



**THE REPUBLIC OF THE UNION OF MYANMAR**  
**MINISTRY OF ELECTRICITY AND ENERGY**



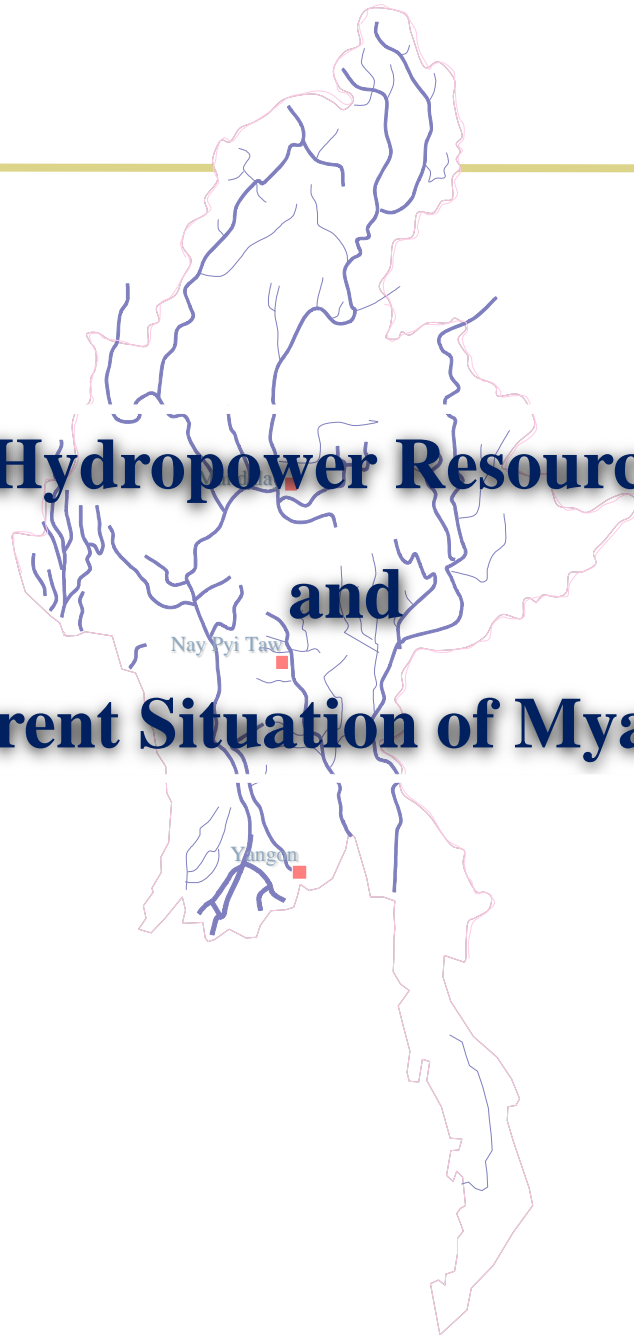
**World Water Day 2017**

**Water Resources Utilization:  
Challenges on Tunneling and Hydropower Development**

**Wunna Htun**  
**Deputy Director (Civil)**  
**Department of Hydropower Implementation**



# Hydropower Resources and Current Situation of Myanmar

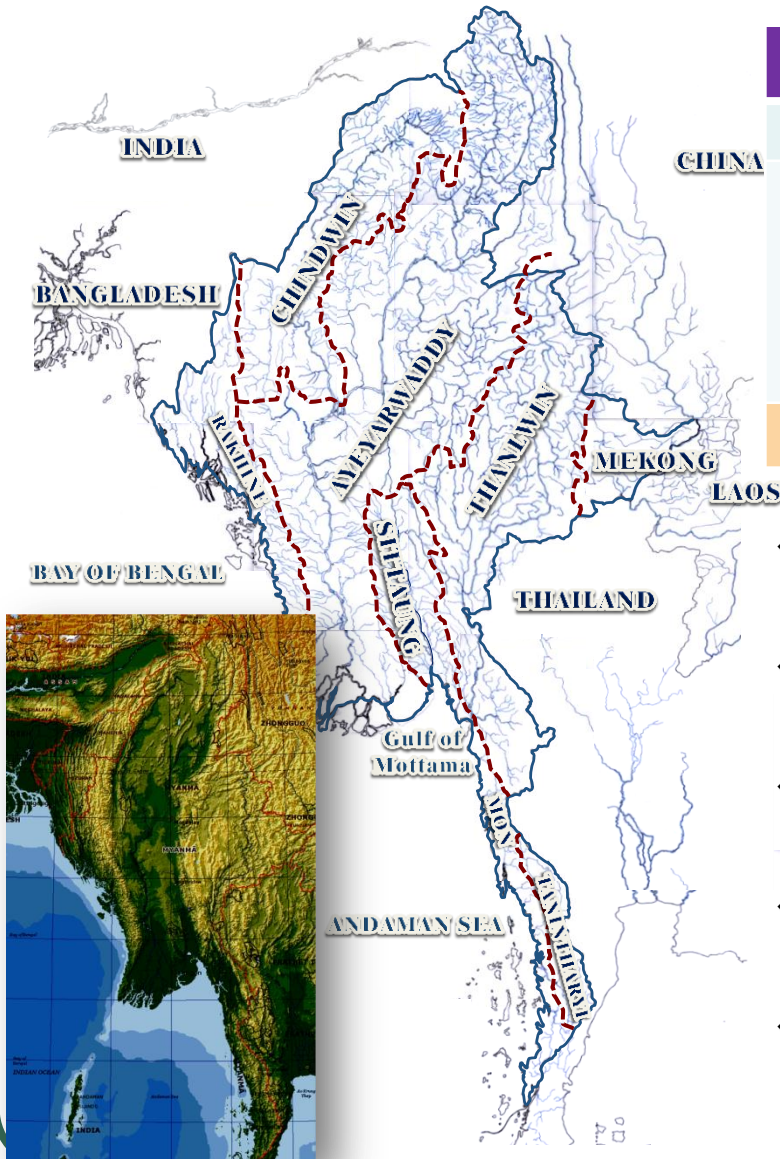


Nay Pyi Taw

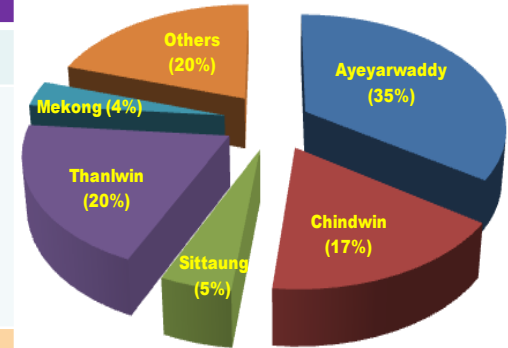
Yangon



# Background of Hydropower Development in Myanmar



River Basins		
Sr.	Name of River	Basin Area (km <sup>2</sup> )
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



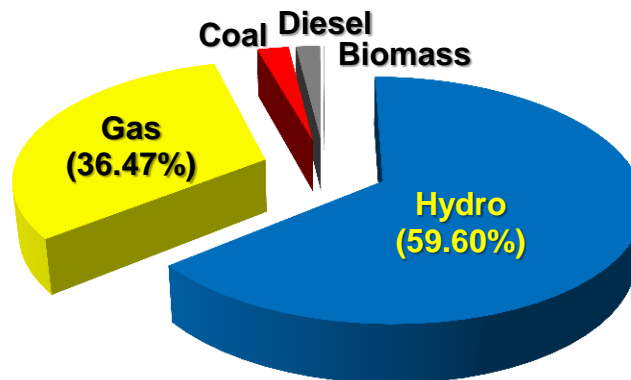
- ❖ Rich water resources because of favorable topography and tropical monsoon climate.
- ❖ Hydropower potential of Myanmar is estimated more than **100,000 MW** (ADB 2012).
- ❖ Currently identified hydropower potential is about **44,300 MW** in total.
- ❖ At present, **total installed capacity** of electric 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)

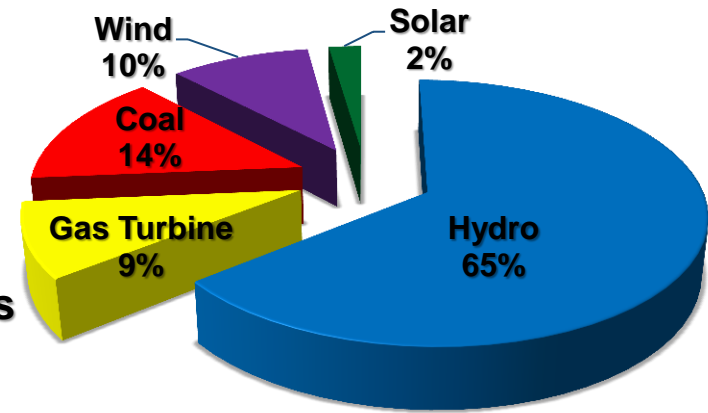
Item	Grid System (MW)	Isolated (MW)	Total (MW)	Percentage
<b>Installed Capacity</b>	<b>5,268</b>	<b>124.81</b>	<b>5392.81</b>	<b>100.00%</b>
<b>Hydroelectric</b>	<b>3,181</b>	<b>33.33</b>	<b>3214.33</b>	<b>59.60%</b>
<b>Gas</b>	<b>1967</b>	<b>-</b>	<b>1967</b>	<b>36.47%</b>
<b>Coal</b>	<b>120</b>	<b>-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





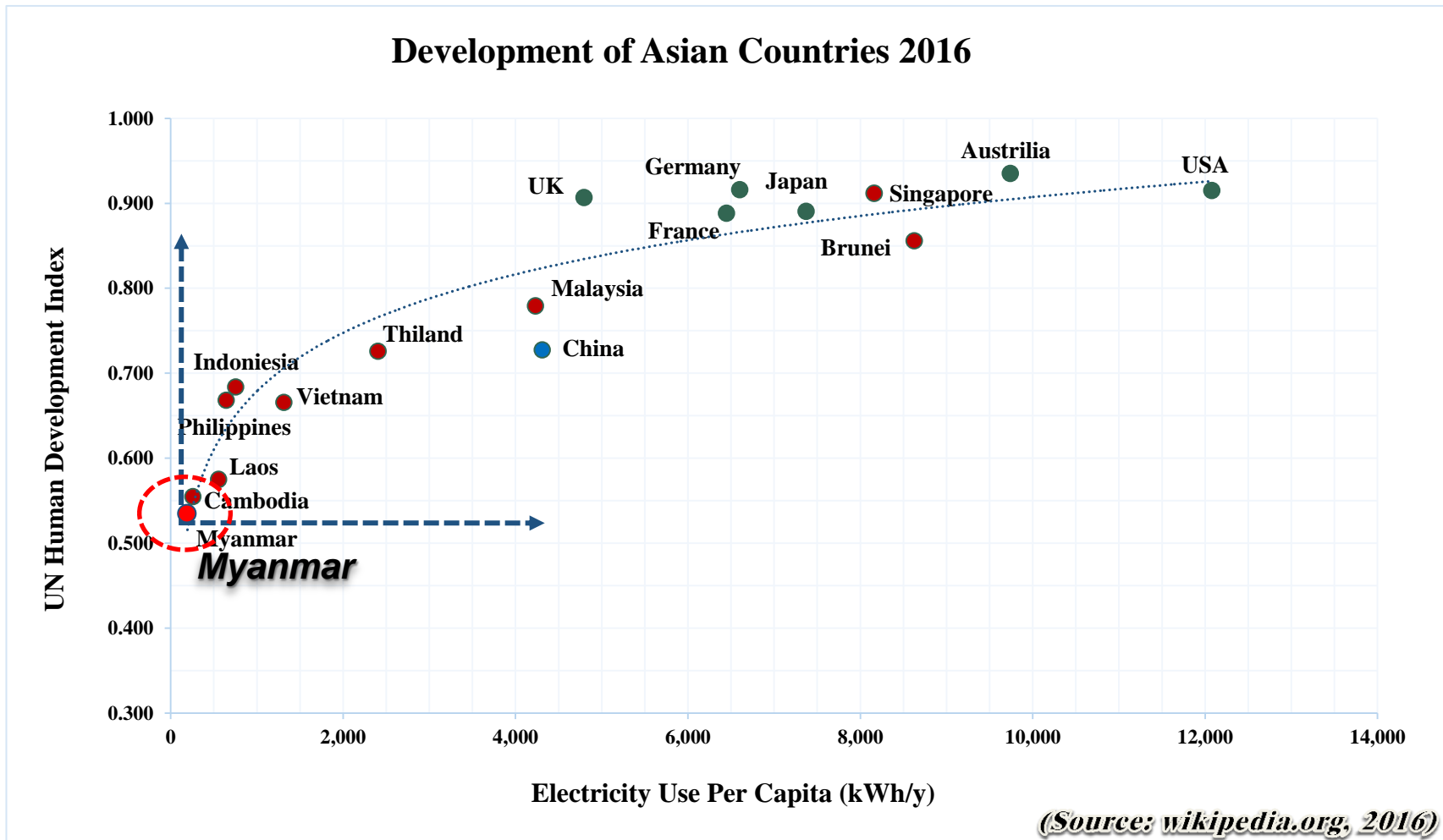
# Strategic Ways on Implementation of Power Resources (Future Plan)

- 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

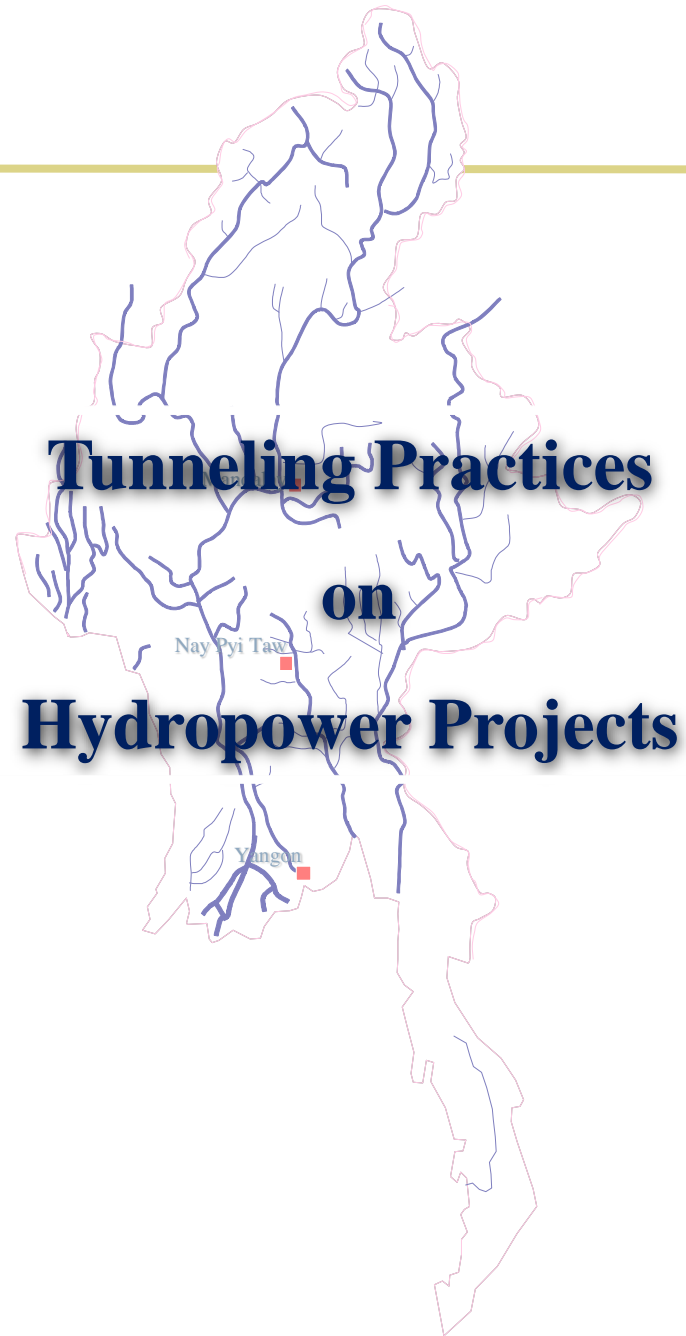


Sector	MOEE		Local Entrepreneurs		Foreign Companies		Total (MW)	Remark
	No.	Installed Capacity (MW)	No.	Installed Capacity (MW)	No.	Installed Capacity (MW)		
Hydro	4	1,494	9	864	40	41,925	44,283	65 %
Gas Turbine	1	240	1	100	25	5,872	6,212	9 %
Coal	-		3	385	9	9,160	9,545	14 %
Wind	-		-		5	6,538	6,538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

# Status of Electric Power Usage & Development of Asian Countries



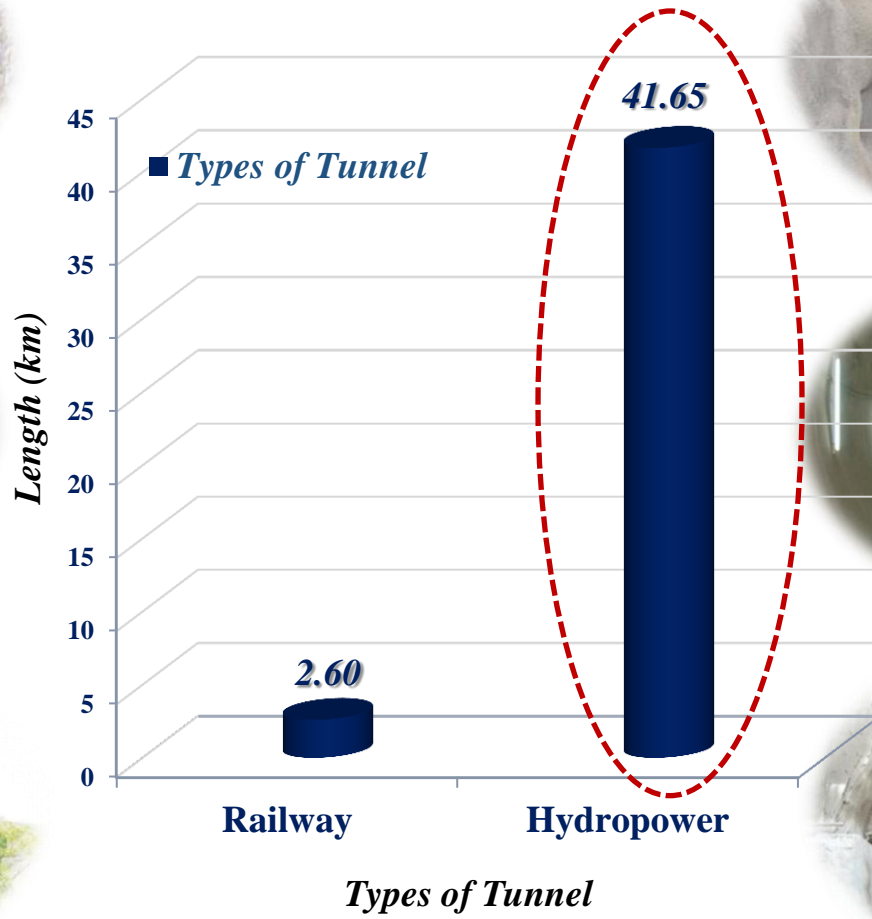
❖ **The role of Hydropower will lead to the Development of Myanmar in future.**





# Background of Tunnels Development in Myanmar

## Tunneling in Myanmar

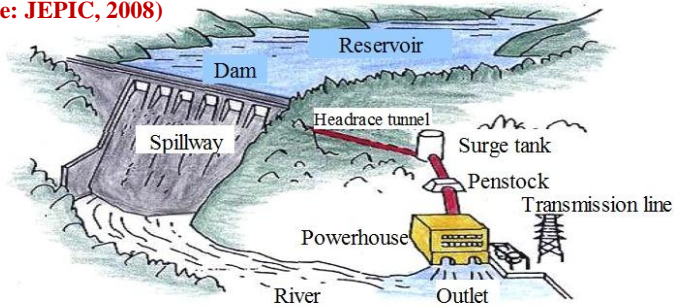


**Most of railway tunnels are since pre war and hydropower tunnels start from 1997.**

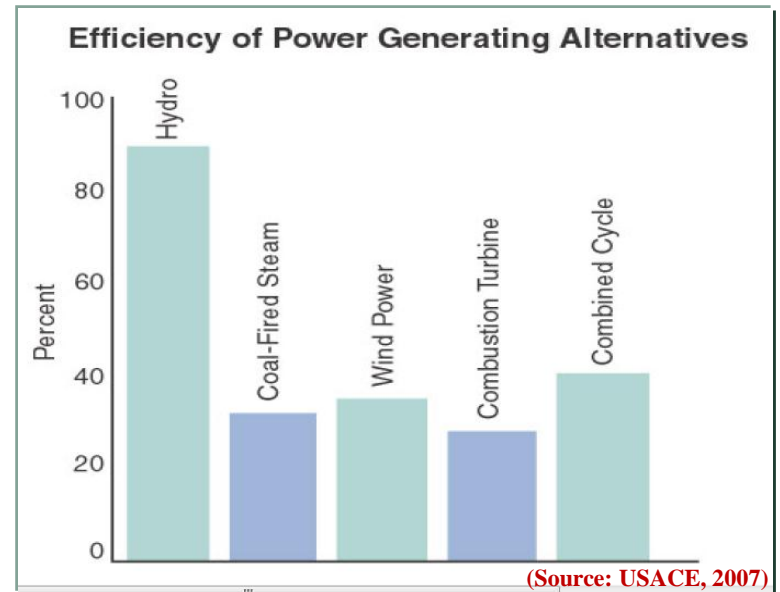
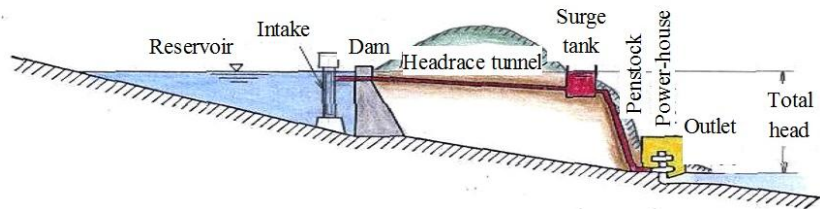


# Features of Hydropower Project

(Source: JEPIC, 2008)



**Dam and Waterway Type**

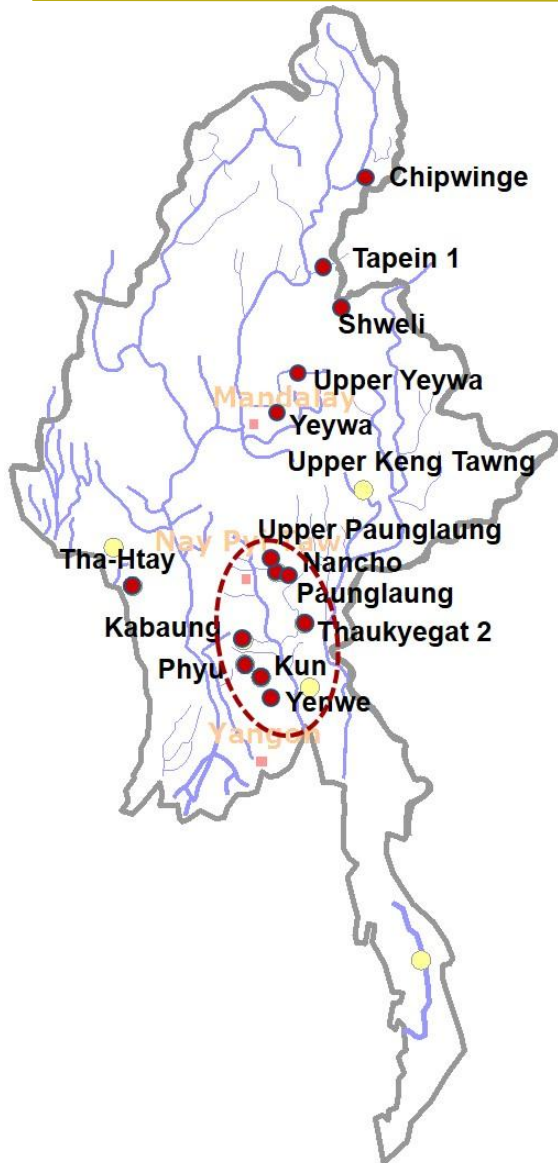


- ❖ Hydropower is the **most efficient** way of power generation alternatives and has many favorable characteristics such as **renewable, clean, reliable and flexible**.
- ❖ For the hydropower development, **dam and waterway hydraulic structures** are main components .
- ❖ For the construction of dam, **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.





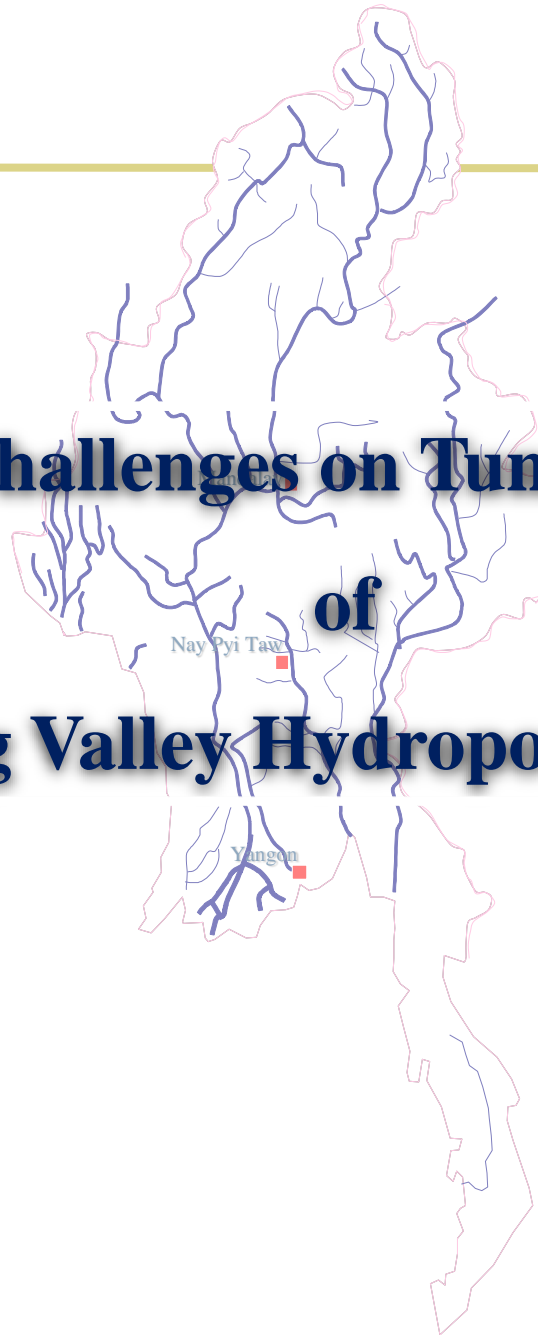
# Tunneling Practices on Hydropower Projects in Myanmar



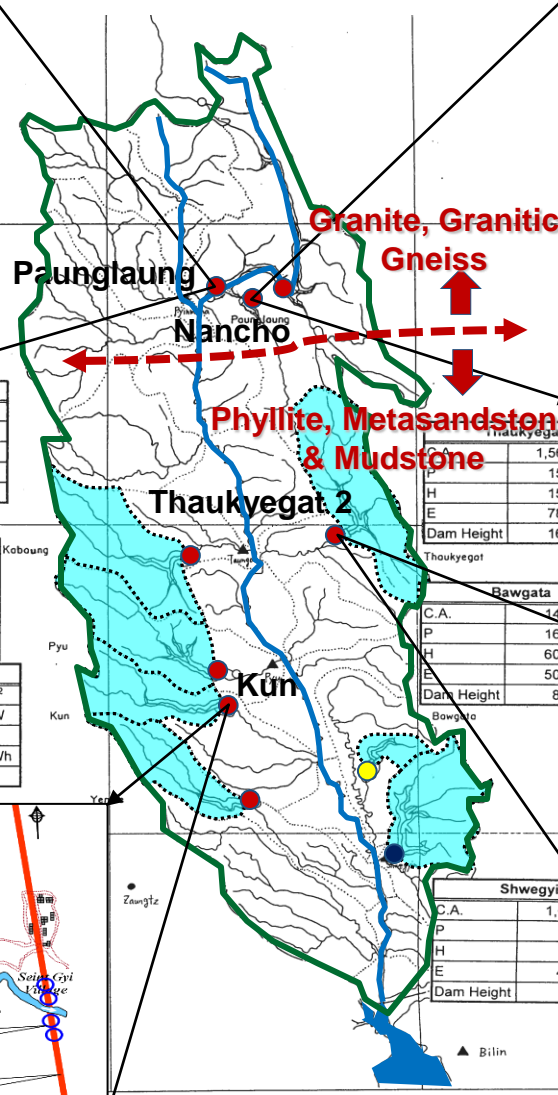
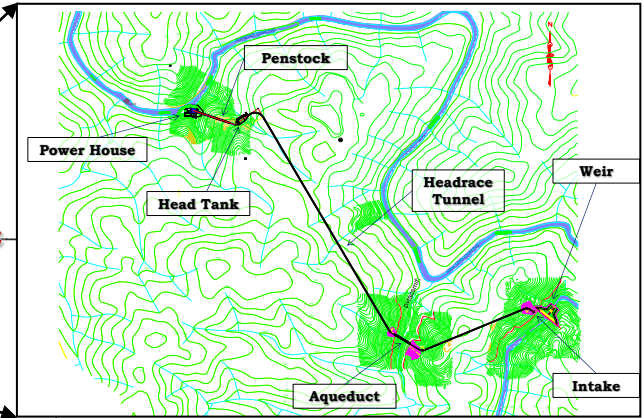
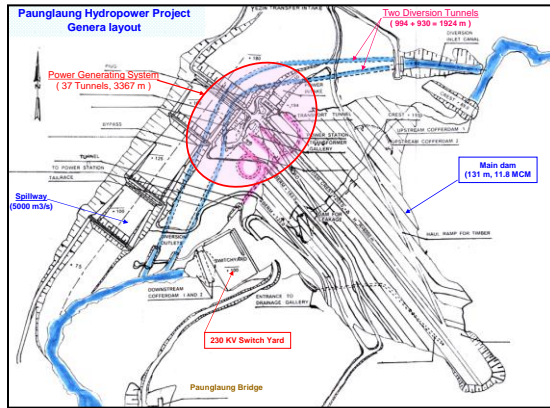
- *Ministry of Electricity and Energy (MOEE) had been trying to implement **large scale hydropower projects** to fulfill the electricity requirement of the country. Most projects include **tunneling works**.*
- *In general, tunnel excavation of hydropower projects include those for **power tunnel, diversion 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 km <sup>2</sup>
P	30 MW
H	50 m
E	120 GWh
Dam Height	55 m

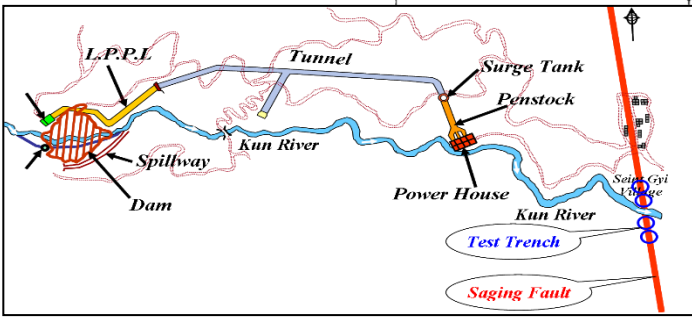
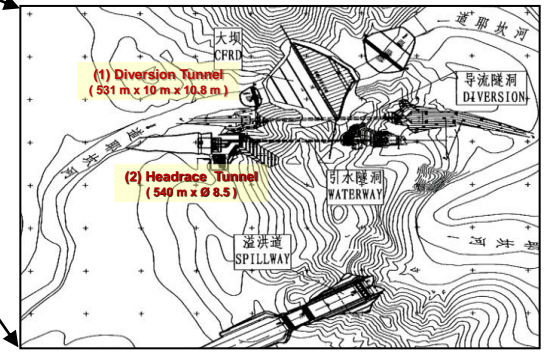
Phyu	
C.A.	1,052 km <sup>2</sup>
P	65 MW
H	96 m
E	260 GWh
Dam Height	55 m

Kun	
C.A.	875 km <sup>2</sup>
P	60 MW
H	82 m
E	190 GWh
Dam Height	73 m

Thaukyegat	
C.A.	1,567 km <sup>2</sup>
P	150 MW
H	151 m
E	780 GWh
Dam Height	168 m

Bawgata	
C.A.	142 km <sup>2</sup>
P	160 MW
H	607 m
E	500 GWh
Dam Height	82 m

Shwegyin	
C.A.	1,080 km <sup>2</sup>
P	120 MW
H	62 m
E	400 GWh
Dam Height	54 m



# General Features of Geology and Tunnel Structures of the Projects

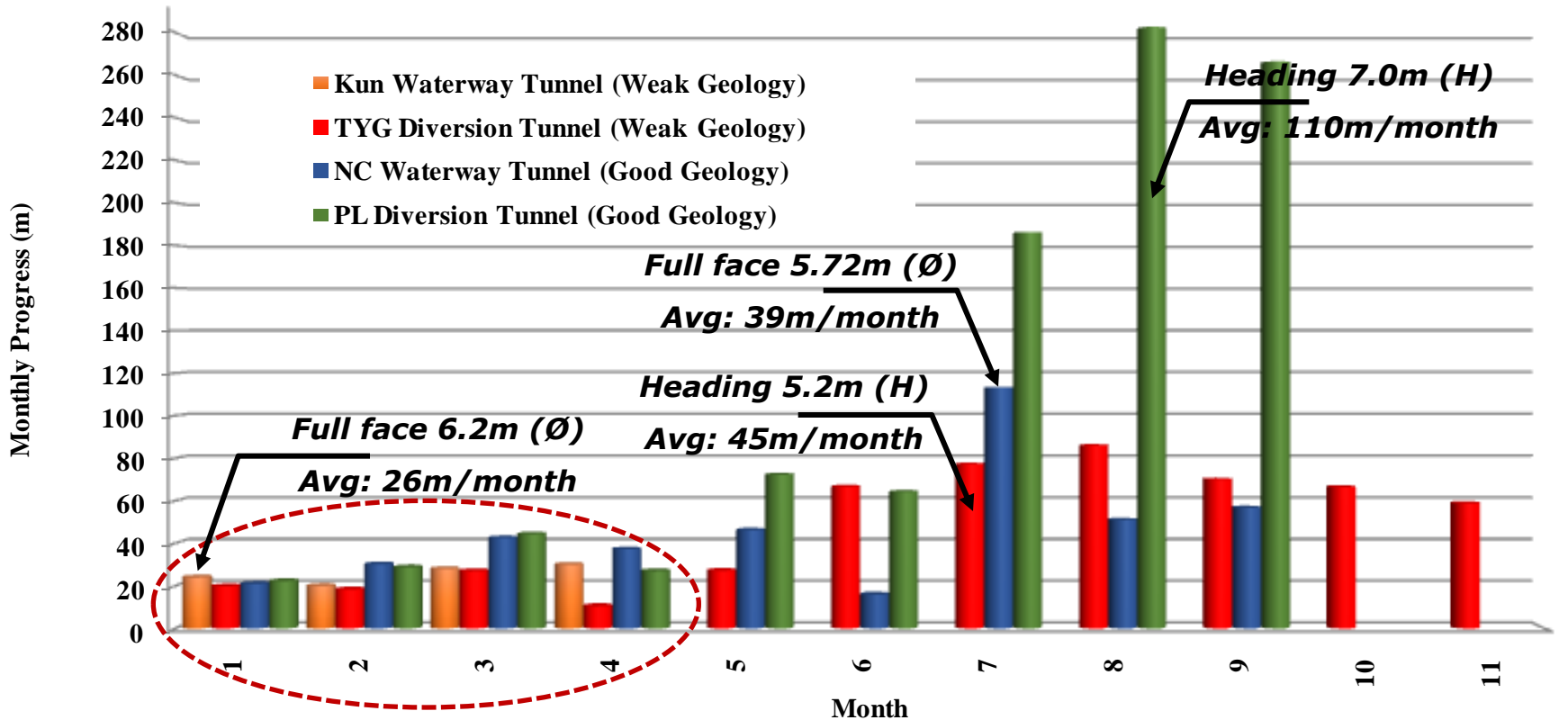
Situation	KUN	Nancho	Thaukyegat	Paunglaung
<b>1. Location</b>				
(1) Sittaung Vally	<i>Downstream most &amp; West to Sittaung River</i>	<i>Upstream most &amp; East to Sittaung River</i>	<i>Middle Downstream &amp; East to Sittaung River</i>	<i>Upstream most &amp; East to Sittaung River</i>
<b>2. Geological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





# Review on Tunneling Progress of Four Projects

## Comparison of Tunneling Progress on Different Geological Area



- **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.





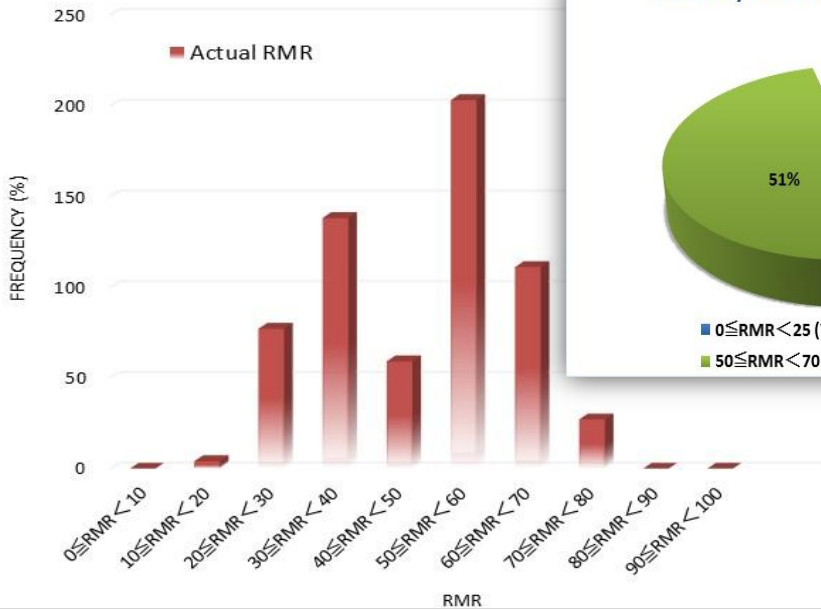
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**Geological Assessment on  
Tunneling of  
*Kun and Thaukyegat Project***

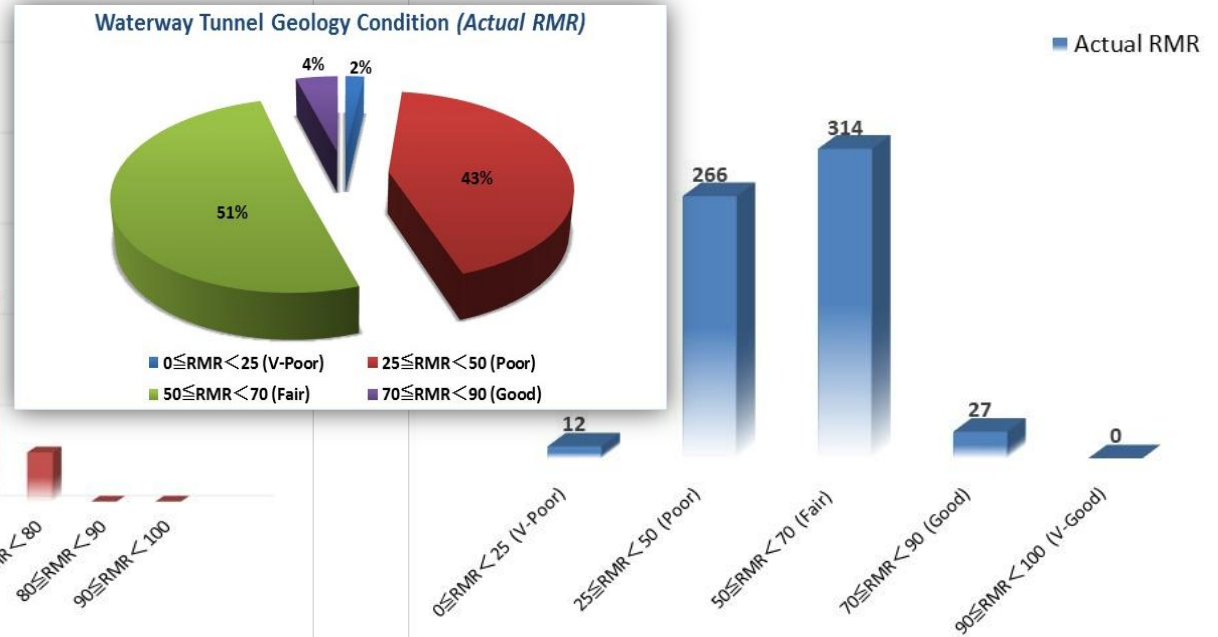


# Analysis on Recorded Tunnel Data of Kun Project

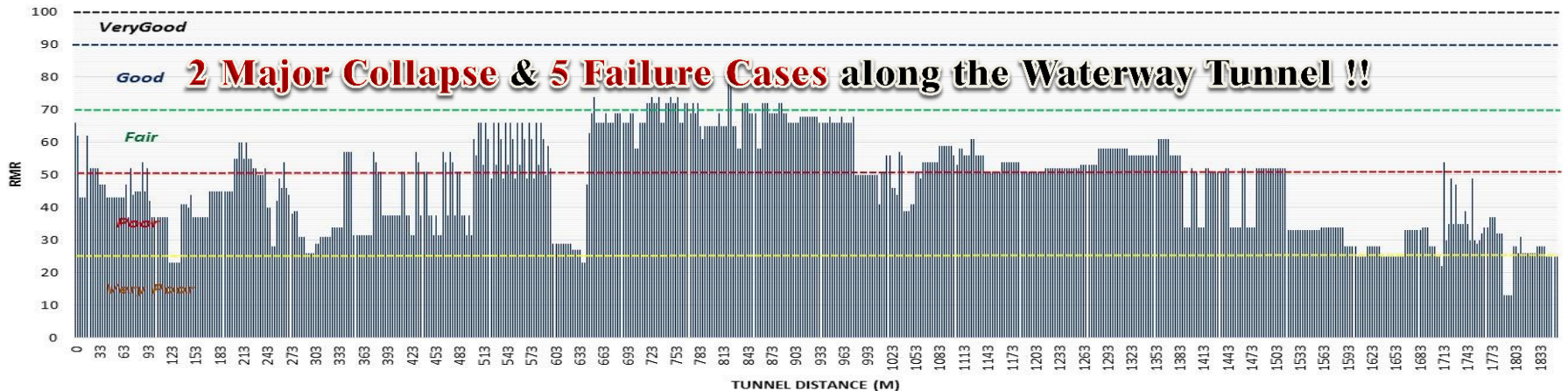
ROCK MASS CONDITIONS ALONG WATERWAT TUNNEL



ROCK MASS CONDITIONS ALONG WATERWAY TUNNEL

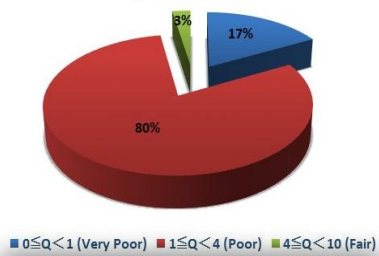


Rock Mass Conditions along Waterway Tunnel of KUN HPP

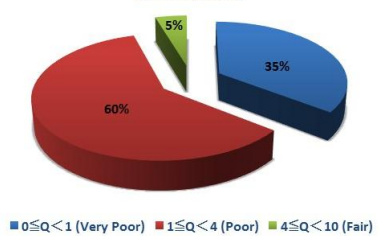


# Analysis on Waterway and Diversion Tunnel of Thaukyegat Project

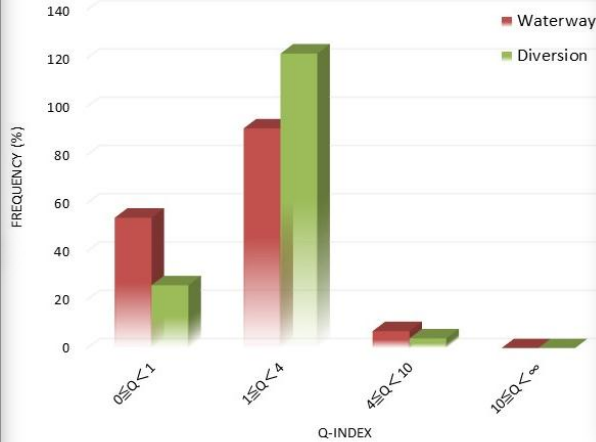
**Diversion Tunnel Geology Condition**  
(Actual Q-Index)



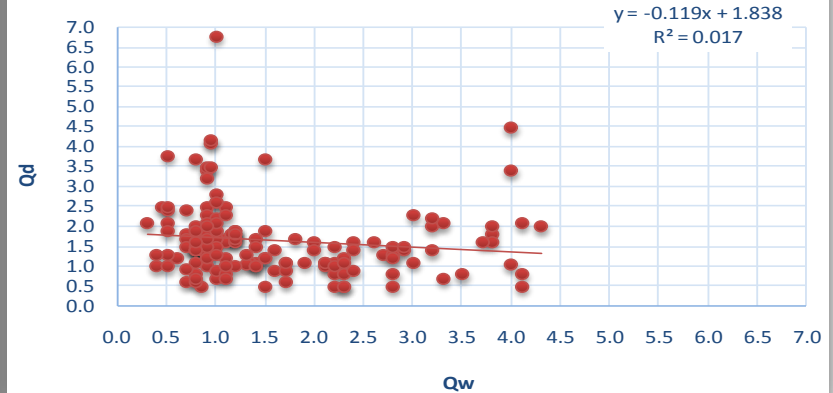
**Waterway Tunnel Geology Condition**  
(Actual Q-Index)



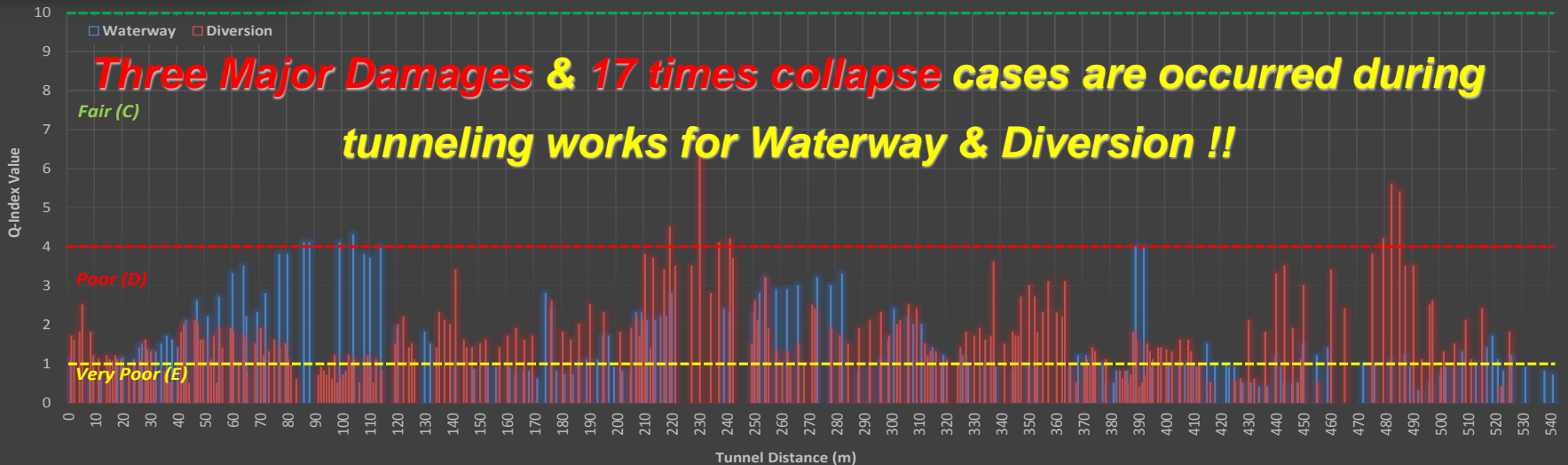
**ROCK MASS CONDITIONS ALONG WATERWAY & DIVERSION TUNNEL**



**Regression line of Actual Q-Index between Waterway & Diversion Tunnel**

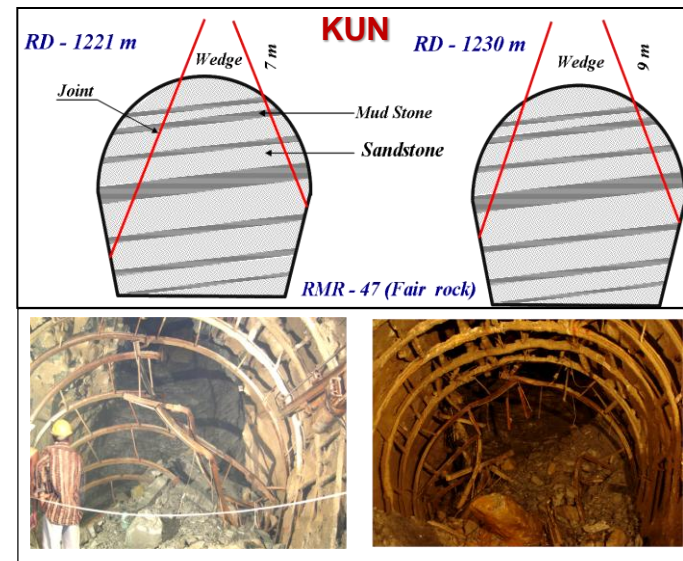
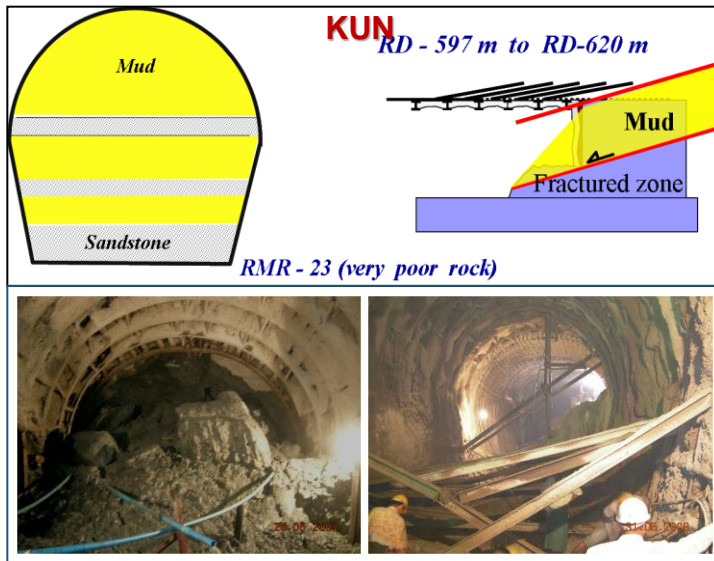


**Comparison of Rock Mass Conditions along Waterway Tunnel & Diversion Tunnel**

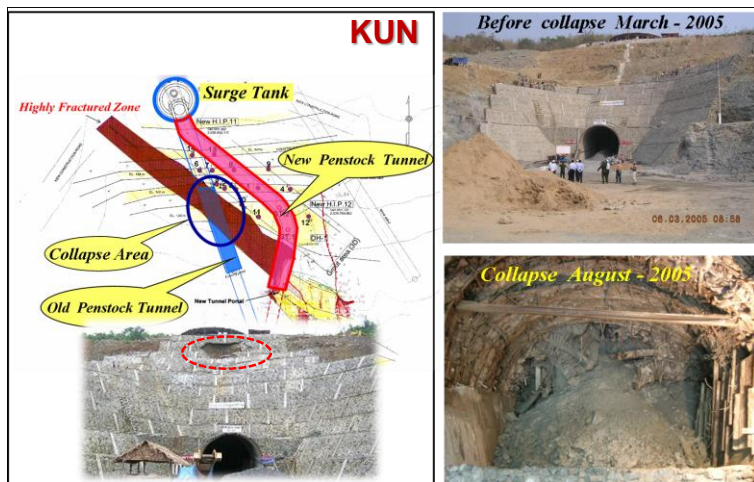




# Failure Mechanisms on Tunneling of Kun and Thaukyegat Project



- ❖ 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.**





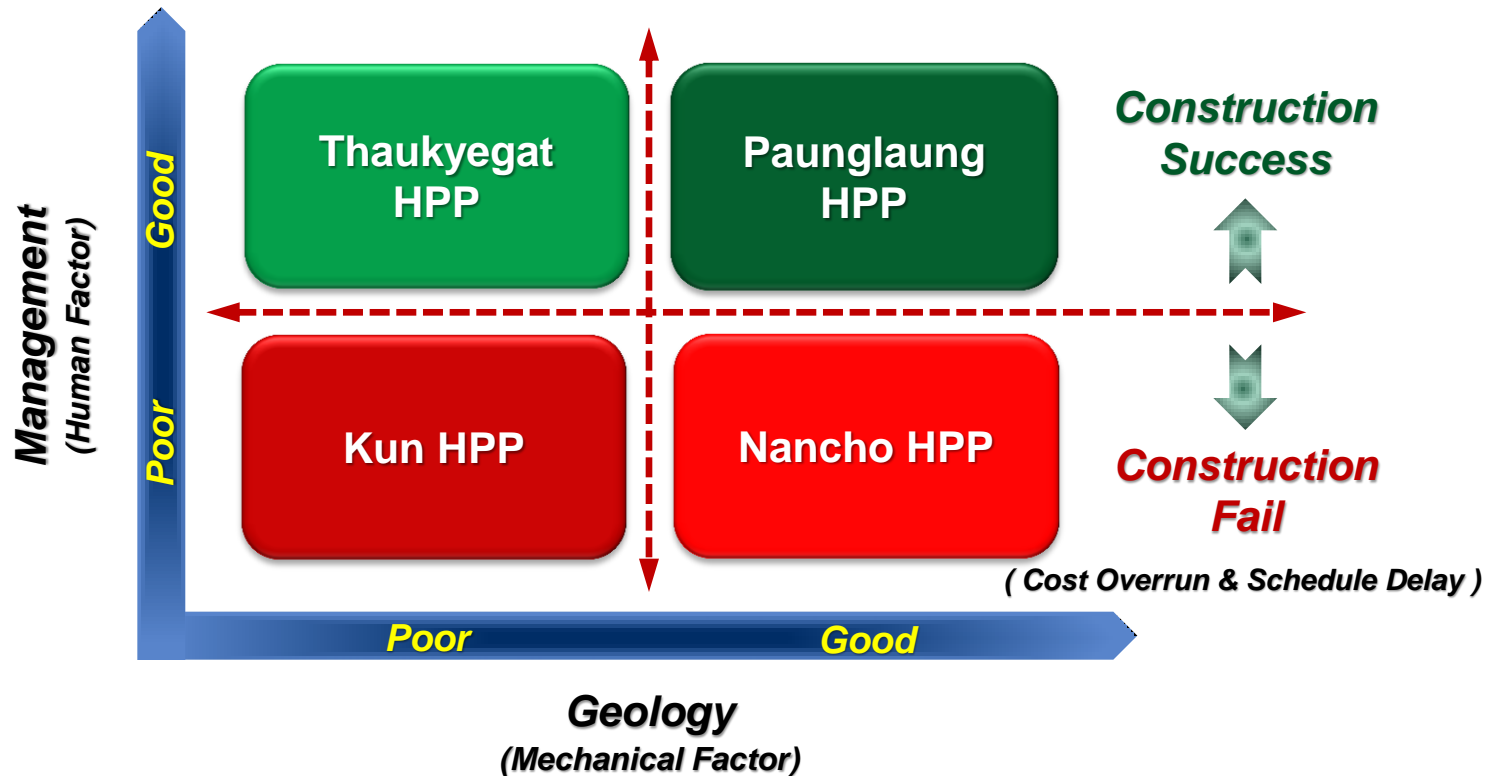
## Review on Case Study Projects

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





# 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**





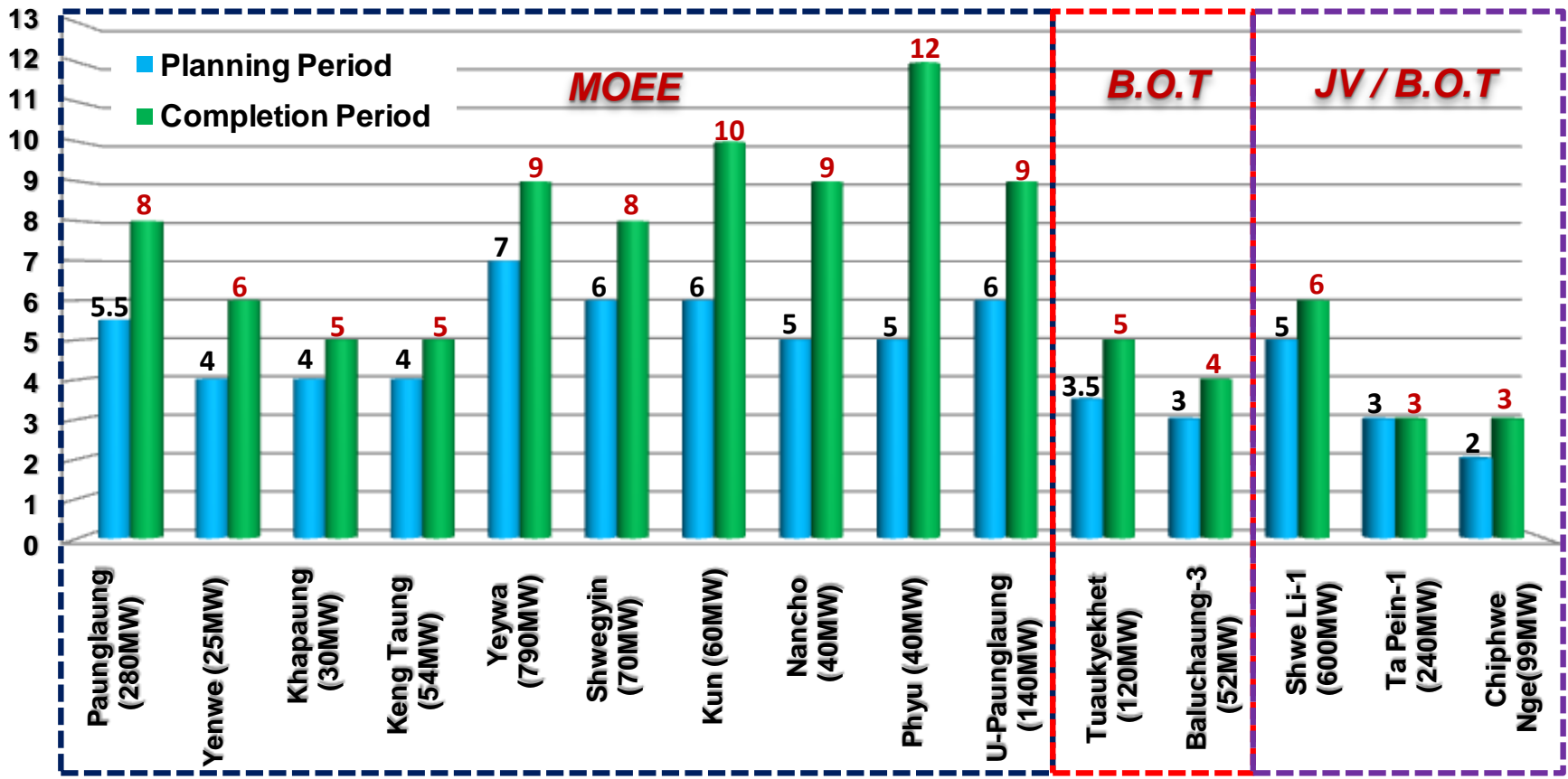
## List of Hydropower Stations (As of Jan, 2017)

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	
<b>Total</b>		<b>3,181</b>			



# Time Frame for Construction of Hydropower Projects

## Comparison of Completion Period for Hydropower Construction (1997 ~ 2016)



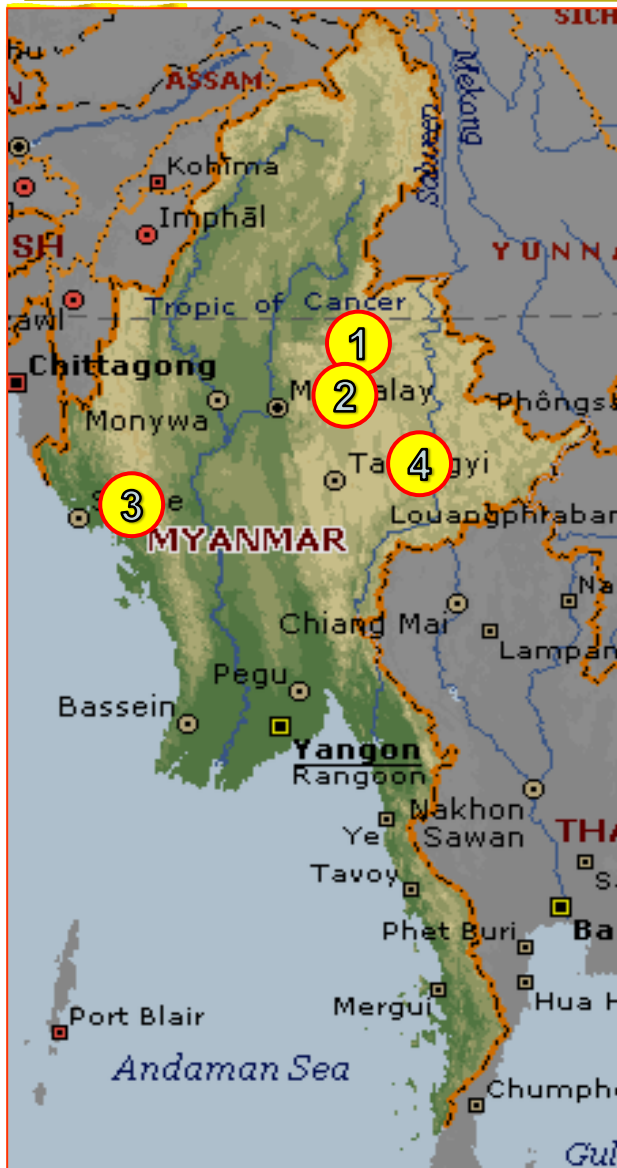




## On going Hydropower Projects under the MOEE

### 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
<b>Total</b>		<b>1,493.5</b>	

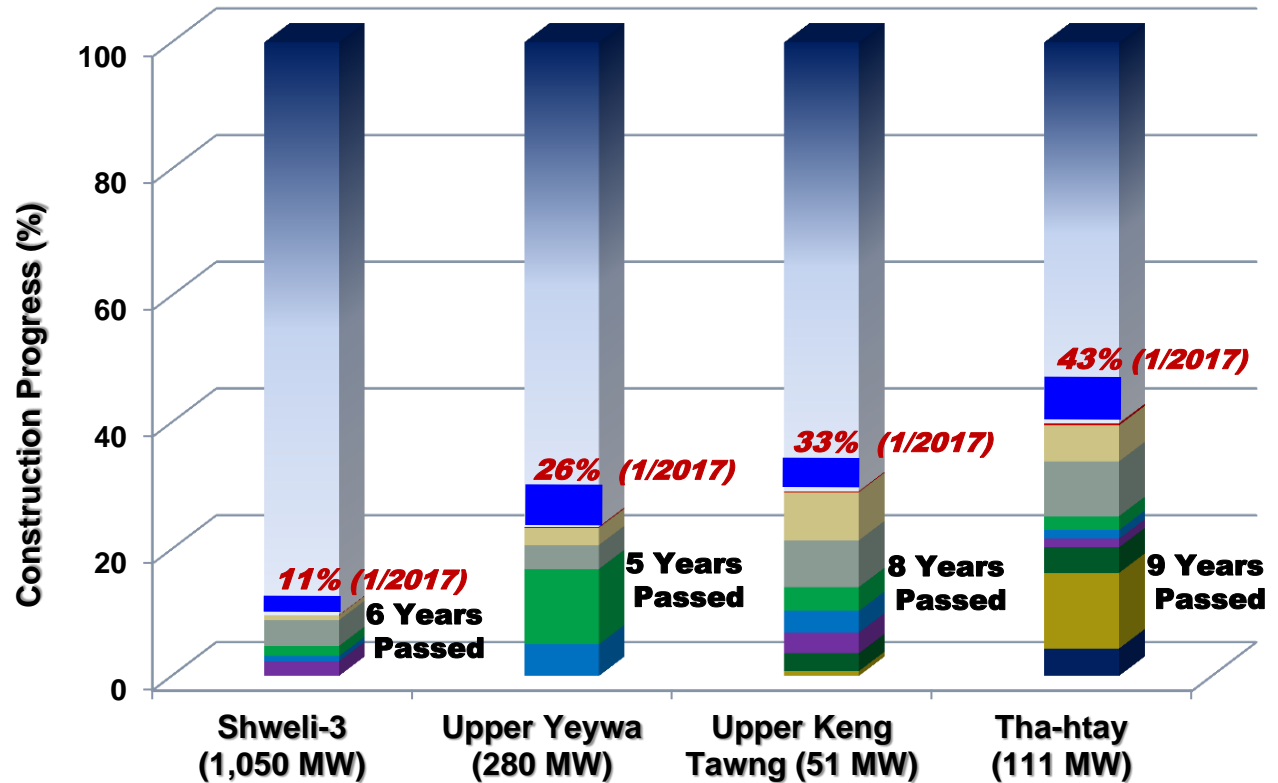




# Current Hydropower Progress (As of Jan, 2017)

## 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)*

#### Upper Yeywa HPP (280 MW)



**River** - Myitnge River  
**Inflow** - 11702 Mm<sup>3</sup>  
**Dam** - RCC Dam, 97 m Height  
**Progress** - 26%





## Current Hydropower Progress (As of Jan, 2017)

### ***Under Implementation of Upper Keng Tawng Hydropower Project (MOEE)***

River - Nam Teng River

Inflow - 2302 Mm<sup>3</sup>

Dam - Zoned Type Rockfill Dam, 57 m Height

Progress - 33%

Upper Keng Tawng HPP (52.5 MW)







## Current Hydropower Progress (As of Jan, 2017)

### *Under Implementation of Tha-htay Hydropower Project (MOEE)*

River - Tha-htay River  
Inflow - 2876 Mm<sup>3</sup>  
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	<ul style="list-style-type: none"><li>▪ <b>Technical Constraints</b> should be improved well.</li><li>▪ <b>Lack of skilled workforce</b> should be managed well.</li><li>▪ <b>Human mistake</b> should be avoided well.</li></ul>	<ul style="list-style-type: none"><li>▪ To prepare <b>human resource development</b>.</li><li>▪ To allocate <b>right person and enough capacity</b> for the project site.</li><li>▪ To <b>organize and right decision</b> for the project.</li></ul>
Procurement	<ul style="list-style-type: none"><li>▪ <b>Insufficient major equipment</b> should be prepared well.</li><li>▪ <b>Resources constraint</b> should be managed well.</li></ul>	<ul style="list-style-type: none"><li>▪ Required machinery equipment should be enough for each <b>Hydropower Projects</b>.</li><li>▪ To prepare resources ahead before starting the <b>Construction Works</b>.</li></ul>
Finance	<ul style="list-style-type: none"><li>▪ <b>Budget delay</b> should be avoided well.</li><li>▪ <b>Budget insufficient</b> should be supplied well.</li></ul>	<ul style="list-style-type: none"><li>▪ <b>Delaying of budget</b> is becoming the high risk factors for hydropower construction works.</li><li>▪ Well preparation for construction is mainly depend on <b>availability of budget</b>, but <b>insufficient of budget</b> may defect on <b>Construction time and Cost</b>.</li></ul>
Construction	<ul style="list-style-type: none"><li>▪ <b>Unforeseen Hydrology and Geology Condition</b> should be investigated well.</li><li>▪ <b>Lack of Systematic Geological Observation</b> should be evaluated well.</li><li>▪ <b>Poor Working Condition</b> should be improved well.</li></ul>	<ul style="list-style-type: none"><li>▪ It can be investigated well by <b>proper technique</b> for <b>hydrological and geological investigations</b>.</li><li>▪ Well <b>observation and evaluation</b> can minimize the geo-risk and cost effective on underground works.</li><li>▪ To improve poor working condition, <b>discussion and well preparation</b> on job site is essential.</li></ul>





# Conclusion

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## *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

