



# APN CAPaBLE

**- Making a Difference -**

Scientific Capacity Building & Enhancement for Sustainable Development in Developing Countries

## **Integrated Assessment Model for Developing Countries and Analysis of Mitigation Options and Sustainable Development Opportunities**

**Final Report for APN CAPaBLE Project:  
2005-CRP2CMY-Shukla**



Energy Research Institute,  
Beijing, China



Indian Institute of Management,  
Ahmedabad, India



Asian Institute of Technology,  
Bangkok, Thailand

# **Integrated Assessment Model for Developing Countries and Analysis of Mitigation Options and Sustainable Development Opportunities**

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**Final Report submitted to APN**

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## Overview of project work and outcomes

### Non-technical summary

The project is jointly implemented by three institutions of excellence: Indian Institute of Management, Ahmedabad (IIMA), India; Energy Research Institute (ERI), China and Asian Institute of Technology (AIT), Thailand. The project work was organized around three themes - i) development of national scenarios with developing country perspective; ii) explicit recognition of developing country dynamics in the modeling, iii) initiation of national modeling exercises and development of national databases in three participating countries. The project teams carried out activities jointly and independently. The joint activities included designing model framework, database and application outlines. Besides, each country team has developed national scenarios and policy modeling in the context of national development plans and greenhouse gas mitigation. The dissemination and project level coordination was done via a comprehensive website ([www.e2models.com](http://www.e2models.com)) which displays intellectual resources related to the project domain including an inventory of papers, and presentations. The website has received excellent feedback from researchers and other stakeholders in terms of its design, relevance of materials and comprehensiveness. The website includes the publications and presentations linked to project activities. Three project workshops were held (AIT, Bangkok in August 2004; ERI, Beijing in September 2005; IIM, Ahmedabad in March 2007) with participation of diverse stakeholders. The project work has led to numerous publications. The project outcomes are interfaced with various international environmental assessments by the project team members participating in the activities such as IPCC's Fourth Assessment Report (AR4), GEO 4, Asia-Pacific Environment Innovation Strategy (APEIS), and Development and Climate project led by UNEP RISO Centre on Energy, Climate and sustainable Development, Denmark.

### Objectives

The present project aimed to:

1. Develop tools for policy analysis for integrating climate change and sustainable development concerns of developing country policy makers.
2. Enhance capacity of developing countries for integrated assessment of climate change mitigation options in the context of sustainable national development priorities and policies.

### Amount received and number years supported

The Grant awarded to this project was:

- US\$ 120,000 for Year1, 2003-2004:
- US\$ 90,000 for Year2, 2004-2005:
- US\$ 90,000 for Year3, 2005-2007.

### Work undertaken

Following Eight (8) comprehensive Reports provides detailed information on the work undertaken and project outputs. The reports are sent separately by the three participating institutions as under:

#### By ERI, China:

1. Report of the Project Workshop II (held in September 2005 at Beijing)
2. China Country Modeling Report

#### By IIM Ahmedabad, India:

3. Report of the Project Workshop III (held in March 2007 at Ahmedabad)
4. India Country Modeling Report
5. Integrated Model Report (jointly prepared by the three partner institutions)
6. Project Website Report

#### By AIT, Thailand:

7. Report of the Project Workshop I (held in August 2004 at Bangkok)
8. Thailand Country Modeling Report

## **Results**

The key output of the project is the CAPaBLE CGE Model which is reported in full in the 'Model Report'. The model applications was made for China, India and Thailand which show that the model as a very useful tool. The project identified the generic Databases which users from developing countries can access free from the web and also the specific databases which more advanced users may subscribe. The project paid keen attention to capacity building training more than 15 doctoral and post-doctoral students, disseminating information to diverse stakeholders from several developing countries from Asia-Pacific region. The project website was used effectively for access to project outputs. Throughout the project implementation, the interfaces were maintained with various international environmental assessments. Project work has lead to numerous publications which has helped capacity building of researchers in developing countries. The project partners contributed to formation of the Asian Energy and Environment Modeling Forum (AEEMF) which was established in July 2004. An important outcome of the project is an extended network among the modeling and climate change mitigation researchers in the Asia-Pacific region and establishment of the fresh links with the international research networks.

## **Relevance to the APN CAPaBLE Programme and its Objectives**

The project has made key contributions in the following areas which are relevant to APN's Science and Policy objectives and agenda: a) Enhancing and creating scientific and analytical capacity for modeling of future projections of greenhouse emissions in three major developing countries in the Asia-Pacific region; b) Development of tools, databases and networking among the greenhouse emissions modelers through an integrated approach; c) Delineating the strategies to identify the mitigation options which provides co-benefits vis-à-vis the national sustainable development goals and the global climate change objectives in the key developing countries in the Asia-Pacific Region.

## **Self evaluation**

Working on multi-country cooperative research projects requires tremendous coordination. The three project teams worked with considerable focus, cooperation, diligence and coordination to deliver what we believe are excellent results; while overcoming the language barriers, understanding the specific national circumstances of each country and appreciating the strengths and weaknesses of each project teams. The project theme and objectives have been among the most challenging area of climate change mitigation research which links climate sciences with policymaking, especially in the developing countries. The project has made significant conceptual contributions, beyond the existing models, scenarios and applications specifically for three key countries in the Asia-Pacific region. We paid considerable attention to capacity building through out the project. A key contribution of the project is to establish network among the modeling and climate change mitigation researchers in the Asia-Pacific region and to establish fresh links with the international research networks. We believe that the final project outputs represent significant contribution vis-à-vis the project objectives.

## **Potential for further work**

Four key areas for further work are: i) enhancing the model developed for the present CAPaBLE project comprehensive to a global model which can align global sustainable development and climate change mitigation in an integrated framework for developing roadmap for transition to a future 'Low Carbon Society', ii) developing strategic technology database for supporting the model for the long-term technology strategy involving innovations and their transfers and deployment in developing countries, iii) dissemination of project work through targeted workshops as well as available forums and iv) sustaining the research network in the Asia-Pacific region and links with international networks. In the context of the last two areas, we plan to continue the project website beyond the project duration. Also, we have plans to convert the final outputs from the project to various publications for wider dissemination.

## **Publications**

### **Papers:**

- Jiang Kejun, Hu Xiulian(2005)Energy Demand and Emissions in 2030 in China: Scenarios and Policy Options, Environment Economics and Policy Studies(accepted)
- Jiang Kejun, Zhu Songli(2005) Analysis on Policy options for Promotion of Clean and Energy Efficient Technologies in transport sector in Beijing, *International Journal Of Environment And Pollution*, No.7, Vol27.
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- Shukla P. R, Rana A, Garg A, Kapshe M, Nair R (2006), "Global Climate Change Stabilization Regimes and Indian Emission Scenarios: Lessons for Modeling of Developing Country Transitions", *Environment Economics and Policy Studies*, Vol. 7, No. 3, pp. 205-231.
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- Garg A, Shukla P.R, Kapshe M (2007), "From Climate Change Impacts to Adaptation: A development perspective for India", *Natural Resources Forum*, 31 (2007), pp. 132-141.
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- Menon-Choudhury D., Shukla P.,R., Biswas D and Nag T (2006), "Electricity Reforms, Firm Level Responses and Environmental Implications", in *Electricity Act and Technical Choices for the Power Sector in India* ( Eds. Kalra P.K and Ruet J), Manohar,

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R.M. Shrestha, S. Malla, S. Kumar and M.H. Liyanage (2005). Least-cost energy system development and its environmental and greenhouse gas implications for Thailand. Research Report, Asian Institute of Technology, Thailand

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Malla S and R.M. Shrestha (2005). Implications of carbon tax and energy efficiency improvement on Thai economy, Research Report, Asian Institute of Technology, Thailand

Malla, S, R.M. Shrestha and S. Kumar (2005). National level energy and emission scenarios development for Thailand. Research Report, Asian Institute of Technology, Thailand

#### **Books:**

Jiang Kejun et al(2005). China's Climate Change Review and Assessment, Leader author of Chapter 17, China Metrological Publishing House, Beijing

#### **Website:**

A comprehensive CAPaBLE project website can be accessed at: [www.e2models.com](http://www.e2models.com)

#### **Workshop Proceedings:**

Proceedings of the three project workshops are submitted to APN as reports. All workshop materials are available on the project website and can be accessed in user-friendly manner.

#### **Acknowledgments**

We thank APN for sponsoring the project and the APN administrators for their efficient and constructive support and guidance. Over the duration of the project, numerous individuals and organizations gave support, encouragement and guidance to our work. We are grateful to them all. Our gratitude is especially due to international modellers who gave us inputs and made available their on-going work on models, scenarios, databases and policy analysis. We thank Prof. Yuzuru Matsuoka from Kyoto University and Dr. Mikkio Kainuma and Dr. Toshihiko Masui from the National Institute of Environment Studies (NIES), Japan for number of discussions on the AIM models and modelling exercises for climate change mitigation and for achieving 'Low Carbon Society' through sustainable development. We are especially thankful to Dr. Toshihiko Masui who worked very closely in the development of CAPaBLE-CGE model which derived important information and insights from his work on AIM-CGE model. Our sincere thanks are due to international climate change economists and modellers Dr. Jae Edmond and Dr. Ronald Sands from JGCRI, University of Maryland, for access to their models and databases and Prof. John Weyant, Stanford University who encouraged us to interface closely with the work of Energy Modelling Forum. Dr. Jean Charles Hourcade provided valuable insights representing the developing country dynamics in long-term scenarios and policy modelling. Our thanks are also due to numerous policymakers, domain experts, academicians, researchers, NGO representatives, officials of international organizations and other stakeholders who spared their valuable time and showed keen interest in the project and those who participated in the project workshops. Finally, we wish to thank the research staff from our three institutions who throughout provided amenable support to the project.

# Technical Report

## Preface

The project is jointly implemented by three institutions of excellence located in China, India and Thailand. The project work followed three themes - i) development of national greenhouse gas mitigation scenarios with developing country perspective; ii) explicit recognition of developing country dynamics in the modelling, iii) initiation of national modelling exercises and development of national databases in three participating countries. Project coordination used a comprehensive website ([www.e2models.com](http://www.e2models.com)) which displays intellectual resources related to the project. The project outputs included three workshops, numerous publications, a CGE model and its national applications and guidance for accessing generic and specific databases.

## Table of Contents

### 1. Introduction

The two aims of the project were: i) Develop tools for policy analysis for integrating climate change and sustainable development concerns of developing country policy makers, and ii) Enhance capacity of developing countries for integrated assessment of climate change mitigation options in the context of sustainable national development priorities and policies. Addressing the project theme and objectives are considered among the most challenging area of climate change mitigation research which links climate sciences with policymaking, especially in the developing countries. The key focus of the project was the developing country context in which to adapt the model, scenarios, databases and the modeling. The project methodology followed exhaustive assessment of present best practices vis-à-vis greenhouse gas mitigation models, scenario building, database development as well as global and national modeling. The details of the methodology are discussed in the next section. The made significant contributions to enhancing and creating scientific and analytical capacity for GHG mitigation modeling in three major developing countries in the Asia-Pacific region, developing a model, generic and national database and networking among the GHG emissions modelers through an integrated approach and delineating strategies to identify the mitigation options keeping in view the socio-economic dynamics in the developing countries.

### 2. Methodology

Working on multi-country cooperative research projects requires tremendous coordination. The three project teams worked with considerable focus, cooperation, diligence and coordination; while overcoming the language barriers, understanding the specific national circumstances of each country and appreciating the strengths and weaknesses of each project teams. The joint activities included designing model framework, database and application outlines. Besides, each country team developed national scenarios and policy modeling in the context of national development plans and greenhouse gas mitigation. The dissemination and project level coordination was done via a comprehensive website ([www.e2models.com](http://www.e2models.com)) which displays intellectual resources related to the project domain including an inventory of papers, and presentations. Three project workshops were held (AIT, Bangkok in August 2004; ERI, Beijing in September 2005; IIM, Ahmedabad in March 2007) with participation of diverse stakeholders. The first workshop was used to gain guidance vis-à-vis the project's aims, approach and direction and the stakeholder expectations. The second workshop provided opportunity to gain mid-course feedback on the direction and results from the project. The third workshop communicated the information about the model and modeling exercises carried out by the project teams.

A summary of scientific methodology is as under:

1. An exhaustive survey of existing models and modeling methodologies was carried out to assess the state-of-the-art of the greenhouse gas mitigation modeling.
2. The strengths and weaknesses of the current models and modeling approaches



for incorporating developing country dynamics were assessed.

3. The generic and country specific databases were examined to assess their adaptation for the modeling applications in the developing countries.
4. An exhaustive literature survey was carried out of the international, regional and national scenario studies to assess how the scenarios incorporate the developing country dynamics.
5. The country teams used some of the existing models for national applications for their respective countries to understand and assess how to incorporate specific national circumstances in model design, data and modeling adaptations.
6. On the basis of this assessment, the project team decided to closely interface with the modeling team at NIES, Japan since the Asia-Pacific Integrated Model (AIM) framework, tools and strategic databases developed at NIES best suited the CAPaBLE project's aims and needs.
7. The project team decided to use the AIM-CGE model and enhanced it to develop the CAPaBLE-CGE model and carried out the country level modeling exercises for greenhouse gas mitigation with this model.
8. During the development of the model, scenario development and modeling exercise, close contacts were maintained with international modelers whose work as the best practices in the state-of-the-art literature.
9. Workshops were used to gain inputs from stakeholders at different stages to correct the course of the project.
10. Project website was used for cost-effective and efficient communications among the project teams and with others.
11. The details of the methodology including model flow charts and equations are available in the comprehensive reports separately submitted as appendix to this report.

### **3. Results & Discussion**

Following Eight (8) comprehensive Reports covers the results and discussion of project outputs. The reports are sent separately by the three participating institutions as under:

By ERI, China:

1. Report of the Project Workshop II (held in September 2005 at Beijing)
2. China Country Modeling Report

By IIM Ahmedabad, India:

3. Report of the Project Workshop III (held in March 2007 at Ahmedabad)
4. India Country Modeling Report
5. Integrated Model Report (jointly prepared by the three partner institutions)
6. Project Website Report

By AIT, Thailand:

7. Report of the Project Workshop I (held in August 2004 at Bangkok)
8. Thailand Country Modeling Report

The reports detail the results and findings. The conclusions below summarize briefly the findings which relate to addressing the two aims of the project.

### **4. Conclusions**

The summary conclusions are presented below vis-à-vis the two aims of the study:

Aim 1: Develop tools for policy analysis for integrating climate change and sustainable development concerns of developing country policy makers.

Related Conclusions:

1. The project teams have developed a CAPaBLE CGE Model which is reported in full in the 'Model Report'.
2. The GAMS code for the model and user information is reported which can be used to run the model.
3. The CAPaBLE model applications using the shared database with the AIM/CGE model database is developed and reported in the model report for China, India



and Thailand. The applications show the model as a very useful tool which can be adapted to specific developing country applications.

4. The Model Report provides information on the generic Databases which users from developing countries can access free from the web. Also, information on the model specific databases is provided which a user may subscribe to for more involved applications.
5. The model and the project reports will be made available on the project website shortly.

Aim 2: Enhance capacity of developing countries for integrated assessment of climate change mitigation options in the context of sustainable national development priorities and policies.

#### Related Conclusions:

12. Capacity building was paid keen attention in the project implementation strategy.
13. More than 15 doctoral and post-doctoral students associated with the three partner institutions directly benefited from the project.
14. Three project workshops received participation from of diverse stakeholders from several developing countries from Asia-Pacific region.
15. Several workshop participants from developing countries remained in contact with the project teams to receive the project outputs including model architecture and databases.
16. The website was used for access to project outputs and received excellent feedback from researchers and other stakeholders in terms of its design, relevance of materials and comprehensiveness.
17. Throughout the project implementation, the interfaces were maintained with various international environmental assessments such as IPCC's Fourth Assessment Report (AR4), GEO 4, Asia-Pacific Environment Innovation Strategy (APEIS) and Development and Climate project led by UNEP RISO Centre on Energy, Climate and sustainable Development, Denmark.
18. The project work has lead to numerous publications which has helped capacity building of researchers in developing countries.
19. The project partners actively worked as the key members of the Asian Energy and Environment Modeling Forum (AEEMF) which was established in July 2004. The project outputs were used to inform nearly 200 participants, mainly young researchers who participated in the three workshops organized by AEEMF.
20. A key contribution of the project to sustained capacity building is the strengthening and extending of the network among the modeling and climate change mitigation researchers in the Asia-Pacific region and establishment of the fresh links with the international research networks.

#### **5. Future Directions**

The key elements of future directions are:

- i) Enhancing the model developed for the present CAPaBLE project comprehensive to a global model which can align global sustainable development and climate change mitigation in an integrated framework for developing roadmap for transition to a future 'Low Carbon Society'.
- ii) Developing strategic technology database for supporting the model for the long-term technology strategy involving innovations and their transfers and deployment in developing countries.
- iii) Dissemination of project work through targeted workshops as well as available forums
- iv) Sustaining the research network in the Asia-Pacific region and links with international networks.

## References

Comprehensive lists of references can be found in the reports which are being sent.

## Appendices

### Conferences/Symposia/Workshops

Three project workshops were held:

Workshop 1: "Integrated Assessment Models (IAMs) for Developing Countries – Sustainable Development and GHG Mitigation Opportunities" was held during 9-10 August, 2004 at the Asian Institute of Technology (AIT), Bangkok, Thailand.

Workshop 2: "Integrated Assessment Models (IAMs) for Developing Countries – Sustainable Development and GHG Mitigation Opportunities" was held during 6-7 September, 2005 at the Energy Research Institute (ERI), Beijing, China.

Workshop 3: "Climate Change Response Strategies: Perspectives in Modelling for Developing Economies", was held during March 9-10, 2007, Ahmedabad, India.

All three workshop proceedings are sent separately as reports to the APN. All workshop materials are available on the project website ([www.e2models.com](http://www.e2models.com)).

### Funding sources outside the APN

We received no direct funding support from any source outside of the APN. The three institutions lent the in kind support such as free access for meeting facilities, libraries and administrative staff support.

### Appendix

Following Eight (8) Full Reports are being separately sent which may be treated as Appendices.

#### By ERI, China:

1. Report of the Project Workshop II (held in September 2005 at Beijing)
2. China Country Modelling Report

#### By IIM Ahmedabad, India:

3. Report of the Project Workshop III (held in March 2007 at Ahmedabad)
4. India Country Modelling Report
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7. Report of the Project Workshop I (held in August 2004 at Bangkok)
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