

Greater Mekong Subregion (GMS) Market Coordination

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Overview



Source: IRMSU (http://51011313126g20-irmsu.blogspot.com/2011/09/blog-post_1006.html).

Participating Countries: Cambodia, People's Republic of China, Lao PDR, Myanmar, Thailand, and Viet Nam

GMS projects – totaled \$15.5 billion as of December 2012

Strategic Priorities:

- Vision a more integrated, prosperous, and harmonious subregion
- "3Cs" Connectivity, Competitiveness, Community

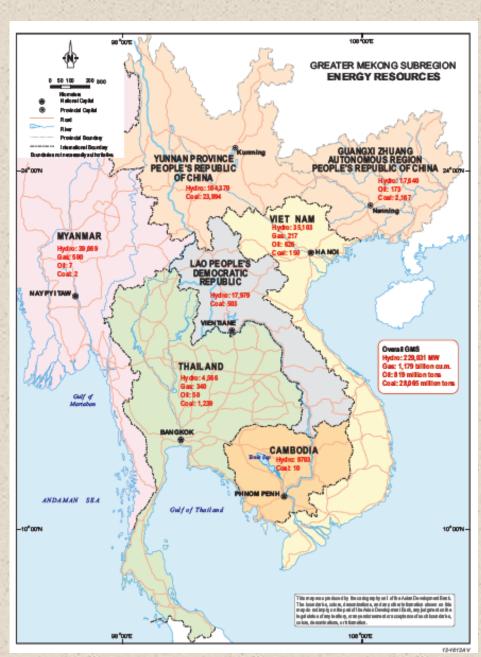


Energy Resource Endowment [1/2]

Recent estimates:

~229 GW annual hydropower potential

- ~1.2 bn cubic meter of natural gas
- ~0.82 bn tons of oil
- ~28.0 bn tons of coal



Source: ADB. 2012. *Greater Mekong Subregion Powert Trade and Interconnection: 2 Decades of Cooperation.* Manila. September.



Energy Resource Endowment [2/2]

GMS is well endowed with energy resources, but they are unevenly distributed.

GMS Energy Resources (2009/latest)

Energy Resource	GMS	Cambodia	Lao PDR	Myanmar	Thailand		Guangxi Zhuang Autonomous Region, PRC	Yunnan Province, PRC
Hydro (MWª)	229,031	9,703	17,979	39,669	4,566	35,103	17,640	104,370
Coal (MT)	28,065	10	503	2	1,239	150	2,167	23,994
Natural gas (BCM)	1,179	n.a.	-	590	340	217	n.a.	n.a.
Crude oil and natural gas liquids (MT)	819	n.a.	-	7	50	626	173	n.a.

BCM = billion cubic meter, GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, MT = million ton, MW = megawatt, n.a. = not available, PRC = People's Republic of China.

Source: World Energy Council. 2010. 2010 Survey of Energy Resources. London. For PRC data, country sources.



^a Refers to technically exploitable capability. The World Energy Council data for hydropower has been converted from terawatt-hours per year to megawatts, using the World Energy Council assumption of 0.40 capacity factor.

Energy Use

GMS Energy Use (kilotons of oil equivalent)

	1990	1995	2000	2005	2009
Cambodia	n.a.	3,373	3,978	4,779	5,182
Lao PDR	1,150	1,322	1,454	1,733	n.a.
Myanmar	10,656	11,768	12,500	15,996	15,062
Thailand	42,028	62,442	72,228	97,226	103,316
Viet Nam	24,325	30,052	37,066	51,188	64,048
Guangxi Zhuang Autonomous Region, PRC	9,157	15,796	18,685	34,080	49,525
Yunnan Province, PRC	13,679	18,484	24,278	42,168	52,576
Indonesia	103,923	133,650	155,444	179,444	201,999
Malaysia	21,988	37,112	47,271	62,070	66,826
Singapore	11,456	18,851	18,068	23,896	18,476

Lao PDR = Lao People's Democratic Republic, n.a. = not available, PRC = People's Republic of China.

Source: ADB. 2011. Key Indicators for Asia and the Pacific 2011; [People's Republic of] China Energy Statistical Yearbook 2011; World Bank 2011. World Development Indicators Online, Guangxi Statistical Yearbook 2011; Yunnan Statistical Yearbook 2010.



Peak Power Demand [1/2]

GMS Peak Load Demand Profile (megawatt)

Year	GMS	Cambodia	Lao PDR	Myanmar	Thailand	Viet Nam	Guangxi Zhuang Autonomous Region, PRC	Yunnan Province, PRC
2000	26,126	114	167	780	14,918	4,890	n.a.	5,257
2010	83,259	467	618	1,573	23,936	16,165	16,300	16,400
2015	148,371	1,008	1,911	2,533	31,734	30,084	31,600	30,100
2020	212,005	1,610	2,665	3,898	42,024	47,608	41,800	39,000
2025	277,220	2,401	2,696	5,596	54,588	71,280	50,290	47,970

GMS = Greater Mekong Subregion, Lao PDR = Lao People's Democratic Republic, n.a. = not applicable, PRC = People's Republic of China.

Note: GMS total includes projected export to rest of PRC from the GMS provinces of PRC.

Sources: ADB. 2002. *Indicative Master Plan on Power Interconnections in GMS Countries*. Manila. ADB. 2010. *Update of the GMS Regional Master Plan*. Manila.

2010 (Actual):

Total: ~ 83 GW Total: ~ 277 GW
Thailand: ~ 29% Thailand: ~ 20%
Guangxi, PRC: ~ 20% PRC*: ~ 50%
Yunnan, PRC: ~ 20% Viet Nam: > 25%
Viet Nam: ~ 20%

* Guangxi + Yunnan

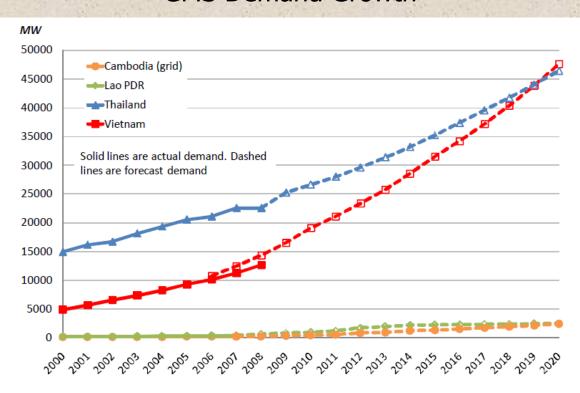
2025 (Forecast):

Cambodia, Lao PDR, Myanmar will benefit from developing power experts given their resource potential vs. their electricity needs



Peak Power Demand [2/2]

GMS Demand Growth



Annual actual and forecast demand growth data is not available for China and Myanmar. Vietnamese projections are available for 2010, 2015 and 2020 and interpolated for other years.

Source: Economic Consulting Associates (for ESMAP). 2010. *Greater Mekong Subregion Transmission and Trading Case Study.* London. January.



Power Trade [1/2]

GMS Power Flows, 2010^a (gigawatt-hour [GWh])

	То						
From	Cambodia	Lao PDR	Myanmar	Thailand	Viet Nam	PRC⁵	
Cambodia		_	_	-	-	-	
Lao PDR	6.6 ^c		-	6,938 ^d	_	_	
Myanmar	-	_		-	-	1,720e	
Thailand	385°	1,042ª, d	-		_	_	
Viet Nam	1,155°	163ª, f	-	-		-	
PRC ^a	-	112.5ª, e	_	-	5,599 ⁹		

-= nil, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.

Note: The table refers to net power flows as recorded by the receiving country.

Source: CSPG (2011); EAC (2011); EGAT (2011); ERAV (2011); EVN (2011).

Established trade flows (circa year):

- To Cambodia from Lao PDR-south (2010); Thailand (2009); Viet Nam (2008)
- To Lao PDR-north from Thailand (1990s); Yunnan, PRC (2009)
- To Thailand from Lao PDR (hydropower, 1971)
- To Viet Nam-north from Yunnan, PRC (2004)
- To Yunnan, PRC from Myanmar (hydropower, 2008)



^a Electricité du Laos Statistics 2011.

^b Refers to power dispatched to and from interconnection in Yunnan Province, PRC.

^c Electricity Authority of Cambodia (EAC). 2011. Report on Power Sector of the Kingdom of Cambodia 2010.

^d Electricity Generating Authority of Thailand (EGAT). 2011. EGAT Annual Report 2010.

e China Southern Power Grid Co. Ltd. (CSPG). http://eng.csg.cn/

f 2009 data. Electricity Regulating Authority of Viet Nam (ERAV). www.erav.vn/

g Electricity Vietnam Center of the National Power System (EVN-NLDC). Annual Report 2010. www.nldc.evn.vn/

Power Trade [2/2]

GMS Power Trade and Net Imports, 2010 (GWh)

	Imports	Exports	Total Trade	Net Imports
Cambodia	1,546	-	1,546	1,546
Lao PDR	1,265	6,944	8,210	(5,679)
Myanmar	-	1,720	1,720	(1,720)
Thailand	6,938	1,427	8,366	5,511
Viet Nam	5,599	1,318	6,917	4,281
PRC	1,720	5,659	7,379	(3,939)
Total	17,069	17,069	34,139	-

^{() =} negative, - = nil, GWh = gigawatt-hour, Lao PDR = Lao People's Democratic Republic, PRC = People's Republic of China.

Note: The table refers to trade within the Greater Mekong Subregion only and does not consider power flows from the Guangxi Zhuang Autonomous Region and Yunnan Province to the rest of the PRC, and Thailand's power imports from Malaysia.

Source: Calculated from table on GMS Power Flows, 2010.

Highlights:

- Total electricity trade = ~ 34,139 GWh
- Net exporters = PRC, Lao PDR, Myanmar
- Lao PDR = largest volume exporter + most competitively priced supplier
- Thailand and Viet Nam meet large and rapidly growing demand with imports from Lao PDR and PRC
- Cambodia can access more affordable power from neighbors vs. own power production
- Remote border regions of Cambodia, Lao PDR, Viet A D Nam benefit from cross-border access

Tariffs [1/2]

GMS Average Power Trade Tariffs, 2010/latest (United States cents per kilowatt-hour [USc/kWh])

	То						
From	Cambodia	Lao PDR	Myanmar	Thailand	Viet Nam	PRC	
Cambodia		-	-	-	-	-	
Lao PDR				4.80c			
	7.02 ^b		-	(1.45 baht)	-	-	
Myanmar	-	-		-	-	n.a.	
Thailand	10.29b						
	(3.10 baht)	6.20 ^d	-		-	-	
Viet Nam	6.14b	6.00e	-	-		-	
PRC		6.21-9.39e					
	-	(0.41–0.62 yuan)	-	-	5.10 ^f		

— nil, Lao PDR = Lao People's Democratic Republic, n.a. = not available, PRC = People's Republic of China.

Note: The table indicates the average import and export price for intra-Greater Mekong Subregion power trade, weighted by the volume of power trade. The specific prices for bilateral cross-border trade vary by project, either set under power purchase agreements (PPAs) or according to the supply price applicable per customer category by the power utilities and suppliers. The table is indicative and does not consider future application of escalation factors as may be provided for in PPAs.

- a ADB reference rates, 31 Dec 2010: 1.00 = 30.13 baht; 1.00 = 6.60 yuan.
- ^b Electricity Authority of Cambodia. 2011. Report on Power Sector of the Kingdom of Cambodia 2010. Average tariffs calculated by weighting tariff rates by 2010 import volumes.
- ^c Electricity Generating Authority of Thailand (EGAT). 2011. EGAT Annual Report 2010. Average tariff calculated from total baht and gigawatt-hour purchases from the Lao PDR.
- d ADB. 2005. Loan to the Lao PDR for Nam Theun 2 Hydroelectric Project. Manila. Cites weighted average cost of the Lao PDR's imported electricity, including EGAT sales to the Lao PDR grid and Provincial Electricity Authority cross-border sales.
- Electricite du Laos. 2010. EDL Annual Report 2010.
- f Viet Nam Net. [People's Republic of] China attempts to raise electricity price, Vietnam under hard pressure. 6 March 2011. http://english.vietnamnet.vn/en/business/

Source: ADB. 2012. Greater Mekong Subregion Power Trade and Interconnection: 2 Decades of Cooperation. Manila.



Power Tariffs [2/2]

GMS Power Import/Export Tariffs, 2010/Latest (USc/kWh)

	Average Import Tariff	Average Export Tariff
Cambodia	71.70	-
Lao PDR	6.17–6.33	4.81
Myanmar	-	n.a.
Thailand	4.80	7.30
Viet Nam	5.10	6.12
PRC	n.a.	5.11–5.15

⁻⁼ nil, kWh = kilowatt-hour, Lao PDR = Lao People's Democratic Republic, n.a. = not available, PRC = People's Republic of China.

Note: The table refers to average import and export price for power trade within the Greater Mekong Subregion only, weighted by the volume of power trade.

Source: Calculated from table on GMS Average Power Trade Tariffs, 2010/latest.



4 Stages of Regional Power Development

- <u>Stage 1</u>: Bilateral cross-border connections through power purchase agreements (PPAs)
- Stage 2: Grid-to-grid power trading between any pair of GMS countries, eventually using transmission facilities of a third regional country
- Stage 3: Development of transmission links dedicated to cross-border trading
- Stage 4: Most GMS countries with multiple seller buyer regulatory frameworks, towards the implementation of a wholly competitive regional market

GMS is in Stage 1 transitioning to Stage 2





Policy & Institutional Framework

<u>Guiding Framework</u>: GMS Expanded Energy Road Map

<u>Aim</u>: Integrated approach to delivering sustainable, secure and affordable energy in the GMS.

Strategic Objectives:

- Enhance energy access for all sectors and communities
- ii. Develop and efficiently utilize indigenous, low carbon and renewable resources
- iii. Improve energy supply security through cross-border trade
- iv. Promote public-private partnerships (PPP) and private sector participation (e.g., SME)

Note: The GMS Expanded Energy Road Map further identified priority regional initiatives across the energy sector and in the three subsectors of power, oil and gas, and coal



Milestones in Power Trade Cooperation [1/2]

1992 — — • Greater Mekong Subregion (GMS) Economic Cooperation Program is initiated.	Institutions
1994 — • The Subregional Energy Sector Study is completed and published in the subsequent year.	
 The 3rd and 4th Ministerial Meetings in Ha Noi and Chiang Mai endorse subregional priority projects, which include eight hydro and transmission line projects, two oil and natural gas projects, and one institutional project, as recommended by the subregional energy sector study. 	
1995 — • The subregional Electric Power Forum (EPF) is established in April 1995.	→ EPF
 The Experts Group on Power Interconnection and Trade (EGP) is established by the EPF, drawn from utilities and GMS member governments. 	→ EGP
1999 — • The Policy Statement on Regional Power Trade in the GMS is adopted at the 6th EPF in December 1999.	
The Policy Statement on Regional Power Trade in the GMS of 1999 is endorsed by the 9th GMS Ministers' Meeting.	
The regional indicative master plan on power interconnection is completed and endorsed in May 2002.	
 The intergovernmental agreement (IGA) on regional power trade in the GMS is signed at the First GMS Summit in November 2002. 	→ IGA
 The Regional Power Trade Coordination Committee (RPTCC) is established to coordinate the implementation of regional power trade pursuant to the IGA. 	→ RPTCC
2004 — • The IGA on regional power trade is ratified by all six GMS countries.	
 The Guidelines for the RPTCC is adopted at the 1st meeting of the RPTCC in July 2004. 	
 The Memorandum of Understanding on the Guidelines for the Implementation of Stage 1 of the Regional Power Trade Operating Agreement (MOU-1) is signed. 	→ MOU-1
The MOU on the Road Map for Implementing the GMS Cross- Border Power Trading (MOU-2) is signed.	→ MOU-2
 The update of the regional master plan on power interconnection is completed. 	
2009 — • The study on building a sustainable energy future in the GMS is published [RETA 6301].	WCDC /
2010 — • The second update of the GMS regional master plan is completed by RTE International [RETA 6440].	WGPG / WGRI
 Discussions on the establishment of the Regional Power Coordination Center (RPCC), the dedicated coordination center for regional power trade, are initiated. 	1 WGRI
2012 — • Two working groups are set up: (i) performance standard and grid code, and (ii) regulatory issues.	ADB
 Intergovernmental MOU is initialed by all members. 	

Milestones in Power Trade Cooperation [2/2]



Source: MONRE, Lao PDR. (http://www.monre.gov.la)

Draft. 27 November 2012



INTER-GOVERNMENTAL MEMORANDUM
OF UNDERSTANDING FOR THE
ESTABLISHMENT OF THE REGIONAL
POWER COORDINATION CENTRE
IN THE GREATER MEKONG SUBREGION

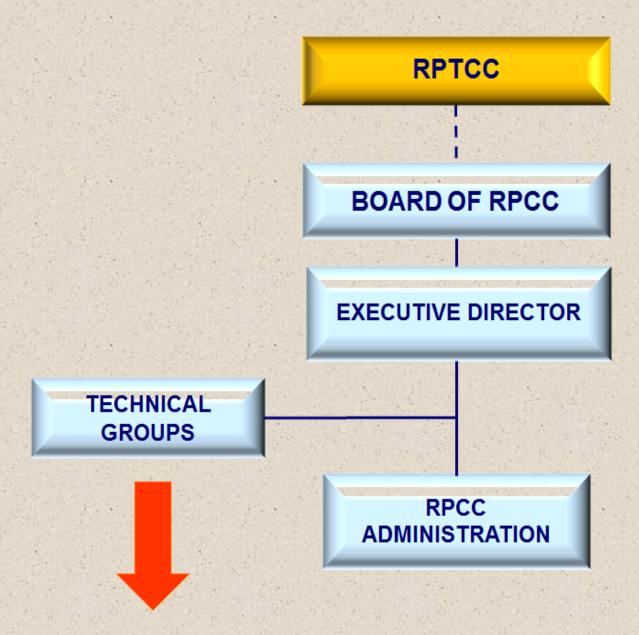
Regional Power Coordination Centre (RPCC).

An institution with legal identity fully dedicated to managing cross-border power infrastructure and trade in the GMS, and fully owned by GMS countries.

Signatures will be completed by end-2013.



RPCC Governance



Interim technical groups:

- Working Group on Performance Standards and Grid Code (WGPG)
- Working Group on Regulatory Issues (WGRI)



Interim Technical Groups: WGPG

- Chair Thailand, Co-chair PRC; Overseeing:
 - Gap analyses on technical performance standards and grid code across 6 GMS countries
 - Implementation plan for harmonization of countries' performance standards and grid code into a regional standard
 - Studies on transmission regulation: (i) policy on scheduling & accounting; (ii) coordinated operational planning; (iii) communication infrastructure; (iv) data exchange)
 - Metering arrangements





Interim Technical Groups: WGRI

- Chair PRC, Co-chair Viet Nam; Overseeing:
 - Study on **regulatory barriers** to power trade development and Stage 2 implementation.
 - Study on Stage 2 Transmission Regulations enabling third party access to interconnections, prioritizing contracts / PPAs, including Stage 2 power trade rules, and Dispute Resolution Mechanism.
- Task forces for transmission pricing mechanism, including wheeling charge for third party access (Chair: PRC, Co-Chairs: LAO & THA)
- Task force for power trade rules in short term cross-border trading (Chair: VIE, Co-Chairs: CAM and THA [TBC])





Development Partners







Absorbed the Australian Agency for International Development [AusAID]







RETA No. 6440 (Sida) [1/2]

Facilitating Regional Power Trading and Environmentally Sustainable Development of Electricity Infrastructure in the GMS

Sida grant: \$5 million

Key outputs:

- Regional power master plan updated (2010)
- Cambodia PDP completed
- Various reference documents generated on performance standards, transmission regulations, metering and communication arrangements
- RPCC related documents prepared: (i) intergovernment MOU framework, (ii) RPCC governance structure, (iii) RPCC headquarters selection criteria
- WGPG + WGRI established
- Regional review of existing environment policies, legislation, regulations and capacity (continued under RETA 7764)
- Study tour to the Southern African Power Pool
- Various capacity-building activities

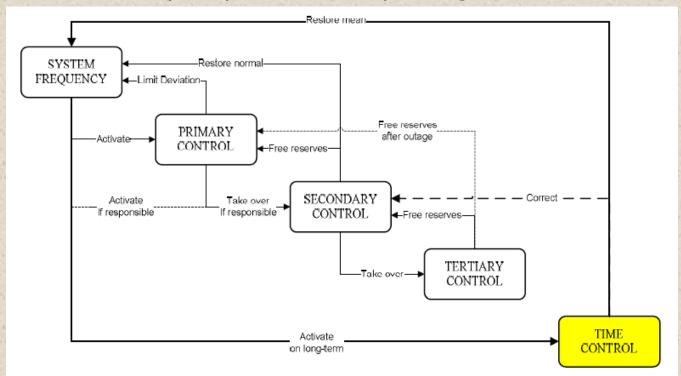


RETA No. 6440 (Sida) [2/2]

Gap analysis on frequency control and operating reserves, was conducted across 6 GMS countries for cross-comparison

Analysis on GMS regulatory barriers was also conducted

Frequency control and operating reserves





RETA No. 7764 (AFD) [1/3]

Ensuring Sustainability of GMS Regional Power Development (Phase I)

AFD grant: €1 million subsidy (+ € 1 million available from French GEF)

Strategic environmental assessment (SEA) is an analytical and participatory approach that aims to:

- Integrate environmental considerations into policies, plans and programmes
- Evaluate inter linkages with economic and social considerations
- Compare between the plan and alternative scenarios – as a planning tool

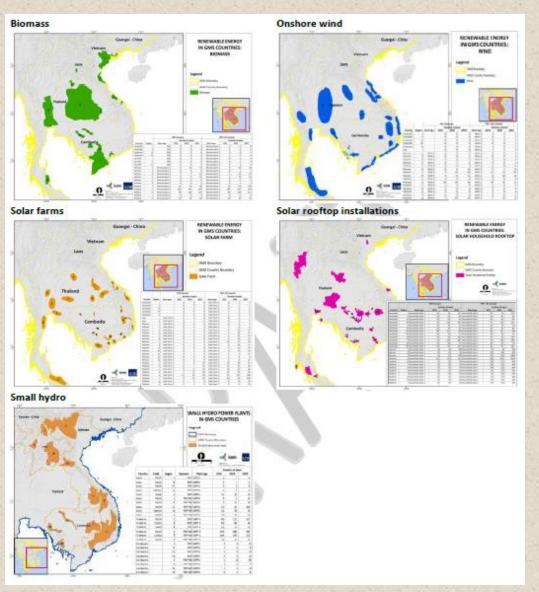
Phase I:

- SEA on baseline scenario
- Scenario analysis with energy security consideration:

More aggressive EE, RE, DSM. Combined with supply risk analysis. Final report under review.



RETA No. 7764 (AFD) [2/3]



Power development scenarios used in impact analysis:

- 1. Business as usual
- 2. Renewable energy-focused power development trajectory
- 3. Energy
 efficiencyfocused
 power
 development
 trajectory

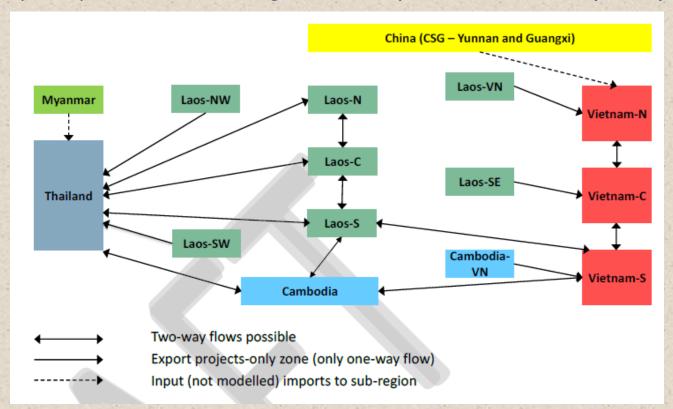
GMS renewable energy resource potential locations



RETA No. 7764 (AFD)

[3/3]

OptGen power sector modeling software outputs for 2011 - 2025 (DRAFT)



	Peak load during the period 2011-2025 (MW) under each scenario						
Interconnection	Current PDP	RE-Regional	RE-Global	EE-Regional	EE-Global		
China - Vietnam_N	2000.0	2000	2000	2000	2000		
China - Laos_N	13.1	13.1	13.1	13.1	13.1		
Laos_VN - Vietnam_N	808	193	808	87	808		
Laos_N - Vietnam_N	0.0	0	0	0	0		
Laos_SE - VN_C	698	698	698	482	698		
Laos_S - Vietnam_S	2400.0	1500	1500	500	0		
Laos_N - Thailand	0.0	600	600	0	300		
Laos_NW - Thailand	3916	3916	3375	3916	3375		
Laos_SW - Thailand	1445	1445	1445	1445	1445		
Laos_S - Thailand	1300.0	1300	1300	300	300		
Laos_S - Cambodia	60.0	60	60	60	60		
Cambodia_VN - Vietnam_S	405	405	405	405	405		
Cambodia - Vietnam_S	216.0	216	216	216	716 (2018)		
Cambodia - Thailand	80.0	500 (2017)	500 (2017)	500 (2017)	80		
Myanmar - Thailand	2050.0	1623	2050	1623	2050		

Next Steps [1/5]

Sida Support Phase II: Harmonizing GMS Power Systems to Facilitate Regional Power Trade

Amount: \$1.5 million (TBC)

Implementation Period: Jan 2014 - Dec 2016

Executing Agency: ADB & GMS members

Aim: To continue support for the RPTCC and eventually the RPCC, WGPG and WGRI

Outputs:

- RPCC established and operations commenced
- GMS-wide performance standards and grid code considered for implementation by WGPG
- GMS-wide regulatory framework guidelines proposed by WGRI

GMS member focal points:

 Energy Sector Country Coordinators to RPTCC, Chair WGPG, Chair WGRI



Next Steps [2/5]

AFD Support Phase II: Ensuring Sustainability of GMS Power Sector Development

Amount: €1.0 million

Implementation Period: ~18 months [TBD]

Executing Agency: ADB & GMS members

Aim: To strengthen policy dialogue on SEA among GMS countries

Components/interventions:

- Capacity building
- SEA approach applied to a national PDP
- Best practices to increase the share of intermittent energy (including smart grids)
- Further integration of energy efficiency as negawatt

Complements work of Subregional Energy Forum (SEF) on energy development, especially in RE, EE and CF



Next Steps [3/5]

GMS Regional Investment Framework (RIF) Implementation [1/2]

The RIF:

- Operationalizes the GMS Economic Program Strategic Framework (GMS-SF), 2012-2022
- Translates the GMS-SF 2012-2022 into a pipeline of investment and technical assistance projects for the 3rd decade of GMS, 2013-2022
- Comprises 10 sector pipelines amounting to about \$51.4 billion in potential projects

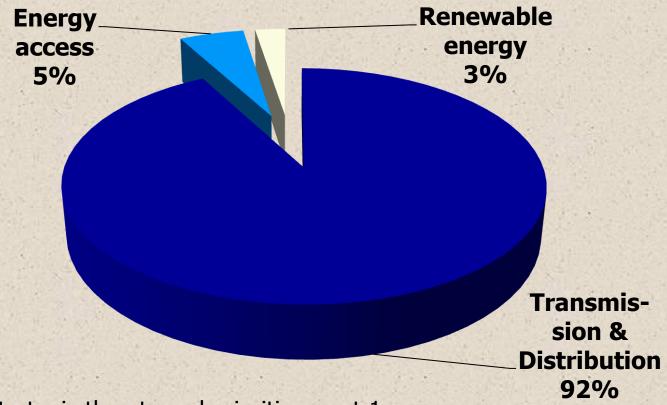
The energy pipeline covers 21 projects with an estimated cost of \$3.2 billion, including:

- 13 investment projects at \$3.2 bn
- 8 technical assistance projects at \$11.5 mn



Next Steps [4/5]

Energy Investments by Subsector (as % of Total Project Cost)



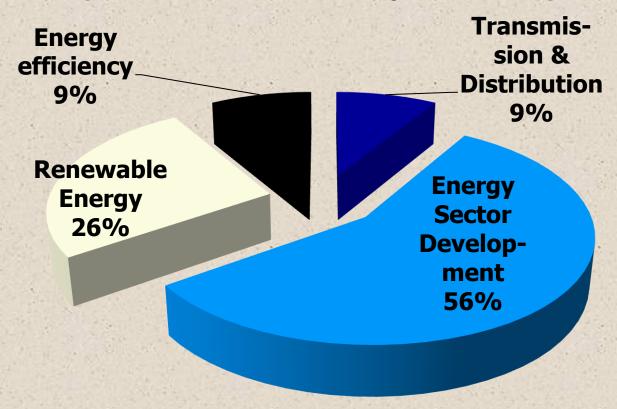
Strategic thrusts and priorities, part 1:

- Regional power integration and interconnection projects (e.g., T&D projects)
- Regional market development projects
- Hydropower project development
- Grid development projects for economic corridor and rural development



Next Steps [5/5]

Energy TAs by Subsector (as % of Total Project Cost)



Strategic thrusts and priorities, part 2:

- Pilot plants under PPP framework
- Establishment of RPCC; and harmonized performance standards, grid codes, market rules, and the like
- Coherent RE and EE plans, and environmentally sustainable development of GMS electricity infrastructure
- Continued support to SEF



Economic Corridors





Thank You

For More Information:

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