ENERGY AND POWER BASELINE

MRC SEA for Hydropower on the Mekong Mainstream

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On behalf of SEA Team

Overview

1. Baseline Context
2. Drivers and Policies
3. Past Trends: Demand and Supply
4. Projected Trends: Demand and Supply
5. Current hydroelectric use and LMB potential
6. Initial Baseline Conclusions

All From a Power Sector Perspective

1. Baseline Context – power perspective

Where is accelerated interest in hydropower coming from?

A. Expanding the role of electricity in Mekong society & the economy:

- Meeting high electricity demand growth:
  - e.g. for underpinning and boosting growth,
  - diversifying the economy,
  - population expansion,
  - urbanization trend and "energy poverty"
- Recognition demand-side management is critical, but supply-side expansion is needed
- Power sector role in regional economic integration, cross-border power trade to reduce investment and operating costs overall

Where is accelerated interest in hydropower coming from? Cont.

B. Optimizing the role of hydropower in development nationally and the GMS region:

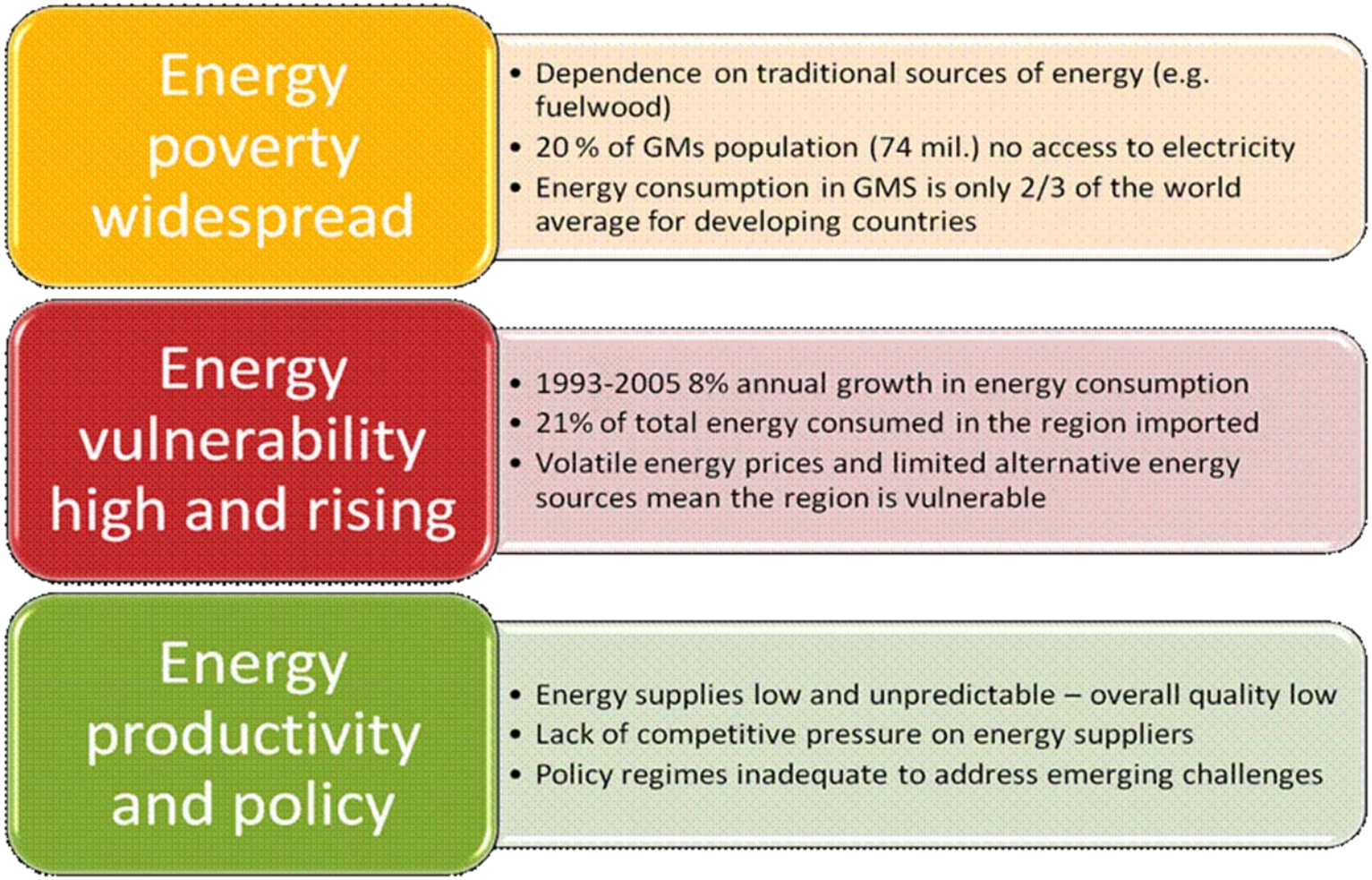
- Maximizing indigenous, renewable resource (at different scales)
- Importing countries: supply diversity – e.g. conventional hydrocarbons (natural gas, coal and oil) are finite and international energy market prices are volatile
- Exporting Countries - Foreign investment (FDI) upwards of $US 24 Billion and revenue generation opportunities

Where is accelerated interest in hydropower coming from? Cont.

C. Other Factors

- Net Exporting countries:
  - Current policies and regulatory frameworks to attract FDI to power sector
  - Private sector / investor response to date (high)
- Net Importing countries:
  - Avoiding hydrocarbon (gas, coal and oil) generation, reduce operating costs (fuel)
  - GHG emission reduction (reducing fossil fuel use)
  - Capacity benefit and power system operation benefits unique to hydropower (voltage stability, ancillary benefits)
- All countries:
  - Realizing opportunities for development synergies in other sectors, e.g. irrigation and navigation
  - Concerns of future electricity price stability

Wider regional energy picture (GMS)



Source: Building a sustainable energy future the GMS, ADB 2009

Electricity consumption in LMB / GMS

relative to other countries + UN Human Development Index

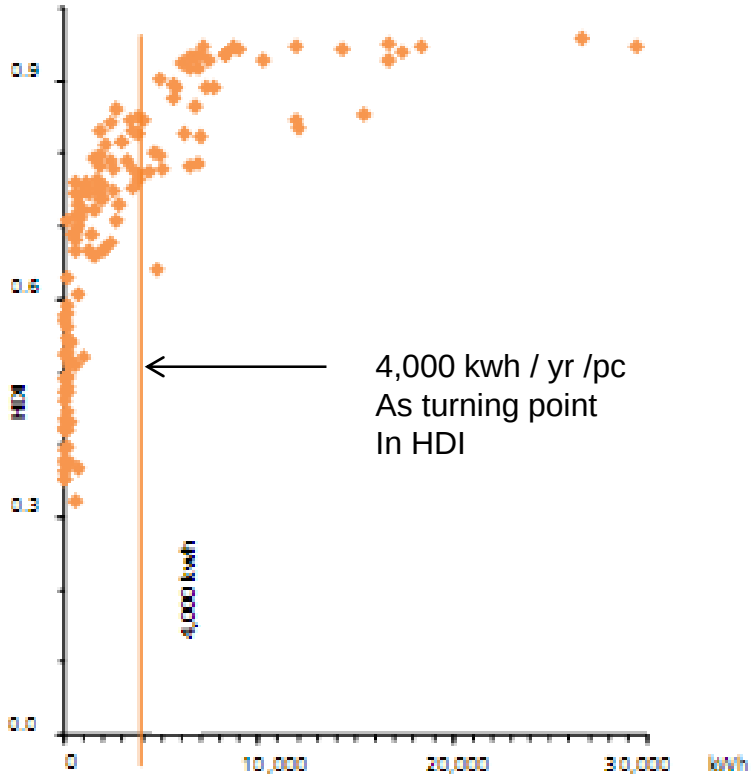
Per Capital Electricity Use

Economy	Kilowatt-hour(kWh)
Cambodia	56
PRC	1,684
Guangxi	1,100
Yunnan	1,252
Lao PDR	187
Myanmar	78
Thailand	1,950
Viet Nam	573
World	2,701
Developing Countries	1,221
OECD	8,795
United States	14,240

Lao PDR = Lao People's Democratic Republic, OECD = Organisation for Economic Co-operation and Development, PRC = People's Republic of China.

Sources: United Nations Development Programme (UNDP). 2007. 2007. *Human Development Report 2007/2008*; National Bureau of Statistics. 2006. *China Energy Statistical Yearbook 2006* (Source of Guangxi and Yunnan data.)

UN Human Development index + Per Capital Electricity Use (2005)



Per capita electricity use

Source: Building Sustainable energy futures in the GMS, AI

kWh = kilowatt-hour.

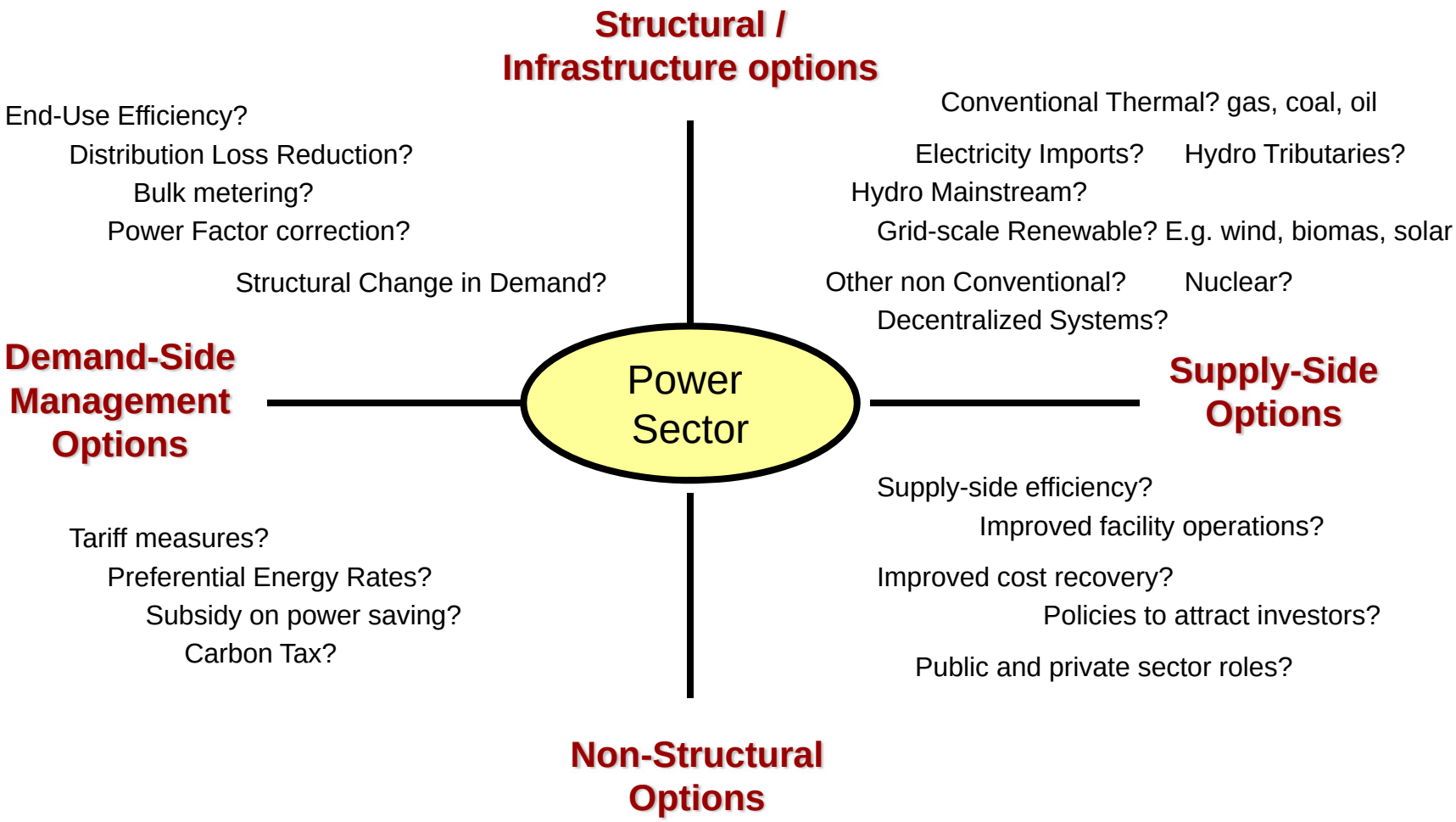
Source: United Nations Development Programme (UNDP). 2007. *Human Development Report 2007/2008 Fighting climate change: Human solidarity in a*

Significant differences in urbanization and household electricity consumption in LMB

Country	Urbanization Ratio	Per capita household consumption (KWh)	Electrification Ratio (%)
Cambodia	17%	29	Less than 20%
Lao PDR	21%	95	60% - 2008 Goal 90% -2020
Thailand	33%	409	+95%
Vietnam	27%	242	+85%

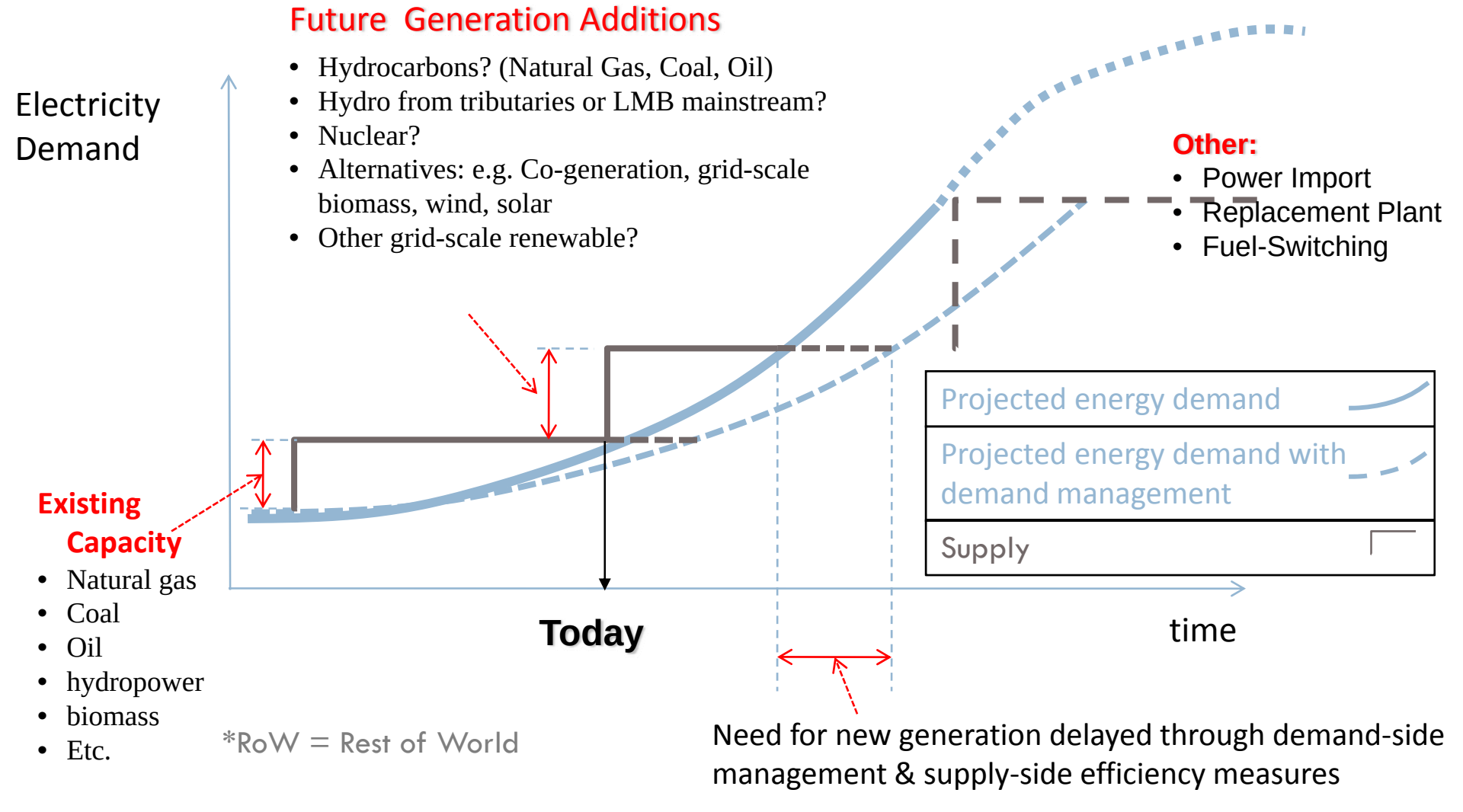
Source: Building a sustainable energy future the GMS, ADB, 2009

Balancing Demand and Supply Options - at all Scales - an aspiration in energy policies



What this means?

For Grid Based Generation Expansion with Demand-Side Management



SEA Objective – Energy and Power Theme

- **Identify** likely net economic benefits of proposed mainstream projects and contribution to the economies of LMB countries.
- **Factor** the net power benefits into the assessment of opportunities and risks for other development sectors, groups (distribution analysis).
- **Understand** the overall economic and financial viability and basis for mitigation of negative impacts for fair distribution of net benefits.

PROJECT NET ECONOMIC BENEFIT – power perspective integrated with full SEA Analysis

PROJECT COST	Export Country	Import Country	
POWER BENEFITS	Export Country	Import Country	
OTHER BENEFITS	Export Country	Import Country	Other LMB Countries
NEGATIVE IMPACTS	Export Country	Import Country	Other LMB Countries

NET ECONOMIC BENEFITS AND THEIR DISTRIBUTION

Positive - Opportunities **Negative - Risks**

Feeds into SEA Distribution Analysis (Sectors, groups)

2. Drivers and Policies

Hydropower & LMB Mainstream proposals in particular

National to GMS Regional Levels

Defined by

1. Overarching National Energy Policies and Regulatory systems attracting FDI to power sector
2. National Power Development Plans (PDPs)
3. **Bilateral Power Trade Agreements**
4. Inter-Governmental Agreement on Power Trade in The Greater Mekong sub-Region (2003)

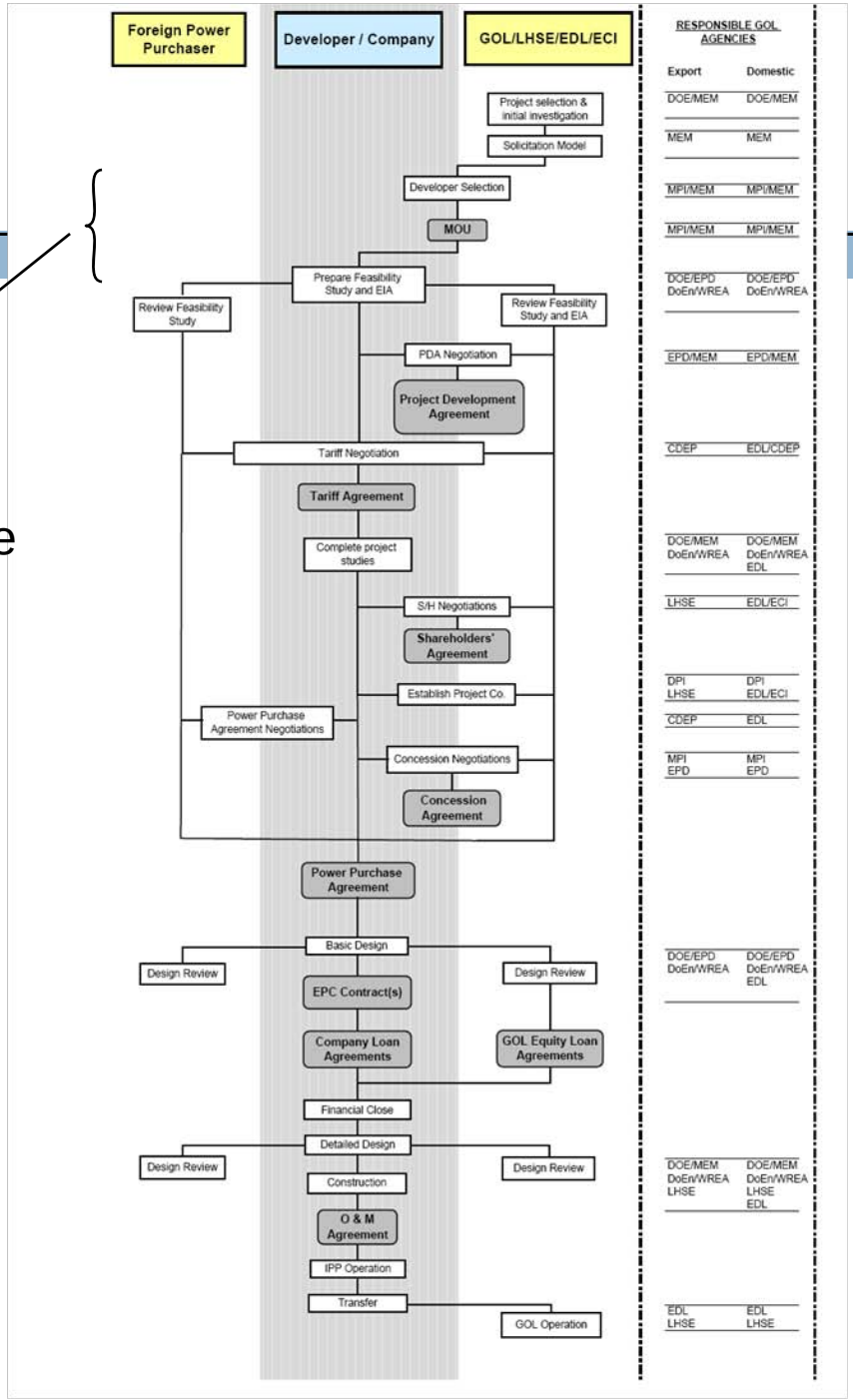
National Regulatory Systems

Illustration of Lao PDR

Most mainstream proposals are here in the regulatory system

- MOUs / LOAs
- feasibility study and EIAs /SIAs

- For tributary &
- Mainstream dams



National Drivers and Policies (I)
Cambodia (as a potential net exporter)

- National Power Demand/Supply Situation
  - More than 20 unconnected load centres throughout the country, no national power grid
  - Low levels of electricity access outside towns
  - 95% of electric power generated through diesel
  - Highest electricity prices in the region (17 – 27 US Cents/kWh)
- National policy targets:
  - adequate electricity supply at reasonable and affordable prices,
  - promote development and national economy,
  - minimize environmental effects
  - Electrification targets 20% >

Cambodia – interest in LMB mainstream LMB hydropower

Main Factors – Opportunity for:

- Revenue from power export
- Secure a portion of electricity generation from mainstream projects for domestic power needs (may significant relative to current supply and cost)
- Have a large renewable power source after concession term expires (to decide for export or domestic supply)

National Drivers and Policies II
Lao PDR (as a net exporter)

- National Power Situation
  - 4 isolated power grids, plans for interconnection
  - Installed capacity 692 MW + 1,088 MW (NT2), 98% hydropower

- National policy targets:
  - Expand electricity network -> 90% electrification by 2020 (60% in 2008)
  - Increase government revenues from IPP export investments
  - Promoting 500 kV grid development within GMS for power system integration
  - Renewable energy (bio-fuel and hydropower focus)

Lao PDR – interest in LMB mainstream LMB hydropower

- MoUs for power export (e.g.)
  - 7,000 MW with Thailand – potentially including LMB
  - 5,000 MW with Vietnam – potentially including LMB
- Revenue from power export
- Portion of generation from projects for domestic power needs (FDI in other sectors e.g. mining)
- Power source after concession term expires (to decide for export or domestic supply)

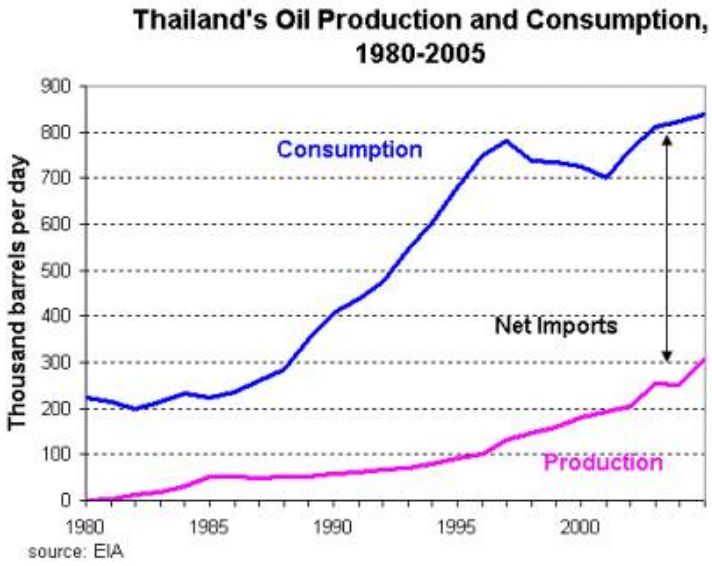
National Drivers and Policies III
Thailand (as an importer)

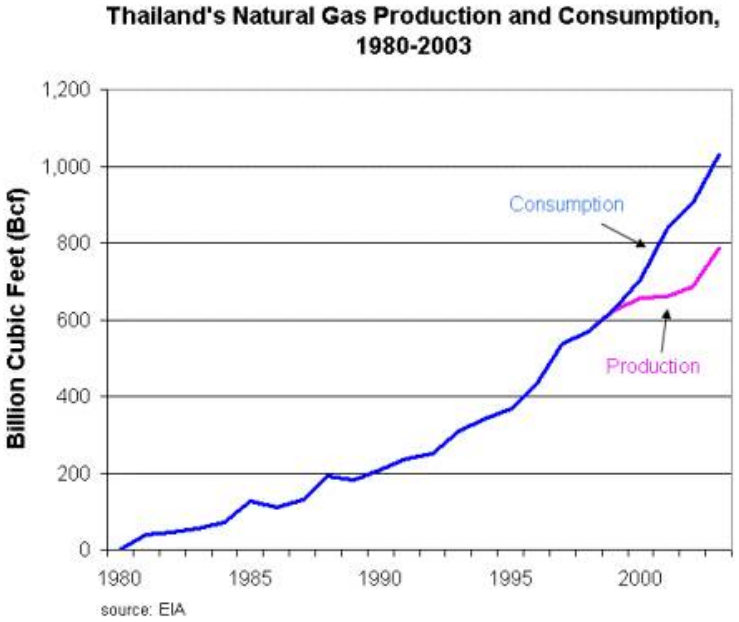
- National Power Demand/Supply situation
  - relies heavily on natural gas → dependent on world market prices to extent Thai gas price calculations are indexed to average oil prices
  - Electricity demand growth strongly linked to GDP
  - +5-6% 2010-2025 in PDP 2007 Revison2 in 2009 (Contested forecasts)

- National policy targets:
  - Energy security and independence,
  - affordable and stable power prices
  - Renewable energy targets

Thailand (Energy/Power) Import Dependence

- Significant level of power import dependency (peak power and for gas generation)
- Imported Natural gas for power from Myanmar (other prospects)
- although domestic natural gas production has risen steadily in recent years, it is still not enough to keep up with the growth in domestic consumption. Proven reserves will deplete in 10-12 years.





Thailand – interest in LMB mainstream LMB hydropower

- MoU with Lao PDR for 7,000 MW – may encompass LMB projects (hydropower and lignite coal in Lao)
  - Existing, Committed, Planned (5548 MW including Hongsa TPP)
- Power imports reduce use of gas (imports), primarily
- Mitigation of supply risk through diversification of generation mix and sources
- Thai interests as investors in LMB projects

National Drivers and Policies IV
Vietnam (as an importer)

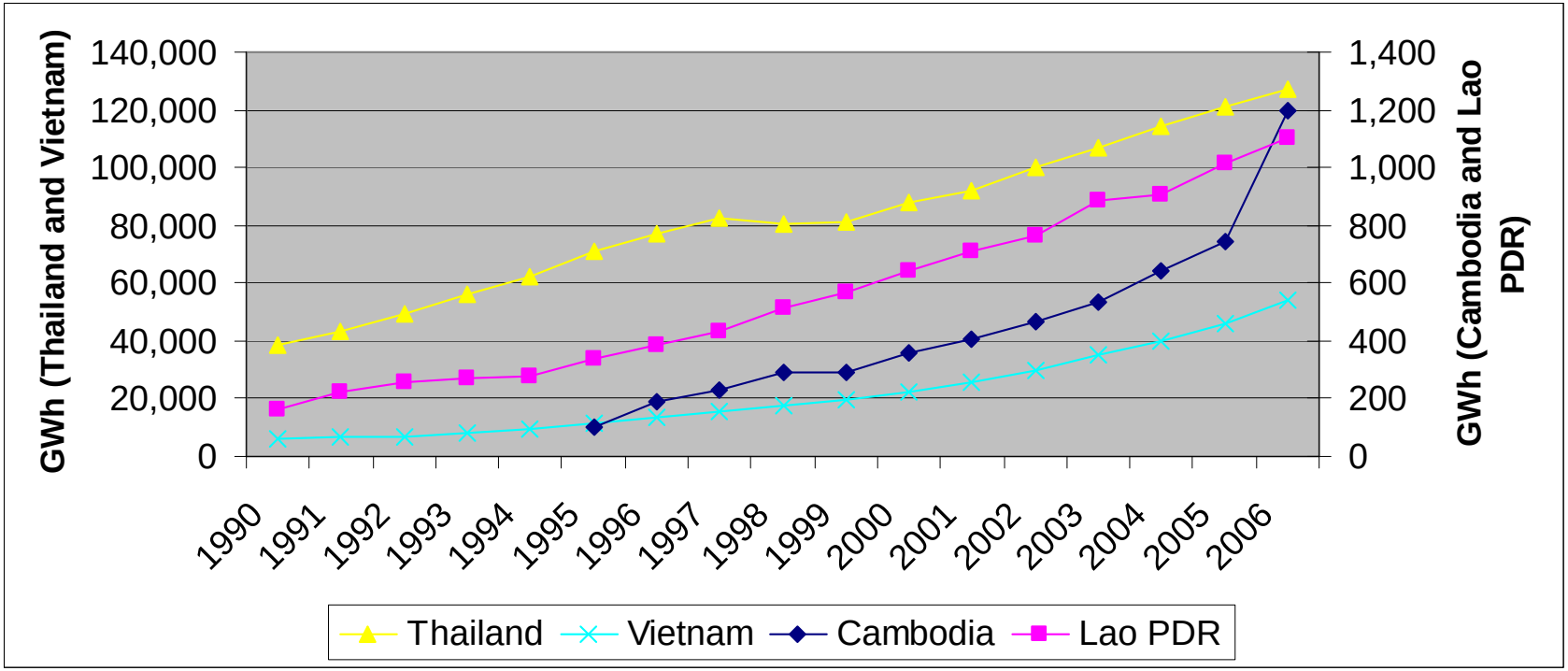
- National Power Demand / Supply Situation
  - Rapidly increasing power demand "dipped" in 2009 to single digit but has resumed 2008 average annual growth rates.
  - Power shortages, grid with high losses and limited capacity
  - Cost of unserved energy 500 $/MWh
  - Additional 21,000 MW planned from hydropower
  - Hydro capacity about 36% (MPVI).
  - Expected full national hydropower to be near fully developed by 2025 (large and medium scale)

- National policy targets:
  - Electrification by 2020
  - Power market reform programme stating with competitive generation markets (Stage 1 2010), privatised investment
  - Energy security and self sufficiency key (e.g. nuclear power decision)

Vietnam interest in mainstream LMB hydropower

- Part of Energy / Power Import Equation
  - Currently import from China (700 MW)
  - MoU with Lao PDR 5,000 MW
  - MP VI: imports to reach 4,800 MW by 2020 representing 7% of peak
  - 800 MW from Lao committed to date
  - VN Projected to start importing coal for power generation from 2014-2015 (national reserves are poor quality)
- Vietnam interests are investors in LMB project

3. Past Trends: Electricity Demand



Average Growth Rates:

Cambodia: 22%

Thailand: 8%

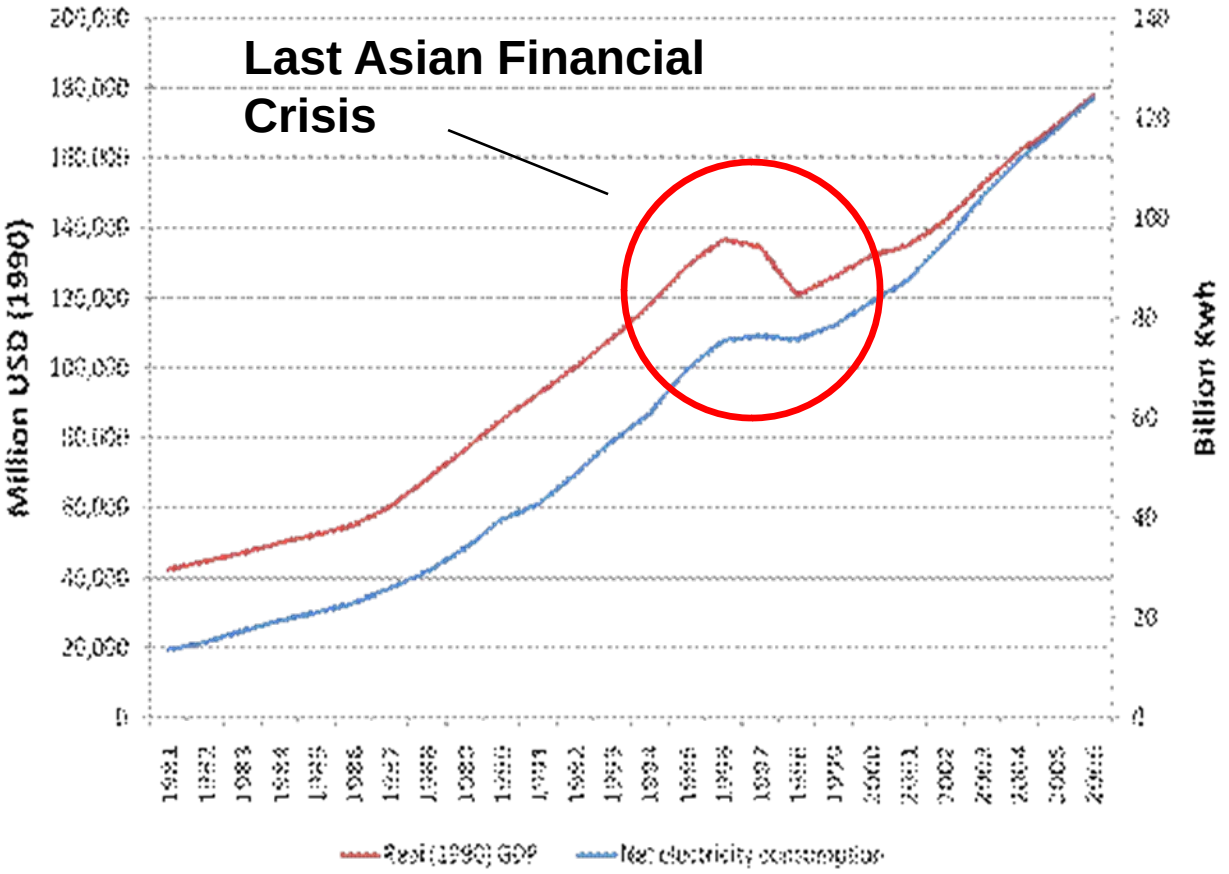
Lao PDR: 12%

Vietnam: 13.5%

Overall trend in GDP growth + electricity consumption remains correlated

Example:

Thailand growth of net electricity consumption and GDP 1982-2006



Growth + Electricity

No trend decoupling of overall energy consumption seen yet - as in OECD economies

4. Projected demand-supply trends

- Set out in National PDPs to 2025 - Generally
- ADB/ RETA 6640 on GMS Transmission Master Plan Update to bring together exploring advantages of integration / interconnection
  - Electricity Demand
  - Fuel Price Projections
  - Generation
  - Transmission interconnection

- Recognized that dynamic situation in demand and supply balance - mainstream LMB hydropower largely determined by bilateral MOUs that reflect “import policies”.

Earlier Demand Projections from RETA 6440

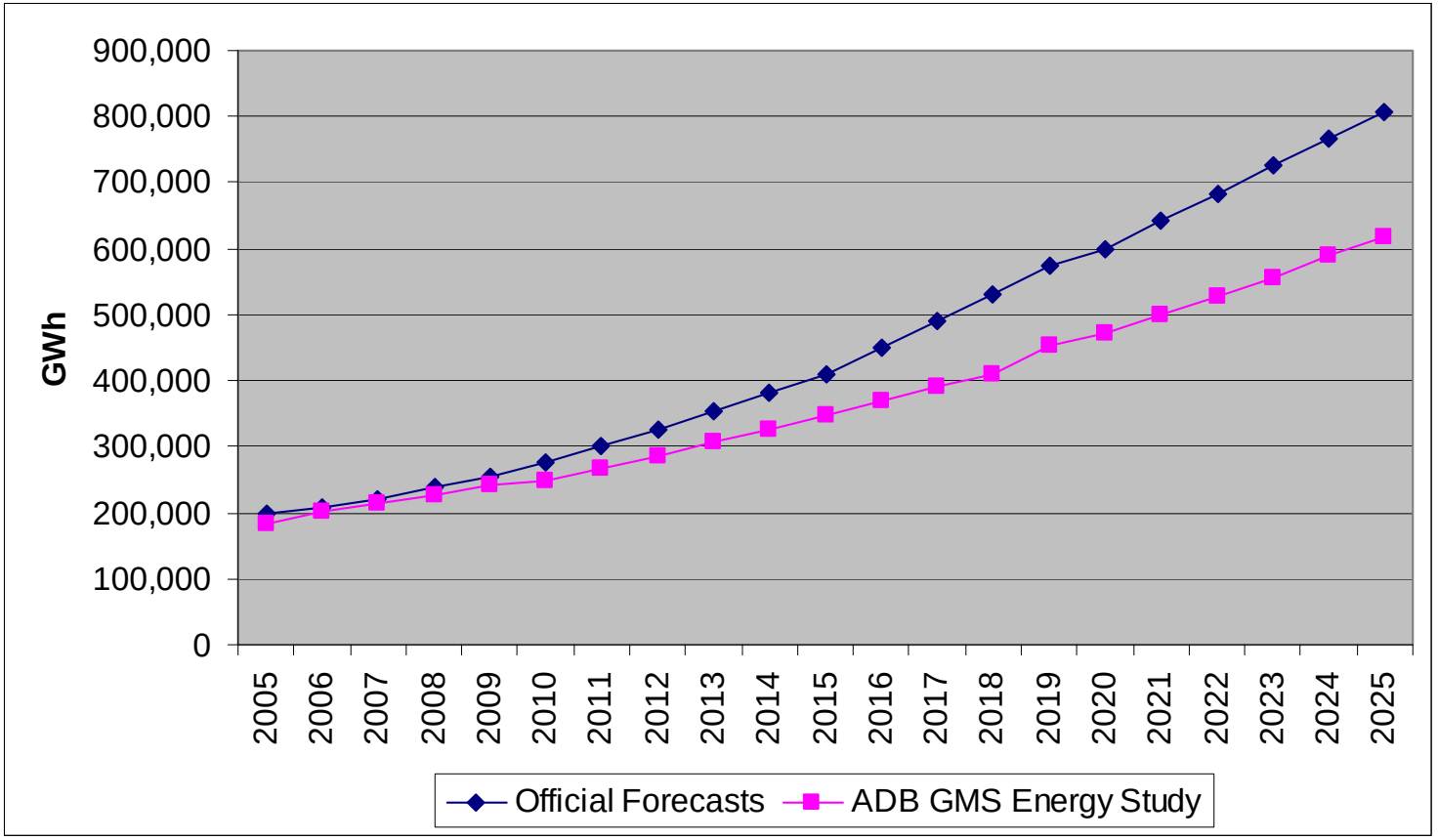
Regional power demand forecasts (MW)

Year	2005	2010	2015	2020	2025
MRC Member Countries					
Cambodia[1/]	302	467	1008	1610	N/A
Lao PDR[2/]	291	646	1,917	2,665	2,696
Thailand[3/]	20,538	23,936	31,734	42,024	N/A
Vietnam[4/]	9255	15,789	29,212	46,264	69,071
MRC Dialogue Partners					
China (Southern Power Grid)[5/]	69,590	114,300	N/A	N/A	N/A
Myanmar[6/]	966	1,573	2,533	3,897	5,595

Validation and discussions ongoing in the RETA Process

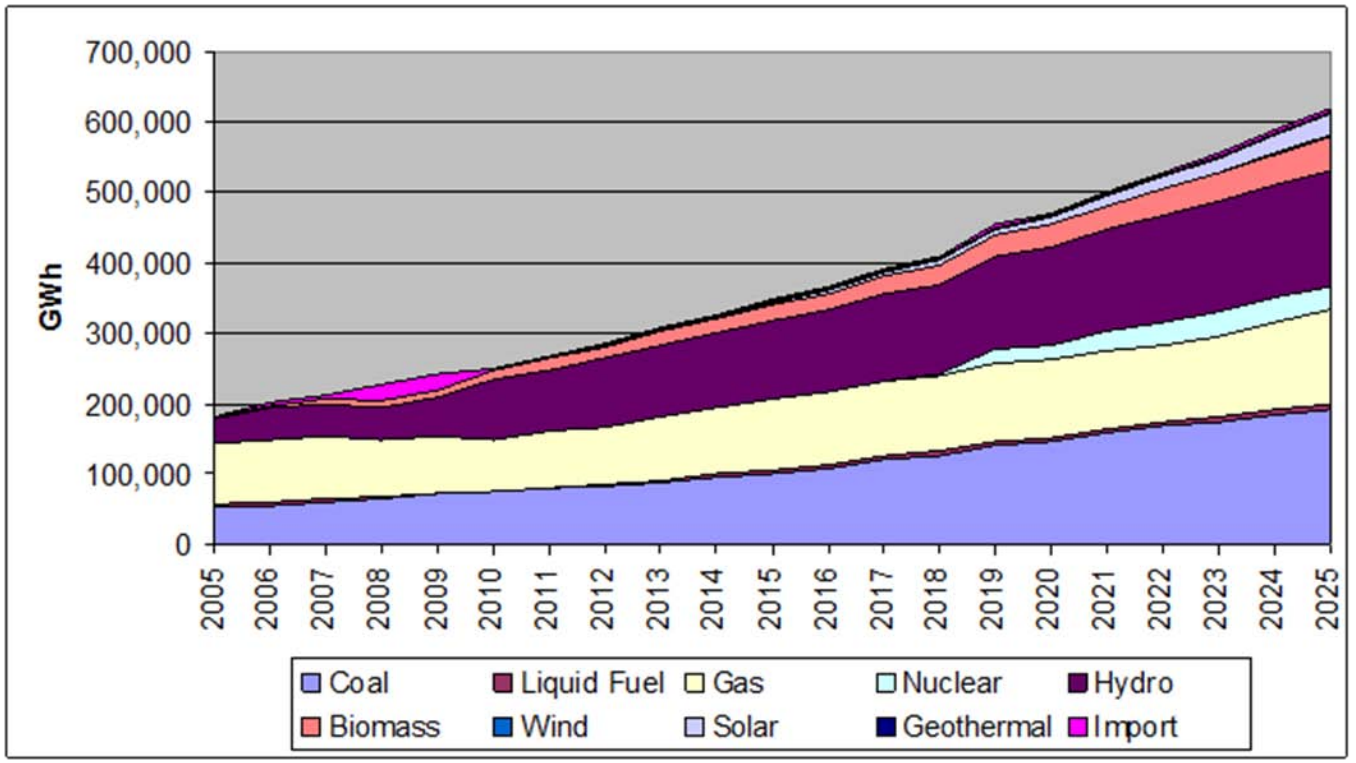
Future Electricity Demand Trends – GMS Level 2008 ADB Study

Forecasts estimate that power demand will triple of quadruple over 20 years…



Regional Energy mix – power generation

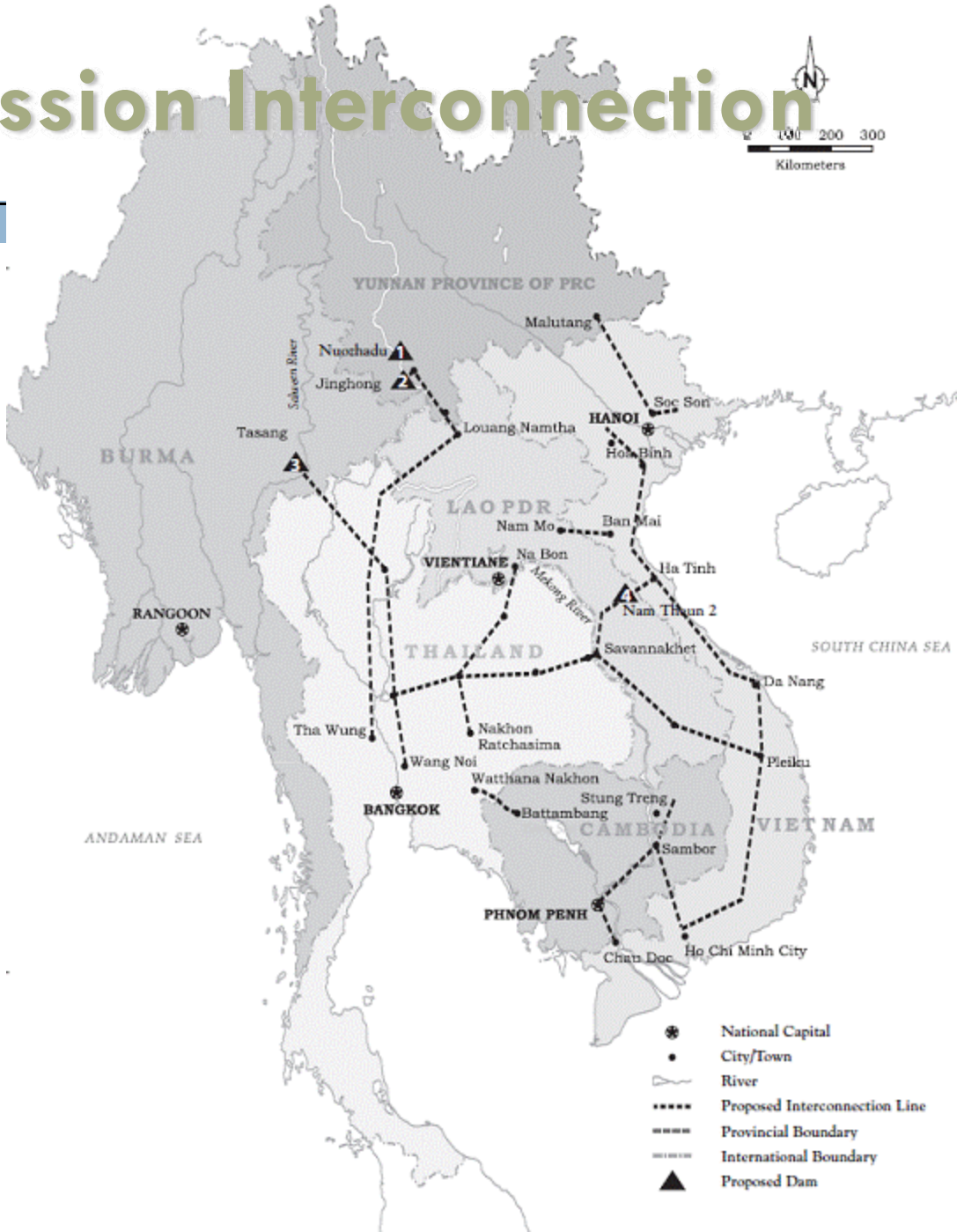
One view of the Future: According to an ADB scenario – integrated systems



Regional Transmission Interconnection

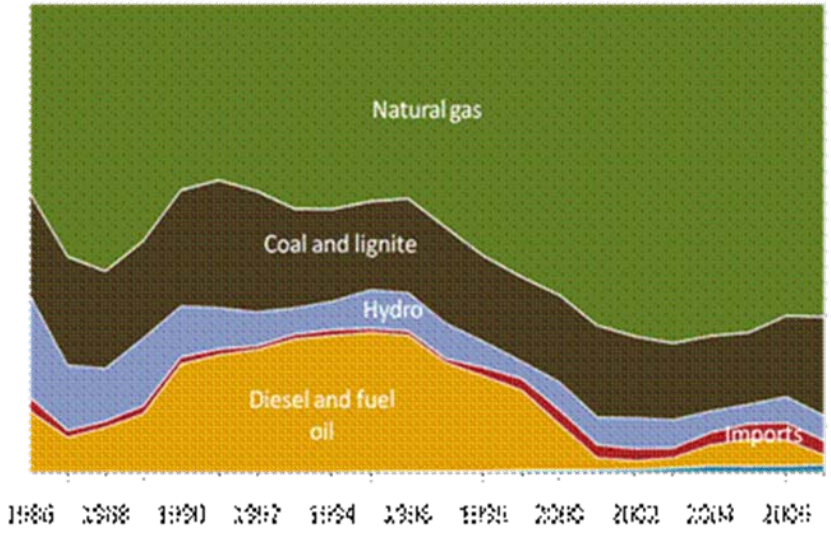
Regional power trade is planned:

- Transmission lines linking the power markets in the region
- Matching resources to demand, Better load management, etc.
- Specific interconnections for LMB mainstream dams
- Existing MOUs 37 GW



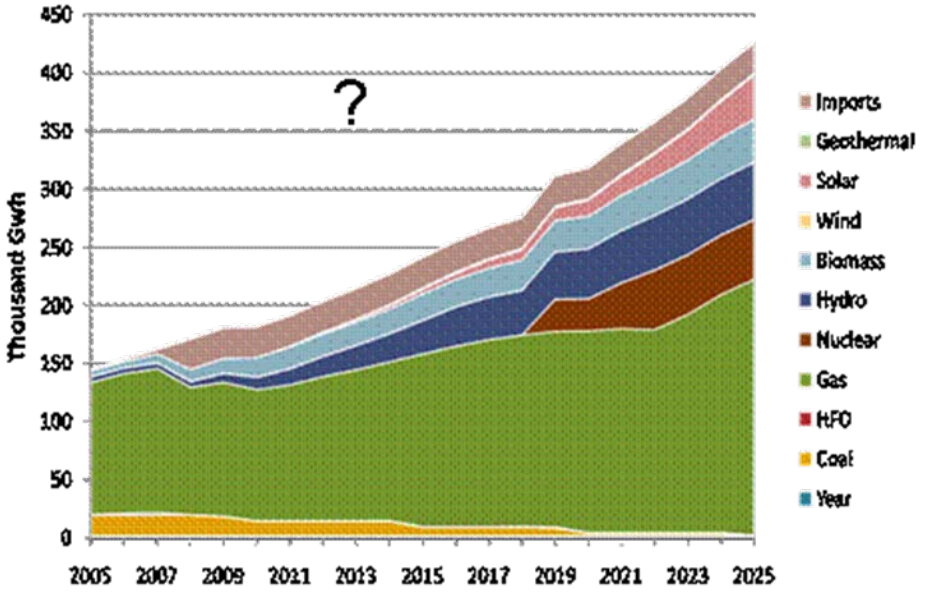
Thailand Electricity Generation by fuel type: Past and Future?

Actual 1986-2006



Source: EGAT (cited Draft Mekong River Basin Hydropower Sector Review in Thailand, 2009)

One Scenario 2005 – 2025 (ADB)



Source: Economics of energy integration , ADB, 2008 (base case)

Possible Discussion Points:

Policies and Trends:

- Power Import Policies?
- Fuel Specific Policies?

Power Development Plans (PDPs)

- ADB/GMS RETA 6440 Planning Update 2010-2025 is working with National PDPs
- Importing Countries:
  - Thailand advanced (PDP 2007 Revision)
  - Vietnam – details limited, demand growth high
- Other GMS Countries
  - PDPs are under various stages of refinement and validation (for detail and update to used in the GMS Master Plan

5. Current hydroelectric use and potential LMB

Capacity (MW):

Remaining Potential
- Tributary 23,300
- Mainstream 14,451

	MW				
	Existing	Definite Future	Potential	**TOTAL**	Mainstream
LAOS	2,778	3,495	17,412	**23,685**	10,171
CAMBODIA	1	1	5,589	**5,591**	4,280
VIETNAM	2,269	2,284	299	**4,852**	0
THAILAND	244	244	0	**487**	0
TOTAL	**5,292**	**6,023**	**23,300**	**34,615**	**14,451**

Energy (GWH):

Remaining Potential
- Tributary 106,515
- Mainstream 64,172

	MEAN ANNUAL ENERGY GWH				
	Existing	Definite Future	Potential	**TOTAL**	Mainstream
LAOS	13,020	16,403	78,153	**107,576**	44,432
CAMBODIA	3	3	27,125	**27,131**	19,740
VIETNAM	10,759	10,879	1,238	**22,876**	0
THAILAND	530	530	0	**1,060**	0
TOTAL	**24,312**	**27,815**	**106,515**	**158,643**	**64,172**

135 Projects currently identified in the MRCS – Hydropower Data Base

Baseline: Remaining LMB GWh Potential

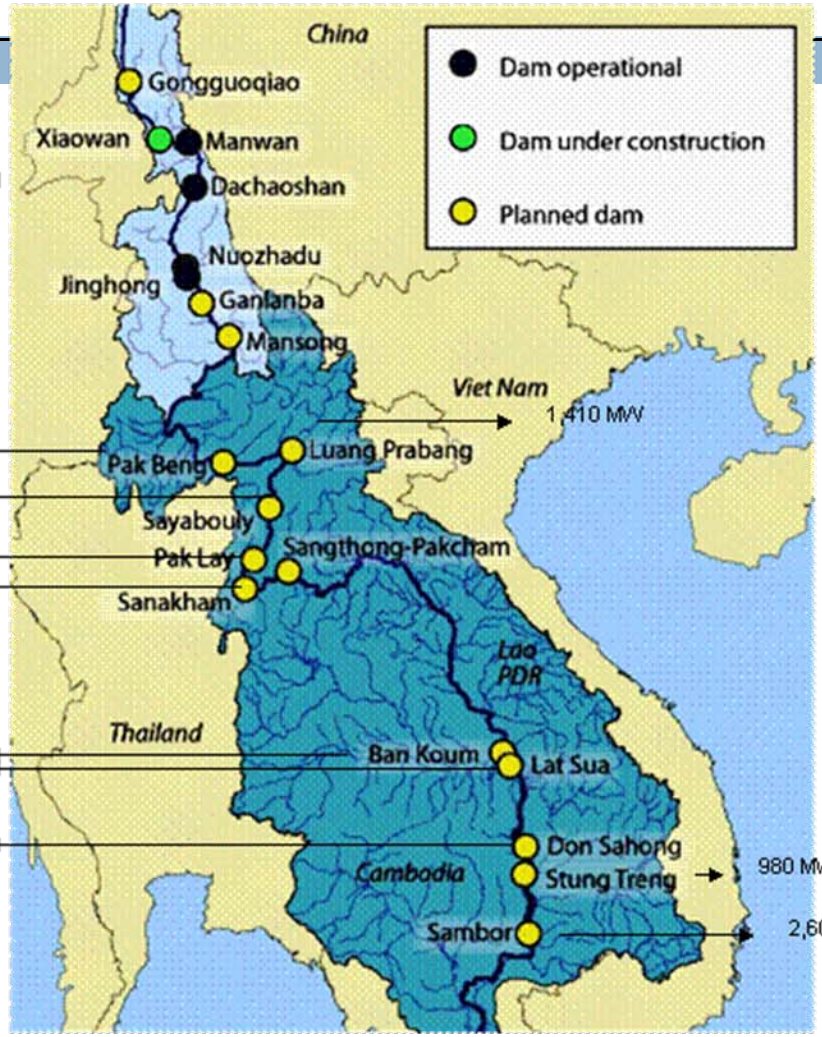
For Energy GWH/year only

Over 60% of remaining potential is tributary

	Tributary	% Total	Maistream	% Total	Total For LMB
LAOS	78,153	45.8%	44,432	26.0%	122,585
CAMBODIA	27,125	15.9%	19,740	11.6%	46,865
VIETNAM	1,238	0.7%	0	0.0%	1,238
THAILAND	0	0.0%	0	0.0%	0
TOTAL	**106,515**	62.4%	**64,172**	37.6%	170,688

Propose Markets for Mainstream Dams

Installed Capacities (MW)
subject to change



PRC

8 in operation, under construction and planned, total 14,600 MW

Myanmar

- No mainstream projects proposed

Viet Nam

Luang Prabang	1,410 MW
Sambor	2,600 MW
Stung Treng	800 MW

Thailand

Pak Beng	1,230 MW
Xayabori	1,260 MW
Pak Lay	1,300 MW
Sanakham	1,200 MW
Ban Khoum	1,827 MW
Lat Sua	800 MW
Don Sahong	360 MW

Lao & Cambodia

- A proportion of generation for domestic power expansion
- Units from schemes, subject to agreements

7. Initial Baseline Conclusions

- From the power perspective (policies + trends)

1. Opportunities for economic and financial viability of mainstream dams has increased due to a combination of factors, notably:
   - Higher low flow from upstream dams in Yunnan PRC, and
   - Upward pressure on the marginal cost of grid-based generation in importing countries (local fuel prices to international prices).
2. Mainstream proposals (i.e. whether the PNPCA is triggered, when, and for what number of projects) largely depends on interest in Thailand and Vietnam (the buyers) in:
   - Maximum acceptable quantum of power import
   - Power economics and other issues such as supply-side diversification, and
   - Continued interest of Cambodia and Lao PDR in foreign exchange earnings from power exports - relative to other development costs.

Initial Baseline Conclusions, cont.

3. Existing Bilateral MOUs for cross-boarder power trade signal the level of interest (of Thailand and Vietnam) on the acceptable quantum of power import - present day.
4. Exports/Imports under existing bilateral MOUs could conceivably be met by power from different sources:
   - tributary or mainstream hydropower
   - or non-power generation (e.g. Hongsa lignite coal Lao>Thailand).
5. There is complementary interest in the FDI represented by mainstream dams:
   - Lao and Cambodia as FDI recipients
   - Other GMS countries as investors, including contractors, suppliers of equipment, goods and services.

Initial Baseline Conclusions, cont.

6. There are strongly divergent views on future electricity demand growth and demand-side management in Thailand and Vietnam (as importers).
7. At the same time, substantial addition of generation on the grid is anticipated in the medium to longer term.
8. All Member States advocate increasing the amount of indigenous renewable energy and cleaner fuels in the electricity supply mix;
9. National policies aim to increase electrification rates and grid connection especially in Cambodia and Lao PDR.
10. It is important to understand the role of power from mainstream dams in meeting urban and rural needs, and over what timeframe.

Suggested questions to participants – Baseline related

1. Are the initial conclusions valid? What changes are suggested?
2. Is the United Nations HDI of 4,000 Kwh/yr/ pc applicable in the Mekong region? Realistic?
3. What alternative non-hydrocarbon sources in the region can replace the quantum of generation by proposed LMB mainstream dams (65,000 GWH)?
4. To what extant are small scale renewable electric sources appropriate for grid power vs decentralized? Do they compete with or complement grid power for rural needs?
5. What trends influence acceptable levels of power import for Thailand and Vietnam power systems?