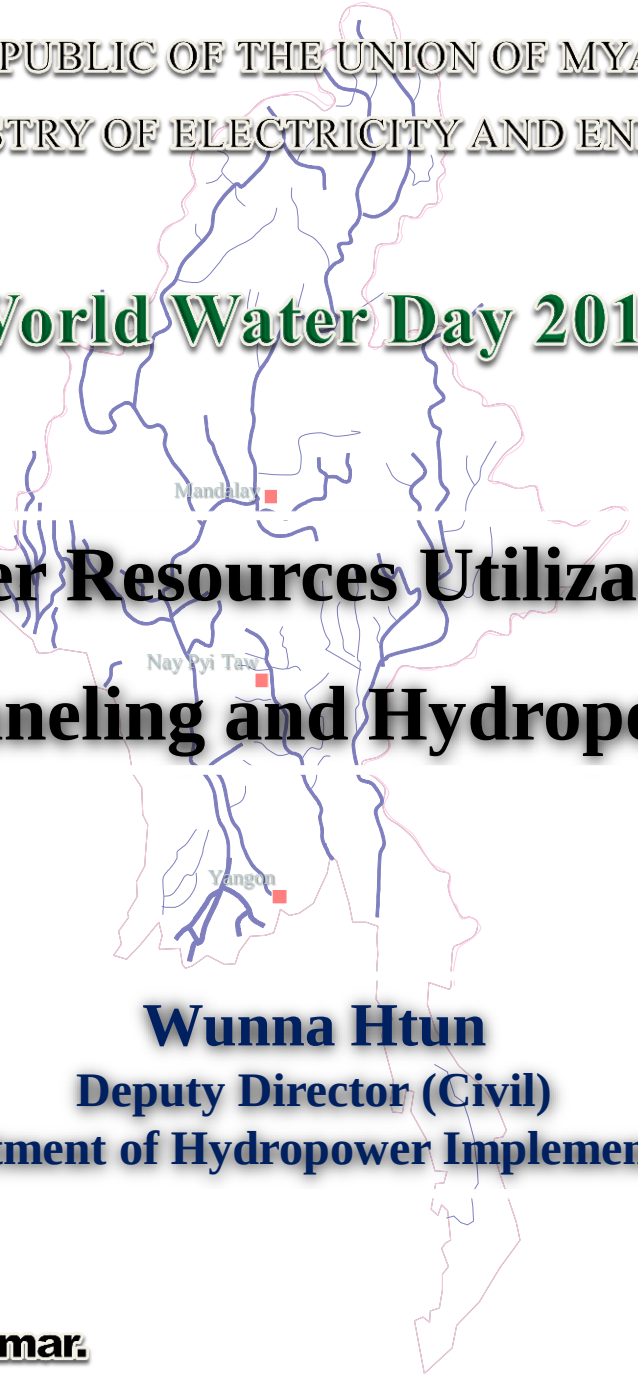
THE REPUBLIC OF THE UNION OF MYANMAR

MINISTRY OF ELECTRICITY AND ENERGY

World Water Day 2017



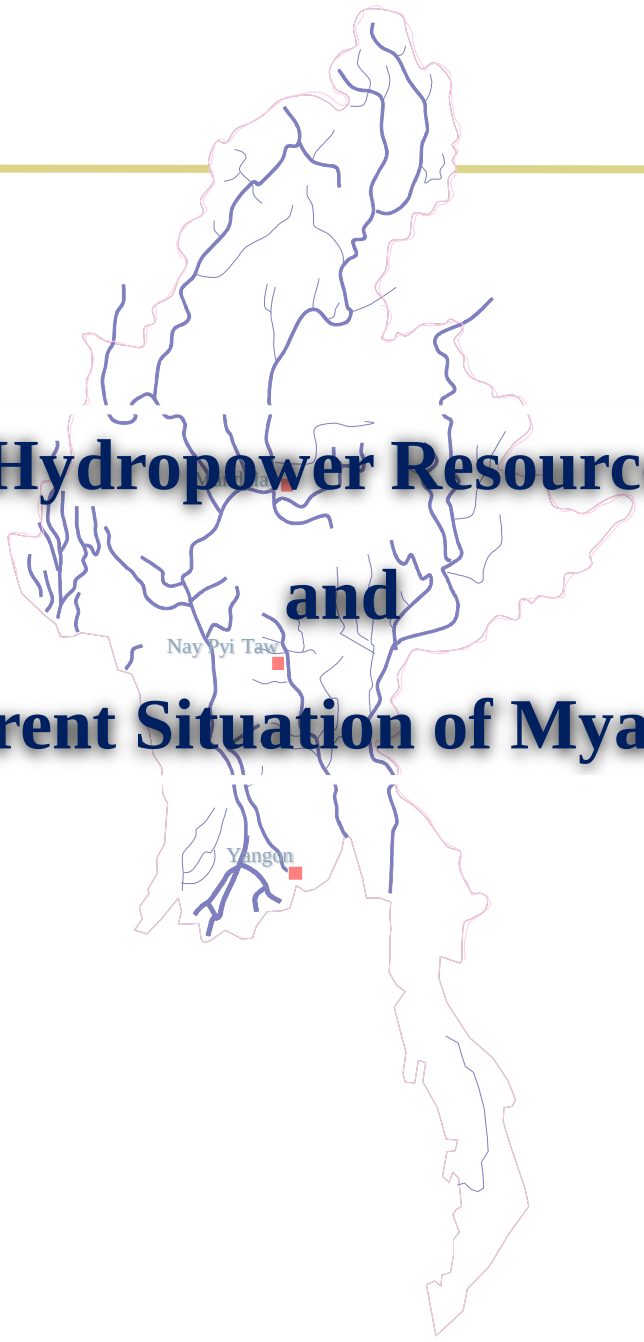
Water Resources Utilization:

Challenges on Tunneling and Hydropower Development

Wunna Htun
Deputy Director (Civil)
Department of Hydropower Implementation

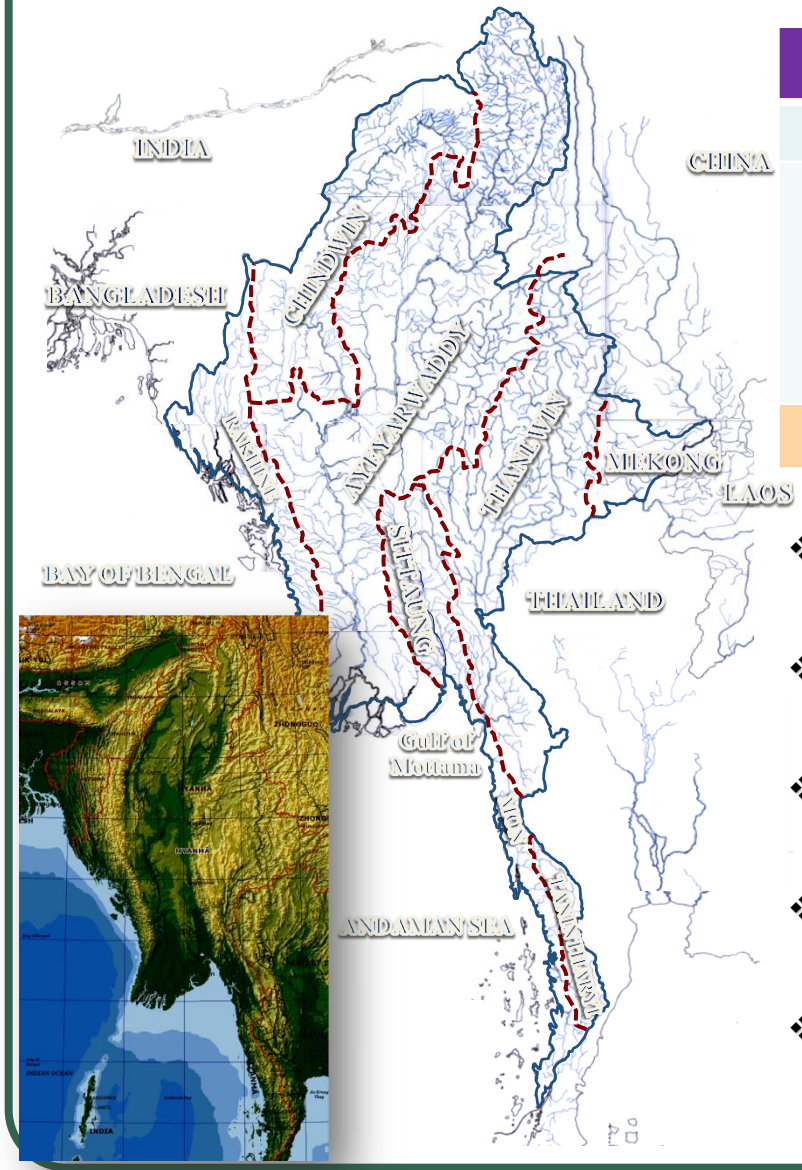
MICC-II, Nay Pyi Taw, Myanmar.

14th March 2017

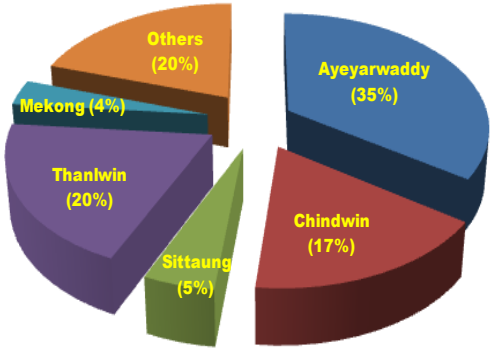


Hydropower Resources and Current Situation of Myanmar

Background of Hydropower Development in Myanmar



River Basins		
Sr.	Name of River	Basin Area (km²)
1.	Ayeyarwaddy	234,706
2.	Chindwin	115,307
3.	Sittaung	32,893
4.	Thanlwin	134,395
5.	Mekong	23,999
6.	Others	135,252
Total		676,552

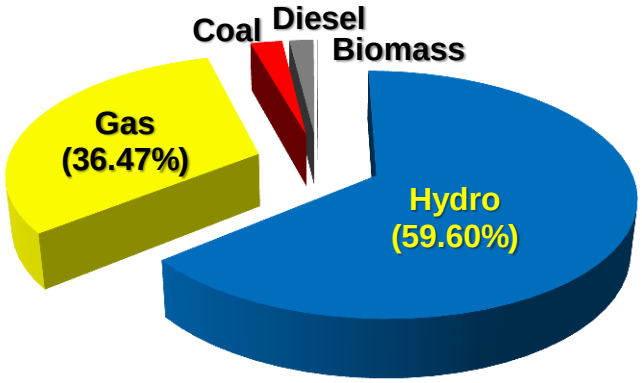


- Rich water resources because of favorable topography and tropical monsoon climate.
- Hydropower potential of Myanmar is estimated more than 100,000 MW (ADB 2012).
- Currently identified hydropower potential is about 44,300 MW in total.
- At present, total installed capacity of electric power is 5,393 MW and 60% from hydro power.
- Just only 7% of the country potential had already been developed and more than 93% of the country potential is still remaining.

Present Situation of Power Sector

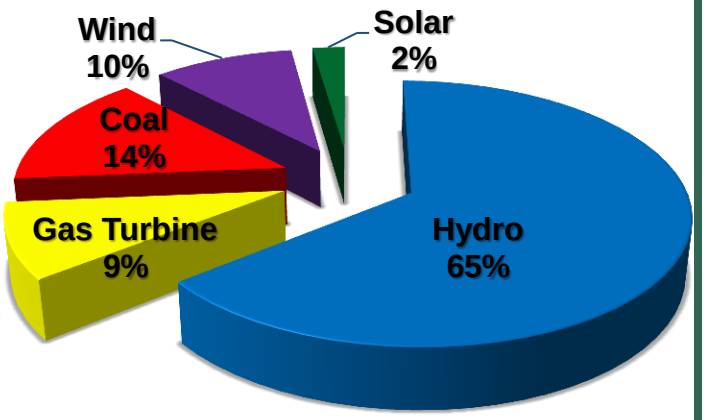
Overview of Current Generation Mix in Myanmar (As of Jan, 2017)

Item	Grid System (MW)	Isolated (MW)	Total (MW)	Percentage
Installed Capacity	**5,268**	**124.81**	**5392.81**	**100.00%**
Hydroelectric	3,181	33.33	3214.33	59.60%
Gas	1967	-	1967	36.47%
Coal	120	-	120	2.23%
Diesel	-	91.48	91.48	1.70%
Bio Mass	-	4.7	4.7	0.09%
Peak Demand	2,756 MW (April, 2016)			



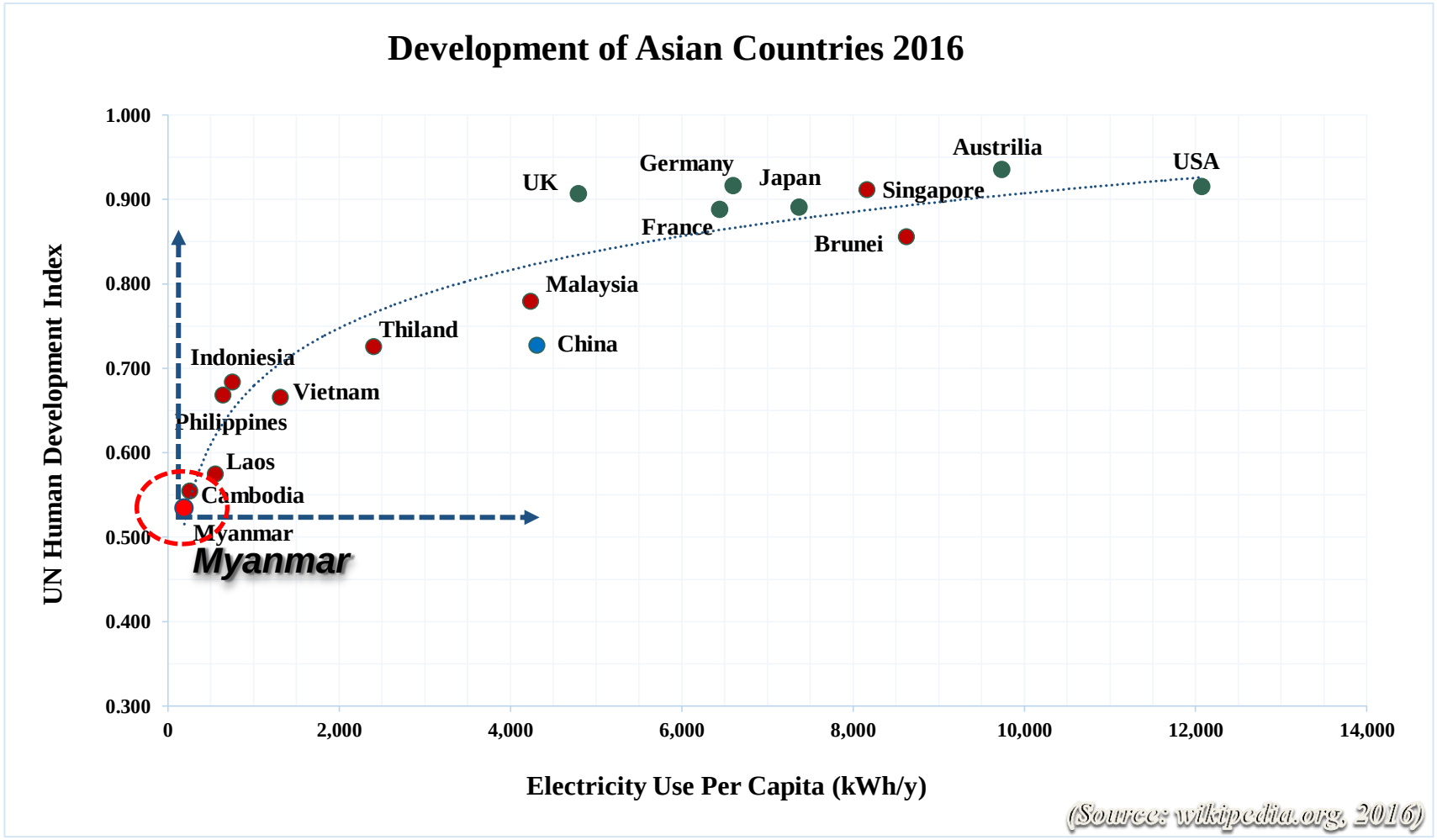
Strategic Ways on Implementation of Power Resources (Future Plan)

- Sole investment by Ministry of Electricity and Energy
- Investment by Local Entrepreneurs on B.O.T basis
- Investment by Foreign Companies on J.V / B.O.T basis

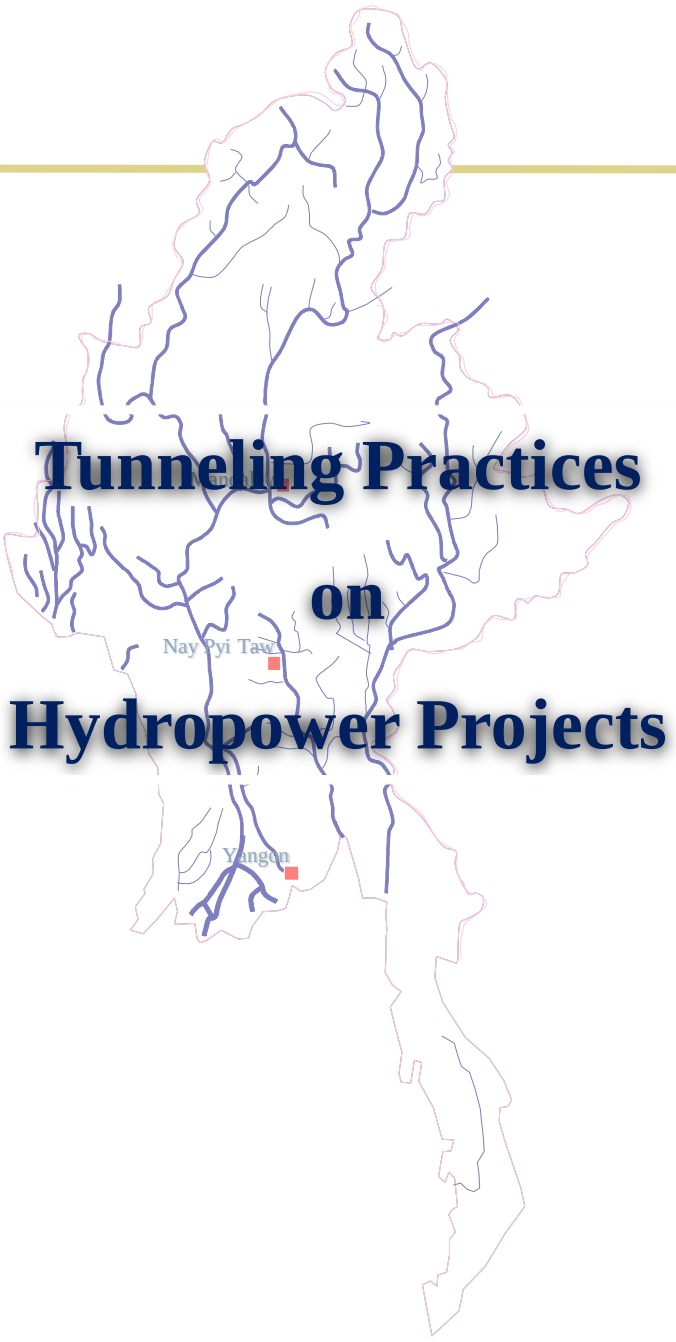


Sector	MOEE		Local Entrepreneurs		Foreign Companies		Total (MW)	Remark
	No.	Installed Capacity (MW)	No.	Installed Capacity (MW)	No.	Installed Capacity (MW)		
Hydro	4	1,494	9	864	40	41,925	44,283	65 %
Gas Turbine	1	240	1	100	25	5,872	6,212	9 %
Coal	-		3	385	9	9,160	9,545	14 %
Wind	-		-		5	6,538	6,538	10 %
Solar	-		-		5	1,510	1,510	2 %
Total	5	1,734	13	1,349	84	65,005	68,088	100 %

Status of Electric Power Usage & Development of Asian Countries

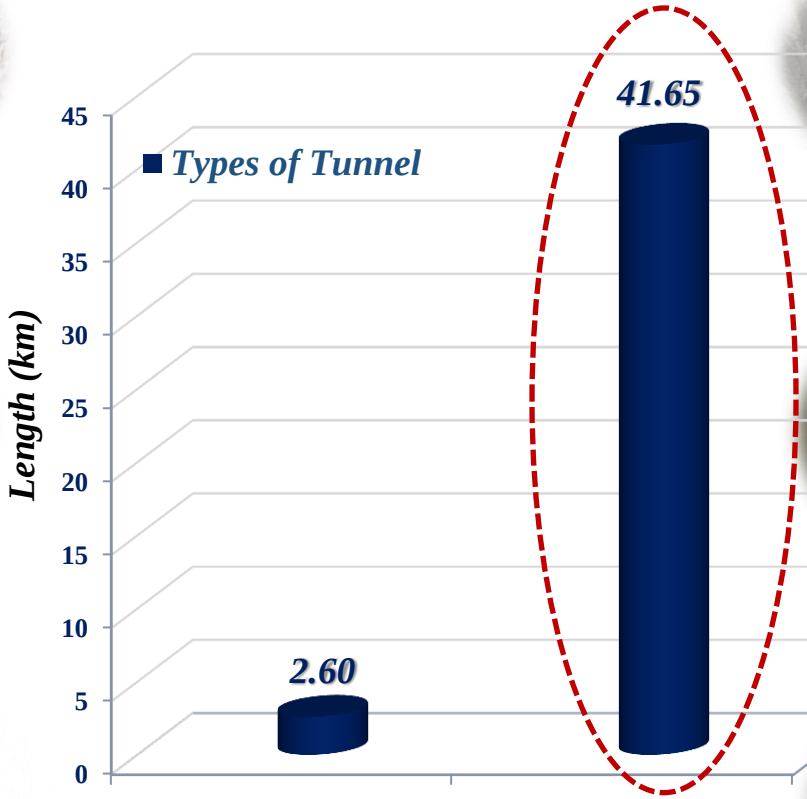


❖ ***The role of Hydropower will lead to the Development of Myanmar in future.***



Tunneling Practices on Hydropower Projects

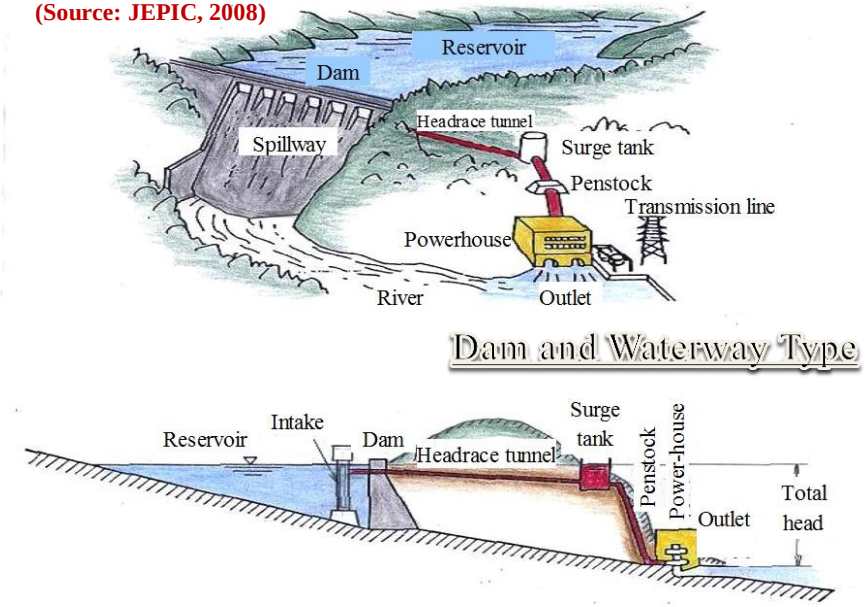
Background of Tunnels Development in Myanmar

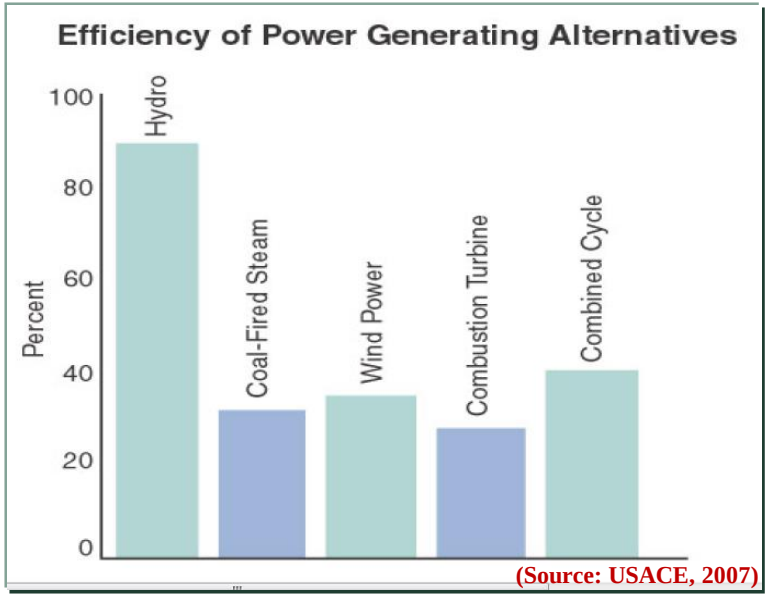


Most of railway tunnels are since pre war and hydropower tunnels start from 1997.

Features of Hydropower Project

(Source: JEPIC, 2008)

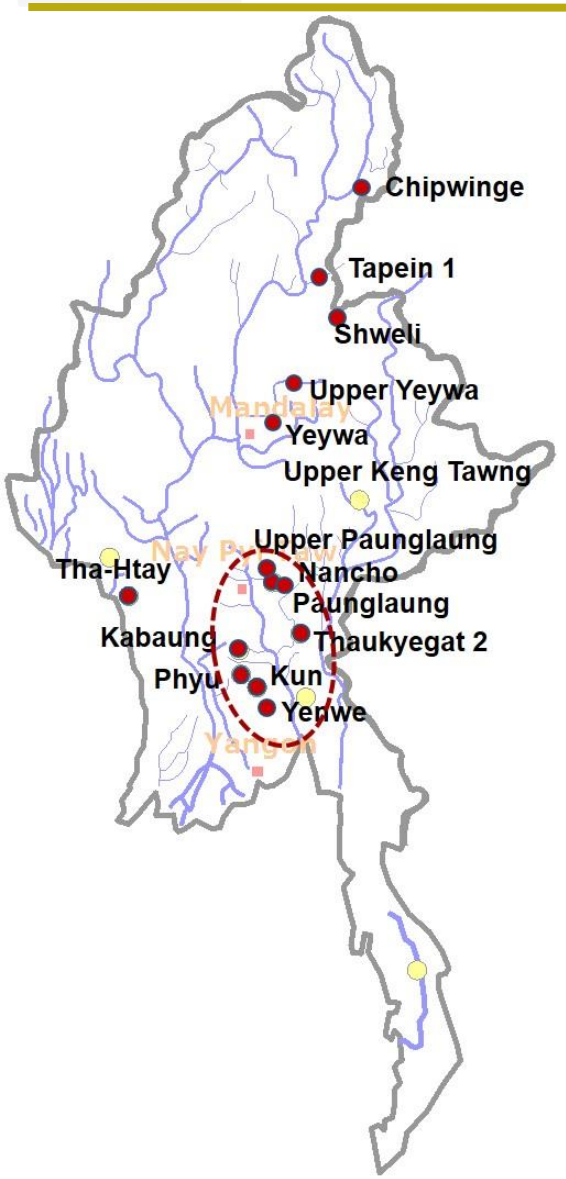




(Source: USACE, 2007)

- Hydropower is the most efficient way of power generation alternatives and has many favorable characteristics such as renewable, clean, reliable and flexible.
- For the hydropower development, dam and waterway hydraulic structures are main components .
- For the construction of dam, diversion tunnel or conduit is vital structure.
- For the power portion, waterway structure is essential and headrace tunnel is major structure from the view points of safety, economic and environmental issue.
- Tunnels are generally considered to be one of the greatest sources of cost and schedule risk for the projects.

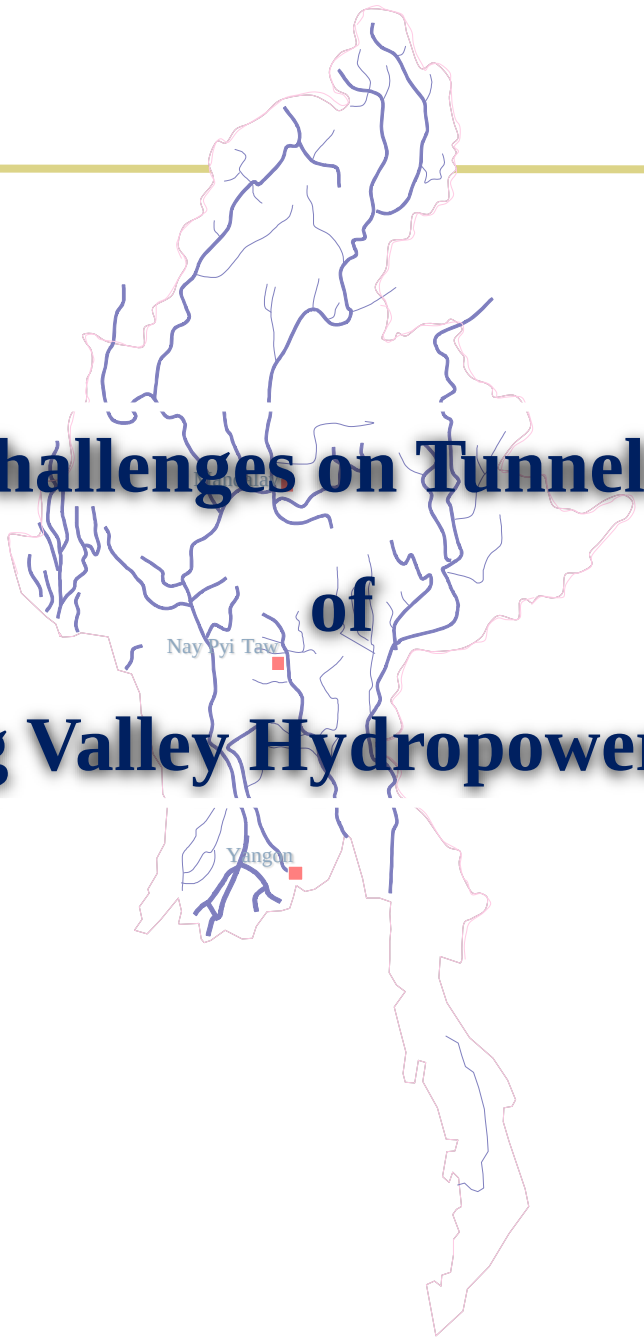
Tunneling Practices on Hydropower Projects in Myanmar



- ***Ministry of Electricity and Energy (MOEE) had been trying to implement large scale hydropower projects to fulfill the electricity requirement of the country. Most projects include tunneling works.***

- ***In general, tunnel excavation of hydropower projects include those for power tunnel, diversion tunnel and access tunnel etc.***

- ***Though tunnels of the projects in the region of hard rock are simple, the tunnel construction in poor geology face much complicated disturbances leading to collapse, especially for Sittaung valley projects which are giving many lessons for tunneling in Myanmar.***

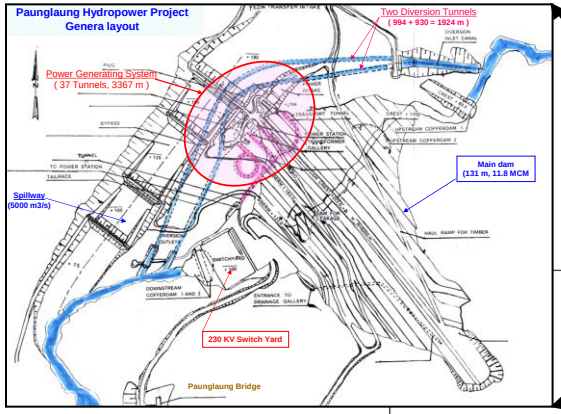


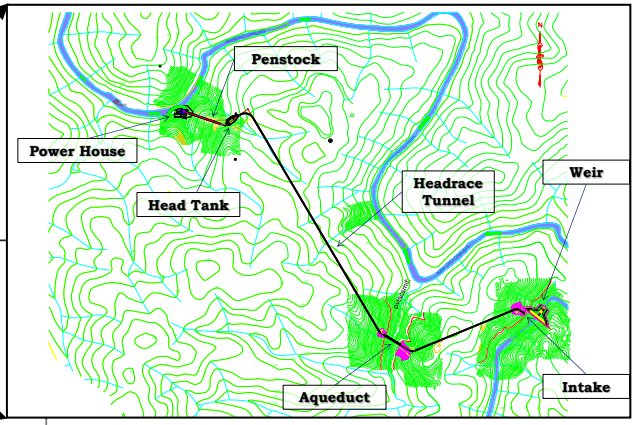
Challenges on Tunneling

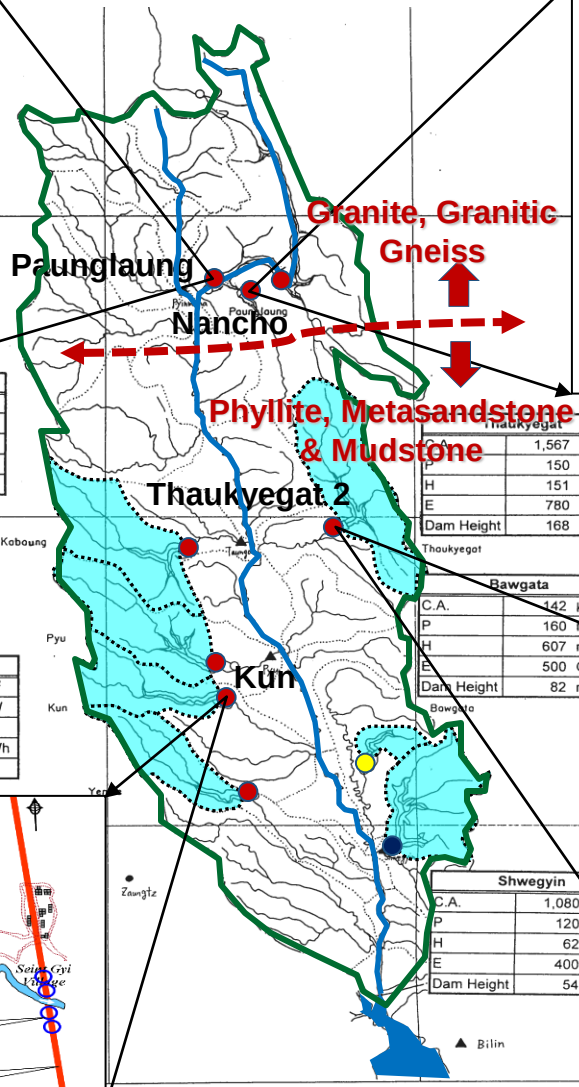
of

Sittaung Valley Hydropower Projects

General Layout and Location Map of Study Projects







Kabaung	
C.A.	1,083 km²
P	30 MW
H	50 m
E	120 GWh
Dam Height	55 m

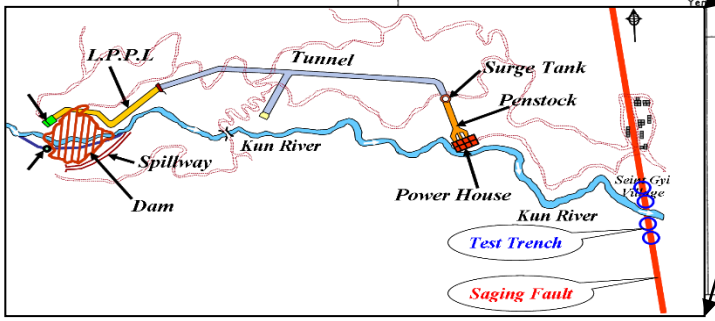
Thaukyegat	
C.A.	1,567 km²
P	150 MW
H	151 m
E	780 GWh
Dam Height	168 m

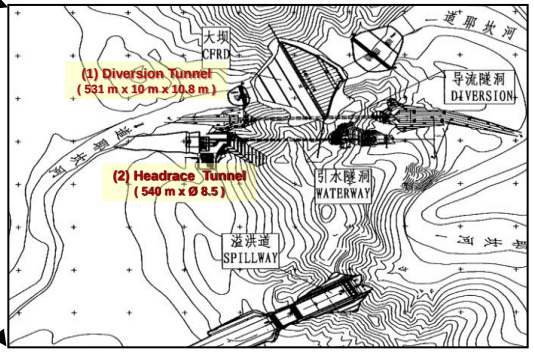
Phyu	
C.A.	1,052 km²
P	65 MW
H	96 m
E	260 GWh
Dam Height	55 m

Bawgata	
C.A.	142 km²
P	160 MW
H	607 m
E	500 GWh
Dam Height	82 m

Kun	
C.A.	875 km²
P	60 MW
H	82 m
E	190 GWh
Dam Height	73 m

Shwegyin	
C.A.	1,080 km²
P	120 MW
H	62 m
E	400 GWh
Dam Height	54 m

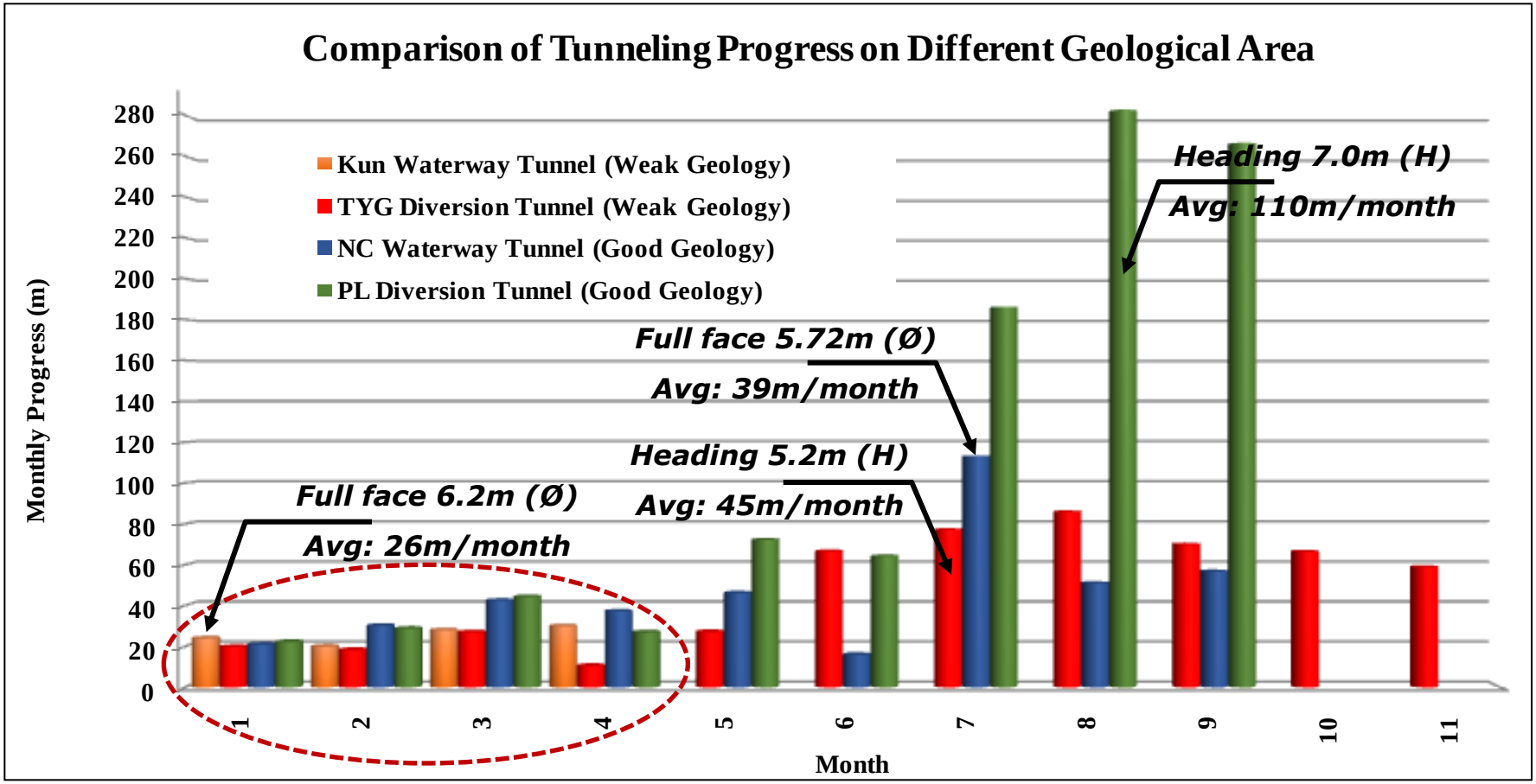




General Features of Geology and Tunnel Structures of the Projects

Situation	KUN	Nancho	Thaukyegat	Paunglaung
1. Location				
(1) Sittaung Vally	Downstream most & West to Sittaung River	Upstream most & East to Sittaung River	Middle Downstream & East to Sittaung River	Upstream most & East to Sittaung River
2. Geological Condition				
(1) Lithology	Meta-sandstone, Mudstone (weak)	Granite, Granitic Gneiss (good)	Phyllite, Schist, Meta-sandstone, (weak)	Granite, Granitic Gneiss (good)
3. Structure				
(1) Diversion Conduit/ Tunnel	1.5 x 3.8 m	2.5 x 3.75 m	531 x 11 x 13 m	994 x 10 x 14 m
(2) Headrace Tunnel (L x Diameter)	1755 x 5.5 m	2352 x 4.72 m	538 x 8.5 m	80 x 8.5 m
4. Power Indices				
(1) Installed Capacity (MW)	60	40	120	280
5. Organization				
(1) Implementation by	Construction Division No.3 (MOEE)	Construction Division No.1 (MOEE)	Gold Energy Co., Ltd (Local Company)	Construction Division No.1 (MOEE)

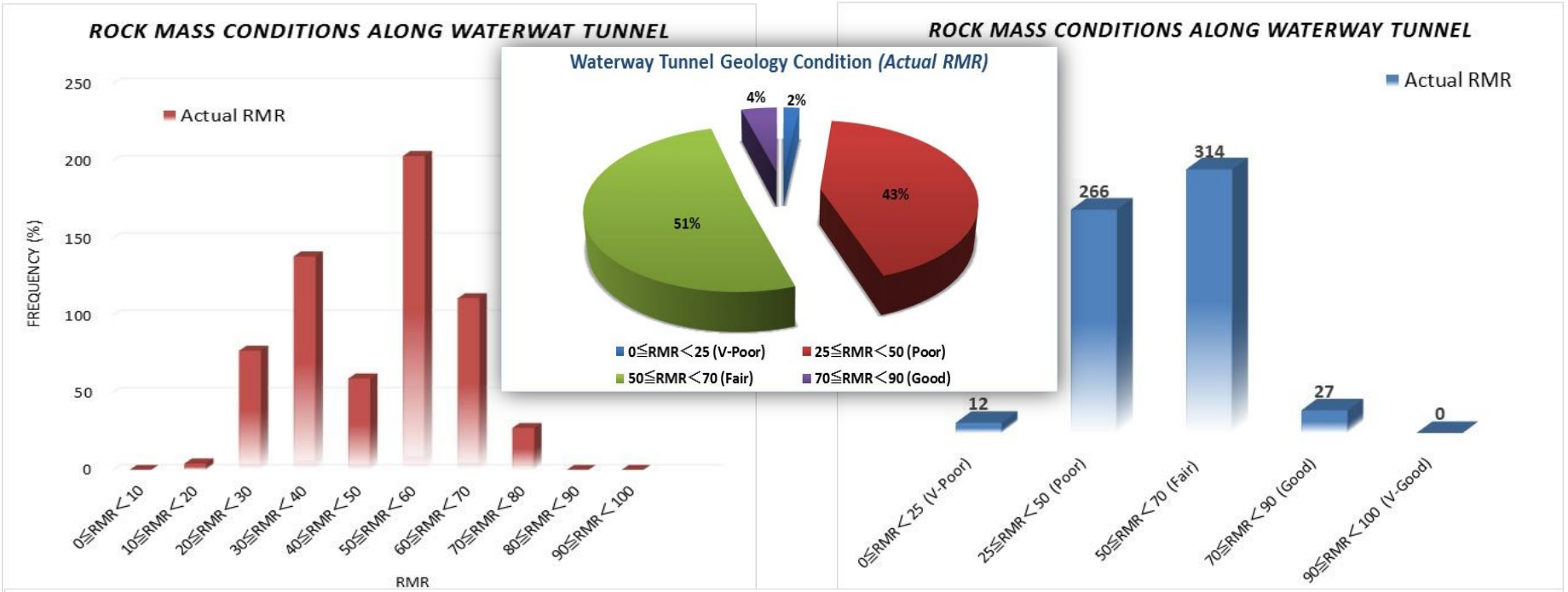
Review on Tunneling Progress of Four Projects

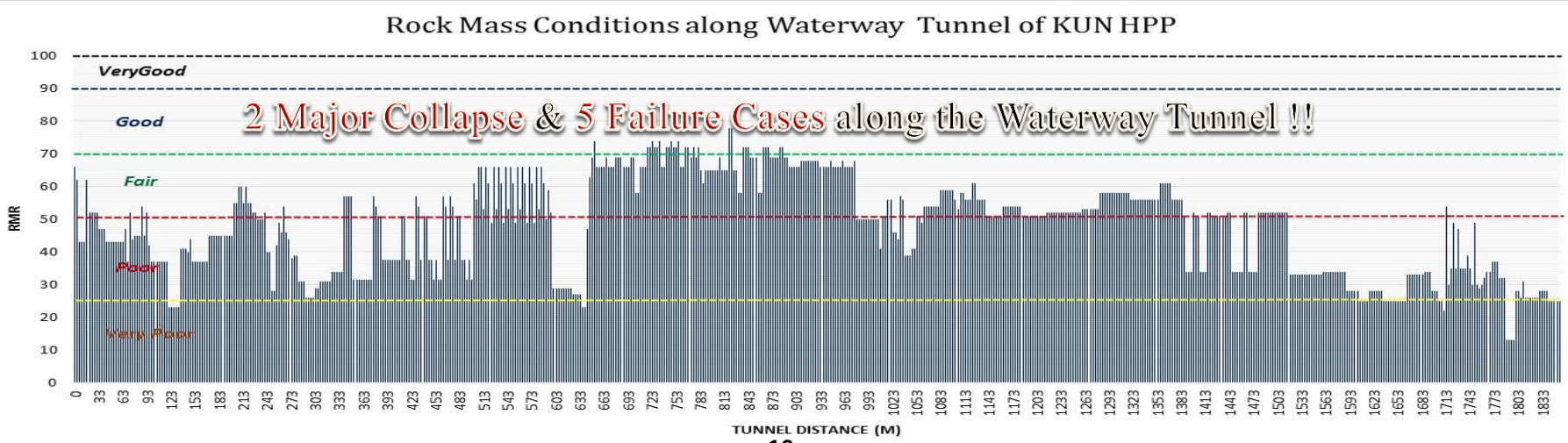


- **All Projects** – Tunnel excavation cannot much speedy on **initial stage** and **inlet/ outlet area of the mountain**. After inlet/ outlet area, can speedy tunneling on both weak or good geology conditions of the mountain.
- **Tunneling Progress** – In the better geology area can excavate **more progress** than weak geology and systematic geological observation is essential.

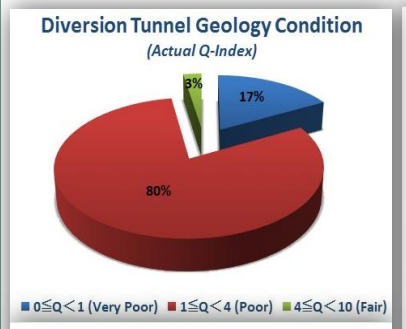
Geological Assessment on Tunneling of *Kun and Thaukyegat Project*

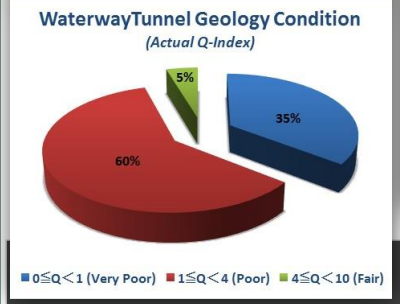
Analysis on Recorded Tunnel Data of Kun Project

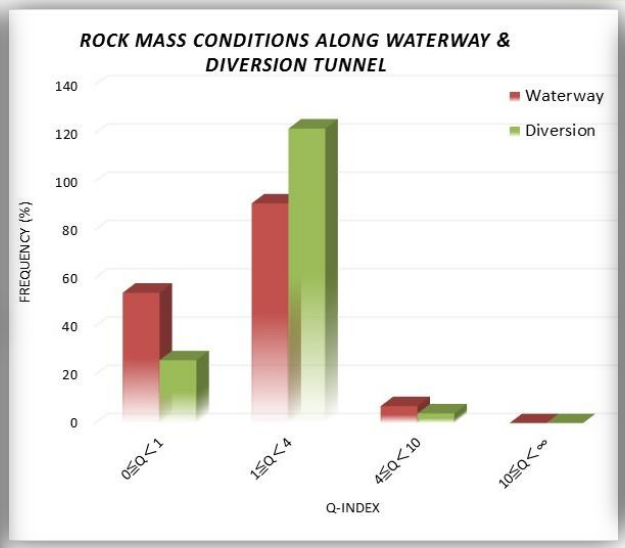


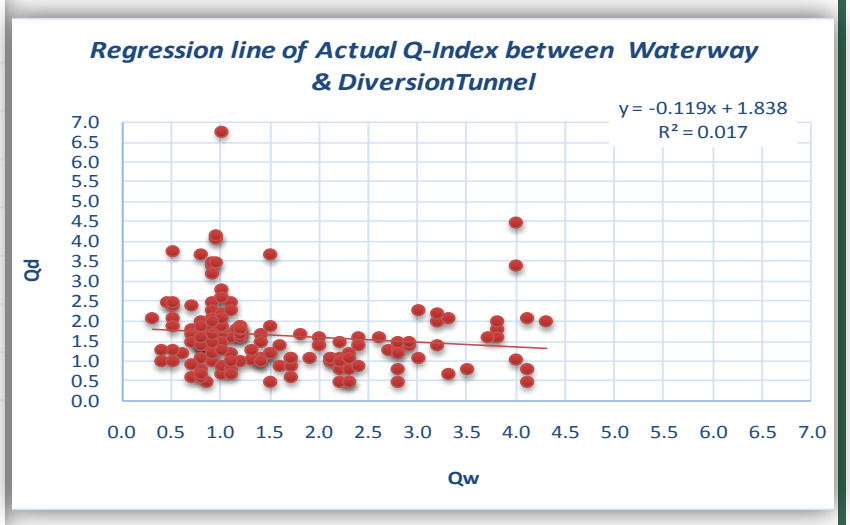


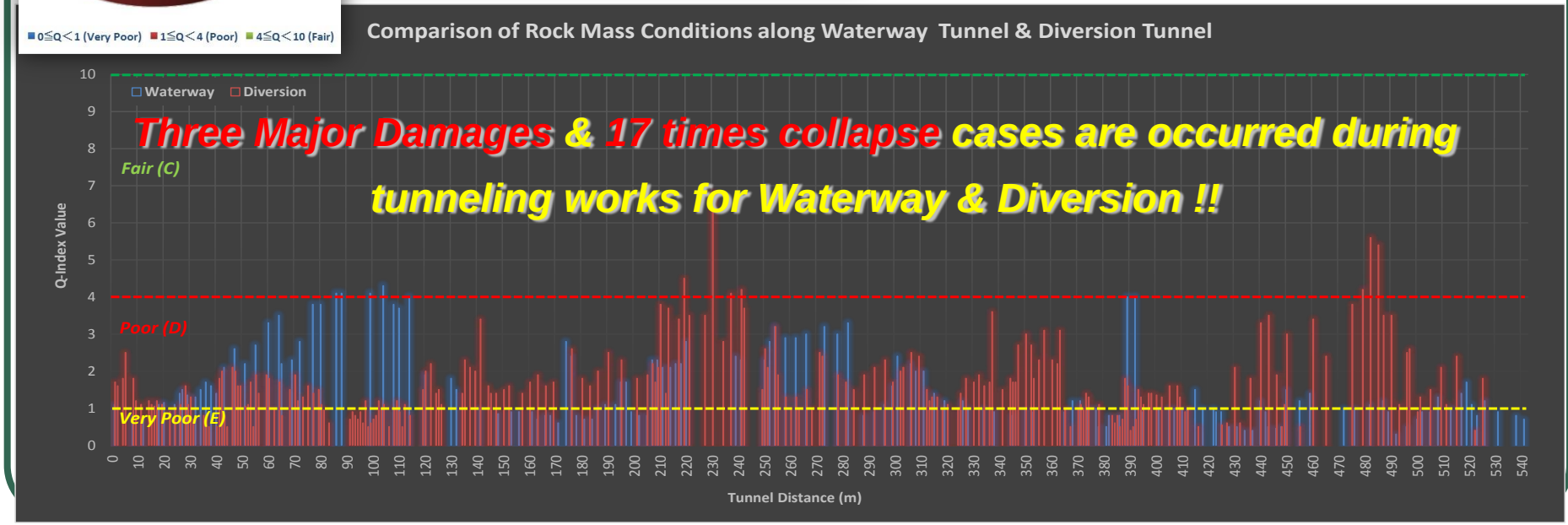
Analysis on Waterway and Diversion Tunnel of Thaukyegat Project



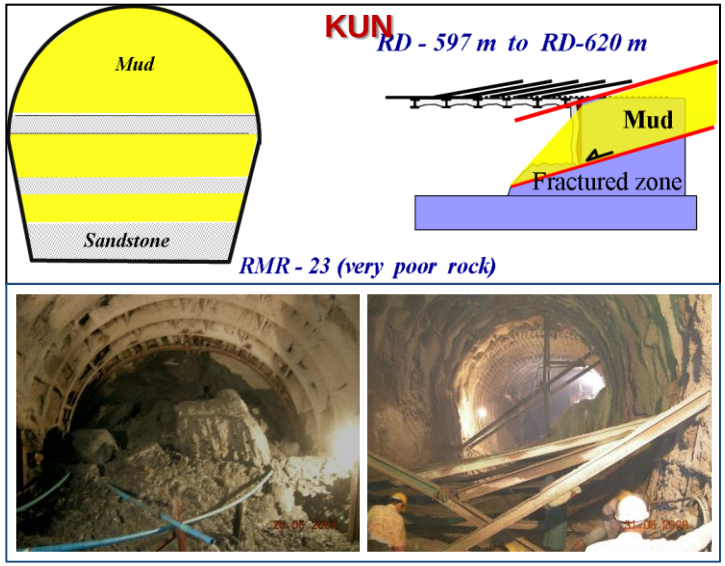


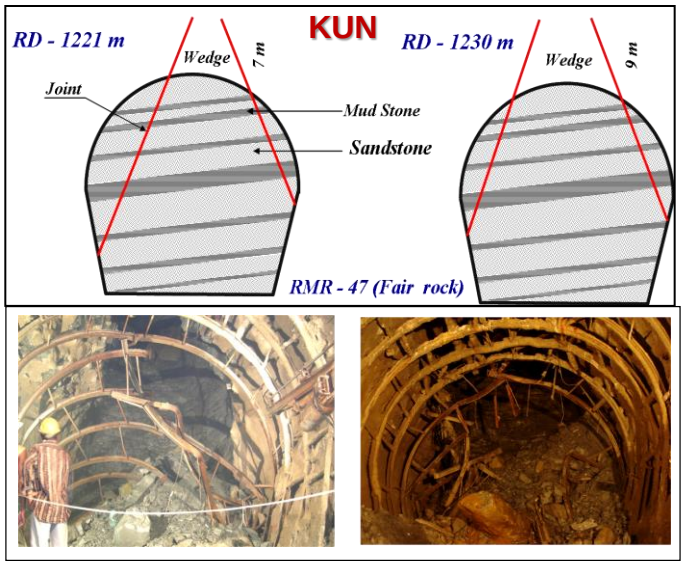




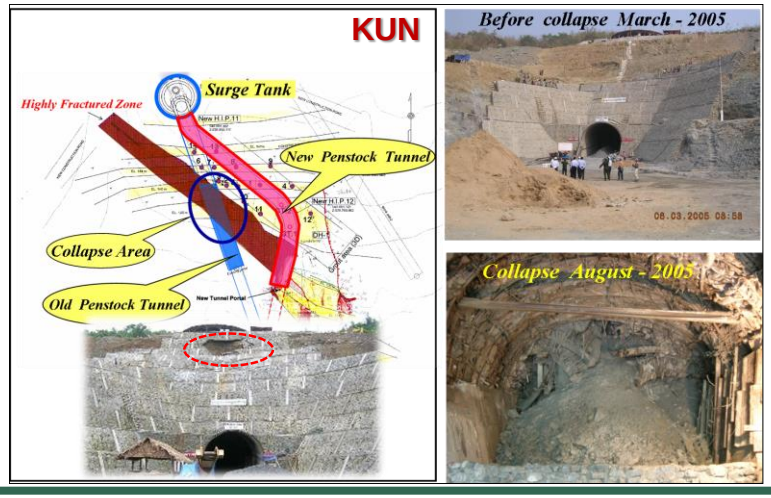


Failure Mechanisms on Tunneling of Kun and Thaukyegat Project





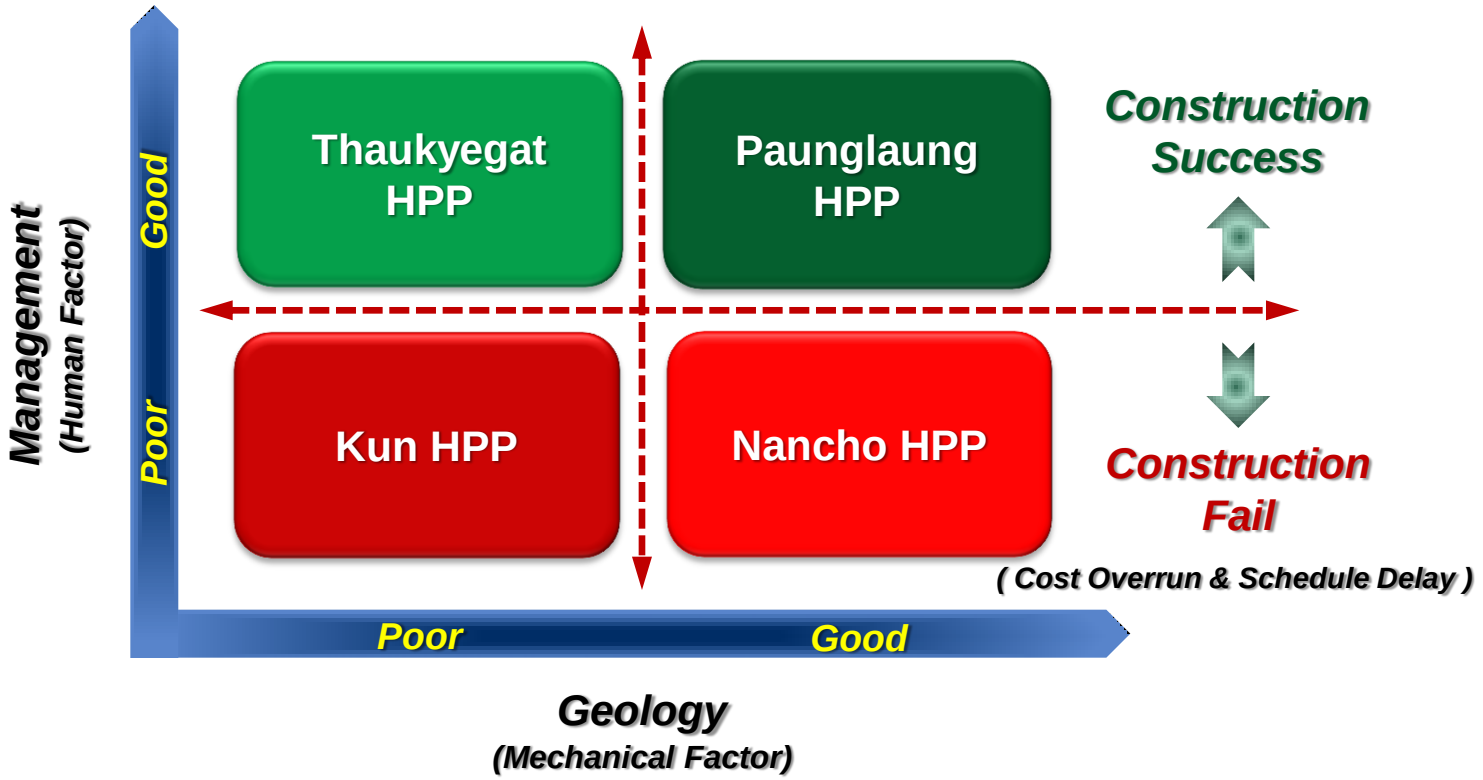
- ***For both Projects, most of failure mechanisms were similar and severer situation on tunnel excavation such as face failure, roof wedge failure and plain failure.***



Review on Case Study Projects

Situation	KUN	Nancho	Thaukyegat	Paunglaung
1. Geological Condition				
1) Lithology	Sandstone, Mudstone (weak)	Granite, Granitic Gneiss (good)	Sandstone, Mudstone (weak)	Granite, Granitic Gneiss (good)
2. Organization Condition				
1) Manage: & Super:	Good	Good	Good	Good
2) Work Plan	Normal	Normal	Normal	Good
3) Cooperation	Good	Good	Good	Excellent
4) Skill of Workers	Normal	Normal	Normal	Good
5) Financial Support	< Normal	< Normal	Good	Good
6) Logistic Support	< Normal	< Normal	Good	Excellent
3. Construction Achievement				
1) Completion Target	5 years Delay	4 years Delay	1.5 years Delay	2.5 years Delay
2) Project Cost	72% Over Run (Over all Cost)	45% Over Run (Over all Cost)	6% Over Run (Over all Cost)	Within Budget (Over all Cost)

Risk Classification on Tunneling of Hydropower Projects



Geo-risk factors are mainly divided into two parts: "geological condition" and "construction management system", which are perceived as "Natural Hazard" and "Man-made Hazard", respectively.

Responses for Existing Risk on Tunneling

- Based on case study results, it would be recommended that the development of tunneling in hydropower projects, the most important is strengthening on "poor construction management system" human factors and "poor geological condition" mechanical factors of tunneling practices.
- In order to scope with difficulties associated "poor construction management system" human factors, following remedial measure would be expected.
  - Skill of construction works.
  - Decision-making system.
  - Procurement system.
  - Financial system.
- In order to scope with difficulties associated "poor geological condition" mechanical factors, following remedial measure would be expected.
  - Improvement of underground geological investigation.
  - Evaluation on rock mass classification.
  - Establishment of database system on past hydropower tunnels data.

Moving Forwards

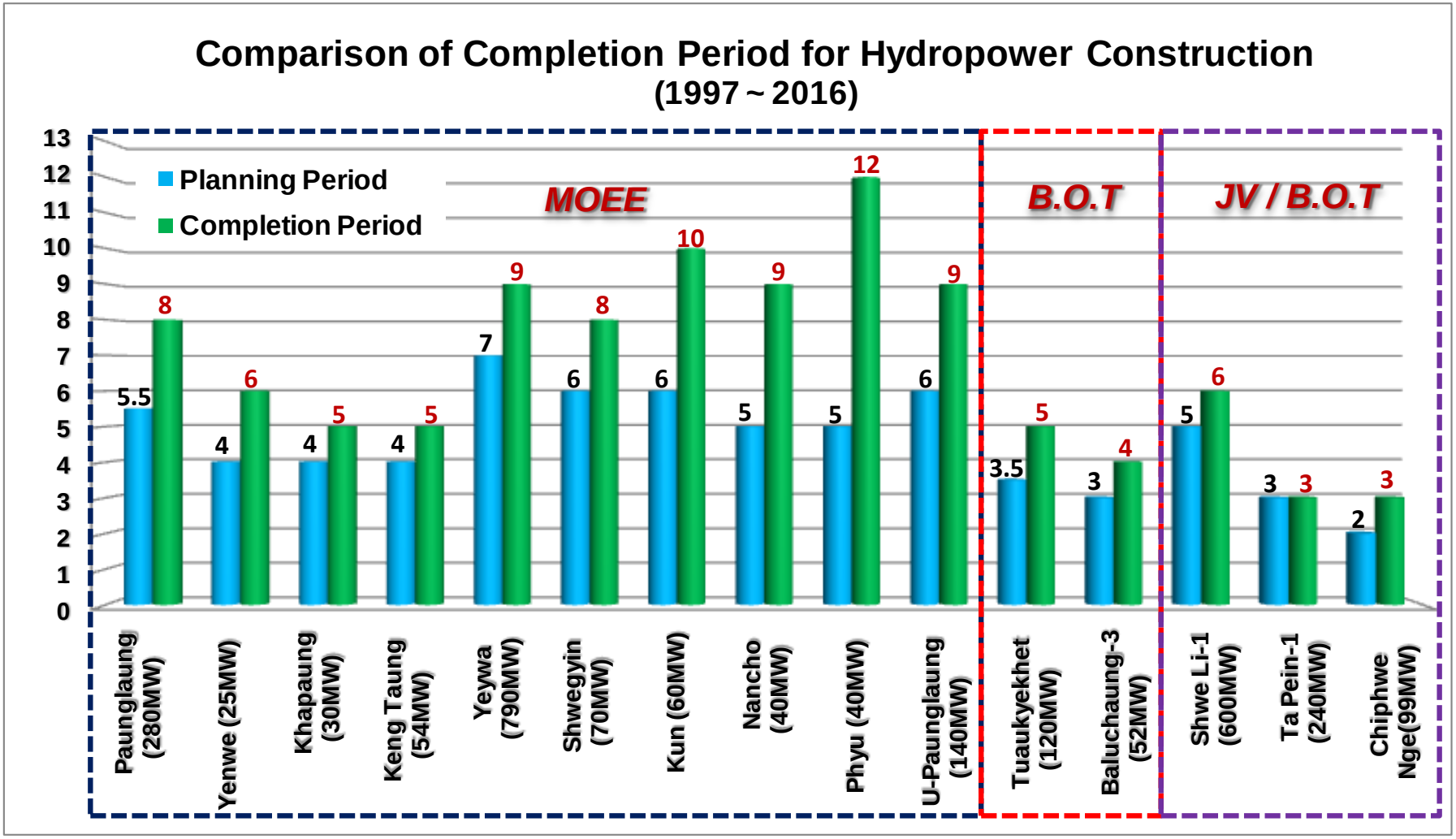
on

Hydropower Development in Myanmar

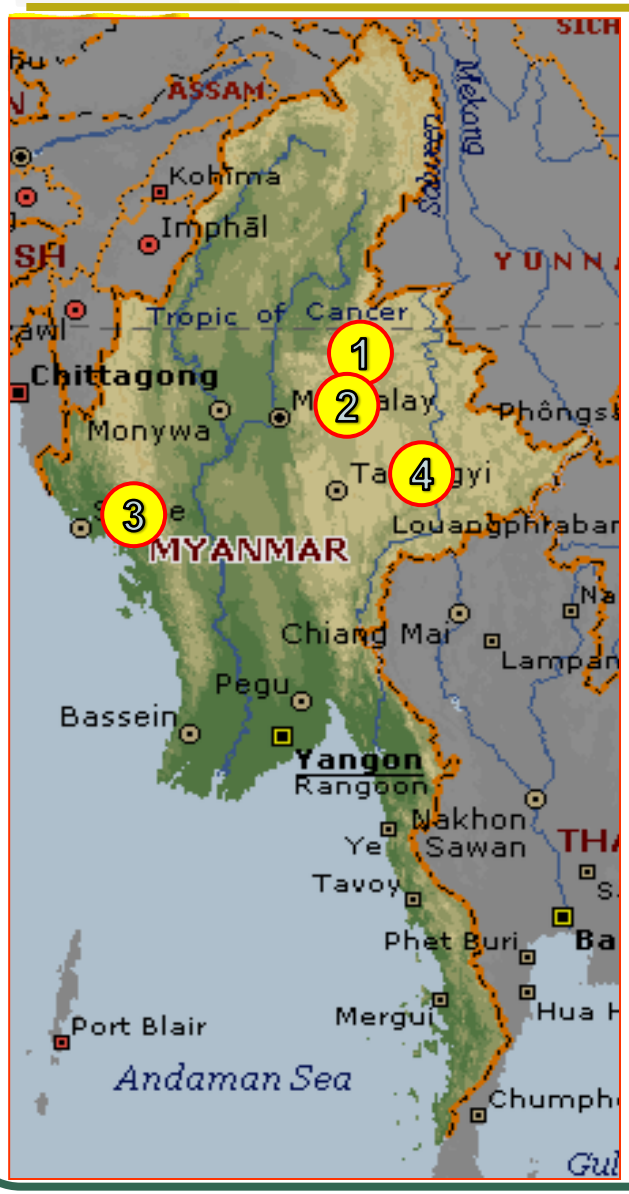
List of Hydropower Stations (As of Jan, 2017)

Sr. No.	Power Stations	Installed Capacity (MW)	Type	Completion Year	Owner
1	Baluchaung-2	168	Dam & Waterway	1960/1974	State Owned
2	Kinda	56	Dam & Waterway	1985	
3	Sedawgyi	25	Dam Type	1989	
4	Baluchaung-1	28	Dam & Waterway	1992	
5	Zaw Gyi-1	18	Waterway Type	1995	
6	Zaw Gyi-2	12	Dam Type	1998	
7	Zaung Tu	20	Dam Type	2000	
8	Thaphenzeik	30	Dam Type	2002	
9	Mone	75	Dam Type	2004	
10	Paunglaung	280	Dam Type	2005	
11	Yenwe	25	Dam & Waterway	2007	
12	Khapaung	30	Dam & Waterway	2008	
13	Keng Taung	54	Waterway Type	2009	
14	Yeywa	790	Dam & Waterway	2010	
15	Shwegyin	75	Dam Type	2011	
16	Kyee-on-Kyee-wa	74	Dam Type	2011	
17	Kun	60	Dam & Waterway	2012	
18	Nancho	40	Waterway Type	2014	
19	Phyu	40	Dam & Waterway	2014	
20	Upper Paunglaung	140	Dam Type	2015	
21	Myo Gyi	30	Dam Type	2016	
22	Tuaukyekhet	120	Dam Type	2014	JV/BOT BOT
23	Baluchaung-3	52	Dam & Waterway	2013	
24	Shwe Li-1	600	Waterway Type	2009	
25	Ta Pein-1	240	Dam Type	2011	
26	Chiphwe Nge	99	Dam Type	2013	
Total		3,181			

Time Frame for Construction of Hydropower Projects



On going Hydropower Projects under the MOEE



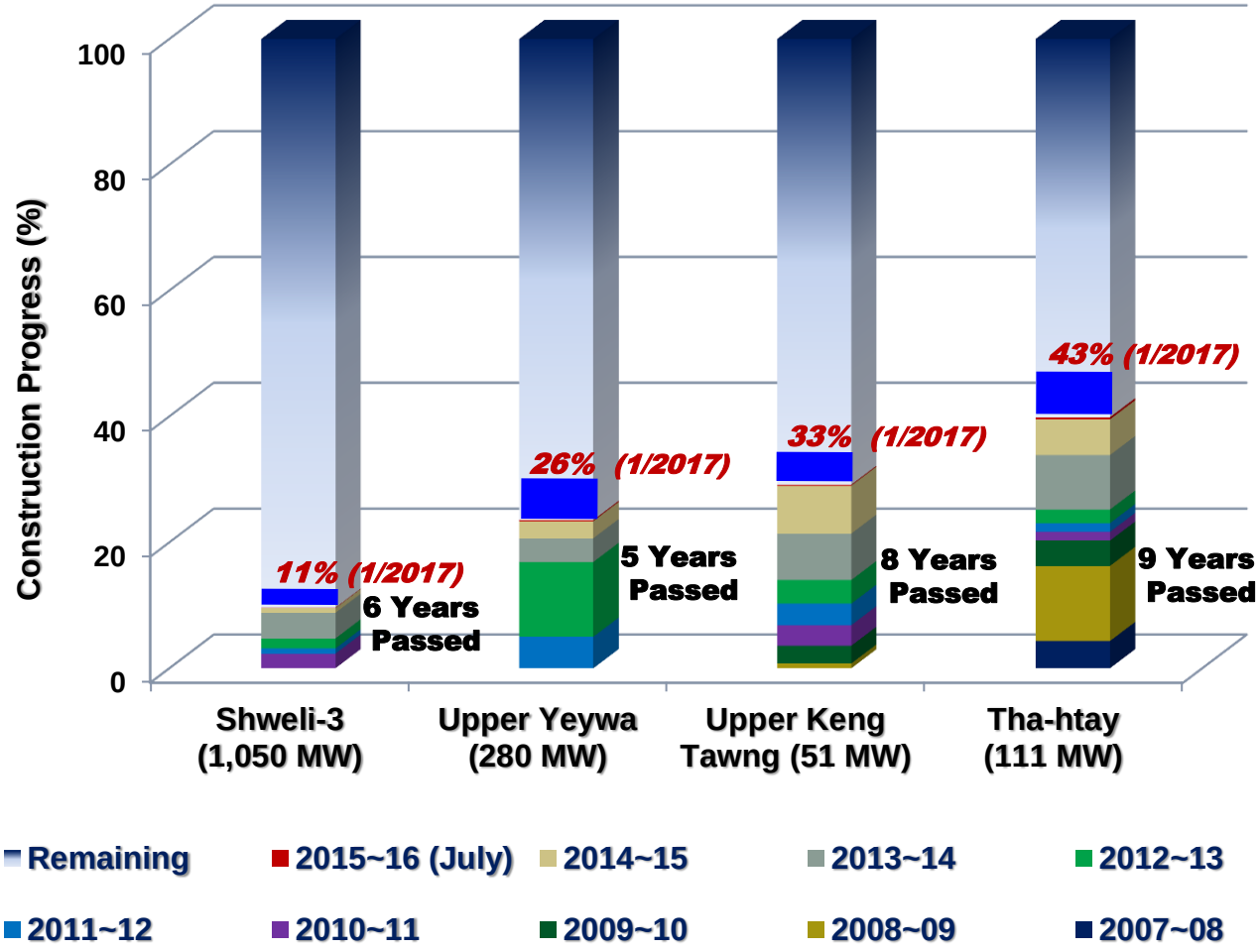
By Ministry of Electricity and Energy (MOEE)

Sr. No.	Projects	Installed Capacity (MW)	States/ Region
1.	Shwe Li-3	1,050	Shan
2.	Upper Yeywa	280	Shan
3.	Tha-Htay	111	Rakhine
4.	Upper Keng Tawng	52.5	Shan
	Total	1,493.5	

Current Hydropower Progress (As of Jan, 2017)

Under Implementation Hydropower Projects (MOEE)

- Implementing all over the country
- Try to implement with JV/BOT model in some projects



Current Hydropower Progress (As of Jan, 2017)

Under Implementation of Shweli (3) Hydropower Project (MOEE)

Current Hydropower Progress (As of Jan, 2017)

Under Implementation of Upper Yeywa Hydropower Project (MOEE)

Current Hydropower Progress (As of Jan, 2017)

Under Implementation of Upper Keng Tawng Hydropower Project (MOEE)

Upper Keng Tawng HPP (52.5 MW)

River - Nam Teng River
Inflow - 2302 Mm^3
Dam - Zoned Type Rockfill Dam, 57 m Height
Progress - 33%

Current Hydropower Progress (As of Jan, 2017)

Under Implementation of Tha-htay Hydropower Project (MOEE)

River - Tha-htay River
Inflow - 2876 Mm^3
Dam - Zoned Type Rockfill Dam, 91 m Height
Progress - 43 %

Tha-htay HPP (111 MW)

Challenges on Implementation of Hydropower Projects

	Potential Challenges	Evaluations
Organization	▪ **Technical Constraints** should be improved well. ▪ **Lack of skilled workforce** should be managed well. ▪ **Human mistake** should be avoided well.	▪ To prepare **human resource development.** ▪ To allocate **right person and enough capacity** for the project site. ▪ To **organize and right decision** for the project.
Procurement	▪ **Insufficient major equipment** should be prepared well. ▪ **Resources constraint** should be managed well.	▪ Required machinery equipment should be enough for each **Hydropower Projects**. ▪ To prepare resources ahead before starting the **Construction Works.**
Finance	▪ **Budget delay** should be avoided well. ▪ **Budget insufficient** should be supplied well.	▪ **Delaying of budget** is becoming the high risk factors for hydropower construction works. ▪ Well preparation for construction is mainly depend on **availability of budget**, but **insufficient of budget** may defect on **Construction time and Cost.**
Construction	▪ **Unforeseen Hydrology and Geology Condition** should be investigated well. ▪ **Lack of Systematic Geological Observation** should be evaluated well. ▪ **Poor Working Condition** should be improved well.	▪ It can be investigated well by **proper technique** for **hydrological and geological investigations**. ▪ Well **observation and evaluation** can minimize the geo-risk and cost effective on underground works. ▪ To improve poor working condition, **discussion and well preparation** on job site is essential.

Conclusion

Moving Forwards on Hydropower Development

- Hydro is cost-effective power resource blessed with rich national potential.
- Focus on Sustainable and Responsible development of Hydropower.
- Action plan should be secured by implementing priority projects.
- Establishing a capacity building for engineers and career nurturing systems.
- Evaluation and feed-back actions on Hydropower implementation.
- Environmental and social impact awareness.
- Moving to Public Private Partnership.
- Subsidization and cross-subsidization by Government gradually released.

THANK YOU ALL!

For Your Kind Attention