ENERGY AND POWER IMPACT
(opportunities and risks)

MRC SEA for Hydropower on the Mekong Mainstream

MRCS Initiative on Sustainable Hydropower
On behalf of the SEA Team
What issues are addressed in each SEA stage?

<table>
<thead>
<tr>
<th>Baseline Assessment</th>
<th>Impact Assessment</th>
<th>Avoidance, Mitigation Enhancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Address trends and different perspectives on:</td>
<td>Focuses on development opportunities + risks</td>
<td>Address the above building on the Baseline and Impact Assessment outcomes</td>
</tr>
<tr>
<td>• Policies on power sectors and cross-border power trade</td>
<td>20-yr BDP Probable Future Scenario (With/Without LMB mainstream and groups.</td>
<td></td>
</tr>
<tr>
<td>• Demand growth projections and electrification</td>
<td></td>
<td>1. Regional distribution of energy and power benefits.</td>
</tr>
<tr>
<td>• Power Sector development plans (generation expansion)</td>
<td></td>
<td>2. Main impacts on individual LMB power sectors.</td>
</tr>
<tr>
<td>• Energy resource base/fuel import policies of countries</td>
<td></td>
<td>3. Regional development contribution of other power-related impacts</td>
</tr>
<tr>
<td>• Analysis of Alternatives for power supply – grid/off grid (e.g. conventional, RE and DSM) + policies for alternatives like feed-in tariff</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Impact Phase - Focuses on 3 questions

1. What is the **regional distribution of power benefits** with/without LMB mainstream + different groups

2. What are the **impacts on individual LMB domestic power sectors**?

3. What is the **regional development contribution of other power-related impacts** to integrate with other sector analysis?

All From a Power Sector Development Perspective
Q1. **What is the impact on regional distribution of LMB power benefits**

**Approach**

Economic analysis of power benefits based on:

- MRC Hydropower Data Base
- Economic supply costs (project by project)
- Competing cost of alternatives for bulk power receiving system
- Power Revenues (economic valuation)
- Assessment is Not a financial or revenue flow analysis.

**Integration with other parts of the SEA**

<table>
<thead>
<tr>
<th>PROJECT COST</th>
<th>Export Country</th>
<th>Import Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>POWER BENEFITS</td>
<td>Export Country</td>
<td>Import Country</td>
</tr>
<tr>
<td>OTHER BENEFITS</td>
<td>Export Country</td>
<td>Import Country</td>
</tr>
<tr>
<td>NEGATIVE IMPACTS</td>
<td>Export Country</td>
<td>Import Country</td>
</tr>
</tbody>
</table>

**NET ECONOMIC BENEFITS AND THEIR DISTRIBUTION**

Positive - Opportunities  
Negative - Risks

Feeds into SEA Distribution Analysis (Sectors, groups)
### Table 2.1 Regional Distribution of LMB Power Benefits for the 20-year Probable Future (with and without LMB mainstream dams) and sensitivity cases

<table>
<thead>
<tr>
<th>LMB Regional Distribution</th>
<th>POWER SUPPLY (GWh/Year)</th>
<th>PROJECTED POWER EXPORT (GWh/Year)</th>
<th>PROJECT INVESTMENT ($USM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAM</td>
<td>LAO</td>
<td>THAI</td>
</tr>
<tr>
<td>2030-20Y-with MD</td>
<td>3,677</td>
<td>20,412</td>
<td>60,694</td>
</tr>
<tr>
<td>2030-20Y-w/o MD</td>
<td>1,703</td>
<td>9,038</td>
<td>26,206</td>
</tr>
<tr>
<td>2030-20Y- MD in zone 2 only</td>
<td>1,703</td>
<td>12,287</td>
<td>50,558</td>
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<tr>
<td>2030-20Y- zone 3 only</td>
<td>1,703</td>
<td>16,759</td>
<td>30,423</td>
</tr>
<tr>
<td>2030-20Y- zone 4 only</td>
<td>3,677</td>
<td>9,441</td>
<td>32,126</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>LMB Regional Distribution</th>
<th>GROSS BENEFIT OF SUPPLY ($USM/Year)</th>
<th>GROSS EXPORT REVENUE Estimated ($USM/Year)</th>
<th>NET OVERALL POWER BENEFIT ($USM/Year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAM</td>
<td>LAO</td>
<td>THAI</td>
</tr>
<tr>
<td>2030-20Year with MD</td>
<td>782</td>
<td>3,555</td>
<td>5,284</td>
</tr>
<tr>
<td>2030-20Y-w/o MD</td>
<td>362</td>
<td>1,574</td>
<td>2,281</td>
</tr>
<tr>
<td>2030-20Y- zone 2 only</td>
<td>362</td>
<td>2,140</td>
<td>4,401</td>
</tr>
<tr>
<td>2030-20Y- zone 3 only</td>
<td>362</td>
<td>2,919</td>
<td>2,648</td>
</tr>
<tr>
<td>2030-20Y- zone 4 only</td>
<td>782</td>
<td>1,644</td>
<td>2,797</td>
</tr>
</tbody>
</table>

**Notes:**
1. Scenarios are based on the MRC Basin Development Plan (BDP 20 year Probable Future - 2030 snap shot)
2. Gross benefit of supply is based on avoided thermal costs in country where power is consumed
Q1. **Summary**

- **Overall power benefits to LMB are significant.** With BDP 20-yr Probably Future Scenario (2030) with/ without LMB mainstream dams (MSSPs) and SEA sensitivity cases of different groups of dams:
  - Difference in net overall economic power benefit 20-PFS with/without proposed LMB mainstream dams is about $US 3-4 billion annually by 2030.
  - Net economic benefit for the upper Lao PDR group is half (48.6 %) the estimated overall economic benefit in the power sector for all 12 MSDP.
  - Economic power benefit depends on the future generation mix assumed
  - Over longer term greatest beneficiary is Lao PDR in all cases.

- **Mainstream projects in Laos and Cambodia represent roughly two thirds of the total new energy potential of hydroelectric projects identified in the LMB** (i.e. hydropower schemes not yet operating or undergoing firm development).

- **Power supply from LMB mainstream hydropower schemes is consistent with LMB power sector policies** - expressed in legislation and combination of National Power Development Plans (PDPs), Regional Power Trade Agreement (2003) and Bilateral Power Trade MOUs.
Q2. What is the impact on individual LMB domestic power sectors (LMB mainstream)

From national power development perspective

- **Development of its mainstream proposals is most critical to the power sector in Cambodia:** This reflects the limited power supply options at present for low-cost bulk power supply (including tributary dams) to displace imported diesel.

- **The Lao PDR power sector can develop tributary projects for domestic use and exports continue at a healthy pace without mainstream projects given the large inventory of economically attractive tributary projects in Laos. Other benefits would be forgone.**

- **The scale of electricity demand in Thailand and Vietnam (96% of LMB combined) and the cost of alternative forms of power supply (thermal) are such that development of LMB mainstream projects would have a minor impact on electricity prices in those power systems, and not radically alter the energy supply strategies of those countries applying least-cost criteria alone.**
Q2. Summary

if LMB mainstream projects are not pursued

- Limited direct impacts on power systems of importing countries (Thailand and Viet Nam). Tariffs would not be appreciably affected. Benefits of supply diversity benefits forgone.

- Impacts on Cambodia’s domestic power sector would be greatest of all LMB countries. Cambodia may pursue coal imports for bulk power supply.

- Both Lao and Cambodia would forgo potential power benefits such as:
  - Power export revenue earnings (earnings are more limited in initial years as debt is serviced, equity contribution recovered).
  - Long-term flexibility for power supply as a development catalyst when 25-yr concession periods end (e.g. choice to continue to export, or used as greater portion of project output for domestic energy economy).
Q3. What is the regional development contribution of other power-related impacts?

Three factors considered in the assessment were the level and regional distribution of:

- Regional FDI Investment
- Regional Employment - excluding indirect employment for services and E&M equipment contracts
- Regional Power Sector emission reduction (e.g. Co2) avoided in thermal power stations (oil, coal and natural gas) when hydropower is used.
### Q3. Other Regional Development Contributions Estimated for Different Scenarios

<table>
<thead>
<tr>
<th>LMB Regional Distribution</th>
<th>Wages During Construction ($USM)</th>
<th>Total Present Value of Wages Construction and Operation ($USM)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>CAM</td>
<td>LAO</td>
</tr>
<tr>
<td>SCENARIO</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2030-20Y with MD</td>
<td>2,769</td>
<td>7,484</td>
</tr>
<tr>
<td>2030-20Y-w/o MD</td>
<td>345</td>
<td>3,314</td>
</tr>
<tr>
<td>2030-20Y - zone 2 only</td>
<td>345</td>
<td>6,081</td>
</tr>
<tr>
<td>2030-20Y - zone 3 only</td>
<td>345</td>
<td>4,550</td>
</tr>
<tr>
<td>2030-20Y - zone 4 only</td>
<td>2,769</td>
<td>3,480</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>SCENARIO</th>
<th>0.86</th>
<th>0.86</th>
<th>0.65</th>
<th>0.97</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>2030-20Y with MD</td>
<td>3</td>
<td>18</td>
<td>39</td>
<td>34</td>
<td>94</td>
</tr>
<tr>
<td>2030-20Y-w/o MD</td>
<td>1</td>
<td>8</td>
<td>17</td>
<td>16</td>
<td>42</td>
</tr>
<tr>
<td>2030-20Y - zone 2 only</td>
<td>1</td>
<td>11</td>
<td>33</td>
<td>21</td>
<td>65</td>
</tr>
<tr>
<td>2030-20Y - zone 3 only</td>
<td>14</td>
<td>20</td>
<td>1</td>
<td>16</td>
<td>52</td>
</tr>
<tr>
<td>2030-20Y - zone 4 only</td>
<td>8</td>
<td>21</td>
<td>3</td>
<td>29</td>
<td>61</td>
</tr>
</tbody>
</table>

**Notes:**
1. Scenarios are based on the MRC Basin Development Plan (BDP 20 year Probable Future - 2030 snapshot)
2. Assumes wages only in the country where project is constructed (adjustments would be made for 2 LMB dams spanning Lao and Thailand). Excludes indirect jobs / wages such as from services, mechanical & electrical equipment manufacture / supply, etc.
3. SEA baseline report considers the split between local and foreign jobs mostly from the GMS region
4. Gross GHG based on avoided thermal generation in the country where power is consumed. Gross is different than net GHG impact, which subtracts potential for GHG emissions from reservoirs (a controversial topic - see Climate Change analysis).
5. Specific GHG emission factor based on power generation mix in each country (i.e., type of thermal supply offset)
Q3. Summary

Net contribution needs integrated with analysis in other sectors

- **Regional FDI Investment Impact:**
  in the LMB probably future scenario is 15.8 billion to 2030 without LMB mainstream. LMB mainstream would add about $US 25 billion. (see economic analysis for potential effects).

- **Regional Direct employment Impact:**
  in LMB mainstream $US 8.0 billion (construction through operation). Other LMB / GMS indirect for equipment and services.

- **Regional Power Sector Emission Impact:**
  LMB mainstream dams calculated to have gross thermal offset of 52 million tonnes Co2/yr by 2030. Net 40-50 million tonnes Co2. Net GHG emission reduction in LMB regional power sector of 70-80 million tonnes Co2/yr by 2030 – mainstream + tributary. (level of emissions from reservoirs is contested- See Climate Change analysis).
Next Phase of the SEA: Hydropower Supply Curves
Status of Projects in National Regulatory Systems

Most mainstream proposals are here in the regulatory system

- MOUs / LOAs
- feasibility study and EIAs / SIAs

- For tributary &
- Mainstream dams
Thank you

Additional Information
slides in handouts attached. Also see the SEA energy and power presentation, summary and working paper at
http://www.mrcmekong.org/ish/SEA.htm
Wider regional energy picture (GMS)

Energy poverty widespread
- Dependence on traditional sources of energy (e.g. fuelwood)
- 20% of GMs population (74 mil.) no access to electricity
- Energy consumption in GMS is only 2/3 of the world average for developing countries

Energy vulnerability high and rising
- 1993-2005 8% annual growth in energy consumption
- 21% of total energy consumed in the region imported
- Volatile energy prices and limited alternative energy sources mean the region is vulnerable

Energy productivity and policy
- Energy supplies low and unpredictable – overall quality low
- Lack of competitive pressure on energy suppliers
- Policy regimes inadequate to address emerging challenges

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

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


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

Source: Building Sustainable energy futures in the GMS, AIB
Balancing Demand and Supply Options - at all Scales - an aspiration in energy policies

Power Sector

Demand-Side Management Options
- End-Use Efficiency?
  - Distribution Loss Reduction?
    - Bulk metering?
    - Power Factor correction?

- Structural Change in Demand?

- Tariff measures?
  - Preferential Energy Rates?
  - Subsidy on power saving?
  - Carbon Tax?

Structural / Infrastructure options
- Conventional Thermal? gas, coal, oil
- Electricity Imports? Hydro Tributaries?
- Hydro Mainstream?
- Grid-scale Renewable? E.g. wind, biomas, solar
- Other non Conventional? Nuclear?
- Decentralized Systems?

Supply-Side Options
- Supply-side efficiency?
  - Improved facility operations?
- Improved cost recovery?
  - Policies to attract investors?
- Public and private sector roles?

Non-Structural Options

What this means?
For Grid Based Generation Expansion with Demand-Side Management

Future Generation Additions
- Hydrocarbons? (Natural Gas, Coal, Oil)
- Hydro from tributaries or LMB mainstream?
- Nuclear?
- Alternatives: e.g. Co-generation, grid-scale biomass, wind, solar
- Other grid-scale renewable?

Existing Capacity
- Natural gas
- Coal
- Oil
- Hydropower
- Biomass
- Etc.

Electricity Demand

Projected energy demand
Projected energy demand with demand management
Supply

*RoW = Rest of World

Need for new generation delayed through demand-side management & supply-side efficiency measures
Power Generation Mix in LMB countries 1990-2006 – Thailand
22% Import + Rising- VN to start coal imports in 2-3 years
Main Factors – Opportunity for:

- Revenue from power export.
- Secure a portion of electricity generation from mainstream projects for domestic power needs – (significant relative to current demand and supply costs).
- Have a large renewable power source after concession term expires (to decide for export or use for domestic supply).
Lao PDR – interest in LMB mainstream

LMB hydropower

- MoUs for power export (e.g.)
  - 7,000 MW with Thailand – potentially including MLMB
  - 5,000 MW with Vietnam – potentially including MLMB

- 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 use for domestic supply).
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)

- Interest in reliable lower cost power options.

- Mitigation of power supply risk through diversification of generation mix and fuel / import sources

- Thai interests as investors in LMB projects
Vietnam interest in mainstream LMB hydropower

- **Part of Energy / Power Import Equation**
  - Current 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 interest as investors in LMB projects
IMPACT ON SUPPLY MATRIX OF IMPORTING COUNTRIES

- Existing or Decided Supply in Thailand and Vietnam 2015
- Other New Supply in Thailand and Vietnam 2015-2025
- Tributary Projects in Laos
- Tributary Projects in Cambodia
- Mainstream Projects in Laos
- Mainstream Projects in Cambodia

35% 6% 6% 6% 2%
## ALTERNATIVE ENERGY COSTS

<table>
<thead>
<tr>
<th>Thermal Generation Technology</th>
<th>Energy Cost of each Technology ($/MWh)</th>
<th>Percent Use of each Generation Technology</th>
</tr>
</thead>
<tbody>
<tr>
<td>High or Medium Speed Diesel Units using Diesel Oil</td>
<td>352.3</td>
<td>LAOS 30.0%</td>
</tr>
<tr>
<td>Low Speed Diesel Units Using Bunker Oil</td>
<td>160.0</td>
<td>CAMBODIA 60.0%</td>
</tr>
<tr>
<td>Combined Cycle Units using Natural Gas</td>
<td>96.4</td>
<td>VIETNAM 100.0%</td>
</tr>
<tr>
<td>Steam Turbine Units using Coal</td>
<td>73.0</td>
<td></td>
</tr>
<tr>
<td>ALTERNATIVE ENERGY COST ($/MWh)</td>
<td>174.2</td>
<td>87.1</td>
</tr>
</tbody>
</table>
## Impact on End-User Tariff of Importing Countries

<table>
<thead>
<tr>
<th>Contribution</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Contribution of Mainstream Dams to Total Energy Supply</td>
<td>8.0%</td>
</tr>
<tr>
<td>Energy Cost Saving Relative to Thermal Alternatives</td>
<td>37.0%</td>
</tr>
<tr>
<td>Saving at Generation Level</td>
<td>3.0%</td>
</tr>
<tr>
<td>Estimated Savings at End User Level</td>
<td>1.5%</td>
</tr>
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