ERC's Role to Enhance Power Supply Security

Prof. Dr. Direk Lavansiri

Chairman, Energy Regulatory Commission (ERC) of Thailand

For Capacity Building India Regulatory 2014, 12 February 2014, Holiday Inn Bangkok

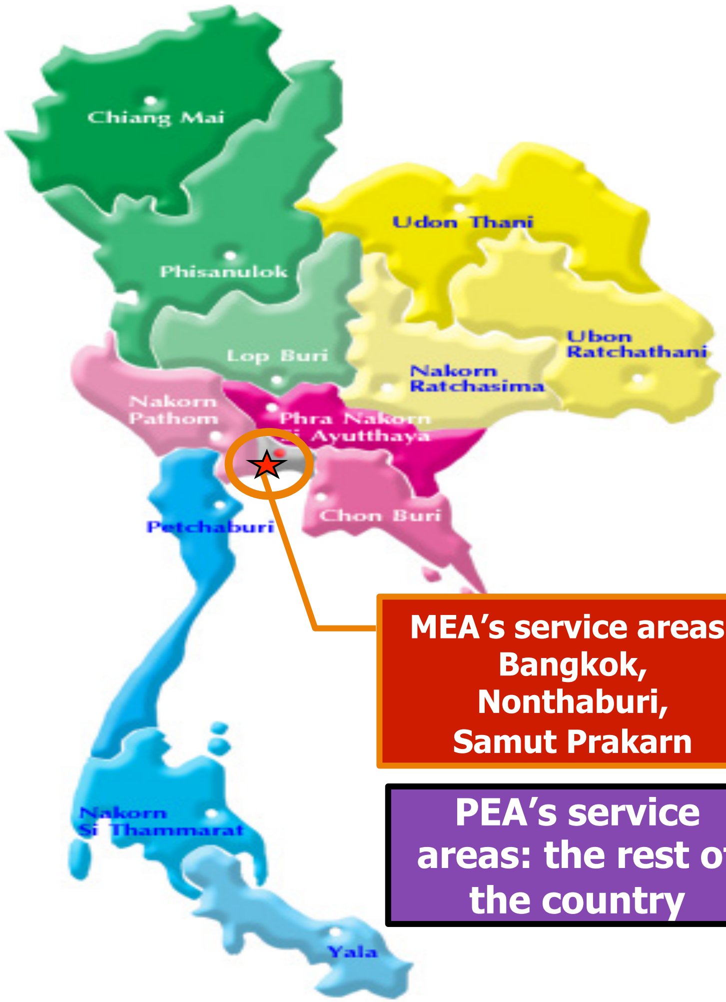
Agenda

- Thailand’s Energy Policy & Energy Management
- ERC’s Functions & Responsibilities vis-à-vis Power Supply
- Overview of Electricity Supply/Demand in Thailand
- Factors Enhancing Power Security – international cooperation, energy efficiency, RE generation development
- ERC and ASEAN Regional Regulatory Developments
- 2013 Energy Crisis in Thailand: Case Study





ABOUT THAILAND



MEA's service areas: Bangkok, Nonthaburi, Samut Prakarn

PEA's service areas: the rest of the country

MEA: Metropolitan Electricity Authority
PEA: Provincial Electricity Authority

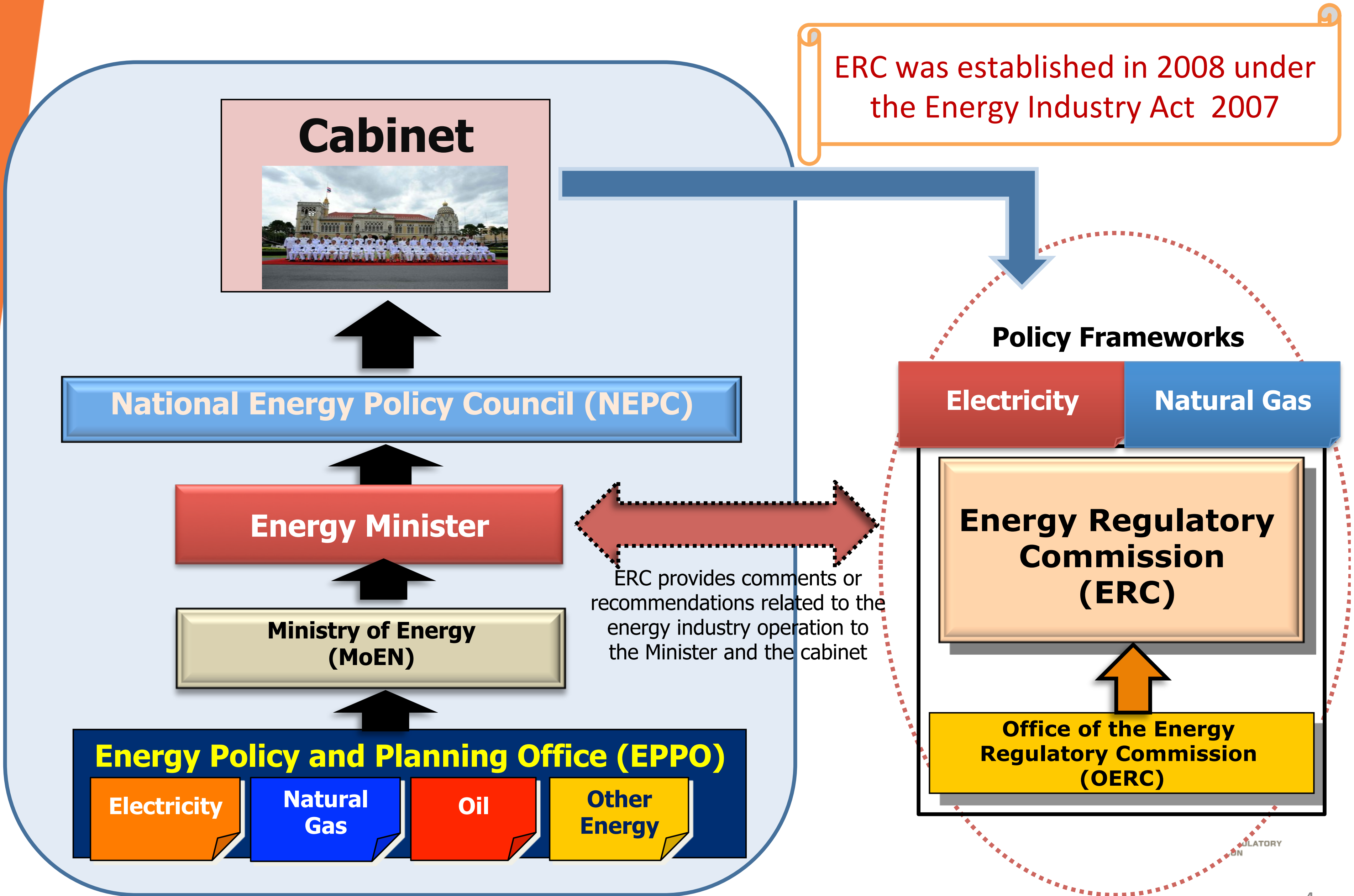
Population (2012)	**67 Million**
Customers (at end-2012)	**19.8 Million**

MEA (3.2 million)	47,880	GWh
PEA (16.6 million)	107,368	GWh
Direct EGAT customers	2,415	GWh
Total Sale in 2012	157,664	GWh

Transmission Network	**19,190 km**
Rural Electrification	**99.8%**

Access, Transmission and Distribution
- Population access to electricity: 99%
- Urban Population access to electricity: 100%
- Rural Population access to electricity: 99.8%
- Distribution and transmission losses: 8%
- National Grid Coverage: 99%
- Reliability of electricity service: Occasional brownouts

Thailand's Energy Management



Policy Statement of the Council of Ministers delivered by PM Yingluck Shinawatra to the National Assembly on 23 August 2011

Energy Policy

- **Promote and enhance energy industry to generate national income.** Investment in energy infrastructure will be increased to make Thailand the hub of regional energy business.
- **Reinforce energy security** through exploration and development of energy sources, both domestic and abroad. Energy sources and types will also be diversified.
- **Regulate energy prices to ensure fairness and to reflect actual costs**
- **Support the production, use, research and development of renewable and alternative energy sources,** with a target of replacing at least 25% of fossil fuels within 10 years.
- **Promote energy conservation** through reduction of energy intensity by 25% within 20 years. Clean Development Mechanisms (CDM) will be used to reduce greenhouse gas emissions and to tackle global warming. Consumer awareness of economical and efficient use of energy will be raised.

คณะกรรมการ กำกับกิจการพลังงาน ENERGY REGULATORY COMMISSION

Energy Regulatory Commission (ERC): Functions and Responsibilities

Regulate through Licensing Schemes

5 License Types for Power Industry

Generation | Transmission | Distribution | Retail | System Operator

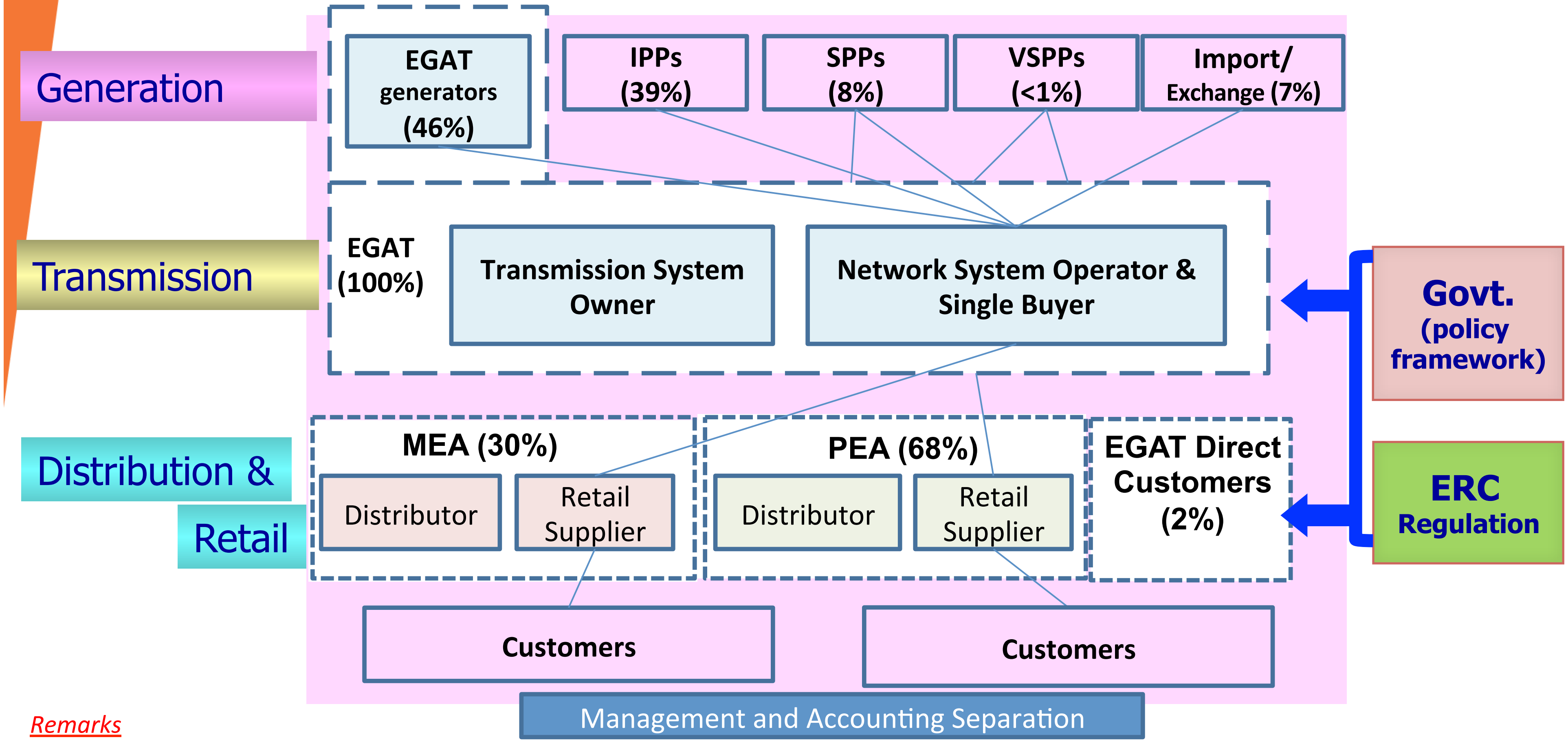
4 License Types for Natural Gas Industry

Supply & Wholesale | Transmission | Retail & Distribution | LNG Terminal

Reliability & Security → **Engineering Standard** → **Quality Service Standard** → **Safety Standard**

Tariff → **Competition** → **RE & EE Promotion** → **Public Participation**

Electricity Structure : Enhanced Single Buyer Model



Remarks

EGAT = Electricity Generating Authority of Thailand

MEA = Metropolitan Electricity Authority

PEA = Provincial Electricity Authority

IPPs = Independent Power Producers (Capacity sold to EGAT > 90 MW)

SPPs =Small Power Producers (Capacity sold to EGAT ≤ 90 MW)

VSPPs =Very Small Power Producers (Capacity sold to MEA/PEA ≤10 MW)

Note: % in (_) = market share as at Dec 2012

Private Power Producers (as of Mar 2013)

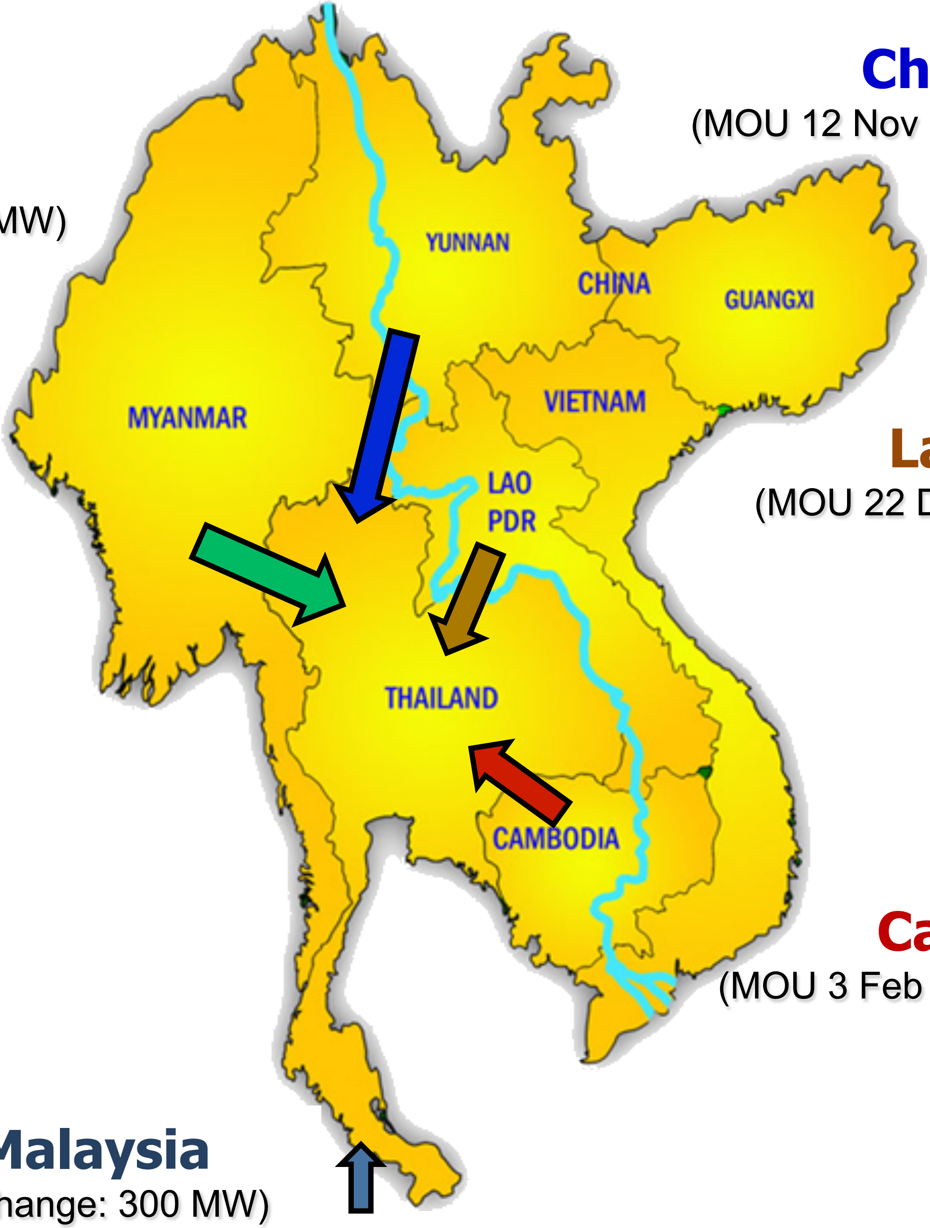
Producers	Supplying to Grid	In Pipeline (pending COD or PPA signing)
IPP (>90 MW)	12,811.6 MW (11) EGAT's 5,474 MW (3) Private 7,337 MW (8)	3,740 MW (3)
SPP (10-90 MW)	3,356.52 MW (71)	PPA signed, pending COD: 4,630 MW (53) Accepted, pending PPA: 1,191 MW (21)
VSPP (≤10 MW)	1,056.15 MW (369)	PPA signed, pending COD: 2,512.52 MW (486) Accepted, pending PPA: 223.69 MW (82)
	17,224.27 MW (451)	**12,297.21 MW (645)**

Remarks: ( ) = No. of projects

Power Purchase from Neighboring Countries

China
(MOU 12 Nov 98 : 3,000 MW)

Myanmar
(MOU 14 Jul 97 : 1,500 MW)

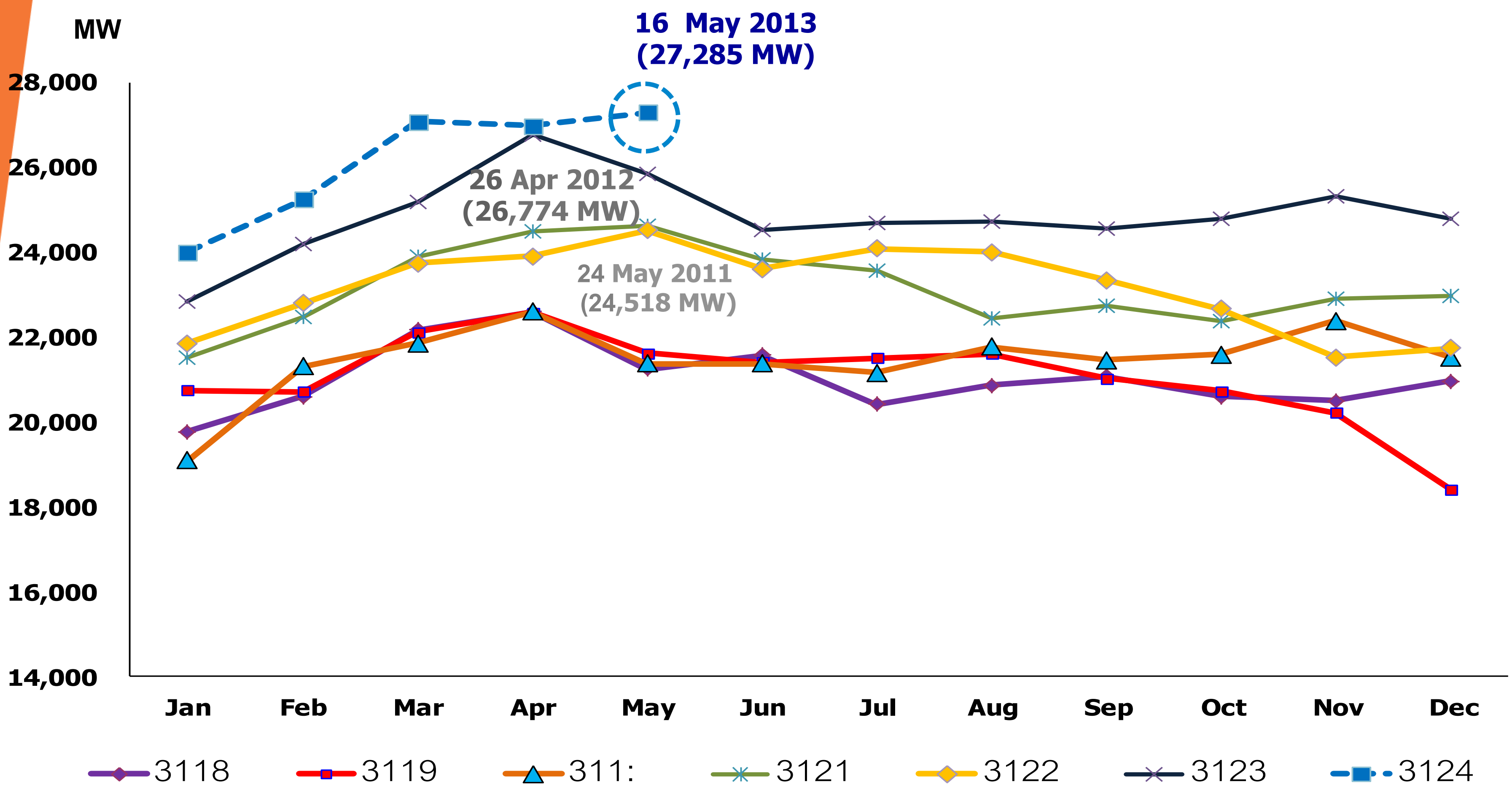


Lao PDR
(MOU 22 Dec 07 : 7,000 MW)

Cambodia
(MOU 3 Feb 00 : Yet to be Defined)

Malaysia
(Exchange: 300 MW)

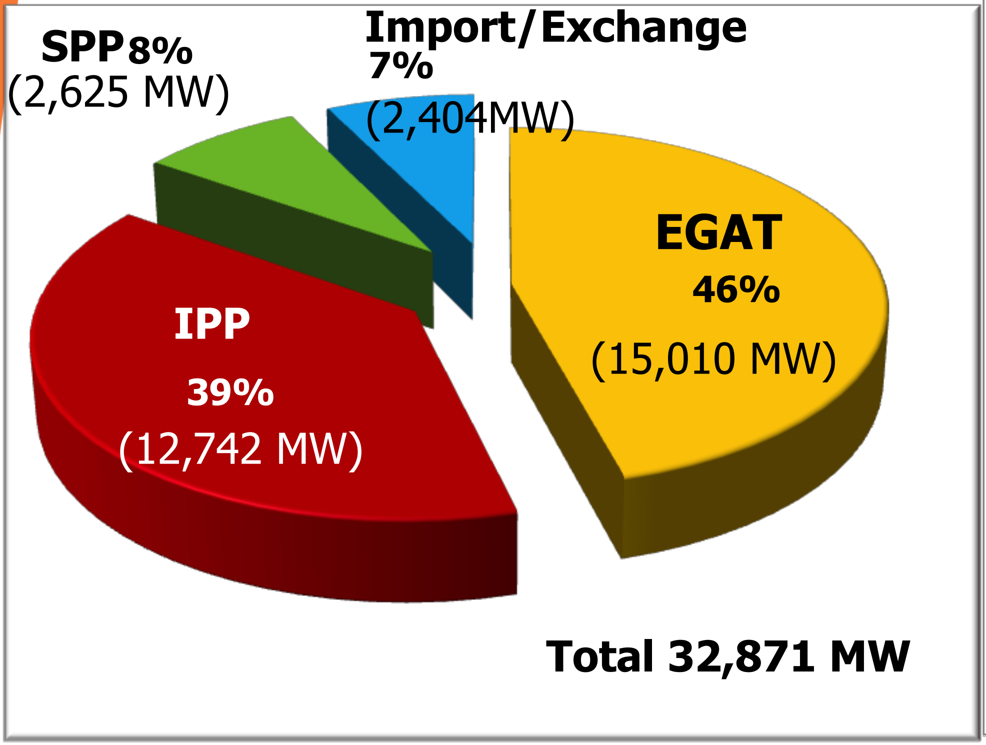
Gross Peak Generation



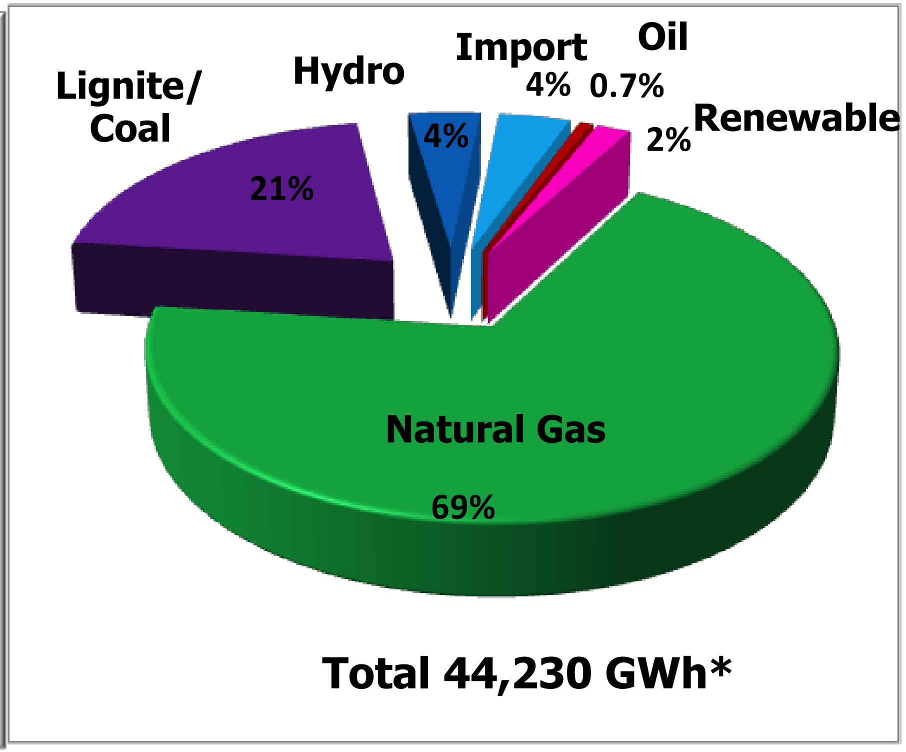
Source: EPPO

Power Generation – Installed Capacity as at March 2013

Share of Installed Capacity by Producer



Power Generation Share by Fuel Type

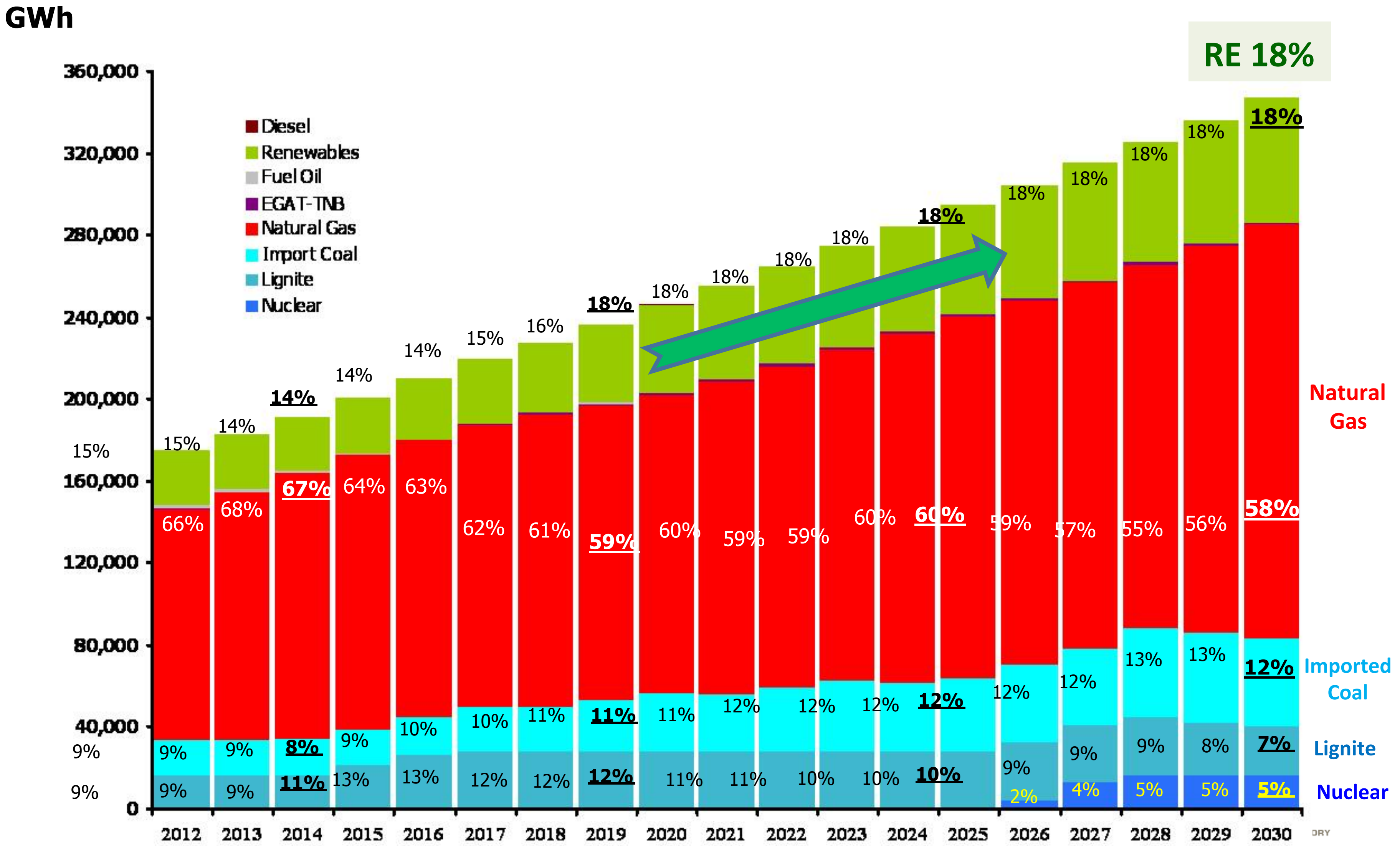


*Jan-Mar

คณะกรรมการ
กำกับกิจการพลังงาน
ENERGY REGULATORY
COMMISSION

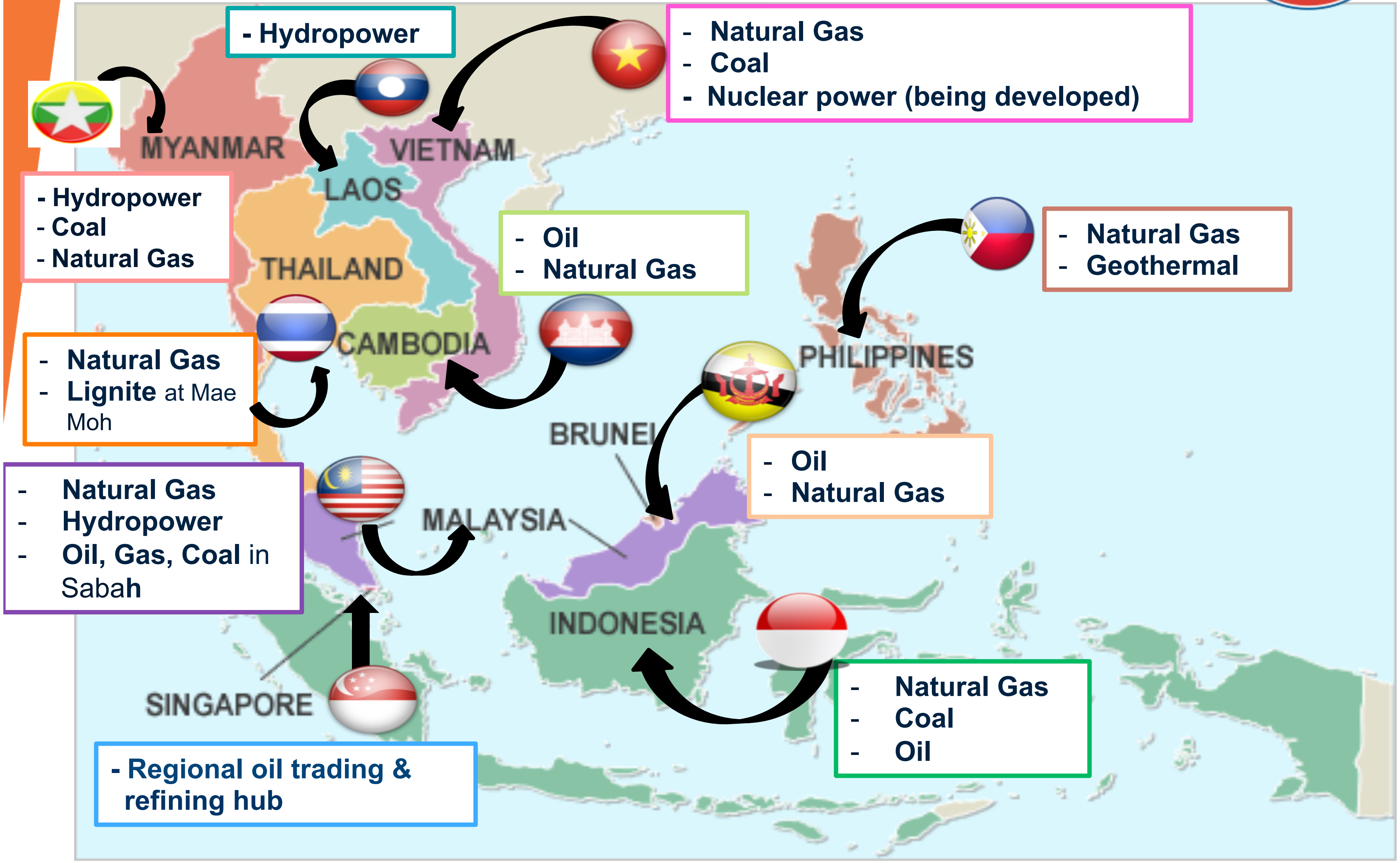
Power Development Plan 2010 : Revision 3

Electricity Generation classified by Fuel Type



Source: EGAT

ASEAN Energy Resources & Cooperation



ASEAN Energy Regulators Network

- Establish a formal network under ASEAN
  - ERC Thailand hosted annual ASEAN energy regulators meeting since 2010 (4th Meeting March 2013 on Interconnectivity and Cross Border Trade)
  - 1st ASEAN Energy Regulators Network (AERN) meeting held March 2012 at the regional forum
  - 2nd AERN Meeting March 2013
  - AERN Terms of Reference still under negotiation
  - AERN TOR to be submitted to 2013 ASEAN Ministers in Indonesia June 2013
  - AERN will focus on regulatory issues related to regional power and gas trade
- 2010 Meeting Identified Challenges and Issues for regulators in ASEAN (next slide)

ASEAN ENERGY REGULATORS' NETWORK (AERN)

Beginning Stage: 2010 - 2011

The 1st AERN 2012

Outcome

- Draft TOR of AERN was circulated to ASEAN Member States for comments
- Thailand ERC organized an Interim AERN meeting on 28-29 Aug 2012 in Bangkok to finalize the TOR of AERN and AERN Work Plan

The 2nd AERN 2013

Outcome

- Final Draft TOR of AERN and AERN Work Plan for 2012-2013
- Preparation for the 31st SOME in Indonesia
- AERN Chairmanship Transition in 2014

	Theme 1 Supply	Theme 2 Climate change	Theme 3 Comp and Affordability	Theme 4 Institutional
Brunei	Fuel source future Reliance on natural gas. High consumption Generation efficiency	Energy Efficiency targets EE&C regulation & promotion Renewable energy development	Low tariffs	Energy education, research and development promotion International networking
Cambodia	Fragmented and large number of systems Rural electrification		High tariffs Tariffs not cost reflective	
Lao	Plan for TSO		EDL unbundling and listing IPPs for generation	Plan to establish regulator
Malaysia	Fuel diversity Decoupling demand from GDP	Renewable targets (financing) Little interest in DSM Introduce feed in tariff	Vertically integrated ESI Reducing energy intensity High reserve margin	EC/EPU Codes review Strengthen regulations/Act
Myanmar	Capacity constraints Trans & Dist Power system operation & upgrading		Privatisation policy	Strengthening the regulatory system
Philippines	Spot market price signals Market based ancillary services	DSM Smart metering	Codes governance. Performance based regl. Retail liberalization Subsidies (lifeline rates)	Consumer education and engagement Staff retention.
Thailand	Codes governance Expiry of PPAs Wholesale purchase arrangements	Promotion of renewable Power planning/IRP Coordination with other agencies	Tariff Review Subsidies	Institutional strengthening Capacity building Networking with other regulators
Vietnam	Introducing cost reflective tariffs No clear PPA process Introduction of comp market	Small & mini hydro development DSM introduced	Introducing market based pricing. Sector unbundling	New organization. Funded from gov budget. MOIT ultimate decision maker

Electricity Access in AEC

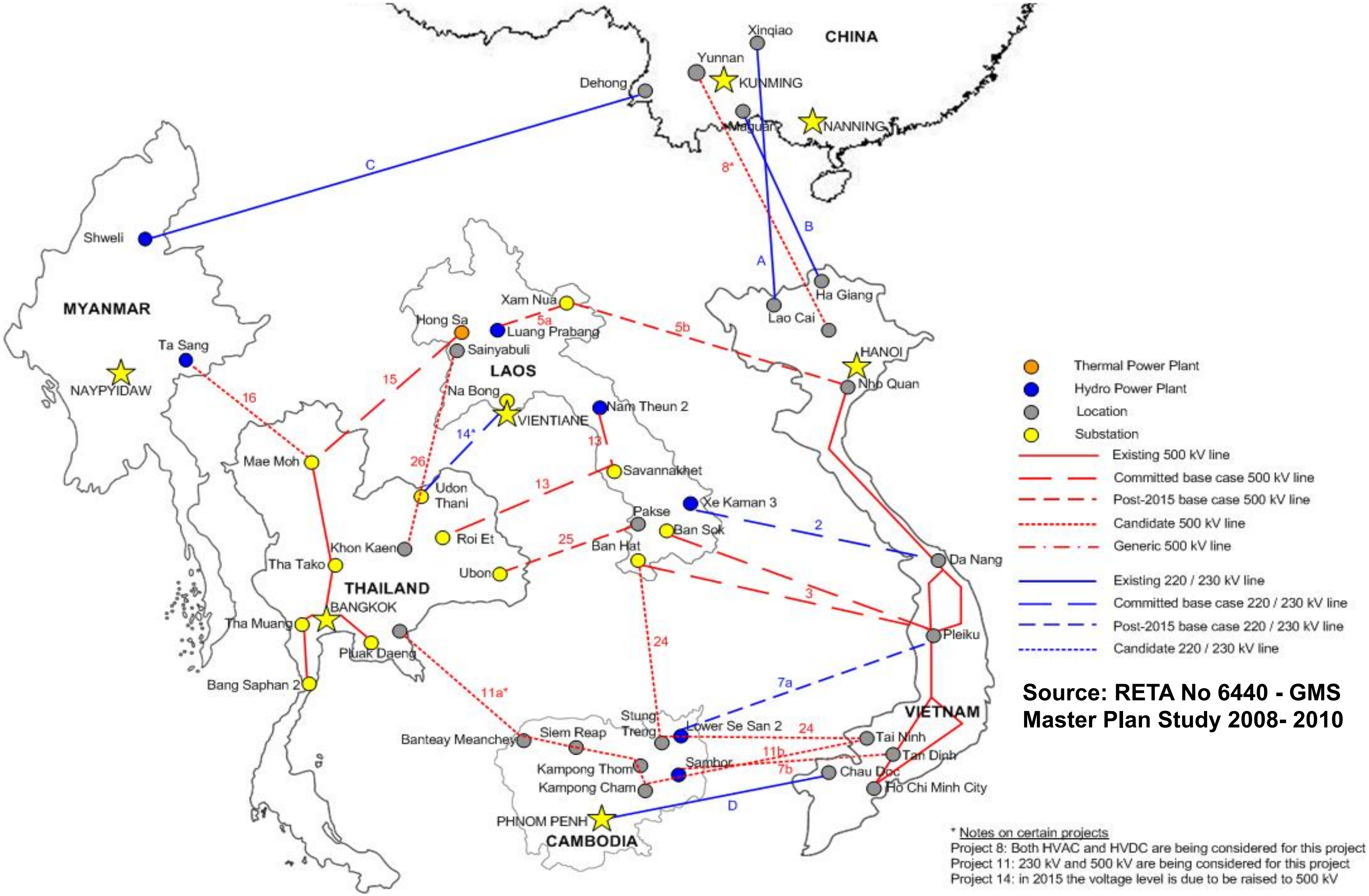
Data for 2009		
Country	Share of Population with Access to Electricity (%)	Number of people without Access to Electricity (millions)
Singapore	100.0	0
Brunei	99.7	0
Malaysia	99.4	0.2
Thailand	99.3	0.4
Vietnam	89.0	9.5
Philippines	86.0	12.5
Indonesia	64.5	81.1
Laos	55.0	2.7
Cambodia	24.0	11.2
Myanmar	13.0	42.8
ASEAN region	71.9	160.3

ที่มา: The Electricity Access Database (IEA)

Structure of ESI in AEC

	Regulators: Independent	Regulators: Department	Structure
Brunei: DES Dept. of Electrical Services		✓ under the Minister of Energy	Single Buyer
Cambodia: EAC Electricity Authority of Cambodia	✓ Set up in 2001		Single Buyer
Indonesia: DEMR Dept. of Energy& Mineral Resources		✓ under Ministry of Energy & Mineral Resources	Single Buyer
Laos (DOE) Department of Electricity		✓ Under the Ministry of Energy and Mines (MEM)	Single Buyer
Malaysia Energy Commission	✓ Set up in 2001		Single Buyer
Myanmar		✓ under the Ministry of Electric Power 1& 2	Single Buyer
Philippines: ERC Energy Regulatory Commission	✓ Set up in 2001		Price Pool
Singapore: EMA Energy Market Authority		✓ under the Ministry of Trade and Industry	Price Pool
Thailand: ERC Energy Regulatory Commission	✓ Set up in 2007		Single Buyer
Vietnam: ERAV Electricity Regulatory Authority		✓ under the Ministry of Industry (MOI)	Cost Base Pool

Overview of the GMS Power Master Plan

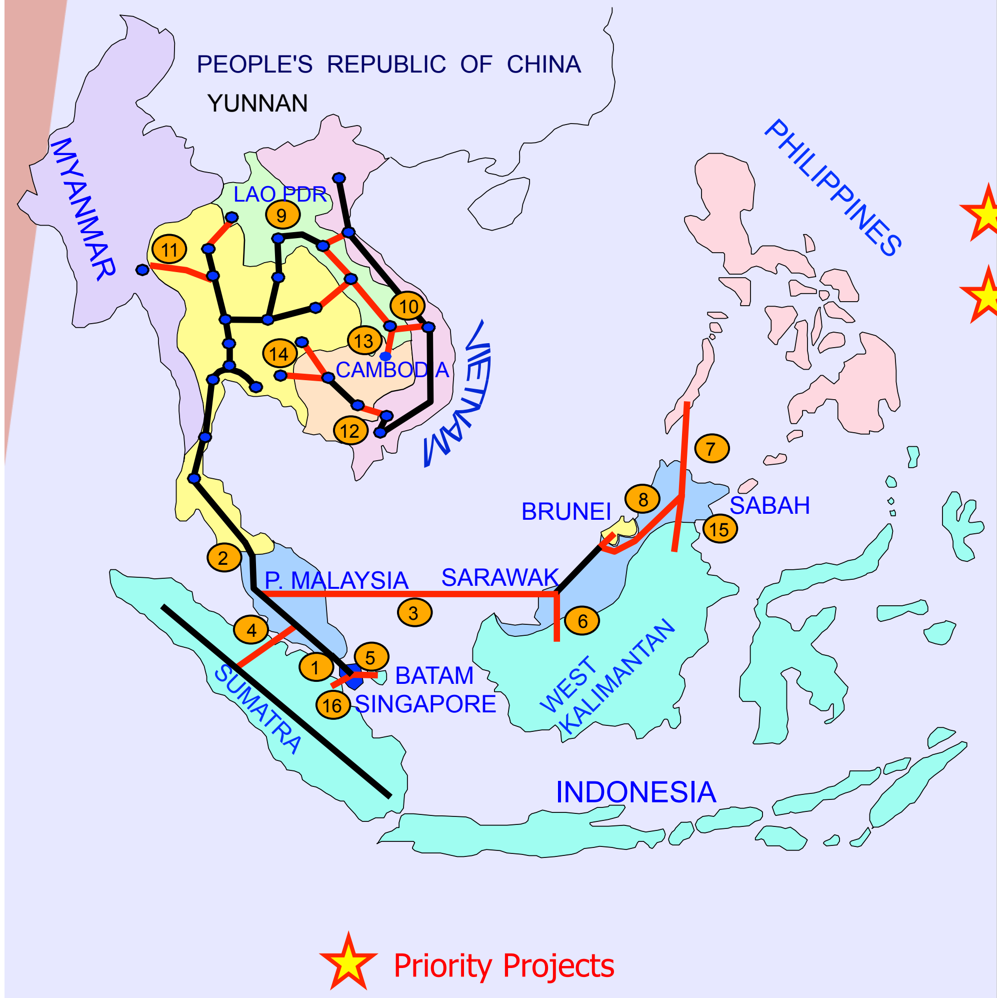


Source: RETA No 6440 - GMS Master Plan Study 2008- 2010

* Notes on certain projects
Project 8: Both HVAC and HVDC are being considered for this project
Project 11: 230 kV and 500 kV are being considered for this project
Project 14: in 2015 the voltage level is due to be raised to 500 kV

ASEAN Interconnectivity Projects

(Updated on 17 January 2013)



		Earliest COD
1)	P.Malaysia - Singapore (New)	2018
3)	Thailand - P.Malaysia	
•	Sadao - Bukit Keteri	Existing
•	Khlong Ngae - Gurun	Existing
•	Su Ngai Kolok - Rantau Panjang	2015
•	Khlong Ngae – Gurun (2nd Phase, 300MW)	2016
3)	Sarawak - P. Malaysia	2015-2021
4)	P.Malaysia - Sumatra	2017
5)	Batam - Singapore	2015-2017
6)	SarPhilippiawak - West Kalimantan	2015
7)	Philippines - Sabah	2020
8)	Sarawak - Sabah – Brunei	
•	Sarawak –Sabah	2020
•	Sabah – Brunei	Not Selected
•	Sarawak – Brunei	2012, 2016
9)	Thailand - Lao PDR	
•	Roi Et 2 - Nam Theun 2	Existing
•	Sakon Nakhon 2 – Thakhek – Then Hinboun (Exp.)	Existing
•	Mae Moh 3 - Nan - Hong Sa	2015
•	Udon Thani 3- Nabong (converted to 500KV)	2018
•	Ubon Ratchathani 3 – Pakse – Xe Pian Xe Namnoy	2018
•	Khon Kaen 4 – Loei 2 – Xayaburi	2019
•	Thailand – Lao PDR (New)	2015-2023
10)	Lao PDR - Vietnam	2011-2016
11)	Thailand - Myanmar	2016-2025
12)	Vietnam - Cambodia (New)	2017
13)	Lao PDR - Cambodia	2016
14)	Thailand - Cambodia (New)	2015-2020
15)	East Sabah - East Kalimantan	2020
16)	Singapore – Sumatra	2020

Regional Integration is currently Bilateral with one-way power flows

MOUs between Thailand and Neighboring Countries

	Capacity (MW)	Signed Dated	Endorser
Thailand - Laos	**7,000**	**22 December 2007**	Ministry of Energy
Thailand –Myanmar	**1,500**	**4 July 1997**	Ministry of Office of the Prime Ministry
Thailand – China	**3,000**	**12 November 1998**	Ministry of Office of the Prime Ministry
Thailand - Cambodia	**N.A.**	**3 February 2000**	Ministry of Office of the Prime Ministry

Remark: MOU between Thailand – Laos of the first signed on 4 June, 1993 Capacity of 1,500 MW

Challenges to Regional Integration

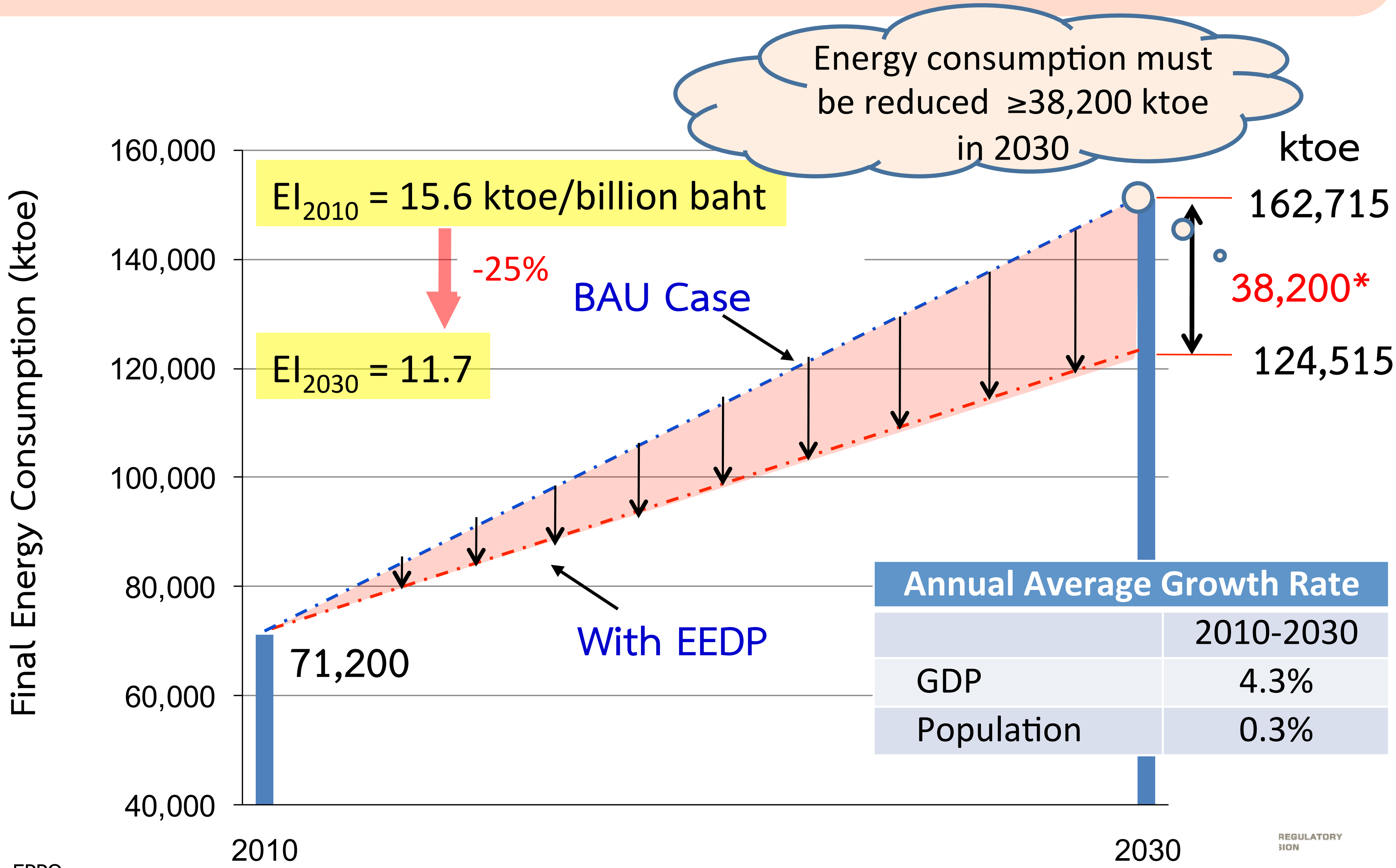
- Economic Viability of Transmission Projects
- Effective Regulatory Framework
- Funding, including private participation

National Differences

- Level of Economic Development
- Level of Infrastructure provision
- Finance and Capital Markets
- Private Sector Development policies
- Tariffs and Subsidies
- Rural Electrification and Access levels
- Access to domestic natural resources

20-Year Energy Efficiency Development Plan (2011-2030)

! Energy Efficiency Targets pursuant to the Government Policy @ 23Aug2011



Annual Average Growth Rate	
	2010-2030
GDP	4.3%
Population	0.3%

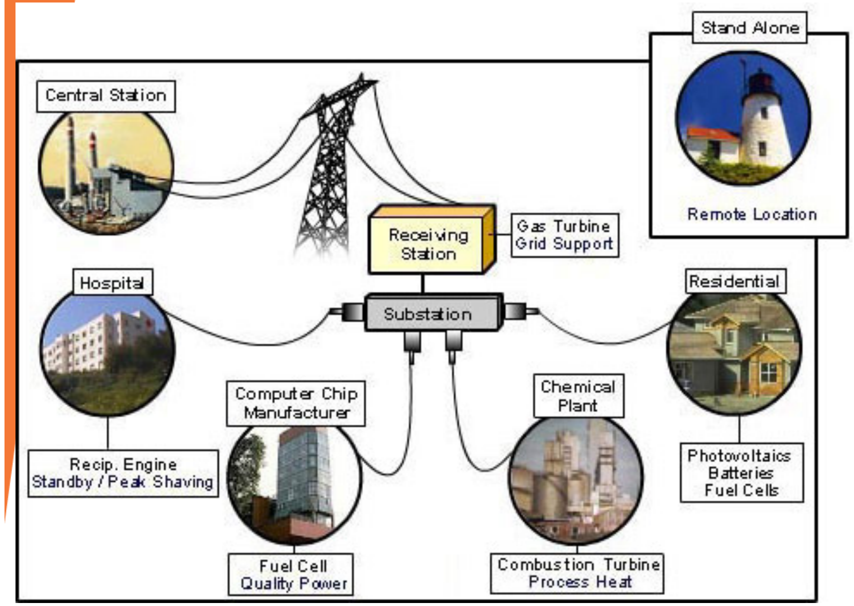
Source: EPPO

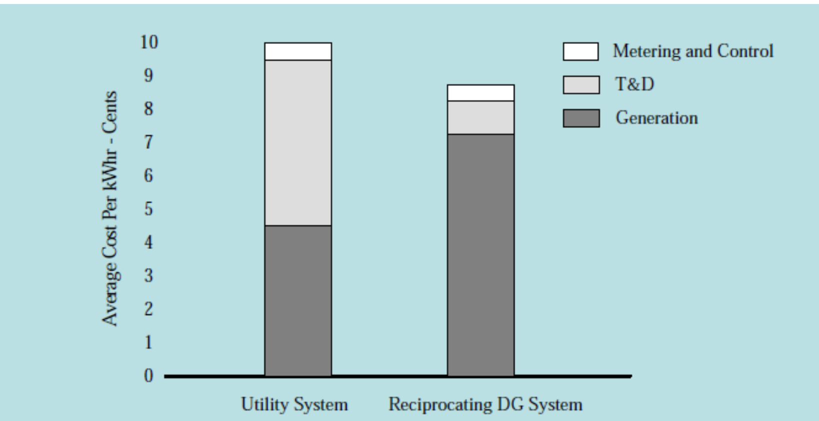
(* Increased from the initial target of 30,000 ktoe)

Target of Alternative/Renewable Development under the 10-year AEDP (2012 - 2021)

Type	Unit	Generating Capacity (at Nov2011)	Target in 2021 (10-year AEDP)
Electricity			**Total: 9,201 MW**
1. Wind	MW	**7.28**	**1,200**
2. Solar	MW	**75.48**	**2,000**
3. Hydro	MW	**86.39**	**1,608**
4. Biomass	MW	**1,751**	**3,630**
5. Biogas	MW	**137.57**	**600**
6. Municipal Solid Waste	MW	**13.45**	**160**
7. New energy for power gen.	MW	**-**	**3**
Replace electricity use	**%**		**10.1%**
Thermal			
8. Solar	ktoe	**1.98**	**100**
9. Biomass	ktoe	**3,285.97**	**8,200**
10. Bio-gas	ktoe	**378.66**	**1,000**
11. MSW	ktoe	**1.26**	**35**
Total	**ktoe**		**9,335**
Bio-fuel			
12. Ethanol	ML/Day	**1.30**	**9.0**
13. Bio-Diesel	ML/Day	**1.62**	**5.97**
14. New fuel replacing diesel	ML/Day	**-**	**25.0**
Total	**ML/Day**		**39.97**
Replace oil (percentage)			**44%**
Ratio of Alternative Energy to Final Energy Consumption			**25%**

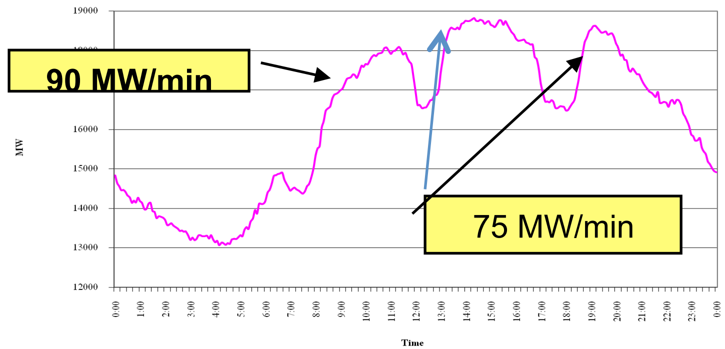
Distributed Generation (DG)



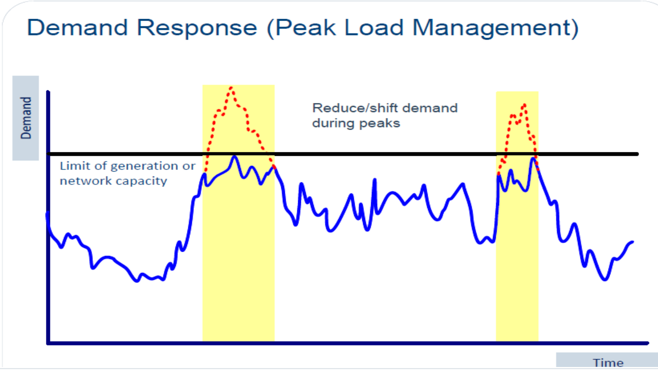


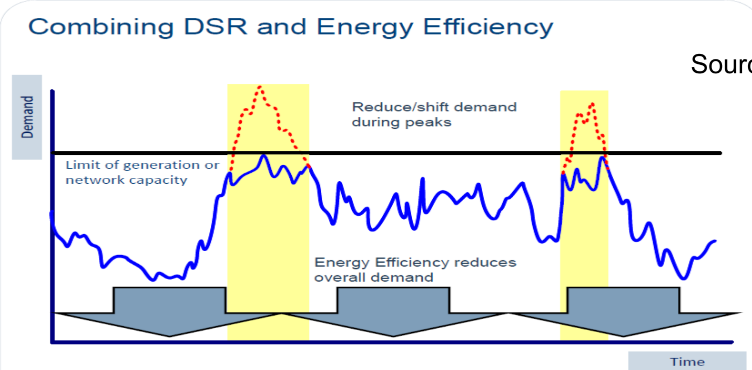
Source : H.L. Willis W.G. Scott Distributed Power Generation New York , Marcel Dekker Inc.

Demand Response



Thailand Load Duration Curve





Source : EnerNOC

Demand Response & Energy Efficiency

Smart Grid

Improvement of grid reliability

Improve security & safety

Improved operational efficiency

Environmental quality

Reduce the price of electricity

Integrating Distributed Generation (DG)

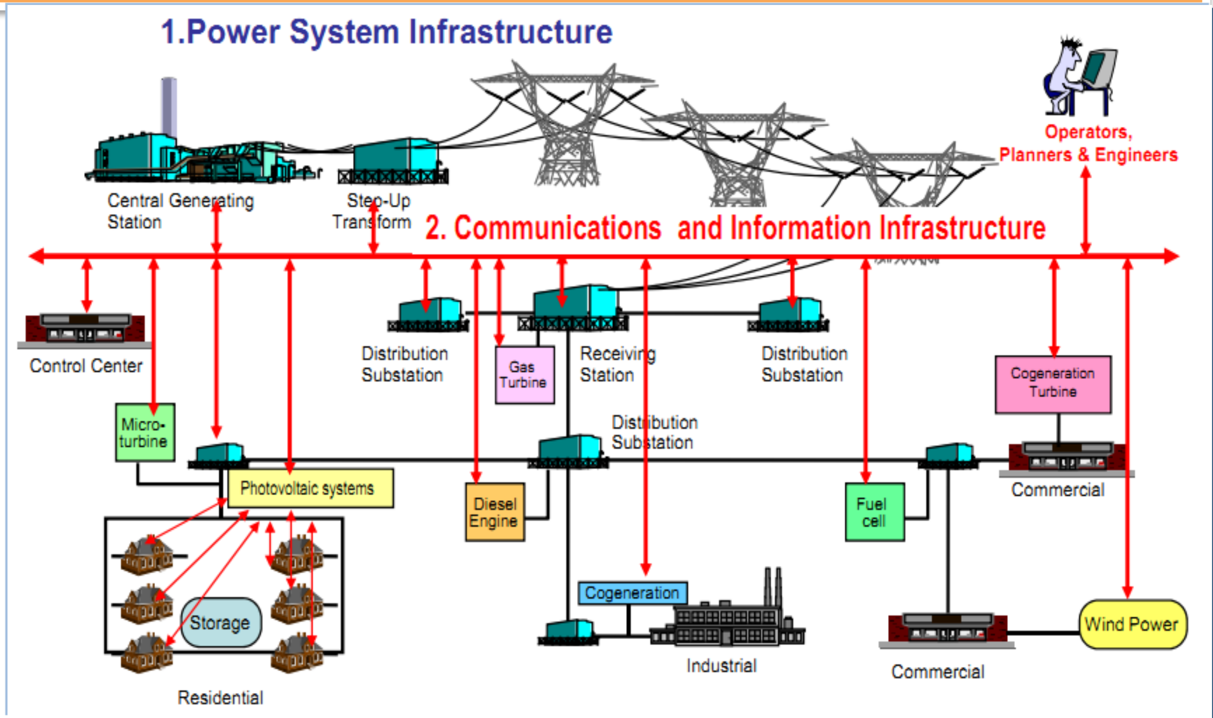
Integrating Demand and Storage (Demand Response)

Integrating large scale Renewable Energy Sources (RES)

Source : European University Institute , Robert Schuman Center for Advanced Studies

Smart Regulation for Smart Grid

Integrating large scale Renewable Energy Sources (RES)



Interoperation is Key Driven

Smart Grid Standards

- Internet protocol standards
- Energy usage information standards
- Standards for plugs used to charge electric vehicles
- Use cases for communication between plug-in vehicles and the grid
- Requirements for upgrading smart meters, which will replace household electric meters
- Guidelines for assessing standards for wire/wireless communication devices ,such as cell phones

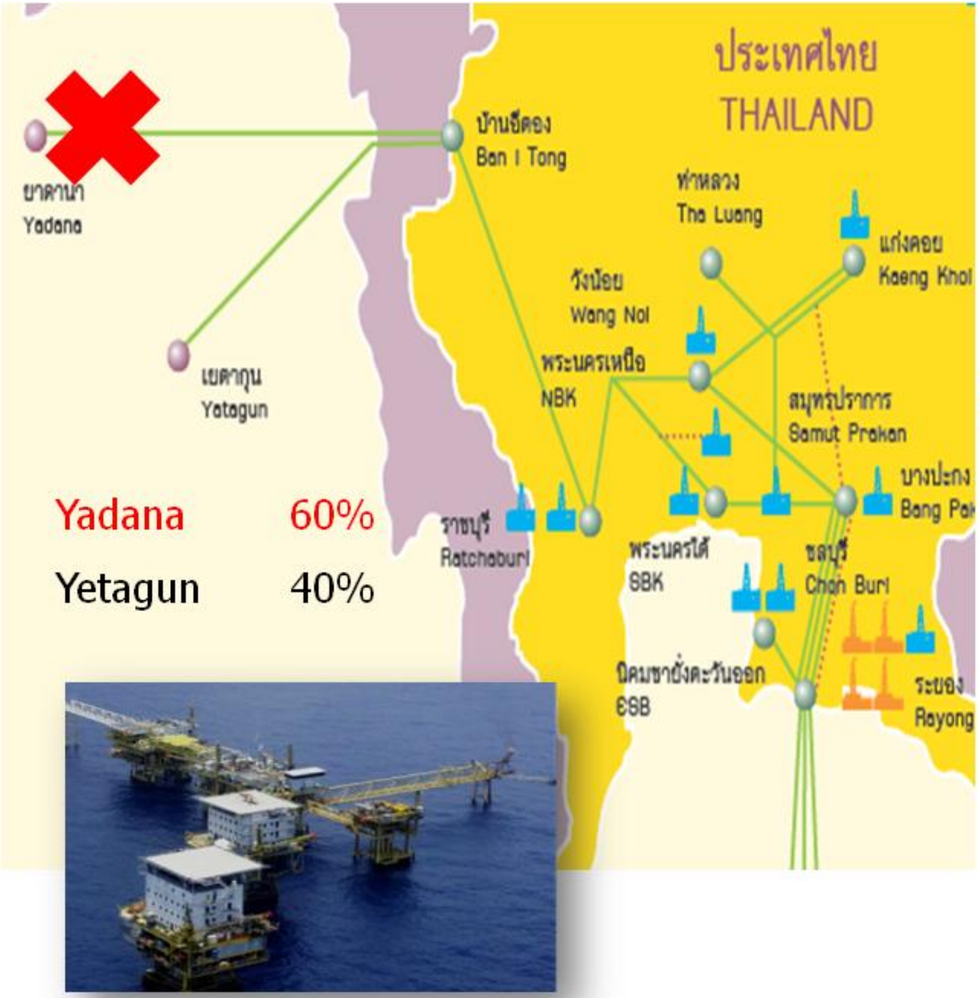
Integrated Both Power & Communication Infrastructure

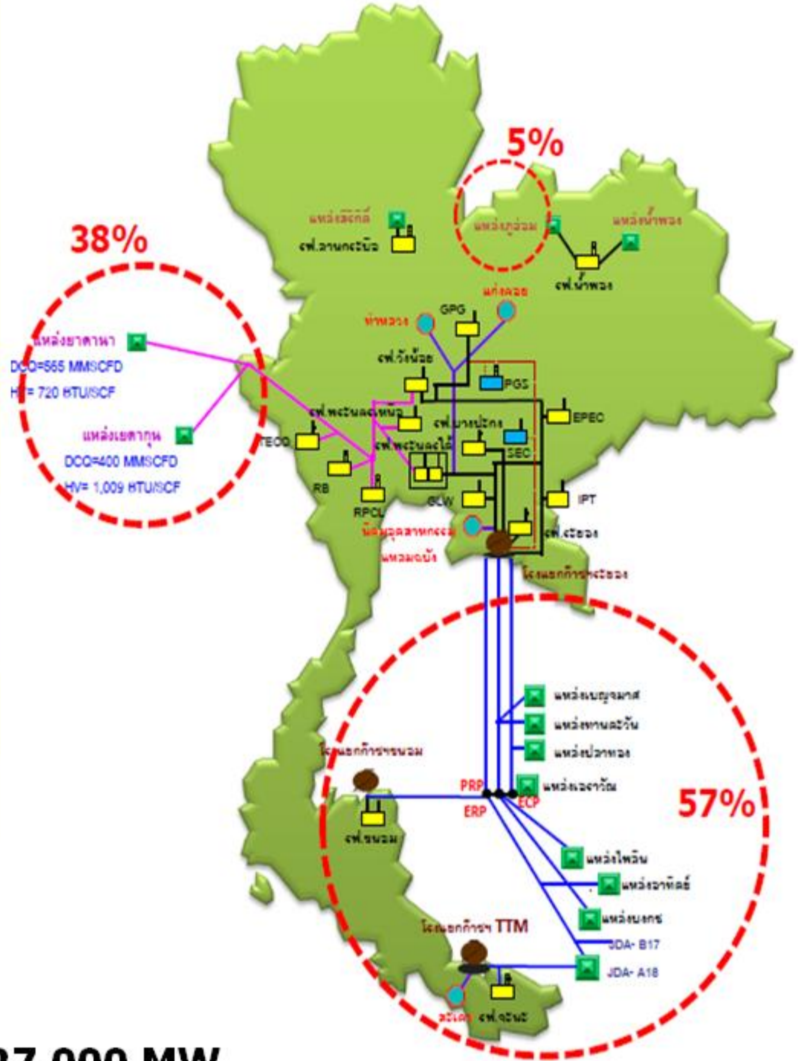
Source: NIST: Summaries of First Six Catalog of Standards Entries

2013 Energy Crises: Case Study

- **Halt in Natural Gas Supply from Myanmar 5-13 April 2013**
- **Massive Power Blackout in Southern Thailand 21 May 2013 (6.52 pm)**
- **Guidelines/Measures on energy crisis management**

Halts in Natural Gas Supply from Myanmar
5-13 April 2013





Available Capacity April, 2013 **27,000 MW**

Source: EGAT

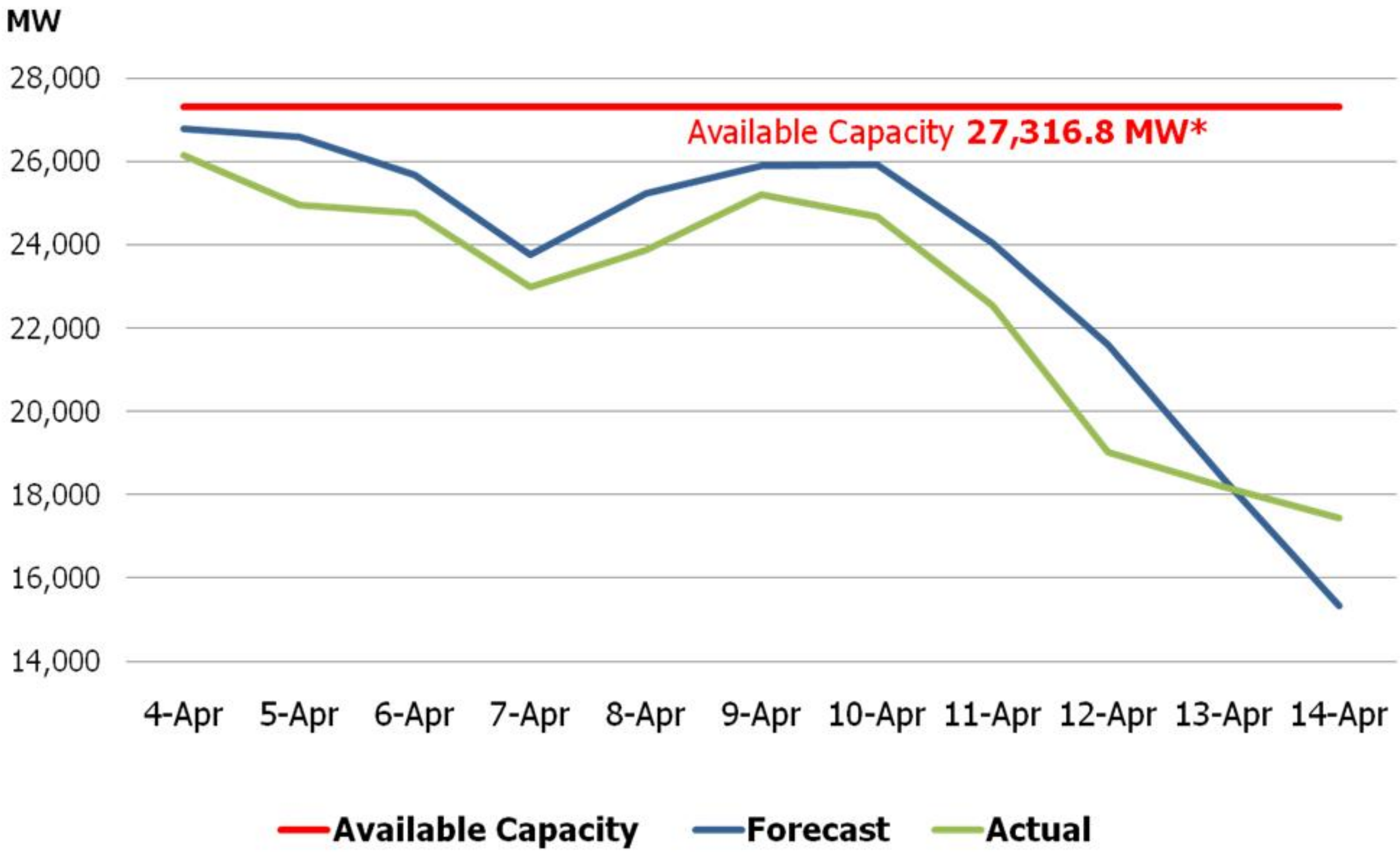
WHY?

• Yanada Gas Production Platform Sinking

- Since 2008 Yanada Gas Production Platform is sinking 23 cm every year.
- This situation cause engineering safety issues.
- The maintenance activities for overcoming this problem occurred in 5-13 April 2013.

EGAT has to switch fuel from Natural Gas to Fuel Oil.

Peak Demand 5–13 April, 2013



Source: EGAT

Massive Power Blackout in Southern Thailand 21 May 2013 (6.52 pm.)

Peak Demand (MW)

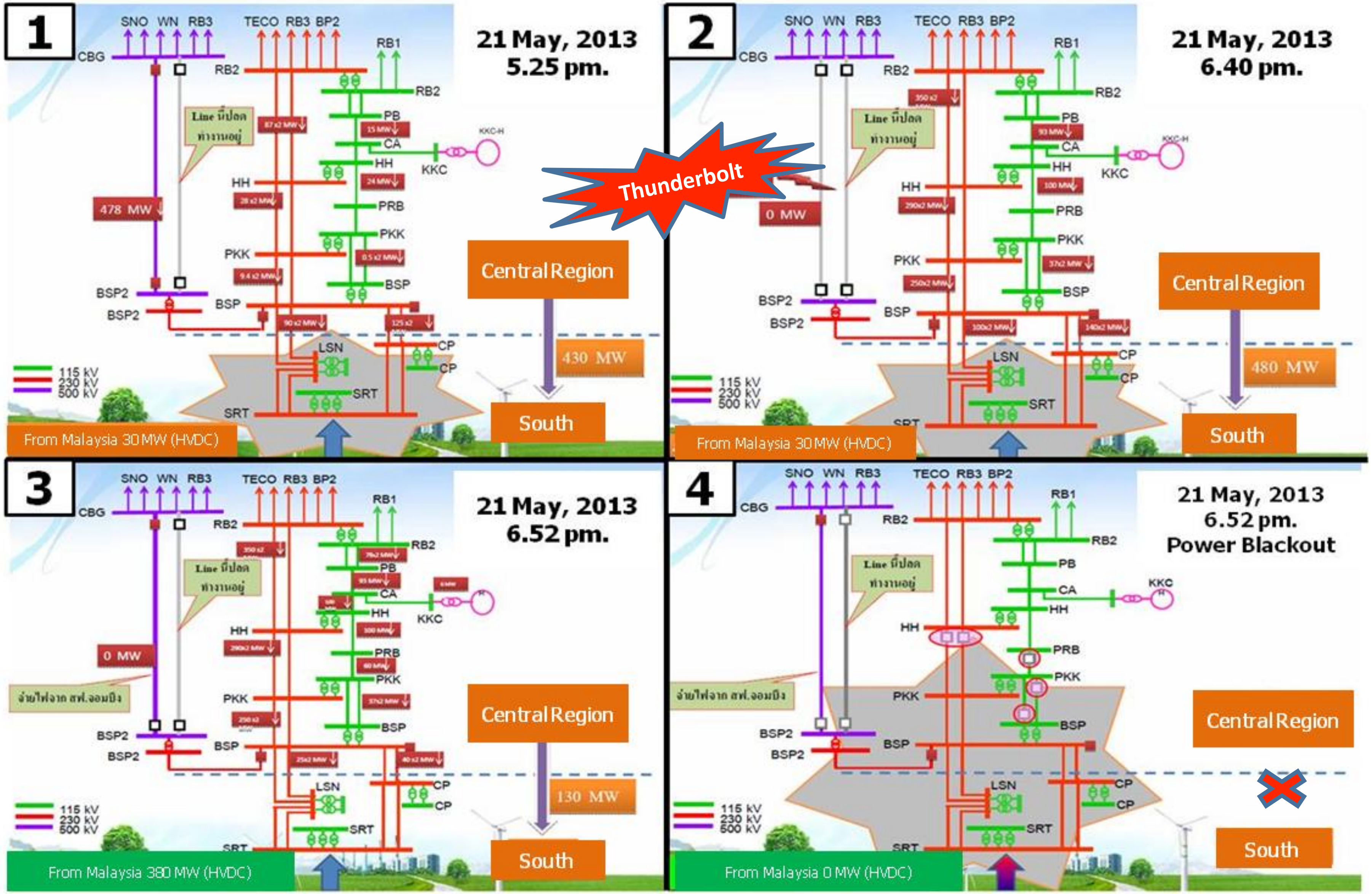
Year	EGAT	Metropolitan	Central	North-East	South	North
2009	22,044.90	8,564.80	7,696.60	2,752.60	1,944.50	2,363.50
2010	24,009.90	9,452.65	8,802.80	3,041.60	2,192.70	2,475.65
2011	23,900.21	9,061.45	8,857.88	2,776.95	2,095.70	2,378.80
2012	26,121.10	9,650.16	9,470.65	3,040.55	2,252.65	2,634.49
2013	26,598.14	9,869.10	9,605.94	3,425.30	2,423.80*	2,718.28

**Peak Demand (MW) 7.30 pm. 2 April, 2013*

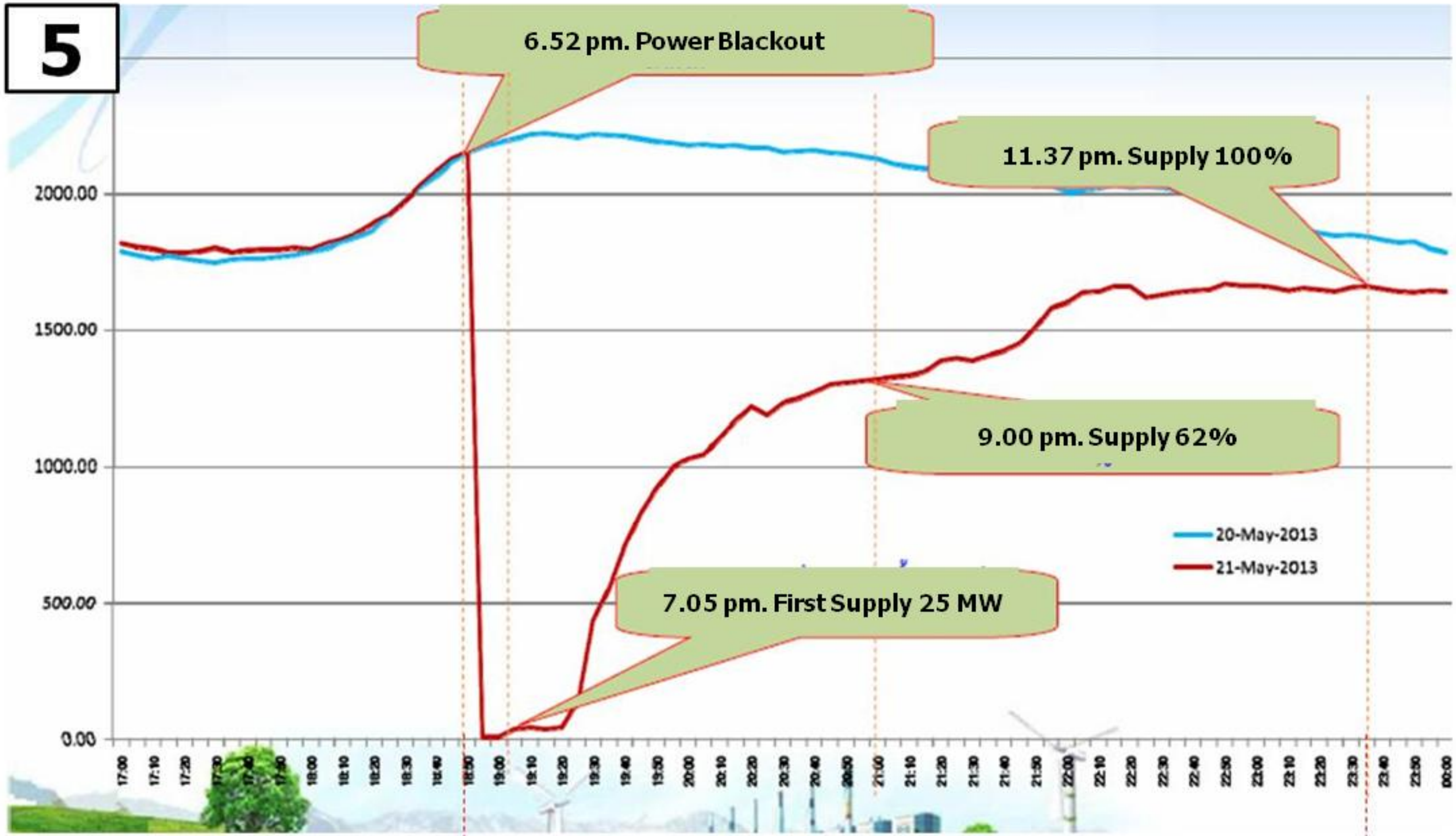
Capacity (MW)

Year	EGAT	Metropolitan	Central	North-East	South	North
2009	29,212.02	1,678.00	19,717.13	1,828.07	2,485.58	3,503.24
2010	30,209.02	2,348.00	19,807.13	2,776.07	2,485.58	3,503.24
2011	31,446.72	2,348.00	19,807.13	3,372.67	2,415.68	3,503.24
2012	32,601.02	2,348.00	20,733.93	3,600.17	2,415.68	3,503.24
2013	33,051.02	2,348.00	21,183.93	3,600.12	2,415.68	3,503.24

Source: EGAT


1
21 May, 2013
5.25 pm.
478 MW
430 MW
Central Region
South
From Malaysia 30 MW (HVDC)
2
21 May, 2013
6.40 pm.
Thunderbolt
0 MW
480 MW
Central Region
South
From Malaysia 30 MW (HVDC)
3
21 May, 2013
6.52 pm.
0 MW
130 MW
Central Region
South
From Malaysia 380 MW (HVDC)
4
21 May, 2013
6.52 pm.
Power Blackout
Central Region
South
From Malaysia 0 MW (HVDC)
115 kV
230 kV
500 kV

Source: EGAT



6.52 pm.

Power Blackout =2,172 MW

11.37 pm.

Source: EGAT

Guidelines/Measures on Energy Crisis Management:

- Balanced source of power supply from each type of fuel: Natural Gas, Coal, Hydropower, Renewable. (Less dependent on Natural Gas).

- Improve Power Supply Reserve in the Southern Region to be less dependent on the Central Region and strengthen the backbone power grid (500/230 kV) in the South.

- Review Energy Crisis Plan and Blackout Restoration Plan as well as continuous exercises.

- Regular audit and review of frequency control and dispatching systems.

Thank you
for your kind attention

Energy Regulatory Commission

www.erc.or.th

Back-up Information

Independent Power Producers

1st IPP Bidding Round

commenced during 2000-2008

IPPs	Fuel Type	Capacity (MW)
1. IPT	**Natural Gas**	**700**
2. TECO	**Natural Gas**	**700**
3. Ratchburi Power	**Natural Gas**	**1,400**
4. Gulf Power	**Natural Gas**	**1,468**
5. BLCP	**Coal**	**1,346.5**
6. Glow IPP	**Natural Gas**	**713**
7. EPEC	**Natural Gas**	**350**
		6,677.5

2nd IPP Bidding Round – Dec 2007

Expected to commence during 2012-2014

IPP	Fuel	Capacity (MW)	COD/ SCOD
1.GHECO-One	Coal	660	Aug 2012
2. National Power Supply (NPS)	Coal	540: Unit 1 Unit 2	Nov 2016* Mar 2017*
3. Gulf JP UT (GUT) (formerly Siam Energy)	Gas	1,600: Unit 1 Unit 2	Jun 2015* Dec 2015*
4. Gulf JP NS (GNS) (Formerly Power Generation Supply)	Gas	1,600: Unit 1 Unit 2	Jun 2014 Dec 2014
		4,400	* Revised COD

3rd IPP Bidding Round – Dec 2012

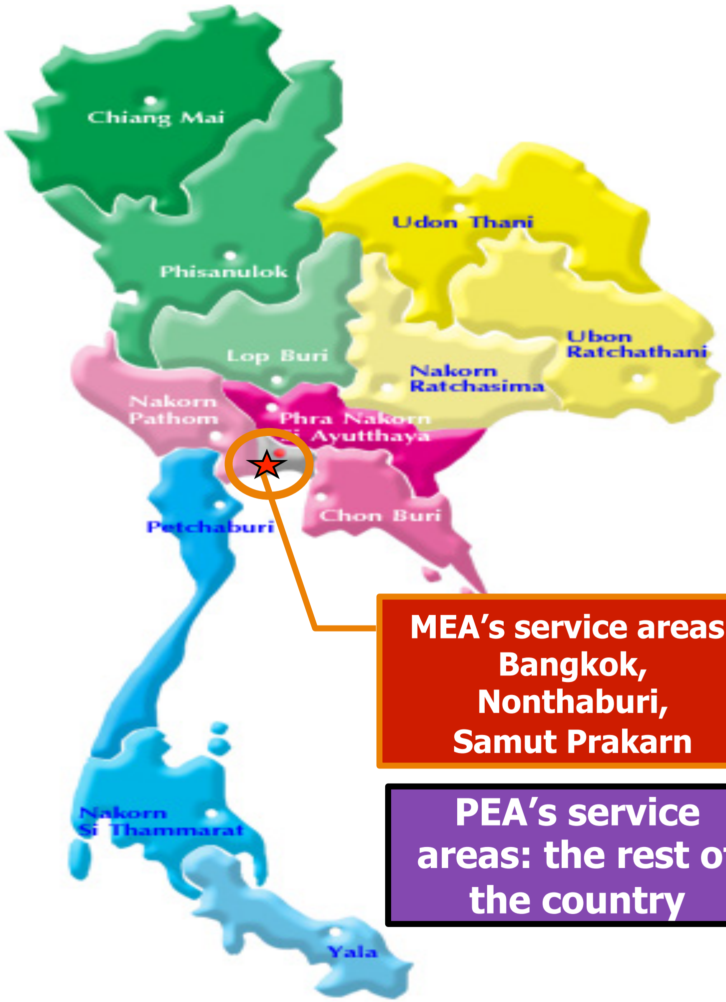
Selection is underway

Expected to commence during 2021-2026

Fuel	Total Expected Capacity (MW)
Gas	5,400

คณะกรรมการกำกับกิจการพลังงาน ENERGY REGULATORY COMMISSION

ABOUT THAILAND



MEA's service areas: Bangkok, Nonthaburi, Samut Prakarn

PEA's service areas: the rest of the country

MEA: Metropolitan Electricity Authority
PEA: Provincial Electricity Authority

Population (2012) — **67 Million**

Customers (at end-2012) — **19.8 Million**

MEA (3.2 million)	47,880	GWh
PEA (16.6 million)	107,368	GWh
Direct EGAT customers	2,415	GWh
Total Sale in 2012	157,664	GWh

Transmission Network — **19,190 km**

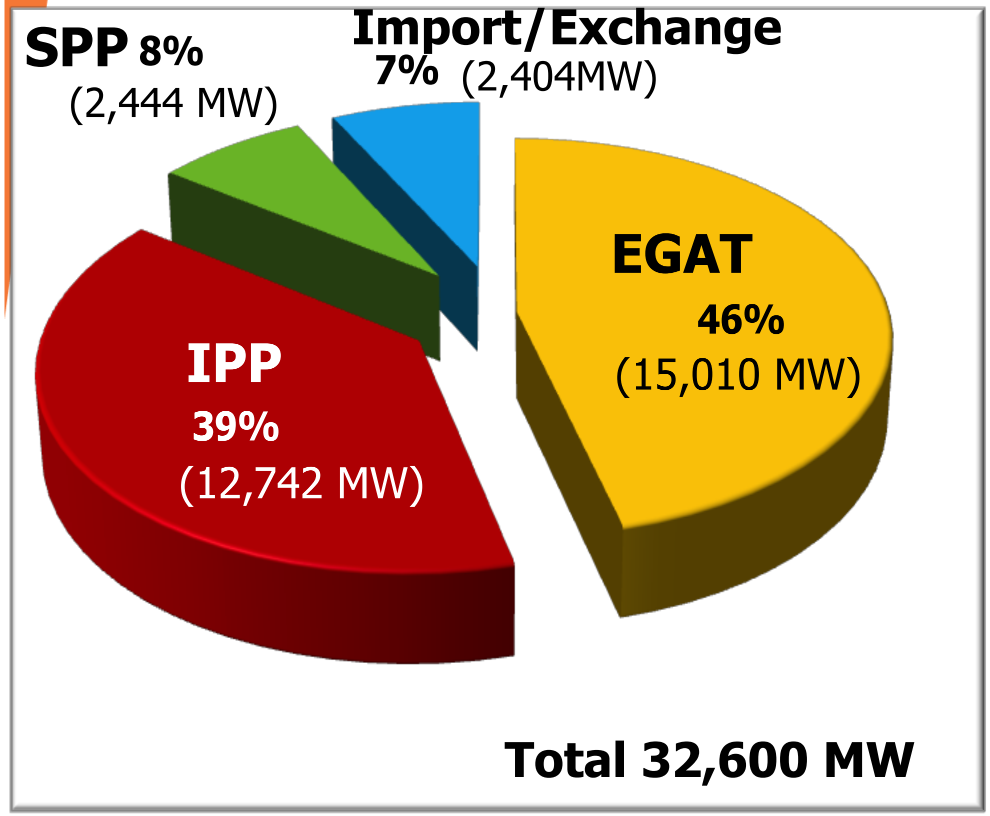
Rural Electrification — **99.8%**

Access, Transmission and Distribution

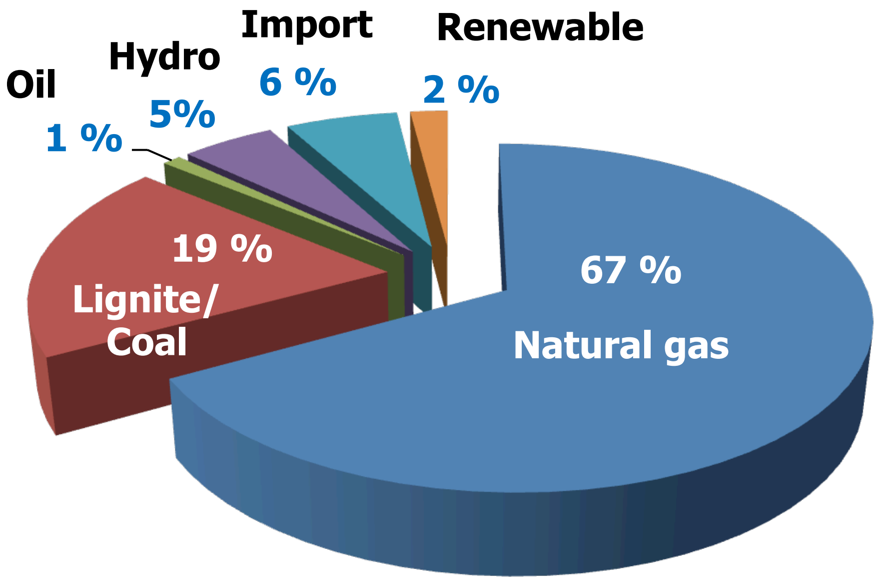
- Population access to electricity: 99%
- Urban Population access to electricity: 100%
- Rural Population access to electricity: 99.8%
- Distribution and transmission losses: 8%
- National Grid Coverage: 99%
- Reliability of electricity service: Occasional brownouts

Power Generation – Installed Capacity as at December 2012

Share of Installed Capacity by Producer



Power Generation Share by Fuel Type



Total 176,973 GWh

Electricity Consumption

Unit: GWh

	2010	2011	2012	2013*	Growth Rate (%)			
					2010	2011	2012	2013*
MEA	45,060	44,195	48,244	11,871	8.0	-1.9	9.2	1.3
PEA	102,470	102,947	111,717	27,845	11.7	0.5	8.5	4.6
EGAT's Direct Customers	1,771	1,713	1,817	411	2.5	-3.3	6.0	-8.3
Total	149,301	148,855	161,778	40,127	10.4	-0.3	8.7	3.4

*Jan-Mar

คณะกรรมการกำกับกิจการพลังงาน ENERGY REGULATORY COMMISSION

Source: EPPO

Electricity Consumption of the Whole Country
(Classified by Tariff Category)

Unit: GWh

Category	2011	2012	2013*	Growth Rate (%)			Share (%) 2013*
				2011	2012	2013*	
Residential	32,799	36,447	8,840	-1.3	11.1	3.1	22.0
Small General Service	15,446	17,015	4,425	-0.9	10.2	10.6	11.0
Medium General Service	23,116	24,889	6,675	-2.7	7.7	14.4	16.6
Large General Service	61,100	66,401	16,857	1.3	8.7	5.7	42.0
Specific Business	4,799	5,405	1,413	1.0	12.6	6.6	3.5
Government & Non-profit Org**	4,888	3,799	39	-3.2	-22.3	-96.7	0.1
Agricultural Pumping	297	377	140	-11.5	27.1	-5.3	0.3
Temporary	841	1,172	317	10.3	39.4	21.8	0.8
Others***	3,855	164,417	1,009	2.6	8.9	-6.5	2.5
Direct Customer	1,713	1,817	411	-3.2	6.0	-8.3	1.0
Total	148,855	161,778	40,127	-0.3	8.7	3.4	100.0

Source: EPPO

* Jan-Mar

** Government agencies have been re-classified to be under SGS/MGS/LGS categories since Oct 2012.

*** Stand by Rate, Interruptible Rate and Free of Charge

Adder for RE Generation -- classified by RE type

Fuel/Technology	2010* Present Adder Rate (Baht/kWh) (FX = 31Baht/USD)	Special Adder for 3 Southernmost Provinces (Baht/kWh)	Special Adder for Diesel Replacement (Baht/kWh)	Support Duration (Years from COD)
1. Biomass				
- Installed capacity ≤ 1 MW	0.50 (US¢ 1.6)	1.00	1.00	7
- Installed capacity >1 MW	0.30 (US¢ 1.0)	1.00	1.00	7
2. Biogas (all sources)				
- Installed capacity ≤ 1 MW	0.50 (US¢ 1.6)	1.00	1.00	7
- Installed capacity >1 MW	0.30 (US¢ 1.0)	1.00	1.00	7
3. Waste (MSW and non-toxic industrial waste)				
- Landfill	2.50 (US¢ 8)	1.00	1.00	7
- Thermal process	3.50 (US¢ 11.3)	1.00	1.00	7
4. Wind				
- Installed capacity ≤ 50 kW	4.50 (US¢ 14.5)	1.50	1.50	10
- Installed capacity > 50 kW	3.50 (US¢ 11.3)	1.50	1.50	10
5. Hydro (Mini/Micro-hydro)				
- Installed capacity 50 - <200 kW	0.80 (US¢ 2.6)	1.00	1.00	7
- Installed capacity < 50 kW	1.50 (US¢ 4.8)	1.00	1.00	7
6. Solar	6.50* (US¢ 21)	1.50	1.50	10

* Cabinet resolution 20Jul2010, applied to projects that have not yet been accepted by Power Utilities.

Status of RE Generation in Thailand (as of Mar2013)

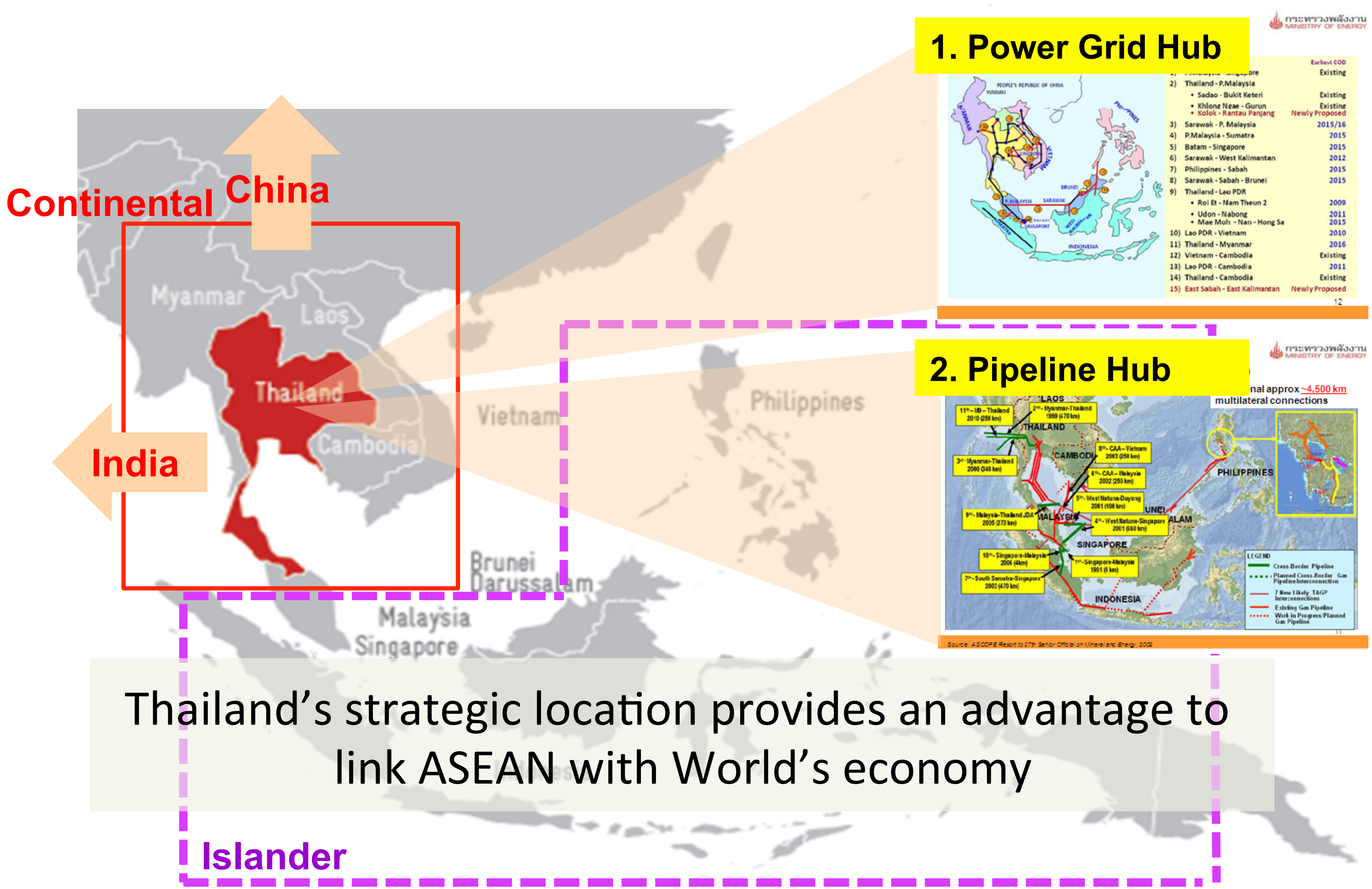
Unit: MW

RE Type	Status of RE Projects Having Applied for Adders				Total Installed Capacity	Target of Installed Cap in 2021 (10-yr AEDP plan)
	Supplying to Grid	PPA signed (pending COD)	Proposal accepted (pending PPA)	Under consideration		
Biomass	1,851	1,498	235	410	3,995	3,630
Biogas	204	65	71	40	379	600
Waste	47	35	100	145	327	160
Hydro (Mini/Micro)	14	6	9	0.03	29	1,608
Wind	209	204	703	2,046	3,162	1,200
Solar	464	1,530	48	963	3,005	2,000
New Form of Energy						3
Total	2,789	3,338	1,165	3,604	10,897	9,201

Geothermal: 1 MW
Tidal: 2 MW

Contracted Cap: 9,077 MW

Thailand's Strategic Location to be Regional Energy Hub



Thailand's strategic location provides an advantage to link ASEAN with World's economy

Source: Team Analysis

Factors Enhancing Power Security

- **Generation System Planning**

  Forecast demand, Generation mix, Alternative Energy, Energy Efficiency, CO_2 Emission, Imports and Reserves

- **Transmission System Planning**

  System Performance Under Normal Condition / Single Contingency, The loss of any single power system element (N-1)

- **Distribution System Planning**

  Ability to supply system maximum demand without infringing standards for voltages or equipment ratings