# Overview of Hydropower Development in the Mekong

## Toward Research Coordination and Research Priorities

## Part 1: The background

**SPLASH**
**European EUWI-ERNET Sponsored Meeting**
**14-15 August, Vientiane, Lao PDR**

**Presentation by**
**Lawrence J.M. Haas**
**MRC Initiative on Sustainable Hydropower (ISH)**

# 3 Topics for orientation

Mekong Hydropower

**1. The Resource Base**

**2. The Status & Trends**

**3. The Development Issues**

**Implementation of 1995 Mekong Agreement**

**MRC + MRC Initiative on Sustainable Hydropower (ISH)**

**Research Coordination**

**Needs & Priorities**

# First a Wider Challenge:

# In concept

## Bridging "Two Worlds" of IWRM & Energy/Power Sector

Integrated Water Resources Management (IWRM)

Energy & Power Sector Development

### IWRM Orientation
(1995 Mekong Agreement) e.g.

- Dublin IWRM principles
- Cross-sector integration
- Synergies and tradeoffs for development balance
- Water allocation and efficiency
- Participation empowerment
- Climate change vulnerability and adaptation
- …

### Power Sector Orientation e.g.

- Energy Security
- Socio-economic growth & diversification of economies
- Export earnings
- Demand-side & Supply-side Alternatives
- Power purchase agreements, tariff negotiations
- Private and PPP finance
- Climate change mitigation
- …

**Empowerment**

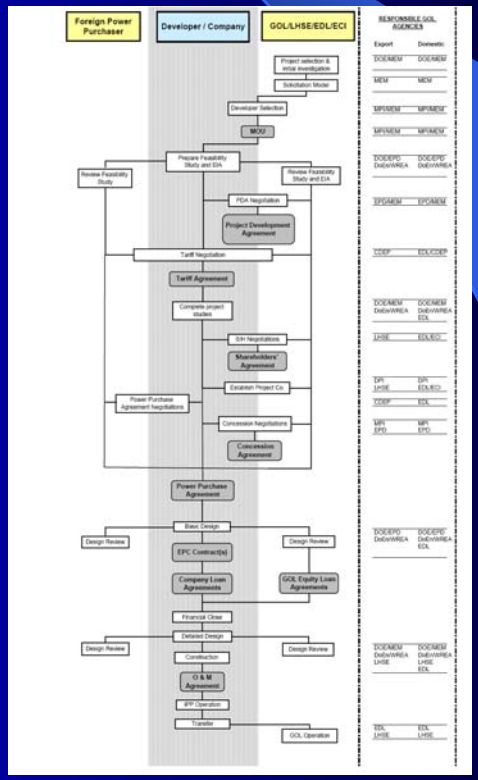
**of local voice in different governance systems**

# Wider Challenge: in Practice

## Mechanisms to better integrate "two world" planning / regulation, procedural and decision frameworks

### For River Basin Cooperation


### For Power Sector Regulation



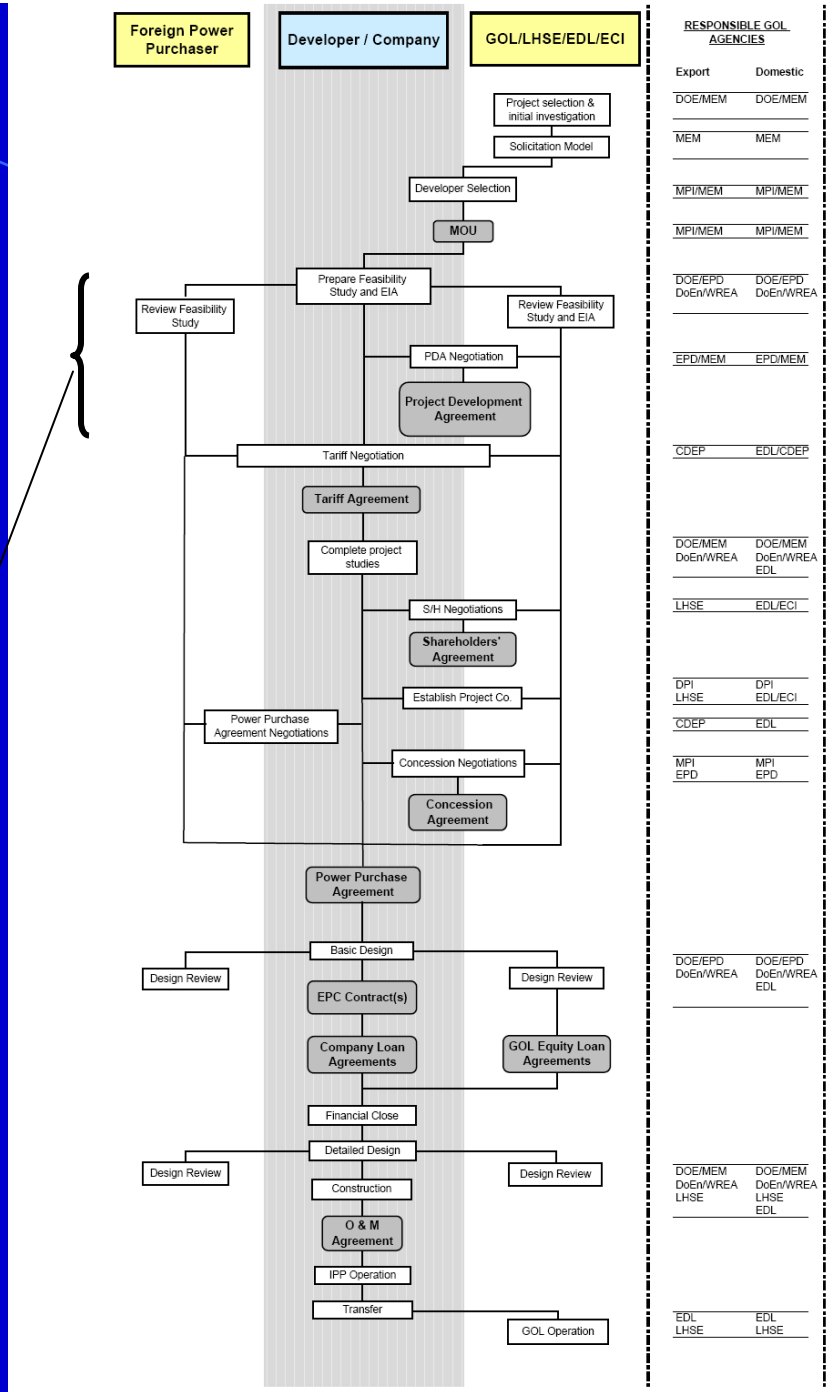
# National power regulatory Systems

## Example of Lao PDR

- **For tributary & mainstream hydropower**

Proposals advancing under national regulator systems + bilateral cross-border power agreements

**Most mainstream proposals are here in the regulatory system**

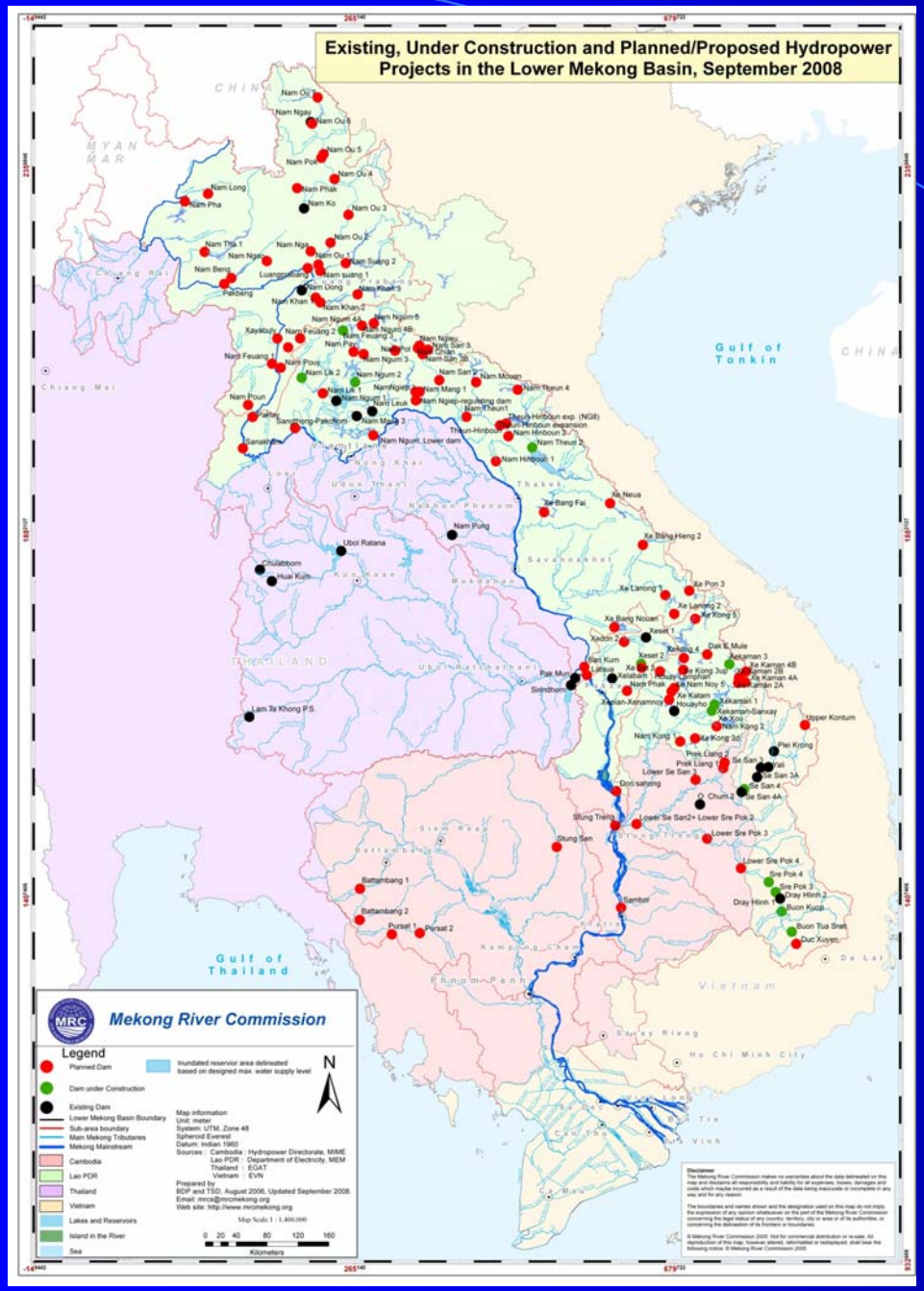


# 1. The Resource Base

| | |
|---|---|
| Mekong Basin | 53,000 MW |
| Lower Mekong Basin | 30,000 MW |

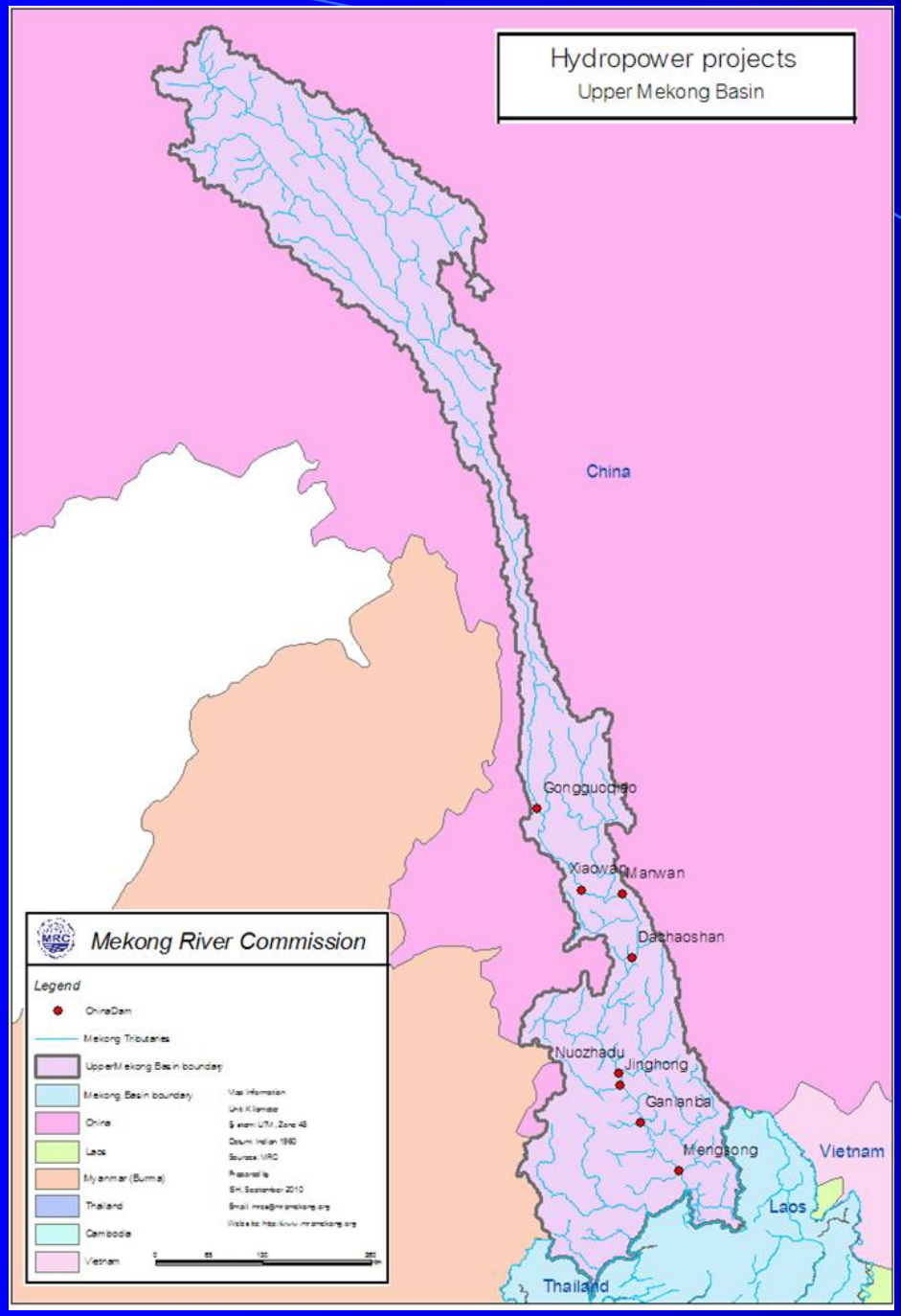
**Potential LMB generation - 134,030 GWh / year**

**equivalent to 20.3 Nam Theun 2 (NT2) projects**




# MRC Hydropower Database

- 135 projects in Database > 10 MW
- 74 per cent are in Lao PDR
- 10 percent are in Cambodia and Viet Nam each
- Thailand not planning any more LMB tributary projects




# Lancang-Mekong Projects in China

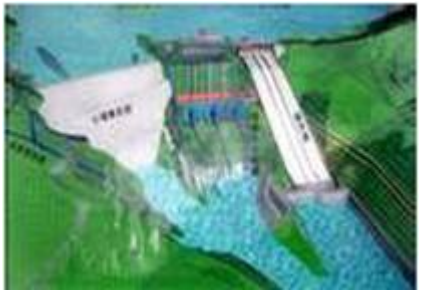
- Lower Lancang Mekong 7 in operation, under construction and planned -16,460 MW
- Upper Lancang?

Mawan1993
( 257 MCM)

Duchashan 2003
(367 MCM)

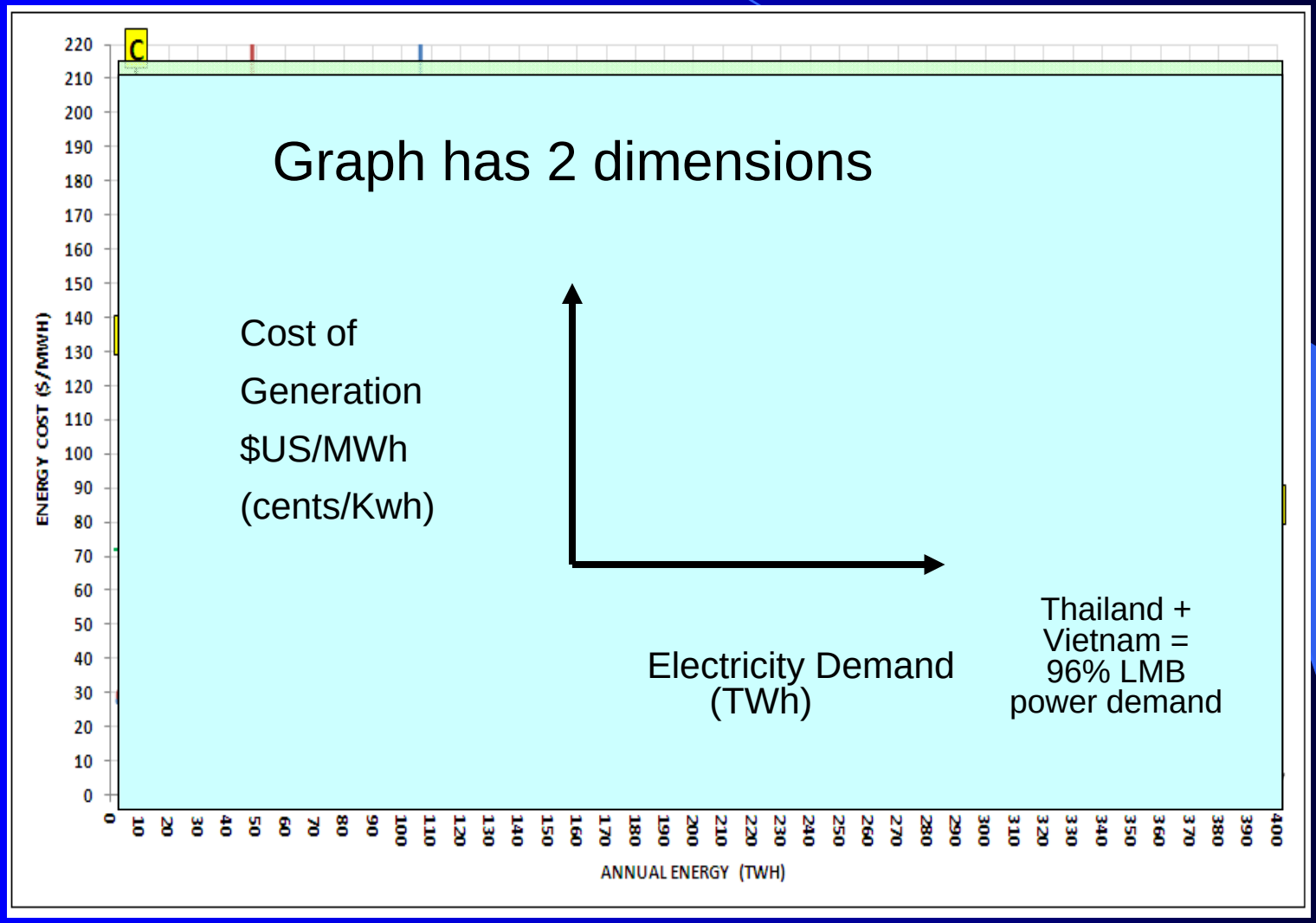
Jinghong 2008
(249 MCM)

Xiaowan 2013
(**9,900 MCM**)



Nuozhadu 2015
(**12,300 MCM**)

# Hydropower Economic Supply Curves for LMB Projects in MRC Hydropower Database



# 2. Status & Trends

- *Strong electricity demand growth nationally*
- *Low levels of relative per capita electricity use*
- *Clear energy-poverty linkages (but to be demonstrated)*
- *Improving national electrification ratios*
- *Regional and bilateral policies for cross-border power trade and electricity grid integration*

# Hydropower in the Lower and Upper Mekong River Basin

- 10 percent (3,235 MW) now operation on Mekong tributaries. Most projects completed in the past two decades.
- A further 3,209 MW under construction on LMB tributaries.
- Significant shift of recent is active consideration up to 12 mainstream hydropower schemes on Lao, Lao–Thailand and Cambodian mainstream reaches (up to 14,000 MW 65,000 GWh/yr.
- GMS and Asia Based investors dominant

- China is actively proceeding with projects in the Upper Mekong basin (UMB), on the Lancang-Mekong mainstream.
- Of seven UMB mainstream projects in operation, under construction or actively planned in Yunnan, the two major storage schemes (Xiaowan and Nozahadu) are expected to operational by 2015.

# Hydropower Status in the Lower Mekong

## By Country – end of 2008

| Country | Parameter | Project Status | | | | |
|---|---|---|---|---|---|---|
| | | In Operation | Under Construction | Under License | Planned | Total |
| **Cambodia** | Number of Projects | 1 | 0 | 0 | 13 | 14 |
| | Installed Capacity (MW) | 1 | 0 | 0 | 5,589 | 5,590 |
| | Annual Energy Generation (GWh) | 3 | 0 | 0 | 27,125 | 27,128 |
| | Investment (Million US$ 2008) | 7 | 0 | 0 | 18,575 | 18,582 |
| **Laos** | Number of Projects | 10 | 8 | 22 | 60 | 100 |
| | Installed Capacity (MW) | 662 | 2,558 | 4,126 | 13,561 | 20,907 |
| | Annual Energy Generation (GWh) | 3,356 | 11,390 | 20,308 | 59,502 | 94,556 |
| | Investment (Million US$ 2008) | 1,020 | 3,256 | 8,560 | 26,997 | 39,833 |
| **Thailand** | Number of Projects | 7 | 0 | 0 | 0 | 7 |
| | Installed Capacity (MW) | 745 | 0 | 0 | 0 | 745 |
| | Annual Energy Generation (GWh) | 532 | 0 | 0 | 0 | 532 |
| | Investment (Million US$ 2008) | 1,940 | 0 | 0 | 0 | 1,940 |
| **Vietnam** | Number of Projects | 7 | 5 | 1 | 1 | 14 |
| | Installed Capacity (MW) | 1,204 | 1,016 | 250 | 49 | 2,519 |
| | Annual Energy Generation (GWh) | 5,954 | 4,623 | 1,056 | 181 | 11,814 |
| | Investment (Million US$ 2008) | 1,435 | 1,312 | 381 | 97 | 3,225 |
| **All Countries** | **Number of Projects** | **25** | **13** | **23** | **74** | **135** |
| | **Installed Capacity (MW)** | **2,612** | **3,574** | **4,376** | **19,199** | **29,761** |
| | **Annual Energy Generation (GWh)** | **9,845** | **16,013** | **21,364** | **86,808** | **134,030** |
| | **Investment (Million US$ 2008)** | **4,402** | **4,568** | **8,941** | **45,669** | **63,580** |

# BDP Scenarios, numbers of LMB hydropower projects and total storage

| BDP Scenario | Number of Tributary Hydropower Projects | Storage / Regulation (BCM) | | % of Mekong Mean Annual Runoff (MAR) |
|---|---|---|---|---|
| | | LMB Tributaries (seasonal to daily) | UMB mainstream (seasonal) | |
| **Baseline situation (2000)** – establishing the reference situation as regards hydrological, economic, environmental and social conditions | 15 | 9.6 | 2.6 | 2.4% |
| **Definite future situation (2015)** – looking at developments expected by 2015 (i.e. existing, under construction or committed) | 41 | 23.7 | 23 | 9.2% |
| **Probable future situation (2030)** – looking at country plans for development in the next 20 years through to 2030, with / without 12 mainstream schemes and variants on these | 71 | 46 | 23 | 14.2% |


Hydropower projects
LMB 20-year plan scenario without mainstream dams
China
Myanmar
Vietnam
Thailand
Cambodia
Gulf of Tonkin
South China sea
Mekong River Commission
Existing Dam
Under Construction Dam
Planned Dam
Main Mekong Tributaries
Mekong Mainstream
Mekong Basin boundary
Flooded extent
Cambodia
China
Laos
Myanmar (Burmar)
Thailand
Vietnam
Sea


Hydropower projects
LMB 20-year plan with 9 mainstream dams scenario
China
Myanmar
Vietnam
Thailand
Cambodia
Gulf of Tonkin
South China sea
Mekong River Commission
Existing Dam
Under Construction Dam
Planned Dam
Main Mekong Tributaries
Mekong Mainstream
Mekong Basin boundary
Flooded extent
Cambodia
China
Laos
Myanmar (Burmar)
Thailand
Vietnam
Sea

# From SEA Impact Assessment:

## Regional distribution of economic benefits in LMB power sectors

Table 2.1 Regional Distribution of LMB Power Benefits for the 20-year Probable Future (with and without LMB mainstream dams) and sensitivity cases

| LMB Regional Distribution | POWER SUPPLY (GWh/Year) | | | | | PROJECTED POWER EXPORT (GWh/Year) | | | | | PROJECT INVESTMENT ($USM) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCENARIO[1] | CAM | LAO | THAI | VIE | TOTAL | CAM | LAO | THAI | VIE | TOTAL | CAM | LAO | THAI | VIE | TOTAL |
| 2030-20Y-with MD | 3,677 | 20,412 | 60,694 | 35,058 | **119,840** | 19,384 | 64,004 | 0 | 0 | **83,389** | 11,669 | 27,165 | 0 | 2,771 | **41,605** |
| 2030-20Y-w/o MD | 1,703 | 9,038 | 26,206 | 16,346 | **53,293** | 1,618 | 28,571 | 0 | 0 | **30,189** | 1,268 | 11,857 | 0 | 2,771 | **15,896** |
| 2030-20Y- MD in zone 2 only | 1,703 | 12,287 | 50,558 | 21,240 | **85,787** | 1,618 | 57,816 | 0 | 0 | **59,434** | 1,268 | 22,031 | 0 | 2,771 | **26,070** |
| 2030-20Y- zone 3 only | 1,703 | 16,759 | 30,423 | 16,346 | **65,231** | 1,618 | 32,788 | 0 | 0 | **34,406** | 1,268 | 16,402 | 0 | 2,771 | **20,441** |
| 2030-20Y- zone 4 only | 3,677 | 9,441 | 32,126 | 30,164 | **75,408** | 19,384 | 30,542 | 0 | 0 | **49,927** | 11,669 | 12,447 | 0 | 2,771 | **26,886** |

Dam Groups

| LMB Regional Distribution | GROSS BENEFIT OF SUPPLY ($USM/Year) | | | | | GROSS EXPORT REVENUE Estimated ($USM/Year) | | | | | NET OVERALL POWER BENEFIT ($USM/Year) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SCENARIO | CAM | LAO | THAI | VIE | TOTAL | CAM | LAO | THAI | VIE | TOTAL | CAM | LAO | THAI | VIE | TOTAL |
| 2030-20Year with MD | 782 | 3,555 | 5,284 | 2,559 | **12,179** | 1,250 | 4,676 | 0 | 0 | **5,926** | 722 | 5,272 | 832 | 834 | **7,659** |
| 2030-20Y-w/o MD | 362 | 1,574 | 2,281 | 1,193 | **5,410** | 100 | 2,113 | 0 | 0 | **2,214** | 273 | 2,394 | 381 | 629 | **3,677** |
| 2030-20Y- zone 2 only | 362 | 2,140 | 4,401 | 1,550 | **8,453** | 100 | 4,219 | 0 | 0 | **4,319** | 273 | 3,958 | 699 | 682 | **5,613** |
| 2030-20Y- zone 3 only | 362 | 2,919 | 2,648 | 1,193 | **7,122** | 100 | 2,425 | 0 | 0 | **2,526** | 273 | 3,556 | 436 | 629 | **4,894** |
| 2030-20Y- zone 4 only | 782 | 1,644 | 2,797 | 2,201 | **7,424** | 1,250 | 2,259 | 0 | 0 | **3,509** | 722 | 2,546 | 459 | 780 | **4,506** |

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

# Remaining LMB Hydropower

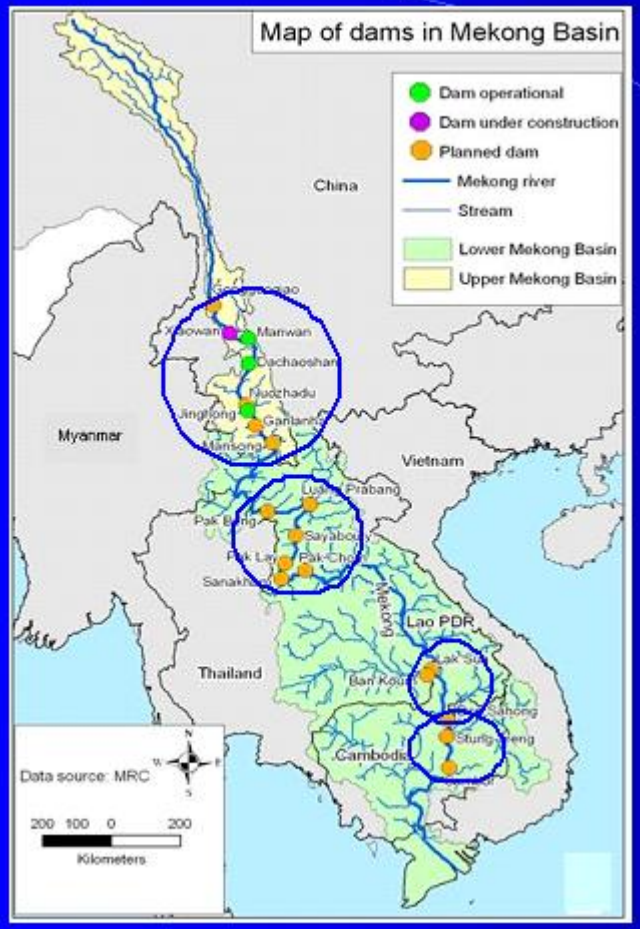
- **Total LMB hydropower 134,030 GWh/year (equivalent to 20.3 Nam Theun 2 (NT2) projects**
- **Remaining LMB potential is 105,000 GWh/ year, (equivalent to about 17.7 NT2s);**
- **Within remaining, tributary projects have a potential of 40,000 GWh/ year (equivalent to about 6.7 NT2s), and**
- **LMB mainstream schemes 65,000 GWh per year (about 11 NT2s).**

NT2 is 1,070 MW - 93% generation (5960 GWh) exported to Thailand (5,354 GWh). 7% of electricity for Lao PDR grid supply.

# 3. Development Issues

- Multi-stakeholder and multi-disciplinary perspectives
- Local > national > regional perspectives

# Opportunities and Risks




## Dams on Mekong mainstream

Upper Mekong (8 existing or planned)

Lower Mekong (11 +1 **proposed**)

## Dams on Mekong Tributaries

Existing and planned – 94 (only hydro dams – does not include irrigation dams)

# From SEA Baseline Assessment:

## Relative electricity use + the UN Human Development Index

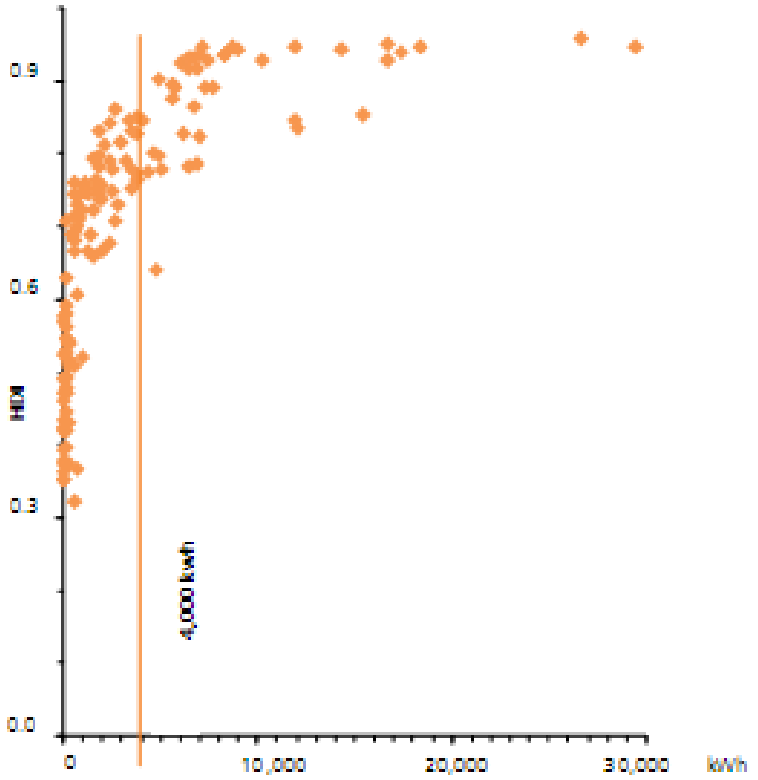
### Per Capital Electricity Use

| 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)




kWh = kilowatt-hour.

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

# MRC Stakeholder Concerns

- Cooperation in sustainable development of the basin
- Wide range of development concerns and visions for the basin development - reconciling these
- Member countries apply basin-wide IWRM approaches in national water and related sector frameworks and development programmes
- the role that water infrastructure will play in striking a balance between development and protection of water resources in the Mekong > sustainability
- Poverty alleviation and economic growth
- Linking sustainable development of regional power sector to sustainable development of the Mekong basin

# Focussing on the strategic concerns

| THEME | KEY ISSUES |
|---|---|
| Power & Energy | 1. …<br>2. …<br>3. … |
| Economic systems | 1. ….<br>2. …<br>3. … |
| Hydrology & Sediment | 1. ….<br>2. …<br>3. … |
| Aquatic Ecosyst. | 1. …<br>2. …<br>3. … |
| Terrestrial Eco systems & agriculture | 1. ….<br>2. …<br>3. … |
| Fisheries | 1. …<br>2. ….<br>3. …. |
| Social systems | 1. …<br>2. ….<br>3. …. |
| Navigation | 1. …<br>2. …<br>3. …. |
| Climate change | 1. …<br>2. …<br>3. … |

**Hydropower Impact = opportunities and risks**

**Issues**
- Sediments and nutrients
- Fisheries
- Livelihoods
- Foreign direct investment
- Power security

**Projects** by significance of impact – groups and individual projects

**Geographic area** (area and country by significance of impact)

**Distribution of costs & benefit**

# Example: SEA Scoping & Inception Stage

**Collaborative process:** To identify themes & issues that each country and each stakeholder interest felt important to balance the development opportunities and risks

**THAILAND**

A. Fisheries
B. Agriculture
C. Wetlands & biodiversity conservation
D. Navigation
E. Health
F. Local Livelihoods & Poverty reduction
G. Migration
H. Irrigation
I. Energy Security/ energy poverty

**LAO PDR**

A. Fisheries (1)
B. Power generation (2)
C. Navigation (2)
D. Tourism (3)
E. Manufacturing/processing industry (4)
F. Water Quality, sedimentation & erosion (5)
G. Resettlement & cultural heritage (6)

**CAMBODIA**

A. Fishery (1)
B. Power & Energy (1)
C. Poverty and livelihood (2)
D. Hydrology and water quality (2)
E. Agriculture and water supply (3)
F. Terrestrial ecology and land use (3)
G. Aquatic diversity and ecosystems and fisheries (3)
H. Navigation (8)

**VIET NAM**

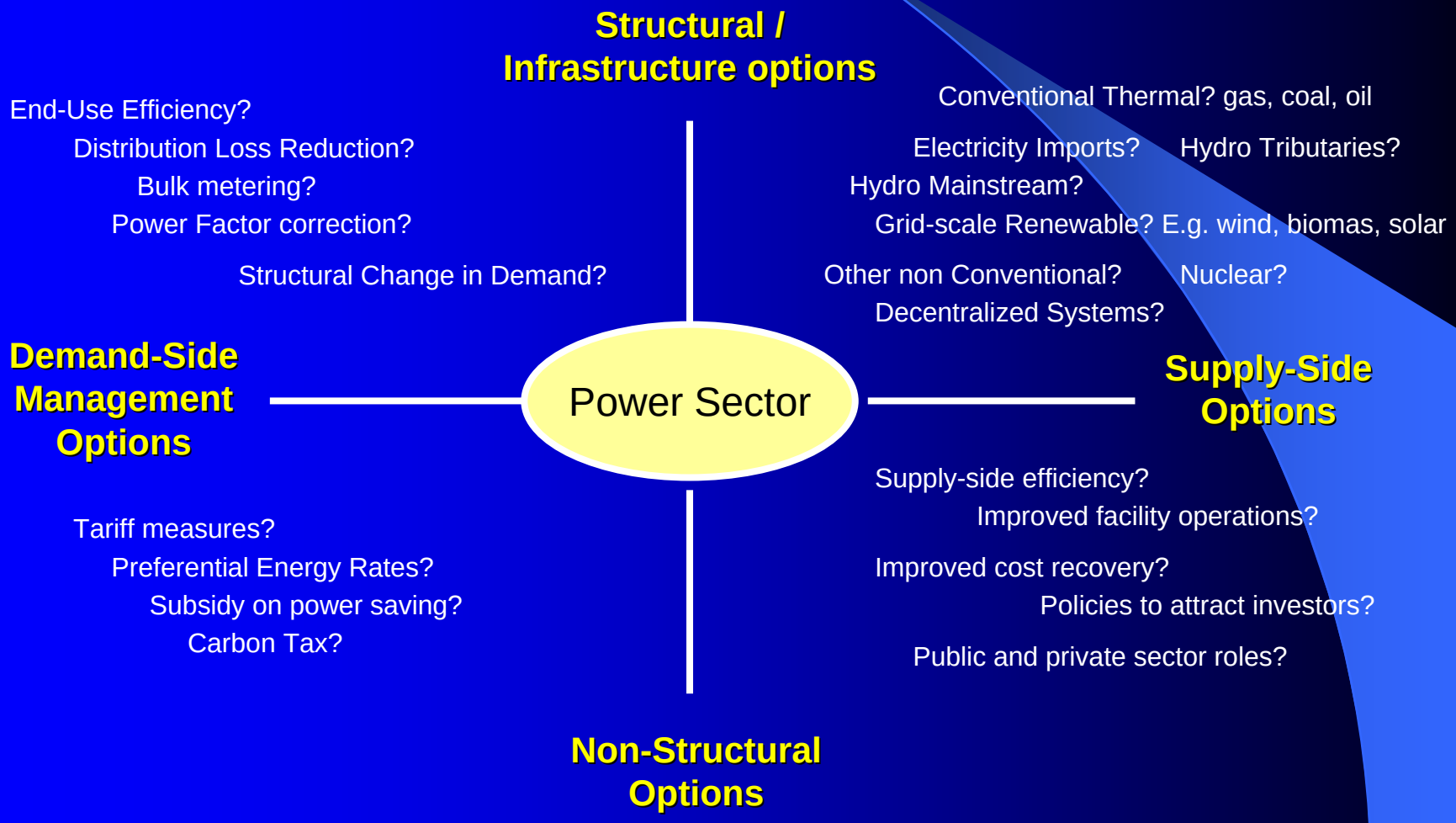
A. Agriculture (1)
B. Fisheries (2)
C. Transport & inland waterways (3)
D. Ecosystem integrity and environment (3)
E. Hydrology and climate change (4)
F. Power generation (unranked)

# Strategic Options to Consider

SEA process offered 4 strategic options:

1. Not to proceed with the mainstream projects
2. Defer a decision on whether or not to proceed and in what form and circumstances
3. Proceed with mainstream development on a gradual phased basis
4. Proceed with rapid development of all 12 projects

# Balancing Demand-Supply Options - at all scales - aspiration in energy policies

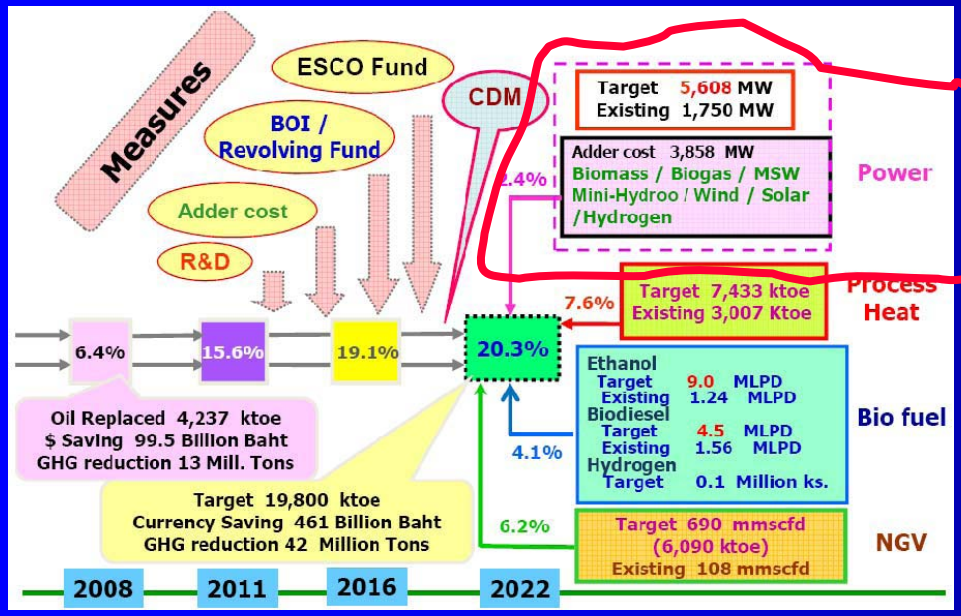


# The question of Alternatives?

## What role RE Promotion Trends Increasing & Import RE import considerations

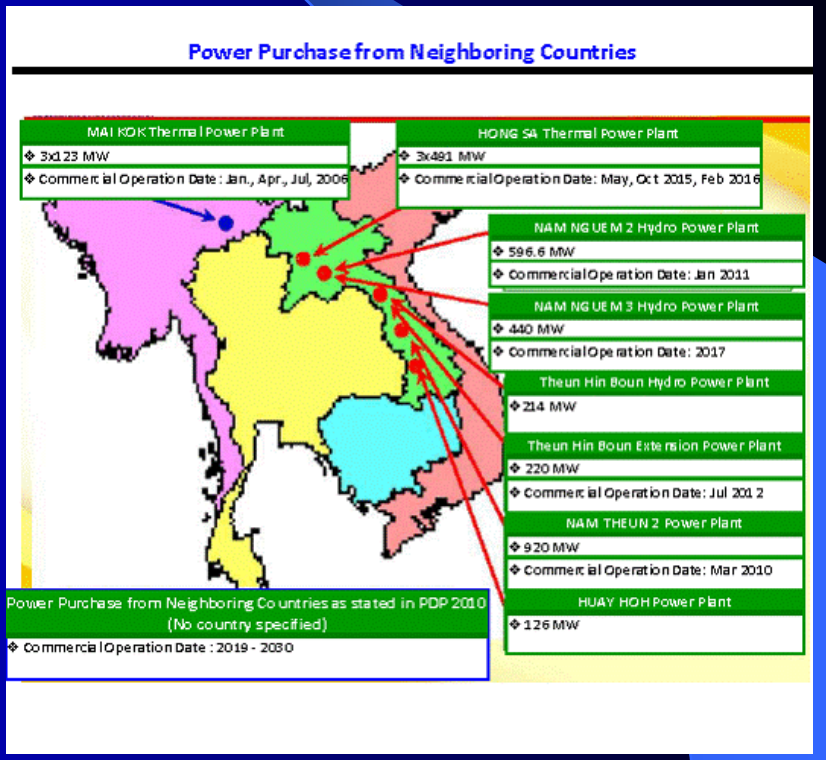
**Thailand Alternative Energy Development Strategies (2008 - 2022)**

**target of 11,216 MW from RE sources by 2022**




## Thailand PDP (2010 Provisional)

•above including hydropower as the major component




Source: EPPO, Ministry of Energy, 2010

**RE sources complementary, not competing – national policies**

# Opportunity Space for Research Coordination for Sustainable Hydropower

## Drivers

- **Accelerating pace of hydropower in Mekong cited as a major interest and challenge for the MRC's mission to implement the 1995 Mekong Agreement**

  - during regional preparations for the MRC Strategic Plan (2011-2015).

- **the Mekong has reached a crossroads on decisions about hydropower in the lower Mekong basin (LMB)**

  - BDP 3rd Regional Multi-Stakeholder Forum on the Basin Development Plan (BDP), July 2010


Thank you