Profiles of 12 proposed Mainstream developments in the LMB

MRC SEA of Mekong mainstream hydropower
REGIONAL IMPACTS ASSESSMENT WORKSHOP

Vientiane, April 2010

Presentation by
Peter-John Meynell & Lawrence J.M. Haas
SEA TEAM
Initiative on Sustainable Hydropower (ISH)
Dams on the mainstream Mekong

Upper Mekong – 8 existing or planned
Lower Mekong – 12 proposed

Dams on Mekong Tributaries

Existing and planned – 94 (only hydro dams – does not include irrigation dams)
Potential Markets for Mainstream Dams

Installed Capacities (MW) subject to change

PRC
8 in operation, under construction and planned, total 16,460 MW

Thailand
- Pak Beng 1,230 MW
- Xayaburi 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
- Luang Prabang 1,410 MW
- Sambor 2,600 MW
- Stung Treng 800 MW

Viet Nam
- Pak Beng 1,230 MW
- Sayabury 1,260 MW
- Pak Lay 1,320 MW
- Sanakham 1,200 MW
- Ban Khoum 1,872 MW
- Lat Sua 800 MW
- Don Sahong 360 MW

Myanmar
- No mainstream projects proposed

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

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
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
Where is accelerated interest in hydropower coming from? Cont.

D. Upstream reservoir development in China

- Engineering / Hydrology:
  - Higher low season flow improving power generation in dry season in proposed LMB mainstream schemes
  - Impact of tributary storage releases (dry season – to a lesser extent)
  - Improving project economics
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
<table>
<thead>
<tr>
<th>Dam</th>
<th>Developer</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pak Beng</td>
<td>Datang International Power Generation</td>
<td>China</td>
</tr>
<tr>
<td>Luang Prabang</td>
<td>Petro Vietnam Power Corporation</td>
<td>Vietnam</td>
</tr>
<tr>
<td>Xayaburi</td>
<td>SEAN &amp; Ch. Karnchang Public Co Ltd</td>
<td>Thailand</td>
</tr>
<tr>
<td>Pak Lay</td>
<td>CEIEC and Sino-Hydro</td>
<td>China</td>
</tr>
<tr>
<td>Sanakham</td>
<td>Datang International Power Generation</td>
<td>China</td>
</tr>
<tr>
<td>Pak Chom</td>
<td>Feasibility study jointly funded by Ministries of Energy from Thailand and Laos</td>
<td>Thailand/Laos</td>
</tr>
<tr>
<td>Ban Koum</td>
<td>Italian Thai Asia Corp. Holdings</td>
<td>Thailand</td>
</tr>
<tr>
<td>Latsua</td>
<td>Charoen Energy and Water Asia Co Ltd</td>
<td>Thailand</td>
</tr>
<tr>
<td>Don Sahong</td>
<td>Mega First</td>
<td>Malaysia</td>
</tr>
<tr>
<td>Thakho</td>
<td>CNR (Compagnie Nationale du Rhône) and EDL</td>
<td>France</td>
</tr>
<tr>
<td>Stung Treng</td>
<td>Song Da Co.</td>
<td>Vietnam</td>
</tr>
<tr>
<td>Sambor</td>
<td>China Southern Power Grid</td>
<td>China</td>
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### Status of Proposed LMB Projects in National Regulatory Systems

*(commissioning dates in MOUs do not reflect current situation)*

<table>
<thead>
<tr>
<th>Dam</th>
<th>Status</th>
<th>Environmental study status</th>
<th>Commission date (in MOUs)</th>
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<tbody>
<tr>
<td>Pak Beng</td>
<td>MoU, feasibility</td>
<td>IEE submitted</td>
<td>2016</td>
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<tr>
<td>Luang Prabang</td>
<td>MoU, feasibility</td>
<td>Feasibility study,</td>
<td>2016</td>
</tr>
<tr>
<td>Xayaburi</td>
<td>MoU, feasibility</td>
<td>Feasibility and full ESIA submitted</td>
<td>2016</td>
</tr>
<tr>
<td>Pak Lay</td>
<td>MoU, feasibility</td>
<td>IEE submitted</td>
<td>2016</td>
</tr>
<tr>
<td>Sanakham</td>
<td>MoU, feasibility</td>
<td>IEE in preparation</td>
<td>2016</td>
</tr>
<tr>
<td>Pakchom</td>
<td>Feasibility in prep.</td>
<td>Not yet</td>
<td>2017</td>
</tr>
<tr>
<td>Ban Koum</td>
<td>MoU, feasibility</td>
<td>Not yet</td>
<td>2017</td>
</tr>
<tr>
<td>Latsua</td>
<td>MoU, pre-feasibility</td>
<td>Not yet</td>
<td>2018</td>
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<tr>
<td>Thakho</td>
<td>MOU</td>
<td>ESIA in preparation</td>
<td>2014</td>
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<tr>
<td>Don Sahong</td>
<td>PDA. detailed planning</td>
<td>Full EIA submitted, Additional studies requested</td>
<td>2016</td>
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<td>Stung Treng</td>
<td>MoU, pre-feasibility</td>
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<tr>
<td>Sambor</td>
<td>MoU, pre-feasibility</td>
<td>Pre-feasibility submitted</td>
<td>2020</td>
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</table>
Statistics: Of Proposed LMB dams
(Upper 5 Lao dams revised based on Lao PDR optimization study)

<table>
<thead>
<tr>
<th>Project Name</th>
<th>Full Supply Level mamsl</th>
<th>Low Supply Level mamsl</th>
<th>Live Storage mcm</th>
<th>Reservoir area sq km</th>
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</thead>
<tbody>
<tr>
<td>Pakbeng</td>
<td>340</td>
<td>334</td>
<td>442</td>
<td>87</td>
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<tr>
<td>Luang Prabang</td>
<td>310</td>
<td>308</td>
<td>734</td>
<td>90</td>
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<tr>
<td>Xayaburi</td>
<td>275</td>
<td>270</td>
<td>225</td>
<td>49</td>
</tr>
<tr>
<td>Paklay</td>
<td>245</td>
<td>242</td>
<td>384</td>
<td>108</td>
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<tr>
<td>Sanakham</td>
<td>220</td>
<td>215</td>
<td>106</td>
<td>94</td>
</tr>
<tr>
<td>Pak Chom</td>
<td>192</td>
<td>190</td>
<td>12</td>
<td>80.3</td>
</tr>
<tr>
<td>Ban Kum</td>
<td>115</td>
<td>115</td>
<td>n/a</td>
<td>132.5</td>
</tr>
<tr>
<td>Latsua</td>
<td>97.5</td>
<td>90</td>
<td>n/a</td>
<td>13</td>
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<tr>
<td><strong>Thakho diversion</strong></td>
<td>71</td>
<td>62</td>
<td>na</td>
<td>na</td>
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<tr>
<td>Don Sahong</td>
<td>75</td>
<td>72</td>
<td>115</td>
<td>290 ha</td>
</tr>
<tr>
<td>Stung Treng</td>
<td>55</td>
<td>50</td>
<td>70</td>
<td>211</td>
</tr>
<tr>
<td>Sambor</td>
<td>40</td>
<td>39</td>
<td>465</td>
<td>620</td>
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<tr>
<td><strong>TOTAL</strong></td>
<td></td>
<td></td>
<td></td>
<td><strong>1367</strong></td>
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</table>
## Statistics: Of proposed LMB dams

<table>
<thead>
<tr>
<th>Project</th>
<th>Rated Head m</th>
<th>Plant Design Discharge m³/s</th>
<th>Installed Capacity MW</th>
<th>Peaking Capability MW</th>
<th>Mean Annual Energy GWh</th>
<th>Firm Annual Energy GWh</th>
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<tbody>
<tr>
<td>Pak Beng</td>
<td>31</td>
<td>7,250</td>
<td>1,230</td>
<td>1,230</td>
<td>5,517</td>
<td>4,073</td>
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<tr>
<td>Luang Prabang</td>
<td>40</td>
<td>3,812</td>
<td>1,410</td>
<td>1,412</td>
<td>5,437</td>
<td>4,205</td>
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<tr>
<td>Xayaburi</td>
<td>24</td>
<td>6,018</td>
<td>1,260</td>
<td>1,260</td>
<td>6,035</td>
<td>5,139</td>
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<tr>
<td>Paklay</td>
<td>26</td>
<td>4,500</td>
<td>1,320</td>
<td>1,320</td>
<td>6,460</td>
<td>4,252</td>
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<tr>
<td>Sanakham</td>
<td>16</td>
<td>5,918</td>
<td>700</td>
<td>700</td>
<td>5,015</td>
<td>3,210</td>
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<tr>
<td>Pak Chom</td>
<td>22</td>
<td>5,720</td>
<td>1,079</td>
<td>1,079</td>
<td>5,318</td>
<td>5,052</td>
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<tr>
<td>Ban Koum</td>
<td>19</td>
<td>11,700</td>
<td>1,872</td>
<td>1,872</td>
<td>8,434</td>
<td>8,012</td>
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<tr>
<td>Latsua</td>
<td>10</td>
<td>9,600</td>
<td>800</td>
<td>800</td>
<td>3,504</td>
<td>2,452</td>
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<tr>
<td>Thakho</td>
<td>15</td>
<td>380</td>
<td>50-60</td>
<td>Cont.</td>
<td>360</td>
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<tr>
<td>Don Sahong</td>
<td>17</td>
<td>2,400</td>
<td>240</td>
<td>240</td>
<td>2,375</td>
<td>1,989</td>
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<tr>
<td>Stung Treng</td>
<td>15</td>
<td>18,493</td>
<td>980</td>
<td>591</td>
<td>4,870</td>
<td>2,937</td>
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<tr>
<td>Sambor</td>
<td>33</td>
<td>17,668</td>
<td>2,600</td>
<td>2,030</td>
<td>11,740</td>
<td>9,150</td>
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<tr>
<td>TOTAL</td>
<td></td>
<td>14,111</td>
<td></td>
<td></td>
<td>64,706</td>
<td>51,239</td>
</tr>
</tbody>
</table>
# Dimensions

(details change as design proceeds)

<table>
<thead>
<tr>
<th>Project</th>
<th>Length of dam (m)</th>
<th>Height (m)</th>
<th>Reservoir area (sq.km)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Foundation to crest</td>
<td></td>
</tr>
<tr>
<td>Pak Beng</td>
<td>943</td>
<td>76</td>
<td>87</td>
</tr>
<tr>
<td>Luang Prabang</td>
<td>1,106</td>
<td>68</td>
<td>90</td>
</tr>
<tr>
<td>Xayaburi</td>
<td>810</td>
<td>32</td>
<td>49</td>
</tr>
<tr>
<td>Pak Lay</td>
<td>630</td>
<td>35</td>
<td>108</td>
</tr>
<tr>
<td>Sanakham</td>
<td>1,144</td>
<td>38</td>
<td>94</td>
</tr>
<tr>
<td>Pak Chom</td>
<td>1,200</td>
<td>55</td>
<td>80.3</td>
</tr>
<tr>
<td>Ban Koum</td>
<td>780</td>
<td>53</td>
<td>132.5</td>
</tr>
<tr>
<td>Latsua</td>
<td>1,300</td>
<td>22</td>
<td>13</td>
</tr>
<tr>
<td>Thakho</td>
<td>No dam</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Don Sahong</td>
<td>1820-720-2730</td>
<td>10.6-8.2-8.3</td>
<td>290 ha</td>
</tr>
<tr>
<td>Stung Treng</td>
<td>10,884</td>
<td>22</td>
<td>211</td>
</tr>
<tr>
<td>Sambor</td>
<td>18,002</td>
<td>56</td>
<td>620</td>
</tr>
</tbody>
</table>
People to be resettled

Comparison shows how optimization could reduce numbers of people to be resettled.

No estimates yet of downstream affected people.

* Proposed to move Latsua dam downstream to eliminate / reduce resettlement with 1m head loss.

<table>
<thead>
<tr>
<th>Dam</th>
<th>Original estimates</th>
<th>Lao PDR Optimization study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pak Beng</td>
<td>6,694</td>
<td>4,250</td>
</tr>
<tr>
<td>Luang Prabang</td>
<td>17,700</td>
<td>5,920</td>
</tr>
<tr>
<td>Xayaburi</td>
<td>2,151</td>
<td>2,440</td>
</tr>
<tr>
<td>Pak Lay*</td>
<td>18,000</td>
<td>5,010</td>
</tr>
<tr>
<td>Sanakham</td>
<td>12,950</td>
<td>1,890</td>
</tr>
<tr>
<td>Pakchom</td>
<td></td>
<td>575</td>
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<tr>
<td>Ban Koum</td>
<td>2,570</td>
<td>935</td>
</tr>
<tr>
<td>Latsua</td>
<td></td>
<td>None?</td>
</tr>
<tr>
<td>Thakho</td>
<td></td>
<td>NA</td>
</tr>
<tr>
<td>Don Sahong</td>
<td>66</td>
<td>66</td>
</tr>
<tr>
<td>Stung Treng</td>
<td>9,160</td>
<td>9,160</td>
</tr>
<tr>
<td>Sambor</td>
<td>19,034</td>
<td>19,034</td>
</tr>
<tr>
<td>TOTAL</td>
<td>88,325</td>
<td>49,276</td>
</tr>
</tbody>
</table>
Illustration of the influence of Yunnan dams on the lower mainstream

**Pak Beng example**

- Minimum dry season flow increase by about 58% from 950 m$^3$/sec March/April to 1,750 m$^3$/sec
- Wet season peaks delayed by about one month from July/August to August/September
- Mean wet season peaks reduced by about 1,000 m$^3$/sec
Quick profiles
12 proposed hydropower developments in the LMB
Pak Beng (1,230 MW)

As shown on the cover of developers feasibility study:

Developer: Datang International Power Generation, China

- Upper most dam in proposed LMB cascade
- Dam in Lao PDR
- Reservoir in Lao PDR
Original Pak Beng design
FSL = 345 masl
MDL = 339 masl
Area = 86.51
Length = 130 – 145 km
Operating 8 – 12 hrs/day

Now revised design
FSL at 340 masl to avoid backwater in Thailand

Core sampling at the dam site
Luang Prabang (1,410 MW)

Developer:
Petro Vietnam Power Corporation

Dam in Lao PDR
Reservoir in Lao PDR
Xayaburi (1,260 MW)

**Developer:**
SEAN & Ch. Karnchang Public Co Ltd, Thailand

Dam in Lao PDR
Reservoir in Lao PDR

- FSL = 275 masl
- MDL = 270 masl
- Area = 49 sq.km
- Extends 150km to Luang Prabang
- Continuous operation, (no peaking)
Xayaburi Spillway Configuration

Similar to most proposed designs
Proposed Xayaburi dam site
Looking upstream
Pak Lay (3,320 MW)

**Developer:**
CEIEC and Sino-Hydro China

Dam in Lao PDR
Reservoir in Lao PDR
Proposed Pak Lay dam site looking upstream
Sanakham (700 MW)

**Developer:**
Datang International Power Generation, China

Dam in Lao PDR
Reservoir in Lao PDR
Pak Chom (1,079 MW)

Developer:

Joint feasibility study:

- Commissioned by Ministry of Energy in Thailand and Ministry of Mines and Energy in Lao PDR
- Panya consultants

Dam in Lao PDR and Thailand
VILLAGES ALONGSIDE STORAGE LEVEL OF PAK CHOM BARRAGE

Villages affected –
1 Laos –
   • 37 households
1 Thailand –
   • 70 households
Other water resources development aspects

- 11 pumping irrigation projects with a total area of 2,944 hectare and
- irrigation area of 2,706.4 hectare
Fish Ladder of Pak Chom and Ban Koum
Ban Koum (1,872 MW)

Developer:
Charoen Energy & Waters Asia Co. Ltd

Dam: Thai-Lao
Reservoir: Thai-Lao
VIILLAGES ALONGSIDE DE STORAGE LEVEL OF BAN KOUM BARRAGE

Reservoir 133 km²

Villages affected
   Thailand - 1
      – 29 households
   Laos - 3
      – 158 households
Other water resources development aspects of Ban Koum

Irrigation

- 22 lift irrigation projects
  11,006.4 hectare
- irrigation area of 7,870 hectare
Latsua (686 MW)

Developer:
Italian Thai Asia Corp. Holdings (Thailand)

Dam in Lao PDR
Reservoir in Lao PDR
Ban Koum and Latsua 1

Latsua recently moved downstream

- Site 1 Reservoir 13 sq km
- Possible flooding villages in Thailand and impacts on Pak Mun dam
Latsua recently moved downstream
- Site 2 - 10 km south of Pakse
- Avoids flooding villages in Thailand and impacts on Pak Mun dam
- But possibility of flooding impacts upon Pakse
- Irrigation of 7,300 ha
Don Sahong (240 MW)

Developer:
Mega First,
Malaysia

Has PDP
Dam in Lao PDR
Reservoir in Lao PDR
Don Sahong dam site
Thakho Diversion (50-60 MW)

- Developer is CNR, France
- Run of river, diversion scheme
- No dam involved
- Diversion of 380 m³/s through canal around Khone Phapheng Falls
- With the Chinese dams, dry season flows increased
  - increased diversion of 470 m³/sec,
  - Increased power generated to 450 GWh/year
Thakho and Don Sahong
Stung Treng (980 MW)

**Developer:**
Song Da Co, Vietnam

Dam and Reservoir
In Cambodia
Sambor (2,600 MW)

Developer:
China Southern Power Grid

Dam and Reservoir in Cambodia
Proposed site of Sambor dam

FSL = 40 masl
MDL = 39 masl
Area = 880 sq km
Population affected 19,034
Reservoirs of proposed dams in Cambodia

**Stung Treng**
- Dam + Embankments 10 km
- 22 m high (15 m head)
- Reservoir 211 sq km

**Sambor**
- Dam + Embankments 18 km
- 56 m high (33 m head)
- Reservoir 620 sq km