ANNUAL REPORT
2011-2012

IRADe Integrated Research and Action for Development

Contents

Overview

Background

IRADe is an autonomous advanced research institute, which aims to conduct research and policy analysis to connect disparate stakeholders such as government, non-governmental organizations, corporations, academia and financial institutions. Since sustainability, climate change, renewable energy, energy efficiency, urban development, poverty, gender equity, agriculture and food security, are considered challenges for the twenty-first century, its research covers these, as well as policies that affect them. Its 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 Cities and Climate Adaptation. In addition, it provides expertise to other ministries and institutions from time to time.

Thematic areas

- Energy and Power System (EPS)
- Urban Infrastructure and Services (UIS)
- Climate Change and Environment (CCE)
- Poverty Alleviation and Gender (PAG)
- Agriculture and Food Security (AFS)

Key activities

- Research and Analysis for Decision Support (RAD)
- Research in Action, Monitoring and Evaluation projects(AME)
- Training and Capacity Building(TCB)
- Policy Advocacy and Dissemination(PAD)

IRADE's objectives

- To develop understanding that integrates multi-stakeholder perspectives concerning issues of development.
- To promote a wider consensus, through research and analysis, on effective policies among stakeholders and policy makers.
- To build capacities among professionals for multi-disciplinary, multi-stakeholder policy analysis.
- To promote ideas and initiatives for inclusive development at local and global levels.
- To promote research support to developing countries for development and also to negotiate international agreements better.

Foreword

It gives me great pleasure to bring out this Annual Report 2011-12. This year, the biggest change was the acquisition of our own premises so that we can settle down the way we wish and not *'fit-in'* in other places. It has given us a sense of stability, permanence as well as sustainability.

We were awarded four new projects from international and national agencies which will have a tangible impact - '*Climate Vulnerability Profiles for 20 Cities*' by RockefellerFoundation, '*Green Accounting System for Andhra Pradesh'* by Gesellschaft für Internationale Zusammenarbeit (GIZ), a collaborative project with Ricardo-AEA Limited, Emergent Ventures India Private Limited (EVI), Gurgaon on *'Policy Options for Carbon Intensity Reduction for India'* by Department for International Development (DFID) and *'Impact of Diesel Price Reforms'* by Shakti Foundation.

We were fortunate to have along a term research project from the Ministry of Earth Sciences (MoES) on socio-economic aspects of climate vulnerability.

This year monitoring and evaluation work was done for Rural Electric Corporation (REC) and also for the Ministry for New and Renewable Energy (MNRE).

We formally completed several past projects such as *'Conservation Strategy for Marine National Park'* for the Ministry of Environment and Forests (MoEF) and *'Energy Transitions for India till 2050'* for Technology Information, Forecasting and Assessment Council (TIFAC) of Department of Science and Technology (DST).

We look forward to completing the on-going projects and also the many new projects that were in the pipeline but awarded after 1st April, 2012 onwards till publication of this report.

Hope that our friends and well wishers will find this report useful, give us their suggestions and continue to support us.

Prof. Jyoti Parikh
Executive Director

1. Climate Change and Environment

1.1 Policy options for reducing carbon intensity in India

An *'Expert Group on Low Carbon Strategies for Inclusive Growth'* chaired by Dr. Kirit Parikh, has been set up to provide technical and policy options to reduce emission intensity by between 20 and 25 per cent before 2020.

Identifying specific policy options to reduce carbon intensity in India is a project that has been undertaken for continuous engagement with Indian stakeholders with collective efforts, through interviews, discussions and roundtables.

The project has selected three key policy instruments: for green/energy efficient buildings; Renewable Energy Certificates (RECs) to develop the renewables sector; and instituting a low carbon institutional framework to stimulate low carbon initiatives in India. The research outcomes aimed to provide practical recommendations for the policy landscape specifically in these sectors. The project referred to lessons learned from the United Kingdom/European Union (UK/EU) policy implementation experiences in executing a low carbon programme that will help India leapfrog to the new paradigm. The collaborators in the study were Ricardo-AEA Limited, Emergent Ventures India Private Limited (EVI). It is supported by the Department for International Development.

The research objectives and outcomes were deliberated with competent stakeholders in a series of roundtable conferences and workshops. Three expert roundtables and one high level workshop were organized with active participation of key policy makers and experts from both India and the UK/EU to analyze the key policy instrument required for low carbon growth in India. Experiences from both the countries were shared. The participant's feedback provided inputs for a prudent policy framework suiting development needs of the country. After taking into account various inputs generated during the consultations, the following recommendations were made:

1. To have a national policy commitment for RECs, with forecasted Renewable Purchase Obligation (RPO) trajectories beyond 2020, and in-built linkages with the state-specific RPO targets for long term success of the REC mechanism in India.
2. Setting a REC Price Guarantor at the national level to stabilise demand-supply imbalances in the REC market.
3. To study the possibilities of setting governing standards and enabling low carbon institutions and recommends that the Planning Commission should establish a dedicated Climate Change Unit (CCU) to oversee implementation of low carbon growth plans.
4. Reducing knowledge gaps and promoting greater information sharing amongst technical experts and the construction industry to incorporate energy efficiency techniques in building design and construction, and thereby promote green buildings in India.

5. To ensure regulatory effectiveness, sustainability/green attributes have to be included in municipal building bye laws as seen in the National Building Code and in Energy Conservation Building Code (ECBC) provisions. (International experience shows that stricter regulatory provisions have been extremely successful in ensuring that designers and building contractors use techniques and technologies for constructing green and energy efficient buildings.)

1.2 Vulnerability of coastal cities on rivers: a case study of Surat

The Ministry of Earth Sciences (MoES) commissioned this study to develop an integrated analytical framework for floods and formulate a disaster management strategy for coastal cities on rivers. The study aimed to assess the vulnerability of the city, especially more vulnerable places such as schools, hospital, slums and industries, to floods and to incorporate climate change concerns in the existing decision support system. It will help suggest adaptation actions that can make a city resilient to climate change induced vulnerability.

Objectives of the project

1) To create a Geographic Information System (GIS) data base that links climatological, hydrological, socio-economic and city infrastructure information.

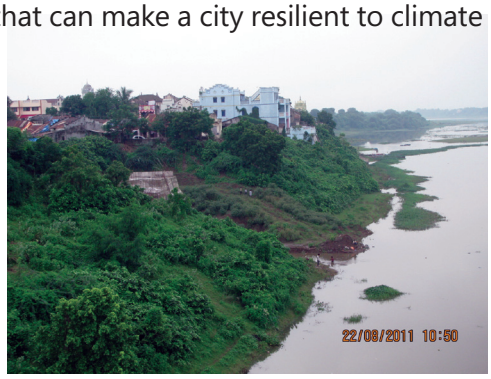
2) To analyze vulnerability of vulnerable groups in the context of socio-economic factors and possible adaptation options that include planning and management in Surat city, which will help create a decision support system.

3) To use GIS mapping to indicate flood prone areas and various probabilities of floods.

4) To suggest adaptation and other measures to reduce vulnerability in the short and long terms after discussions with administrators and policy makers.

5) To mainstream climate concerns in long-term city development plans by providing inputs for climate change concerns in urban planning, land use planning, and alternatives to enhance a city's resilience to climate change and variability.

Preliminary visits and stakeholder collaboration have begun.



Flood Prone Areas along River Tapti,

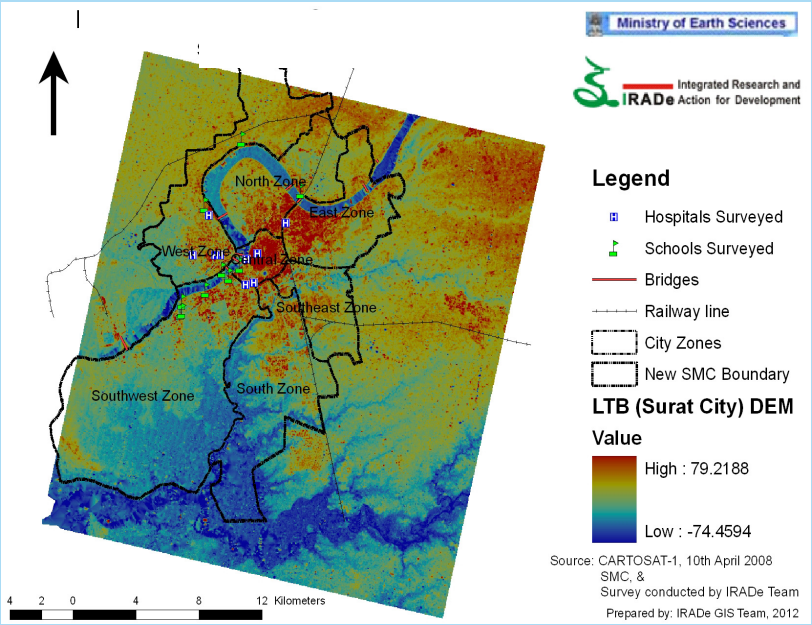
Field Visit by IRADe Team, Surat

Kakrapar Dam, Surat

Work completed

- The carrying capacity of the Tapi River has been estimated.
- A GIS data base has been developed and GIS custom maps of the city and region identifying areas and populations at risk have been made.

Most Flood Affected Schools and Hospitals in Surat



- **Surat City has seven zones**

1. West Zone
2. North Zone
3. East Zone
4. South Zone
5. Central Zone
6. South East Zone and
7. South West zone

- **Survey in Surat has focused on the four most vulnerable zones**

1. West Zone,
2. South West Zone,
3. North Zone, and
4. Central Zone

- A relief map, digital elevation model based on Cartosat-1 imagery, thematic maps, base map of the Tapi River Basin and base map of Surat City have been made.
- A pilot survey of schools and hospitals has been conducted in Surat to identify vulnerabilities, damages and adaptation options.

Major tasks accomplished

Carrying Capacity and its significance to Surat City

Flood prone areas or higher vulnerable areas to the flood may be derived from the carrying capacity of the river or part of river cross sections. According to the carrying capacity calculated for the Tapi River, some of the following measures can be taken to avoid submergence:

- In Adajan and Athwa, lines area width of the cross sections are nearly 500 m which affects the carrying capacity of the Tapi river. In these particular situations widening and deepening of the river bed can help increase the carrying capacity and decrease vulnerability of nearby areas.
- In the case of Rander and Nana Varacha regions, where the river bank differences are higher, provision of retaining walls, providing bunds or provision of flood gates can reduce the vulnerability of nearby areas.
- From Jahangir Pura to Amroli village, where encroachment is rampant and where the river is turning, the carrying capacity at those sections are very low because of the lower velocity and large sedimentation. In such cases, the provision of flood gates, provision of reservoir or the widening of the river banks are the best structural measures to reduce the vulnerability to some extent.

Mapping of flood vulnerability zones in Surat City

- Flood vulnerability analysis of the study area helped us in identifying floodplains which are in low elevation areas and subjected to flooding resulting in economic losses. These areas including schools, hospitals, buildings, properties, commercial and industrial establishments, slums etc need to be regulated to minimize threats to loss of lives and properties. The major component of floodplain management studies is assessment of the impacts of flooding. High resolution satellite imageries, relief map and land use, hydraulic characteristics of river channel and floodplain surveys, and probable water levels can be considered for predictive flood hazard mapping.
- The Lower Tapi Basin (LTB) receives an average annual rainfall of 1,376 mm, and these heavy downpours result in devastating floods and water logging downstream. The LTB contains the Ukai and Kakrapar reservoirs and part of the flow is diverted for irrigation from Kakrapar weir. The major crops grown are cotton and maize, followed by soyabean. The prevailing land use is mixed forest, agricultural land, rural and urban settlements. The topography in LTB comprises narrow valleys and gently sloping ground. The main reasons for flooding in LTB are heavy rainfall and discharge due to high water levels from Ukai Dam. Therefore, the flood problems of the river system are inundation due to the over flowing of the banks, inadequate drainage capacity of the river, congestion at the point of confluence, and an excessive silt load factor.

Surveys of locations and establishments where the vulnerable groups congregate (children, patients and poor in schools, hospitals and slums respectively)

- Pilot surveys for the most vulnerable targets like schools and hospitals have been conducted in March 2012. It has been observed that several problems have been occurring repeatedly to the schools due to flood. Some schools are situated in low-lying areas which can get submerged during heavy rains; such areas need urgent attention. Children are the future of the nation and they are a more vulnerable segment of the society as well. In such a situation, the government has to step in and provide grants and required remedial measures to minimize vulnerability level of the flood affected schools.
- The study aimed to understand the damage to hospital buildings. These are one of the lifelines at the time of disasters and are also considered to be most vulnerable. Due to their significant role in recovery from disasters, impacts of a disaster on the community will be determined by the level of damage on hospital infrastructure. In this study, hospitals that were partially or fully affected by the unanticipated flood of 2006 were surveyed and analyzed. Among the seven zones of the city, the north, south, east, west, south-east, north-west and central zone – the most vulnerable four zones were studied namely: west, south-west, north and central.

1.3 Green accounting for Andhra Pradesh

The Green Accounting Study for the State of Andhra Pradesh is supported by Gesellschaft für Internationale Zusammenarbeit (GIZ). The objective of this study is to develop a strategy to understand depletion of natural resources so that various indicators can help policy makers assess environmental damage.

Forest resource accounting

Andhra Pradesh (AP) occupies around 63,814 sq km of land under forest, out of a total geographical area of 275 lakh sq km. The total area was classified as protected and productive forests. Productive forests occupy around 25,364.26 sq km and protective forests occupy 38,449.47 sq km. Legally forests are classified as reserved (50,478 sq km), protected (12,365.34 sq km.) and un-classed forests (969.76 sq km). Income accrued from forestry was Rs. 94.54 crores in 2005-06 (AP Forest Department 2007). IRADe hopes to suggest the methodology for calculating benefits of ecosystem services provided by forests.

Water resource accounting

Environmental accounting for water involves assessing the value of stock depletion and the value of loss of water quality. We focused on the former.

Surface water: Andhra Pradesh has small and large rivers flowing through different parts of the state. The state has three major rivers - Godavari, Krishna and Pennar and 37 smaller rivers, draining into the sea. The two major rivers are Krishna and Godavari stretch over hundreds of kilometres and create the large perennial cultivated area in the state. The state's (surface and ground) water resources are estimated to be 108 BCM, out of which about 62 BCM are currently being utilized for drinking, agriculture, industry and power generation. The current percentage withdrawal of available water in the state is 58 per cent.

Ground water: Andhra Pradesh is spread over 275 lakh ha. The state comprises of 23 districts and 1,104 mandals. The net annual ground water availability is 32 BCM. Due to frequent poor and erratic rainfall, there is a pressure on groundwater utilization. In the 23 districts of Andhra Pradesh, 21 mandals are over-exploited and 77 are critical. The ground water situation does not indicate any serious problem excepting in specific mandals.

The first project meeting with 40 Andhra Pradesh officials was held on 9th February 2012 in Hyderabad. In this meeting, three sectors were shortlisted for detailed green accounting - ground water, forestry and Municipal Solid Waste (MSW) in Hyderabad. Guidance methodology documents for all the three sectors in Andhra Pradesh in 2012 were prepared by IRADe.

1.4 Analysis to strengthen the industrial solid waste management system in Andhra Pradesh

Brot für die Welt (Bread for the World) tasked IRADe with the preparation of a pre-feasibility study on Investigation of the status of the municipal solid waste management system in the Industrial Park (IP) Cherlapalli (Greater Hyderabad, Andhra Pradesh, India) and suggestions for a step forward to a sustainable waste management system. The study was elaborated in close cooperation with GIZ, non-governmental organizations, industries, industrial park management, technology provider and other relevant authorities.

IRADe studied the viability of various solutions for the municipal solid waste management system in the industrial park. The study also addressed social, economic and environmental concerns, including

livelihoods of the involved workers. The pilot work on strengthening the municipal solid waste management system in IP Cherlapalli was done. The investigation covered the analysis of different waste streams, and the state of the existing waste management system, the identification of all the different stakeholders, consultations with them, and the identification of viable technical options for collection, segregation, storage, treatment, disposal, recycling, staff requirements etc. along with a rough cost estimate for a sustainable waste management system.

Conclusions

Municipal solid waste management is a legal obligation on industries (waste generators), and therefore, waste management is no longer a voluntary or moral responsibility, but a statutory requirement. Industries at the park have to pay the appropriate charges for municipal solid waste management and penalties for improper waste segregation. Furthermore, the different segregated waste items should be treated separately. For example the high amount of collected organic waste (approximately 50%) should be treated appropriately.

2. Urban Development

2.1 Centre of Excellence in urban development

The Ministry of Urban Development has designated IRADe as a *Centre of Excellence* in the area of urban development on climate change vulnerability and adaptation. The Centre is engaged to address urban development issues at the national, state and local levels and renders support to state and local government in key areas of urban development

The centre has actively participated in the Service Level Benchmark (SLB) initiative of the Ministry of Urban Development. The service level benchmark sets the standards for service delivery in the areas of water supply, waste water, drainage, solid waste management, e-governance and urban transport. It is likely that projects sanctioned under Jawaharlal Nehru National Urban Renewal Mission (JNNURM) are moving towards these benchmarks.

Further, the centre has a focus on supporting cities for better urban management through assisting in national urban strategies while crystallizing the nurtured role of cities in sustainable development. This involves active participation through knowledge support and critical findings for sub-groups on urban planning and storm water management as part of sustainable habitat parameters towards realization of the National Mission on Sustainable Habitat.

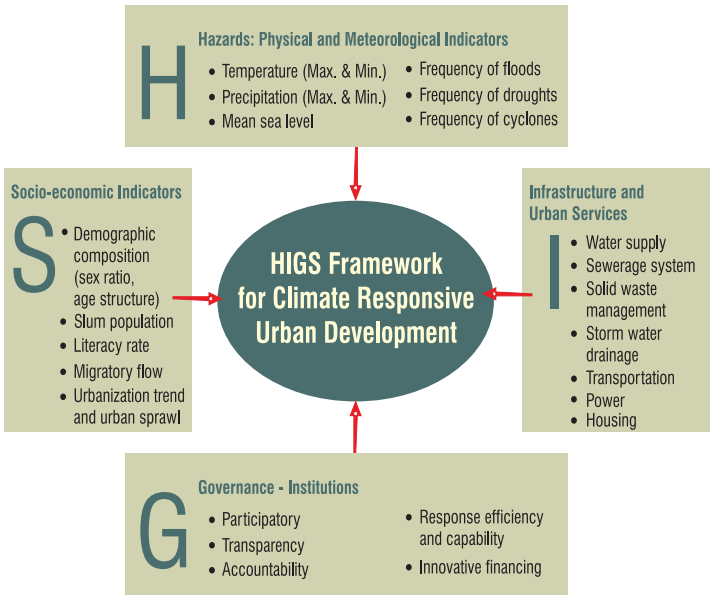
In order to strengthen capacity building initiatives in the area of urban planning, lectures on course modules - urban planning, climate change and energy were delivered at the School of Planning and Architecture (SPA), New Delhi. In addition, internships were offered to eight students of the Centre for Environment Planning and Technology (CEPT) University, Ahmedabad.

2.2 Urban climate resiliency policy support

Supported by Rockefeller Foundation, under the Asian Cities Climate Change Resilience Network (ACCCRN) project on vulnerability profiles for India's urban centres, this study intends to further the understanding on urban vulnerability to climate change, while analysing core urban services such as water supply, drainage, solid waste management, energy, transportation and housing. An effective foundation for climate responsive urban development requires understanding a city level vulnerabilities, practices and adaptation options and preferences.

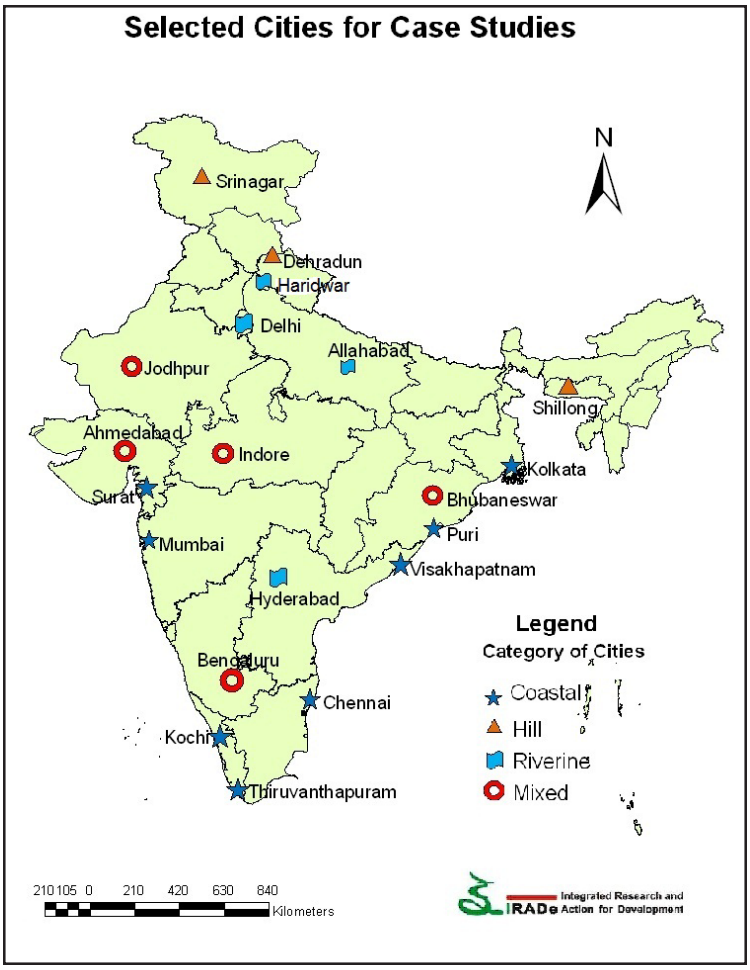
Vulnerability profiles of 20 Indian cities have been prepared. The selection of cities was based on a

The HIGS framework



range of factors including exposure to hazards, population growth rate and geographical spread across the country etc.

The Hazard-Infrastructure-Governance-Socio-economic characteristics (HIGS) framework that evolved during this project presents a holistic approach for sustainable urbanization of Indian cities. The methodology provides flexibility to converge data within these four variables. The four sets of variables that have been identified describe the characteristics of the city, for example: 1) exposure to geo-physical variables; 2) infrastructure; 3) population and urbanization trends; and 4) the institutional framework of the city and the managing authority. It could guide a larger effort on climate resilient urban development for Indian cities systematically.



Thus, a coherent set of urban resilience measures can be conceptualized through the framework. Insights developed can help in natural hazard risk reduction and urban renewal interventions.

It also attempts to improve the understanding of vulnerability of various sectors so as to better manage low probability high impact climate induced extreme events. This also involves identifying the potential stresses and resilience building to augment the ability of the cities to withstand, prepare for, and recover from the projected impacts of climate change by upgrading infrastructure and designating areas for a particular land-use. A series of city studies presents more detailed information related to key climate change induced vulnerability in these cities.

3. Energy System and Technology Assessment

3.1 Evaluation of the impacts of Rajiv Gandhi Grameen Vidyutikaran Yojana and its implementation

The Rajiv Gandhi Grameen Vidyutikaran Yojana (RGGVY) is a flagship programme of the Government of India for total rural electrification. This project was awarded by the Rural Electrification Corporation Limited (REC) to study the progress of the programme in terms of coverage, quality of coverage (includes verification of erection of village distribution infrastructure, electrification of Below the Poverty Line (BPL) households, access to power of households, etc) in Assam, Gujarat, Himachal Pradesh (HP), Rajasthan and Uttar Pradesh (UP). One of the objectives is to study various state governments and their agencies responsible for various tasks in the successful implementation of RGGVY projects.

Villagers being surveyed

The study was based on field surveys and analysis of real time consumer response. It was found that that despite constraints and limitation of the programme, it has visible positive impacts. These are: (a) electricity supply for more than 6-8 hours in most of the rural areas; (b) benefits for education, health, communication and economic development in the villages; (c) better implementation of the *'National Rural Electrification Policy'* and (d) opportunities for power generation from renewable energy resources. The IRADe team conducted detailed household surveys in villages, focussed group discussions, stakeholder consultations, interviews with senior officials from Distribution Companies (DISCOMs) and REC to assess the impact of RGGVY.

Findings and recommendations

The supply hours of electricity in the range between six and 24 hours varies from state to state, and district to district. The power situation is good in Himachal and Gujarat. However, supply lasted only from 0.5 to 2 hours during the evening (peak) hours.

BPL power connections have been released in phases; and access to electricity has been provided in public places located within a populated area. In Gujarat and Himachal Pradesh, almost all BPL households (HHs) have been electrified. It was observed that a large number of BPL HHs and rural populations live in small hamlets of less than 100 (which are not covered under RGGVY), particularly in the states like Rajasthan and Assam. Efforts must be made to electrify these households in 12th Plan projects. Electrification of public places is an important aspect of village electrification that has to be coordinated. The state governments in Gujarat and HP have schemes to facilitate total electricity coverage of all public places (schools, health centres, community halls, etc.).

An adequate consumer mix (BPL, Above the Poverty Line (APL), commercial, agricultural) is essential to ensure long term sustainability of rural electrification. Billing and revenue collection processes have been streamlined in Rajasthan, UP, Gujarat and HP, but efficiency varies. In Gujarat and HP almost 100 per cent billing is being done and the villagers are regularly paying the bills, except in few tribal areas and by some habitual defaulters. In Rajasthan 80 per cent villagers in the survey sample receive bills bimonthly but only 65 per cent of HHs was seen to make payments regularly.

Distribution transformer failure due to overload

During the survey, some consumers claimed that (a) their standard of living has improved, (b) the place is more secure, and (c) women can work inside the house during evening hours on household chores. Despite positive impacts it is observed that the current level of electrification is not enough to induce overall economic development in the villages, as envisaged in the National Electrification Policy. More sustained efforts are required to increase benefits of rural electrification and factors such as quality and reliability of supply, and the overall distribution governance must be improved substantially.

Franchisees system

No operating franchisee was found in the surveyed RGGVY villages, except in some areas of Assam, Gujarat and UP. DISCOMs have outsourced some of its functions in the revenue cycle and have named it as a franchisee. The poor deployment of franchisees is due to the poor hours of supply, poor consumer mix, scattered villages (low density), commercial disputes due to contractual obligations, lack of the financial viability of franchisees in rural areas. Since franchises are not being developed, the conditions in RGGVY for the 12th Plan may be relaxed, and state governments should review the organization of the franchise system to suit local conditions, and potential revenue generation with proper security.

In the 12th Plan, the RGGVY programme should earmark some funds for research and development of cheap and reliable smart meters, an interface linking renewable grid to state grid, energy efficient equipment used in rural India and computer aided rural network design that includes Virtual Elevator Interface (VEI) and REDB. GIS based DPR preparation can be taken up based on a computer aided rural network design.

Both in the 10th Plan and 12th Plan, the whole approach towards rural electrification has been largely based on distribution infrastructure asset creation, which has been implemented very successfully so far. In the 12th Plan, a more comprehensive approach is required towards rural electrification with a shared vision between central and state governments.

3.2 Assessment of alternative road maps on petroleum price reform

The Government of India has long maintained price controls on four 'sensitive' petroleum products - petrol, diesel, liquefied petroleum gas and kerosene. Although the government attempts to insulate consumers from the excessive cost burden of these products due to high global prices and price shocks, it impacts India's own financial and macroeconomic stability. Moreover, with rising international prices, there are a few or no upward revisions on the prices of subsidized petroleum products, resulting in an exceedingly large burden on the government to maintain these low prices.

The objective is to develop a few alternative policy road maps for diesel price rationalization that will be used to stimulate discussion amongst key government decision makers (ministries) to identify, and build consensus in support of the most politically feasible price rationalization pathway and assess the impact of price rises on various sectors like automobile, telecom and agriculture, across road maps. The study is sponsored by the Climate Works Foundation, United States of America.

For a more detailed understanding of the fiscal implications of diesel price reforms, separate analysis and research was carried out. This work was very generously supported by the Ministry of Finance, Government of India.

Key findings

- Rational petroleum product pricing is critical for an efficient economy, for promoting growth and for containing inflation and both the central and state governments have roles to play. The centre should lead and hopefully some states could follow.
- Continuing with the present policy of no change in diesel price is not tenable. The growing debt/ equity ratios of oil public sector units may soon make them unviable and then even supply of petroleum products can be disrupted. This could have very large economic and social costs.
- Also the long term costs a year or two later, in terms of inflation of no change can be very high and does require some action on the diesel prices.
- Tax rates should be the same on diesel and petrol. If higher revenue is required and vehicle owners are considered the best source of revenue, different tax instruments should be used. For example, an annual road tax can provide similar revenues. Information technology will ensure that payments, collections and monitoring of this tax is done precisely.
- An abrupt increase of 30 per cent in diesel price would increase it by Rs.12 per litre. This would lead to an inflationary increase of 2.3 percentage points. It would also fuel inflationary expectations as people may not appreciate the long term deflationary impact. This would also face strong political opposition.
- A gradual price increase over four quarters may have smaller immediate inflation. However, each quarterly increase in price would require the same political capital and would face political opposition. The public discontent of any price increase would be given a boost every quarter by the opposition.

3.3 Indian perspectives on global energy scenarios till 2050

This project *'Developing CGE Model with Activity Analysis for Climate Policies for India'* was awarded by Technology Information, Forecasting and Assessment Council (TIFAC) for a collaborative project

with International Institute for Applied Systems Analysis (IIASA), Luxemburg, Austria under the TIFAC-IIASA programme. It aimed to:

- study existing IIASA global regional energy scenarios from India's perspectives;
- suggest new scenarios suitable for India and reflect India's viewpoints;
- extend the time horizon for India's energy projections up to 2050; and
- get familiarized with the process of developing energy scenarios for other world regions.

This will help us to address energy security issues and understand energy transitions needed in the future that are consistent with global perceptions and research and development.

In the activity analysis model developed during the project the time frame was extended till 2050. The IRADe model was modified to bring in number of features so that the results from the model for India can be compared to the results that the IIASA model provided at the global level. Resource constraints for coal, crude and natural gas were included and imports of these commodities were limited to specified shares in world production keeping in mind the share of other countries. These features helped in comparing the inputs and outputs of the IRADe and IIASA models. Some of the inputs on CO_2 emissions pathways were used in the IRADe model. Global Energy Assessment (GEA) scenarios were developed by IIASA and IRADe. The share of imports of energy commodities in the energy trade and resource availability was assumed using national data sources and compared to assumptions in the GEA scenarios. The IIASA models develop scenarios at a global level and for 11 global regions. India is included in the South Asia region in the IIASA model.

New and current technologies as provided in the GEA scenarios like Carbon Capture and Storage (CCS), coal, nuclear, solar photovoltaic (PV), off shore wind on shore wind, solar thermal with and without storage, advanced nuclear, CHP, energy efficiency, biofuels and others, were analyzed by the IRADe team and an assessment made as to their technological feasibility for India.

A comparative analysis of the GEA scenarios was also conducted along with four other projections such as Shell 2050, World Energy Technology Outlook (WETO (H2), International Energy Technology Outlook (IEO) World Energy Outlook-2010 and Greenpeace energy revolution. They provide international, national, industrial and NGO perspectives. All the projections provide perspectives about the increase in the share of clean energy however, the range of percentage varies significantly.

Dr. Probal Ghosh of the IRADe visited IIASA twice during the TIFAC-IIASA-IRADe project. The first was in the June 2010 for six weeks. During this time, results of the 41 IIASA model forecasts were compared and analysed for their implications for India. Following this analysis, the IRADe team chose to use the high energy demand with conventional transportation choice as the reference for India. The results of this scenario were further used to compare with the results of the IRADe model and the four other projections. The IRADe team provided suggestions to the IIASA team about India's concerns and perspectives which got incorporated during Dr. Ghosh's second visit, in August 2011, when the final results of the study was perfected and a draft report readied with the joint efforts of IRADe and IIASA.

3.4 Preparation of master plan of Jodhpur city under Solar Cities Devolvement Programme of the Ministry of New and Renewable Energy

Under the Solar City Programme of the Ministry of New and Renewable Energy (MNRE), Jodhpur city has been chosen to reduce conventional energy demand by 10 per cent in the next five years using renewable energy and energy efficiency projects.

Energy conservation covers residential and commercial sectors, municipal services like water pumping and street lighting, solar water heating systems, and rooftop solar energy-based electricity generation. The plan aims to convert 20 per cent of the energy needed for water heating in residential and commercial buildings to solar heating, traffic lights to solar-based light emitting diodes (LEDs) and streetlights to solar ones. Electricty generation targets for renewable energy can accelerate its implementation.

The activity wise tasks achieved are:

- Prepare energy base-line of Jodhpur City for year 2011-12
- Survey energy use pattern to identify options for Energy Efficiency
- Project energy demand for 5 year and 10 year periods. Develope a sector wise strategy with techno-economic feasibility of different renewable energy and energy efficiency options for different sectors.
- Carry out renewable energy resource assessment to identify the potential renewable energy sources for the city.

The activity wise tasks that will be undertaken are:

- Conduct stakeholder consultation to discuss the Draft Master Plan and sector wise strategies to determine and identify the viability of the recommended sector specific strategies for achieving the objective of 10 per cent reduction in energy consumption from the conventional energy resources at the end of five years.
- Prepare and finalize Master Plan based on inputs received in stakeholder consultation meeting.

4. Agriculture and Food Security

4.1 Study on Indian agriculture, 2040

IRADe developed a multi-sectoral inter temporal activity analysis model appropriate to study Indian agriculture till 2040 and used it to generate scenarios that help arrive at policy conclusions. The main objectives of the project were:

- modelling agricultural outputs and productivity;
- impact of irrigation and technology on agriculture;
- impact of migration of labour from agriculture to non-agriculture sectors;
- impact of trade policies on agriculture; and
- policy options to improve agricultural output and productivity.

Work completed

The IRADe team has extended the linear expenditure based demand system for 10 consumer classes, five each for the rural and urban sectors. Rural and urban populations which were earlier exogenous to the model have now been made endogenous by including migration of population from rural to urban areas. The migration is assumed to be a function of the relatives incomes generated in the agriculture and non-agriculture sectors. The agriculture sector in the IRADe model has been disaggregated to allow for more detailed analysis of the agricultural sector and its issues. Currently there are 15 agricultural sectors compared to the four initially. Land and irrigation have been introduced into the model as explicit constraints. Exports and imports specifications have been made more rational. Sector specific total factor productivity and commodity specific usage efficiency parameters have been provided (earlier this was only for the energy inputs). With this updated model, a reference/base run for projecting aggregate economic performance and the performance of the agricultural sector up to 2040 has been obtained. These have been compared to seven additional scenarios involving higher and lower productivity growths, higher and lower irrigational potential and higher imports possibility.

A preliminary report was presented to the Planning Commission in early March on the structural transformation of the Indian economy and its long term agricultural future. On structural change, the key finding was that the productivity gap between agriculture and non-agriculture is still widening rapidly. Urban areas have primarily absorbed skilled workers, making it difficult for most rural people to take advantage of the urban economy because of the slow agricultural growth and a slowdown in agricultural productivity growth.

Agriculture has also not been able to increase its labour productivity much or absorb more labour. Therefore, most rural employment is generated in the rural non-farm economy. While supporting rural income growth, the rural non-farm sector is not a sector that can lead the structural change between agriculture and non-agriculture.

With total factor productivity growth in the Indian economy of 1.5 per cent, and some improvements in energy efficiency, the model of the Indian economy discussed above generates economic growth over the next thirty years at close to 8.4 per cent. Despite declining income elasticity for food, the demand for food keeps rising rapidly because of population growth and rapid income growth. Since cultivable area is constant and irrigation cannot grow very fast, the model tries to import additional food requirements, which, if unconstrained would rise to levels that would jeopardize India's food sovereignty and security, and would perhaps be beyond the capacity of global markets to supply. The combined constraints on imports and growth of land and irrigation will be so severe that economic growth would have to slow down. Such a slowdown could only be averted under much more rapid growth, at the rate of the Chinese total factor productivity growth. The interesting feature of the model is that it traces the joint implications of rapid increase in food demand, constraints on food imports, and limited land and water resources and was therefore able to analyze the interactions of the constraints.

The results of the analysis were presented to another wide audience of academicians and academic experts in a one day seminar held at India International Centre, New Delhi on 27th April and a two day conference held at Associate Chambers, New Delhi on 28th and 29th April. The report was finally released after a very detailed refereeing process including foreign referees, at a function held at the India International Centre on 18th January.

5. Events – Workshops, Meetings and Lectures

5.1 Workshop on Indian perspectives on global energy scenarios till 2050

The workshop was organised by TIFAC/IIASA on 28th December, 2011 to present the IRADe results and the draft report. The workshop provided some valuable suggestions in order to make the scenarios more realistic. An additional recommendation was to revise technological assumptions about availability of fossil fuels, especially natural gas of which many people were very optimistic.

The objective of the workshop was – given India's potential to become a significant global energy user – to suggest new scenarios suitable for India, which required existing IIASA global regional energy scenarios to be studied. Hence, IRADe along with IIASA, helped to identify energy transitions for the sake of sustainable development and combating the ever changing climate and also help India present its perspective to improve global energy scenarios.

5.2 Workshop on achieving India's goal to reduce carbon intensity

The workshop *'Achieving India's 2020 Goal to Reduce Carbon Intensity: Discussion of the Indian Policy Context and Lessons Learned from UK/EU Policy Instruments'* was held on 18th August, 2011 in India Habitat Centre, New Delhi. Dr. Kirit Parikh chaired the session. The members present were Mr. Chris Dodwell and Mr. Adarsh Verma from Ricardo-AEA, Dr. Ajay Mathur, Director General, Bureau of Energy Efficiency, Dr. P C Maithani, Director, Ministry of New and Renewable Energy, Mr. Sanjay Dube, Mr. Prima Madan and Mr. Gautam Jindal from EVI, Prof. Jyoti Parikh, Mr. C R D Biswas and Mr Deepak Rai from IRADe.

The objective of the workshop was to share lessons learned from the UK/EU policy experiences on practical policy instruments, to help India *'leapfrog'* to its eventual target without repeating the same path developed countries traversed. The event discussed a few important subjects: (a) Renewable Energy Certificates (RECs) that offer a means to incentivise the development and deployment of renewable energy to a level that would not otherwise arise; (b) green/energy efficient buildings standards and codes, which have been developed principally in order to measure and rate environmental performance to drive sustainable construction; (c) car average fleet fuel efficiency standards that can offer an effective way to improve vehicle fleet fuel efficiency to reduce both, dependency on oil and CO_2 emissions from the transport sector; and (d) climate change institutions to create a political and industry support structure that will increase effectiveness of climate policy and provide a statutory force to facilitate the low carbon economic growth paradigm. Some of these experiences suited the Indian context. The project will also identify the potential to use international climate finances, such as the UK's £2.9 billion International Climate Fund, to support implementation of one or more specific policies. The roundtable presented an opportunity to identify the right questions with respect to specific policy areas which the project might focus on. The discussions will also provide focussed topics for future workshops and roundtables during the course of the study.

5.3 Roundtable meeting on achieving India's goal to reduce carbon intensity

The meeting on *'Achieving India's 2020 Goal to Reduce Carbon Intensity'* was held on 19th April, 2012 at Willow, India Habitat Centre, New Delhi. The meeting was chaired by Dr. Kirit Parikh, Chairman,

Integrated Research and Action for Development (IRADe) and Chairman, Expert Group on Low Carbon Strategies for Inclusive Growth.

The participants included Mr. Chris Dodwell from AEA, Dr. Kirit Parikh, Prof. Jyoti Parikh, Mr. C. R. Dutta Biswas, Mr. Adarsh Verma and Mr. Rajiv Panda from IRADe, and Mr. Vinod Kala, Mr. Sanjay Dube, Mr. Alok Barnwal and Mr. Ashutosh Pandey from EVI.

The Honourable Mr. Gregory Barker graced the event as the Chief Guest. He emphasized the importance of good governance that must be realized for progressive development policies and action plans, and said that a long term policy is needed for better behaviour of technological systems and the market. For good and effective policies the challenging issues facing the nation must be studied with passion and pragmatism. The interaction between institutions, governance and financial systems is important for effective policy implementation.

Entrepreneurs are major players in the developmental activities and the framework in which they function should be understood. The factors they look for in government policies are: (a) transparency, (b) longevity, and (c) certainty. The contexts of government policies are dynamic. Hence, tweaking policies is expected periodically. The UK government enacted the Climate Change Act – 2008. The Act enjoys support of all political parties in the UK.

Mr. Chris Dodwell addressing the roundtable

There was an open discussion on Renewable Energy Certificates, green and energy efficient buildings and a low carbon institutional framework. The highlights of the meeting were: (a) Renewable Energy Certificates have been introduced in India under the guidance of Central Electricity Regulatory Commission (CERC) and the bankability of RECs need to be tuned according to renewable purchase obligations set among the states; (b) technology innovation centres with respect to certain technologies should be promoted and the corresponding capacity building is required to develop skilled manpower to run the technology; (c) the Government of India has established the National Clean Energy Fund, however, increased financial support and investment for low carbon technologies are needed; (d) green and energy efficient building standards should be adopted at the earliest as India is yet to build 70 per cent of the buildings targeted for 2030; (e) key lessons for India from the UK Carbon Trust experience; and (f) implementing the National Action Plan on Climate Change (NAPCC) requires further strengthening the capacity and role of existing governance and enabling institutions for low carbon growth in India.

Other highlights were: a) a carbon budget be planned within a long term framework; (b) reliability of statistical information to be established; and (c) analysis of a low carbon transition roadmap needs to worked at – 2050 calculator may be developed in the Indian context

5.4 Meeting on capacity building for green accounting in Andhra Pradesh

The meeting, *'Capacity Building for Green Accounting for Andhra Pradesh'*, was chaired by Mr. Paul Samuel, IAS, Special Secretary to the Government of Andhra Pradesh, was organized by the Andhra Pradesh Forest Department under the guidance of Mr. B. S. S. Prasad, IFS, Special Secretary (Environment), Andhra Pradesh Forest Department, on capacity building for green accounting across different sectors of the state. The Executive Director - IRADe, Prof. Jyoti Parikh, Chairman IRADe - Prof. Kirit Parikh and Senior Advisor - GIZ, Dr. Shailendra Kr. Dwivedi were present to discuss the background, status and queries of natural resource accounting. Many officials from various departments were present in this meeting. It was realized that green accounting is an important tool and serves as a compass to direct development and requires all departments to take much deeper notice of it. Prof. J. Parikh made a presentation on objectives, importance and benefits of NRA for states of India and Dr. K Parikh made a presentation on the methods of natural resource accounting. A number of questions and suggestions were entertained.

In this meeting, three sectors were shortlisted for detailed green accounting – groundwater, forestry and municipal solid waste. Guidance methodology documents for all three sectors for Andhra Pradesh 2012 were prepared by IRADe.

5.5 Lectures at IRADe

The following lectures were organized at IRADe:

- Presentation by Dr. Kirit Parikh and Prof. Hans Binswanger on the *Report of the Study of Agriculture Scenario 2040*.
- Dr. B. Sengupta, former Member Secretary, Central Pollution Control Board on *Current Environmental Issues in India and probable solutions*.
- Mr. Sunand Prasad, an architect in UK, on *Restoration of Urban Spaces and Buildings.*
- Prof. P.S. Ramakrishnan, INSA Honorary Senior Scientist, School of Environmental Sciences, JNU on *Biodiversity.*

6. Professional Activities and Internships

6.1 Selected list of events participated by IRADe staff.

Prof. Jyoti K. Parikh

- Chaired a session at the India stakeholder consultation for the *Asia Pacific Human Development Report on Climate Change* organized by United Nations Development Programme (UNDP) on 27the April, 2011, New Delhi.
- Attended the first Meeting of the *Working Group on New and Renewable Energy for the 12th Five Year Plan (2012-17)* organized by MNRE on 29th April, 2011, New Delhi.
- Review meeting of the *Jawaharlal Nehru National Solar Mission* on invitation from the Prime Minister's Office (PMO) on 9th May, 2011, New Delhi.
- Attended the board meeting of The North South Institute (NSI) on 10th to 13th May, 2011, Ottawa, Canada.
- Review meeting in the PMO on *National Mission on Enhanced Energy Efficiency* on 20th May, 2011, New Delhi.
- Meeting in the PMO on *National Water Mission* on 23rd May, 2011, New Delhi.
- Attended IPCC's Working Group III. *First lead author meeting* on 11th July, 2011, Changwon City, Korea.
- Attended *NEERI Research Council Meeting* on 19th July, 2011, Nagpur
- Keynote speaker at the roundtable *Developing City Resilience Strategy for India* organized by the National Institute of Urban Affairs (NIUA*)* under ACCCRN on 5th August, 2011, New Delhi.
- Chaired a session at Indian Institute of Forestry's (IIFM) *Workshop on Biodiversity Accounting* on 15th September, 2011, Bhopal
- Panelist at the symposium on *Ënergy Policies and Global Governance for Green Development* jointly organized by SIIS and FES on 19th September, 2011, Shanghai, China.
- Attended the *Gender and Energy Policy Practitioners Meet* organized by ENERGIA on 12th – 14th*h December, 2011, Amsterdam, Netherlands*
- *Review meeting* on EU Project *POLINARES* on 15th – 17th December, 2011 at NATO, Brussels, Belgium.
- Panelist at the Women and the Green Economic Forum *at Delhi Sustainable Development Summit 2012,* chaired by Ms. Elinor Ostrom on 1st February, 2012, New Delhi
- EU-India roundtable topic *Modeling to Policymaking*, chaired by Mr. Robert Donkers, EU India on 2nd February, 2012, New Delhi
- Chief Guest at the workshop *Emission trading system in India – a viable policy option in the future*. Organised by Winrock International India on 17th February, 2012, New Delhi
- Attended the *Board Meeting of National Institute of Urban Affairs(NIUA)* on 29th February, 2012, New Delhi
- Attended WG III *lead author meeting of IPCC* on 13th March, 2012, Wellington, New Zealand

Mr, Rakesh Ranjan

- Participated in the IIT Bombay and SIMSR *Workshop on Climate Change, Urban Vulnerability and Adaptation Planning* on February 9-10, 2012 at IIT Bombay, Mumbai.
- Participated in the ACCCRN *Partner Organization Meeting* on 15th November 2011 at Social Room, The Energy and Resources Institute, New Delhi.

Mr. Rajiv Ratna Panda

- Participated in the *Workshop on Enhancing Capacity for Low Emission Development Strategies: Economy-wide Analysis of Low Carbon Growth Strategies: Modelling and Abatement Options* under the United States – India partnership, organized by the Planning Commission.
- Participated in the *India-International Nuclear Symposium* organised by World Nuclear Association on 22 February 2012 at Hotel Taj Palace, New Delhi.
- Participated in the *Regional Rollout of Sustainable Energy for All* organised by UN-Energy, UNIDO, the UN Foundation, the Asian Development Bank and The Energy and Resources Institute (Feb1,2012, New Delhi)
- Participated in the workshop on *Learning from Emerging Energy Innovations* in Asia with a focus on energy access/clean energy: contributing to the discourse on an institutional framework for sustainable development (31th January 2012 New Delhi).
- Participated in the conference on *Solar PV Market and Policy in India*, January 27-28, 2011, Hotel Imperial New Delhi.

6.2 Internships

Depending on ongoing research, IRADe regularly undertakes capacity building programmes. This year it was on energy, climate change, vulnerabilities and hazard analysis.

The Centre of Excellence for Urban Development welcomed six students from three different institutions. Four interns were from Centre for Environmental Planning and Technology University (CEPT University), and one from School of Planning and Architecture (SPA), Bhopal worked for two months at IRADe in climate change and urban vulnerabilities projects. A student from Gokhale Institute of Politics and Economics worked on petroleum pricing.

The following interns worked in the thematic area of cities and climate change.

Ms. Ankita Sharma	CEPT University Ahmedabad - Urban planning batch
Mr. Kanishk Gadpale	CEPT University Ahmedabad - Environmental planning batch
Mr. Dinesh Singh	CEPT University Ahmedabad - Urban planning batch
Ms. Ritika Mandhyan	CEPT University Ahmedabad - Urban planning batch
Ms. Rini Sharma	SPA Bhopal - Urban planning batch

Mr. Abhishek Jha Gokhale Institute of Politics and Economics
worked in the thematic area of petroleum pricing.

9. List of Projects

No.	Title of the project	Funding agency	Status
1.	Urban climate resiliency policy support: vulnerability profile of India's urban centres in the context of climate change	Rockefeller Foundation	*Ongoing*
2.	Identifying specific policy options with the aim of reducing carbon intensity in India	DFID, AEA	*Ongoing*
3.	Vulnerability of coastal cities on rivers to climate change: a case study of Surat to develop an adaptation framework	The Ministry of Earth Sciences	*Commenced*
4.	Investigating and planning the strengthening of the municipal solid waste management system in the Industrial Park Cherlapalli/Andhra Pradesh	Brot für die Welt (Bread for the World)	Complete
5.	Green accounting study for the state of Andhra Pradesh	Gesellschaft für Internationale Zusammenarbeit	*Commenced*
6.	Diesel price and under recoveries: macroeconomic impacts, funding agencies	Ministry of Finance	Complete
7.	Evaluation of the Rajiv Gandhi Grameen Vidyutikaran Yojana in the states of Assam, Gujarat, Himachal Pradesh, Rajasthan and Uttar Pradesh	Rural Electrification Corporation	*Almost complete*
8.	Assessment of alternative road maps on reforming petroleum prices	Shakti Foundation	Complete
9.	Study of Indian agriculture till 2040	Centennial Group Holdings LLC, Washington DC	Complete
10.	Indian perspectives on global energy scenarios till 2050	Technology Information, Forecasting and Assessment Council	Complete
11.	*Centre of Excellence* in the area of urban development, on climate change vulnerability and adaptation	Ministry of Urban Development	*Ongoing*

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. The ministries include Ministry of Environment and Forests, Ministry of New and Renewable Energy, the Planning Commission, Ministry of Power, Ministry of External Affairs, Ministry of Earth Sciences, 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 Stanford University, California and United States Environmental Protection Agency (USEPA), USA; Wuppertal Institute for Climate, Environment and Energy, WISION-Germany, Deutsche Gesellschaft fuer Internationale Zusammenarbeit (GIZ), Germany; ENERGIA-International Network for Gender and Sustainable Energy, Netherlands; British High Commission; International Institute for Applied Systems Analysis (IIASA), Austria, etc. IRADe has collaborated with private sector and multinational organizations and NGOs such as SEWA, Petroleum Federation of India, PricewaterhouseCoopers, ICF International, Rockefeller Foundation, Institute for Social and Environmental Transition (ISET), Center for Clean Air Policy (CCAP) and Shakti Foundation, among others.

IRADe carried out monitoring and evaluation work for Rajiv Gandhi Grameen Vidyut Yojana (RGGVY) for rural electrification. It has done pioneering work in the area of Natural Resource Accounting (NRA) in general, and for Goa and Andhra Pradesh, specifically; climate adaptation for Ministry of Earth Sciences; and low carbon strategy for inclusive growth for the British High Commission.

IRADe

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