



# Trans-Regional Energy Connectivity Between the ASEAN Power Grid and the South-Asia Power Grid: Prospects and Opportunities

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**SARI/EI/IRADe**



**Plenary Address**

**The ASEAN Power Grid Summit 2018- Enhancing APG Investment Towards Regional Energy Optimisation“**

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The Lao People's Democratic Republic (Lao PDR)**



# Content

- Brief About SARI/EI
- Overview of South Asia and It's Power Sector
- Cross Border Electricity Trade (CBET) in South Asia (SA)
- Indian Experience of Regional Power Grid Integration, Private Investment and Market Development.
- Lesson Learnt from South Asia Regional Power Grid and Market development in South Asia.
- Prospects : Why to Integrate ASEAN and South Asia Power Grid
- Opportunities – Short Term, Medium and Long Term Outlook for Integration of ASEAN and South Asia Power Grid
- Stages for Power system Integration and Power Trade between ASEAN and SA Power Grid
- Possible Trans-Regional Transmission Interconnections South Asia and ASEAN Power Grid.
- Market Model for Power Trade between ASEAN and South Asia Power Grid- Development of Cross Border Transmission Infrastructure.
- CBET Investments Risk and Regional Investment Framework
- Way Forward

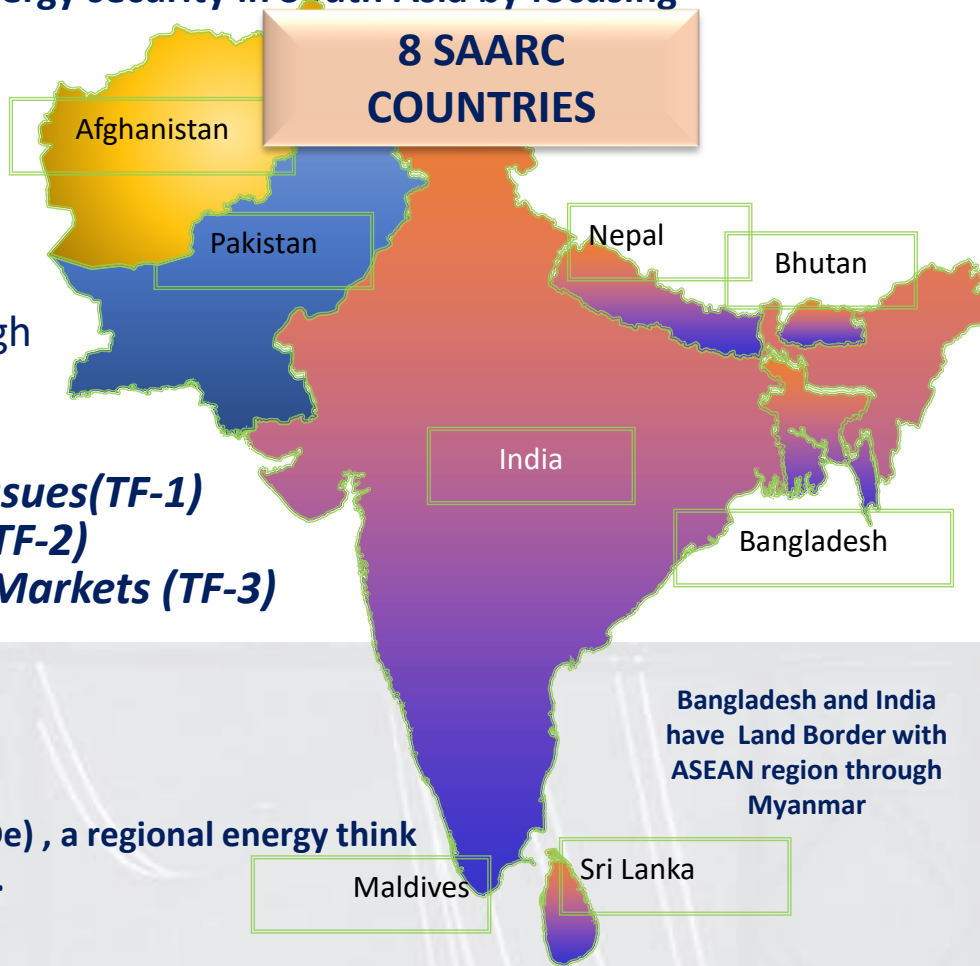
# South Asia Regional Initiative for Energy Integration (SARI/EI)

- SARI/E is a long standing program of USAID started in the year 2000
- Program has consistently strived to address energy security in South Asia by focusing
  - 1) Cross Border Energy Trade
  - 2) Energy Market Formation and
  - 3) Regional Clean Energy Development
- SARI/EI–Phase IV (2012-2018): Key Outcomes

Three Key Development Outcomes through three Task Forces (TFs) :

- 1. Coordinate policy, legal and regulatory issues(TF-1)**
- 2. Advance transmission interconnections (TF-2)**
- 3. Establish South Asia Regional Electricity Markets (TF-3)**

- Demand Driven ‘Bottom Up’ Approach
- Integrated Research and Action for Development (IRADE) , a regional energy think tank-based in Delhi, India is the implementing partner.



Task Forces are represented by Government Nominated members of level of Directors/Chief Engineers/Members etc. from Utilities, Regulators, planners, Power Exchanges of South Asian Countries. Project Steering Committee (PSC) is the apex body of the program and provides overall strategic directions. PSC members consist of Senior level officials from the country governments, SAARC, ADB, Independent Energy Experts/Diplomats.

Disclaimer : By making any reference to a particular geographic area or by using the term "country" and Map in this document, IRADE/USAID does not intend to make any judgement as to the legal or other status of any area/Map. The map used is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

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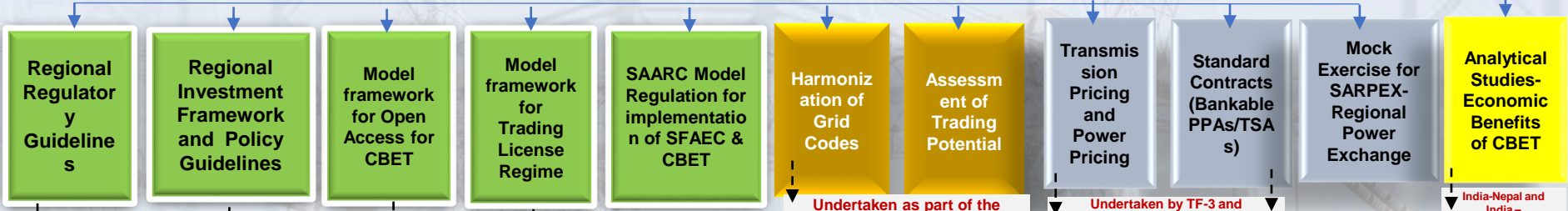
**SARI/EI Overall Framework for development of CBET and Regional Power Grid in SA**

**SAARC Framework Agreement on Energy (Electricity) Cooperation (SFAEC)**

**CBET facilitation through**

**Institutional Mechanism**  
SAFER  
SAFTU  
Investment Forum

**Task Force Demand Driven Studies/Activities**



Undertaken as part of the TF-1 and has been Published

Undertaken as part of the TF-2 and Published

Undertaken by TF-3 and Published

India-Nepal and India-Bangladesh Published

Investment Forum  
SAFTU  
SAFER

**Suggested Changes/Amendments in Electricity Laws, Regulations and Policies (L&R&P) of South Asian Countries.**



# South Asia: World's Fastest Growing Region



**South Asia Remains World's Fastest Growing Region (US \$3.3 Trillion).**

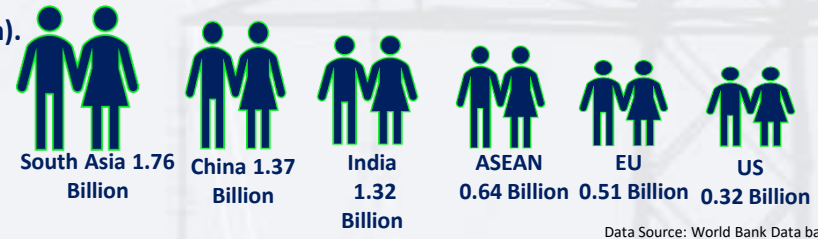
**Economic Growth (EG) expected to pick up to 6.9 % in 2018 and further to 7.1 % on an average in 2019-20.**

**Home to 1.76 billion, 23 % of world's population.**

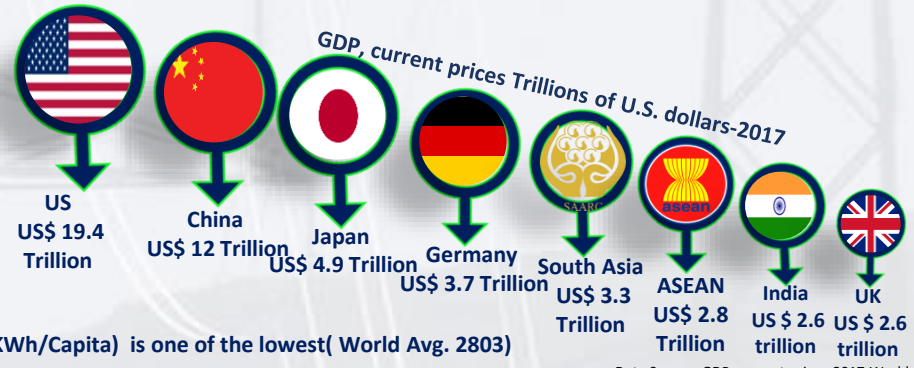
**India is the largest economy (US \$ 2.6 Trillion). in the region and geographically centrally located.**

**High Economic Growth Drives Energy Demand Growth.**

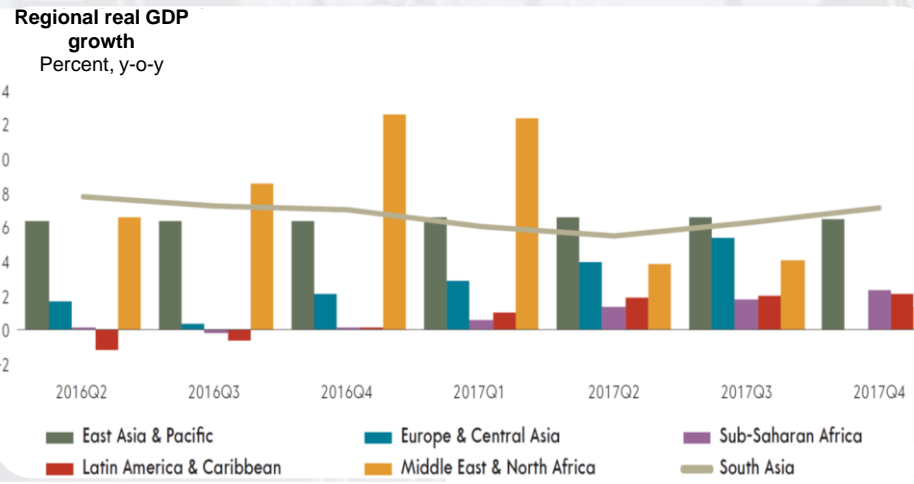
**Electricity demand in SA projected to grow at average rate of \*5.2% annually from 2013-2040. Per capita energy consumption (963 KWh/Capita) is one of the lowest( World Avg. 2803)**



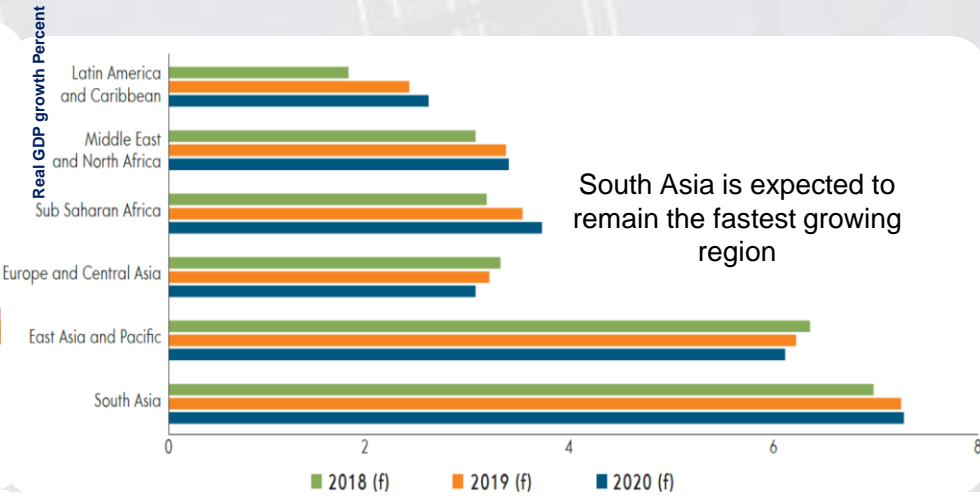
Data Source: World Bank Data base



Data Source: GDP, current prices-2017-World Economic Outlook April 2018-IMF Database



Source: South Asia Economic Focus Spring 2018-World Bank



South Asia is expected to remain the fastest growing region

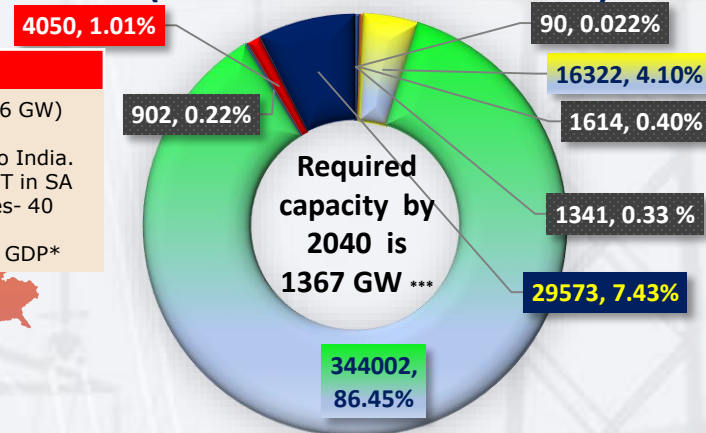
Source: South Asia Economic Focus Spring 2018-World Bank- <https://openknowledge.worldbank.org/handle/10986/29650>



# South Asia Power System –A Snap Shot

## South Asia Power Installed Capacity

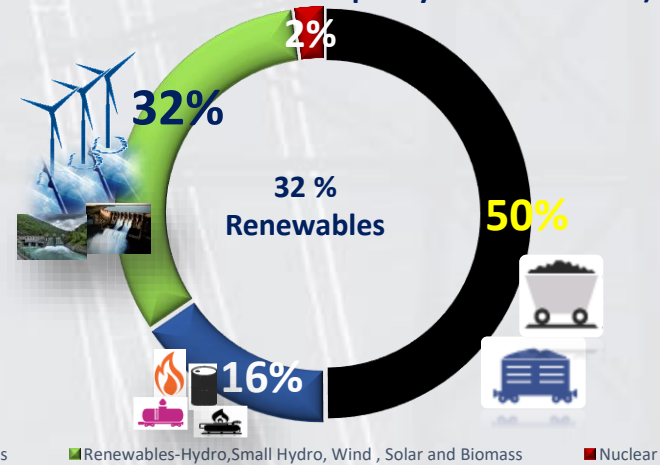
(397894 MW as on March,2018)



■ Afghanistan ■ Bhutan ■ Bangladesh ■ India  
■ Nepal ■ Sri Lanka ■ Pakistan ■ Maldives

\*\*\* For Indi-IEA-India Energy Outlook, Nepal- Electricity Demand Forecast Report (2015-2040)

## South Asia Power Installed Capacity Fuel Mix -2018



### Afghanistan

- Small power system (1.3 GW)
- High Electricity Imports high, Hydro Dominated.
- Proposed interconnection with Central Asia and Pakistan

### Nepal

- Very Small power system (.9 GW)
- Under utilized hydro potential
- Net importer of electricity now but potential to export in future

### Bhutan

- Small power system (1.6 GW)
- Large hydro potential
- Net exporter of power to India.
- Champion of Hydro CBET in SA
- Hydro Export contributes- 40 percent of government revenue., 25 percent of GDP\*



### Pakistan

- Mid sized (29 GW) power system
- Gas and Oil dependent.
- Import Electricity from Iran
- Proposed interconnection with Central Asia & Afghanistan

### India

- Very Large Power System (**344 GW**), Largest energy consumer and supplier in SA region
- Third largest producer and fourth largest consumer globally\*\*
- Large coal reserves, import of oil & gas
- Interconnections with Nepal, Bhutan and Bangladesh.
- **114 GW** of Renewable Energy (including Large Hydro)
- Net Exporter of Electricity-exporting 5,798 Million Units in 2017

### Maldives

- Fragmented and very small power systems
- Diesel dependent, Limited possibility of interconnection



### Bangladesh

- Mid Size power system (16 GW) with high gas dependence
- Interconnected with India
- Declining Gas reserves-Resource Crunch, 660 MW import from India

### Sri Lanka

- Small power system (4 GW)
- Hydro capacity nearing full potential
- Focus on conventional (gas/ coal) and renewable for future developments.
- High Peak Demand, Fuel mix is changing

Sri Lanka

**Bangladesh and India have Land Border with ASEAN region through Myanmar**

\* Source- <https://www.ibef.org/download/Power-October-20171.pdf>  
CBET-Cross Border Electricity Trade

\*\* and hydropower infrastructure development contributes another 25 percent of GDP through the construction sector. Source-<http://www.worldbank.org/content/dam/Worldbank/document/SAR/bhutan-country-snapshot-spring-2014.pdf>

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Data Source: Compiled by Author from Various Sources/SAR/IEI Data Source, CEA-India, DHPS-Bhutan, Ministry of Energy, NEA-Nepal, CEB, Ministry Energy-Sri Lanka, NITDC, NEPRA-Pakistan, DABS-Afghanistan

# Regional Resource Potential: Hydro Potential :350 GW !



**Vast potential of hydro power:350 GW**

**Bhutan, Nepal, Pakistan, India have 30,83, 59, 150 GW respectively.**

**Nepal and Bhutan can build exported oriented hydro plants.**

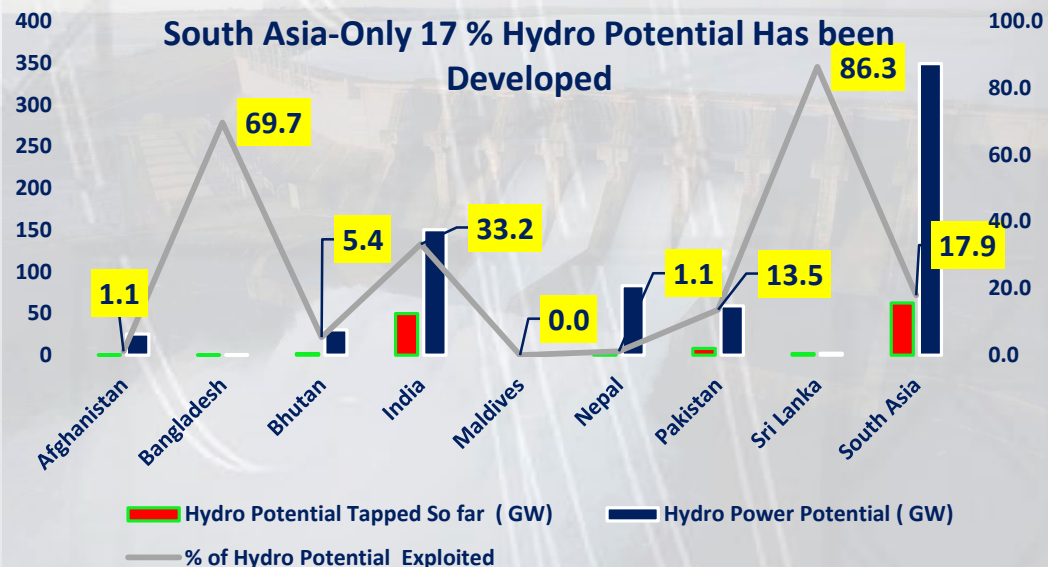
**Significant Coal deposits in India and Pakistan.**

**Coal deposits in Bangladesh yet to be exploited effectively.**

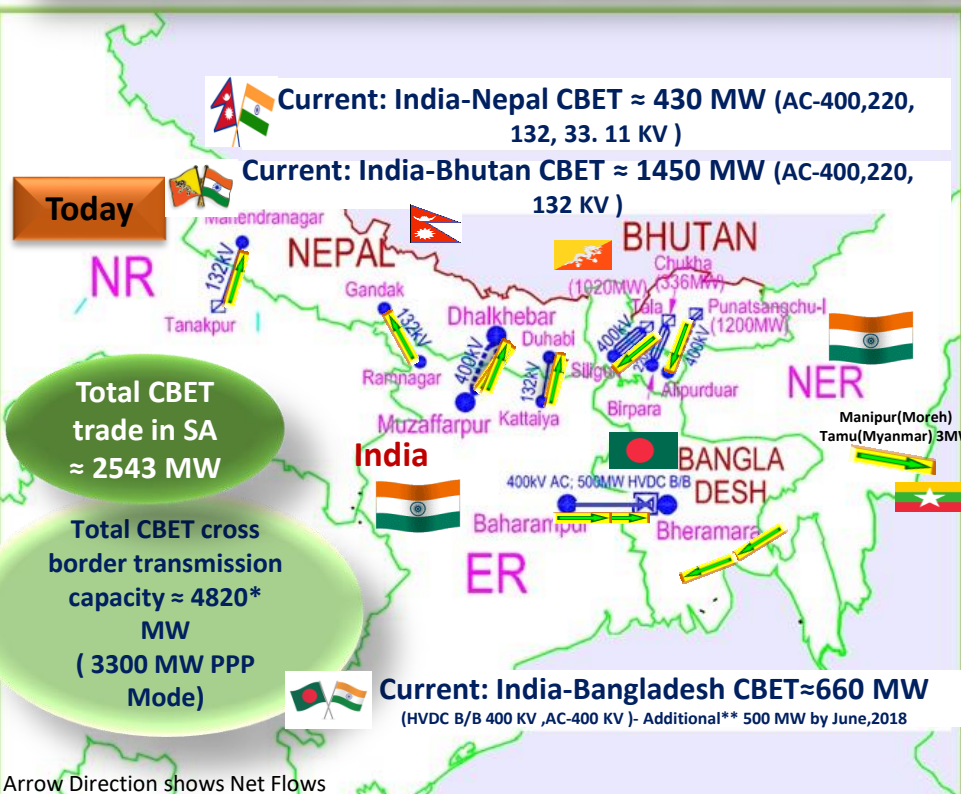
**In addition ,there is a huge renewable energy resources like solar and wind.**

Country	Coal (million tons)	Oil (million barrels)	Natural Gas (trillion cubic feet)	Biomass (million tons)	Hydro (GW)	Solar Power (Kwh/sq. m per day)	Wind Power (MW)
Afghanistan	440	NA	15	18-27	25	NA	NA
Bhutan	2	0	0	26.6	30	NA	4825
Bangladesh	884	12	8	0.08	0.33	3.8-6-5	Limited Potential
India	90,085	5,700	39	139	150	4-7	1,51,918
Maldives	0	0	0	0.06	0	NA	NA
Nepal	NA	0	0	27.04	83	3.6-6.2	3000
Pakistan	17,550	324	33	NA	59	5.3	24000
Sri Lanka	NA	150	0	12	2	NA	25000
<b>Total</b>	<b>108,961</b>	<b>5,906</b>	<b>95</b>	<b>223</b>	<b>349.33</b>		<b>208743</b>

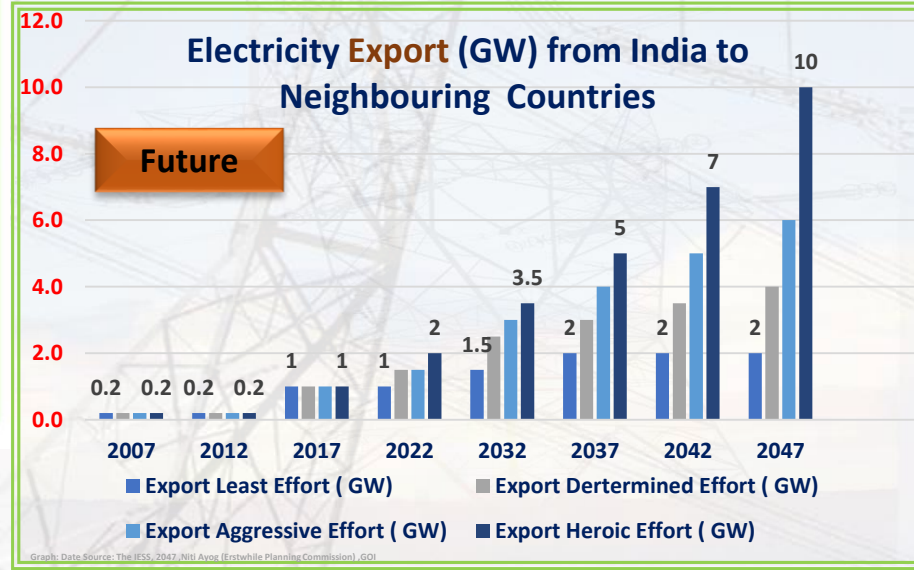
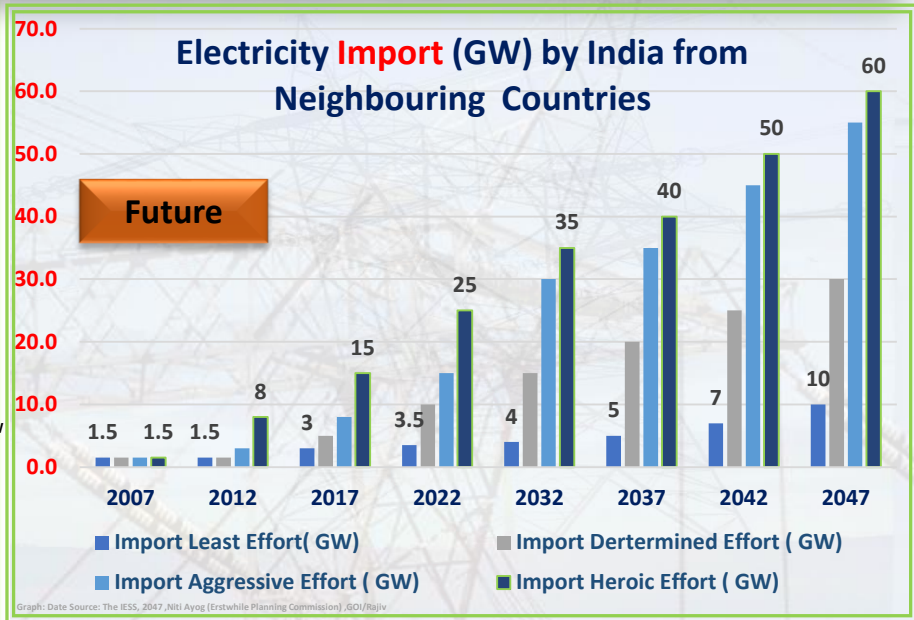
Source: SAARC Secretariat (2010) for Bangladesh, Bhutan, India, Nepal, Sri Lanka; CWC (2005) for Indian States and WAPDA (2011) for Pakistan and Other Sources



# Current Status of Cross Border Electricity Trade (CBET) and Future Trading Scenarios



Bhutan → India	India → Bangladesh	India → Nepal
<ul style="list-style-type: none"> <li>Tala: 1.80 INR/kWh for 1<sup>st</sup> year (now 1.98 INR/kWh) (0.003 US\$/kWh)</li> <li>Dagachhu: 2.40 INR/kWh for 1<sup>st</sup> year (started in 2015) (0.04 US\$/kWh)</li> </ul>	<ul style="list-style-type: none"> <li>NVVNL: 2.40-2.86 INR/kWh (Aug'14-May'15) (0.04 US\$/kWh)</li> <li>PTC: 4.26-5.00 INR/kWh (Dec'13-May'15) (0.071 US\$/kWh)</li> <li>Tripura-Bangladesh Rs 5.50 per unit (0.091 US\$/kWh)</li> </ul>	<ul style="list-style-type: none"> <li>Treaty/Bilateral: Current 5.40 INR/kWh (0.09 US\$/kWh)</li> <li>PTC: 4.55, 4.35, 4.30, 3.75 INR/kWh (FY11-14)</li> <li>NVNL-NEA PPA (160 Mw) INR/kwh 3.60 (0.05 US\$/kWh)</li> </ul>



Source: Compiled from various resources, News Paper articles etc.

\*\* <https://www.dhakatribune.com/bangladesh/power-energy/2018/05/17/500mw-to-be-imported-from-india-in-june>

\* Total maximum transfer capacity of lines



# South Asia Power Grid: Transmission Capacity by the year 2036/2040

- Significant Transmission System Interconnection ( Both AC and DC) are Planned and Proposed.
- Total current CBET cross border transmission capacity ≈ 4820 MW
- 43.2 GW additional Cross Border Transmission Inter. Capacity by 2036.
- Large scale hydro power development in Bhutan and Nepal.
- Additional 500 MW\* capacity ( India-Bangladesh) by June,2018.
- India-Bhutan: - Mangdechhu -720 MW by November,2018
- 1,200 MW Punatsangchhu-I Hydroelectric Project likely to be completed by Mar'2022 and
- 1,020 MW Punatsangchhu-II Hydroelectric Project likely to be completed by Mar'2021 are at advance stage of construction .
- By the end of 2018 – 2543+500+720= 3763 MW South Asia Power trade
- By the end of 2022-3725+1200+1020+= 5983 MW South Asia Power trade

## SOUTH ASIA POWER GRID

Additional 43.2 GW Cross Border Grid Interconnection by 2036



	by 2036/40	MW
1	Nepal-India	15800
2	Bhutan-India	17000
3	India-Sri Lanka	500
4	India-Bangladesh	4900
5	Nepal to Bangladesh via India	2000
6	Bhutan to Bangladesh via India	1000
7	India-Pakistan	1000
8	Afghanistan-Pakistan	1000
9	Total	43200
10	By 2036	MW
11	India-Myanmar	1500
12	Bangladesh - Myanmar	500
	Total MW	45200

Source: CEA-Perspective Transmission Master Plan, Bangladesh- PSMP-2016, Other Sources

All Fig are in MW

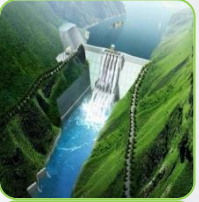
Compiled from CEA-Perspective Transmission Master Plan, Bangladesh- PSMP-2016, Other Sources 1Bangladesh-India Bheramara –Baharampur-Existing 500 MW 2 From Nepal 1,000 by 2030 Power import by using Case 3 T/L (upgrade to 765kV AC) and From Nepal (Purnea -Barapukuria), 1,000 by 2025, Power import by using Case 3 T/L (initially 400kV AC) 3 Bhutan-Bangladesh via- India 1000 MW-Bongaigaon/Rangia -Jampur1,000 by 2030-Power import from Bhutan 4 400 MW by 2020 ( 100 MW existing) Construction of HVDC (500MW) in Comilla Construction of HVDC (500MW) in Comilla. S/S. Some load (100 MW) in Comilla (N) S/S will be disconnected from Indian System 5 1000 MW by2023 and 1000 MW by 2025 ( Power Import Using Case 2 T/L (± 800kV HVDC) 6 1000 MW by 2030 Bibiyana-Meghalaya (PSSP) 7 At the Proposal Stage , detailed planning to be done.



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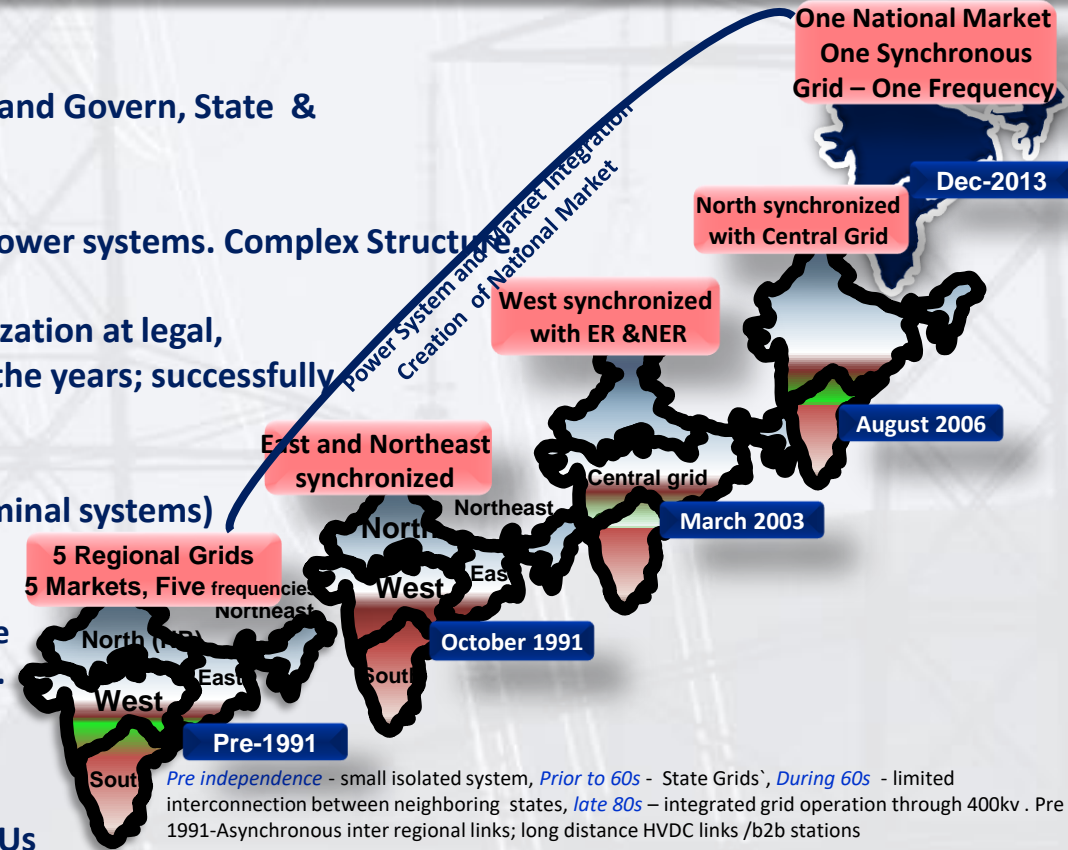


# Indian Experience of Regional Power Grid Integration and Market Development

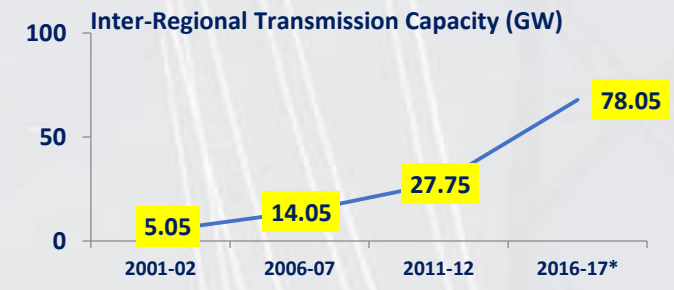
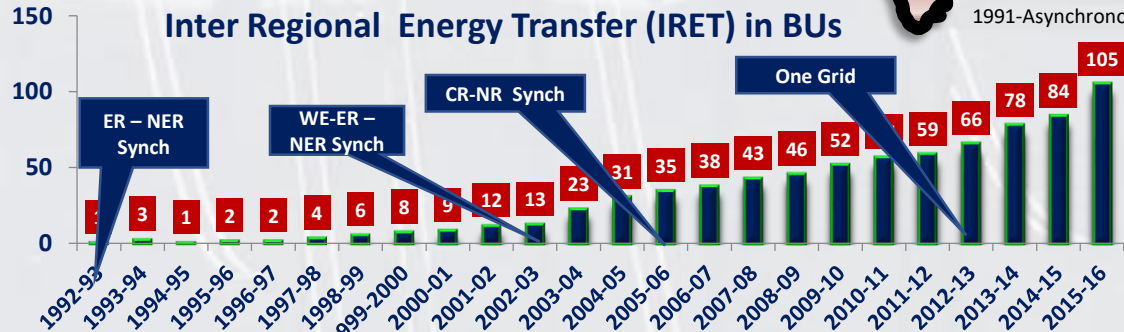


# India's Power Sector Experience : It's Relevance towards Integration of Power system and Market Integration Development in Regional Context

- Electricity in the Concurrent List.
- Both Centre and state have power to legislate and Govern, State & Centre's policy, regulation coexist ( 29 states).
- India had different regional grid i.e. different power systems. Complex Structure
- Considerable amount of Coordinated Harmonization at legal, technical and regulatory level happened over the years; successfully integrated the regional grids.
- Mix of HVDC (Bipolar , Back to back, Multi-terminal systems) and HVAC interconnection
- Integration of Regional Grid played the crucial role for Development of India's National Power Market.



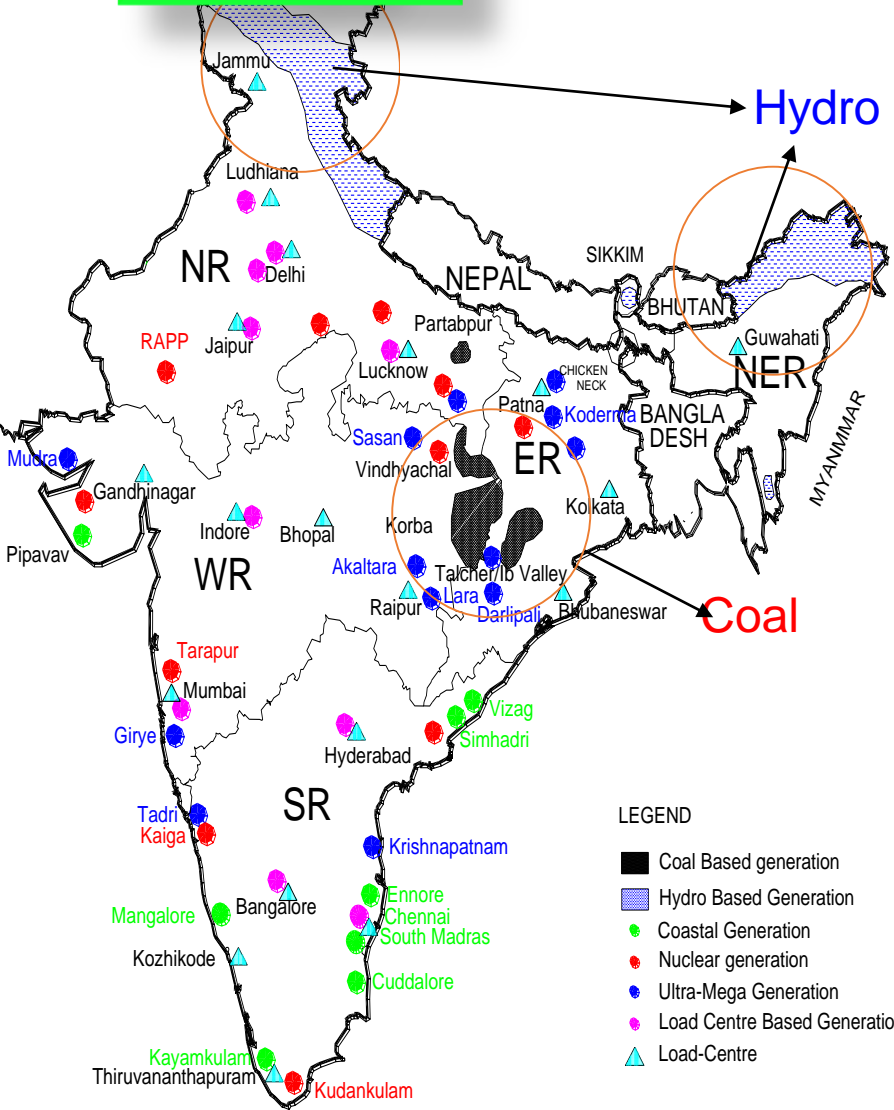
Pre independence - small isolated system, Prior to 60s - State Grids, During 60s - limited interconnection between neighboring states, late 80s – integrated grid operation through 400kv . Pre 1991-Asynchronous inter regional links; long distance HVDC links /b2b stations



Systematic regional planning, grid integration, coordinated harmonization- 9 BUs in 2002 to 105 BUs of IRET by 2016

# India's Power Sector Experience : It's Relevance towards Integration of Power system and Market Integration Development in Regional Context

India



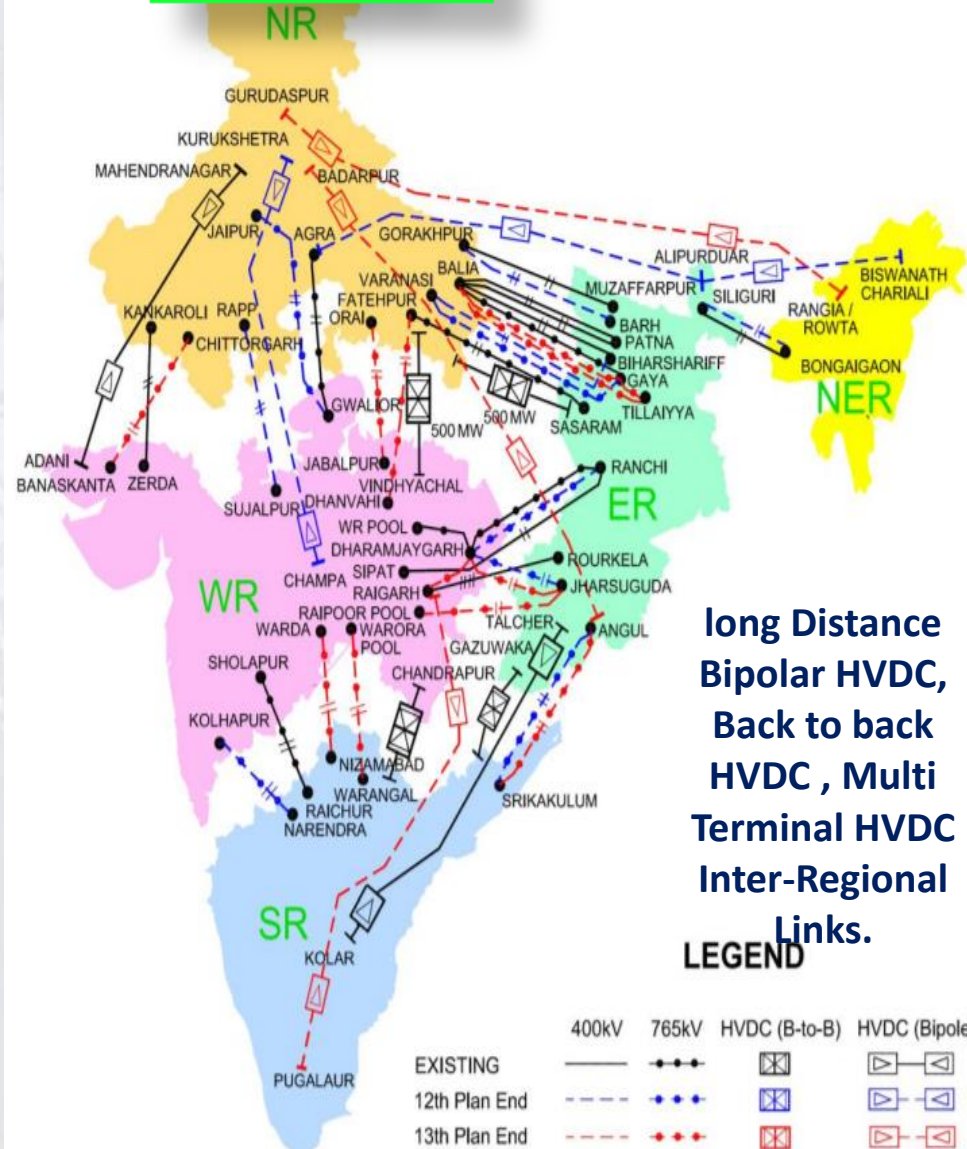
Hydro

Coal

LEGEND

- Coal Based generation
- Hydro Based Generation
- Coastal Generation
- Nuclear generation
- Ultra-Mega Generation
- Load Centre Based Generation
- Load-Centre

India

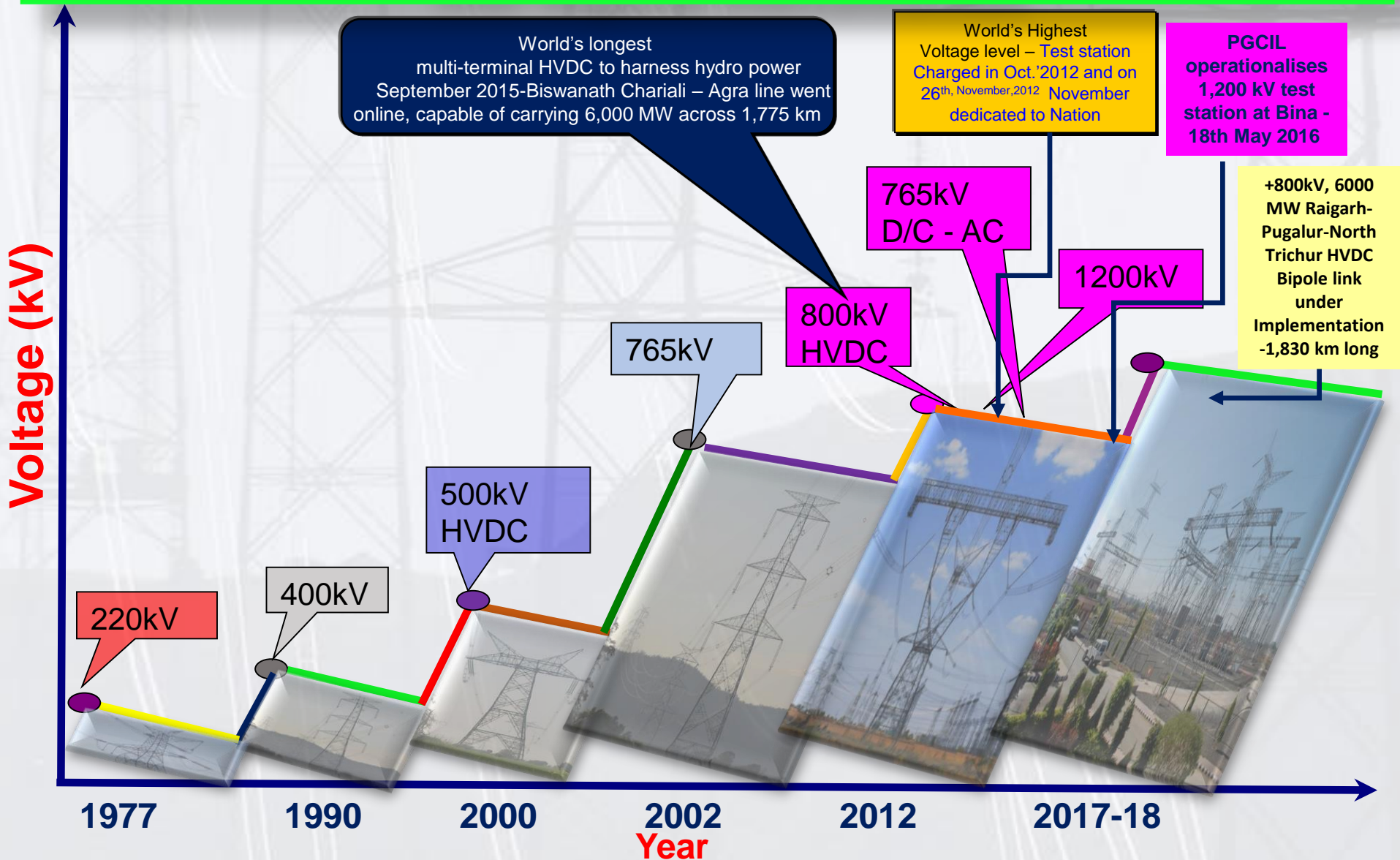


long Distance Bipolar HVDC, Back to back HVDC, Multi Terminal HVDC Inter-Regional Links.

LEGEND

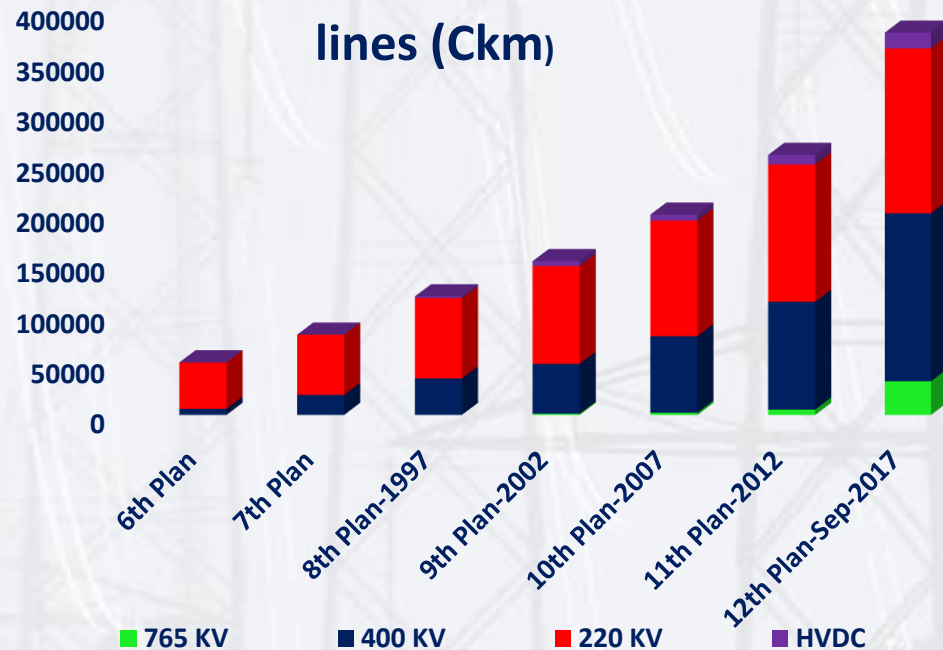
- |               | 400kV | 765kV | HVDC (B-to-B) | HVDC (Bipole) |
|---------------|-------|-------|---------------|---------------|
| EXISTING      |       |       |               |               |
| 12th Plan End |       |       |               |               |
| 13th Plan End |       |       |               |               |

# India- Ultra High Voltage and Extra High Voltage Transmission for Inter-Regional Interconnection

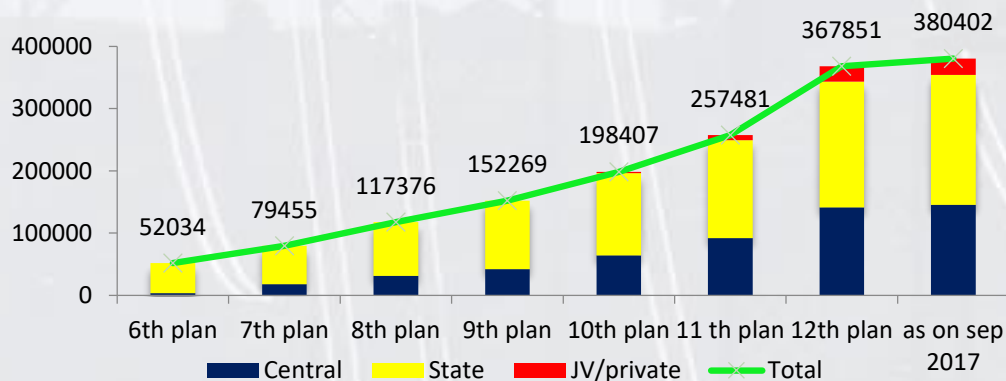


# Growth in Transmission Capacity

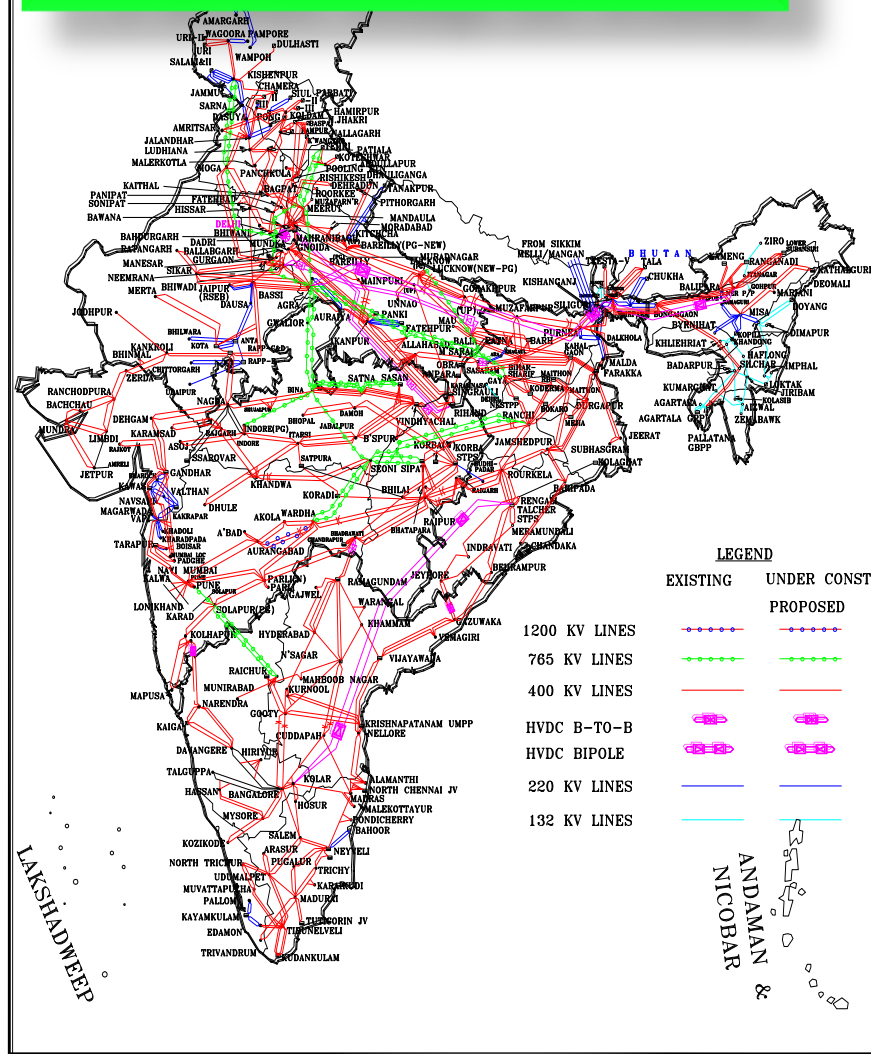
## Growth in Transmission lines (Ckm)



## Growth in Transmission Capacity



## Power Map of India



# Carefully Designed Power Sector Reform for Investment and Market Development



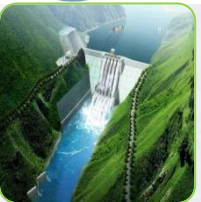
With the Legal Framework mandated under EA Act-2003, Power Trading and Power Market Developed – Legal, Regulatory Framework is Important , though Initially friendly Guidelines/Regulation and calibrated approach were adopted to promote investment and Market Development



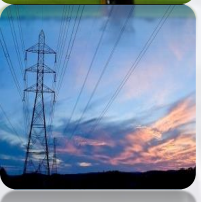
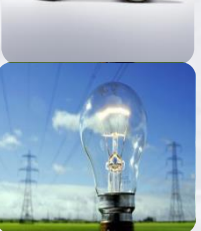
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**Are these steps were useful?**

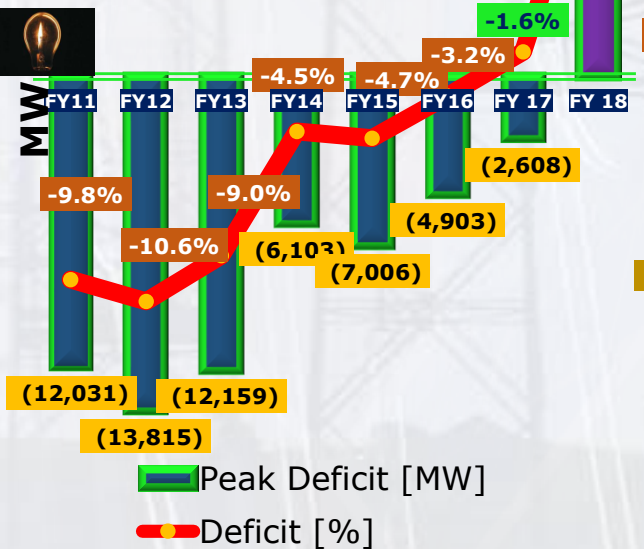




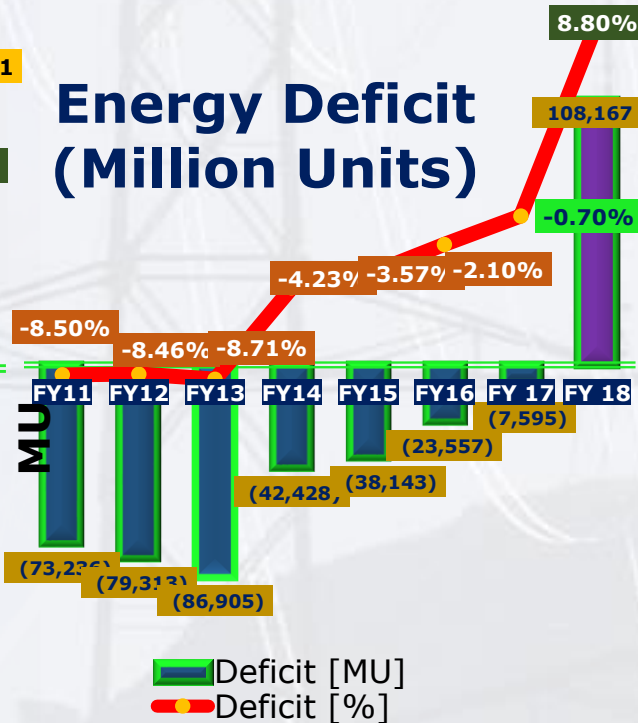
# India: Demand-Supply Scenario, Private Sector Investment

The demand-supply deficit has progressively reduced over the last five years. For the First time India is expected to be power surplus in 2018

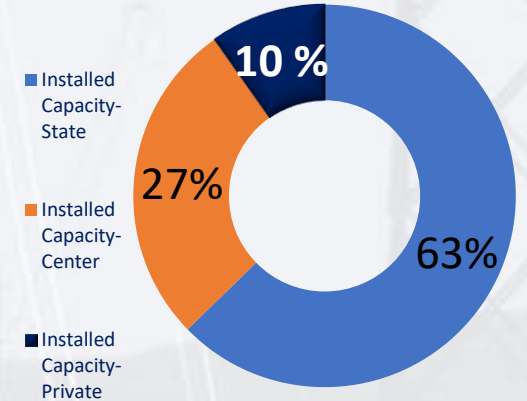
## Demand-Supply Peak Deficit (MW)



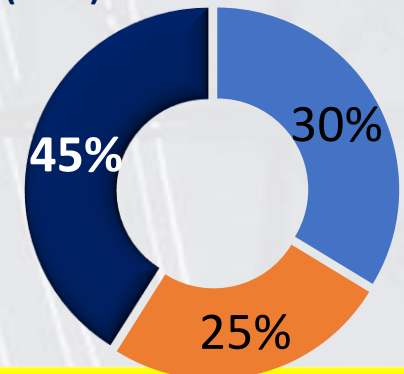
## Energy Deficit (Million Units)



## Share (10%) of Private Sector - 2001

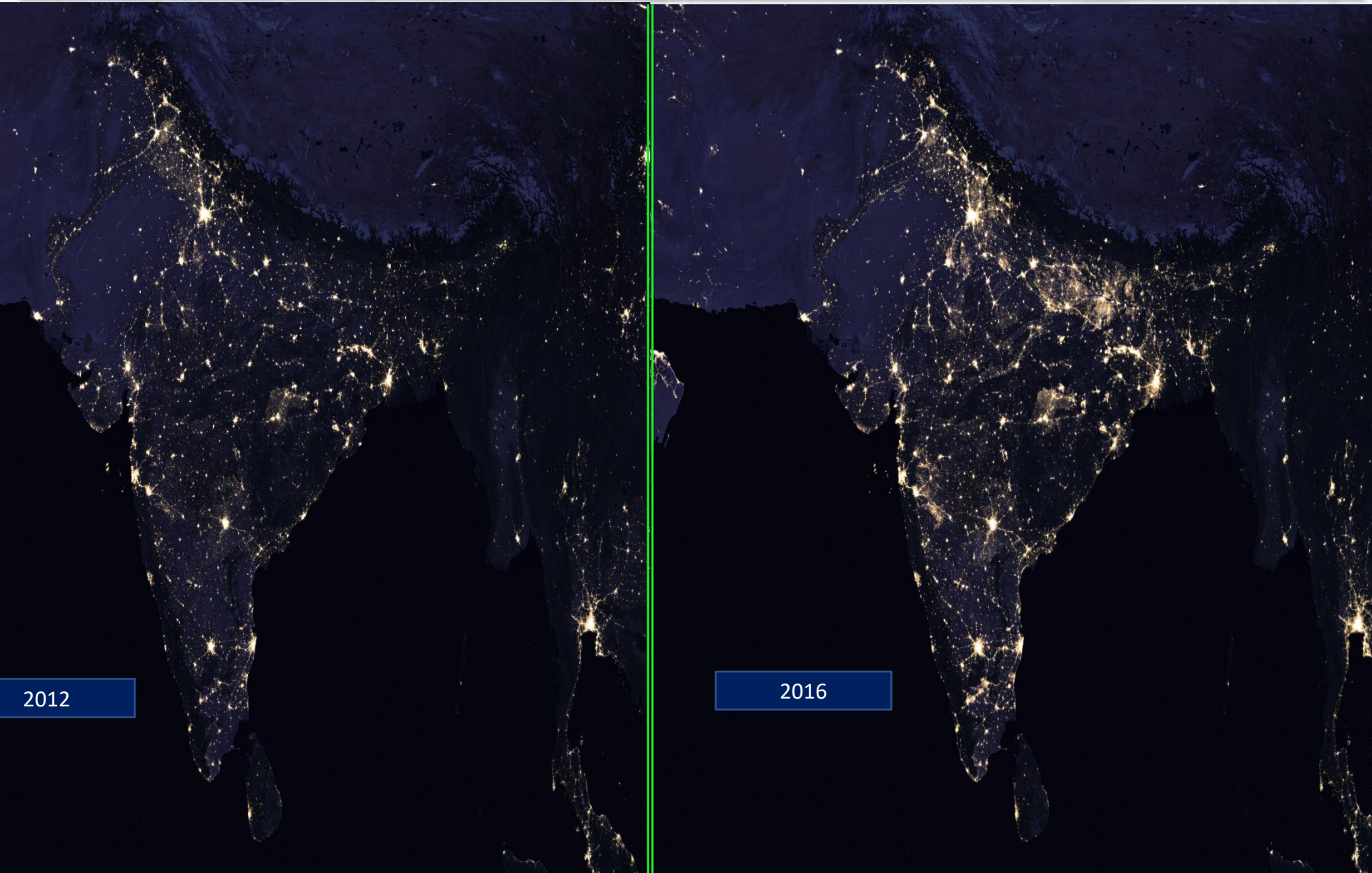


## Share (45%) of Private Sector - 2018



**High Deficits: In 1997 Energy and peak deficits were 11.51% and 17.97% respectively, Country Recorded the lowest ever demand-supply gap (2017) both in terms of energy (-0.70 %)and peaking (-1.6%)**

# India Power Sector Growth Impact



2012

2016

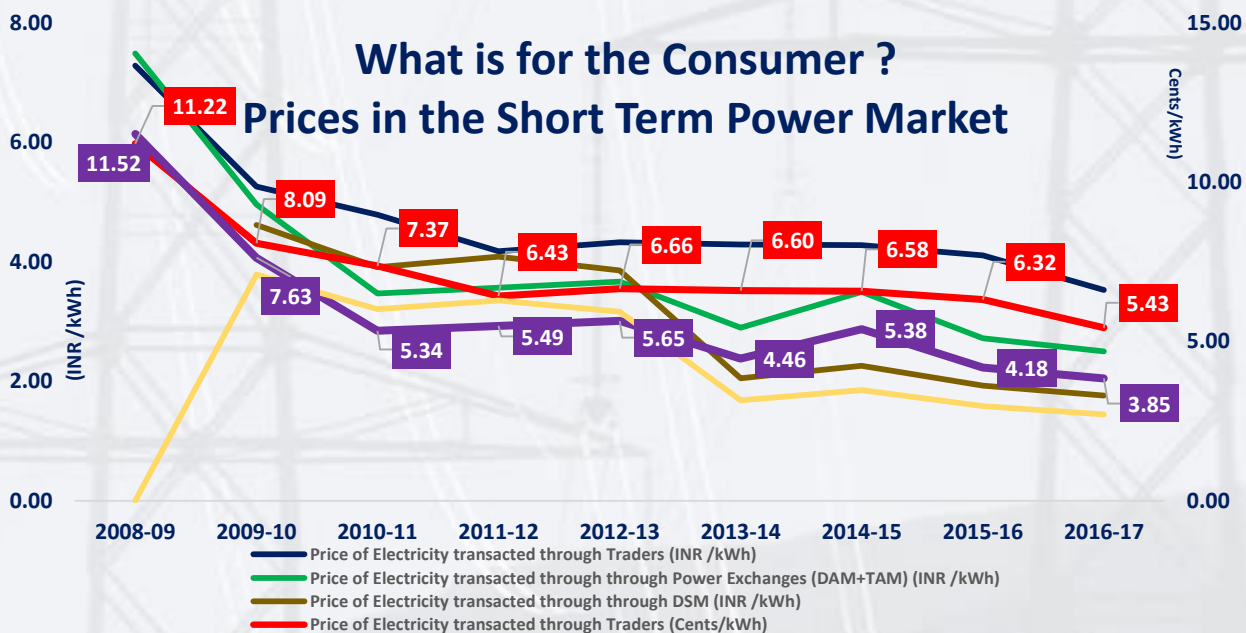
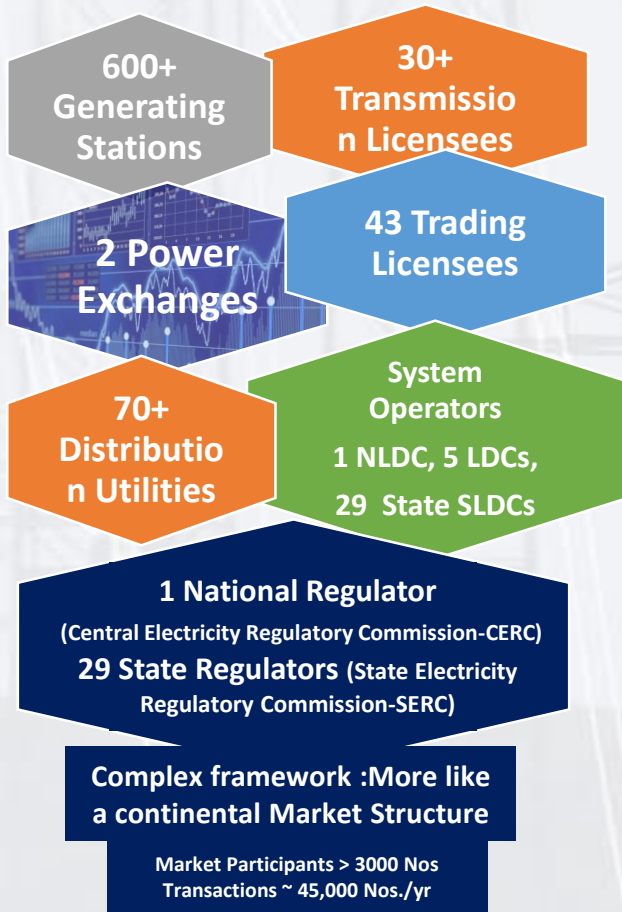


# Power Market in India-What is the benefit for the Consumer ?



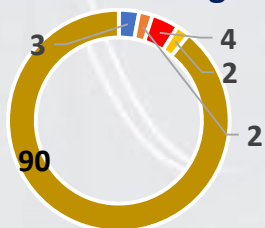
# Power Market in India

## Competitive Power Market



- Price have gone down due to competition, choice and market. Benefit to the Consumer
- Price through Exchange : ₹ 7.49 /Kwh (11.5 Cents) in 2009 to ₹2.5/ /Kwh (3.8 cents) in 2017
- Price of Electricity (Trader): ₹ 7.29/Kwh (11.2 Cents) in 2009 to 3.53/Kwh (5.4 Cents) in 2017

### Share (%) of Market Segments , 2016-17



**Size of Short Term Power Market**  
₹ 240 Billion (4.2 Billion US \$)

**Size of Bilateral Trader Market**  
₹ 145 Billion (2.43 Billion US \$)

**Size of PX Market**  
₹ 95 Billion (1.59 Billion US \$)

ST power market transaction in FY 2017 was 119.23 BU or 10.3 % of total power procured

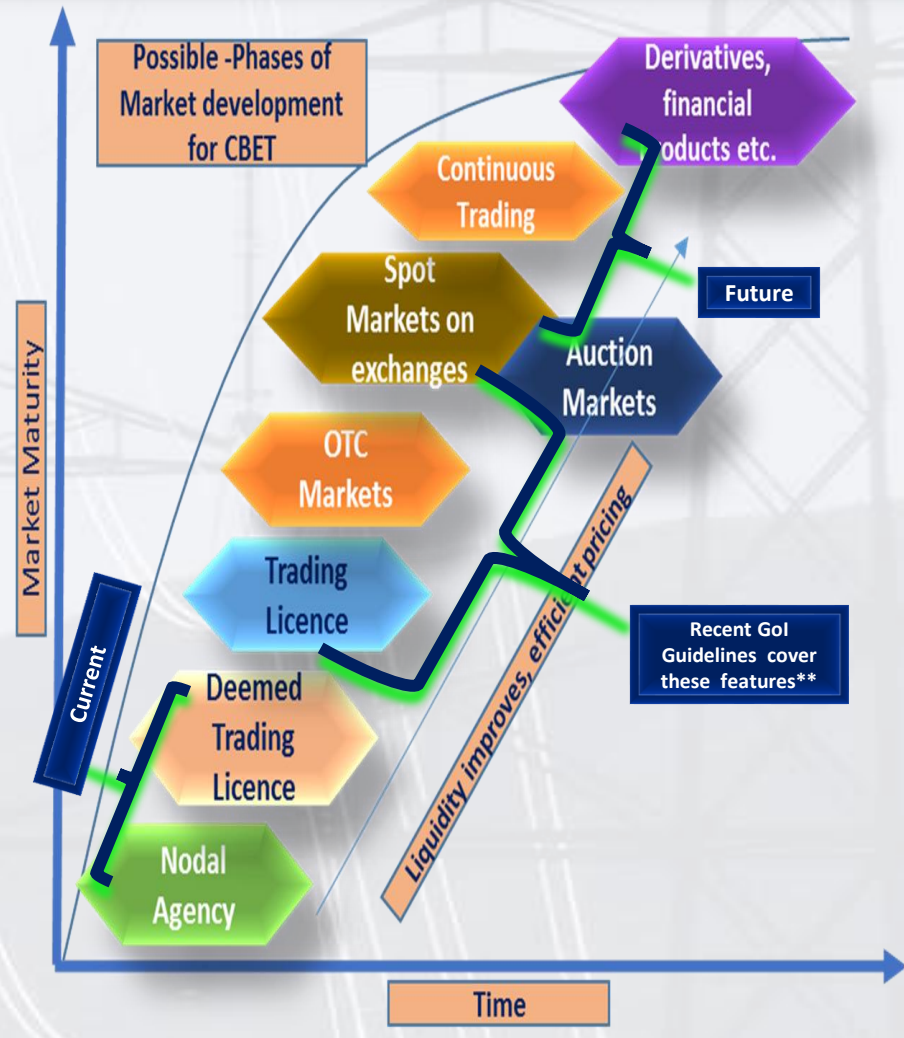
- Bilateral Transactions through traders
- Bilateral Transactions between DISCOMS
- Power Exchange Transactions
- Transactions through DSM
- Long Term Transactions

Note: 1 US\$= 60 ₹, Data Source: CERC Annual Report on Short-term Power Market in India, 2015-16

Short Term refers to contracts of less than one year- Includes bilateral trader segment , power exchange segment with transactions, DSM segment, Direct transactions of electricity between DISCOMS.

# How Indian Power Market Development Benefited Cross Border Power Trade !

Country	Current CBET Trading Arrangements	Type of Transaction i.e. Negotiated ( G to G ) based on Negotiation or Market determined
Bhutan ( Exporter ) → India	Chukka (336 MW) , Kurichhu (60 MW) Hydro Projects – Long Term Contracts	Negotiated ( G to G )
	Tala Hydro Project (1040 MW)-Long Term Contract	Negotiated ( G to G )
	Dagachhu Hydro Project (126 MW)	<b>Commercial</b>
	Contract with TPTCL (Trader) (Long Term)- Sold in India Power market *	<b>Commercial</b>
India (Net Exporter) → Bangladesh	Long-term contract with NNVNL for 250 MW	Negotiated ( G to G )
	Medium-term contract with for 250 MW	<b>Market determined /Commercial</b>
	160 MW India-Tripura	Negotiated ( G to G )
India( Net exporter) → Nepal	Bilateral contracts / Treaties to the tune of 300 MW	Negotiated ( G to G )
	130 MW More	<b>Market determined /Commercial</b>



\*\* Only TAM, Intra day/Contingency Contracts is allowed as per the GOI Guideline

**Even though CBET Policy Governing Framework is mainly through Bilateral Agreements/MoU between Countries. Commercial /Market form of CBET and Price Discovery is established ( Mix of Long , Medium, Short and Power exchange based CBET \*\*\*)**

Trilateral Memorandum of Understanding between Bangladesh, Bhutan and India for Cooperation in the field of Hydroelectric Power had been worked-d out and \* Power from the Dagachhu HPS is being sold to various India buyers on bilateral basis in the short term market. noted that it would be signed at an occasion when leaders of all three countries would be present together. -India - Bangladesh Joint Statement April 08, 2017 \*\*http://cercind.gov.in/2017/draft\_reg/Annexure1.pdf \*\*\* Power exchange based CBET yet to start though TAM, Intra day/Contingency Contracts is allowed as per the GOI CBTE Guideline

# Lessons Learned from South Asia Power Grid development , CBET & Development of Regional Power Market

Deepening bilateral trade, accelerating the implementation of planned projects. Mix of AC/HVDC connections for safe and secure integration of power system.

Disseminate the positive benefits of trade, making consumer central in CBET argument.

While deepening bilateral trade, recognising the market form of trade- allowing bilateral trade on commercial/market basis.(Out of 2543 MW , ~ 510 MW -commercial/market basis).

Bottom up Approach for Regional Regulatory Framework (RRFs) for CBET & Institutionalisation of CBET process : Coordinated Harmonization through existing mechanism for CBET only, This will make preparation /adoption of regional regulation acceptable easy and acceptable. RRFs are important.

Strong level of operational, system operator, technical/grid code harmonization, Joint Planning , imbalance settlement mechanism via formal/informal Institutionalised process is a prerequisite

Innovative ways to address legal issues, without pursuing long process for amending Laws

Opening up of electricity sector guided by respective national priorities with the aim of promoting competition\*, Regulatory & Technical capacity building. Opening of Power Exchange for CBET

No preconditions such as sector reform, unbundling etc for CBET, Co-existence of different degree of market reform in different South Asian Countries.

Taking steps for trilateral cooperation/trade , sub regional, transit trade (India-Bangladesh-India) Road to Regional full scale Multilateral trade is through bilateral, trilateral and sub regional route. Allowing CBET through Power Exchange (Gradual opening of Products\*\*)

## Challenges

✓ Different of policy, legal, and regulatory mechanisms

✓ Countries are Different stage of power sector , depth of regulatory framework

✓ Building Strong of transmission system interconnections;

✓ Developing Regional Electricity Markets from bilateral markets

\* SAARC framework agreement for energy cooperation (electricity)

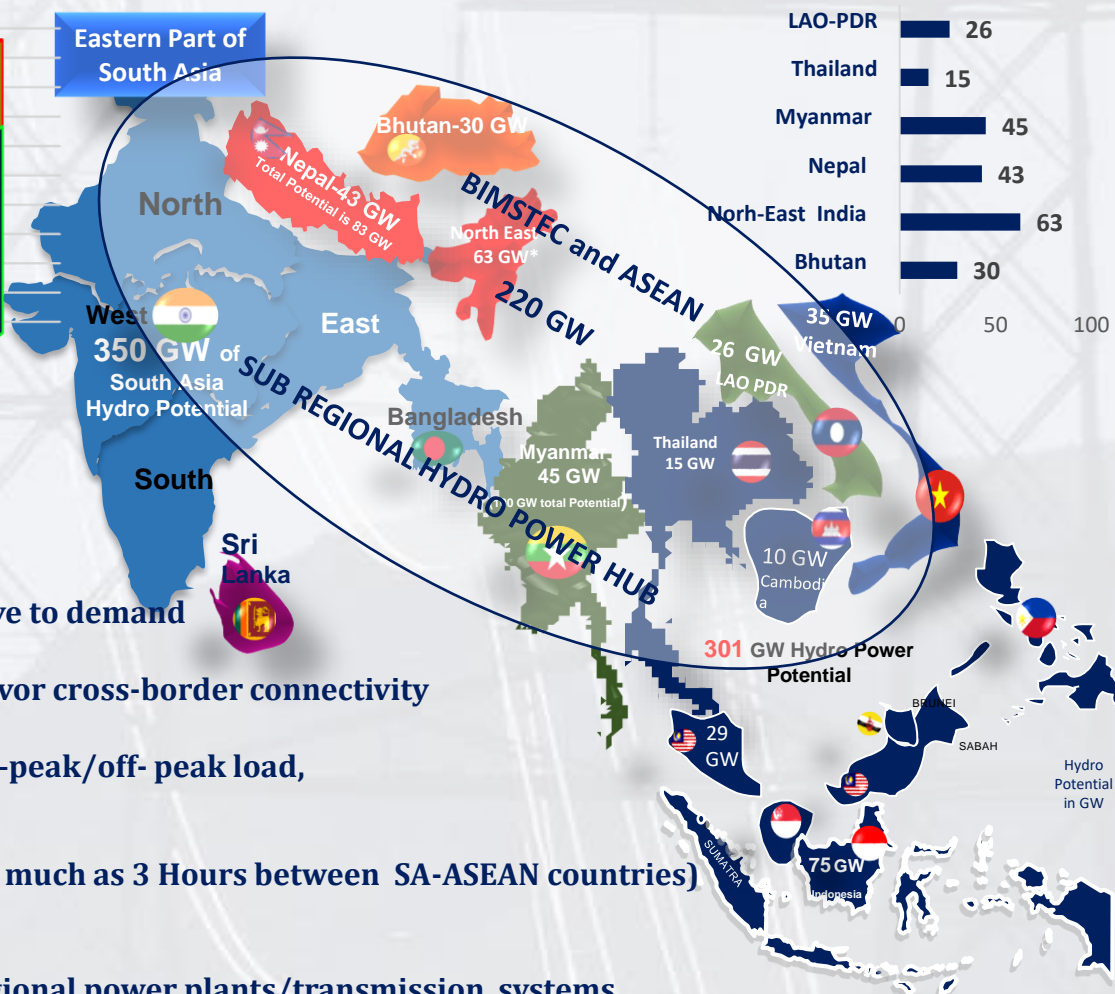
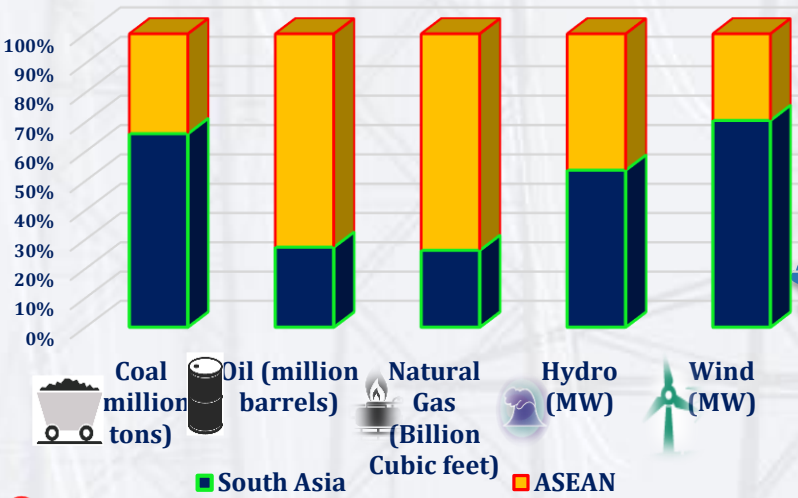
\*\*Term Ahead , intraday/contingency Markets are allowed now



# Prospects - Why Integrate SOUTH ASIA POWER GRID-ASEAN POWER GRID ?

# Why Integrate SOUTH ASIA POWER GRID-ASEAN POWER GRID ?

## Energy Resource Complementarity between South Asia -ASEAN



- Complementarity of Energy Resources.
- Differences in energy resource endowments relative to demand
- Access to Large Market -India Locational factors favor cross-border connectivity
- Optimal hydro thermal mix- better load balancing -peak/off- peak load, Renewable Load Management .
- Difference in time zones is high (Time difference as much as 3 Hours between SA-ASEAN countries) .Difference in daily load curve- Timing Peak Load.
- Economies of scale and operation from building regional power plants/transmission systems -linking electric power grids
- Improved energy security and reliability via diversification of supply, Reduced environmental damage- access to clean sources such as hydropower

South Asia+ASEAN	South Asia	ASEAN	Total
Coal (million tons)	1,08,981	55972.8	164954
Oil (million barrels)	5,806	15674	21480
Natural Gas (Billion Cubic feet)	95,000	266500	361500
Hydro (MW)	3,49,330	301570	650900
Wind (MW)	2,08,743	87000	295743

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\* <https://www.easternpanorama.in/index.php/other-articles/3626-resources>



- Opportunities –
- Short
- Medium and
- Long Term Outlook

**for Cross Border Power  
Trade and Integration  
of ASEAN & South Asia  
Power Grid**



- Opportunities –
- Short Term Outlook

**for Cross Border Power  
Trade and Integration of  
ASEAN & South Asia  
Power Grid**



# Opportunities for Power Trade Integration ASEAN and South Asia Power Grid- Short Term Outlook

- Taking Steps to increase import of electricity form South Asia (i.e. through India) to ease out power shortage situation and increase the power availability in Particularly in Myanmar (Bridge Country Between South Asia and ASEAN )
- Establish more no. of HV cross border transmission interconnection across borders and build evacuation capacity to main load centers.
- Accessing Power Market in India, A Vibrant power market & power exchange platform exist . **Multiple source for best Price Pick.**
- Competitive Price- APCC, Trader and PX price are **5.3, 5.4 and 3.8 cents/Kwh** respectively-Taking Advantage of Indian Power market

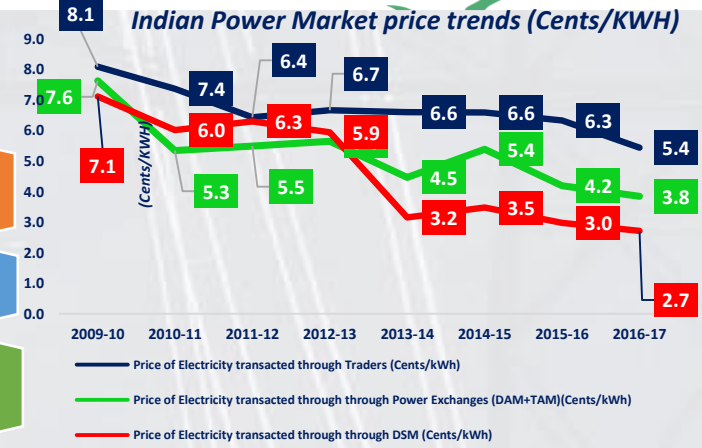
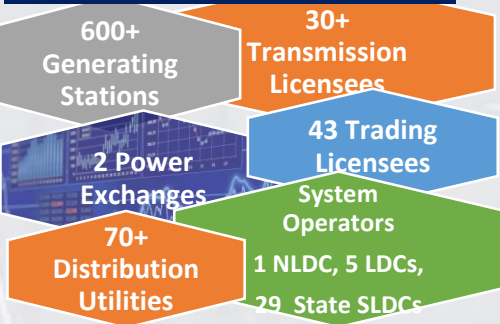


## Low Hanging Fruit- Tie up PPA with the Projects




8276 MW of Commissioned Project with out PPA

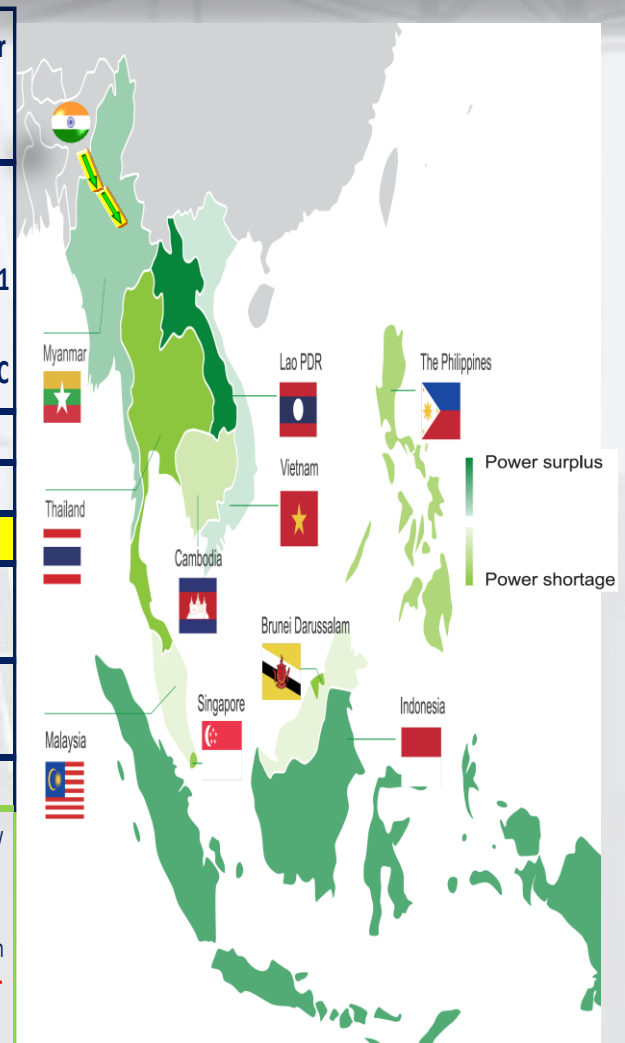
8896 MW of not yet Commissioned Project with out PPA

### Competitive Power Market In India



# Opportunities – Short Term Outlook for Power Trade & Integration ASEAN and South Asia Power Grid

Country**			 Indian Average Power Price - 2016***			Potential Saving - Million USD - Benefits for ASEAN countries (with out taking in to account Transmission cost)		
	ASEAN-5's average electricity tariffs in 2015 (USD/Kwh) & Myanmar *	ASEAN-5's average electricity tariffs in 2015 (Cents/Kwh) & Myanmar*	Price from Power Exchange (Cents/Kwh)	Price From Trader (Cents/Kwh)	Average Power Purchase Cost (Cents/Kwh)	Purchase from Exchange (1000 MW round Clock 1 year)	Purchase from Trader (1000 MW round Clock 1 year)	Purchase (1000 MW round Clock 1 year) at a Price of APCC
Indonesia (PLN)	0.09	9	3.8	5.3	5.2	455.52	324.12	332.88
Malaysia (TNB)	0.08	8				367.92	236.52	245.28
 Myanmar	0.068	6.8 (7.9)				262.8 (359)	131.4 (227)	140.16 (236)
Philippines (MERALCO)	0.18	18				1243.92	1112.52	1121.28
Singapore (Singapore Power)	0.15	15				981.12	849.72	858.48
Thailand (EGAT)	0.10	10				543.12	411.72	420.48



\* Source: REGIONAL COMMENTARY October 2016 ASEAN-5 Power Sectors-Given the liberalised power sectors of Singapore and the Philippines, their electricity tariffs are market-driven. However, the electricity rates of the other ASEAN-5 members are regulated and controlled by their respective governments.  
 Myanmar-Electricity Tariffs: Wide range 35 – 150 kyats/kWh ; “Domestic tariffs” – largely residential customers 35-54 kyats/kWh; Non-residential customers 75-150 kyats/kWh. Industrial users pay 75 kyats per unit up to 500 units; 100 kyats from 501-10,000 units; 125 kyats from 10,001-50,000 units; and 150 kyats from 50,001 to 300,000 units (Average 92.5 kyats/kWh ( Apprx-6.8 Cents/Kwh) is taken for Calculation) (- Tariffs for gas-based power are close to Ky 105/kWh Myanmar (Apprx-7.9 Cents/Kwh)-Benefits in Million USD \*\* Only ASEAN countries whose Data were available in the Public Domain were taken in to consideration.\*\*\*-  
 CERC Annual Market Monitoring Report- 1USD@ 65 INR

**Short Term Outlook-Myanmar can Potentially save around 227-359 Million US \$ for 1GW import from SA(India)**

- Opportunities –
- Medium Term Outlook

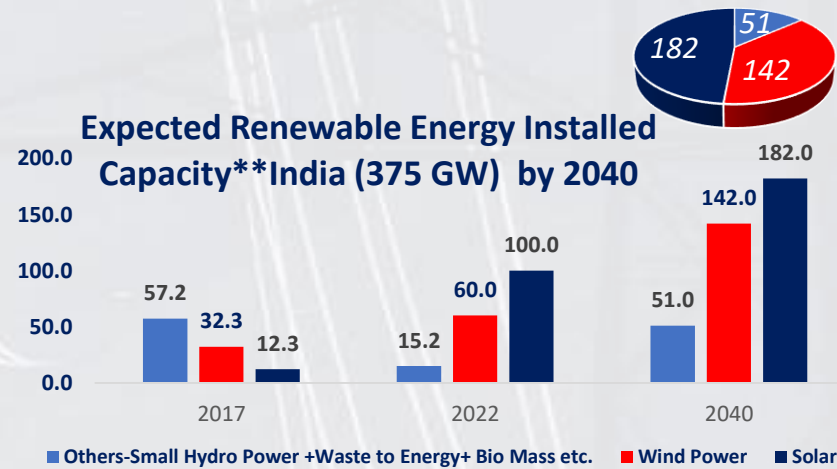
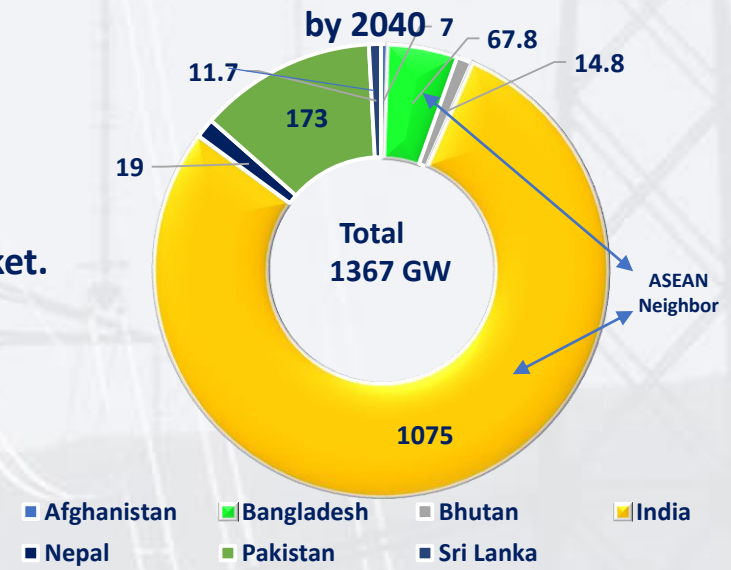
# for Cross Border Power Trade and Integration of ASEAN & South Asia Power Grid



# Opportunities – Medium Term Outlook for Cross Border Power Trade and Integration ASEAN and South Asia Power Grid

- To take steps to accelerate the development of hydro power for **Export of Surplus Only**. South Asia Power Demand is high (SA needs 1367 GW of installed capacity by 2040), build transmission interconnection ([India, Bangladesh](#))
- Hydro rich ASEAN countries can focus on tapping South Asia market.
- High Renewable Energy Growth in SA (375 GW of RE\* in India by 2040-182 GW Solar and 142 GW wind). Power system needs a flexible, fast responsive with Demand response to address intermittence. 53 GW of Spinning reserve requirement for India only by 2040.
- Hydro power and natural gas of ASEAN can provide balancing support-shall help in [renewable energy integration](#). Exploiting the Ancillary Market in India. This will improve the viability of hydro projects.
- Both reservoir and pumped storage hydropower \*\* and gas are flexible sources of electricity- that can help to address intermittence wind and solar

South Asia Power Required Capacity\* in GW by 2040



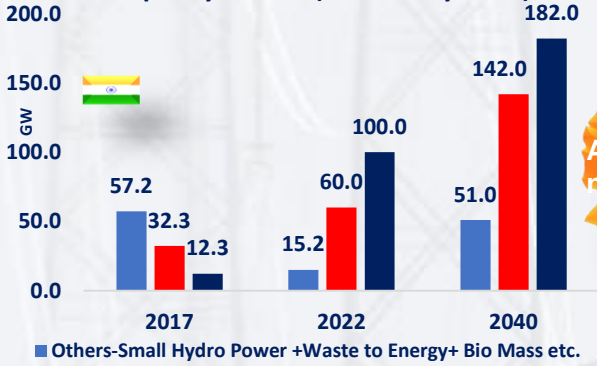
\* Do not include Large hydro

\*\*Storage hydropower (including pumped storage) currently represents 99% of the world's operational electricity storage.

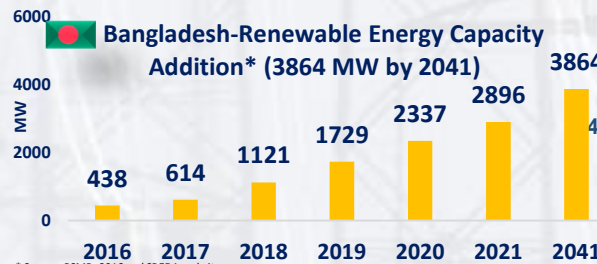
\* Source: Compiled from India-IEA-India Energy Outlook-Nepal- Electricity Demand Forecast Report (2015-2040) and Policy Research Working Paper 7341  
 \*\* With out large hydro Source: Compiled from India-IEA-India Energy Outlook, CEA Data , National Electricity Policy-CEA and Authors' own Calculation

# Regional Hydro Power (ASEAN and South Asia) can help in Inter-Regional Renewable Energy Grid Integration and Grid Balancing

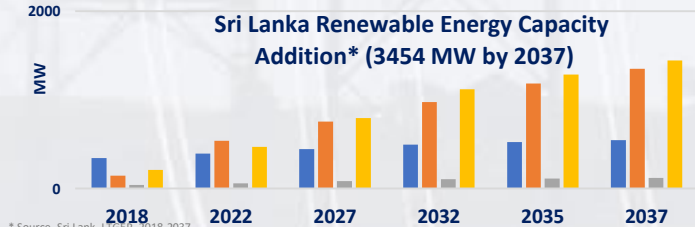
Expected Renewable Energy Installed Capacity\*\* India (375 GW by 2040)



\*\* With out large hydro Source: Compiled from India-IEA-India Energy Outlook, CEA Data , National Electricity Policy-CEA and Authors' own Calculation

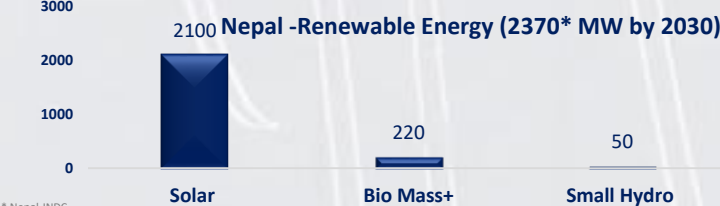


\* Source- PSMP -2016 and SREDA website

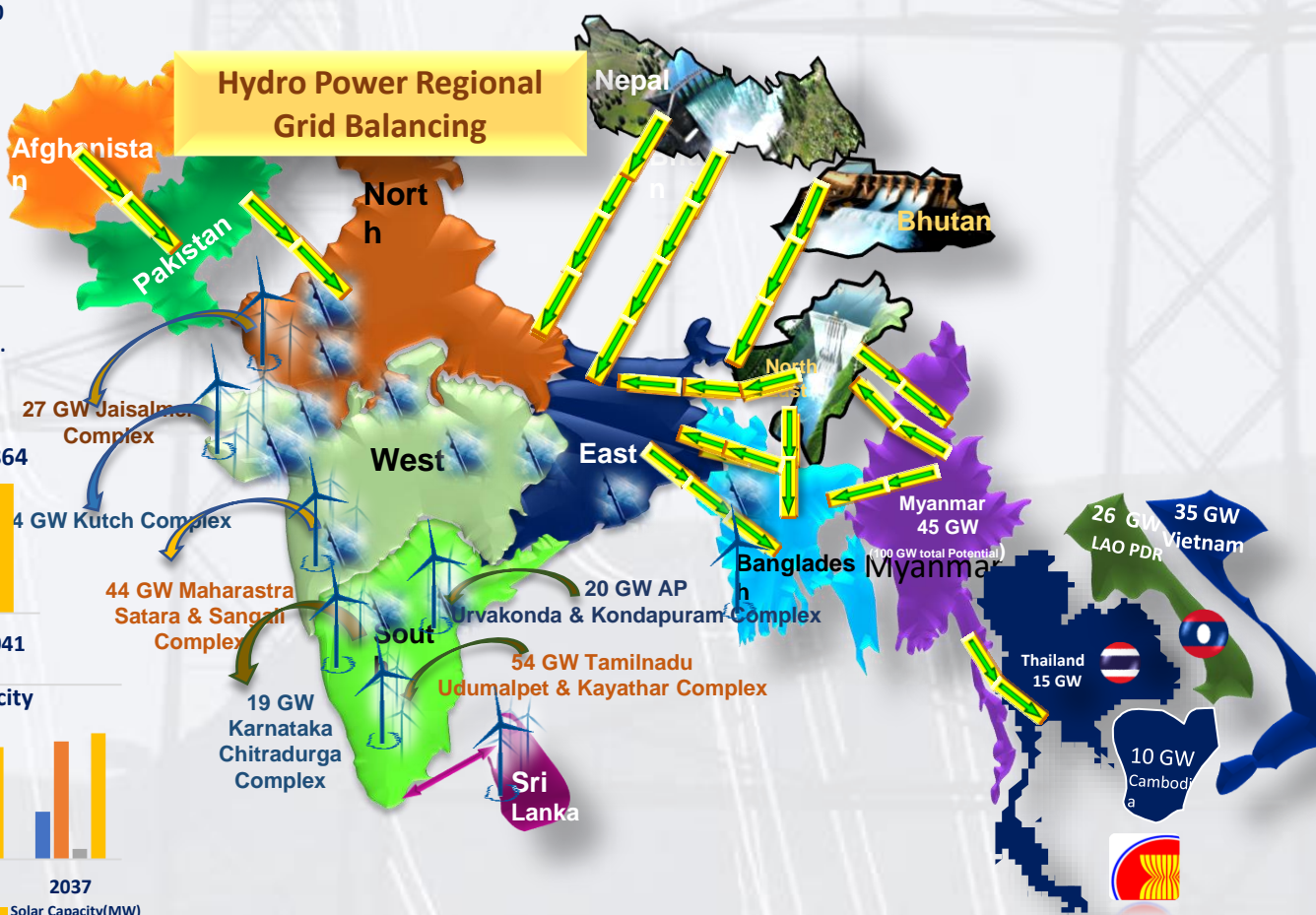


\* Source- Sri Lanka- LTGEP-2018-2037

■ Mini hydro Capacity(MW) ■ Wind Capacity(MW) ■ Biomass Capacity(MW) ■ Solar Capacity(MW)



\* Nepal-INDC



Northern ASEAN Countries

• Opportunities –

# Long Term Outlook

## for Cross Border Power Trade and Integration of ASEAN & South Asia Power Grid



# Opportunities – Long Term Outlook for Cross Border Power Trade and Integration ASEAN and South Asia Power Grid-Trans –Regional Grid : ASEAN-South Asia-Central AsiaN

Cross Border Power Trade is Increasing Significantly in the South Asia and ASEAN and GMS Region. These region complementarity is very high.

India-Myanmar Grid Connection

Myanmar the Energy Bridge between Regions ( SA- ASEAN)

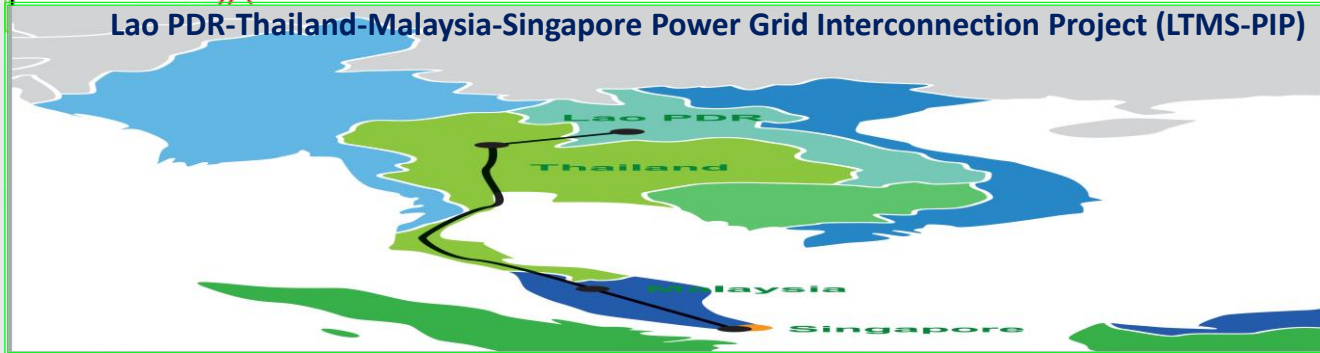
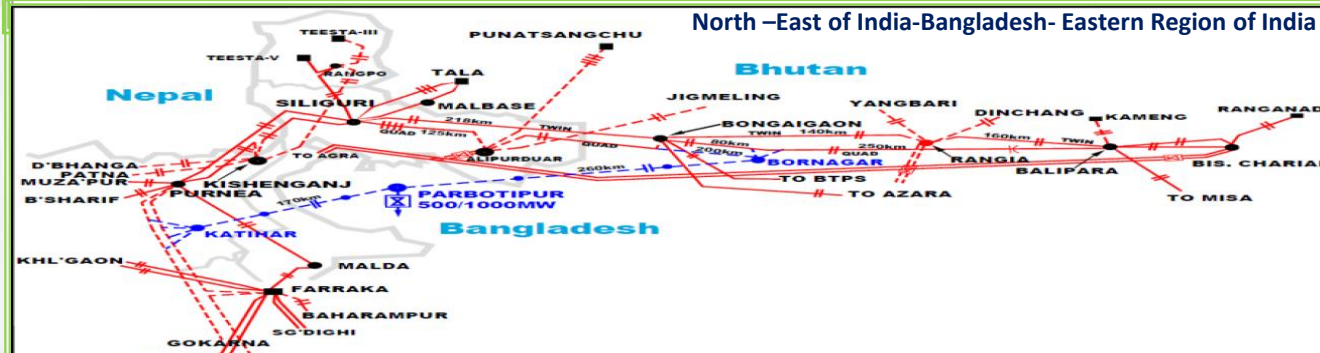
North –East of India-Bangladesh- Eastern Region of India

Lao PDR-Thailand-Malaysia-Singapore Grid Interconnection Project (LTMS-PIP)

CASA-1000- Central Asia-South Asia.

Pakistan-India and Pakistan-Iran Power Link

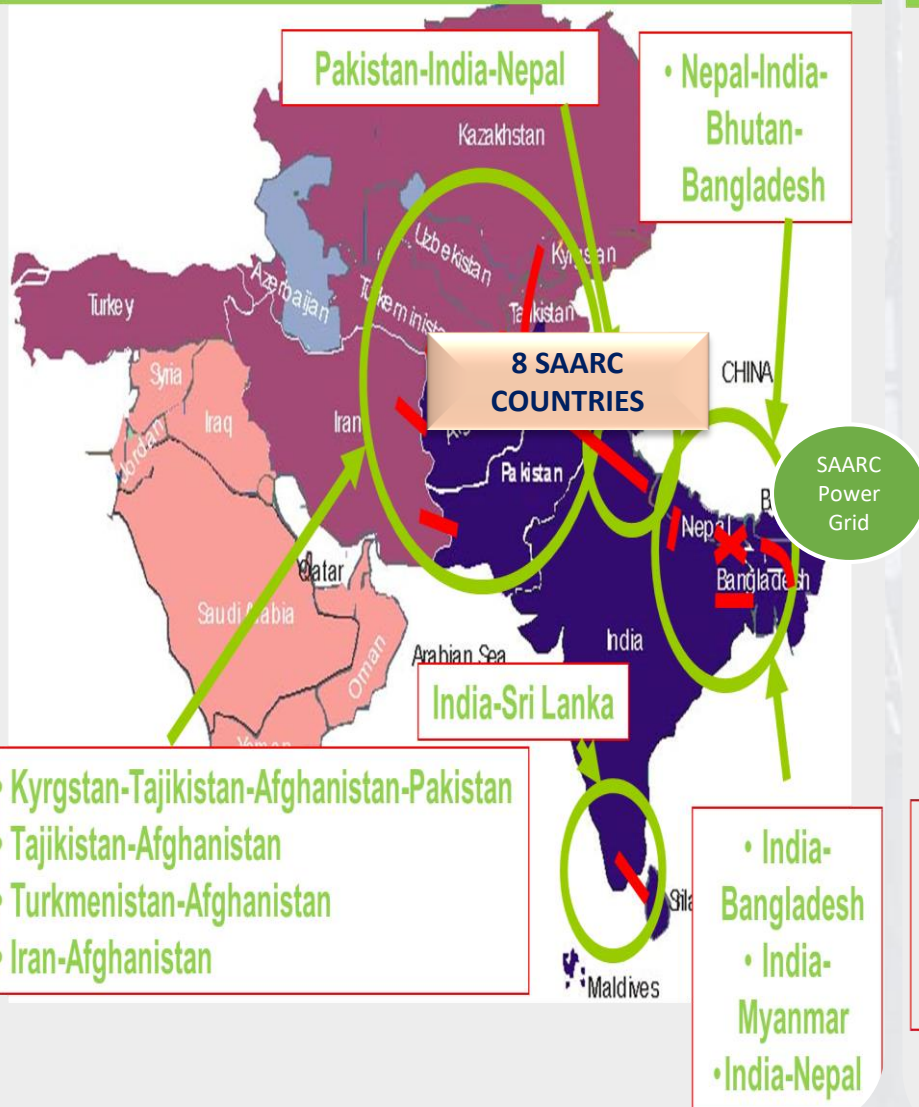
Many countries have low per capita electricity consumption and access of electricity one of the lowest). Asian region untapped energy resource is very good.



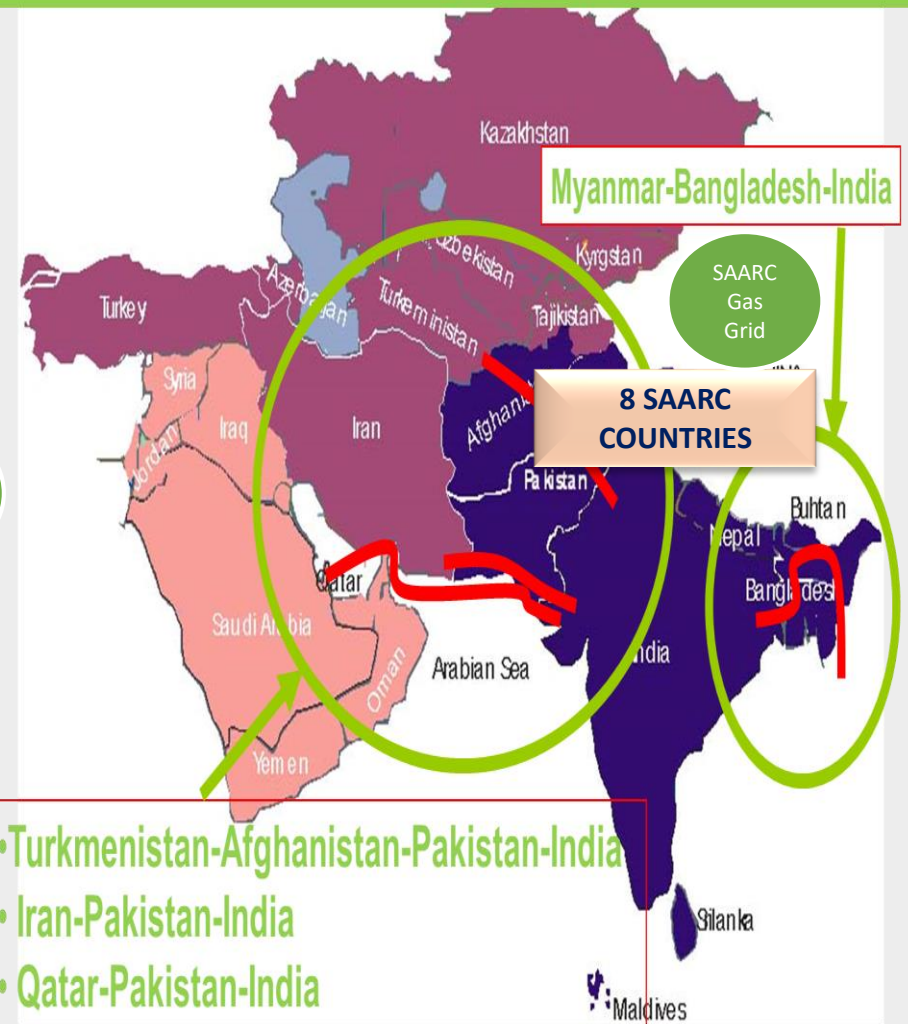
Source: National Power Belt Way-IPPAI-Energizing the Country by offering Plug-and-Play 24x7 Power • Harnessing the potential of transnational power trade in Asia from Tajikistan to Singapore  
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 Source: <http://www.casa-1000.org/Docs/CASA1000Brochure.pdf>  
 Trans-Regional Energy Connectivity Between the ASEAN Power Grid and the South-Asia Power Grid: Prospects and Opportunities/ASEAN Power Grid Summit 2018: 21 -23 May 2018/Railw/SARI/FEI/IRADE/Confidential ©SARI-2018

# SAARC Energy Grid: Power and Gas Grid

## SAARC Energy Ring – Power Grid



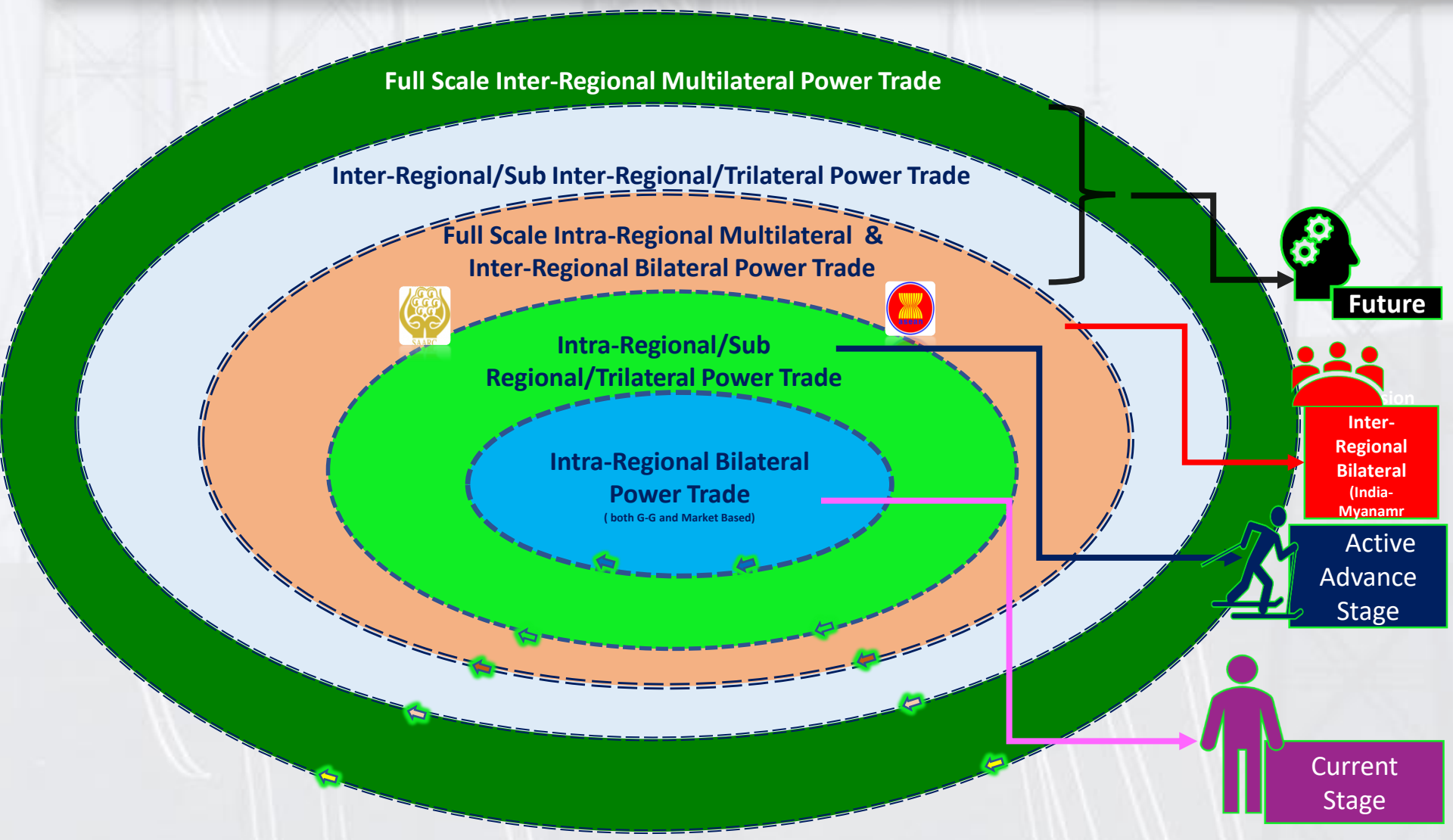
## SAARC Energy Ring- GAS GRID



Pipelines from the east and the west can further be extended to Nepal

# How to Integrate South Asia and ASEAN Power Grid ? Possible Trans-Regional Transmission Interconnections South Asia and ASEAN

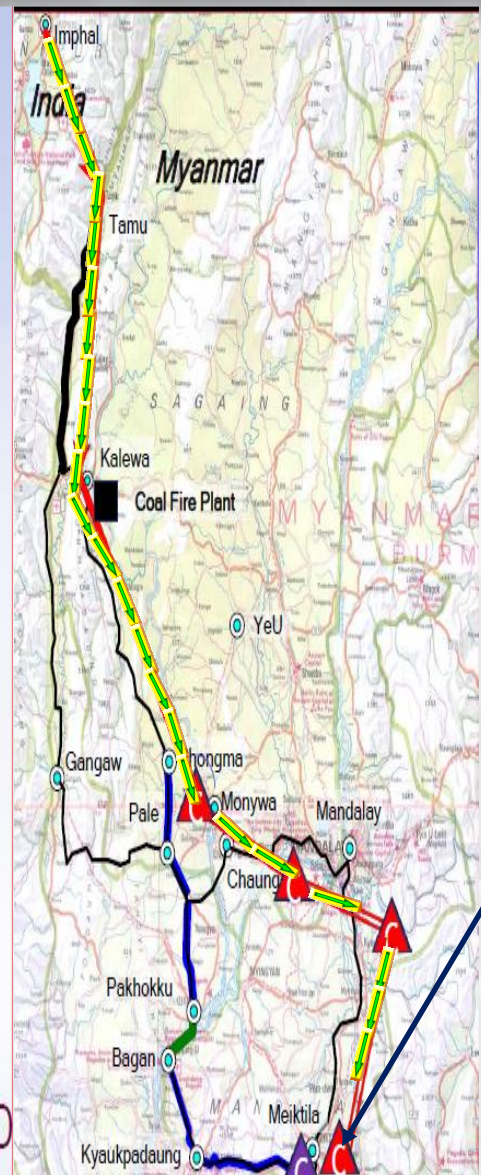
# Stages for Power system Integration and Power Trade between ASEAN and South Asia Power Grid



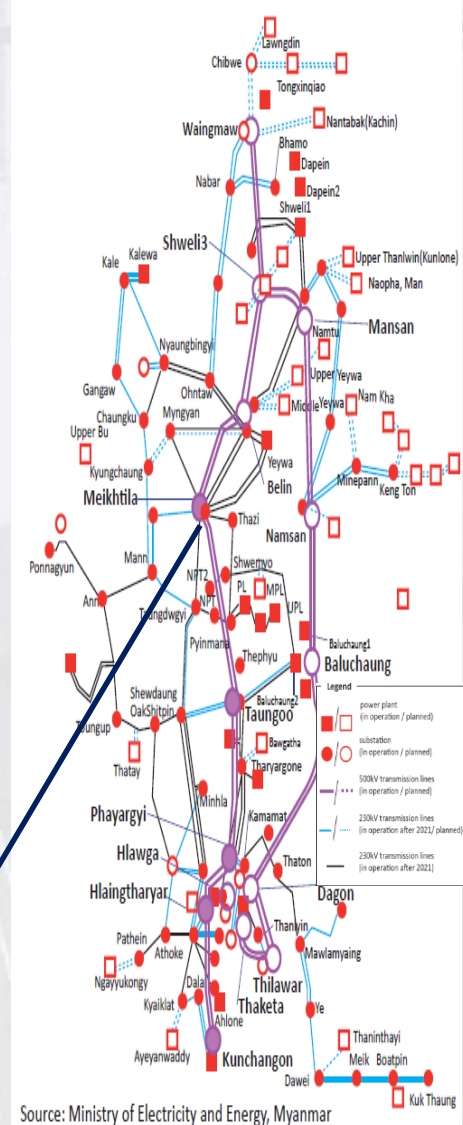
# START WITH SIMPLE

# Possible Interconnection -South Asia-ASEAN

- Considering the terrain, possible interconnection with India could be through the state of Manipur / Mizoram(India) through Myanmar to ASEAN
- The interconnection possibility with Bangladesh is also needed.
- While larger interconnection will take time, steps should be taken to increase more no. of border town interconnection with India.



OUTLINE OF POWER SYSTEM EXPANSION IN 2030



India and Myanmar exploring the Possibility of developing a coal based power plant at Kalewa Shwe Taung Development Co Ltd has shown interest in setting up a 500MW hydroelectric power plant in the Rakhine state and export electricity to Bangladesh.

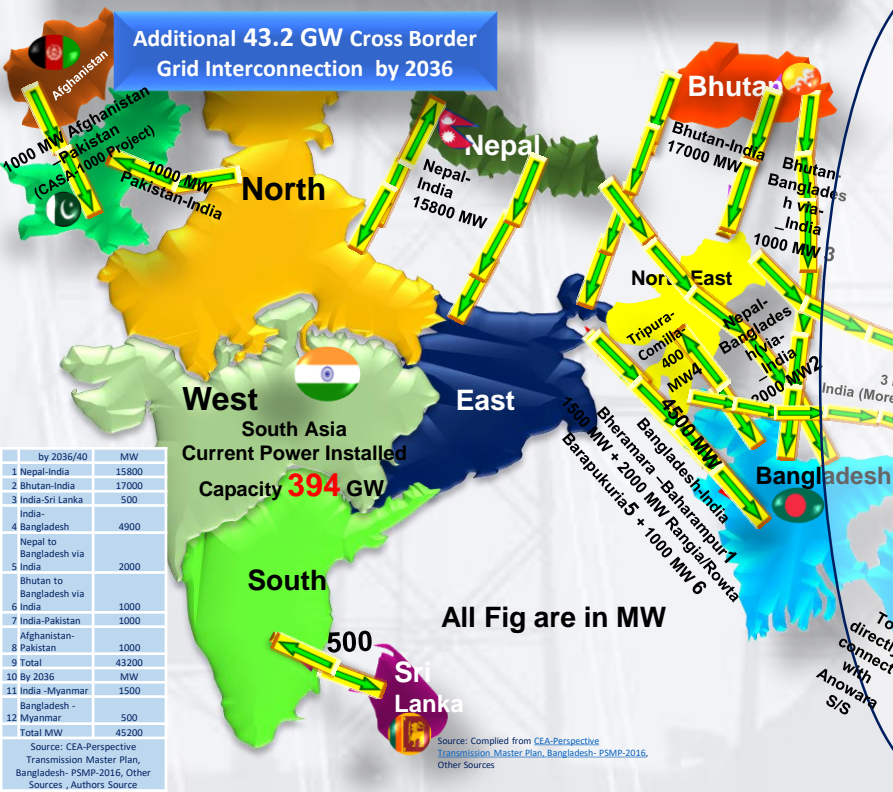
Source: Presentation by Myanmar Electric Power Enterprise, Ministry of Electric Power

Source: Ministry of Electricity and Energy, Myanmar

# Possible Interconnection -South Asia-ASEAN

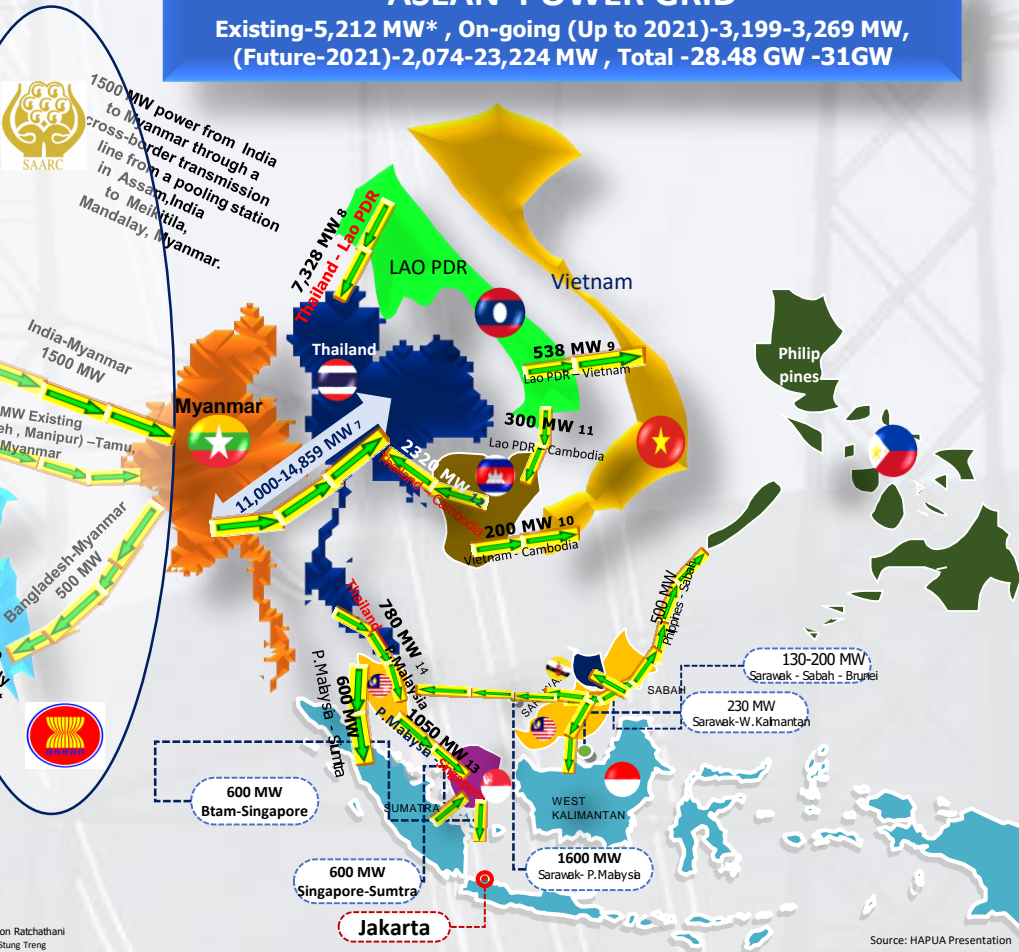
## SOUTH ASIA POWER GRID

Additional 43.2 GW Cross Border  
Grid Interconnection by 2036



## ASEAN POWER GRID

Existing-5,212 MW\*, On-going (Up to 2021)-3,199-3,269 MW,  
(Future-2021)-2,074-23,224 MW , Total -28.48 GW -31GW



Source: HAPUA Presentation

# ASEAN+ South Asia Power Grid -Will be one of the world's Largest Integrated Trans-Regional Power System by 2040 = 1996 GW ( 1367\* GW + 629\*\* GW)

Source: \* India-IEA-India Energy Outlook-Nepal- Electricity Demand Forecast Report (2015-2040) <http://documents.worldbank.org/curated/en/84614468001468272/pdf/NP57341.pdf> \*\* 5th ASEAN Energy Outlook -BAU

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# Power Market Model/Options for Power Trade between ASEAN and South Asia Power Grid and system Integration

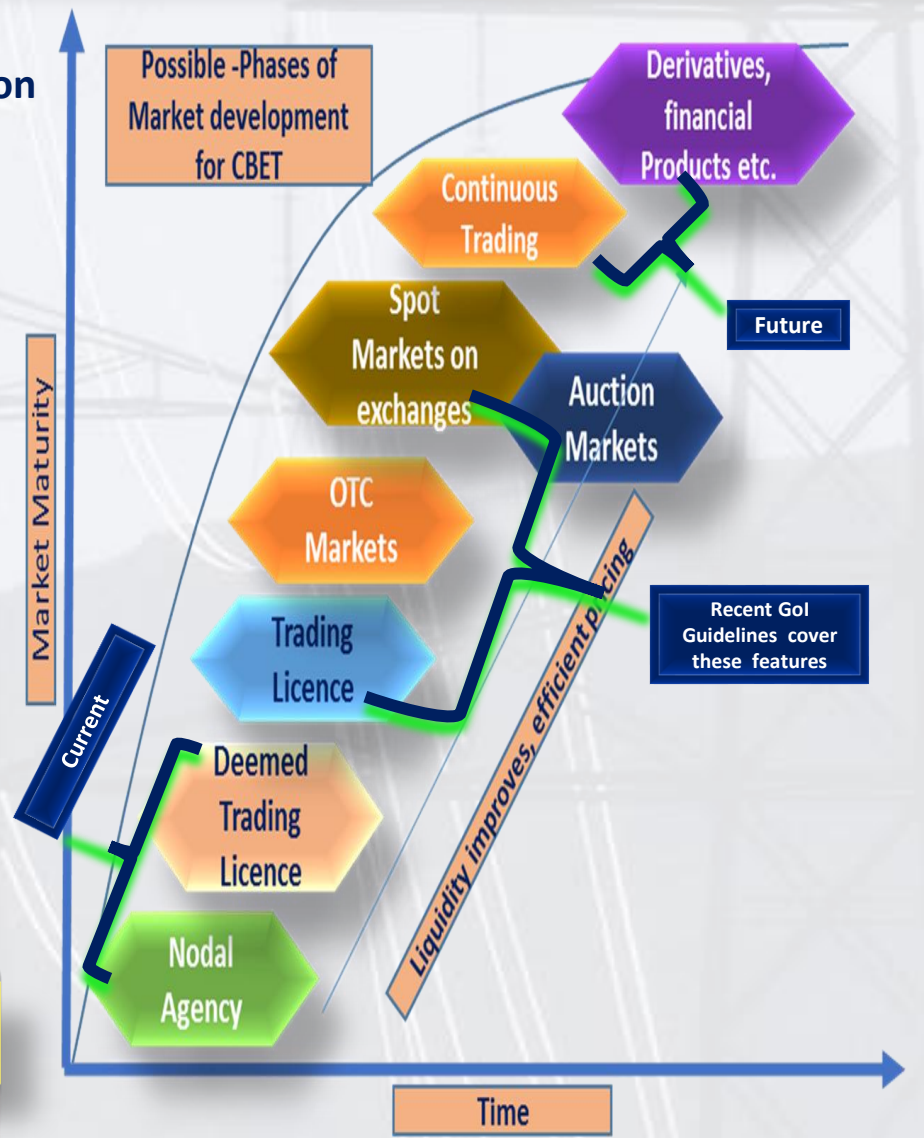
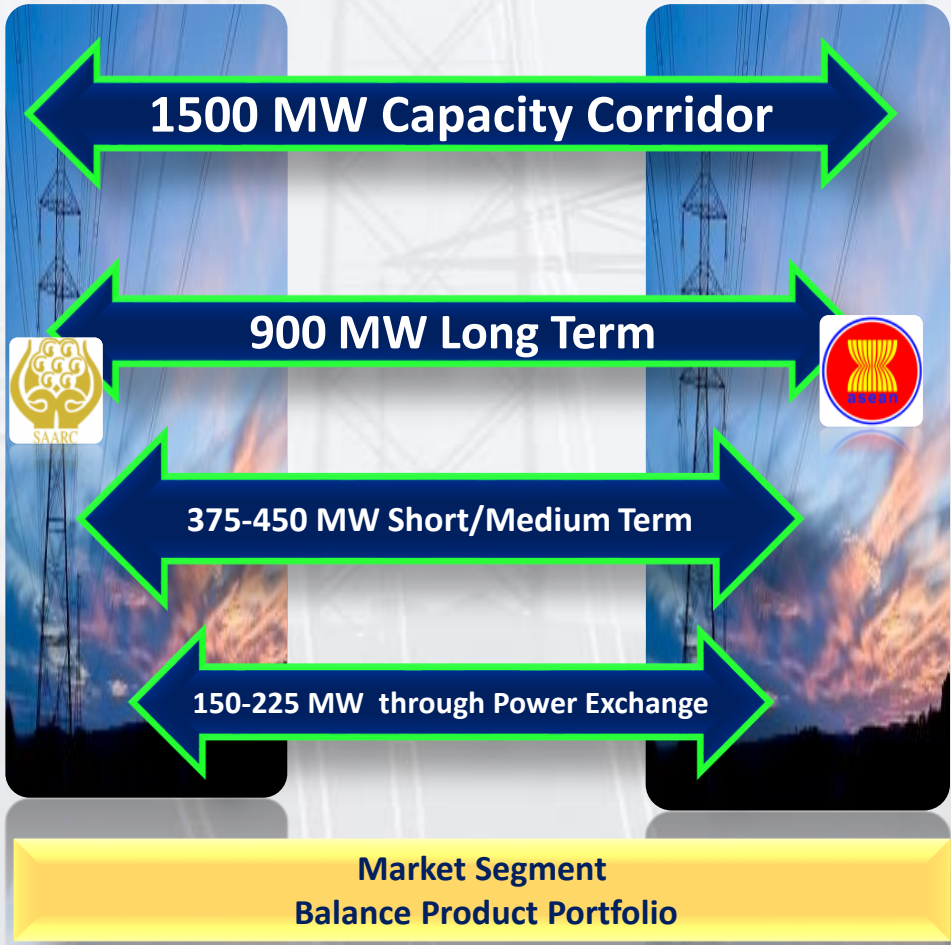


Power Market & Trading



# Market Model for Power Trade between ASEAN and South Asia Power Grid- Development of Cross Border Transmission Infrastructure

Approach for Development of Cross Border Transmission Infrastructure & it's economic utilization



# Cross Border Electricity Trade Investments: Risk

## Why Inter-Regional Cross-border Electricity Trade Investment are Risky

- Project risks in general tend to be high with out a comprehensive Policy, Regulatory framework for **large CBET project development.**
- Inter-Regional Cross-border element greatly amplifies the risks due to **geopolitical, economic and trade related factors.**
- Even projects that appear to have feasible , rationale, economical **in practice struggle to get it financed and built.**
- Project risks in general tend to be high in **countries without wide experience on large project development and cross border trade.**



**Political:** What happens if for political reasons the flow is prevented in the exporting, intermediary (if relevant) or importing country ?



**Regulatory:** What happens if the domestic Policy, regulatory framework changes which impacts CBETproject/Investment ? What is the protection available to buyers/sellers/Investor ?



**Economic:** What happens if the economic assumptions on the project changes? What is the protection available to buyers and sellers ?



**Trade Barrier:** What happens if a tax or duty that affects the economic fundamentals is imposed ?



**Infrastructure:** What happens if the infrastructure to transfer the energy is not built or is not available when needed ?

# Need for Comprehensive Investment Friendly Inter-Regional Investment Framework for Inter-Regional Power Trade between ASEAN and South Asia

## Inter-Regional Cross border power trade

- Guidelines/ procedures/ frameworks for undertaking Inter-Regional / Inter-Regional –bilateral CBET generation and Transmission projects
- Transmission Planning: (Inter- Regional Planning)
- Technical & Operation challenges - grid code
- Transmission pricing framework
- Open access rights, Power market framework
- Deviation settlement mechanisms
- Legal & Regional regulatory framework for CBET.

## PPP attractiveness

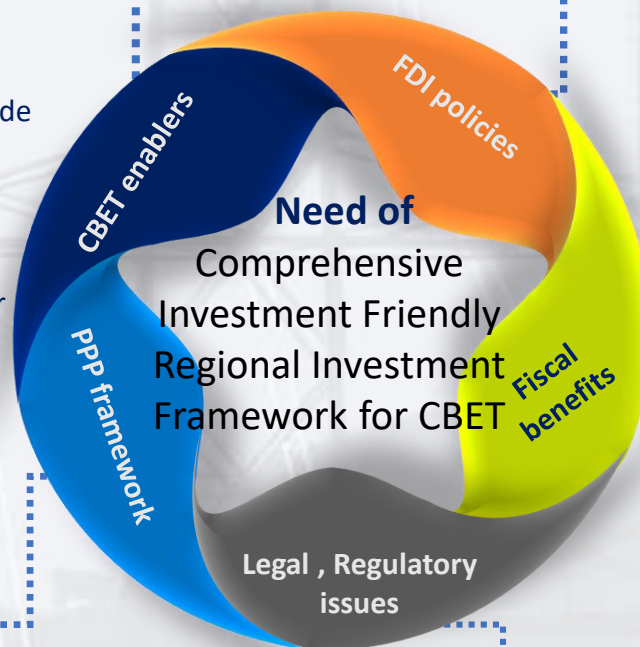
- Contractual framework
- Royalty regimes
- Standardize contract documents (PPA & TSA)
- Single window clearance
- Regional skill development center
- BOO, and BOOT business models under PPP
- Guarantee against expropriation

## Policy drivers and inhibitors

- Repatriation of profits and tax on expatriates income
- Minimum capital requirement
- Protection of foreign investment
- Outward direct investment
- Limits on foreign equity participation
- Stable tax regime and Corporate governance

## Incentives offered to developers

- Fiscal benefits - Tax holidays
- Concessional interest rates
- Incentives – Export incentives, Exemption of electricity duty and excise duty
- Off-taker Risk:-Addressing through Currency hedging (Currency swaps, options, forward contract)
- USD denominated PPA



## For investment protection

- Protection of Investment
- Dispute settlement mechanism
- Contract enforcement
- Regional Regulatory framework
- Regional Investment Protection Treaty
- International investment agreements (BIT, FTA)



## Way Forward

- **Start with Inter-Regional Bilateral Power Trade:** Bilateral flows under a commonly accepted legal and contractual framework creates confidence. Prior to investing in specific cross-border assets, simple trading mechanism provides confidence.
- **Detailed Transmission planning study:** Need to carry out detailed study for transmission interconnection between South Asia and ASEAN through Myanmar.
- **Sub Regional Approach.** BIMSTEC and ASEAN can cooperate among each other. Expedite the signing of the BIMSTEC Trans-power exchange and grid interconnection, hydropower development, energy security. Myanmar is the gateway to ASEAN.
- **Learn by doing From the Experience:** Trade will throw valuable experiences. Create the institutional structure and capabilities that can record/retain that experience and put to use at the investment stage.
- **Keep up the Momentum and Visibility:** Large scale Investment will require much more than trade. Keep building on the institutional structures, treaties and agreements that will provide long term visibility.
- **Capturing the Need of Non-Energy Benefits of Hydro:** Non-Energy Benefits of Hydro needs to be captured in the context of Renewable Energy Integration and Grid Balancing. Need to build Market Mechanism. Declaring Hydro as Renewable Energy.
- **Harmonization/Coordination of Policy and Regulations:** Regional policy and regulatory framework, Regional Transmission master plan for CBET. Regional Regulatory framework.
- **Integration of power markets :** Balance mix of Negotiated and Commercial/market determined Tariff for CBET.
- **Investment Friendly Investment Framework:** Investment Friendly Inter-Regional Investment Framework for Inter-Regional Power Trade





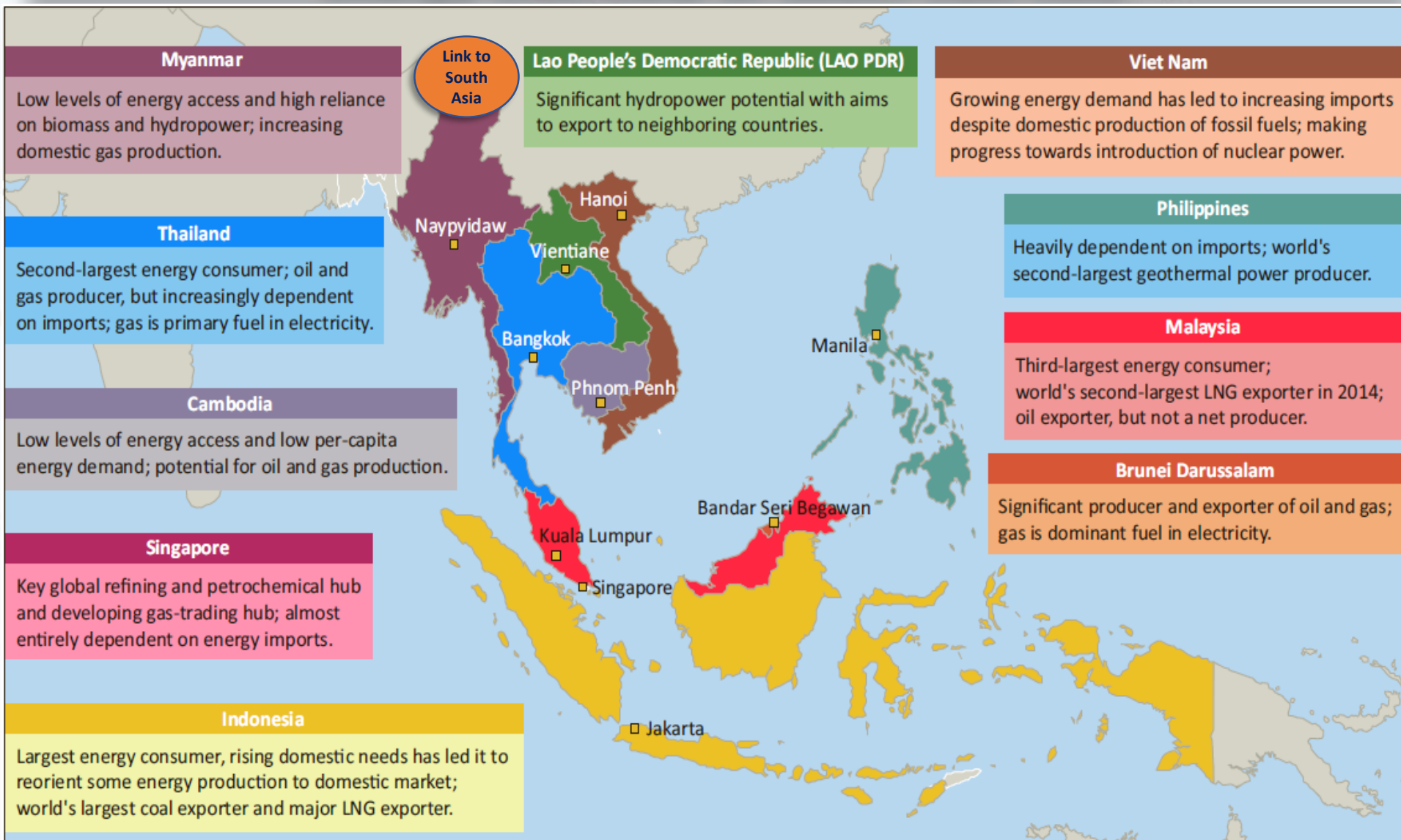
“You can't cross the sea merely by standing and staring at the water.” - Rabindranath Tagore

# Thank You

Contact  
[rajivratnapanda@irade.org](mailto:rajivratnapanda@irade.org)  
[rajivratnapanda@gmail.com](mailto:rajivratnapanda@gmail.com)



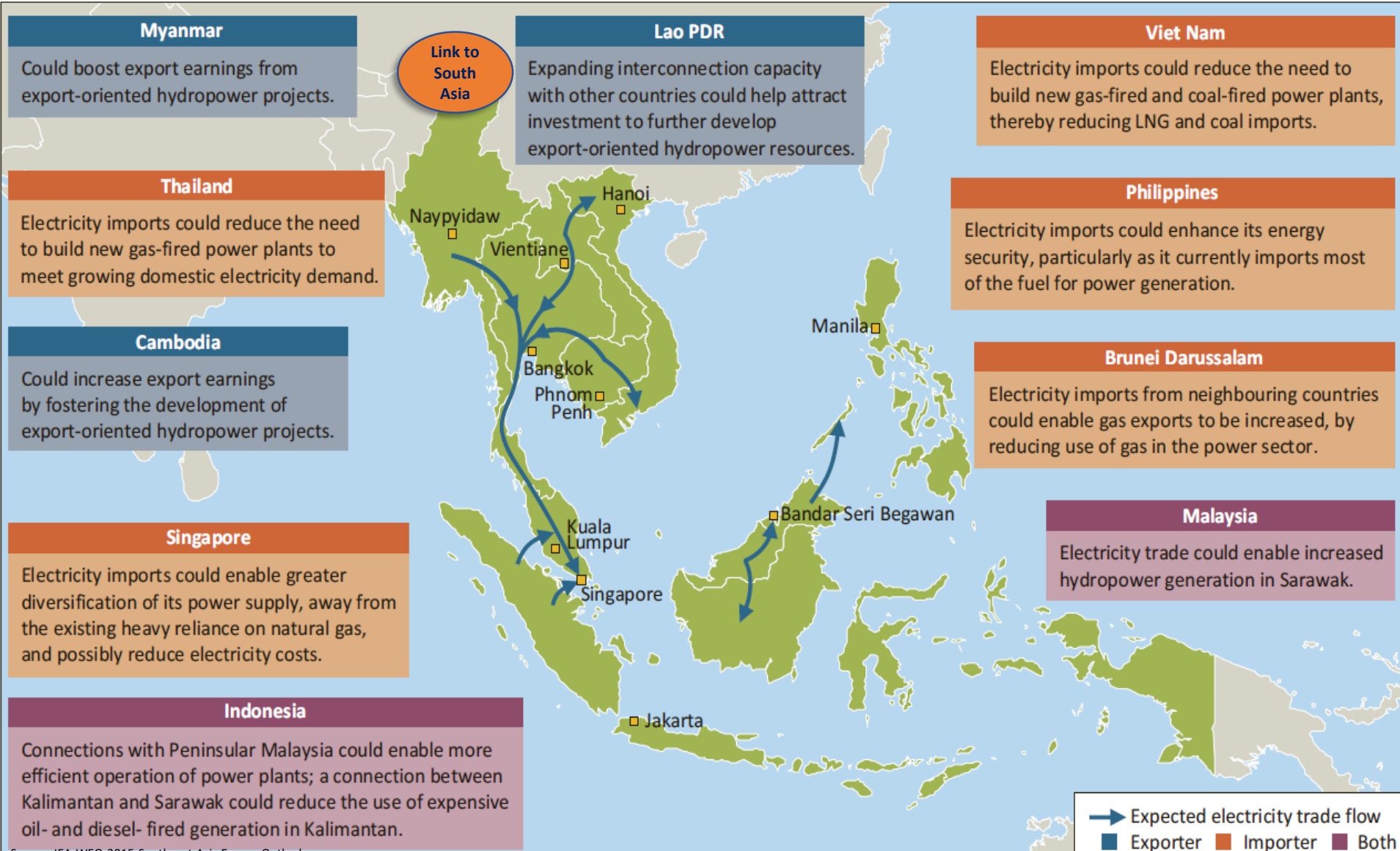
# Energy Overview of South East Asia



Source: IEA-WEO-2015-Southeast Asia Energy Outlook

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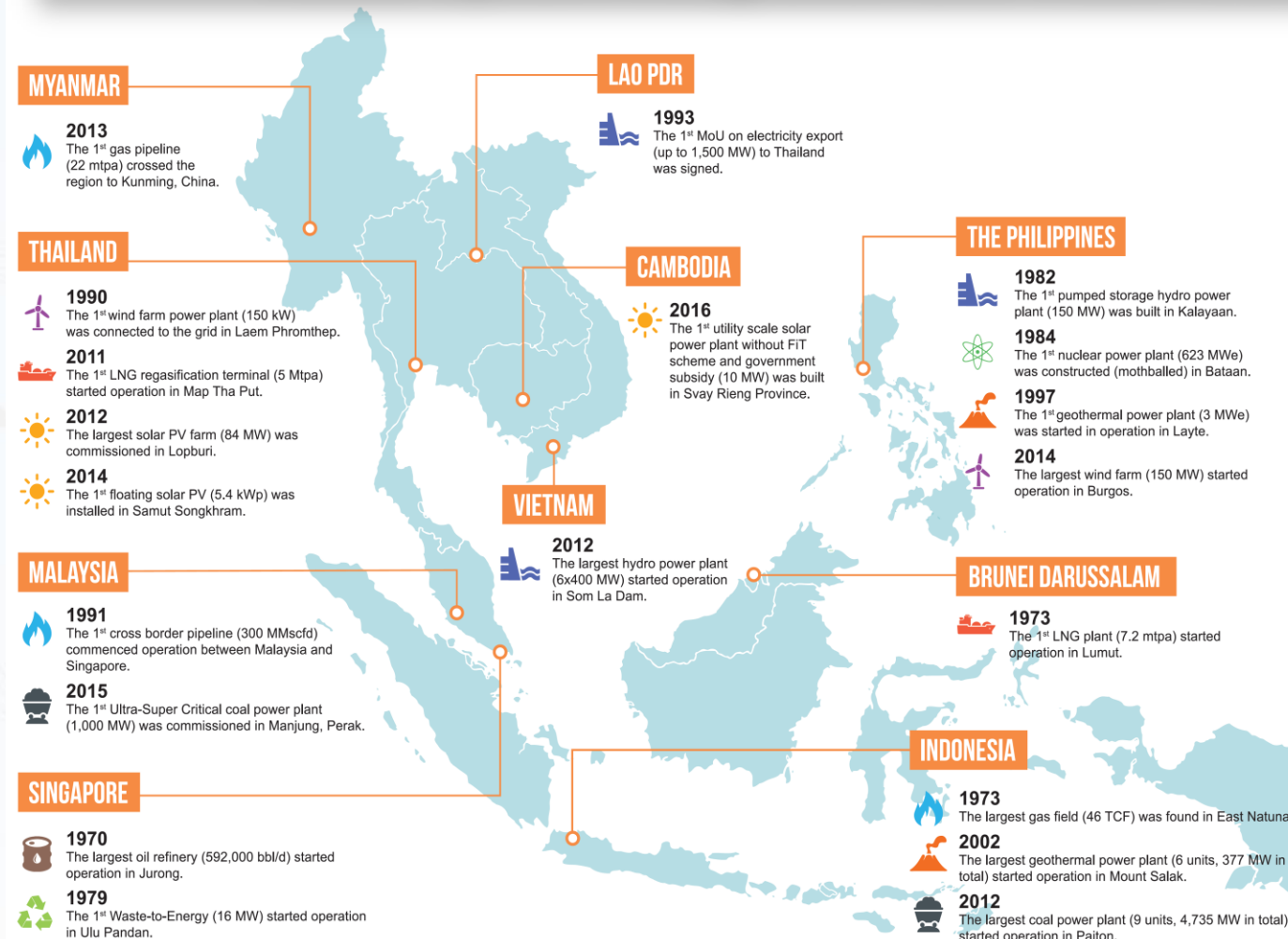
# Potential implications and benefits of enhanced power grid interconnections South East Asia







Source: IEA-WEO-2015-Southeast Asia Energy Outlook

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# Power/Energy System Integration Milestones and Trade ASEAN Countries














## SOCIO-ECONOMIC INDICATORS

	1967	2015
 <b>MEMBER</b>	ASEAN 5	ASEAN 10
 <b>GDP</b>	US\$23 BILLION	US\$ 2,432 BILLION
 <b>POPULATION</b>	185 MILLION	629 MILLION
 <b>GDP PER CAPITA</b>	US\$ 122	US\$ 3,867

## ENERGY INDICATORS

 <b>TOTAL PRIMARY ENERGY SUPPLY</b>	 <b>TOTAL FINAL ENERGY CONSUMPTION</b>
454.8 MTOE 2005    626.8 MTOE 2015	306.4 MTOE 2005    427.3 MTOE 2015
 <b>INSTALLED CAPACITY</b>	 <b>ELECTRICITY GENERATION</b>
104.9 GW 2005    205.4 GW 2015	500.3 TWH 2005    926.8 TWH 2015

## RENEWABLE ENERGY INDICATORS

      	
<b>FROM THE TOTAL PRIMARY ENERGY SUPPLY</b>	<b>FROM THE INSTALLED CAPACITY</b>
2005  9.6%	2005  22.2%
2015  13.6%	2015  24.3%

## ASEAN IN 2017



Achieved the completion of additional physical interconnection with capacity of 1,723 MW.  
**5,212 MW**  
the total capacity of the ASEAN Power Grid (APG).



- 13 Trans-ASEAN Gas Pipeline (TAGP) bilateral projects connecting six ASEAN Member States (AMS) with a total 3,673 km.
- 6 LNG regasification terminals with a total capacity 27.5 mtpa.



# Energy Resources in ASEAN Countries

**Fossil Energy Resources in ASEAN Countries**


Source: ASEAN Power Cooperation Report

**Renewable Energy Resources in ASEAN Countries**


Source: ASEAN Power Cooperation Report

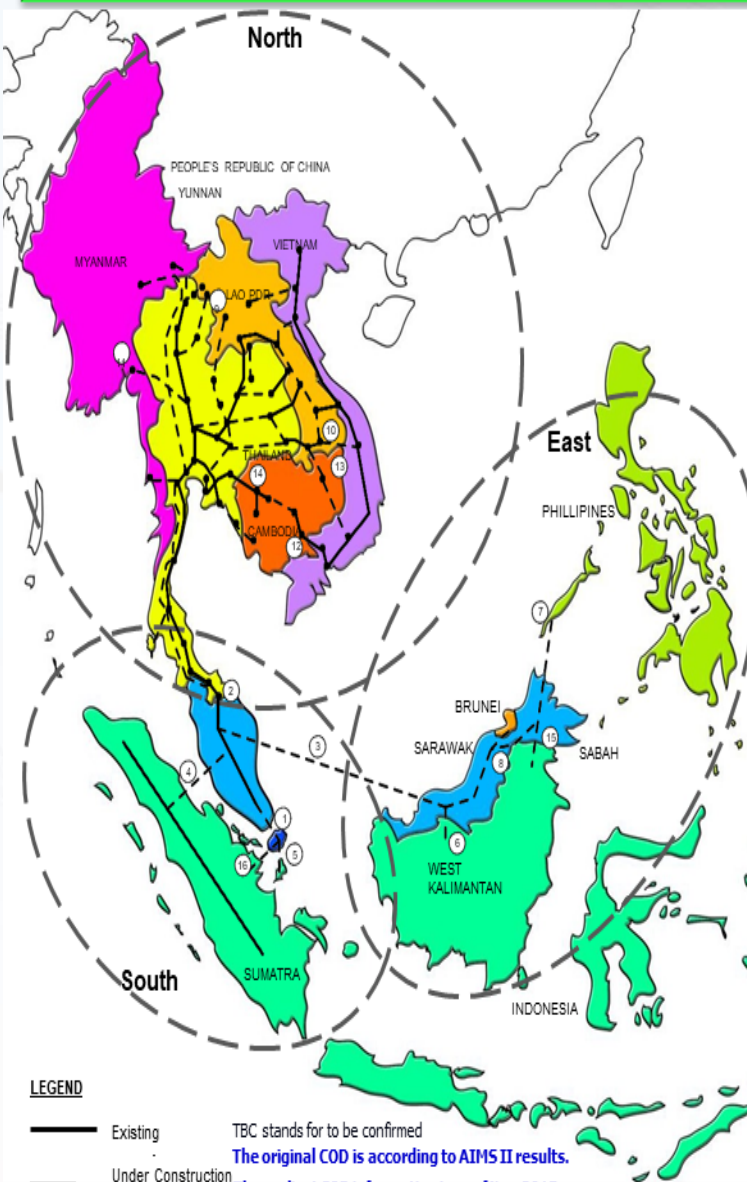
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Source: ASEAN Power Cooperation Report

Projects	Natural Gas (trillions m <sup>3</sup> )	Petroleum (100 million tons)	Hard Coal (100 million tons)	Lignite (100 million tons)
gross reserves	16.74	63	983.4	3534.3
exploitable volumes	6.46	18.2	375.3	102.3
Percentage of gross reserves(%)	38.6	28.9	38.2	2.9
Of which: Indonesia (%)	28	86	81	45
Vietnam (%)	33	8		10
Malaysia (%)	27	5		36
Thailand (%)			10	

Nation	Biomass (GW)	Geothermal (GW)	Hydropower (GW)	Wind (GW)	Tidal Energy (GW)	Solar (kWh/m <sup>2</sup> /day)
Brunei Darussalam			0.07			9.6-12
Cambodia			10			5
Indonesia	32.6	28.9	75		49	4.8
Lao PDR	1.2	0.05	26			3.6-5.3
Malaysia	0.6		29			4.5
Myanmar			40.4	4		5
The Philippines	0.24	4	10.5	76	170	5
Singapore					0.03-0.07	3.15
Thailand	2.5		15			5-5.6
Vietnam	0.56	0.34	35	7	0.1-0.2	4.5

# ASEAN Interconnection Projects (Updated in Mar 2016)


**LEGEND**

- Existing
- - - Under Construction
- ..... Future

TBC stands for to be confirmed  
**The original COD is according to AIMS II results.**  
**The earliest COD information is as of Nov 2015.**  
**The Priority Projects, which refer to the APAC 2016-2020, are underlined and indicated in Red.**

	<u>Original COD</u>	<u>Earliest COD</u>
1) <b>P.Malaysia - Singapore</b>	Existing	Existing
• Plentong – Woodlands	2018	post 2020
• P.Malaysia - Singapore (2 <sup>nd</sup> link Plentong - Woodlands)		
2) <b>Thailand - P.Malaysia</b>	Existing	Existing
• Sadao - Bukit Keteri	Existing	Existing
• Khlong Ngae - Gurun	2014	TBC
• Su Ngai Kolok - Rantau Panjang	2016	TBC
• Khlong Ngae – Gurun (2nd Phase, 300MW)	2015 - 2021	2025
3) <b>Sarawak - P. Malaysia</b>	2015 - 2021	2025
4) <b><u>P.Malaysia - Sumatra</u></b>	<u>2015</u>	<u>2021</u>
5) <b>Batam - Singapore</b>	2015 - 2017	post 2020
6) <b>Sarawak - West Kalimantan</b>	2012	2015
7) <b>Philippines – Sabah</b>	2020	TBC
8) <b>Sarawak - Sabah – Brunei</b>	2020	2020
• Sarawak – Sabah	2020	2020
• <u>Sarawak – Brunei</u>	<u>2012-2016</u>	<u>2019</u>
9) <b>Thailand - Lao PDR</b>	Existing	Existing
• Roi Et 2 - Nam Theun 2	Existing	Existing
• Sakon Nakhon 2 – Thakhek – Then Hinboun (Exp.)	2012	Existing
• Mae Moh 3 - Nan - Hong Sa	2015	Existing
• Udorn Thani 3- Nabong (converted to 500KV)	2017	2019
• Ubon Ratchathani 3 – Pakse – Xe Pian Xe Namnoy	2018	2019
• Khon Kaen 4 – Loei 2 – Xayaburi	2019	2019
• <u>Thakhek - Phao PDR (Thakhek)</u>	2015 - 2023	2019-2023
10) <b>Lao PDR – Vietnam</b>	2011 – 2016	2016 – 2020
• Xekaman 3 – Tranhmy	Existing	Existing
• Xekaman 1 – Pleiku 2		2016
11) <b>Thailand - Myanmar</b>	2016 - 2025	2018-2026
12) <b>Vietnam - Cambodia (New)</b>	Existing	Existing
• Chau Doc – Takeo – Phnom Penh	Existing	Existing
• Tay Ninh – Stung Treng	2016	TBC
13) <b><u>Lao PDR – Cambodia</u></b>	<u>2011</u>	<u>post 2018</u>
14) <b>Thailand - Cambodia (New)</b>	2015 - 2017	post 2020
• Aranyaprathet – Banteay Meanchey	Existing	Existing
• Thailand – Cambodia	2015-2017	post 2020
15) <b>East Sabah - East Kalimantan</b>	newly Proposed	TBC
16) <b>Singapore – Sumatra</b>	2020	post 2020

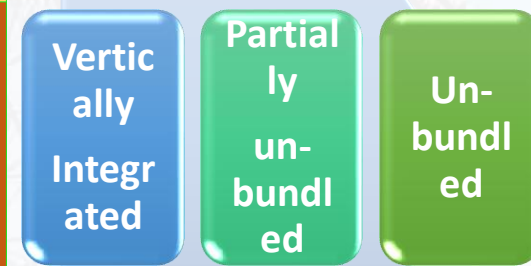
Status of ASEAN Interconnection Projects by Regions (Updated in Mar 2016)				
	Exist (MW)	On-goin (Up to 2021) (MW)	Future (MW)	Total (MW)
<b>Northern System</b>	<b>4,152</b>	<b>2,469</b>	<b>15,774-18,924</b>	<b>22,395-25,545</b>
9 Thailand - Lao PDR	3,584	1,879	1,865	7,328
10 Lao PDR - Vietnam	248	290	-	538
11 Thailand - Myanmar	-	-	11,709-14,859	11,709-14,859
12 Vietnam - Cambodia	200	-	-	200
13 Lao PDR - Cambodia	-	300	-	300
14 Thailand - Cambodia	120	-	2,200	2,320
<b>Southern System</b>	<b>450</b>	<b>600</b>	<b>1,800</b>	<b>2,850</b>
1 P.Malaysia - Singapore	450	-	600	1,050
4 P.Malaysia - Sumatra	-	600	-	600
5 Batam - Singapore	-	-	600	600
16 Singapore - Sumatra	-	-	600	600
<b>Eastern System</b>	<b>230</b>	<b>30-100</b>	<b>600</b>	<b>860-930</b>
6 Sarawak - W.Kalimantan	230	-	-	230
7 Philippines - Sabah	-	-	500	500
8 Sarawak - Sabah - Brunei	-	30-100	100	130-200
15 E.Sabah - E.Kalimantan	-	-	-	-
<b>Northern - Southern System</b>	<b>380</b>	<b>100</b>	<b>300</b>	<b>780</b>
2 Thailand - P.Malaysia	380	100	300	780
<b>Southern - Eastern System</b>	<b>-</b>	<b>-</b>	<b>1,600</b>	<b>1,600</b>
3 Sarawak - P.Malaysia	-	-	1,600	1,600
<b>Grand Total</b>	<b>5,212</b>	<b>3,199-3,269</b>	<b>20,074-23,224</b>	<b>28,485-31,705</b>

# Power Market Structure of ASEAN Countries

Country	Regulator	Regulator independence	Market structure
Brunei Darussalam	Dept. of Electrical Service	Under the Ministry of Energy	Single buyer
Cambodia	Electricity Authority of Cambodia	Independent	Single buyer
Indonesia	Dept. of Energy and Mineral Resources	Under the Ministry of Energy and Mineral Resources	Single buyer
Lao PDR	Dept. of Electricity	Under the Ministry of Energy and Mines	Single buyer
Malaysia	Energy Commission	Independent	Single buyer
Myanmar	Ministries of Electric Power	Under the Ministries of Electrical Power	Single buyer
Philippines	Energy Regulatory Commission	Independent	Price pool
Singapore	Energy Market Authority	Under the Ministry of Trade and Industry	Price pool
Thailand	Energy Regulatory Commission	Independent	Single buyer
Viet Nam	Electricity Regulatory Authority	Under the Ministry of Industry	Cost-based pool

# Power Market Structure in South Asian Countries

Country	Policy	Regulation	Generation	Transmission	System Operation	Power Trading/Market Structure
Afghanistan 1.3 GW	Ministry of Energy and Water (MEW)	Electricity Regulatory Authority	DABS	DABS	DABS	Single Buyer (SB), DABS
Bangladesh 16.3 GW	Ministry of Power, Energy and Mineral Resources	Bangladesh Energy Regulatory Commission	BPDB, EGCB, APSCL, NWPGC, IPPs, SIPPs, Rental Plants	PGCB	PGCB	Single Buyer, BPDB, Multiple Seller (MS)
Bhutan 1.6 GW	Ministry of Economic Affairs (MEA)	Bhutan Electricity Authority (BEA)	Druk Green Power Corporation (DGPC)	Bhutan Power Corporation (BPC)	BPC (NLDC)	Export Licensee , SB Model
India 344 GW	Central: Ministry of Power under Gol, State: Power/Energy Department under the State Government	Central: CERC, State: SERCs/ JERCs	Central: NTPC, NHPC, NPCIL, UMPPs, IPPs, MPPs State: State-owned GenCos, IPPs, CPPs	Central: POWERGRID (CTU), Private/JV Licensees State: STUs, Private/JV Licensees	Central: POSOCO (NLDC & 5 RLDCs) State: SLDCs	Multiple Buyer and MS Model Central: Inter-state Licensees; State: Discoms / Trade Cos (Include State Holding Cos) / Intra-state Licensees, Power Exchange Platform
Nepal .9 GW	Ministry of Energy (MoE)	Electricity Tariff Fixation Commission (ETFC)	Nepal Electricity Authority (NEA), IPPs	NEA	NEA	SB Model –NEA, Multiple Seller (MS)
Pakistan 29 GW	Ministry of Water and Power (MOWP)	National Electric Power Regulatory Authority (NEPRA)	State-owned generating companies formed after restructuring of WAPDA (CPGCL, JPCL, LPGCL, NPGCL) & other IPPs	National Transmission & Despatch Company (NTDC)	NTDC	SB Model , CPPA, Multiple Seller (MS)
Sri Lanka 4 GW	Ministry of Power and Energy (MOPE)	Public Utilities Commission of Sri Lanka (PUCSL)	Ceylon Electricity Board (CEB), IPPs	CEB Transmission Licensees	CEB Transmission Licensees	SB Model, Multiple Seller (MS)



- Afghanistan (DABS)
- Bangladesh (FENAKA)
- Nepal (NEA)
- Sri Lanka (CEB)
- (Separate Trans. Utility)
- Bhutan (Separate Gen. utility)
- India (Separate G,T,D utilities)
- Pakistan (Separate G,T,D utilities))

Except India most of SA countries have SB Model. Power Trading/Power exchange Platform Exist in India only

# South Asia Power Grid

## Similarities

# ASEAN Power Grid

Eight Countries, 1.76 billion, 23 % of world's population.

Ten Countries, 634 Million People

Total Installed Capacity South Asia-398 GW

Total Installed Capacity ASEAN 206 GW

4.8 GW of Cross Border Transmission Capacity ( 3300 MW PPP)

5.21 GW of Cross Border Transmission Capacity

Cross Border Power Trade are Bilateral in Nature

Cross Border Power Trade are Bilateral in Nature

Steps are being taken to move from Bilateral to Multilateral (Trilateral Trade:- Bhutan-India-Bangladesh , Nepal -India-Bangladesh)

Steps have been taken to move from Bilateral to Multilateral (Lao PDR-Thailand-Malaysia-Singapore Power Grid Interconnection Project (LTMS-PIP)

Power Market Structure: Except India all other SA countries have Single Buyer Model. In India-Competitive power market & power exchange exist. (Wholesale Competition)

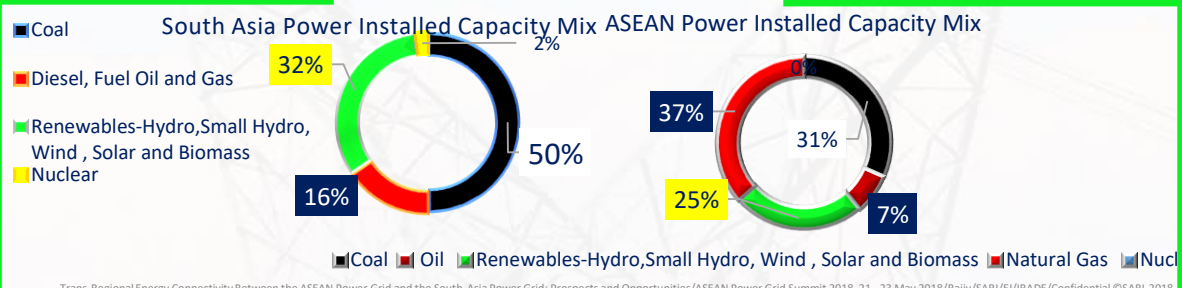
Power Market Structure: Except Singapore, Philippines, Vietnam all other ASEAN countries have Single Buyer Model. In Singapore (Wholesale), Philippines (Wholesale and Retail) have price pool structure, DAM market. Vietnam –Cost Pool-

Regional Power Market Issues: Different Policy, Regulatory, Legal Framework; Restricted Access to Indian Market; Investment Challenges; G to G versus Market form of Trade, Investment Challenges;

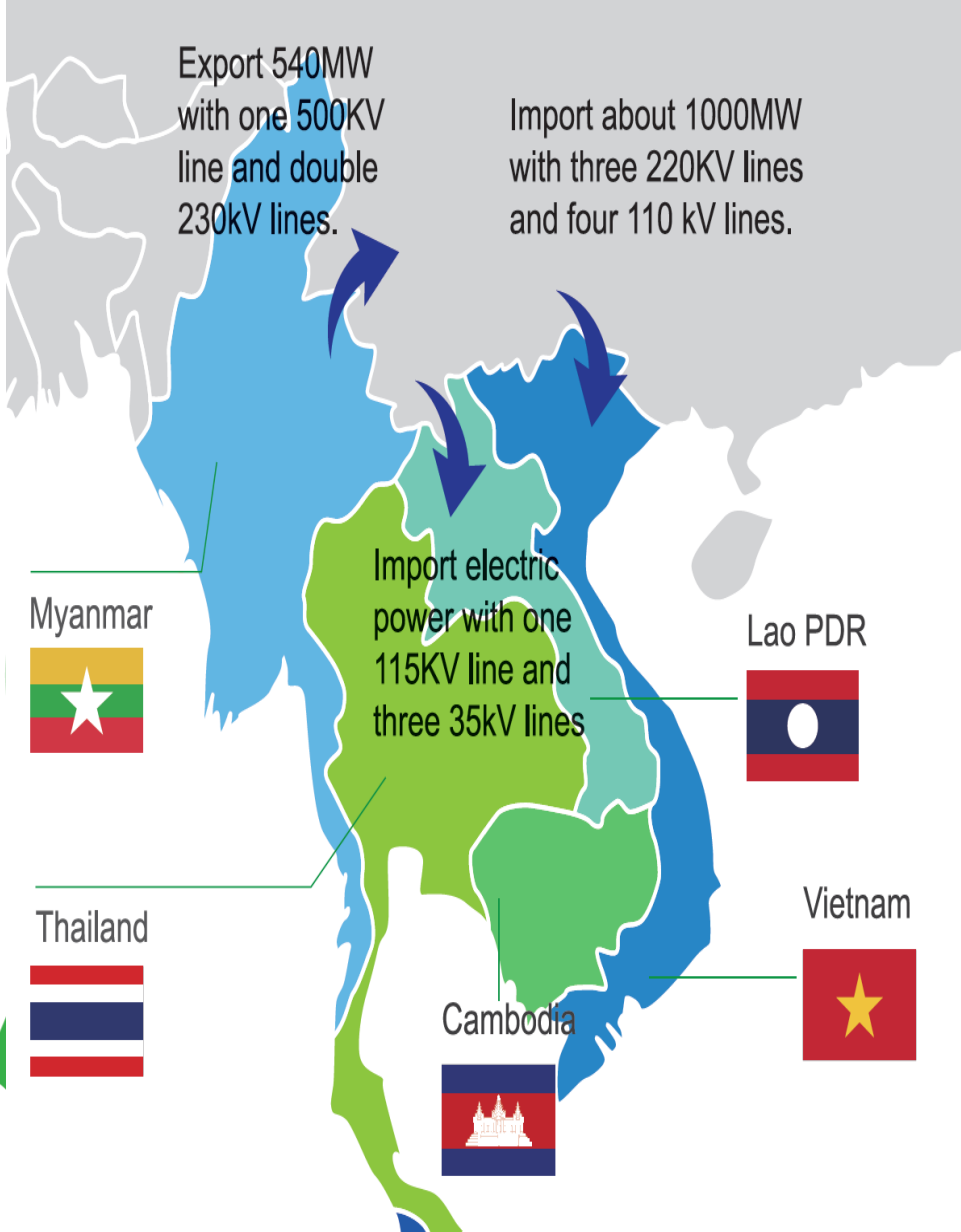
Regional Power Market Issues: Different Policy, Regulatory, Legal Framework; Investment Challenges; Sector Restructuring Concern, Concern on regional Power

G to G versus Market form of Trade, Sector Restructuring Concern, Full Opening of Power Exchange for CBET, Self Sufficiency Concern

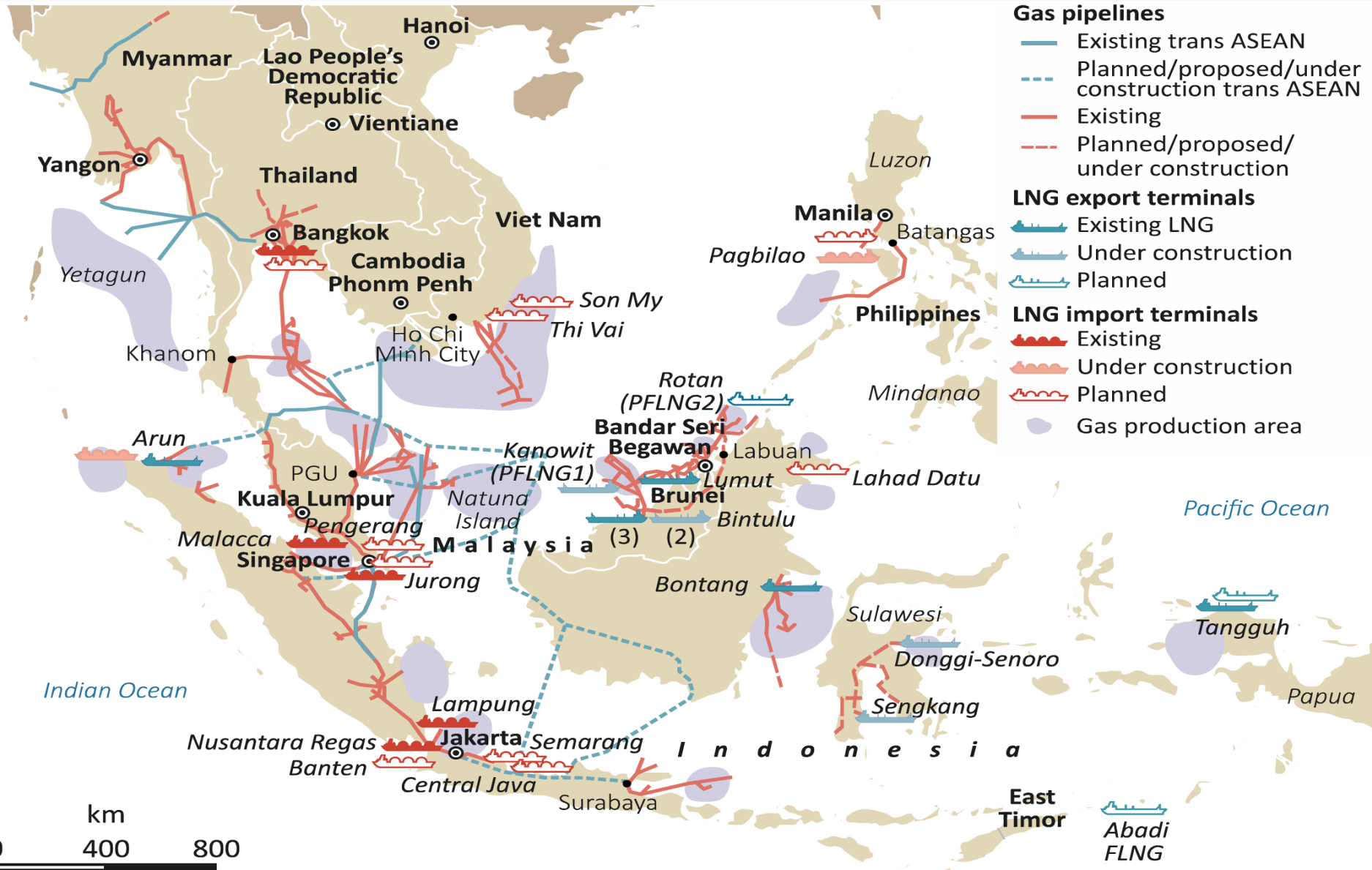
Exchange (PX) ,development/Opening of PXs for CBET, Self Sufficiency Concern , National Priorities vs Regional Priorities,



# Power System Integration and Trade ASEAN Countries



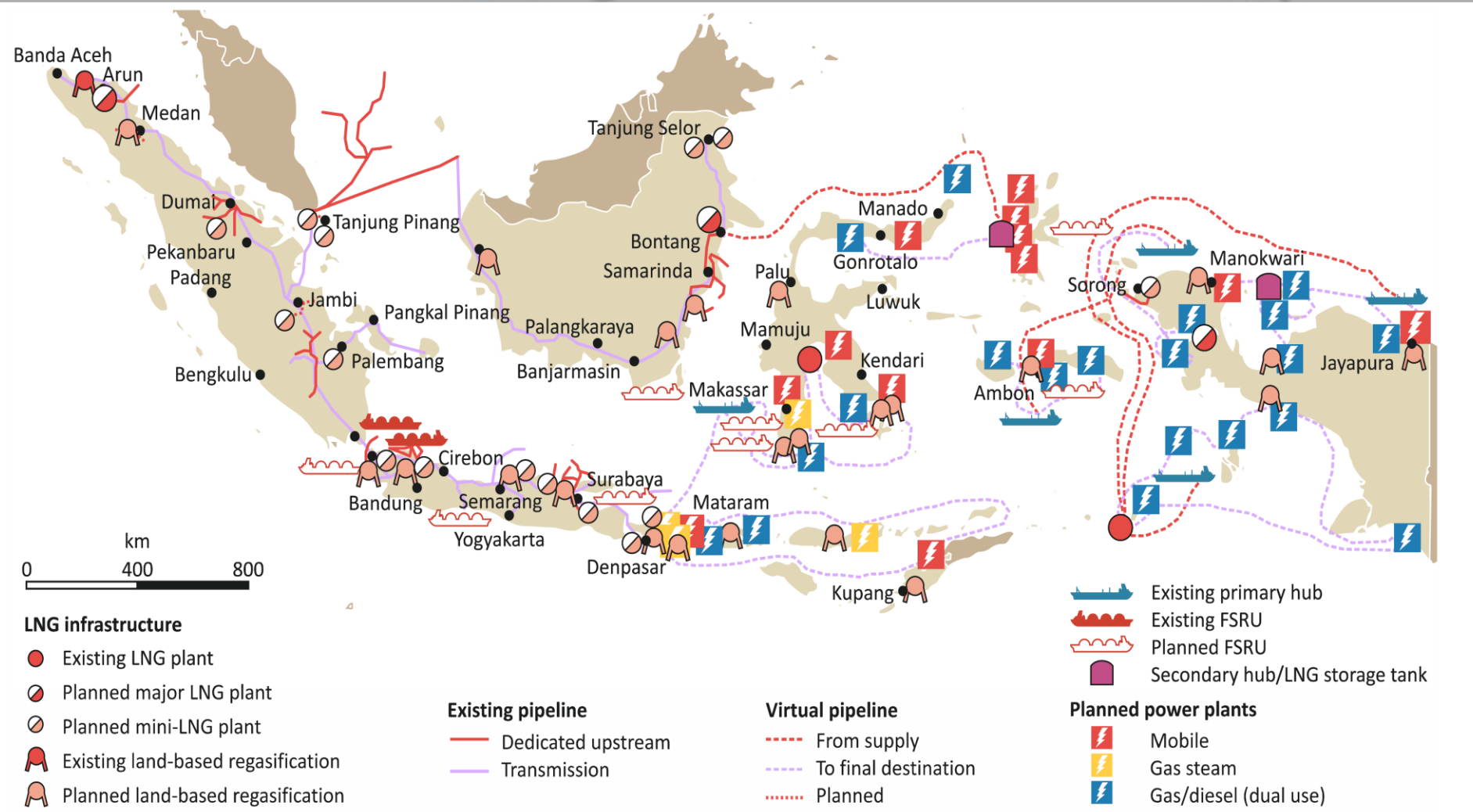
# Key natural gas resources and infrastructure in Southeast Asia



This map is without prejudice to the status of or sovereignty over any territory, to the delimitation of international frontiers and boundaries, and to the name of any territory, city or area.

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# Indonesia's natural gas-based electrification plans



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*Natural gas infrastructure has been identified as a central component in Indonesia's energy access strategy*

Notes: LNG = liquefied natural gas; FSRU = floating storage and regasification units. "Virtual pipeline" refers to routes by which gas is delivered by ship, instead of using pipelines. Source: LNG Infrastructure Roadmap 2016-2030 (MEMR, 2016). Source: IEA-WEO-2017-Southeast Asia Energy Outlook  
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