



The ESMOPO project – MARKAL modelling of three ASEAN countries and the role of clean technologies

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General Information



- Source of funding: **Co-financed by the European Commission through EC-ASEAN Energy Facility (EAEF) Program**
- Project duration: **2005 - 2007**
- Countries under consideration: **Indonesia, Philippines and Vietnam**
- Partners:
 - Chalmers University of Technology (Project Co-ordinator), Sweden
 - Stockholm Environment Institute (SEI), Sweden
 - Department of Energy, Energy Policy and Planning Bureau (EPPB), Philippines,
 - Institute of Energy (IE), Vietnam,
 - Agency for the Assessment and Application of Technology (BPPT), Indonesia

Project Objectives

- **Identify country-wise sets of appropriate power generation technologies (main focus on renewable and advanced fossil ones) bringing economic and environmental benefits.**
- **Quantify the implications of using these technologies in terms of energy savings, fuel substitution, investment needs, pollution avoided etc.**

Project Objectives II

- **Identify the potential market in the ASEAN region for European energy industries and financial institutions.**
- **Develop appropriate institutional and policy frameworks**
 - **to enhance the use of the advanced technologies in the countries under consideration, and**
 - **to contribute to successful economic and technological cooperation between EU and ASEAN regions.**

Background

Indonesia, Philippines and Vietnam are

- developing countries with growing populations and strongly growing economies;
- countries with low per capita energy consumption but with enormous potential demand growth (9-15% annual growth in electricity demand);
- endowed with both renewable and fossil resources;
- countries with a total population approaching 400 million.

Background cont'd

The countries are under reference developments going from

- being energy exporters, or minor importers,
- to become major energy importers

Comparison I

		Indonesia	Philippines	Vietnam	Germany
Population	Million	220	81	82	82
GDP per capita	US\$2004(PPP)	3460	4890	2700	25000
Electricity consumption per capita	kWh	387	467	421	6700

Comparison II – efficiency of thermal power plants

Technology	Philippines	Vietnam	Indonesia
Coal	31-38%	25-38%	28-37%
Oil steam	30.0	29.8	37.0
Diesel	37.0	29.6	37.0
CCGT	50.0	48.1	40.0
Gas turbine		34.0	24.0
Biomass	23.0		36.2

European **coal super-critical** plants

Unit and country	Year	Output (MWe)	Net efficiency % LHV basis
Esbjerg 3, Denmark	1992	385	45
Meri Pori, Finland	1993	560	43.5
Rostock, Germany	1994	500	43
Nordjylland 3, Denmark	1998	385	47
Avedørevaerket 2(DK)	2002	400	46.8
Bexbach II(D)	2002	750	46

Source: Henderson 2003, Lako 2004

Methodology

Component 1: Modelling and scenario analysis

Component 2: Policy and institutional framework

Component 1:

- **Applies existing national energy models in MARKAL framework**
- **Main focus on the power sector**
- **Scenarios:**
 - **Business as Usual Scenario: continuing current trends in population, economy, technology and human behaviour.**
 - **Technology Scenario: Enhanced use of clean and advanced technologies (European technologies).**
 - **Time frame of the analysis: 2000-2030**

Scenarios (common to all countries)

Business-as-Usual scenario (BAU)

- **BAU-L (BAU-Low oil price case)**
- **BAU-H (BAU-High oil price case)**
- **Technology scenario**
 - **TECH-L (BAU-L+Technology database)**
 - **TECH-H (BAU-H+Technology database)**

Country specific scenarios

- Reduction in Primary energy consumption scenario - Vietnam and Indonesia
- Import reduction scenario - Philippines

Oil Price (2004US\$/barrel)

	IEA	WETO
2004	38	38
2010	35	43
2020	37	57
2030	39	71

Compound annual growth rate for population and GDP (%)

	2003-05	2005-10	2010-15	2015-20	2020-25	2025-30
Population						
Indonesia	1.64	1.42	1.26	1.04	1.00	1.00
Philippines	2.12	2.03	1.85	1.63	1.48	1.28
Vietnam	1.41	1.07	1.16	1.02	0.75	0.75
GDP						
Indonesia	6.0	6.1	6.5	6.5	6.5	6.5
Philippines	5.3	6.6	6.6	6.6	6.6	6.6
Vietnam	7.5	7.2	7	6.5	6.6	6.5

Some characteristics of the country models

- **Price inelastic useful (sometime final) energy demand by end-use sectors exogenous.**
- **Except Indonesia, models do not allow inter-fuel substitution in demand sectors.**
- **Partial equilibrium model (energy sector does not interact with the whole economy)**

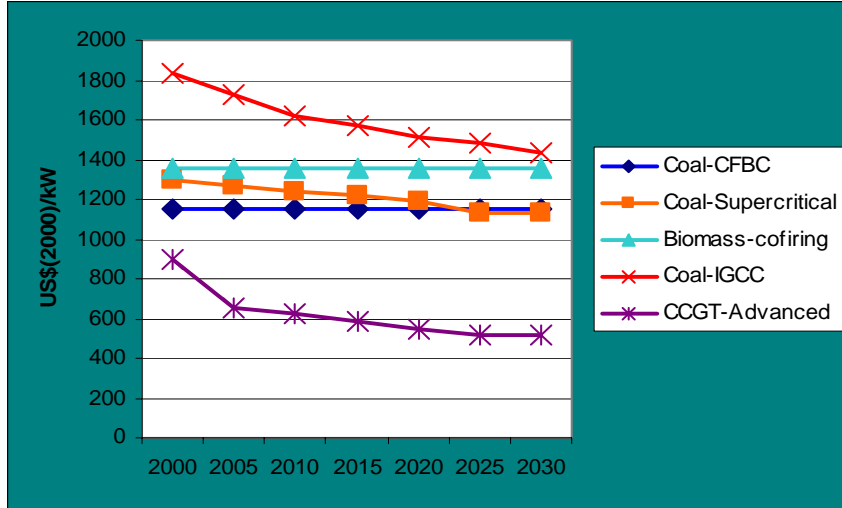
Development of technology database

- **Based on published literature and expert judgements (Experts include local and international (mainly European) equipment suppliers, power utilities, research institutions).**
- **Collection of data on their projected performance (techo-economic-environment) parameters.**

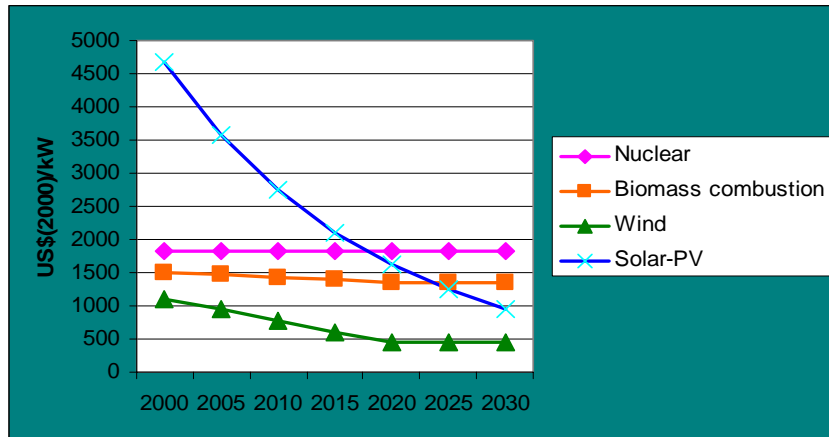
Technologies identified

- **Fossil technologies,**
 - Coal super critical,
 - Circulating fluidised bed combustion (CFBC)
 - Integrated Gasification Combined Cycle (IGCC)
 - Advanced gas combined cycle (GCC)
 - Biomass-cofiring (with coal)
- **Renewable sources,**
 - Wind-onshore
 - PV/solar thermal,
 - Micro/mini hydro, and
 - Biomass
- **Nuclear**

Capital cost development (advanced fossil technologies)



Capital cost development (nuclear and renewable technologies)



Thermal efficiency (%) development

	2010	2020	2030
Coal-supercritical	48	50	51
Coal-IGCC	50	54	55
CCGT-Adv	57	60	63
Biomass-combustion	30	30	30

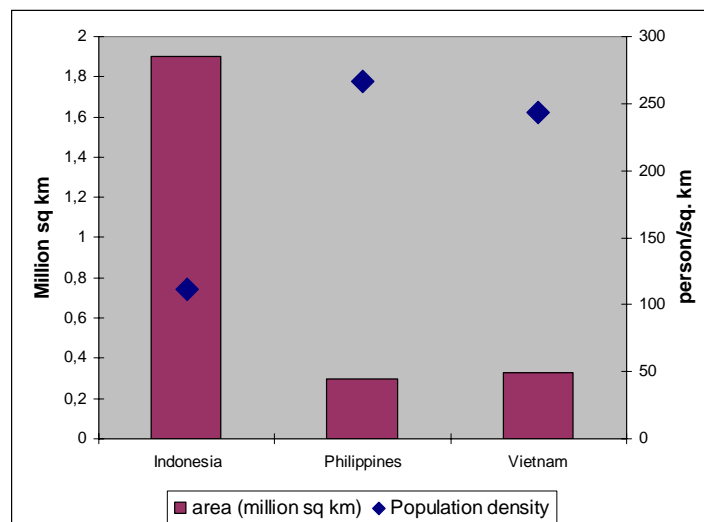
Expected outputs

- **Improved country modelling framework and technology database**
- **Country-specific appropriate renewable and advanced fossil technology portfolios for power generation**
- **Implications on energy system (cost, fuel consumption, substitution) due to the penetration of renewable, advanced fossil and nuclear technologies,**
- **GHG emissions, mitigation potentials and costs**
- **(Policy and institutional framework needed to enhance the penetration of these technologies and to make successful technological and economic cooperation between two regions)**

Caveats while interpreting the results

- Results are sensitive to the techno-economic assumptions.
- €\$ exchange rate which was erratic particularly during 2000-03 has some influence on cost data and hence the results.
- Price impact on energy demand has not been considered.
- Costs related to technology transfer are not modelled

Area and population density



Renewable energy potentials

Resource type	Unit	Indonesia	Philippines	Vietnam
Hydro potential				
<i>Theoretical potential</i>	TWh	2150	na	300
<i>Technical potential</i>	TWh	400	na	
<i>Economic potential</i>	TWh	40	na	80
Biomass potential	mt	32,4	18,1	12,6
Geothermal	MW	20000	4790	na
Small hydro	MW	712	1286	800-1400
Wind	MW	448	70000	160000

Source: hydro potential: WEC survey of Energy resources 2001

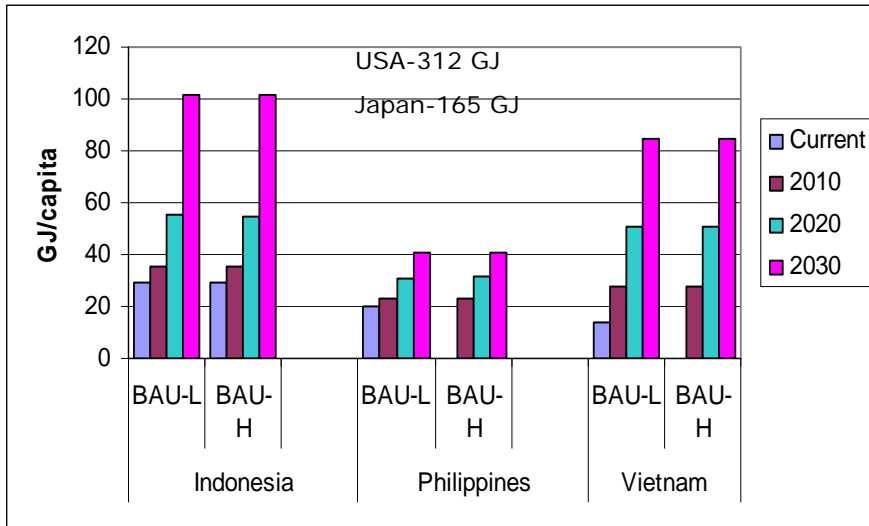
Biomass: Indonesia and Philippines - WEC Survey of Energy resources 2001
Vietnam - Biomass for electricity generation in Vietnam, Nguyen D C(2004)

Geothermal: Indonesia - WEC survey of energy resources 2001
Philippines - DOE, Philippines

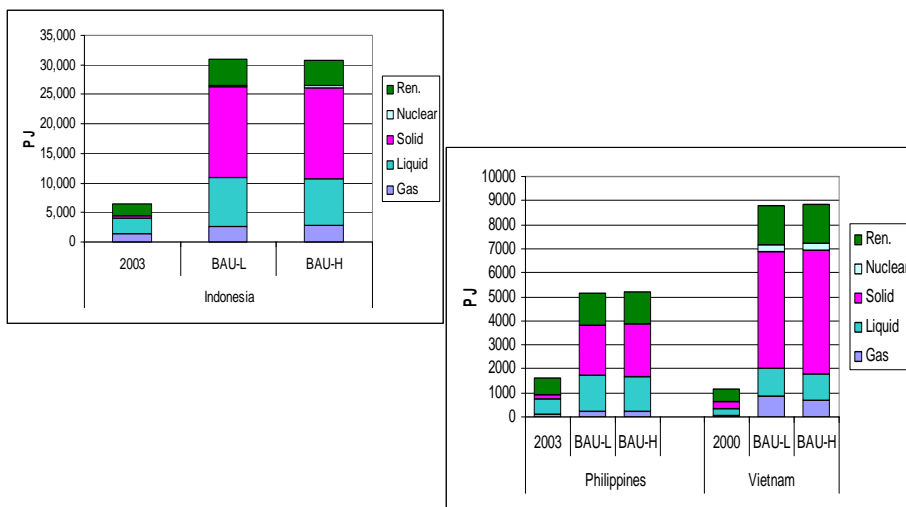
Wind: Indonesia- ACE-ICRA,
Philippines-EIA website
Vietnam-Nguyen (2005)

Results – BAU scenarios

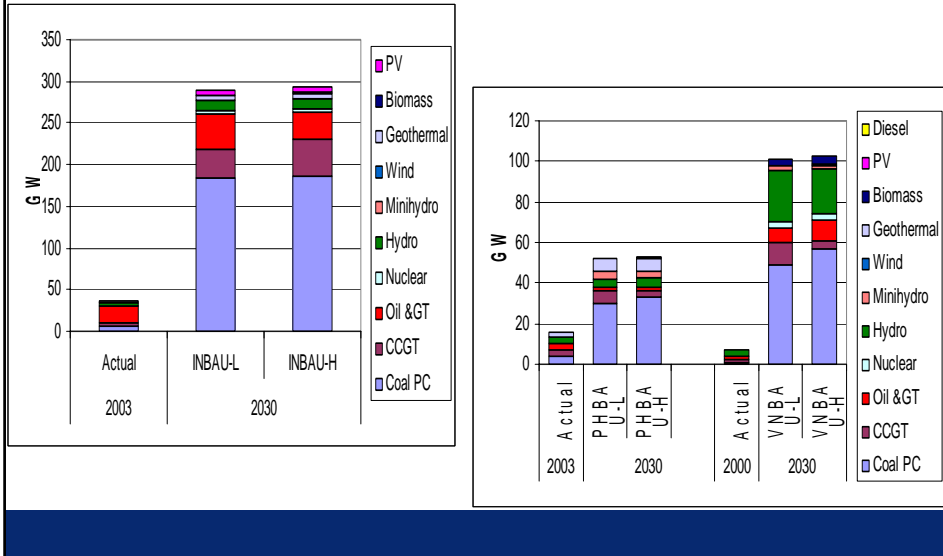
Per capita energy consumption



Primary energy mix 2003 and 2030



Power generation capacity

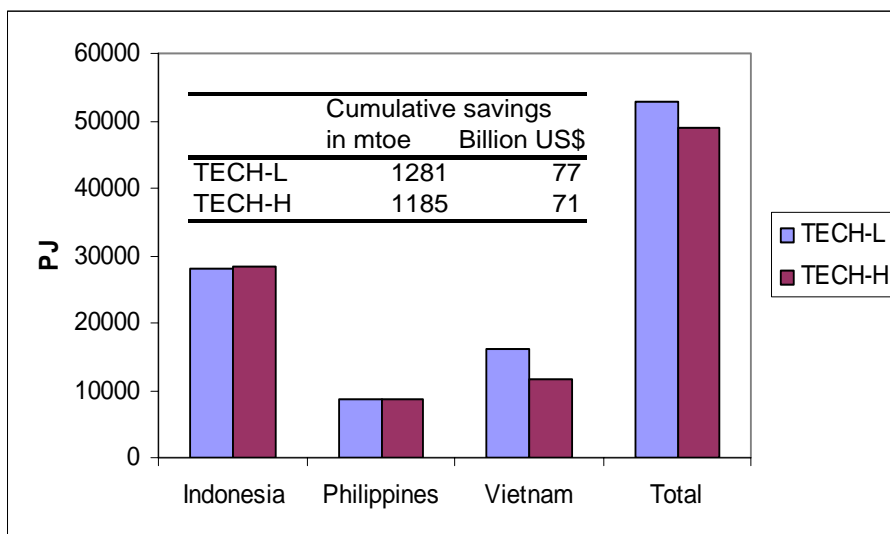


Size of the power market (2000-30) in terms of additional capacity requirements

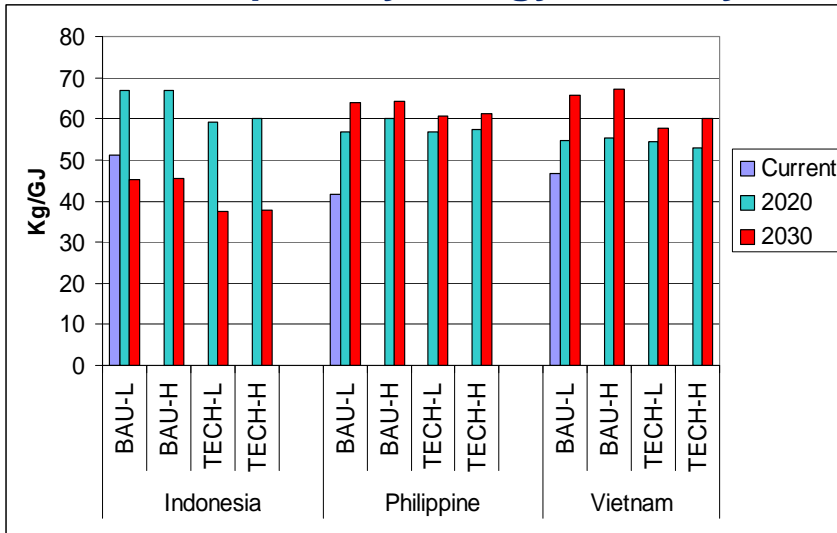
- **Indonesia- 256 GW**
- **Philippines- 36 GW**
- **Vietnam-95 GW**

Results – Tech scenarios

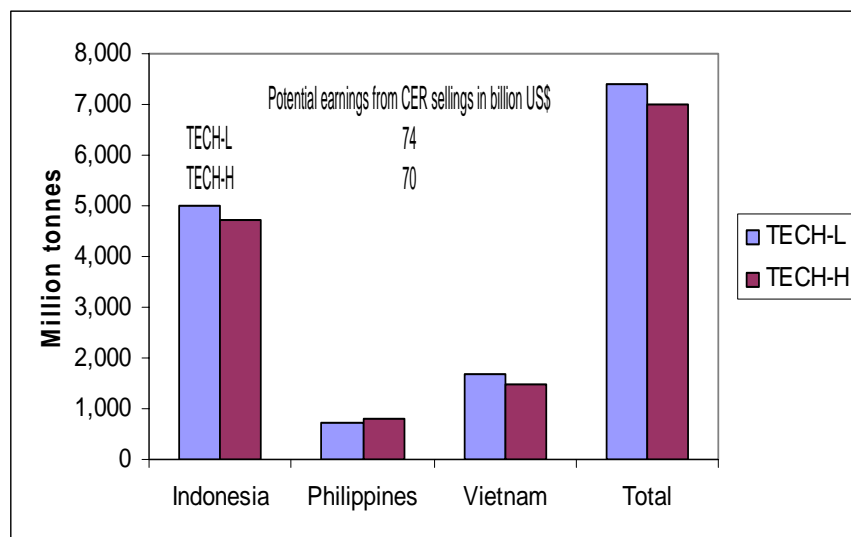
Cumulative energy savings in three countries



CO2-primary energy intensity



Cumulative CO2 reduction potentials



 Priority clean and advanced technologies by country

Technology	Indonesia	Philippines	Vietnam
Coal	CFBC	Coal-super critical	Coal super critical, CFBC
Natural gas	CCGT-Adv	CCGT-Adv	CCGT-Adv
Nuclear	Nuclear	Nuclear	Nuclear
Renewables	PV, Biomass	Biomass, wind	Wind, Biomass, Solar PV

Issues

- **How is the CO₂ potential captured?**
- **What role can CDM play?**
- **Co-benefits?**

Thank you

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