), Germany; Rockefeller Foundation; British High Commission; International Institute for Applied Systems Analysis (IIASA), Austria; British High Commission (BHC), Centre for Clean Air Policy (CCAP), USA; International Institute for Sustainable Development (IISD), South South North Trust (SSNT) etc. IRADe has partnered with academic, private sectors, multinational organizations, think tanks and NGOs. These include Shakti Foundation, Indian Council of Social Science Research (ICSSR), SEWA, Petroleum Federation of India, Pricewaterhouse Coopers, ICF International, Rockefeller Foundation, Institute for Social and Environmental Transition (ISET), Center for Clean Air Policy (CCAP), Indian Council for Research on International Economic Relations (ICRIER), InsPIRE Network for Environment, Stanford University and Sir Dorabji Tata Trust (SDTT) among others.

IRADe has also developed strategic partnerships and is part of global networks like the USAID's Low Emissions Asian Development (LEAD) program - ASIA-LEDS, ENERGIA-International Network for Gender and Sustainable Energy, Netherlands; Global Clean Cook Stoves Forum, UN Foundation; Asian Cities Climate Change Resilience Network (ACCCRN), Global Technology Watch Group (GTWG-DST), Climate Action Network South Asia (CANSA).

IRADe has carried out some pioneering work in the field of state level energy planning, city level climate resilience planning, other climate change studies and livelihood studies in agriculturally vulnerable flood prone areas.

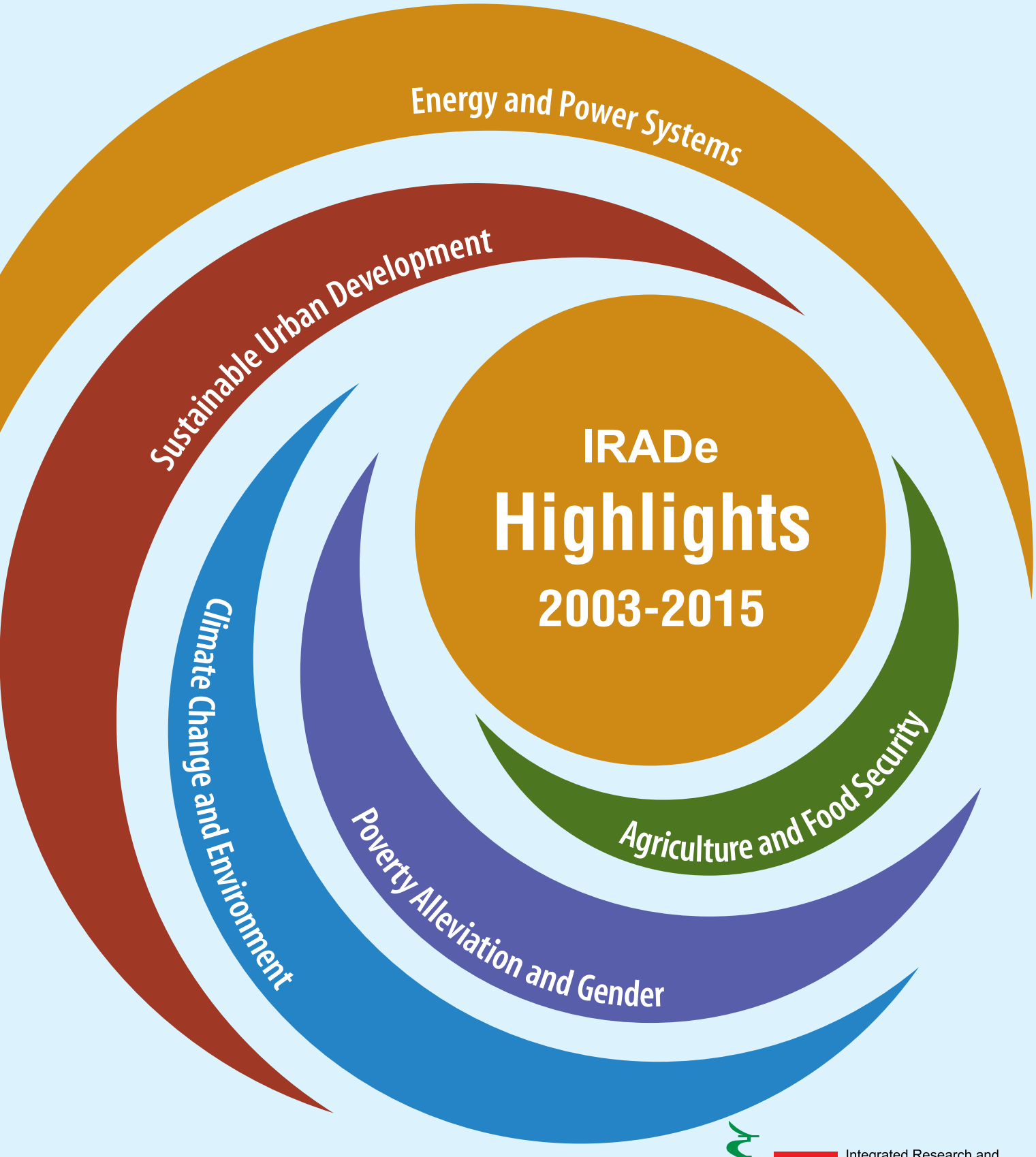
List of Projects

S.No.	Title	Funding Agency	Status
1.	Modelling Studies on Greenhouse Gas Emissions (GHG) and Emission Intensity of Indian Economy	Ministry of Environment Forest and Climate Change (MoEF&CC), GoI	Completed
2.	Review of status of Marine National Park (MNP), Jamnagar and evolving vision statement for management of MNP	GIZ and the Ministry of Environment, Forests and Climate Change	Completed
3.	Environmentally Sustainable and Integrated Energy Strategies for Gujarat	Gujarat Energy and Petrochemicals Department and Gujarat Power Corporation Limited (GPCL)	Completed
4.	Clean Cooking fuel: Issues and Challenges	International Institute for Sustainable Development (IISD)	Completed
5.	South Asian Regional Initiative For Energy Integration (SARI/EI)	United States Agency for International Development (USAID)	Ongoing
6.	Global Technology Watch Group (GTWG) on Advanced Coal Technologies (ACT) for Power Generation	Ministry of Science and Technology, Department of Science and Technology, Government of India	Ongoing
7.	Energy Sector Reforms and impact on Gender	ENERGIA	Ongoing
8.	Policy engagement work in India to educate decision makers at national/ state/city level to urban climate change resilience and integrate the concepts into wider planning discourse	Rockefeller Foundation under ACCCRN Project	Ongoing
9.	Udaipur Solar City Master Plan	Udaipur Municipal Corporation, Government of Rajasthan, MNRE funded scheme	Ongoing

Partners and Sponsors

Integrated Research and Action for Development (IRADe)
C-80 Shivalik, Malviya Nagar, New Delhi - 110017
Tel.: 91 (11) 2667 6180, 2667 6181, 2668 2226
Web: www.irade.org

Integrated Research and Action for Development



IRADe Integrated Research and Action for Development

Integrated Research and
Action for Development

IRADe
Highlights
2003-2015

Integrated Research and
IRADe Action for Development

C-80 Shivalik, Malviya Nagar, New Delhi – 110017
Tel.: 91-11-2667-6180, 2667-6181, 2668-2226
Email: info@irade.org Web: www.irade.org

Overview

IRADe

Background

IRADe is an independent advanced research institute which aims to conduct research and policy analysis to engage stakeholders such as government, non-governmental organizations, corporations, academic and financial institutions. Energy, climate change, urban development, poverty, gender equity, agriculture and food security are some of the challenges for the twenty first century. Therefore, IRADe research covers these, as well as 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 and Development Organisation by the Department of Scientific and Industrial Research (DSIR), Ministry of Science and Technology (MoST). It has also been selected as a Centre of Excellence by the Ministry of Urban Development (MoUD) for urban development. In addition, it provides expertise to other ministries, national and international institutions and partners with other reputed organisations.

Thematic Areas

- Energy and Power System
- Sustainable Urban Development
- Climate Change and Environment
- Poverty Alleviation and Gender
- Agriculture and Food Security

Cross Cutting Themes

- Inclusive Development
- Technology Assessment
- Modelling and Systems Analysis
- Sustainability and Resource Efficiency
- Socio-Economic Impact

Key Activities

- Research and Analysis for Decision Support
- Action and Implementation at Local Level
- Training and Capacity Building
- Policy Advocacy and Dissemination
- Maintaining and Evaluations of Projects

IRADe's Objectives

- Integrate multidisciplinary and multistakeholder 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.

Contents

Miles Travelled.....

IRADe

Prof. Jyoti Parikh, PhD
Executive Director, IRADe

Integrated Research and Action for Development's (IRADe's) journey began with an idea of addressing real-life problems. As no real life problem can be examined with a single discipline or from one point of view, it meant using multi-disciplinary and multi-stakeholder approaches. We always had a clear vision – to develop understanding which would integrate multi-stakeholder perspectives especially for a public policy purpose. Such an approach would help build consensus among stakeholders and bring people on the same platform towards a common goal. Before starting IRADe, considerable preparatory work was done when we were in Mumbai, where we met various like-minded people and drafted its charter.

Although registered in September 2002, IRADe started operating on July 2003. We began in one room with a meagre amount and now have a team of 40, with a building of our own in South Delhi. IRADe has now evolved in to a well-established, globally recognized and a sought after think tank for policy analysis. It become a Centre of Excellence for urban development in a short span.

In the thematic areas chosen by IRADe, we not only do policy analysis and research but also carry out monitoring and evaluation of policies and programmes, disseminate our findings, organize policy dialogues, carry out action projects, surveys and training. We believe we have made a difference through several influential projects such as South Asia Regional Initiative for Energy Integration (SARI), climate resilient urban development, vulnerability profiles of Indian cities, low carbon development pathways for sustainable India, climate negotiations, modelling of Indian economy, techno-economic assessment of emerging technologies such as biofuels, carbon capture and storage and renewable energy, price reforms for petroleum products, etc. We also do city (30 cities) and state level analysis of climate vulnerabilities (Himachal Pradesh and Uttarakhand), environmental accounting (Goa and Andhra Pradesh), energy strategy for sustainable development (Gujarat) and livelihood and gender justice.

Over the years, we have concluded 108 projects that span work from research projects to preparation of policy briefs. However, we have always stressed quality over quantity i.e., our work is often in-depth as some projects are over 3 to 5 years duration. We disseminate work through events/workshops/ conferences, training programmes and stakeholder consultations. Some notable workshops and mega conferences are well remembered for their advance preparation and effective delivery. Projects and studies done in each of the five thematic areas are presented here, where the first page introduces the theme and indicates sub-thematic areas.

The success we have achieved is due to dedicated and sincere efforts of many of the past and present staff of IRADe. Many well wishers, decision makers and other think tanks have helped us over these years. Many sponsors have generously supported us not once but several times. Over the years, the Council members have always given their whole hearted support.

We present you a compendium of these efforts made over 12 years to understand us better. We have provided glimpses of events and highlights of the research projects. We hope our work speaks louder than our words and that we have made a difference by introducing new ideas through policy analysis.

We are happy to see our vision – IRADe – growing!

Jyoti K. Parikh

Jyoti Parikh
Executive Director

GOVERNING COUNCIL, 2015

Prof. Kirit S. Parikh, PhD
Chairman, Former Member, Planning Commission

Prof. Jyoti K. Parikh, PhD
Member Secretary, Energy, Environment and Climate

Ms. Ela Bhatt
Founder
Self Employed Women's Association

R.A. Mashelkar, PhD
Former Director General, Council for Scientific & Industrial Research

Ms. Meera Shankar
Former Ambassador, GoI

Prof. Deepak Nayyar
Economist, Former Vice Chancellor, Delhi University

Mr. Suresh Prabhu
Minister of Railways

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Lord Nicholas Stern
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Prof. Gustav Speth
Yale University

FOUNDING MEMBERS, 2002

Prof. Kirit S. Parikh, PhD
Chairman, Former Member, Planning Commission

Manmohan Singh, PhD
Former Prime Minister, India

Ms. Ela Bhatt
Founder, SEWA

Mr. Adi Godrej
Industrialist

Mr. Keshub Mahindra
Industrialist

R.A. Mashelkar
Former Director General, CSIR

Mr. Shirish Patel
Consulting Civil Engineer

Prof. Jyoti K. Parikh, PhD
Member Secretary, Energy, Environment and Climate Change

IRADe founding members (from left to right): Kirit Parikh, Shirish Patel, Manmohan Singh, Jyoti Parikh, RA Mashelkar and Adi Godrej

IRADe is registered under Society's Act in 2002 at New Delhi. It is an R&D organization recognized by the Department of Scientific & Industrial Research (DSIR), Ministry of Science & Technology (MoST). IRADe is also recognized as a Centre of Excellence for Urban Development and Climate Change by the Ministry of Urban Development (MoUD).

Events, Meetings and Workshops: Some Memories

IRADe

IRADe organizes events for disseminating results, policy diagnosis, multistakeholder consultations etc. IRADe plans these carefully to ensure the presence of decision makers to take the conclusions further in real life. IRADe's events are inaugurated and participated by luminaries such as the President of India, Prime Minister, cabinet and state level ministers, secretaries and other heads of national and international organizations including private and public sectors. IRADe also has an international presence. These events are organised in various parts of India and abroad.

Energy Conclave 2006, 'Implementing the Integrated Energy Policy – The Way Forward', 26–28 July 2006

The Energy Conclave 2006 on Implementing the Integrated Energy Policy inaugurated by the Prime Minister Dr. Manmohan Singh was a mega event of three days with more than 300 participants including high-level delegates from various sectors such as coal, oil, gas, power, renewable energy, energy efficiency, finance, science and technology and sustainable development.

It was an unprecedented event during which policies for energy sectors were discussed and recommendations were presented to the Planning Commission.

The Hon'ble Prime Minister Dr. Manmohan Singh giving the inaugural speech at the Energy Conclave, 26 July 2006, New Delhi

Energy Technology Conclave, 2008

IRADe in collaboration with India Energy Forum and World Energy Council organized Energy Technology Conclave on 13–14 March 2008 at New Delhi. The highlight of the event was the talk delivered by former President of India Dr. A.P.J. Abdul Kalam.

He emphasized energy independence, clean-green-energy, provision of Urban Amenities in Rural Areas (PURA) by creating physical, electronic and knowledge connectivities leading to economic connectivity. He outlined a vision of a safe, prosperous, happy and socio-economically developed nation by 2020.

Energy and Climate Summit

Mr. Suresh Prabhu, M.P. addressing the event

IRADe organized the Energy and Climate Summit 2009 to explore interactions of climate change and energy system on 3–4 February 2009 at New Delhi. Union Minister of Power Sushil Kumar Shinde presided, while Montek Singh Ahluwalia, deputy chairman of the Planning Commission, inaugurated it. The summit was attended by energy sector professionals.

Financial Sector Reforms Conclave, 6–8 January 2005

Shri P. Chidambaram, Union Finance Minister, inaugurated the IRADe-IIEF (Invest India Economic Foundation) State Market Conclave 2005, which was aimed at examining financial policy reforms needed to support and foster 8 per cent growth.

Shri P. Chidambaram, Union Minister, Finance inaugurating the IRADe-IIEF State Market Conclave 2005, 6–8 January 2005, New Delhi

Accelerating India's Growth: A Talk by Prof. Joseph Stiglitz

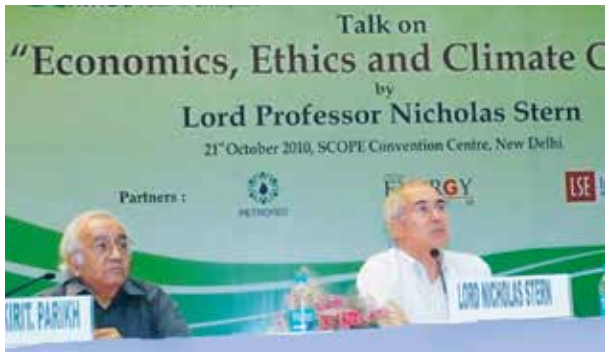
Nobel Laureate Prof. Joseph Stiglitz from Columbia University was the chief guest and was invited to India for an interactive session on 'Accelerating India's Growth: What is needed? as part of the 10th anniversary celebration of IRADe.

Prof. Stiglitz, one of the most influential economists in the world today, emphasized the need for accelerating India's growth and the role of reform. He, however, cautioned against blindly following IMF/World Bank prescriptions and advised keeping country's circumstances in mind.

Economics, Ethics & Climate Change – A talk by Prof. Nicholas Stern

Prof. Lord Nicholas Stern, IG Patel Professor of Economics and Governance, London school of Economics (LSE) delivered a very thought provoking lecture on 'Economics, Ethics and Climate Change' at New Delhi on October 21, 2010. It was organised by IRADe in partnership with PetroFed, World Energy Council, Indian Member Committee; India Energy Forum and LSE India Observatory.

Prof Stern, argued that both economic and ethical considerations call for strong and immediate actions to deal with climate change. While all must act, the burden must be largely borne by industrialized countries.



Alternative Roadmaps on Reforming Diesel Price in India

The workshop was organized by IRADe on 22 August 2012, at Hotel Claridges, New Delhi. Dr. Kirit Parikh, Chairman, IRADe, highlighted the background of the study and stressed the immediate need to reform diesel pricing in India, as it would benefit the economy in the long run.

The workshop brought out the impact of liberalizing diesel pricing for different stakeholders. They included truckers association, farmers, car manufacturers, consumer association, telecom tower owners etc. Many of them felt either that the diesel price rise was not bad for them in the long run and they needed to adapt or that they could

handle the impact, except the trucking association, which felt that only with fuel-efficient trucks it could handle the price rise.

Supported by Shakti Foundation

Biodiesel Summit

IRADe took the lead in 2005 to work on biodiesel sector to explore the relevance of biodiesel option for India. IRADe organized a two-day summit to discuss biodiesel policy and energy security from the perspectives of various stakeholders, viz., farmers, processing units, oil industries, users and regulatory agencies, six ministries participated in the summit.

India's Energy Transition till 2050 in the Global Context

A round table discussion was organized to release the report 'Indian Perspectives on Global Energy Scenarios till 2050'. During the event held on February 8, 2014 at India Habitat Centre, New Delhi, key findings and some of the critical messages concerning the roadmap for transition in the energy mix in India were presented.

The report is based on analysis done in collaboration with the International Institute for Applied Systems Analysis (IIASA), Austria and sponsored by Technology Information, Forecasting and Assessment Council (TIFAC), Department of Science & Technology, Government of India (GOI). Member of the Planning Commission Dr. K. Kasturirangan was the chief guest and released the IRADe-TIFAC-IIASA report, followed by a round table discussion chaired by Dr. Pavel Kabat, CEO and Director General, IIASA.

A New Global Green Deal? – Towards Green Energy Policies for Sustainable Development

IRADe organized an international conference on 'A New Global Green Deal? – Towards Green Energy Policies for Sustainable Development' on 24–25 September 2010 in New Delhi. The conference was supported by Friedrich Ebert Stiftung.

This conference was held to discuss, debate and explore the emerging opportunities for sustainable socio-economic development in the context of energy security and economic crisis. China, Germany, USA, Korea, EU, IMF and UNCTAD shared their concepts on policy issues and strategies on nationally appropriate new green technologies, prudent and proven renewable energy technologies and impact of climate change for holistic global development. Leading experts from India discussed low-emission technologies, technology transfer, role for multilateral agencies, clean energy investment framework, policy and regulatory challenges and enabling mechanism. The participants included public and private sector

executives, officials from Ministries of Central and State governments, national financial institutions, legal and management consultants, environmental scientists, research and development institutions and non-governmental organizations (NGOs).

Sustainable and Climate-Resilient Urban Development

Urbanization and climate change are among the most challenging issues facing India and the world in the coming decades. The international workshop on sustainable and climate-resilient urban development drew a unique combination of decision makers, city mayors and local government representatives, local NGOs and international research experts.

Intensive discussions and presentations held over a two-day period generated a wide array of conceptually grounded and highly practical insights and guidance on how India can begin to address urban challenges in the context of climate change.

The two-day workshop was jointly supported by the UK Department for International Development and the Rockefeller Foundation, US. The workshop was organized by the ACCCRN India Programme partners, IRADe and Institute for Social and Environmental Transition (ISET) with active support from other ACCCRN India partner organizations.

Regional Workshops for Disaster-Resilient and Sustainable Cities

In the year 2014, IRADe, a Centre of Excellence of the Ministry of Urban Development (MoUD) worked extensively in the area of disaster resilience from the point of view of preparing cities and mainstreaming disaster resilience in urban planning. Four regional workshops on 'Sustainable and Disaster-Resilient Urban Development' covering different cities including Shillong, Guwahati and Bhubaneswar (Eastern India); Pune, Ahmedabad and Bhopal (Western India); Vishakhapatnam, Hyderabad (South India) and Dehradun, Srinagar (Northern India) were conducted with active participation of the urban local bodies, parastatal bodies, researchers and urban planners of the respective cities. The workshops were mainly sponsored by the MoUD.

1. North India workshop: 30 December 2014 at New Delhi

   The workshop was inaugurated by **Mr. Shankar Aggarwal, Secretary, Ministry of Urban Development, Government of India.**

2. **East India workshop: 17 October 2014 at Guwahati, Assam**

   The workshop was inaugurated by Mr. Daya Ram Rajbangshi, Additional Commissioner, Guwahati Municipal Corporation, Government of Assam.

3. **South India workshop: 09 October 2014 at Vishakhapatnam, Andhra Pradesh**

   The workshop was inaugurated by G.C. Kishore Kumar, Secretary, Visakhapatnam Urban Development Authority (VUDA), Andhra Pradesh.

4. **West India workshop: 09 September 2014 at Ahmedabad**

   The workshop was inaugurated by Mr. G. S. Aloria, Additional Chief Secretary, Urban Development and Urban Housing Department, Government of Gujarat.

The purpose of the workshops was to build awareness on city disaster-resilience mechanism, dissemination of knowledge and to suggest strategies for disaster-resilient cities. The workshops aimed at building the capacity of city stakeholders (policy makers, urban planners, city administrators, experts, academicians and aid agencies from different regions of India) to strengthen the disaster resilience mechanism and help them deal with related issues and formulate adaptation strategies.

Considerable time was spent in preparing reports of the 10 cities containing hazard analysis, spatial planning as well as levels of benchmarks of urban services.

We acknowledge the support of our Asian Cities Climate Change Resilience Network (ACCCRN) partners.

South Asia Regional Initiative for Energy Integration: Cross Border Electricity Trade

USAID FROM THE AMERICAN PEOPLE SARI/EI

IRADe is the implementing partner for USAID's South Asia Regional Initiative for Energy Integration (SARI/EI) for advancing regional energy integration and Cross Border Energy Trade (CBET) among eight South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Pakistan, Nepal, Sri Lanka and the Maldives).

South Asia Regional Conference of SARI/EI on Cross Border Electricity Trade, 4-5 Oct 2013, New Delhi

SARI/EI South Asia Investor Workshop was held on 24-25 Sept 2014, New Delhi

IRADe in association with the Indian Energy Exchange Limited (IEX) organized a visit to Amsterdam and Paris for understanding the legal and regulatory issues, governance, operational and other aspects of European Regional Power Market, 13-19 July 2014

The SARI/EI inaugural conference on Cross Border Electricity Trade was held in Oct 2013 and was inaugurated by the then deputy chairman of the Planning Commission, Montek Singh Ahluwalia. The conference had a large turnout including high level delegates from both public and private sectors from all the eight participating nations.

IRADe in association with the Confederation of Indian Industry (CII) organized the South Asia Investor workshop in September 2014, an important platform for investors, developers, financial institutions, Multilateral Development Banks and high-level officials from the region to explore challenges and investment opportunities to enhance CBET among the South Asian nations. As cross-border generation and transmission interconnection projects are capital intensive, various aspects require, transparency, reliability and harmonization of policies and regulations to attract investment.

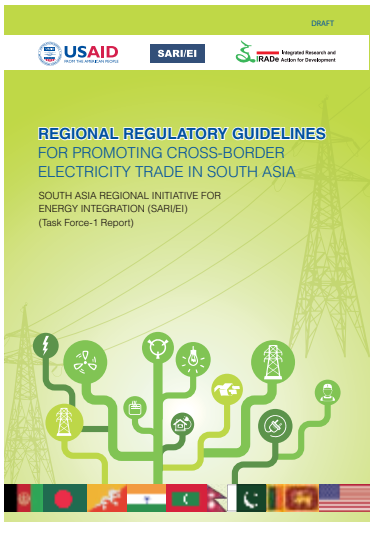
Other Meetings and Conferences

- The SARI/EI team visited Colombo, Sri Lanka from 18-20 December 2012 to meet stakeholders to apprise them of SARI/EI roadmap.
- A workshop on Issues before Regulators in South Asia Region was held on 19–20 February 2013 in Kathmandu, Nepal.
- The first meeting of Task Force-I was held on 24–25 July 2013, in Dhaka, Bangladesh for planning its core activities towards coordination

SARI/EI Project Steering Committee consists of senior Government representatives and think-tanks of SA countries, ex-diplomats and specialists. The first meeting of the PSC was held on 12 March 2013 at New Delhi. The Committee met again in January 2014 at New Delhi and in December 2014, at Dhaka to review the progress of SARI/EI annual activities.

of policies, legal and regulatory frameworks for CBET. Members met again to evaluate the progress in February 2014 in Sri Lanka, in June 2014 at Bhutan and in December 2014 at Bangladesh Dhaka. The Task Force recently brought out the following reports (draft final): (i) "*Recommendations on Regulatory Guidelines for CBET in South Asia*" and (ii) "*Required Changes in Electricity Laws, Policies and Regulations of South Asian Countries for promoting CBET*".

- The first meeting of Task Force-2 was held on 21-22 August 2013, at Thimpu, Bhutan. The team met again in April 2014 at Kathmandu, and in February 2015 at Colombo, to drive the objectives for advancement of transmission system interconnections, both technical and operational aspects of them.



- The first meeting of Task Force-3 was held in Mumbai in April 2014, for creating an enabling environment to establish an electricity market in the South Asia region.
- During 5-6 August 2015 SARI/IRADe released Regional Regulatory Guidelines for CBET.

International Training Programmes 2004, 2005, 2006 and 2007

IRADe organized International Training Programmes (ITP) for four years, every year since 2004, on Renewable Energy Technology (RET) for participants from Asia and Africa. The various topics covered under RET were as follows:

1. 'Renewable Energy in Local, National and Global Context from Socio-economic Perspectives', March 2004.
2. 'Renewable Energy: Techno-Economic, Finance and Socio-Environment Issues', 7–17 December 2004.
3. 'Alternative Fuels: Energy Security, Techno-Economic and Environmental Issues' 23–30 March 2006.
4. 'Role of Renewable Energy in Energy Planning and Expanding Livelihood Options', 14–22 March 2007.

Training-of-Trainers on Economic Instruments for Environmental Management in Asia, 27-29 April 2005

IRADe is a member institution for Network of Institutes for Sustainable Development (NISD) set up under UNEP

The 3-day Training-of-Trainers Workshop on the Use of Economic Instruments (EI) for Environmental Management in Asia was organized by IRADe and was supported financially and technically by UNEP's Economic and Trade Branch. Participants were from China, Indonesia, Vietnam and Nepal. UNEP's Division of Environmental Policy Implementation and the Indian Ministry of Environment and Forests provided additional support.

IRADe-UNEP "Training Session on Capacity Building–Environment, Trade and Sustainable Development"

IRADe organized a Training Session on Capacity Building–Environment, Trade and Sustainable Development" on November 24, 2004 in New Delhi in view of the need to build the capacity of planners, industrial organizations, environmentalists, business community, trade associations and decision makers. The United Nation Environment Program (UNEP) financed the workshop. It was based on the Training Module: Introduction into Capacity

Building for Environment, Trade and Sustainable Development, developed by the UNEP-UNCTAD Capacity Building Task Force (CBTF). Participants came from Research and Information System of Non Aligned and other Developing Countries (RIS), United Nations Conference on Trade and Development (UNCTAD), different ministries, the Planning Commission and several universities.

Workshop on Food Security: Present and Future, 16th September 2008, New Delhi

IRADe celebrated its 6th Foundation day with a panel discussion, organized on "Food Security: Present and Future" at India International Center on 16th September, 2008. The workshop was attended by renowned academicians and NGOs. Dr. Kirit Parikh chaired the penal, and Dr. Abhijit Sen, Member Planning Commission was the chief guest of the event. The eminent panelists were Dr. S. Mahendra Dev, Chairman of CACP, Dr. Ashok Gulati of IFPRI and Dr. Suman Bery, Director General, NCAER.

The workshop highlighted some key aspects necessary to address the issues of food security like maintaining a buffer stock for food grains, use arable land to the maximum, use improved irrigation practices, water management techniques and application of technology (for Fertilizer, Seeds, farm practices and Pesticides etc.). Reduce soil degradation, food wastages needs to be reduced at source upto end user (including Logistics and PDS). Reduce the subsidy burden on the Government in Agriculture sector. Improving credit facilities and co-operative farming practices need to evolve. The food security can be ensured effectively by integrating food grain production, allied agro-products, access to the market, production of value added items, technology enhancement etc. Food security is important mission of Government of India. The effective cooperation of Private and Public sector is essential to make the mission of the Government a success.

International workshop on Carbon Capture and Storage (CCS) in power sector in India 22-23 January 2008 at New Delhi

IRADe conducted a workshop on CCS for reducing Green House Gas (GHG) and CO_2 emission which are important from the point of climate and reducing pollution from fossil fuel based power plant. The workshop was inaugurated by Shri. Kapil Sibal, who was the Minister of Science and Technology and Earth Science. The sponsors were Department of Environment, Food and Rural Affairs (DEFRA), UK, the British High Commission of India, Department of Science and Technology (DST) and Planning Commission.

The workshop highlighted that Carbon Capture and Sequestration (CCS) technology is one of the emerging technologies to restrict CO_2 emission to atmosphere from industrial processes. In the context of Thermal Power plant (TPP), it is a bundle of technologies; preventing the release of carbon dioxide emission with flue gases to the atmosphere.

CCS process chain consists of, (a) capturing the carbon dioxide in flue gases emitted in TPP and then separating it (b) transporting the separated carbon dioxide to the sequestration site (CO_2 as supercritical fluid) and finally (c) securely storing the carbon dioxide at the identified sequestration sites in liquid state. The potential underground sequestration sites are depleted oil and gas fields, deep saline aquifer formations, deep ocean bed, sedimentary rocks, basalt rock formation etc., are being studied for efficacy, stability; these sites are located few kilometer below earth having protective rock covering to prevent CO_2 leakages and (d) Monitoring and Verification of sequestration sites for establishing compliance of Government Regulation is also important.

Workshop stressed that developed countries should lead by example by establishing successful demonstration CCS in their own country. Ongoing R&D works to make CCS technologies, techno-economic viable. Develop and enable legal and regulatory frameworks for CCS at the national and international levels, including long-term liability regimes. Incorporate CCS into emission trading schemes and post-Kyoto instruments. New thermal power plants to include capture/storage readiness (facilities) [Capture ready thermal power plant] considerations within plant design to be commissioned by 2015.

Energy and Power Systems

IRADe

Themes and Projects

South Asia Cross Border Electricity Trade

- South Asia Regional Initiative for Energy Integration (SARI/EI)

State Level Energy Analysis

- Sustainable and Integrated Energy Strategy for Gujarat

Energy Price Reforms

- Assessment of Alternative Road Maps on Reforming Diesel Prices
- Analysis of Kerosene-free Delhi Scheme
- Assessing the Impact of Diesel Subsidy Reform since January 2013
- The Impact of India's Diesel Price Reforms on Trucking Industry

Energy Technology Assessment

- Energy Transitions Needed Till 2050
- Techno-Economic Assessment for Bioenergy in India
- Global Technology Watch Group on Advanced Coal Technologies for Power Generation
- Analysis of Carbon Capture and Storage Technology in Power Sector, India

Rural and Renewable Energy

- Evaluation of Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)
- Overview and Assessment of Indian Renewable Energy and Rural Electrification Programme in the Context of Rural Development

Monitoring and Evaluation

- Monitoring and Evaluation of Off-Grid Solar Photovoltaic Systems Installed in Punjab and Himachal Pradesh in the Years 2008, 2009 and 2010
- Evaluation of Franchise System in Assam, West Bengal, Nagaland and Rajasthan
- Evaluation of Solar Thermal Demonstration Projects in Four States of India
- Evaluation of Solar Photovoltaic Programme in Six States of India
- Survey and Evaluation of Remote Village Area Electrification Project through Solar Photovoltaic System in Rajasthan and Haryana
- Village Energy Security Programme in Vavdi and Vaddithar Hamlets in Patan District of Gujarat

Biodiesel Analysis and Implementation

- Integrated Analysis of Diesel Substitutes from Oilseeds for India
- Rural Microenterprise Model for Biofuel Extraction in India

Fuelling India's Growth

- Natural Gas Demand by Indian Fertilizer Sector
- Fuelling India's Growth: Past Trends and Scenarios 2004–05 to 2011–12
- Fuelling India's Growth: Vision 2030
- Impact of Fuel Scarcity and Pollution on Rural Poor, 2004 Himachal Pradesh
- IRADe Modeling Activities

Introduction

IRADe has a strong presence in energy policy studies in India. These include energy needs of India in the context of global energy scenarios, pricing policy and reforms, technology assessment, energy access, programme evaluation, role of renewable energy trade and long-term (2050) perspectives on energy.

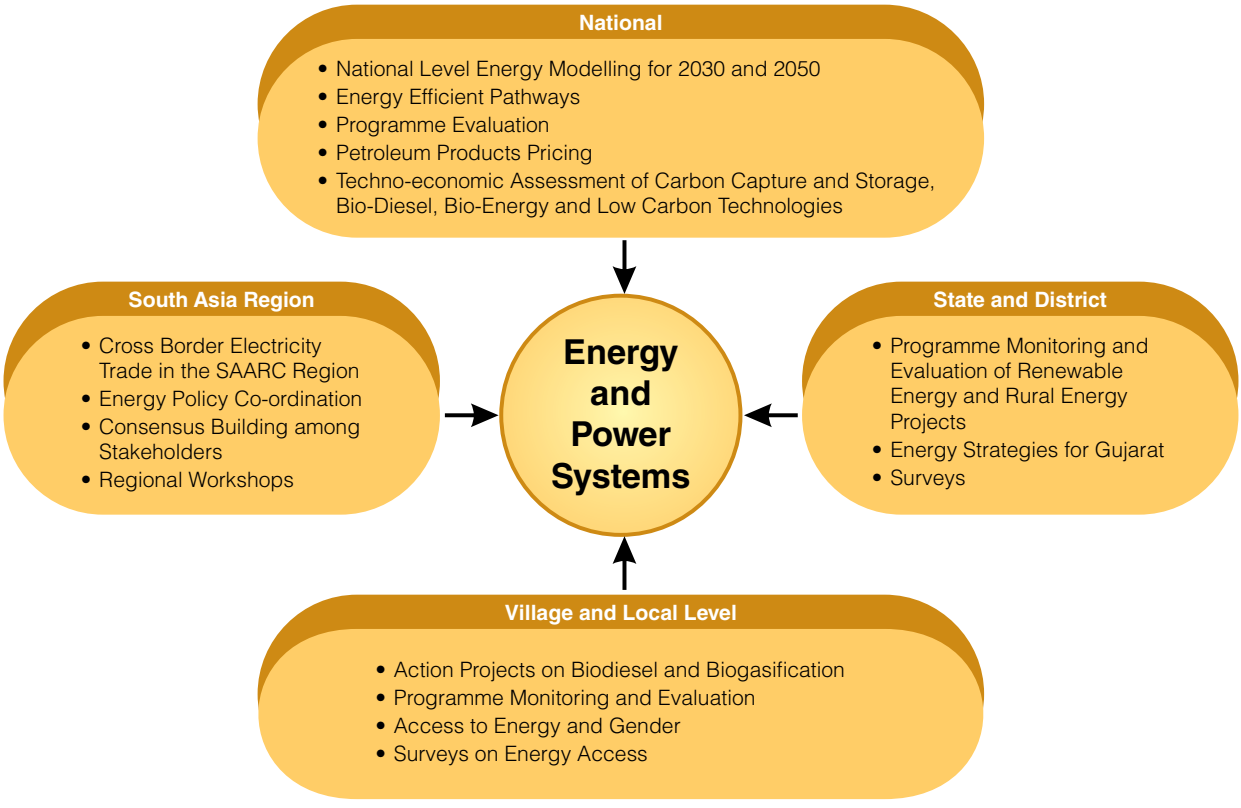
The analytical research included under-standing the changes in trends of energy production, consumption, imports and exports of petroleum fuels and their contribution to the overall energy mix in India.

Technology assessment exercises carried out include carbon capture and storage, biodiesel, renewable technologies and star-rated appliances. Fuel demand and specific sectors that impact energy consumption and energy transition till 2030 and 2050 are studied.

South Asia Regional Power trade is now a major project with a duration of five years supported by SARI/USAID.

Access to modern energy for poor, especially for women, is a major concern always reflected in IRADe research and have undertaken several projects involving surveys and analysis.

Our policy analysis cover areas related to pricing of and access to energy and also technology perspective for long term. These also explore issues linked with poverty and gender as well as climate change.

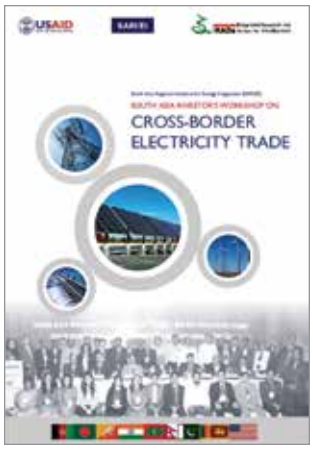


South Asia Cross Border Electricity Trade

South Asia Regional Initiative for Energy Integration (SARI/EI)

The SARI/EI program promotes regional energy integration and Cross Border Electricity Trade (CBET) in eight South Asian countries (Afghanistan, Bangladesh, Bhutan, India, Pakistan, Nepal, Sri Lanka & the Maldives). At present all of these countries face energy shortage. The region has

Dasho Sonam Tshering, Hon. Secretary, Ministry of Economic Affairs, Royal Government of Bhutan addressing SARI/EI Task Force Members, July 2013



the highest untapped hydro potential in the world and is also the least interconnected. Thus regional integration can enhance energy security for all. IRADe was selected by USAID for promoting CBET for the years 2012–17 to address policy, legal, and regulatory issues related to energy in the region; promote transmission interconnections; and works toward establishing a regional market exchange for electricity. SARI/EI activities are driven by Task Forces and guided by a Project Steering Committee.

Studies initiated/proposed under SARI/EI

Task Force 1

a. Review of Electricity Laws, Regulations, Policies and Legal Structure for SA.

b. Investor friendly Policies/guidelines for SA power sector (proposed).

Task Force 2

a. Electricity Trading Potential Assessment in SA.

b. Harmonization of Grid Codes, Operating procedures and standards for CBET.

Task Force 3

a. Assessment of commercial terms and conditions for CBET and model of Power Exchange in SA.

b. Market Rules and Pilot Market design (proposed).

Research and Analytical Studies

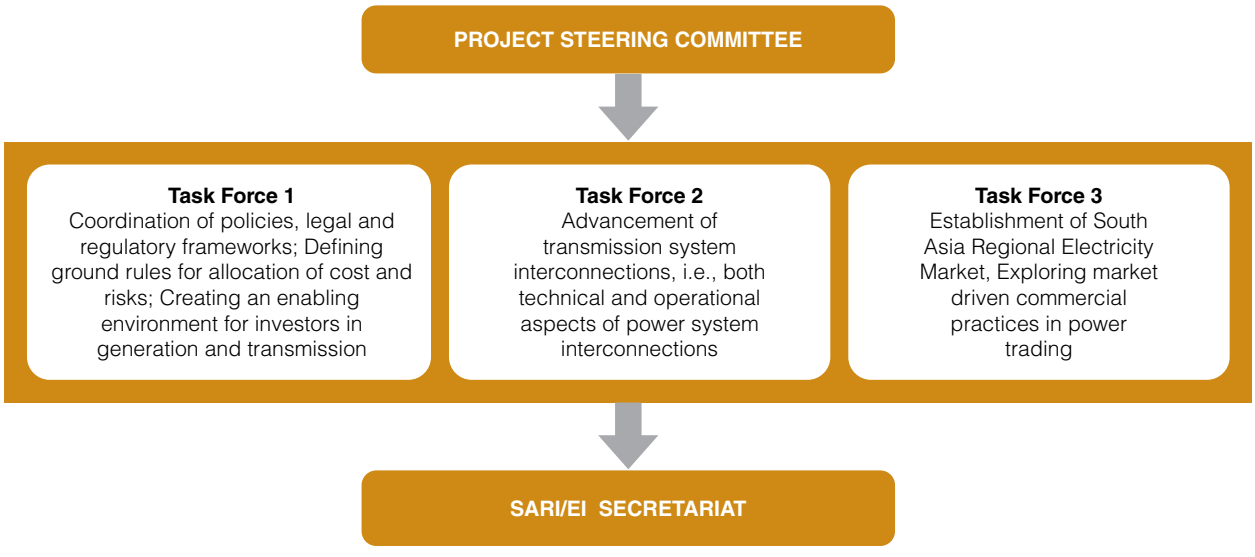
IRADe's in-house research work resulted in a background paper on CBET potentials and a concept paper on investment requirements for CBET. IRADe is working towards developing internationally acceptable energy models for econometric analysis of CBET benefits for participating South Asian countries

Publications

The Task Force-1 completed an elaborate study on **"Coordination of Policy, Legal and Regulatory framework"** which brought out (i) "Recommendations on Regulatory Guidelines for CBET in South Asia" and (ii) "Required Changes in Electricity Laws, Policies and Regulations of South Asian Countries for promoting CBET". These regulatory guidelines and amendments recommended will provide the initial framework towards enabling participating countries to recognise cross border power trading.

The Background Paper highlights the current status of and the overall benefits of CBET to South Asian economy, challenges and opportunities.

- The current status of regional energy integration including the past energy trade, projects in pipeline and those that are in various stages of planning;
- Review of the existing literature including the academic literature covering developments



in other parts of the world (such as Greater Mekong, European, North American and African CBET experiences), as well as South Asian studies (by ADB, SEC, World Bank and USAID).

- Issues in development of a regional power market.

The **concept paper on "CBET in South Asia: Challenges and Investment Opportunities"** analyses the investment requirements for cross-border electricity trade in the region and challenges for each South Asian country including the way forward. IRADe's in-house concept paper brought out the critical analysis of investment requirements, challenges and opportunities in CBET in SA region. Key highlights of the concept paper are:

- Power sector overview of SA countries and CBET
- Key drivers for investment in CBET
- South Asia investment climate
- Key investment challenges in CBET
- Key opportunities and investment requirements in each SA countries.

Working Paper on Bhutan

A working paper on Bhutan was prepared to assess the impact of CBET on the economy of Bhutan. It highlights the positive impact of power exports on Bhutanese economy and provides revised projected electricity demand till 2050 (using ARIMA Model), and electricity supply projections based on the upcoming power plants considering slippages review.

IRADe's India Activity Model

The results were updated using the revised trading potential of Bhutan and the earlier estimated potential of Nepal (based on NEA's demand estimates). The model provides India's projections with CBET and without CBET on key indicators such as energy mix, electricity generation mix, CO_2 reduction, reduction in total investments and energy sector investment requirements, reduction in import dependence of coal and fossil fuels etc.

Analytical Study

Under SARI/IE program IRADe is carrying out an Analytical Study with the primary purpose to build the consensus for cross border electricity trade. It will involve multi-country analysis (currently Nepal) and bringing out the economic (macro and micro) importance of power trade besides other country benefits. In addition, it will carry out a set of activities to build consensus through various channels and create political climate for co-operation. The Consensus building activities will bring together stakeholders from power sector, financial and diplomatic communities and other energy experts.

The objective of the study is to critically assess the need for CBET among the nations of the South Asia region through comprehensive analytical studies that quantify the technical, economic, environmental and energy market benefits of cross border interconnection in the region.

The outcome of the studies will rigorously form estimates of benefits to inform the discussion by all three Task Forces of the SARI/EI and pave the path to prepare and develop regional energy markets and make them sustainable in order to foster economic growth of this region.

State Level Energy Analysis

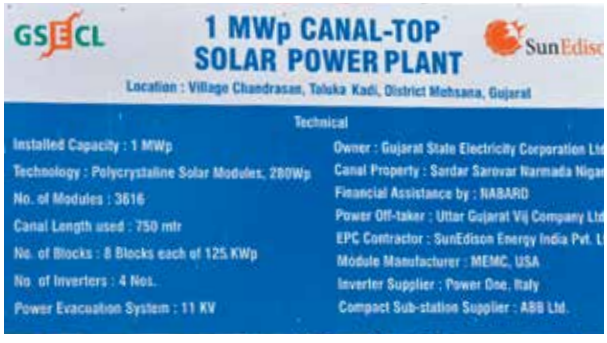
Sustainable and Integrated Energy Strategy for Gujarat

IRADe is requested to prepare a policy document on "Environmentally Sustainable and Integrated Energy Strategy for Gujarat" by the state government. Under the project, socio-economic status and energy and environment profile of the state are studied to predict energy demand for the next two decades.

Based on current energy scene, energy requirements are worked out for a number of scenarios of economic growth and structure of the economy. While exploring supply strategies the factors that are taken into account, among others, for policy formulation are energy imports, conservation, access to consumers at affordable cost and infrastructure needed.

Stakeholder meeting in progress at GPCL, Gandhi Nagar

IRADe research team on visit to 1 MW solar power plant on Ash Dyke of the 850 MW Gandhi Nagar thermal power station, Gandhi Nagar



Energy-mix needed for the energy demand is discussed along with energy supply strategies.

GOVERNMENT OF GUJRAT

GUJARAT POWER CORPORATION LTD.

Supported by
Gujarat Energy & Petrochemicals Department & Gujarat Power Corporation Limited (GPCL)

Energy Price Reforms

Assessment of Alternative Road Maps on Reforming Diesel Prices

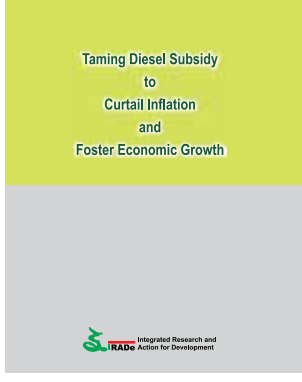
Government has been keeping consumer price of diesel below cost of supply and was reluctant to raise diesel price mainly due to fear that it might lead to inflation, even though administered price of petroleum products leads to large under-recoveries of costs due to the difference between cost of supply and sale receipts.

Partial financing of under-recoveries by the government is done by direct budgetary support and indirectly by the public sector, oil marketing companies (OMCs) and upstream oil companies (ONGC and OIL). The high level of under-recoveries raises fiscal deficit, which in turn leads to higher money supply resulting in higher inflation, prompting the Reserve Bank to raise interest rate that lowers investment and economic growth rate over time.

To explore this trade-off between short-term impact and medium-term outcomes in terms of economic growth and inflation, IRADe conducted a study titled 'Taming Diesel Subsidy to Curtail Inflation and Foster Economic Growth'. The aim of the study was to assess alternative roadmaps to reform diesel prices in India.

An econometric model using quarterly data was estimated and alternative policies were simulated. While raising diesel price will increase inflation in the short run, over time the GDP will be higher and inflation substantially lower than when diesel price is not raised. Also the impact of a 10 per cent increase in diesel price on the poorest 10 per cent of consumers will be an increase of less than 0.6 per cent of their consumption expenditure.

IMPACT: IRADe organized a stakeholder consultation meeting and a meeting at the Finance Ministry. Subsequently, the government raised diesel price and announced a policy of monthly increase in diesel price eventually freeing it.



Government of India

SHAKTI SUSTAINABLE ENERGY FOUNDATION

Supported by
Ministry of Finance and Shakti Sustainable Energy Foundation

Analysis of Kerosene-free Delhi Scheme

'Kerosene-free Delhi' (KFD) scheme was launched by the Delhi Government in 2012. It gave a free LPG cylinder, a two-burner gas stove, regulator and gas pipe to ration card holders using kerosene. IRADe found the scheme to be reasonably successful as it reduced indoor air pollution but, at the same time, it failed to include the poor as it focused only on the holders of ration cards, thus excluding the others, i.e. the homeless with no identity card or address.

It was also found that some kerosene use continued to bridge days between the order and delivery of a gas cylinder. IRADe recommended supply of 5 kg cylinders. The government has recently announced that supply of 5 kg cylinders will be increased.

The LPG kit distributed under KFD scheme

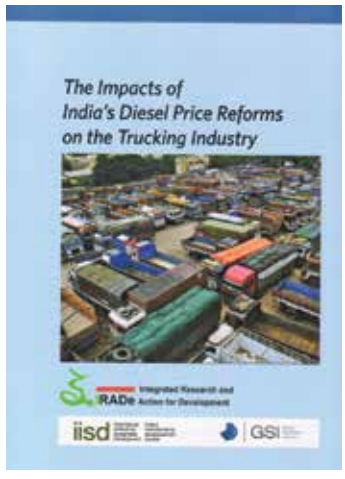
Assessing the Impact of Diesel Subsidy Reform since January 2013

The diesel subsidy was gradually reduced beginning January since 2013. Macroeconomic impact was examined on how diesel price increase has impacted diesel consumption pattern, its consuming sectors, car sales and how diesel price increase has allowed OMCs to recover losses.

The study concludes that reforms helped the OMCs to recover a major part (more than half) of the under-recoveries. The pattern of diesel and petrol car sale had reversed and consumption of diesel has come down. The reduction in fiscal subsidy could soon ease monetary situation.

The Impact of India's Diesel Price Reforms on Trucking Industry

The trucking industry is vulnerable to high diesel costs due to the inherent structural and regulatory issues of the industry. The study team consulted various stakeholders in the business in and around Delhi, Jodhpur and Guwahati to assess how diesel price reforms have affected them. It found that waiting time at toll gates, road conditions, uncertainty of getting return freight, mileage of trucks and regulatory issues are some of the other reasons that raise trucking costs. IRADe suggested an SMS/web-based clearing mechanism for return journey freight.



iisd

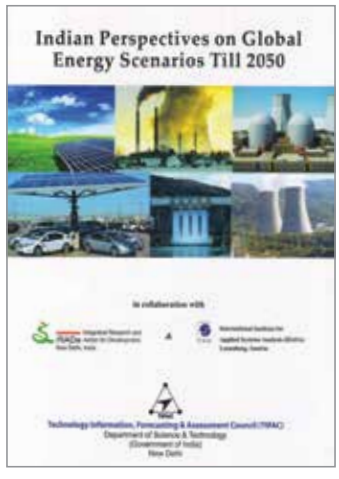
Supported by
International Institute for Sustainable Development

Energy Technology Assessment

Energy Transitions Needed till 2050

Indian Perspectives on Global Energy Scenarios till 2050

TIFAC supported a collaborative project with International Institute for Applied Systems Analysis (IIASA), Austria. The objective was to understand energy transition needed in India that is consistent with global perceptions and to identify research and development required for the transition. IRADe studied IIASA's energy scenarios for global regions from India's perspectives. The



project provided a global energy vision for India till 2050.

In IIASA's scenario, carbon capture and storage (CCS) played an important role. IRADe scenario without CCS pushed more nuclear and gas plants along with renewables. IRADe's work with IIASA helped identify technologies for the energy transition needed for sustainable development including for combating climate change. It also helped India to present its perspective in the development of global energy scenarios that reflects India's concerns.

Techno-Economic Assessment for Bioenergy in India

India needs to develop all forms of energy resources as it is short of conventional fossil fuel. The study reflects various issues of bioenergy in India.

The paper prioritized investment opportunities for technology development and its market adaptation under appropriate policies. It found that among various bioenergy options in India, biodiesel, bioethanol and biomass gasification are the most relevant, where investments for technology and market development could be made.

Wastelands could be used for growing oilseed plants for producing biodiesel, irrigated land for sugarcane-based ethanol production and small plots in village location can be used for producing fuel wood for gasification: thus land requirements can remain complementary to agriculture.

Supported by
Technology Information, Forecasting and Assessment Council (TIFAC)

Global Technology Watch Group on Advanced Coal Technologies for Power Generation

The main objective of the project is to establish a Global Technology Watch Group (GTWG) for monitoring and keeping a close watch on the status of coal technologies in India and abroad, to evaluate them for use in India and to facilitate the development of a viable roadmap of Advanced Coal Technologies (ACT) for sustainable power generation.

IRADe in consortium with three IITs (Madras, Bombay and Delhi) will carry out the sustainability analysis of the selected technologies for the country. Sustainability analysis will take into account, environment, socio-economics and technology aspects while suggesting the appropriate options. The present coal technologies are low in efficiency and have high emission of pollutants. Highly efficient, friendly and economically viable ACT need to be developed and deployed at the earliest. The existing non-technological barriers like isolated and fragmented research and development, lack of effective collaborative research and focused team work can be overcome by establishing a national ACT network which will bring together stakeholders from industry, academia, government and society to encourage, facilitate, catalyse and actuate purposeful sharing of knowledge and resources at national and international levels. This will help create a coal database, facilitate the development of a coal roadmap and culminate in the creation of a global ACT network for the benefit of coal power generation in the country.

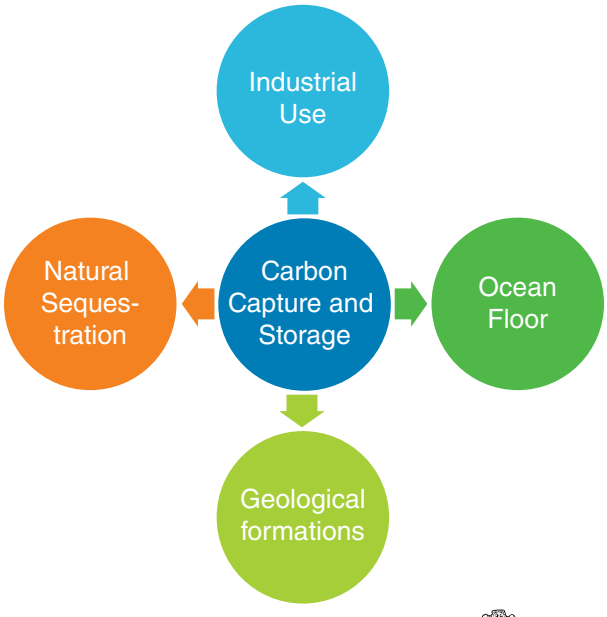
Supported by
Ministry of Science & Technology, Department of Science & Technology, Government of India

Analysis of Carbon Capture and Storage Technology in Power Sector, India

IRADe projected emissions of carbon dioxide from power plants in future, carried out a literature survey to identify developments in carbon capture technology and evaluated economic and technical viability of each aspect. Specification of sequestration sites, identification of the way forward for development, evaluation of monitoring options of CCS and regulatory issues were discussed.

The study provided an opportunity for policy makers to identify critical issues. It also recommended that

the impact of CCS on the cost of power generation should be assessed with various options to define appropriate technology and costs under Indian conditions.



Department of Science and Technology
Ministry of Science and Technology
Government of India

Supported by
Department of Science and Technology, Government of India

Rural and Renewable Energy

Evaluation of Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY)

Under the project, IRADe was to study in five states – Assam, Gujarat, Himachal Pradesh, Rajasthan and Uttar Pradesh – the progress of village electrification in terms of coverage and quality of coverage (such as infrastructure, electrification of Below Poverty Line (BPL) households, etc.).

IRADe studied 25 districts and 125 villages i.e. five districts in each state and five villages in each district. Implementation issues for RGGVY were discussed with various government agencies, Discoms, district officials, village panchayats and households. We found that good quality rural electricity distribution infrastructure was built and positive socio-economic impact was observed. Also, while BPL consumers benefited, there was a need for wider acceptance by Above Poverty Line (APL) households to receive and pay for electricity for better utilization of the distribution network and its economic viability. In this scheme, 'electrified' villages as per definition, hamlets and sub-villages were left out. Also the focus was on meeting household needs and electricity for productive purposes received less attention. The next phase of the programme should address these issues.

The project assessed benefit of the programme to families, especially women and children.

Ministry of Power

आरईसी REC
रूरल इलेक्ट्रीफिकेशन कारपोरेशन लिमिटेड
Rural Electrification Corporation Limited

Supported by
Rural Electrification Corporation

Overview and Assessment of Indian Renewable Energy and Rural Electrification Programme in the Context of Rural Development

The project gives an overview and assessment of the national and state policies to promote renewable energies, rural electrification and relevant issues in rural development. It also looks at institutions and various stakeholders of the GOI programmes, who need to be guided for investment in this sector. This thematic paper was commissioned by the World Renewable Energy Conference (WREC 2009) in Delhi and was widely distributed to the participants at WREC and beyond.

SPV Panel for rural lighting in village

giz Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Supported by
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Monitoring and Evaluation

Monitoring and Evaluation of Off-Grid Solar Photovoltaic Systems Installed in Punjab and Himachal Pradesh in the Years 2008, 2009 and 2010

The Ministry of New and Renewable Energy (MNRE) is implementing a country-wide Solar Photovoltaic programme (SPV) of demonstration and promotion of solar photovoltaic lighting systems, stand-alone power plants and other new and specialized systems in the country. The evaluation was conducted through surveys of beneficiaries and discussions with the officials of MNRE and state nodal agencies (PEDA of Punjab and Himurja of Himachal Pradesh).

It was found that a large percentage of systems installed were working.

Supported by
the Ministry of New and Renewable Energy, Government of India

Evaluation of Franchise System in Assam, West Bengal, Nagaland and Rajasthan

The Ministry of Power (MoP) had awarded a study to IRADe to assess franchise systems in Assam, Nagaland and West Bengal. Rural Electricity Corporation (REC) awarded further studies to IRADe for evaluating the franchise systems operating in different district distribution circles in Assam, West Bengal, Nagaland and Rajasthan through sample villages in these states. This project covered villages in Bankura and Dibrugarh districts in West Bengal & Assam and the REC project survey included villages in Purulia, Jodhpur and New Bongaingaon districts.

Conclusions were drawn from the studies that franchises require adequate supply of good-quality power maintained by utilities to work effectively. Also capacity building of franchises should be done at the beginning.

Supported by
the Ministry of Power, Government of India

Evaluation of Solar Thermal Demonstration Projects in Four States of India

The MNRE had provided solar cookers and solar water heaters to the residents of villages in four states namely Rajasthan, Haryana, Uttarakhand and Gujarat. Overall, the users of solar thermal products were satisfied. 90 per cent of the users felt that food cooked with solar cookers tasted better and was healthier. They were happy that the solar cooker does not require fuel and needed little maintenance. They were aware that these products had a long operational life, but could only be used during the day, and their effectiveness depended on the season.

Supported by
the Ministry of New and Renewable Energy, Government of India

Evaluation of Solar Photovoltaic Programme in Six States of India

The MNRE had provided village residents in six states, namely Rajasthan, Haryana, Uttarakhand, Gujarat, Manipur and Karnataka, with solar technologies such as home lighting systems, water pumps, lanterns and street light systems. Evaluation done by IRADe for MNRE through the field visits focused on verification and collection of beneficiary level information regarding

functioning and maintenance of the solar systems and satisfaction level of beneficiaries. Their lifestyles have changed gradually following work done under the scheme. The benefits accrued were increased working hours for useful tasks, increased study hours of children, decline in consumption of kerosene and decline in environmental accidents such as snake and insect bites. Beneficiaries have started using mobile phones, radios, telephones etc.

Supported by
the Ministry of New and Renewable Energy, Government of India

Survey and Evaluation of Remote Village Area Electrification Project through Solar Photovoltaic System in Rajasthan and Haryana

The MNRE had provided subsidy for solar home-lighting and street-light systems to residents in the remote villages of India, which could not be covered by the national power grid. In the survey done by IRADe for MNRE, it was observed that a target-oriented approach was followed during its implementation. The implementing agencies did not fully adhere to the guidelines stipulated by MNRE.

Approximately 15 per cent of the systems were found to be non-functional. Improvements in maintenance and service support from equipment suppliers are needed.

Supported by
the Ministry of New and Renewable Energy, Government of India

Village Energy Security Programme in Vavdi and Vaddithar Hamlets in Patan District of Gujarat

Village Energy Security programme in Vavdi and Vaddithar in Patan District of Gujarat is a part of the Village Energy Security Programme under Remote Village Electrification programme of the MNRE. IRADe installed biogas plants, improved stoves, wood gasifier based electricity generator and jatropha plantation for biodiesel in two villages, Vavdi and Vaddithar of Santalpur Taluka of Patan district of Gujarat. IRADe in close cooperation with the Self-Employed Women's Association (SEWA), Gujarat Energy Development Agency (GEDA), the village Panchayat and village population implemented the programme that aimed to provide access to electricity through biomass resources to households in remote villages which are not likely to be covered through grid extension.

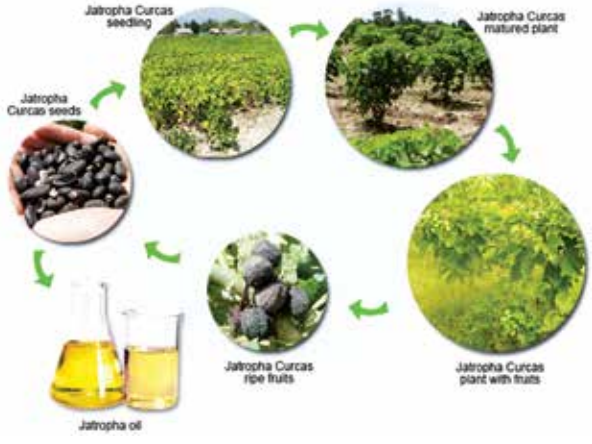
Biodigesters were set up in both the villages to provide lighting to 50 homes. Secretary, MNRE Mr. V. Subramaniam dedicated it to Vavdi village. 100 improved cook stoves were also distributed in each village at subsidized rates. Self-help groups were formed and were given electric flour mills, soap making units, etc., for income generation.

Supported by
The Ministry of New and Renewable Energy, Government of India

Biodiesel Analysis and Implementation

Integrated Analysis of Diesel Substitutes from Oilseeds for India

This study reviewed the entire chain of stakeholders in biodiesel production sale and consumption. It suggested a policy framework for land availability for oil seeds plantation, minimum support price for oilseeds, farm subsidies for cultivating plantations for oilseeds, tax exemption for entrepreneurs and sale of biodiesel. Financial incentives may be provided to oil companies as they ensure quality



oil and take various types of risks. An action plan to reduce cost of production, increase financial viability and market linkages was also discussed for biodiesel production and sale. It was followed by a multi-stakeholder conference.

PETROFED

Rural Microenterprise Model for Biofuel Extraction in India

IRADe formulated a microenterprise model for biomass-based energy system at the village level. The objective was to extract oil that provides an alternative source of fuel in rural areas. IRADe set up a biodiesel extrusion unit in Bawal, Rewari district of Haryana.

The villagers were explained how to use the extraction machine and get biodiesel.

Dr. A. R. Kidwai, Hon'ble Governor of Haryana, observing the oil extraction unit at Bawal, Haryana

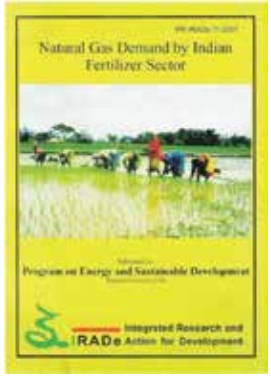
WISIONS

Supported by
Sustainable Energy Project Support (SEPS) of WISIONS, Germany

Fuelling India's Growth

Natural Gas Demand by Indian Fertilizer Sector

Natural gas is the preferred feedstock for urea manufacture. The demand for natural gas for the next two decades was projected for the fertilizer sector. These projections were made in the context of changing government policies regarding the fertilizer industry, such as farm gate price regulation and self-sufficiency level of indigenous urea production. The current growth plan of natural gas supply and evolving supply scenario in the future were also considered in the study. Depending on the price of urea the need for natural gas was projected to be between 27 BCM and 34 BCM for 2025–26.



Supported by
Programme on Energy & Sustainable Development (PESD) of Stanford University, USA

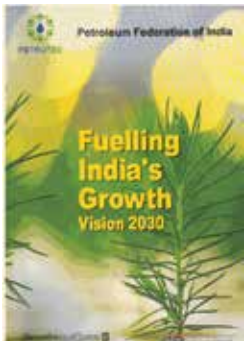
Fuelling India's Growth: Past Trends and Scenarios 2004–05 to 2011–12

IRADe did a study on 'Fuelling India's Growth: Past Trends and Scenarios 2011–12' focusing on the drivers of oil and gas demand. It analyses the broad trends observed in commercial energy mix, growth rates of each of the refined petroleum fuels, crude oil and natural gas during 1998–99 to

2003–04. The analysis was enriched and validated through direct interaction with the member companies of PetroFed.

Fuelling India's Growth: Vision 2030

The drivers of demand for each of the fuels were identified through econometric models using data till 2011–12. Econometric models establish relationships of demand for commodities with other variables. Using these relationships, the demand scenarios for the milestone years 2016–17, 2020 and 2030, with special focus on hydrocarbons, were developed. Based on these projections, the broad commercial energy mix has been indicated for 2020 and 2030.

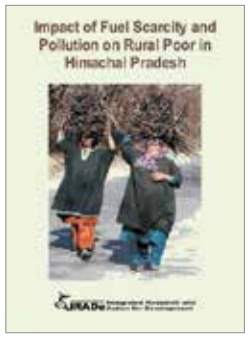


Supported by
Pricewaterhouse Coopers Pvt. Ltd. (PwC)

Impact of Fuel Scarcity and Pollution on Rural Poor, 2004 Himachal Pradesh

The research project assessed the impact of scarcity of clean and traditional fuels on health and time spent in gathering traditional fuels. We studied pollution in economic terms by observing how traditional biofuels are used by vulnerable groups comprising the rural poor in Himachal Pradesh. Observations were also made on socio-economic circumstances, access to fuel and need and willingness to pay for cleaner fuels.

The key findings showed that about 21 per cent of rural adults might be having some symptoms of respiratory diseases.



Supported by
Global Development Network (GDN)
through SANEI, New Delhi

IRADe Modeling Activities

The IRADe 'activity' model was first developed under the project "Developing a CGE model with Activity Analysis for climate policies in India up to 2030" funded by the Ministry of Environment and Forests, Government of India during 2006-2009. The model since then has evolved and has answered many concerns through various versions (see table below) such as implications for GHGs emissions, need for energy transitions, food security, strategies low carbon pathways for the country among others. It has endogenous income distribution and demand determination with specific technological alternatives, it is basically period and multi-sector models that cover the whole economy in an activity analysis framework. This permits alternative technologies in different sectors to provide a comprehensive profile of GHG emissions and possible policies to reduce them and calculates emission intensity in keeping with the voluntary pledges of India. Thus in principle different versions of the model can be used to construct scenarios to achieve desired emission targets and sectoral productivity as well as social indicator targets.

S. No.	IRADE Model Reference	Funded by	Theme addressed	Year
1	IRADe-AA30	Ministry of Environment and Forest	India's GHG Emissions Profile: Results of Five Climate Modeling Studies	2006-09
2	IRADe-ET50	Technology Information, Forecasting and Assessment Council, Department of Science and Technology	India's Energy Transition till 2050 in the Global Context	2010-13
3	IRADe-AG40	Centennial Group, USA	Study on Indian Agriculture, 2040	2009-11
4	IRADe-EQ30	South South North Trust, South Asia	Impact of Mitigation and Poverty Alleviation	2012
5	IRADe-LCSD	World Wildlife Fund	Low Carbon Pathway for Sustainable Development	2012-14
6	IRADe-LCSIG	Planning Commission, India	Study on Economy-wide Model for Low Carbon Strategy for inclusive Growth	2013-14
7	IRADe-NEG50	MoEF&CC, New Delhi	Modelling Studies on Greenhouse Gas Emissions and Emission Intensity of Indian Economy	2014-15
8	IRADe-SARI35	USAID	South Asian Regional Initiative for Energy Integration	2012-17

Sustainable Urban Development

IRADe

Themes and Projects

➔ Climate Change and Cities

- Climate Vulnerability Profiles of 20 Indian Cities
- Policy Brief on Emerging Mechanisms and Responses of Cities to Climate – ACCCRN
- Working Paper on HIGS Framework for Climate-Resilient Urban Development
- Mainstreaming Climate Resilience in Urban Development: Policy Landscape for Urban Climate Resilience

➔ Disaster Resilience

- Sustainable and Disaster-Resilient Cities: Case Studies and Capacity Building of 10 JnNURM Cities
- The Time is Now: Sustainable and Climate-Resilient Urban Development (2010)
- Vulnerability of Coastal Cities on Rivers to Climate Change: Case Study of Surat
- Policy Level Engagement for Developing Climate Resilient Smart Cities
- City Disaster Management Plans of Six Cities – Bhubaneswar, Gangtok, Shimla, Vijayawada, Madurai and Thiruvanthapuram

➔ Solar Cities

- Preparation of Master Plan with Detailed Action Plan for Jodhpur under Solar Cities Development Programme

➔ Urban Waste Management

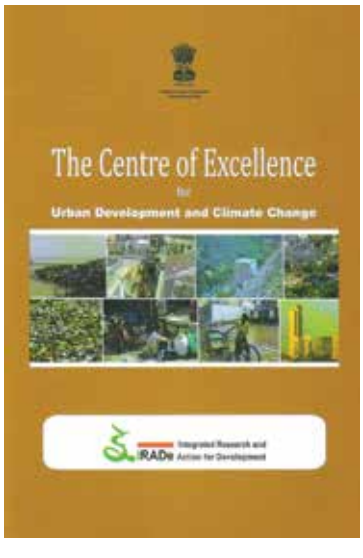
- Landfill Waste Management in Okhla, New Delhi

Introduction

In 2008, IRADe was designated as Centre of Excellence (CoE) in the area of urban development and climate change by Ministry of Urban Development, (MoUD) GOI. IRADe collaborates with national institutions, state urban departments, municipal corporations, urban local bodies, NGOs and academia for capacity building, promoting awareness, research and training on specific topics in the areas of urban development and climate change in more than 29 cities across 19 states.

As the CoE, IRADe is furthering the agenda of integrating various urban development efforts and documenting best practices and policy level prescriptions that could be understood and adopted by the state and national level decision makers and local administrations to help them link climate issues with the existing programmes in urban development. Presentations were made on project objectives, results, methodology and future strategy for climate resilience of India's cities to various forums such as organized by IPCC-SREX, European Union, UNESCAP and others.

We are grateful to MoUD, Ministry of Earth Sciences (MoES), US Environmental Protection Agency (USEPA), Asian Cities Climate Change Resilience Network (ACCCRN), Department of International Development (DFID) and United Nations Development Programme (UNDP) for supporting various initiatives under this thematic area.



Centre of Excellence Projects – 29 Cities and 19 States

Geographical Coverage

Project Cities

1. Srinagar
2. Shimla
3. Haridwar
4. Dehradun
5. Delhi
6. Allahabad
7. Gorakhpur
8. Jodhpur
9. Ahmedabad
10. Surat
11. Indore
12. Bhopal
13. Gangtok
14. Shillong
15. Guwahati
16. Kolkata
17. Bhubaneswar
18. Puri
19. Pune
20. Mumbai
21. Hyderabad
22. Visakhapatnam
23. Vijaywada
24. Chennai
25. Madurai
26. Bengaluru
27. Kochi
28. Thiruvananthapuram
29. Puducherry

Project States

1. Jammu & Kashmir
2. Himachal Pradesh
3. Uttarakhand
4. Delhi
5. Uttar Pradesh
6. Rajasthan
7. Gujarat
8. Madhya Pradesh
9. West Bengal
10. Sikkim
11. Meghalaya
12. Assam
13. Odisha
14. Maharashtra
15. Telangana
16. Andhra Pradesh
17. Karnataka
18. Tamil Nadu
19. Kerala

Centre of Excellence Projects in Urban Development and Climate Change

The work involved three components:

1. Rapid assessment of vulnerabilities to climate change of Indian cities. It was done for 14 key cities in India based on indicators of vulnerability to climate change. IRADe's approach and methodological framework include developing an index to assess the vulnerability to climate change, generating baseline data pertaining to urban development in terms of socio-economic and infrastructure characteristics. This can help in formulating efficient urban policies and programmes.

2. Augmenting city development plans for Surat and Haridwar to address climate change impact: The study analyses the potential threats of climate change and adaptation options in urban planning. Based on this analysis, some policy actions for resilience and climate change adaptation were suggested that could be implemented by the local urban/municipal bodies. Two city level analyses were carried out.

IRADe's study recommended engagement of various decision makers like householders, government, ULBs and major corporations in identifying options and creating awareness.

Supported by
Ministry of Urban Development, Government of India

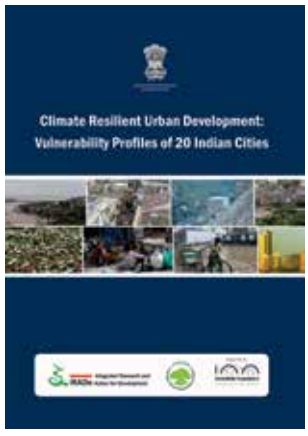
Ministry of Urban Development
Government of India

Climate Change and Cities

Climate Vulnerability Profiles of 20 Indian Cities

The study developed climate vulnerability profiles for 20 cities (Ahmedabad, Allahabad, Bengaluru, Bhubaneswar, Chennai, Dehradun, Delhi, Haridwar, Hyderabad, Indore, Jodhpur, Kochi, Kolkata, Mumbai, Puri, Shillong, Srinagar, Surat, Thiruvananthapuram and Visakhapatnam), which were getting funds under the Jawaharlal Nehru National Urban Renewal Mission. It assessed climate-induced risks from various hazards such as cyclones, storms, floods and droughts. It also highlighted the infrastructure needed for resilience and the importance of governance and institutional framework at city level. It helped to better understand city-level vulnerability by exploring various aspects that influence the vulnerability of the cities and the nature of action needed to reduce it.

IRADe conducted primary surveys, secondary surveys, assessment studies and provided analytical support.



Supported by
Rockefeller Foundation under ACCCRN Project

Policy Brief on Emerging Mechanisms and Responses of Cities to Climate – ACCCRN

IRADe prepared a policy brief to explore various aspects influencing the vulnerability of the cities. It highlights IRADe's approach that similar climate events can produce very different levels of socio-economic impact, depending not only on the location and timing of the occurrence, but also on the resources and agility of the societies to respond to climate impact.

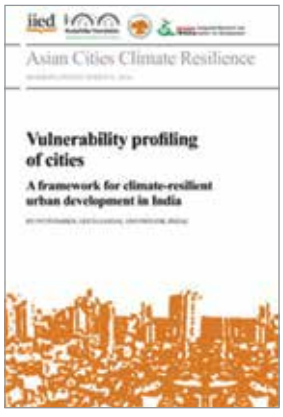
The working paper was presented at the National Conference on Emerging Mechanisms and Responses of Cities to Climate Change held in New Delhi on 10 December 2013.

TARU

Supported by
TARU Leading Edge Pvt. Ltd.

Working Paper on HIGS Framework for Climate-Resilient Urban Development

In order to put the methodology in the public domain IRADe prepared a working paper describing it to address hazards (H) through infrastructure-governance-socio-economic (HIGS) framework for Rapid Vulnerability Analysis (RVA) of cities. The working paper helps policy makers, urban planners, city administrators, experts, academicians, students and aid agencies to appreciate issues regarding urban climate vulnerability and helps them deal with climate-related impact and formulate adaptation strategies.



Supported by
International Institute for Environment and Development (IIED), UK

Mainstreaming Climate Resilience in Urban Development: Policy Landscape for Urban Climate Resilience

IRADe reviewed the approach and work related to ACCCRN, supported by the Rockefeller Foundation, from policy perspective and supported assessment of vulnerabilities due to disasters such as floods and droughts and developed climate resilience strategies for three cities, namely Gorakhpur, Surat and Indore.

IRADe identified the opportunities to orient urban development programmes in order to promote city-level climate resilience.

The lessons from these are brought to national level and the city governments are also apprised of the relevant opportunities offered by the central government. IRADe suggested that an integrated policy framework and co-ordinated decision making are needed at the national, state and city levels.

Disaster Resilience

Sustainable and Disaster-Resilient Cities: Case Studies and Capacity Building of 10 JnNURM Cities

The objective of the study was to assess the state of disaster resilience of 10 selected cities, namely Dehradun, Srinagar (North India), Shillong, Guwahati, Bhubaneswar (East India), Pune, Ahmedabad, Bhopal (West India) and Vishakhapatnam, Hyderabad (South India). Four regional workshops were also organized to get feedback from the city officials and stakeholders covering the different regions with active participation of the Urban Local Bodies (ULBs), parastatal bodies, researchers and urban planners of the respective cities.

The study revealed that the ULBs face a big challenge to keep pace with the need to increase infrastructure and service provision for citizens

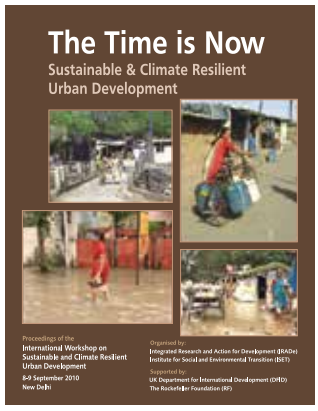
and simultaneously ensure inclusive growth for the urban poor. Through this study, IRADe has recommended an integrated approach for sustainable and disaster-resilient development in these cities. This will help the local governments as generally they have limited resources available to address development issues ranging from health, education, infrastructure and services, and often disaster risks do not emerge as clear priorities.

Ministry of Urban Development
Government of India

Supported by
Ministry of Urban Development, Government of India

The Time is Now: Sustainable and Climate-Resilient Urban Development (2010)

This report relates the direct impacts of climate change such as extreme temperatures and floods as well as the indirect impacts of climate change such as changes in global grain markets that lead to spikes in food prices. With a rapidly growing urban population, the future challenges for urban administrations will be huge.



Supported by
Department for International Development and The Rockefeller Foundation. Co-organized with the Institute for Social and Environmental Transition

Vulnerability of Coastal Cities on Rivers to Climate Change: Case Study of Surat

The main objective was to develop an integrated analytical framework for floods and disaster management strategy for urban areas in the background of a specific case study of the city of Surat. This is to assess the vulnerability of the city and its people to floods and to develop a procedure to incorporate climate change concern in the existing framework with a decision support system. It suggested adaptation actions that can make a city resilient to climate change induced vulnerability.

The objective of this study is to also assess the hydrological vulnerability of the people and the public infrastructure of Surat. The elements of infrastructure under consideration include buildings (schools, hospitals, slums, and industries) within and adjacent to the floodplains, roads, bridges, etc. An original systems approach is used in the study to gather and examine available data in order to develop an understanding of the relevant climatic effects and their interactions with infrastructure. For this, a hydrological model of the river is developed to assess the extent of inundation and water depths under various scenarios, which may arise due to climate change. An integrated hydraulic modelling system and spatial analysis software have been used in the study.

With information on the likely depth of flooding in different parts of the city, citizens and local

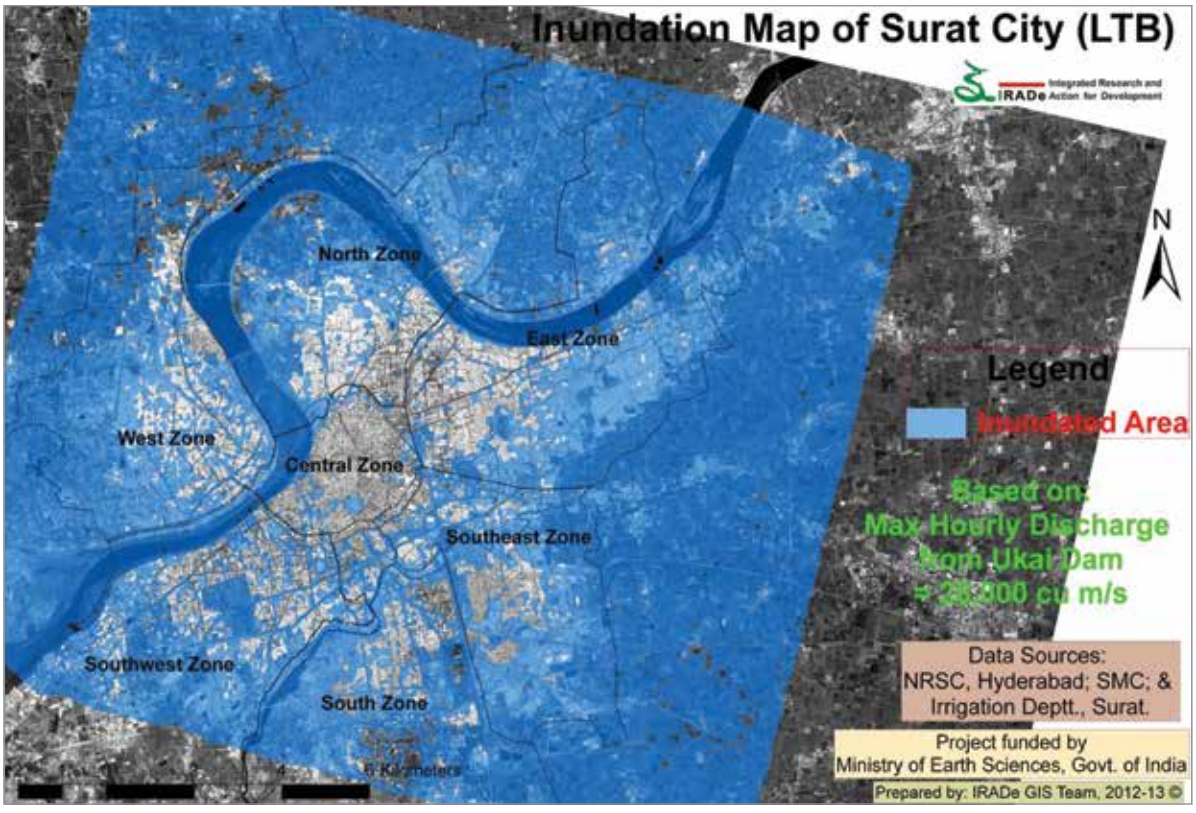


Figure: 28,000 cu m/s water discharge from Ukai dam (Year 2006 level)

administrators can take effective measures such as avoiding certain areas, building on stilts, providing shelters etc.

Ministry of Earth Sciences
Government of India

Supported by
Ministry of Earth Sciences, Government of India

Policy Level Engagement for Developing Climate Resilient Smart Cities

IRADe, supported by the Rockefeller Foundation, has strived to position urban challenges in the larger policy framework provided by state and national institutions. IRADe engages decision makers for informing them on urban climate change resilience and integrating the concepts into wider planning discourses.

IRADe proposed inclusion of climate resilience in smart city plans through engagement at various levels in Ministry of Urban Development, state and city level urban bodies for climate resilient smart city framework. IRADe is engaged with two cities viz. Ahmedabad and Guwahati for integrating climate resilience in the smart city plans.

Supported by
Rockefeller Foundation under ACCCRN Project

City Disaster Management Plans of Six Cities – Bhubaneswar, Gangtok, Shimla, Vijayawada, Madurai and Thiruvanthapuram

United Nations Development Programme (UNDP) selected IRADe to review the City Disaster Management Plans (CDMP) of six cities with a view to assess the clarity, comprehensiveness, efficiency, appropriateness and dissemination of disaster management measures as part of city disaster management plan.

This also includes the integration of climate risk management measures in the CDMP planning process and plan document. IRADe has made specific recommendations and presented

strategies to each city administration on addressing the gaps established during the review process to update the existing CDMPs. These six cities have made progress in disaster risk management while making efforts to prepare city disaster management plan.

Supported by
United Nations Development Program

Solar Cities

Preparation of Master Plan with Detailed Action Plan for Jodhpur under Solar Cities Development Programme

The significance of this assignment was to 'prepare a master plan' with detailed action plan for various activities for the years 2009–10, 2010–11 and 2011–12 during the 11th plan period for development of Jodhpur as solar city as per the specifications, guidelines and terms and conditions of MNRE.

The objective of the master plan was to set a goal of minimum 10 per cent reduction in projected total demand of conventional energy at the end of five years to be achieved through energy saving from energy efficiency measures and generation from renewable energy installations.

The proposed master plan was accepted by Jodhpur Municipal Corporation.

Government of India
Ministry of New and Renewable Energy

Supported by
Jodhpur Municipal Corporation and
Ministry of New & Renewable Energy

Urban Waste Management

Landfill Waste Management in Okhla, New Delhi

IRADe studied the gases emitted from the landfill site of Okhla, New Delhi and analysed whether the gases can be captured commercially as the landfill site emits methane. The assessment was done based on the information provided by the officials at Central Pollution Control Board, Delhi Pollution Control Committee, Municipal Corporation of Delhi and Okhla landfill site and observations made during site visits. Feasibility of the land fill gas (LFG) supply as domestic fuel to the surrounding areas by using the existing network of the Okhla Sewage Treatment Plant was assessed. It was not found suitable in current conditions.

Supported by
United States Environmental Protection Agency,
Washington DC

Integrated Research and Action for Development

IRADe and COP 21, Paris 2015

Intended Nationally Determined Contributions

IRADe was one of the two institutes who did the modeling work for India's Intended **Nationally Determined Contributions (INDC) for the COP 21, Paris** at the request of the Ministry of Environment, Forest & Climate Change (MoEFCC). IRADe developed a special version of the model for climate change negotiations **IRADe-CC-Neg**. (See modeling activities at IRADe). By **projecting Indian economy with 38 sectors till 2050 with 4 fossil fuel sectors and 10 power generation options**. It examined implications of INDC's through various scenarios. IRADe showed that it is **possible to promise 40% electricity generation capacity from non-fossil sources**, i.e. solar, wind, nuclear and hydro power. It showed the economic impacts of alternative INDC targets mandated and on poverty–keeping in view India's energy resources, economic growth and ensuring inclusive development. It also showed that **India can reduce 35% carbon intensity**. IRADe continues to explore this further. The model provided scenarios for total, sectoral, cumulated (cumulative) and per capita emissions and CO_2 intensities for all years till 2050 under normal and ambitious actions.

COP 21, Paris Dialogues

As events leading up to Paris, IRADe and The French Embassy held two dialogues to address significant issues in the context of COP 21. A seminar was organised on **Long-term Sustained Climate Finance** for **structured mitigation and adaptation** on June 29th, 2015. The recommendations largely focused on the importance of mitigation technologies and adaptation which were raised during the Paris negotiations.

The **Cities Resilience to Climate Change** dialogue held on October 30th, 2015 where IRADe presented extensive work it has carried out on climate resilience in 20 cities. We also engaged with prominent experts including Ms. Thara, Municipal Commissioner of Ahmedabad and Dr. Sudhir Krishna, Former Secretary, MoUD to share and direct discussions in the context of India's expectation aligned to the Paris text. These discussions were largely attributed to sustainable planning for climate resilient infrastructure.

National Energy Policy

Niti Aayog requested IRADe to contribute recommendations towards **India's National Energy Policy** in the context of **Climate Change and Environment**. A stakeholder consultation was held on November 6, 2015 which served as a platform to gather and discuss their policy positions on various sectors including that of Energy and Climate Change, Transport and Air-Pollution and CAMPA. Following India's INDC submission to the UNFCCC for the Paris Climate Agreement 2015, this platform served as a **discussion forum to plan further actions to achieve India's established INDC targets for 2030**. The findings of the workshop are disseminated across decision making bodies leading to wide-ranging energy policy implications.

Climate Change and Environment

IRADe

Themes and Projects

Climate Mitigation

- Greenhouse Gas Reduction Potential, Sectoral Base Lines and Opportunities for Clean Development Mechanism
- Mapping of Carbon Capture and Storage Activities in India to Promote Research and Development Initiatives
- Low Carbon Technologies Implementation and Policy Issues

Climate Adaptation

- Climate Change and Himalayan Ecosystem – Uttarakhand
- Methodology Development for Climate Change Adaptation
- Socio-economic Vulnerability of Himachal Pradesh to Climate Change

Climate Negotiations

- Developing Economy-wide Model for Low Carbon Strategies for Inclusive Growth (LCSIG)
- Climate Negotiations from Indian Perspective
- Critical Evaluation of the 12th Five Year Plan from a Climatic Perspective
- First Biennial Update Report to UNFCCC: Updation of Information on Mitigation Actions for National Circumstances

Environment: Natural Resource Accounting (NRA)

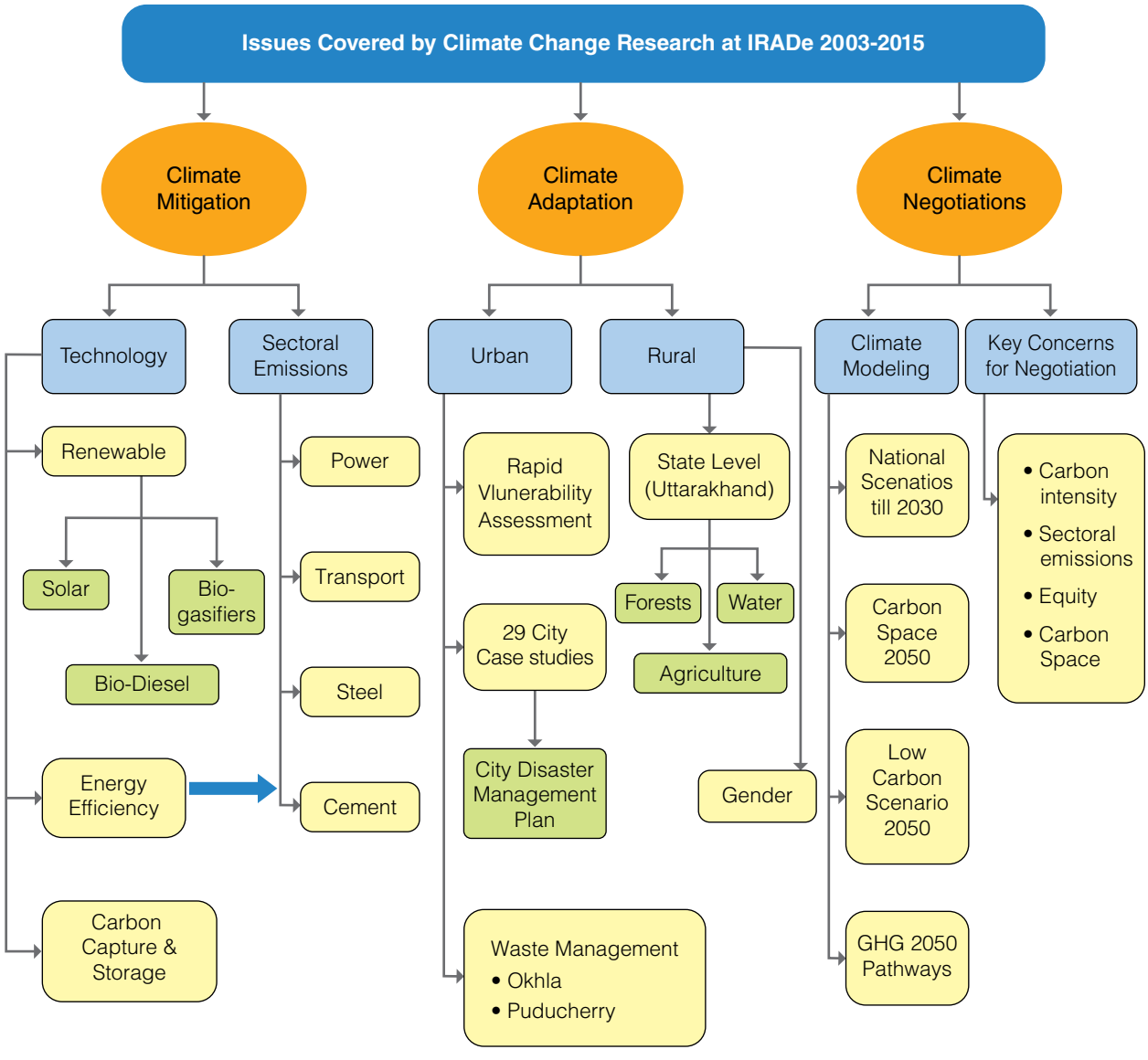
- Natural Resource Accounting in Goa, Phase II, under SEEA Framework
- Measuring Ecosystem Services for Green India Mission: A Case Study of Paderu Project in Andhra Pradesh
- Ecosystem Management of Marine National Park, Jamnagar, Gujarat
- Review of Status of Jamnagar Marine National Park and Evolving Vision Statement for Its Management
- Pre-feasibility Study of Integrated Waste Management and Landfill Gas Recovery and Utilization at Puducherry
- ENVISION – Information System Reforms at the Ministry of Environment and Forests, 2006–07
- Supporting National Study on the Economics of Ecosystems and Biodiversity (TEEB – India Initiative)

Introduction

Local and global environmental issues, especially climate change, loom large with increasing risks. As the way forward, IRADe has adopted a multi-disciplinary approach and carries out national projects for both climate mitigation and adaptation in the country.

In climate change, IRADe intensively covers climate mitigation, adaptation and negotiations. Further, IRADe provides inputs using the activity analysis model in the area of low carbon pathways until 2030 and 2050 for Climate Policies in India. As a member of NATCOM institutions and Indian Network on Climate Change Assessment (INCCA), IRADe assists in country reports and provides inputs on negotiating positions, arguments and policy suggestions to ensure equity principles.

IRADe's environment project portfolios include environmental accounting and valuation for Goa and Andhra Pradesh with a focus on tourism, waste management and water pollution. Biodiversity and Ecosystem management for Marine national Parks are also addressed.



Climate Mitigation

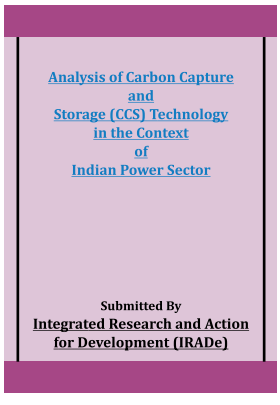
Greenhouse Gas Reduction Potential, Sectoral Base Lines and Opportunities for Clean Development Mechanism

IRADe examined the methodology of 'Baselines for Renewable Energy Projects under Clean Development Mechanism (CDM)' in the power sector for India. The study found that India's power sector has considerable scope for improvement in transmission and distribution (T&D) losses. The suggested short-term and long-term measures to reduce these include installation of appropriate conductors, capacitors, reconfiguration of the network, upgradation to high-voltage transmission, etc. The project also analysed opportunities in the cement sector, co-generation schemes, wind power and hotel industry and other sectors for defining baselines. It studied the approaches to greenhouse gas (GHG) reduction and policies towards CDM followed by these industries.

Supported by
Ministry of Environment, Forests and Climate Change, Government of India

Mapping of Carbon Capture and Storage Activities in India to Promote Research and Development Initiatives

IRADe conducted a review of technological status of CCS globally and surveyed perceptions of the scientific and technical manpower employed in India. The various elements of costs of CCS, carbon capture, transport of carbon dioxide and storage were examined. It was felt that till the economics of CCS is demonstrated by plants in industrialized countries, India should not adopt CCS. However, there may be scope for designing plants to be CCS ready and to pursue research and development in CCS. Perhaps an international research and development centre may be established in India.



The outcome of the project is that India has to continue with basic research on CCS with a larger range of technology options and progress to applied research in selected fields. Indian entrepreneurs should be able to gain business opportunities at a later date when commercialization of CCS technology becomes viable.

British High Commission New Delhi

Supported by
British High Commission and Government of UK

Low Carbon Technologies Implementation and Policy Issues

This study analyses low carbon technologies (LCT) in power, steel, cement and transportation sectors. The analysis for cement and steel sectors identified a range of potential mitigation options. A comprehensive roadmap for implementing each policy option was provided including identification of the key factors involved, the key barriers to policy implementation and associated major benefits. International policies that supplement the suggested domestic policy options had also been described, along with implications for the structure of international climate policies. This was done jointly by ICF International, India and IRADe.

CCAP CENTER FOR CLEAN AIR POLICY

Supported by
Centre for Clean Air Policy (CCAP), USA

Climate Adaptation

Climate Change and Himalayan Ecosystem – Uttarakhand

IRADe examined how agriculture, water and forests will be affected by climate change, which could lead to loss of livelihoods of the poor in the Himalayan ecosystem of Uttarakhand. A variety of data and methodologies are used in the study, which include vulnerability assessment by observing indicators, sustainable livelihood approaches, IPCC projections of climate (4th Assessment Report); Participatory Rapid Appraisal (PRA) Approach and public consultation with multi-stakeholders.

Changes in water regime due to climate change will increase floods and droughts, reduce water availability in hilly regions requiring women to walk more for water, lead to change in cropping patterns, lower agricultural productivity and increased deforestation and soil erosion. The impact can be reduced by water harvesting, groundwater recharge, conservation, reintroduction of native crops, grasses and trees and protection of forests through joint forest management.

MINISTRY OF ENVIRONMENT AND FORESTS
Government of India

Supported by
Ministry of Environment and Forests, Government of India

Methodology Development for Climate Change Adaptation

IRADe has developed a methodology for climate vulnerability assessment and adaptation on various components of city infrastructure. It involves city infrastructure assessment and adaptation strategy that includes sustainable management of water, adequate storm water drainage capacity, effective solid waste disposal and public health measures. Climate resilience requires sound urban design.

Supported by
the Ministry of Urban Development,
Government of India

Socio-economic Vulnerability of Himachal Pradesh to Climate Change

The state of Himachal Pradesh is vulnerable to climate change due to its geo-ecological location. The study develops methods to determine impact of climate variability. It assesses the impact of climate change and variability on agriculture and forests. Vulnerability assessment was done of agriculture and forest resources at different time scales, taking into account economic activities in

future. It shows socio-economic vulnerability of livelihood because of impact of climate change on natural resources, like shift of apple belt, increased forest fires, changes in non-timber forest products, rice-growing areas, etc.

Department of Science and Technology
Ministry of Science and Technology
Government of India

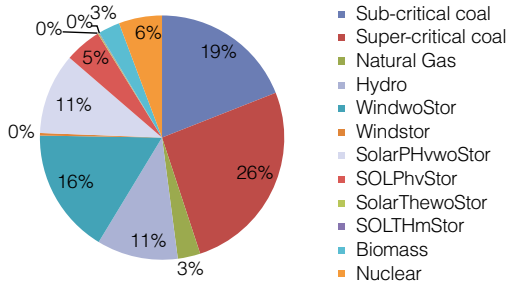
Supported by
Ministry of Science and Technology, Government of India

Climate Negotiations

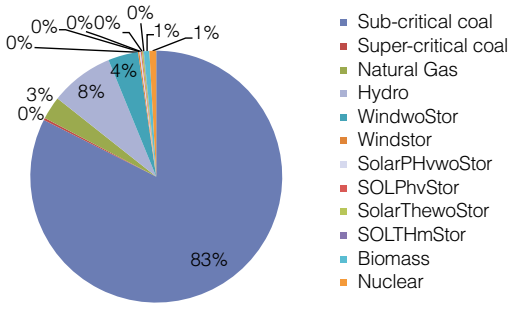
Developing Economy-wide Model for Low Carbon Strategies for Inclusive Growth (LCSIG)

The Expert Group on Low Carbon Strategies for Inclusive Growth (LCSIG) appointed by the Planning Commission had submitted its interim

Power Generation Capacity in GW in 2030 in LCIG



Power Generation Capacity in GW in 2030 in BIG



report in 2011. It provided low carbon technology alternatives for key energy-intensive sectors in India. But the assessment of these technologies at macro-economic level was not done. IRADe developed IRADe-LCSIG model to assess the impacts on growth rate, carbon emissions and energy and emission intensities of various low carbon measures.

The results were reflected in the final report of the Expert Group. It was found that India can reduce emission intensity by 25 per cent by 2022, but it would involve some loss of GDP.

Planning Commission
Government of India

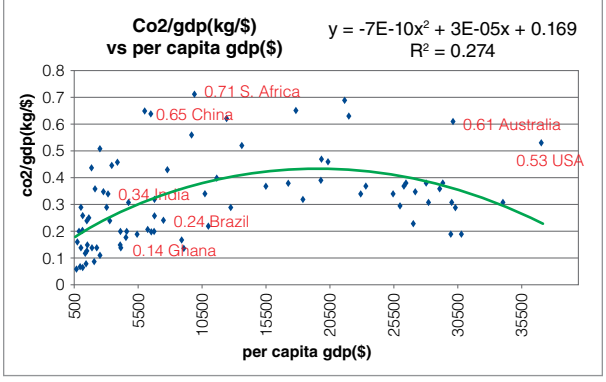
Supported by
Planning Commission, Government of India

Climate Negotiations from Indian Perspective

An international agreement will have to decide on principles of deciding which country should do what. The UNFCCC division of countries as annex I countries and non-annex I countries is no longer viable as many non-annex I countries have developed and have high levels of GHG emissions.

International comparisons of emissions, mitigation efforts, energy efficiency and emission quotas were done to outline a number of alternative paradigms. Four approaches were proposed in this report:

1. A three-tier approach, differentiating higher and lower emitters among the non-Annexure I parties
2. Sectoral approach where emission targets are set for sectors
3. Carbon dioxide intensity (of GDP) approach to differentiate countries as shown in the figure.
4. Focus on adaptation.



Data Source: EIA (2002)

Fig shows the relationship between carbon intensity and per capita GDP. It first increases with per capita GDP and then decreases.

Supported by
the Ministry of External Affairs,
Government of India

Critical Evaluation of the 12th Five Year Plan from a Climatic Perspective

IRADe carried out critical evaluation of the Twelfth Five Year Plan (GOI 2012) which focuses on faster, more inclusive and sustainable growth from a climatic perspective. The plan states that 'No development process can afford to neglect the environmental consequences of economic activity, or allow unsustainable depletion and deterioration of natural resources'.

Climate change has been explicitly addressed in India's 12th Five Year Plan. The plan document incorporates a chapter on sustainable development which outlines the required policy measures for LCSIG and focuses on a number of mitigation measures.

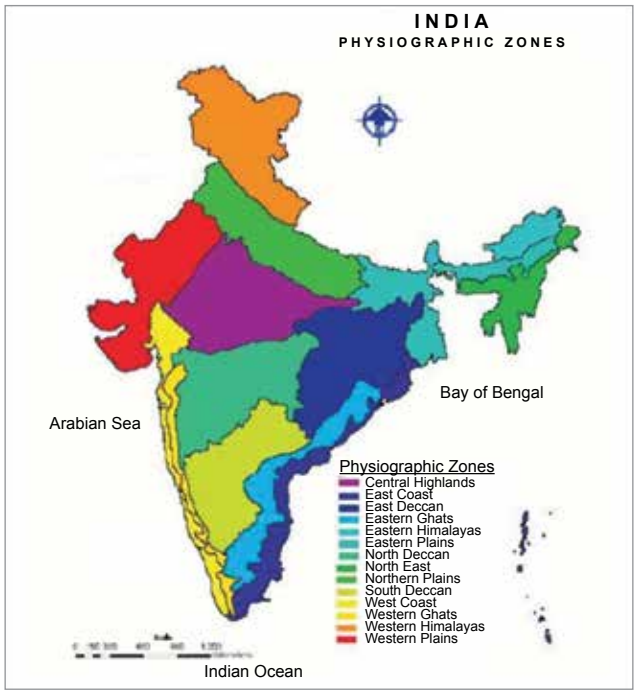
Specific measures are proposed for transport sector, energy efficiency in industries and commercial buildings, and water use efficiency in agriculture. A green technology firm is also proposed to promote green products, waste management and recycling.

Supported by
ICRIER 'The New Climate Economy Project'.

First Biennial Update Report to UNFCCC: Updation of Information on Mitigation Actions for National Circumstances

The study provides an update on national circumstances explained in the second national communication in the Biennial Update Report (BUR).

The broad scope of the study was to compile information on national circumstances, including climate, natural resources, agriculture and livestock, natural disaster, demographic profile, households, governance profile, economic profile, energy profile, power sector, transport, reforms and greenhouse gas emissions, low carbon strategy and India's commitment to climate change and sustainable development.



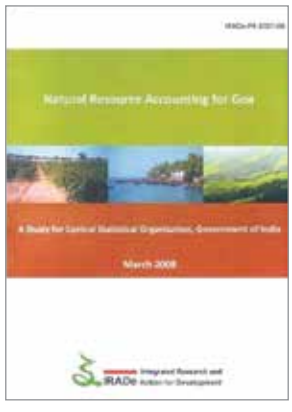
The report pointed out that India enacted the Energy Conservation Act, 2010 for efficient use of energy and its conservation. To improve energy efficiency of the coal-based power plants and reduce the GHG emissions, it was decided that new thermal power plants should be based on super critical technology. India has also levied cesses on coal, petrol and diesel to fund green technology.

Supported by
Inspire Network for Environment, NATCOM

Environment: Natural Resource Accounting (NRA)

Natural Resource Accounting in Goa, Phase II, under SEEA Framework

IRADe did the Natural Resource Accounting for three sectors: (1) Tourism; (2) Solid waste generation from municipal waste; and (3) Water pollution by industries, using the United Nation's System of Economic and Environmental Accounting (SEEA) framework. Physical and monetary accounts for these sectors were prepared.



When the value of environmental degradation due to tourism and municipal waste is taken into account Goa's net state domestic product (SNDP) goes down by 6 per cent but due to afforestation the gain is also 6 per cent and so overall Goa's SNDP remains nearly unaffected.

Supported by
Central Statistical Organization, Government of India

Measuring Ecosystem Services for Green India Mission: A Case Study of Paderu Project in Andhra Pradesh

Green India Mission (GIM) is one of the eight missions of the climate action plan. IRADe conducted primary field survey with the forest department of Paderu Division in Visakhapatnam District to highlight the dependence of local communities on ecosystem services and how they currently benefit from them.

Non-timber forest products (NTFPs) are critically important to local forest users as a primary, supplementary or emergency source of income and were found to contribute an estimated average of 19 per cent of a household's cash annual income.

While Tendu leaves generated income for many more people, honey gave higher total income to only a select few. Furthermore, 27 per cent households of the study area were found to receive at least some income from the collection,

processing and selling of NTFPs, majority of whom were poor to extremely poor.

Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH

Supported by
Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)

Ecosystem Management of Marine National Park, Jamnagar, Gujarat

Rapid industrial development in Jamnagar had its impact on the marine national park. The project studied the overall potential threats, formulated a conservation and management plan consistent with stakeholders' plans and suggested an implementation plan through a blend of economic instruments and control measures in order to protect the marine life, unique corals and mangrove ecosystem. Assessments were carried out for various potential impacts from different sources in the park areas on marine ecosystem and critical pollution sources such as industries, ports and shipping activities on the marine national park. Simultaneously, the prospect of developing an ecotourism corridor in the marine national park and the nearby Khijadia Bird Sanctuary was investigated.

The project brought together the stakeholders ranging from government officials, representatives of industries, officers of the municipality, NGOs, academics and the private sector.

MINISTRY OF ENVIRONMENT AND FORESTS
Government of India

Supported by
Ministry of Environment and Forests, Government of India

Review of Status of Jamnagar Marine National Park and Evolving Vision Statement for Its Management

IRADe is conducting a study for GIZ and the MoEF to review the status of the marine national park in Jamnagar district of Gujarat since its creation in 1982. The project will undertake macro-assessment of the ecological status of the marine national park and the impact on its stakeholders. Preparation of a vision statement for sustainable and workable management for healthy coexistence of the marine national park and economic hotspots is proposed as well.

Pre-feasibility Study of Integrated Waste Management and Landfill Gas Recovery and Utilization at Puducherry

An assessment of the potential for LFG utilization was carried out for a Puducherry landfill.

The study was based on information provided by the Puducherry Pollution Control Committee and Puducherry Municipality and observations made during the site visit. The model results indicated that various constraints are likely to limit future LFG recovery to a maximum of 22.8 cubic meters per hour.

Supported by
United States Environmental Protection Agency (USEPA)

ENVISION – Information System Reforms at the Ministry of Environment and Forests, 2006–07

The key objective of 'ENVISION' was to use information technology to transform the functioning of the MoEF and the various constituent organizations under its purview with a business process perspective and also to transform the means of rendering services to its various stakeholders. IRADe was hired as the domain expert in the team of Price waterhouse Coopers (PwC). IRADe suggested steps for faster delivery, which the MoEF has already implemented.

MINISTRY OF ENVIRONMENT AND FORESTS
Government of India

Supported by
Price waterhouse Coopers (PwC); Ministry of Environment & Forests

Supporting National Study on the Economics of Ecosystems and Biodiversity (TEEB – India Initiative)

'Economic value of ecosystem services and biodiversity are used to enhance effectiveness of conservation and management of three priority ecosystems, namely forests, inland wetlands and coastal and marine ecosystems.

GIZ in partnership with the Ministry of Environment and Forests (MoEF) is implementing a technical cooperation project 'Incentives for sustainable management of biodiversity and ecosystem services'. Under this initiative, about 12 field-based primary case studies on valuation of ecosystem services in forests, inland wetlands and coastal and marine ecosystems had been undertaken.

To support a national study on The Economics of Ecosystem and Biodiversity (TEEB-India), IRADe is doing extensive literature survey to assess the existing knowledge and studies on valuation of biodiversity and ecosystem services.

IRADe is also providing support to the Scientific and Technical Advisory Group (STAG) for preparing an overall structure/wireframe of TEEB-India report in addition to providing support to review and short-list case study concept notes to present to the project's scientific and technical advisory group (STAG).

Poverty Alleviation and Gender

IRADe

Themes and Projects

➔ **Energy, Poverty and Gender Nexus**

- The Impact of Clean Fuel Access Policy on Women's Empowerment in Himachal Pradesh
- Gender Audit of National Energy Policies of India
- Mainstreaming Gender in Energy Policy 2006 for Planning Commission
- Reducing Drudgery of Women Carrying Biofuels, 2007–08: E-discussion and Field Surveys
- The Third ENERGIA National Focal Points Meeting
- National Stakeholder Consultation on Gender Issues, Millennium Development Goals and Poverty Alleviation

➔ **Gender – Climate Change**

- Gender and Climate Change – Event Organised at COP-Delhi
- MAPS India Study on Poverty and Low Carbon Development Strategies
- Assessing Socio-economic Vulnerability to Climate Change: A Case Study of Assam

Introduction

In order to address poverty issues in all the other 4 thematic areas, to enhance capabilities of women and to ensure increased participation of women in decision making, IRADe focuses on the poor, especially women, while discussing energy, environment, climate change, cities or agriculture. In the energy sector, IRADe is advocating that more attention should be given to the non-commercial energy sector (fuel-wood) managed by women, providing 27 per cent of national energy. Currently, sustainable energy for all (SE 4 all) are some of the high profile initiatives of the UN and others. In the last few years, IRADe has undertaken various research studies in this sector to address this burning issue and organised or participated in conferences.

Energy, Poverty and Gender Nexus

The Impact of Clean Fuel Access Policy on Women's Empowerment in Himachal Pradesh

This study focused on poverty, gender and environment and health issues in Himachal Pradesh and involved a gender-specific survey to address this issue. The study found that women walk approximately 30 km on hilly terrains in a month to collect fuel-wood.

Primary survey estimated accessibility and use of clean fuel by households for 30 villages in two districts and a survey on the kerosene depots was also conducted to get the seller's perspective of the supply situation under Public Distribution System (PDS). It was found that the people in HP are willing to pay for kerosene, the fuel next on the energy ladder to biofuels, but due to increased availability of LPG, the demand for kerosene has been on the decline.

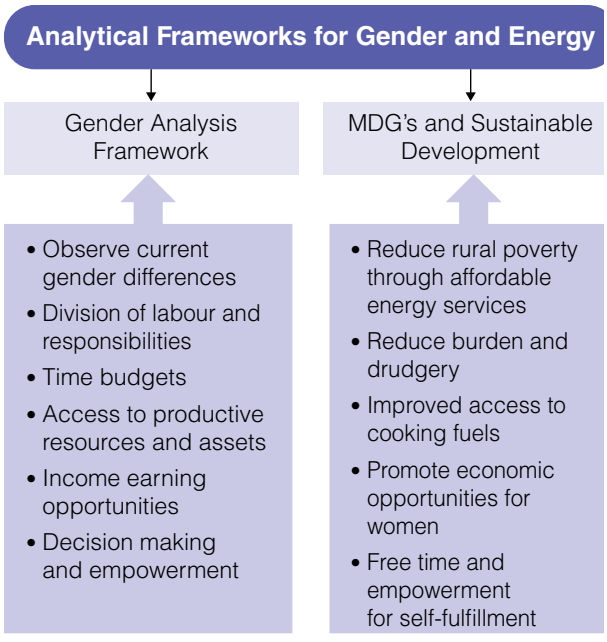
Bio-fuel chain and health impacts

Activity	Health Impact
Gathering: • Search and Collect Biomass • Walking • Cutting	• Physical Stress • Bruises • Snake bites • Insect bites
Processing: • Chopping to pieces and stacking • Bundling • Drying	• Allergies • Chapped hands
Transporting: • Walking and transporting of Heavy Loads	• Backache • Headache • Knee pain
Cooking: • Water heating • Home industries	• Respiratory • Eye diseases • Infant mortality • Adverse pregnancy • Heart diseases

Supported by
DFID/KAR through ENERGIA of ETC Foundation

Gender Audit of National Energy Policies of India

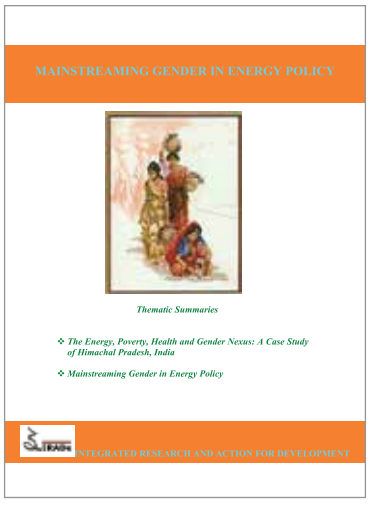
This is a collaborative exercise to draw attention to the lack of gender concerns in National Energy Policies (NEP) in India. The gender audit exercise was carried out to define an approach in making NEP more gender responsive in terms of their content and process. The key recommendations consisted of (a) reorienting monitoring and evaluation mechanisms to reflect gender concerns in energy programmes; (b) linking women's empowerment with energy development; (c) inter-ministerial coordination in addressing energy security; and (d) operationalizing the goal of 'Making cooking fuels available within 1 km of habitations'.



Supported by
ENERGIA of ETC Foundation

Mainstreaming Gender in Energy Policy 2006 for Planning Commission

The project highlighted gender-related concerns that included capacity building and special training to women in various institutions/universities to create a cadre of energy professionals. Policy needs to go beyond cooking energy, and emphasis should be on providing energy for other needs of livelihood and security. Research should be pursued for development of various biofuel species, cultivation practices and appliances (stoves). Health issues included how to minimize respiratory diseases from indoor air pollution and how to reduce the daily drudgery of women so that they can spend more time on generating income. A more participatory approach to energy policy decisions will allow both men and women to engage in defining energy problems and in implementing solutions appropriate to geographic locations in India.



Planning Commission
Government of India

Background paper and presentation prepared for Expert Committee to formulate Energy Policy, Planning Commission

Reducing Drudgery of Women Carrying Biofuels, 2007–08: E-discussion and Field Surveys

In 2010, IRADe was chosen as the National Focal Point (NFP) of ENERGIA-International Network for Gender and Sustainable Energy. As a part of network activities, IRADe organized an e-debate with professionals from gender studies, energy and poverty on a common platform on certain identified issues to share best practices and develop ideas for gender-energy-poverty related research activities. The second level of the exercise was field survey on the suggestions received from focused group exercise done in one village each in North India (Rajasthan) and South India (Karnataka) respectively by partners, Social Policy Research Institute, Jaipur in Rajasthan and TIDE, Bangalore in Karnataka. The results of the surveys highlighted the difference in opinions and willingness to adopt new ideas in two different geographical locations in India.

For example, Rajasthan preferred LPG kitchen and local varieties as fuel sources whereas Karnataka was exploring options based on coconut waste.

The Third ENERGIA National Focal Points Meeting

ENERGIA Asia Network in collaboration with IRADe organized the third ENERGIA National Focal Point (NFP) meeting during November 1-3, 2006. IRADe is active in advocating more attention to the non-commercial energy sector (fuel-wood) managed

by women, which is the second largest energy source after coal. IRADe also advocated bringing energy within 1 km of rural habitats and organized and participated in events related to United Nations Commission on Sustainable Development (CSD). The group engaged in discussing and developing a set of monitoring criteria and National plans for each National Focal Point.

Supported by
ENERGIA - the International Network on Gender and Sustainable Energy

National Stakeholder Consultation on Gender Issues, Millennium Development Goals and Poverty Alleviation

A half-day consultation was organized by IRADe in collaboration with the All India Women's Conference funded by ENERGIA – the International Network on Gender and Sustainable Energy. Key issues were energy, millennium development goals (MDGs), poverty alleviation and implementation of official National Energy Policies.

The participants supported recommendations drafted by IRADe in the national paper and suggested that poverty alleviation is about increasing people's productivity, for which all issues of health, education, electricity and fuel need to be addressed.

Supported by
ENERGIA - the International Network on Gender and Sustainable Energy

Gender – Climate Change

Gender and Climate Change – Event Organised at COP-Delhi

One of the first side events on Gender and Climate change was organized at COP 8, 2002, New Delhi. An issue paper prepared for this is referred often.

1. Later in 2008, another issue paper was written on 'Mainstreaming Gender in Climate Change: Policies, Programmes', which was circulated widely.
2. A 3-day training programme was facilitated by IRADe for the Asia-Pacific office of UNDP on mainstreaming gender in climate change at Sri Lanka.

Supported by
United Nations Development Programme (UNDP)

MAPS India Study on Poverty and Low Carbon Development Strategies

With support of Mitigation Action Plans and Scenarios (MAPS), an initiative of developing countries, IRADe did pioneering work using a macroeconomic model to link poverty, income inequality and rural–urban disparity in the context of climate change up to 2030.

It showed that development initiatives like cash transfers or reducing inequality may not have a large impact on carbon dioxide emissions. Similarly, mitigation actions like improving energy efficiency will not affect development efforts and poverty levels negatively. The study showed that co-benefits approach can be useful in this context.

Supported by
South South North Trust, Cape Town, South Africa

Assessing Socio-economic Vulnerability to Climate Change: A Case Study of Assam

This study was aimed at assessing vulnerability of Assam to climate change and its socio-economic implications on sectors such as agriculture, water and forestry in the state. The implications of climate change are complex and multi-dimensional. Thus, vulnerable groups such as farmers, forest dwellers and other multiple stakeholders, especially women, were surveyed to assess vulnerability of livelihoods in climate-sensitive sectors such as agriculture and forestry. Loss of livelihoods and hardships were documented through primary survey.

Water logging due to floods for weeks caused problems in walking to the market or schools and also for defecation.

Supported by
Indian Council of Social Science Research, New Delhi

Agriculture and Food Security

IRADe

Themes and Projects

➔ **Food Security**

- Food Security Bill: Issues, Impact, Effectiveness and Alternatives
- Extension of Minimum Support Price: Fiscal and Welfare Implications 2007–08

➔ **Agricultural Development, Economic Growth and Livelihood**

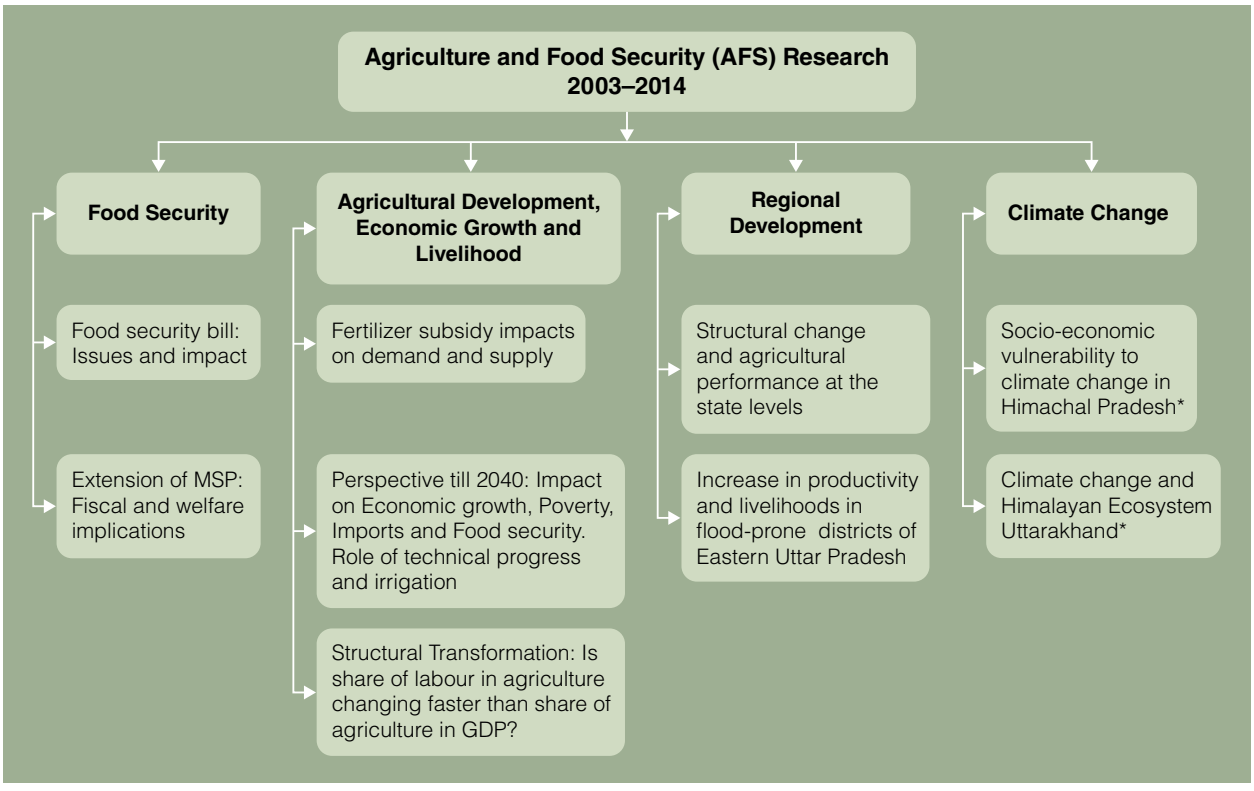
- Demand, Supply and Subsidy Analysis for Indian Fertilizer Sector
- Indian Agriculture 2040
- Structural Transformation of the Indian Economy and its Agriculture
- India 1960–2010: Structural Change, Rural Non-Farm Sector and the Prospects for Agriculture

➔ **Regional Development**

- India 1980–2008: Structural Change and Agricultural Performance at the State Levels
- Factors Affecting Productivity of Northern Flood Plains of Eastern Uttar Pradesh

Introduction

Food security issues now should also include climate change. To enhance food security, IRADe focuses on yield growth in agriculture, a rational development strategy for handling the issues of excess labour in agriculture sector, management of arable land in India, institutional approach for collective action and rational use of irrigation water etc. The domestic self-sufficiency ratio for food security needs to be optimized. IRADe has worked on the following projects related to the field of agriculture and food security:



**Described under sectors on climate change*

Food Security

Food Security Bill: Issues, Impact, Effectiveness and Alternatives

The impact of the Food Security Bill on nutrition, costs and foodgrain production is explored. Considering the difficulties of identifying the poor it argues for direct benefit transfer after excluding the clearly identifiable rich.

Extension of Minimum Support Price: Fiscal and Welfare Implications 2007–08

The Planning Commission, GOI, awarded IRADe the research project to study the implications of extending the minimum support price (MSP) to more states. After an analysis of implications for the welfare of producers and consumers in Madhya Pradesh and Uttar Pradesh, it was recommended that MSP could be extended in many states, because more states are growing rice and wheat than earlier.

There are national gains in reduction in transport of grains and benefits of government policies reach farmers in more states.

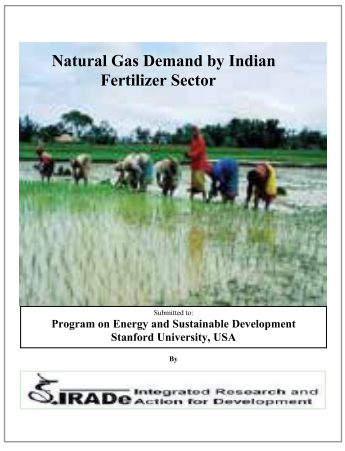
Planning Commission
Government of India

Supported by
Planning Commission, Government of India

Agricultural Development, Economic Growth and Livelihood

Demand, Supply and Subsidy Analysis for Indian Fertilizer Sector

IRADe carried out this study to analyse the fertilizer demand, assess the impact of various feedstock prices, estimate the total subsidy for the fertilizer sector, suggest a range of policy alternatives, recommend viable policy and reform options for policymakers for India and carry out a comparative study of domestic policy and global fertilizer policies. Fertilizer consumption increases with increase in irrigated area. It is sensitive to price and relative price affects nutrient balance. A 30 per cent increase in net irrigated area can increase fertilizer subsidy by 60 per cent. The need to moderate subsidy through gradual increase in price and/or effective targeting of the small farmer are suggested.



Department of Fertilizers
Ministry of Chemicals and Fertilizers
Government of India

Supported by
Department of Chemicals and Fertilizers, Government of India

Indian Agriculture 2040

Rapidly growing Indian economy will call for a transformation of Indian agriculture over the next 30 years with profound implications for diversification of production, rural-urban migration, agricultural profitability and food security.

To explore these issues, IRADe has developed a macro-economic model with endogenous income distribution. A unique demand system was estimated based on Indian data. The study showed that if India is to maintain a reasonable level of self-sufficiency in foodgrains, an agricultural growth rate of at least 4 per cent is needed to support a GDP growth rate of 8 per cent, requiring expansion of irrigated area and increased agricultural productivity.

Supported by
Centennial Group, USA

Structural Transformation of the Indian Economy and its Agriculture

With economic growth, labour is expected to move out of agriculture. The turning point of structural transformation is when the share of labour in agriculture declines faster than the share of agricultural GDP in total GDP.

Despite accelerating economic growth, the structural transformation of the Indian economy has been slow.

Labour absorption in the urban economy, and especially in the manufacturing sector has been low, formal sector jobs are few and declining as a share of employment and labour contracts are increasingly informal. As a consequence, and combined with rapid population growth, the labour force in the rural areas is still growing fast. Agricultural growth has not responded to the accelerating income growth and agricultural employment is growing slowly.

India 1960–2010: Structural Change, Rural Non-Farm Sector and the Prospects for Agriculture

The agriculture sector now generates the largest number of jobs in India. Rural non-farm self-employment has become especially dynamic with farm households rapidly diversifying to increase income.

The growth of the rural non-farm sector is a structural transformation of the Indian economy, but it is a stunted one. It generates few jobs at high wages with job security and benefits. It is the failure of the urban economy to create enough jobs, especially in labour-intensive manufacturing, that prevents a more favourable structural transformation of the classic kind. The bottling up of labour in rural areas, however, means that farm sizes will continue to decline, agriculture will continue its trend to feminization and part-time farming will become the dominant farm model.

CENTENNIAL GROUP INTERNATIONAL
policy and strategic advisors

Regional Development

India 1980–2008: Structural Change and Agricultural Performance at the State Levels

Out of 15 states, six are now experiencing convergence of the share of the agricultural labour force with the share of agricultural output – Kerala, Punjab, Haryana, Maharashtra, West Bengal and Tamil Nadu – with convergence still very slow in the last two states. The factors behind the convergence differ among the states. It is clear that structural transformation has started in India, but is not yet generalized.

Supported by
Integrated Research for Action and Development (IRADe)

Factors Affecting Productivity of Northern Flood Plains of Eastern Uttar Pradesh

IRADe carried out in-depth research to understand the drivers of growth and livelihoods and obstacles in the selected districts and clusters where Sir Dorabji Tata Trust (SDTT) supported projects are undertaken by NGOs. IRADe assessed the production and resource potential and devised strategies in consultation with stakeholders and participating NGOs to overcome various challenges encountered by the region, strengthen the clusters and generate synergy using data and analysis for Bahraich, Kushinagar and Shravasti, three of the poorest districts in Uttar Pradesh. A vision document is prepared that identifies options to increase livelihood.

In these districts electricity supply is poor and inadequate.

There exist large gaps between potential and actual productivity of major crops. Lack of proper

marketing channels both for purchasing farm inputs and selling produce hampers diversification.

Supported by
Sir Dorabji Tata Trust (SDTT)

Agri-extension services are inadequate and certified seeds are not available in time. The irrigation potential of canals in Bahraich and Kushinagar is not fully realized due to siltation and poor maintenance of canals. Private diesel-operated tube wells are expensive. IRADe suggested strengthening of extension services with agri-clinics providing credit to agriculturists, improving canal management and diversification of agriculture to cash-rich crops and measures to fully exploit the value chain of crops by utilizing by-products in productive activities.

IRADe in News

Publication: The Times Of India Delhi;Date: Dec 17, 2011;Section: Editorial;Page: 24

Heading For Grain Drain

As it stands, the food security plan is flawed and can have a negative impact

Kirit S Parikh

THE OP-ED PAGE

Swachh Bharat should include Swachh air

A roadmap for cleaner urban centres can be merged into the smart cities framework

DEATH BY BREATH

Be ambitious at Lima

Larger promises of emissions reduction would benefit India. But any agreement must also be fair

JYOTI PARIKH AND KIRIT PARIKH

TOTAL GHG EMISSIONS INCLUDING LAND-USE CHANGE AND FORESTRY

IN INTERNATIONAL forums on climate change, India is often painted as obstructionist, whereas China is lauded as a good guy.

साझा चुनौती का सामना

पर्यावरण परिवर्तन के प्रभावों से निपटने के लिए हो रहे उपायों का विश्लेषण कर रही हैं ज्योति पारिख

Publication: The Times Of India Kolkata;Date: Aug 31, 2012;Section: Editorial;Page: 16

Driving The Wrong Way

If the government can't raise diesel prices, it should at least stop subsidising diesel cars

Kirit S Parikh

Disaster-resilient cities

Lessons from Srinagar and Guwahati on how to protect our cities from natural disasters

JYOTI PARIKH

Article rank 29 Dec 2013 Business Standard JYOTI PARIKH

Turning the lights on across South Asia

Why cooperation across the Indian subcontinent to ensure energy security is an idea whose time has come

Despite its huge hydro power potential, the South Asian region is the least interconnected in the world. And it can be topped only through cooperation

The South Asia Region (SAR), one of the poorest in the world, has long faced an energy crunch. Nearly 6… million people are without access to electricity. Without electricity, they are not likely to be on the developm… bus in the near future. The per-person annual electricity consumption of SAR is 563 units; the world average… 3,000, and it is 12,000 in the US.

Decision Support Provided to Various Ministries by IRADe

IRADe

S.No.	Ministry	Projects
1.	Ministry of Urban Development (MoUD)	• Centre of Excellence for Urban Development and Climate Change • Sustainable and Disaster Resilient Urban Development
2.	Ministry of Environment and Forests (MoEF)	• GHG Reduction Potential, Sectoral Baselines and Opportunities for CDM Projects • First National Communication (FNC) for India's national circumstances for addressing climate change to the UNFCCC (NATCOM) • National Framework for Risks, Impact and Vulnerability Assessment for Mountain Ecosystems, Uttarakhand • Ecosystem Management of Marine National Park, Jamnagar, Gujarat • Activity Analysis Model for Climate Policies for India • Third National Communication (TNC) for India's national circumstances for climate change for NATCOM for UNFCCC • Modelling Studies on Greenhouse Gas Emission and Emission Intensity of Indian economy
3.	Ministry of New and Renewable Energy (MNRE)	• Village Energy Security Programme (VESP) in Vavdi and Vaddithar villages in Gujarat • International Training Programmes on various themes of renewable energy conducted for four years for senior officers from Africa and Asia on techno-economic, financial and socio-environmental issues • Evaluation Surveys of Remote Village Electrification (RVE) Programme Solar Photovoltaic and Solar Thermal Applications in six states • Techno-economic and Socio-agronomic Analysis of Biodiesel System • Monitoring and Evaluation of Solar Photovoltaic System Programme in Himachal Pradesh and Punjab (2012) • Monitoring and Evaluation of RVE Programme in two states (Rajasthan and Haryana) (2009) • Jodhpur Solar City Master Plan • Evaluation of Solar Photovoltaic System Programme in six states (Rajasthan, Haryana, Uttarakhand, Manipur, Karnataka and Gujarat) • Evaluation of Solar Thermal Demonstration Project in four states (Rajasthan, Haryana, Uttarakhand and Gujarat)

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S.No.	Ministry	Projects
4.	Department of Science and Technology (Ministry of Science and Technology)	• International Workshop on Carbon Capture and Storage (CCS) in Power Sector in India. • Analysis for Carbon Capture and Storage (CCS) Technology in Power Sector in India • Vulnerability Analysis of Himachal Pradesh to Climate Change • Global Technology Watch Group (GTWG) on Advanced Coal Technologies (ACT) for Power Generation
5.	Technology Information, Forecasting and Assessment Council (TIFAC)	• Techno-economic Analysis for Bioenergy options • Indian Perspectives on Global Energies Scenarios till 2050
6.	Ministry of External Affairs	• Analysis of Alternative Approaches of Climate Negotiations
7.	Central Statistical Office (CSO)	• Natural Resource Accounting (NRA), Goa
8.	Ministry of Power	• Evaluation of Franchise System in West Bengal, Assam and Nagaland
9.	Rural Electrification Corporation (REC)	• Evaluation of Franchise System in Assam, Rajasthan and West Bengal • Evaluation of Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) in the states of Gujarat, Assam, Rajasthan, Uttar Pradesh and Himachal Pradesh
10.	Planning Commission/Niti Ayog	• Conducting a research study on extension of Minimum Support Price (MSP), Fiscal and Welfare Implications • Modelling for low carbon strategy for inclusive growth • National Energy Policy
11.	Ministry of Chemicals & Fertilizers (Department of Fertilizers)	• Demand, Supply and Subsidy Analysis for Indian Fertilizer Sector
12.	Ministry of Earth Sciences (MoES)	• Vulnerability of Coastal Cities on Rivers to Climate Change – Case Study of Surat
13.	Ministry of Finance	• Assessment of Alternative Roadmaps on Reforming Diesel Prices in India
14.	Government of Manipur	• Renewable Facility Development at Raj Bhavan, Manipur
15.	Delhi State Government	• CDM Training Programme for Delhi State Government Agencies

IRADe's Collaboration with International, Multilateral and Non-Government Organizations/Institutions

IRADe

S.No.	Organization	Projects
1.	Gujarat Power Corporation Ltd. (GPCL)	• Environmentally Sustainable and Integrated Energy Strategy for Gujarat State
2.	U.S. Agency for International Development (USAID)	• South Asia Regional Initiative for Energy Integration (SARI/EI)
3.	Sir Dorabji Tata Trust (SDTT)	• Analysis of Factors affecting productivity of Northern Flood Plains of Eastern Uttar Pradesh with a view to synergize SDTT efforts in the region
4.	South South North Trust (SSN)	• MAPS India Study on Poverty and Low Carbon Development Strategies
5.	International Institute for Sustainable Development (IISD)	• The Impact of India's Diesel Price Reforms on the Trucking Industry • Assessing the Impact of Diesel Subsidy Reform since January 2013 • Analysis of Kerosene Free Delhi
6.	GIZ - Deutsche Gesellschaft für Internationale Zusammenarbeit	• Preparation of report on status of renewable energy in India • Renewable Energy Component of the Indo-German Energy Programme • Green Accounting Study for the State of Andhra Pradesh • Green Accounting for PADERU project, Andhra Pradesh • Indian Renewable Energy Status Report - Background Report for DIREC 2010 • Translation of National Action Plan on Climate Change for the urban sector. • Supporting National study on the Economics of Ecosystems and Biodiversity (TEEB-India) • Review of status of Marine National Park, Jamnagar and evolving vision statement for its management of MNP
7.	The World Bank	• IRADe-IIEF State of Market Conclave 2005: Second Generation Financial Sector Reforms in India • National Environmental Institutional Assessment

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S.No.	Organization	Projects
8.	Rockefeller Foundation, US/ ACCCRN	• International Workshop on 'Sustainable and Climate Resilient Urban Development' • Climate Vulnerability of Cities • Urban Climate Resiliency Policy Support; Vulnerability profile of India's urban centres in context of climate change • Climate Resilient Urban Development: Vulnerability Profiles of 20 Indian Cities • High level engagement at state and national level in India to integrate urban climate resilience in various policies and programmes
9.	Institute for Social and Environmental Transition (ISET) through ACCCRN	• Asian City Climate Change Resilience Transition (ISET) through ACCCRN Network (ACCCRN) • Climate Policy environment in India
10.	TARU Leading Edge Pvt. Ltd.	• A Policy Brief on Emerging Mechanisms and Responses of Cities to Climate-ACCCRN
11.	British High Commission	• Mapping of Carbon Capture and Storage (CCS) activities in India to promote R&D initiatives
12.	World Energy Council-Indian Member Committee (WEC-IMC)	• A public lecture by Lord Professor Nicholas Stern on 'Economics, Ethics and Climate Change'
13.	United States Environmental Protection Agency (USEPA)	• Pre-feasibility study of integrated waste management, landfill gas recovery and utilization at Puducherry, India
14.	CCAP-Centre for Clean Air Policy, USA	• Analysis of GHG Emissions for Major Sectors in India: Opportunities and Strategies for Mitigation
15.	ENERGIA, ETC Foundation, Netherlands/DFID-Department for International Development, New Delhi	• The Energy, Poverty and Gender Nexus in Himachal Pradesh, India: The Impact of Clean Fuel Access Policy on Women's Empowerment • Gender Audit of National Energy Policy in India • National Stakeholder Consultation: Gender issues, MDG and Poverty alleviation for Commission for Sustainable Development held at UN, New York • Energy Sector Reforms along with IISD consortium • Establishing inter-ministerial linkages to address energy accessibility to poor women in rural and urban areas (ENERGIA)
16.	Petroleum Federation of India, New Delhi	• Integrated Study of Diesel Substitutes from Oilseeds in India
17.	Stanford University, USA	• A Political Economy Analysis of Demand for Natural Gas in the Indian Fertilizer Sector • National Consequences of Electricity Pricing Reforms on Agriculture Using General Equilibrium Approach

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S.No.	Organization	Projects
18.	Pricewaterhouse Coopers	• Projection for Petroleum Products,Natural Gas and Substitutes up to 2030 • ENVISION – Information Systems Reforms at the Ministry of Environment and Forests
19.	Wuppertal Institute for Climate, Environment and Energy (WISIONS), German	• Rural Micro-Enterprise Model for Biofuel Extraction in India at Bawal, Haryana
20.	Self-employed Women Association (SEWA), Gujarat	• Preparation of energy activities and Pilot Demonstration Project on renewable energy
21.	United Nations Environmental Programme	• Training Session on Capacity Building, Environment, Trade and Sustainable Development
22.	Institute of Global Environmental Strategies, Japan	• Opportunities for Energy Efficiency and Clean Development Mechanism (CDM) in Cement and Building Materials
23.	Centennial Group, USA	• Study on Agriculture 2040
24.	GTZ-ASEM Project	• Study on Agriculture 2040 Transition of NAPCC for the Urban Sector
25.	United Nations Development Programme	• Climate Change and Gender • International Training Workshop at Colombo, Sri Lanka
26.	Shakti Foundation	• Assessment of Alternative Roadmaps on Reforming Petroleum Prices
27.	Brot für die Welt ('Bread for the World')	• Consultancy service for support in investigating and planning the strengthening of the municipal solid waste management system in Industrial Park, Cherlapalli, Andhra Pradesh
28.	DFID, UK partnership, AEA Technology & Emergent ventures	• Identifying Specific Policy Options with the Aim of Reducing Carbon Intensity in India
29.	Indian Council for Research on International Economic Relations	• Critical Evaluation of the 12th Five Year Plan from a Climatic Perspective

PR: List of IRADe Project Reports

IRADe

Project Report No. & Year	Title of Project	Funding Agency
IRADe-PR-52 (2015)	Supporting National study on the Economics of Ecosystems and Biodiversity (TEEB-India)	• Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
IRADe-PR-51 (2015)	Environmentally Sustainable and Integrated Energy Strategy for Gujarat	• Gujarat Power Corporation Ltd. (GPCL)
IRADe-PR-50 (2015)	Preparation of Third National Communication (TNC) and other new information to the UNFCC project, India's First Biennial Update Report-National Circumstances	• InsPIRE Network for Environment, NATCOM
IRADe-PR-49 (2015)	Socio Economic Vulnerability of Himachal Pradesh to Climate Change	• Department of Science and Technology (DST)
IRADe-PR-47 (2015)	Analysis of factors Affecting the agricultural productivity in the Flood Plains of Eastern Uttar Pradesh to Synergise Investments by the Trusts	• Sir Dorabji Tata Trust (SDTT)
IRADe-PR-48 (2014)	Sustainable and Disaster Resilient Urban Development	• Ministry of Urban Development (MoUD)
IRADe-PR-46 (2014)	Critical Evaluation of the 12th Five-Year Plan from a Climatic Perspective	• Indian Council for Research on International Economic Relations (ICRIER)
IRADe-PR-45 (2014)	Assessing the Impacts of Diesel Subsidy Reform Since Jan 2013	• International Institute for Sustainable Development (IISD)
IRADe-PR-44 (2014)	Analysis of Kerosene Free Delhi Scheme	• International Institute for Sustainable Development (IISD)
IRADe-PR-43 (2014)	Prospects for Regional Cooperation on Cross-Border Electricity Trade in South Asia	• US Agency for International Development (USAID)
IRADe-PR-42 (2014)	Economy wide Model for Low Carbon Strategy	• Planning Commission
IRADe-PR-41 (2014)	Research Study on Low Carbon Development Pathways for an Inclusive India	• World Wildlife Fund, Germany and World Wildlife Fund, India

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Project Report No. & Year	Title of Project	Funding Agency
IRADe-PR-40 (2013)	CDMP Review of Six cities	• United Nations Development Programme
IRADe-PR-39 (2013)	The Impacts of India's Diesel Price Reforms on the Trucking Industry	• International Institute for Sustainable Development
IRADe-PR-38 (2013)	Identifying specific policy options with the aim of reducing carbon intensity in India	• Department for International Development and AEA
IRADe-PR-37 (2013)	Climate Resilient Urban Development: Vulnerability Profiles of 20 Indian Cities	• Rockefeller Foundation
IRADe-PR-36 (2012)	Assessing Socio-Economic Vulnerability to Climate Change: A case study of Assam	• Indian Council of Social Science Research
IRADe-PR-35 (2012)	Maps India Study on Poverty and Low Carbon Development Strategies	• South South North Trust
IRADe-PR-34 (2012)	Monitoring & Evaluation of Off Grid Solar Photovoltaic Systems installed in Punjab and HP in 07-08, 08-09 and 09-10	• Ministry of New and Renewable Energy
IRADe-PR-33 (2012)	Taming Diesel Subsidy to Curtail Inflation and Foster Economic Growth	• Shakti Foundation, Ministry of Finance
IRADe-PR-32 (2012)	Measuring Ecosystem Services for Green India Mission-Case study of Paderu project I Andhra Pradesh	• Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
IRADe-PR-31 (2011)	Investigating and planning the strengthening of the municipal solid waste management system in the Industrial Park Cherlapalli/Andhra Pradesh	• Bread for the World
IRADe-PR-30 (2011)	Evaluation of the Rajiv Gandhi Grameen Vidyutikaran Yojana in the states of Assam, Gujarat, HP, Rajasthan, U.P.	• Rural Electrification Corporation
IRADe-PR-29 (2011)	Techno-economic and Socio-agronomic Analysis of Bio-diesel System	• Ministry of New and Renewable Energy
IRADe-PR-28 (2010)	Management of Ecosystem of Marine National Park, Gujarat in Harmony with Industrial Development	• Ministry of Environment and Forests
IRADe-PR-27 (2010)	Indian Renewable Energy Status Report, Background Report for DIREC 2010	• German Technical Cooperation (GTZ) and National Renewable Energy Laboratory
IRADe-PR-26 (2010)	Indian Perspectives on Global Energies Scenarios till 2050	• Technology Information, Forecasting and Assessment Council and International Institute for Applied Systems Analysis

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Project Report No. & Year	Title of Project	Funding Agency
IRADe-PR-25 (2010)	Study of Indian agriculture till 2040	• Centennial Group Holdings LLC
IRADe-PR-24 (2010)	Modeling for the Indian Agriculture Study	• Centennial Group
IRADe-PR-23 (2009)	Activity Analysis Model for Climate Policies for India	• Ministry of Environment and Forests
IRADe-PR-22 (2009)	Green Accounting for the State of Andhra Pradesh	• Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ)
IRADe-PR-21 (2009)	Three-tier Systems for Climate Negotiations	• Ministry of External Affairs
IRADe-PR-20 (2009)	Climate Change and Himalayan Ecosystem	• Ministry of Environment and Forests
IRADe-PR-19 (2009)	Methane Emission and Pump Test Study from Landfill - Puducherry and Okhla, New Delhi Waste Management	• United States Environmental Protection Agency
IRADe-PR-18 (2009)	Study for Evaluation of Solar Thermal Energy Demonstration Programme During 10th Plan	• Ministry of New and Renewable Energy
IRADe-PR-17 (2009)	Evaluation of Solar Photovoltaic Programme	• Ministry of New and Renewable Energy
IRADe-PR-16 (2009)	Analysis of GHG Emissions for Major Sectors in India: Opportunities and Strategies for Mitigation	• Centre for Clean Air Policy, USA
IRADe-PR-15 (2009)	Analysis for CCS Technology in Indian Power Sector	• Department of Science and Technology (DST)
IRADe-PR-14 (2009)	Demand, Supply and Subsidy Analysis for Indian Fertilizer Sector	• Department of Fertilizer
IRADe-PR-13 (2008)	Extension of Minimum Support Price (MSP): Fiscal and Welfare Implications	• Planning Commission
IRADe-PR-12 (2009)	Gender Analysis of Renewable Energy in India: Present Status, Issues, Approaches and New Initiatives	• ENERGIA
IRADe-PR-11 (2007)	Demand for Natural Gas in the Indian Fertilizer Sector	• Stanford University, USA
IRADe-PR-10 (2007)	Evaluation of Franchises System in Assam	• Rural Electrification Corporation
IRADe-PR-09 (2007)	Evaluation of Franchises System in West Bengal	• Ministry of Power

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Project Report No. & Year	Title of Project	Funding Agency
IRADe-PR-08 (2007)	Natural Resource Accounting (NRA) Goa Phase-II	• Central Statistical Office
IRADe-PR-07 (2006)	Gender Oriented Energy Policy	• ENERGIA
IRADe-PR-06 (2006)	GHG Reduction Potential, Sectoral Baselines and Opportunities for CDM Projects	• Ministry of Environment and Forests
IRADe-PR-05 (2005)	The Energy Poverty and Gender Nexus in Himachal Pradesh, India: The Impact of Clean Fuel Access Policy on Women's Empowerment	• ENERGIA and Department for International Development
IRADe-PR-04 (2004)	Consequences of Electricity Pricing Reforms on Agriculture	• Stanford University
IRADe-PR-03 (2003)	Impact of Fuel Scarcity and Pollution on Rural Poor, a comparative analysis of vulnerable groups in HP	• SANEI, Global Development Network
IRADe-PR-02 (2003)	India's National Circumstances for Addressing Climate Change (NATCOM)	• Ministry of Environment and Forests
IRADe-PR-01 (2003)	Gender & Climate Change (COP 8)	• United Nations Development Programme

About IRADe

IRADe networks with the government, ministries/departments, international organizations, public and private sectors, academic experts, NGOs, and consultants to work on projects awarded by them. IRADe provides decision support to eleven ministries that include Ministry of Environment and Forests and Climate Change, Ministry of New and Renewable Energy, Niti Aayog (formerly Planning Commission), Ministry of Power, Ministry of External Affairs, Ministry of Earth Sciences, Ministry of Urban Development, Department of Science and Technology, Central Statistical Organization under Ministry of Statistics and Programme Implementation, Technology Information, Forecasting and Assessment Council (TIFAC), etc. for many national level projects.

At the international level, IRADe has worked with bilateral and multilateral organization like the World Bank, Asian Development Bank (ADB), U.S. Agency for International Development (USAID); United Nations Development Programme (UNDP); United States Environmental Protection Agency (USEPA), Wuppertal Institute for Climate, Environment and Energy, (WISION) Germany; Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ), Germany; Rockfeller Foundation; International Institute for Applied Systems Analysis (IIASA), Austria; British High Commission (BHC), Centre for Clean Air Policy (CCAP), USA; International Institute for Sustainable Development (IISD), South South North Trust (SSNT) etc.

IRADe has partnered with academic, private sectors, multinational organizations, think tanks and NGOs. These include Shakti Foundation, Indian Council of Social Science Research (ICSSR), SEWA, Petroleum Federation of India, Pricewater House Coopers, ICF International, Rockefeller Foundation, Institute for Social and Environmental Transition (ISET), Center for Clean Air Policy (CCAP), Indian Council for Research on International Economic Relations (ICRIER), InsPIRE Network for Environment, Stanford University and Sir Dorabji Tata Trust (SDTT) among others.

IRADe has also developed strategic partnerships and is part of global networks like the USAID's Low Emissions Asian Development (LEAD) program – ASIA-LEDS, ENERGIA-International Network for Gender and Sustainable Energy, Netherlands; Global Clean Cook Stoves Forum, UN Foundation; Asian Cities Climate Change Resilience Network (ACCCRN), Global Technology Watch Group (GTWG-DST), Climate Action Network South Asia (CANSA).

IRADe has carried out some pioneering work in the field of state level energy planning, city level climate resilience planning, other climate change studies and livelihood studies.

Jyoti Parikh, Executive Director, IRADe

Professor Jyoti K Parikh, Executive Director of (IRADe) was a **Member of the Prime Minister's Council on Climate Change – India and is a recipient of Nobel Peace Prize awarded to IPCC authors in 2007**. She served as the senior professor and Acting Director of Indira Gandhi Institute of Development Research (IGIDR), Mumbai 1986-2003, International Institute for Applied Systems Analysis (IIASA), Austria for 8 years (1980-86, 76-78) and Planning Commission, as senior energy consultant at New Delhi (1978-80).

She has served as energy consultant to the World Bank, the U.S. Department of Energy, EEC, Brussels and UN agencies such as UNIDO, FAO, UNU, and UNESCO, Environment Consultant to UNDP, World Bank and so on. She worked as an advisor to various ministries for Gov. of India.

She obtained her M.Sc. from University of California, Berkeley, in 1964 and Ph.D. in Theoretical Physics from University of Maryland, College Park in 1967. She has guided 12 Ph.D. theses in energy, environment and climate change and given lectures in more than 40 countries around the world.

Her publications include nearly 200 project research papers and 25 books and monographs and span many areas ranging from policy analysis of energy and environment, climate change policies, modeling, technology assessment, power sector, natural resource management, agriculture, health, poverty and gender.

She has held national and international appointments, which includes the Technical Advisory Committee (TAG) for Energy Trust Funds Programmes of the World Bank; the advisory Board of Tyndall Center for Climate Change, University of East Anglia, Norwich, UK, 2001-2004; Scientific and Technical Advisory Panel (STAP) to Global Environment Facility (GEF) – 1995-1998.

She was on the Board of directors of Indian Renewable Energy Development Agency Ltd (IREDA) 2001-2004 and also National Institute of Urban affairs (NIUA), MoUD, GoI.

She has served on editorial boards of several Internationals Journal e.g. Utilities Policy and Energy and as a reviewer for many other journals.

Kirit S Parikh, Chairman, IRADe

Professor Kirit Parikh, Chairman of IRADe was a former Member of India's Planning Commission (2004-2009) with the status of Minister of State. He has been a member of the Economic Advisory Councils (EAC) of five Prime Ministers of India, Rajiv Gandhi, V.P. Singh, Chandra Shekhar, P.V. Narasimha Rao and Atal Bihari Vajpayee.

He was awarded "*Padma Bhushan*" by the president of India, the third highest civilian award in India. He was also a recipient of Nobel Peace Prize awarded to IPCC authors in 2007.

He was the Founder Director (Vice Chancellor) of the Indira Gandhi Institute of Development Research (IGIDR), Mumbai. He is a Fellow of the National Academy of Sciences, India. He has a Doctor of Science in Civil Engineering and a Master's Degree in Economics from Massachusetts Institute of Technology (MIT), USA and M. Tech from IIT (Kharagpur). He has been a Professor of Economics since 1967. From 1997 to 1998, he was Special Economic Adviser to the Administrator, United Nations Development Programme (UNDP), New York.

He has been a member of many high level advisory committees spanning diverse areas such as the Indian National Committee for Environmental Planning & Coordination (1971-74), the National Committee on Science and Technology (1974-76) and the Fuel Policy Committee (1970-74).

He chaired the Expert Committee on "Integrated Energy Policy" and also the Expert Group on "Low Carbon Strategy for Inclusive Growth" set up by the Planning Commission. He is widely recognized as the architect of India's integrated energy policy. He also played an important role in energy policy reforms in the country.

He has authored, co-authored and edited 29 books in the areas of planning, water resource management, appropriate technology for housing, optimum requirement for fertilizers, energy systems, national and international food policies, trade policies, general equilibrium modeling, natural resources accounting, inclusive growth and strategies for low carbon development.

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