Evaluation of Energy System Forecasting and GHG Emission Models in the LEAD Countries

(Bangladesh, Cambodia, Indonesia, India, Laos, Malaysia, Nepal, The Philippines, Thailand, Vietnam)

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Catalyzing an Era of Green Growth

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Outline of the Presentation

- Model evaluation objectives
- Model evaluation framework
- Criteria for inclusion of models in the evaluation
- Models included
- Presentation of results
- Conclusions

Objectives of Model Evaluation

AIT plays a number of roles in LEAD, including being a provider of research and analysis

LEAD requested AIT to conduct an evaluation that :

- Identifies the models most commonly used for energy system and GHG emission forecasting in the LEAD countries.
- Describes users and modeling studies.
- Assesses the circumstances under which each model is “fit for purpose”, i.e., suitable for the intended purpose.

The Evaluation Framework

To satisfy these objectives:

- Model evaluation framework is developed on the basis of:
  - appropriateness/relevance
  - efficiency
  - effectiveness
- Evaluation is assessed based on:
  - literature survey (model documentation guides, user manuals, articles in scientific journals, research reports, technical reports, websites, press releases, etc.)
  - interview (model users)
  - experiences

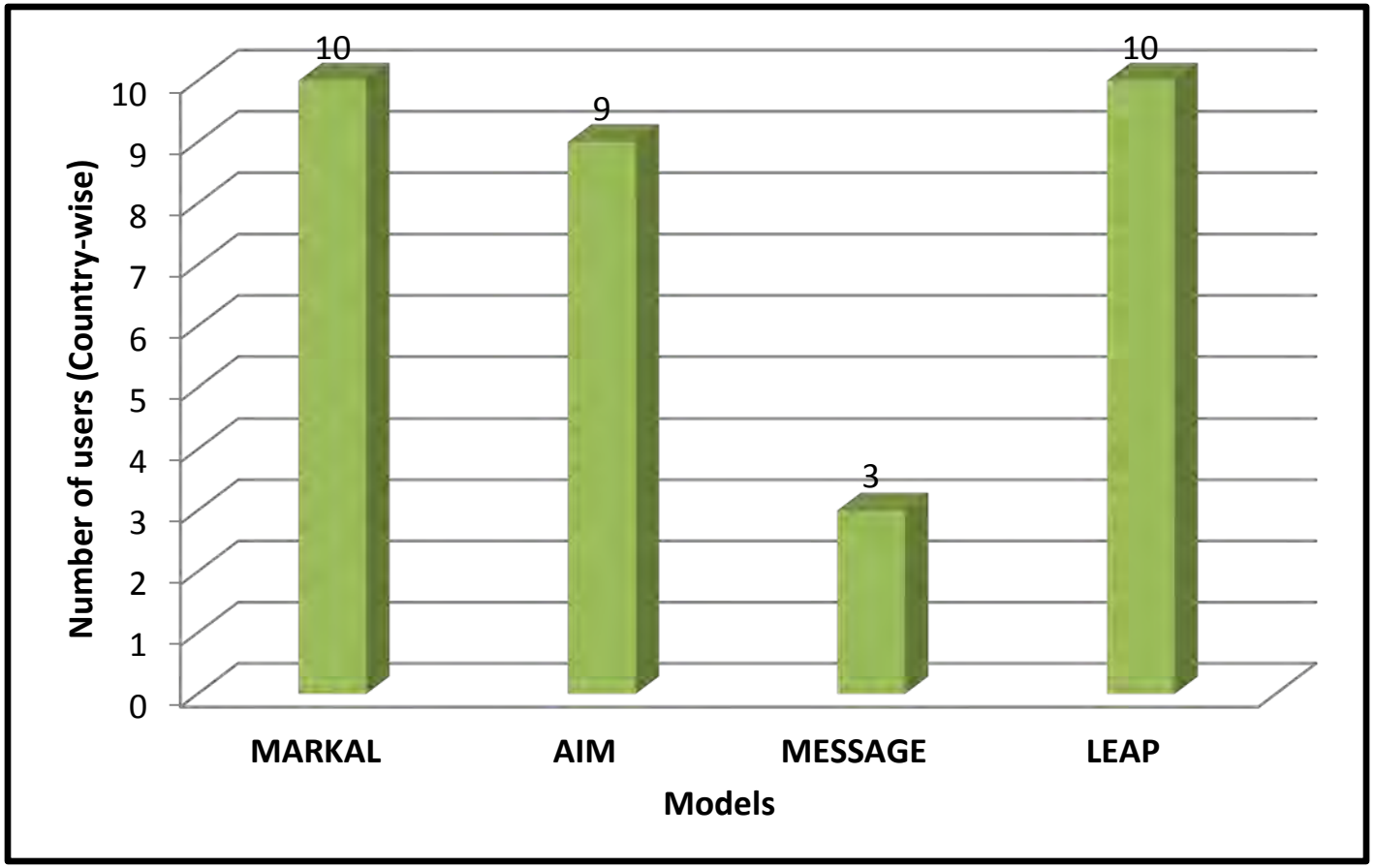
Criteria for Inclusion of Models in this Evaluation

- Models must be:
  - Widely used by leading LEDS institutions (government agencies, research institutes, private sectors) in the LEAD countries or widely used by institutions cooperating with the LEAD countries
  - Primarily designed:
    - integrated energy, economy and environmental analysis
    - low emission development strategies (LEDS)
    - green growth plans, national communications
    - screening of energy sector technologies
  - Cited in scientific literature
  - Thoroughly tested and generally found to be credible
  - Actively being developed and professionally supported

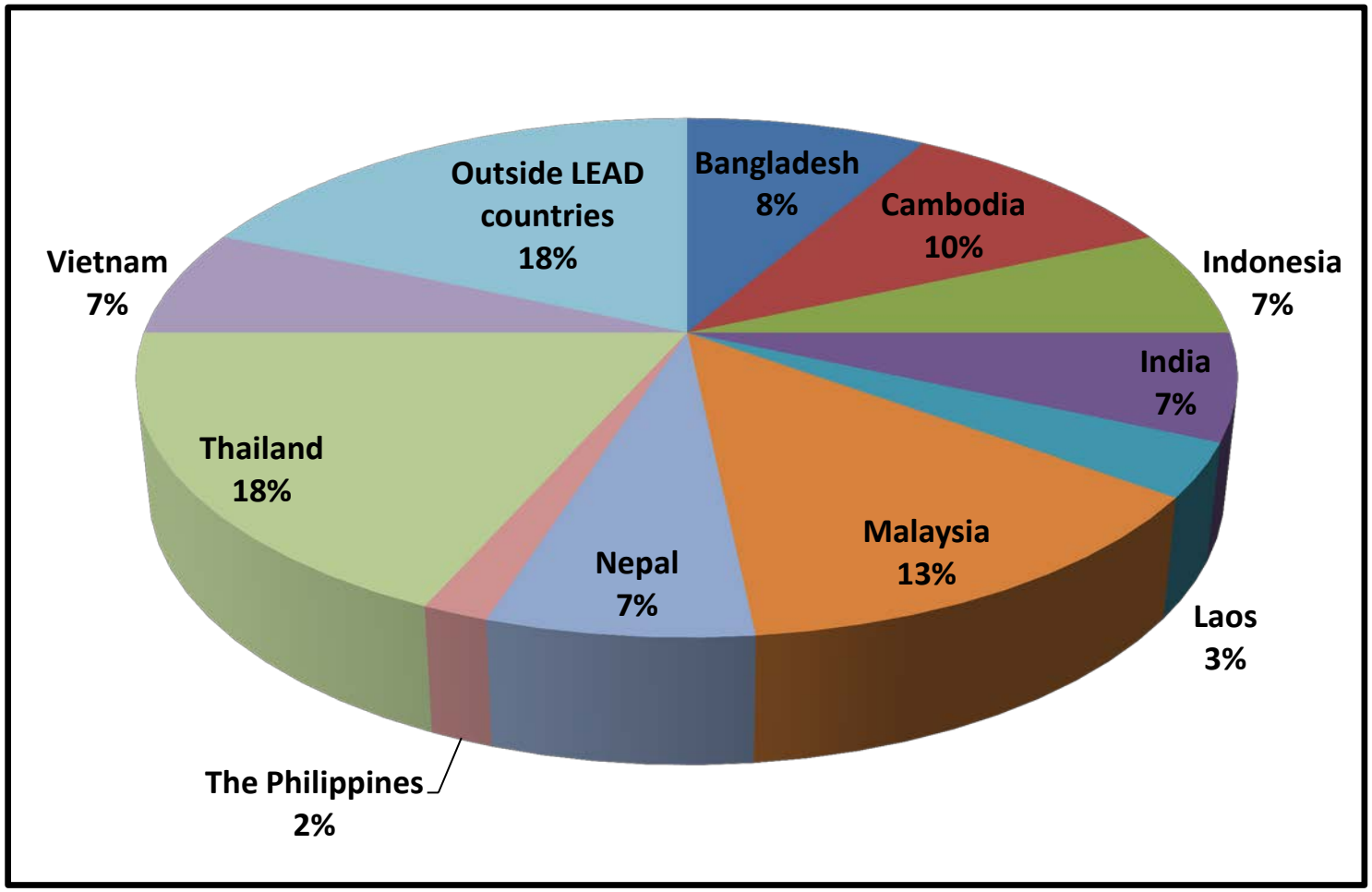
The Four Models Included in the Evaluation

- MARKAL (MARKet Allocation)
  - Developed by IEA/ETSAP
  - Optimization model
- AIM (Asia-Pacific Integrated Model)
  - Developed by the National Institute for Environmental Studies, Japan, and Kyoto University, Japan
  - Optimization model
- MESSAGE (Model for Energy Supply Strategy Alternatives and their General Environmental Impact)
  - Developed by International Atomic Energy Agency (IAEA)
  - Optimization model
- LEAP (Long-range Energy Alternatives Planning)
  - Developed by Stockholm Environment Institute (SEI)
  - Accounting model

Number of Countries with Users of the Four Models (10 LEAD Countries)

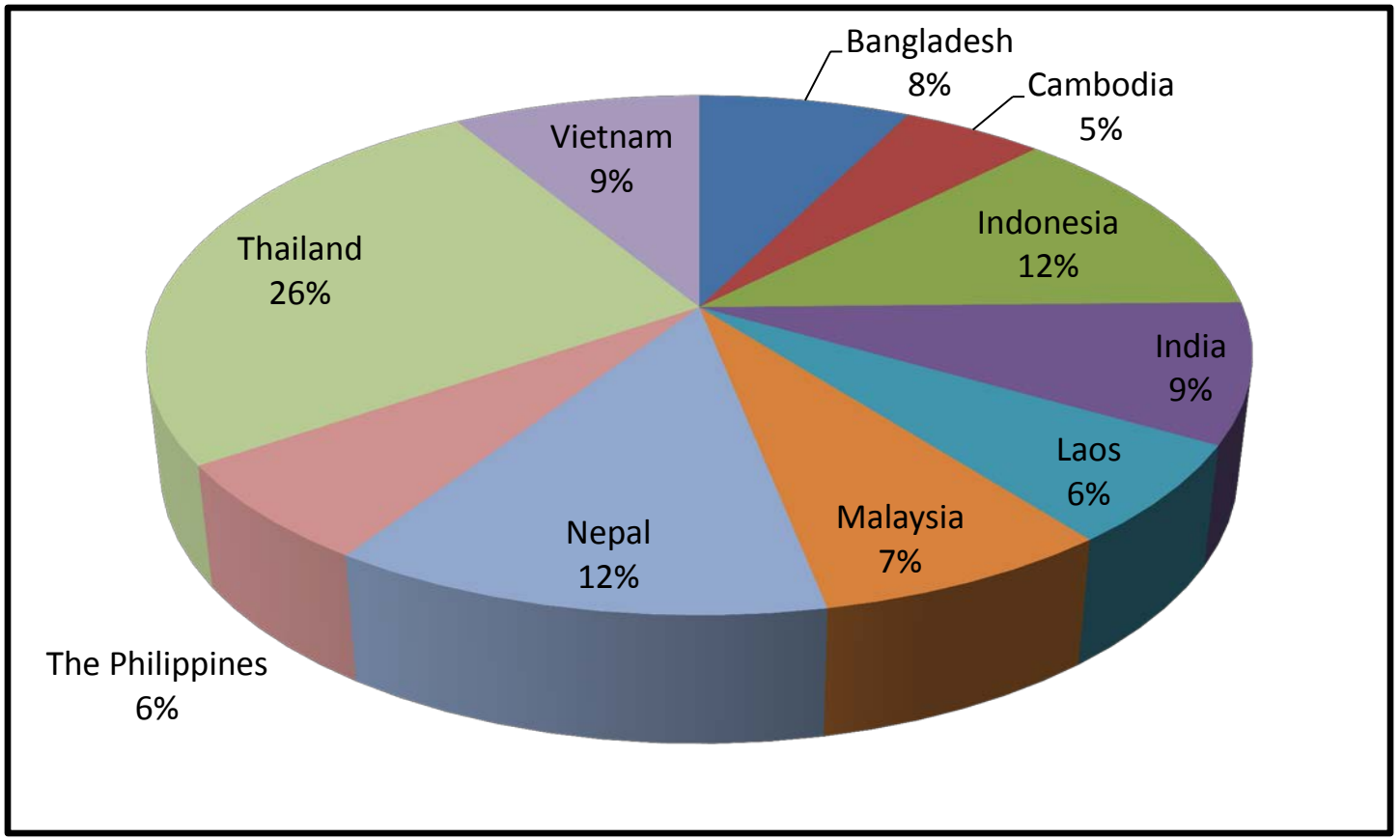


Participating Institutions by Country



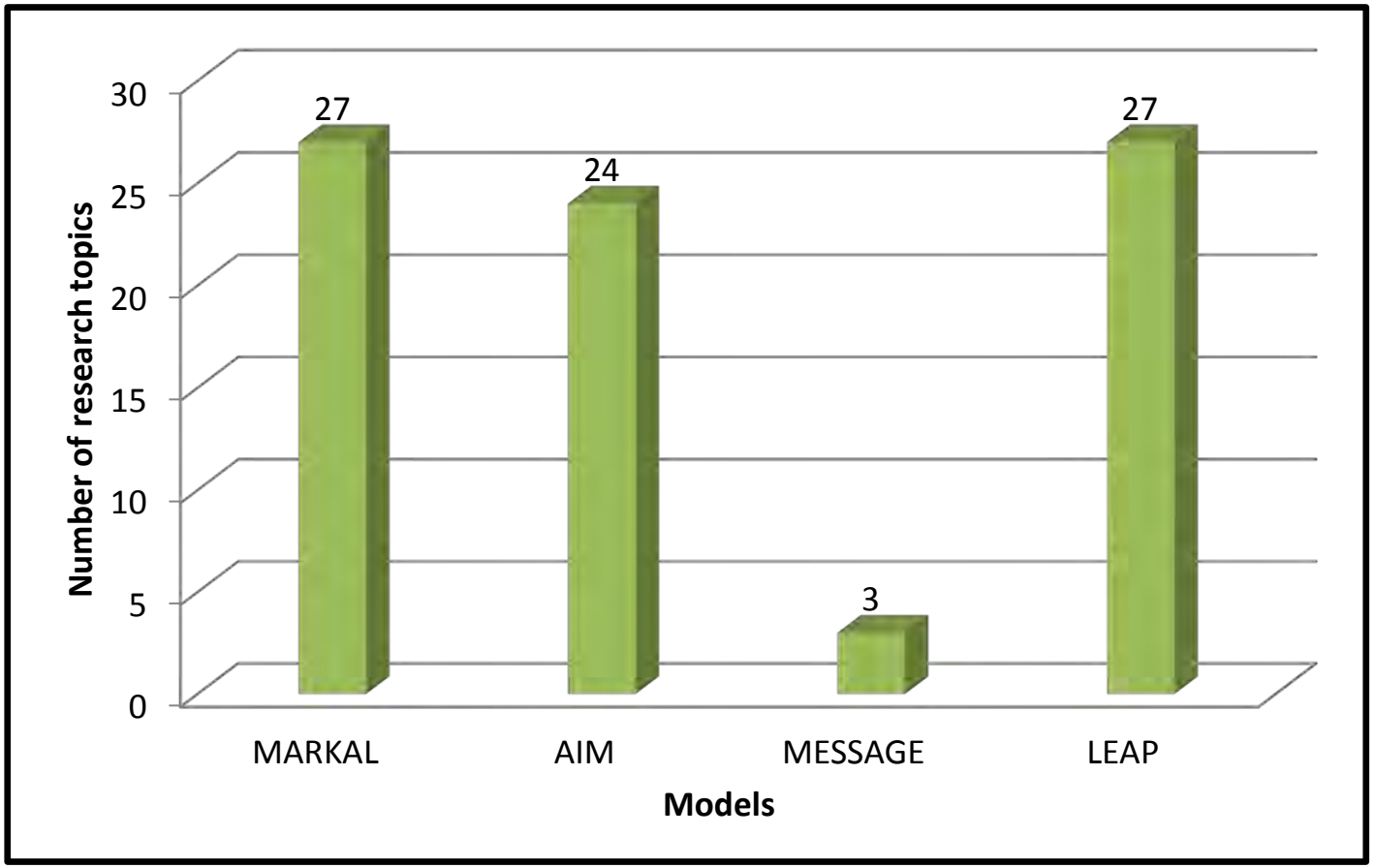
Total participating institutions = 60 (*please see Annex for participating institutions*)

Country Modeling Studies Using the Four Models



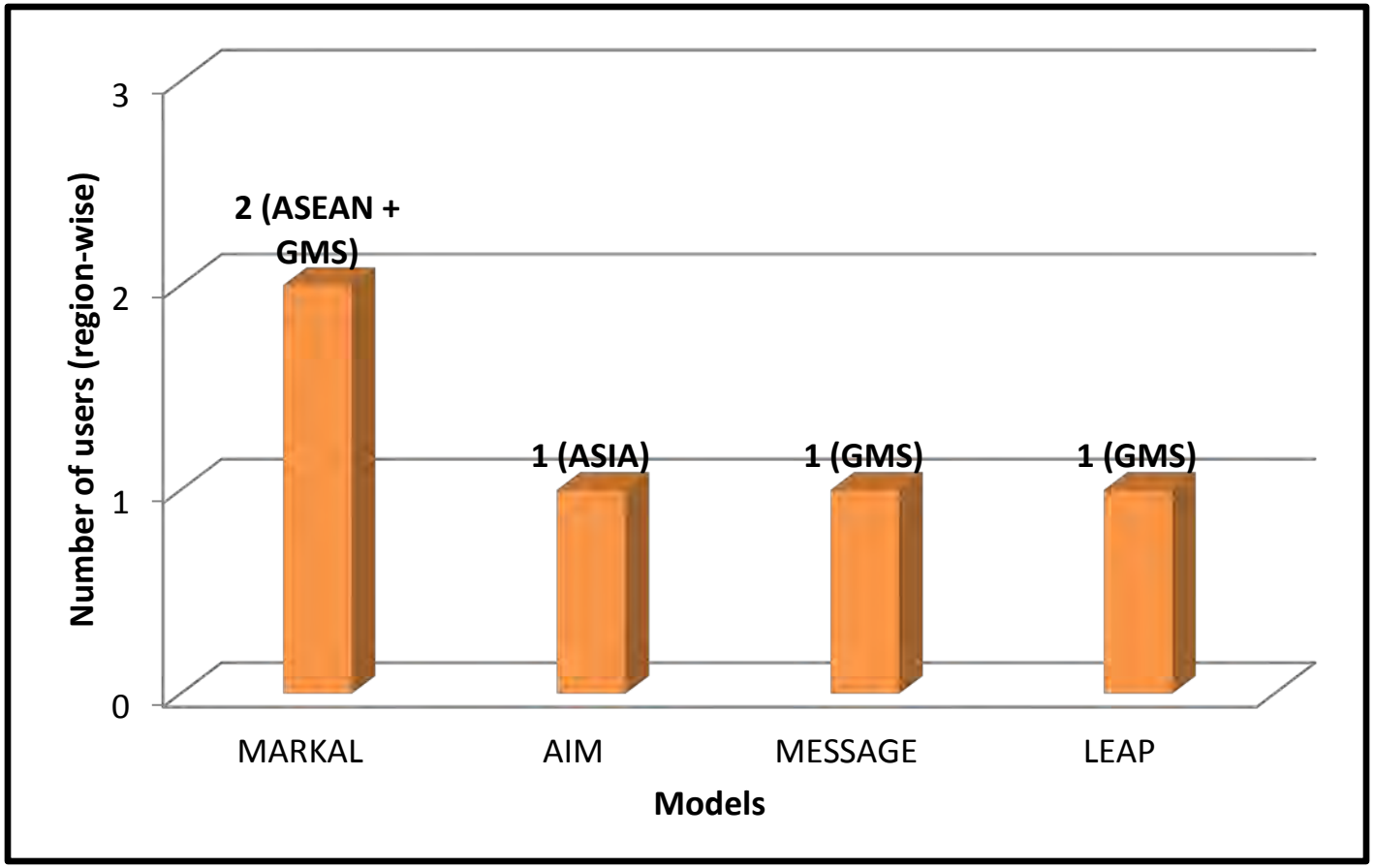
Total country-level modeling studies = 81 (*please see Annex for modeling studies*)

Number of Country Modeling Studies Using the Four Models in 10 LEAD Countries

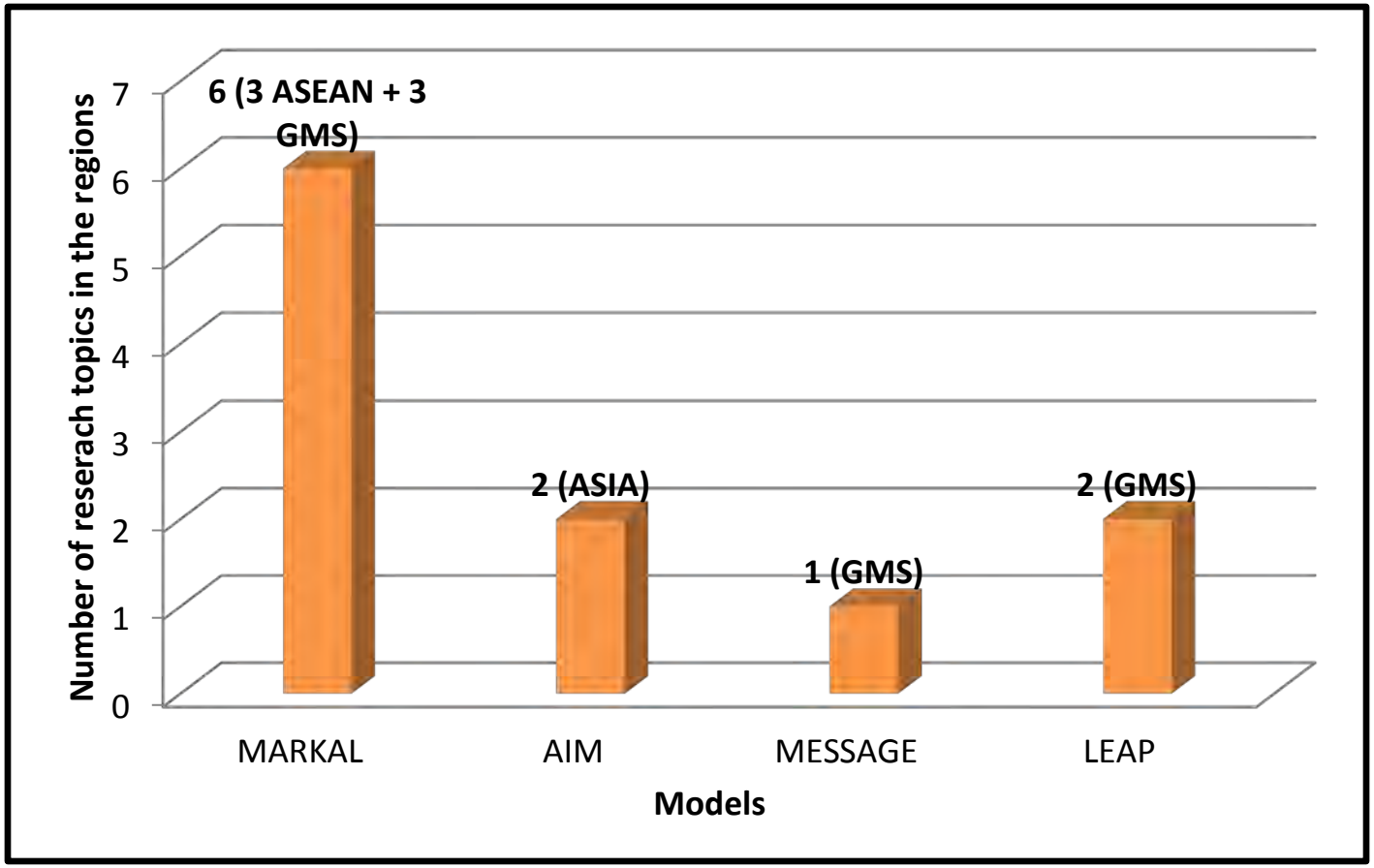


There are at least 81 country-level modeling studies using MARKAL, AIM, MESSAGE and LEAP that have been conducted in the LEAD countries (*please see Annex for modeling studies*)

Number of Users of Four Models (Regional-Level Studies)



Number of Regional-Level Modeling Studies



Total number = 11

Applications of the Models: Research Topics

The 92 modeling studies (81 country-level and 11 regional-level) fall in the following topic categories:

- Country energy outlook development
- Analyzing low emission development strategies:
  - climate policies
  - different emission scenarios
  - combining emission scenarios with climate policies
- Developing Marginal Abatement Cost (MAC) Curve
- Co-benefit analysis (e.g., local air pollution, energy security)
- Evaluating the effects of regulations, e.g., subsidies
- Energy trading

Applications of the Four Models

- MARKAL, AIM, and MESSAGE are commonly used for:
  - Climate policy assessment
  - Analyzing the emission scenarios
  - Analyzing the combining emission scenarios with climate policies
  - Country energy outlook development
- LEAP is commonly used for studies on emission scenarios without climate policies
- The selection of using MARKAL, AIM, MESSAGE, and LEAP depends on:
  - Cost of the models
  - Ease of use the models
  - Research funding for using the models

Problems Encountered in Applying the Models in the LEAD countries

- Reference Energy System (RES) is not available
- National database (e.g.: energy balance, technical & cost data technologies, data on non-commercial energy emission factors, time series data) is not supporting
- Scenarios and strategies development
- Troubleshooting

Conclusions (1)

- MARKAL, AIM and LEAP are models that commonly used in LEAD countries.
- Among the 60 institutions that have been identified working on country modeling studies, around 60% have used LEAP, while AIM and MARKAL are around 32% and 23% respectively.
- MARKAL and LEAP are the most frequently used for country modeling studies, and then followed by AIM.
- For regional modeling studies, MARKAL model is commonly used (i.e. six regional modeling studies), and then followed by AIM and LEAP models (two regional modeling studies each), while MESSAGE model is only one regional modeling study.

Conclusions (2)

- The selection of the software depends on the research topics:
  - MARKAL, AIM, and MESSAGE have been used for research topics analyzing on (i) climate policy assessment, (ii) emission scenarios, (iii) combining emission scenarios and climate policy analysis, and (iv) country energy outlook development
  - LEAP has been used for research topics analyzing on emission scenarios
  - The selection of the models also depends on:
    - cost of the models
    - ease to operate the models
    - donor research funding to use the models

Conclusions (3)

- MARKAL is most fit for purpose when:
  - Optimization model is important in the study context
  - The users have a deep understanding on reference energy system and optimization technique
  - Technical and statistical data are relatively plentiful
  - To get the model run and troubleshooting is important
  - GHG emission reduction target is more important rather than GHG mitigation
  - A large number of complex and interacting technology options need to be assessed
  - Macroeconomic implications become part of the analysis,
  - License is already available

Conclusions (4)

- AIM is most fit for purpose when:
  - Optimizing models are important in the study context
  - A large number of complex and interacting technology options need to be assessed,
  - The users have enough technical and statistical data
  - The users have a deep understanding on reference energy system and optimization technique
  - The study is related to energy tax, CO_2-, SO_2-, NO_x-taxes, energy constraint, CO_2-, SO_2- and NO_x- constraints
  - The users have opportunity to attend a training and can benefit from understanding the model development and calculation process from beginning to end

Conclusions (5)

- MESSAGE is most fit for purpose when:
  - The study needs an optimization approach
  - Technical and statistical data are less plentiful
  - Only a small number of complex and interacting technology options need to be assessed
  - The users have a deep understanding on reference energy system and optimization technique
  - There is a dedicated team to work on MESSAGE and have somebody to train MESSAGE

Conclusions (6)

- LEAP is most fit for purpose when:
  - The users are not familiar with Reference Energy System and concept of optimization
  - GHG mitigation is more important than GHG emission reduction target
  - Assumptions of optimizing models are not reasonable in the study context
  - Data is relatively less plentiful
  - LEAP's license is already available

Thank You!

Annex

Catalog (Country) (1)

Country	Participating Institution	Model	Modeling Studies
Bangladesh	Center for Development Research (ZEF), University of Bonn,Walter-Flex-Str. 3, 53113 Bonn, Germany; Energy Institute, Atomic Energy Research Establishment, Bangladesh Atomic Energy Commission, Dhaka, Bangladesh; Mechanical Engineering Department, Malaviya National Institute of Technology, JLN Marg 302017, Jaipur, India	MARKAL	➢ Impacts of CO2 emission constraints on technology selection and energy resources for power generation in Bangladesh ➢ The future choice of technologies and co-benefits of CO2 emission reduction in Bangladesh power sector ➢ Impacts of CO2 emission constraints on penetration of solar PV in the Bangladesh power sector
	Department of Environment, Bangladesh	AIM	➢ Bangladesh Low Carbon Scenario
	Asian Institute of Technology, Thailand	AIM-MAC	➢ Marginal Abatement Cost (MAC) Curve development of Bangladesh
	Bangladesh University of Engineering & Technology; Energypac Engineering Ltd.; International Islamic University of Chittagong	LEAP	➢ Energy Forecasting of Bangladesh in Gas Sector Using LEAP Software

Catalog (Country) (2)

Country	Participating Institution	Model	Modeling Studies
Cambodia	Ministry of Industry, Mines and Energy, Cambodia	MARKAL	➢ Analysis of power supply options for the interconnected grid
	Head of Office, Climate Change Department, Ministry of Environment, Cambodia	AIM	➢ Low Carbon Development in Cambodia
	Ministry of Industry, Mines and Energy (MIME), Cambodia; UNDP, Cambodia; Group for Renewable Energy, Environment and Solidarity (GERES), Cambodia	LEAP	➢ Residential in energy demand in rural Cambodia: An empirical study for Kampong Speu and Svay Rieng
	The Energy Data and Modeling Center The Institute of Energy Economics, Japan; The ASEAN Centre for Energy; The National ESSPA Project Teams for SOE Leaders of Cambodia; Ministry of the Economy, Trade and Industry, Japan	LEAP	➢ Cambodia energy outlook

Catalog (Country) (3)

Country	Participating Institution	Model	Modeling Studies
Indonesia	Badan Pengkajian dan Penerapan Tekhnologi, Indonesia	MARKAL	➢ Gas utilization: national gas pipelines, alternative fuel mix for power plant, and demand sectors in Indonesia ➢ The future demand for natural gas in Indonesian regions with particular reference to the use of CNG in transport ➢ The future technologies for power plant in Indonesian regions with particular reference to the use of renewable energy and small scale coal steam power plant
	Asian Institute of Technology, Thailand	AIM	➢ Implications of carbon tax in energy sector development in Indonesia ➢ Implication of CO2 emission reduction target: a case of Indonesia ➢ Implications of introducing Renewable Portfolio Standard (RPS) in Indonesia
	Institut Teknologi Bandung, Indonesia	AIM	➢ Low carbon society scenario toward 2050 in Indonesia
	Institut Teknologi Bandung, Indonesia; Bogor Agriculutre University, Indonesia	AIM	➢ Indonesia national study using coupled Energy/model and AFOLU model

Catalog (Country) (4)

Country	Participating Institution	Model	Modeling Studies
Indonesia	Asian Institute of Technology, Thailand	AIM-MAC	➢ Marginal Abatement Cost (MAC) Curve development of Indonesia
	SIIT, Thamasat University, Thailand	LEAP	➢ Demand side management options in the household sector through lighting efficiency improvement for Java-Madura-Bali islands in Indonesia

Catalog (Country) (5)

Country	Participating Institution	Model	Modeling Studies
India	TERI, India	MARKAL	➢ National Energy Map for India: Technology Vision 2030
	Indian Institute of Management, Ahmedabad, India	AIM	➢ Co-benefits of CO2 and SO2 mitigation policies in India using AIM/Enduse model ➢ Low Carbon Society in Asia: Activities in India ➢ Constructing Indian national scenarios with "Conventional Mitigation" and "Sustainable development" which corresponding to global 2 C scenarios
	Bhabha Atomic Research Centre, Mumbai, 400085, India	MESSAGE	➢ Energy Supply, Demand and Environmental Analysis – A Case Study of Indian Energy Scenario
	TERI, India	LEAP	➢ Policies to reduce energy use and environmental emissions in the transport sector: A case of Delhi city ➢ Energy demand and environmental implications in urban transport — Case of Delhi

Catalog (Country) (6)

Country	Participating Institution	Model	Modeling Studies
Laos	Ministry of Industry and Handicrafts, Electricity, Laos	MARKAL	➢ Energy security and diversity
	University of Turku , Finland; Department of Electricity Ministry of Energy and Mines, Lao PDR	LEAP	➢ Interlinkages between energy and livelihoods ➢ Modeling approach for Energy Planning
	Finland Futures Research Centre, Turku School of Economics, Pinninkatu 47, 33100 Tampere, Finland	LEAP	➢ Rural energy survey and scenario analysis of village energy consumption: A case study in Lao People's Democratic Republic ➢ Estimating residential consumption in Laos

Catalog (Country) (7)

Country	Participating Institution	Model	Modeling Studies
Malaysia	PTM Malaysia Energy Center, Malaysia	MARKAL	➢ Fuel diversification – economics and environmental impact of alternative fuel mix ➢ Cost and environmental impact of renewable energy technologies ➢ GHG mitigation options with emphasis on energy efficiency and renewable energy strategies
	Alam Sekitar Malaysia (ASMA), Pusat Tenaga Malaysia (PTM), Universiti Putra Malaysia (UPM), Malaysia	AIM	➢ The estimation of carbon dioxide (CO2) emissions from the transport sector in Malaysia (2000-2020)
	Universiti Teknologi Malaysia	AIM	➢ Extending the reduction plan of the 2nd National Communication with ExSS and AFOLU model

Catalog (Country) (8)

Country	Participating Institution	Model	Modeling Studies
Malaysia	Department of Chemical Engineering, Faculty of Chemical and Natural Resources Engineering, Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia; Deputy Chancellor Office (Development and Innovation), Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia; Institute of Environmental and Water Resource Management (IPASA), Universiti Teknologi Malaysia, 81310 Skudai, Johor, Malaysia	LEAP	➢ Projection of CO2 Emissions in Malaysia

Catalog (Country) (9)

Country	Participating Institution	Model	Modeling Studies
Nepal	Asian Institute of Technology, Thailand	MARKAL	➢ Energy and environmental implications of carbon emission reduction targets: case of Kathmandu Valley, Nepal ➢ Co-benefits of a carbon tax in Nepal ➢ Transport sector electrification in a hydropower resource rich developing country: energy security, environmental and climate change co-benefits
	Asian Institute of Technology, Thailand	AIM-MAC	➢ Marginal Abatement Cost (MAC) Curve development of Nepal
	Asian Institute of Technology, Thailand	MESSAGE	➢ Atmospheric CO2 stabilization scenarios in Nepal
	The Institute of Engineering (IOE), Tribhuvan University , Nepal	LEAP	➢ End-use Energy Demand Forecast of Nepal
	Practical Action Nepal Office Pandole Marga, Kathmandu, Nepal	LEAP	➢ Study to determine outline plans for eliminating energy poverty in Nepal
	Ministry of Population and Environment, Kathmandu, Nepal	LEAP	➢ Initial National Communication to the Conference of the Parties of the United Nations Framework Convention on Climate Change

Catalog (Country) (10)

Country	Participating Institution	Model	Modeling Studies
Nepal	National Institute for Environmental Studies (NIES), Japan	LEAP	➢ Urban transport and environment in Kathmandu Valley -Local air pollution control and its synergy with global carbon concerns
	Institute of Engineering, Tribhuvan University, GPO Box: 1175, Kathmandu, Nepal; Alternative Energy Promotion Center, Energy Sector Assistance Programme, His Majesty's Government of Nepal, Dhobighat, Lalitpur, Nepal	LEAP	➢ Mitigation potential of greenhouse gas emission and implications on fuel consumption due to clean energy vehicles as public passenger transport in Kathmandu Valley of Nepal: A case study of trolley buses in Ring Road

Catalog (Country) (11)

Country	Participating Institution	Model	Modeling Studies
Philippines	Department of Energy, Philippines	MARKAL	➢ Impact of natural gas expansion ➢ Promoting renewable energy in a restructured electricity market ➢ Increasing renewable energy utilization by full cost accounting of electricity supply
	Department of Energy, Philippines	AIM	➢ Low carbon society scenario toward 2050 in The Philippine
	Department of Energy, Philippines	LEAP	➢ National energy plans

Catalog (Country) (12)

Country	Participating Institution	Model	Modeling Studies
Thailand	National Energy Policy Office, Thailand	MARKAL	➢ Removing the subsidy on LPG and implementing a policy to increase the use of CNG in transport ➢ Fuel options for power generation in Thailand ➢ Renewable energy in Thailand
	Asian Institute of Technology, Thailand	MARKAL	➢ Effect of Renewable Portfolio Standard on Energy security and the Environment : Case of Thailand ➢ Co-benefits of CO2 emission reduction in a developing country
	Asian Institute of Technology, Thailand	AIM	➢ Scenario-based analyses of energy system development and its environmental implications in Thailand ➢ To analyze the implications of carbon tax, CO2 emission targets, renewable portfolio standard (RPS) on energy security and co-benefits
	SIIT, Thammasat University, Thailand	AIM	➢ Low carbon society scenario toward 2050 in Thailand ➢ Low carbon society Vision 2030 Thailand
	Asian Institute of Technology, Thailand	AIM-MAC	➢ Marginal Abatement Cost (MAC) Curve development of Thailand
	University of Technology, Sydney	MESSAGE	➢ Long-term impacts of alternative energy-environmental scenarios for Thailand

Catalog (Country) (13)

Country	Participating Institution	Model	Modeling Studies
Thailand	Asian Institute of Technology, Thailand	LEAP	➢ CO2 emission and mitigation strategies in a city: a case study of Bangkok
	Bioenergy Laboratory, National Metal and Materials Technology Center (MTEC), Pathumthani 12120, Thailand; Department of Mechanical Engineering, King Mongkut's University of Technology Thonburi (KMUTT), Bangkok 10140, Thailand; Asian Transportation Research Society (ATRANS), Bangkok 10110, Thailand; Department of Transportation Engineering and Socio Technology, College of Science and Technology, Nihon University, Chiba 274-8501, Japan	LEAP	➢ Scenario Analyses of Road Transport Energy Demand: A Case Study of Ethanol as a Diesel Substitute in Thailand

Catalog (Country) (14)

Country	Participating Institution	Model	Modeling Studies
Thailand	Department of Mechanical Engineering, King Mongkut's University of Technology Thonburi (KMUTT), Bangkok, Thailand ; Bioenergy Laboratory, National Metal and Materials Technology Center (MTEC), Pathumthani, Thailand; The Joint Graduate School of Energy and Environment (JGSEE) King Mongkut's University of Technology Thonburi, Bangkok, Thailand; College of Integrated Science and Technology (CISAT), Rajamangala University of Technology Lanna (RMUTL), Chiang Mai, Thailand	LEAP	➢ Construction of Energy Demand Model in Thai Transportation Sector: A Case Study for Ethanol as Diesel Substitute
	Royal Institute of Technology Stockholm, Sweden	LEAP	➢ Energy Analysis for Sustainable Mega-Cities

Catalog (Country) (15)

Country	Participating Institution	Model	Modeling Studies
Thailand	Centre for Environmental Strategy, University of Surrey, Guildford, GU2 7XH, UK	LEAP	➢ Power sector scenarios for Thailand: An exploratory analysis 2002–2022
	Energy Research institute, Chulalongkorn University; Electrical Department, Faculty of Engineering, Chulalongkorn University	LEAP	➢ The Outlook of Energy-related GHG emission in Thailand
	Thammasat University	AIM	➢ Thailand national study using coupled CGE and enduse model and applying Thailand NAMA
	The Joint Graduate School of Energy and Environment, King Mongkut's University of Technology Thon Buri, Thailand, and Sirindhorn International Institute of Technology (SIIT), Thammasat University, Klong Luang, Pathumthani, Thailand	LEAP	➢ Scenario-Based Assessment of Energy Savings in Thailand: A Long-range Energy Alternative Planning Approach ➢ Land Transport Demand Analysis and Energy Saving Potentials in Thailand ➢ Assessment of Energy Saving Potential in the Thai Residential Sector: Long-range Energy Alternatives Planning Approach

Catalog (Country) (16)

Country	Participating Institution	Model	Modeling Studies
Vietnam	Ministry of Industry, Vietnam	MARKAL	➢ The strategy orientation for electricity supply ➢ Analysis of power development strategies in compliance with environmental and energy security issues ➢ Energy pricing and its implication for energy efficiency and environment
	University of Technology, Sydney, Australia	MARKAL	➢ Analysis of future energy pathways for Vietnam
	Asian Institute of Technology, Thailand	AIM	➢ A study on effects of CO2 emission reduction targets in Vietnam
	Institute of Strategy and Policy on Natural Resources and Environment (ISPONRE); Institute of Meteorology, Hydrology and Environment; Ministry of Natural Resources and Environment	AIM	➢ Analysis of Vietnam energy related and AFOLU related GHG emission reduction
	Asian Institute of Technology, Thailand and University of Alberta, Edmonton, Alberta, Canada	LEAP	➢ Greenhouse gas mitigation potential of biomass energy technologies in Vietnam using the long range energy alternative planning system model

Catalog (Region) (1)

Region	Participating Institution	Model	Modeling Studies
ASEAN	Institutions in Brunei, Cambodia, Indonesia, Laos, Malaysia, Philippine, Singapore, Thailand	MARKAL	➢ Trans ASEAN energy network ➢ ASEAN energy market integration ➢ Policies and strategies toward energy trade and sustainable development in ASEAN
GMS	Asian Institute of Technology, Thailand	MARKAL	➢ Effects of hydropower development in Laos for the energy systems of Lao PDR and Thailand ➢ Effects of cross-border power trade between Laos and Thailand: Energy security and environmental implications ➢ Regional energy resource development and energy security under CO2 emission constraint in the greater Mekong sub-region countries (GMS)
ASIA	Musashino University, 3-3-3, Ariake, Koto-ku, Tokyo, 135-8181, Japan, National Institute for Environmental Studies, 16-2, Onogawa, Tsukuba, Ibaraki, 305-8506, Japan	AIM	➢ GHG emission scenarios in Asia and the world: The key technologies for significant reduction

Catalog (Region) (2)

Region	Participating Institution	Model	Modeling Studies
ASIA	National Institute for Environmental Studies, 16-2, Onogawa, Tsukuba, Ibaraki, 305-8506, Japan	AIM	➢ The Role of Asia in Mitigating Climate Change: Results from the Asia Modeling Exercise
GMS	SIIT, Thammasat University, Thailand	LEAP	➢ Renewable energy utilization and CO2 mitigation in the power sector: A case study in selected GMS countries ➢ Demand Side Management and CO2 Mitigation in Selected GMS Countries: The Household Sector
GMS	Integriertes Ressourcen Management (IRM-AG) , Vienna, Austria	MESSAGE	➢ Economics of energy integration: Application of MESSAGE model in the GMS

Evaluation of Selected Models (1)

Characteristic	MARKAL	AIM	MESSAGE	LEAP
Developer	IEA/ETSAP	National Institute Environmental Science (NIES)	International Atomic Energy Agency (IAEA)	Stockholm Environment Institute (SEI)
Home page	www.etsap.org	www-iam.nies.go.jp/aim/	www.iiasa.ac.at	www.energycommunity.org
Scope	Integrated energy and GHG scenarios	Integrated energy and GHG scenarios	Integrated energy and GHG scenarios	Integrated energy and GHG scenarios
Methodology - Model type - Solution algorithm	 Optimization Linear programming	 Optimization Linear programming	 Optimization Linear programming	 Accounting & spreadsheet Accounting
Geographic applicability	Local, national, regional, global	Local, national, regional, global	Local, national, regional, global	Local, national, regional, global
Data requirements	Medium-high	Medium-high	Medium-high	Low-medium

Evaluation of Selected Models (2)

Characteristic	MARKAL	AIM	MESSAGE	LEAP
Default data included	None	None	None	Database with costs, performance and emission factors (Inc. IPCC factors)
Time horizon	User controlled. Typically reporting for 5 or 10 year time period	User controlled. Typically reporting for 5 or 10 year time period	User controlled. Typically reporting for 5 or 10 year time period	User controlled. Annual results
Expertise required	High	High	High	Medium
Level of effort required	High	High	High	Low-Medium
Reporting capabilities	Basic	Basic	Basic	Advanced

Evaluation of Selected Models (3)

Characteristic	MARKAL	AIM	MESSAGE	LEAP
Data management capabilities	Basic	Basic	Basic	Advanced
Software requirements	Windows, GAMS, solver & interface	Windows, GAMS, solver & interface	Windows, GAMS, solver & interface	Windows
Software cost	$8,500-$15,000 (including GAMS, solver & interface)	Free	Free	Free to NGO, Govt. and researchers in non-OECD countries
Typical training required & cost	8 days, $30,000 - $40,000	n/a	n/a	On request: 5 days/$5,000. Also regular international workshops
Technical support & cost	Phone or email $10,000 for 80 hours	n/a	n/a	Phone, email or web forum. Free limited support.

Evaluation of Selected Models (4)

Characteristic	MARKAL	AIM	MESSAGE	LEAP
Reference materials	Manual available to registered users	Manual free on website	Manual free on website	Manual & training materials free on website
Languages	English	English	English	English, French, Spanish, Portuguese, Chinese
National database availability	Lack	Lack	Lack	Lack
Troubleshooting	Difficult	Very difficult	Very difficult	Easy
Clarity of manual	High	Medium	Low	High
Input data	We don't need to save several times	We don't need to save several times	Very tricky and we have to save several times otherwise the data is lost	We don't need to save several times

Evaluation of Selected Models (5)

Characteristic	MARKAL	AIM	MESSAGE	LEAP
Level of difficulty to master the models	Medium	High	High	Medium
Difficulty to get the model run	Medium	High	High	Low