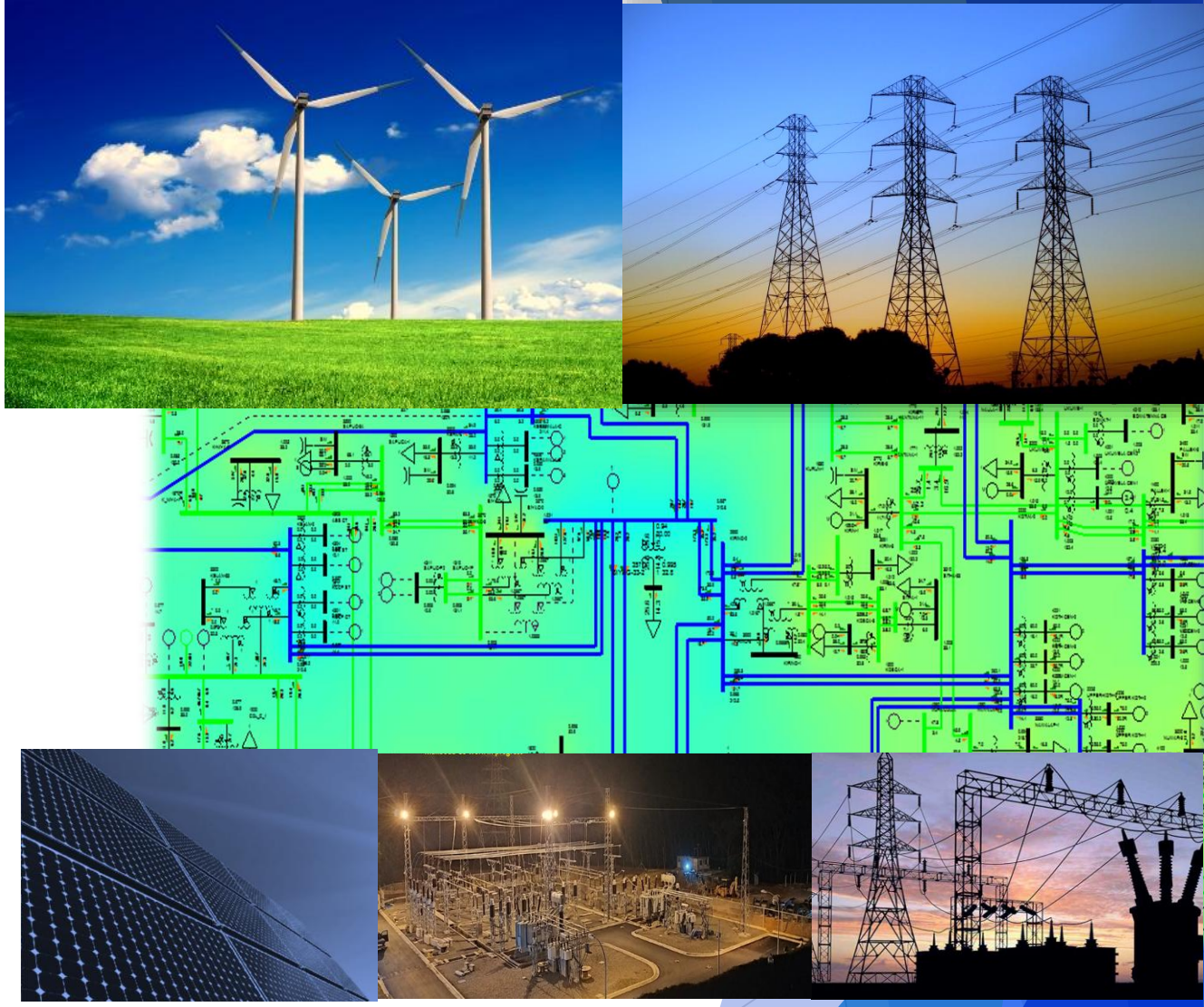
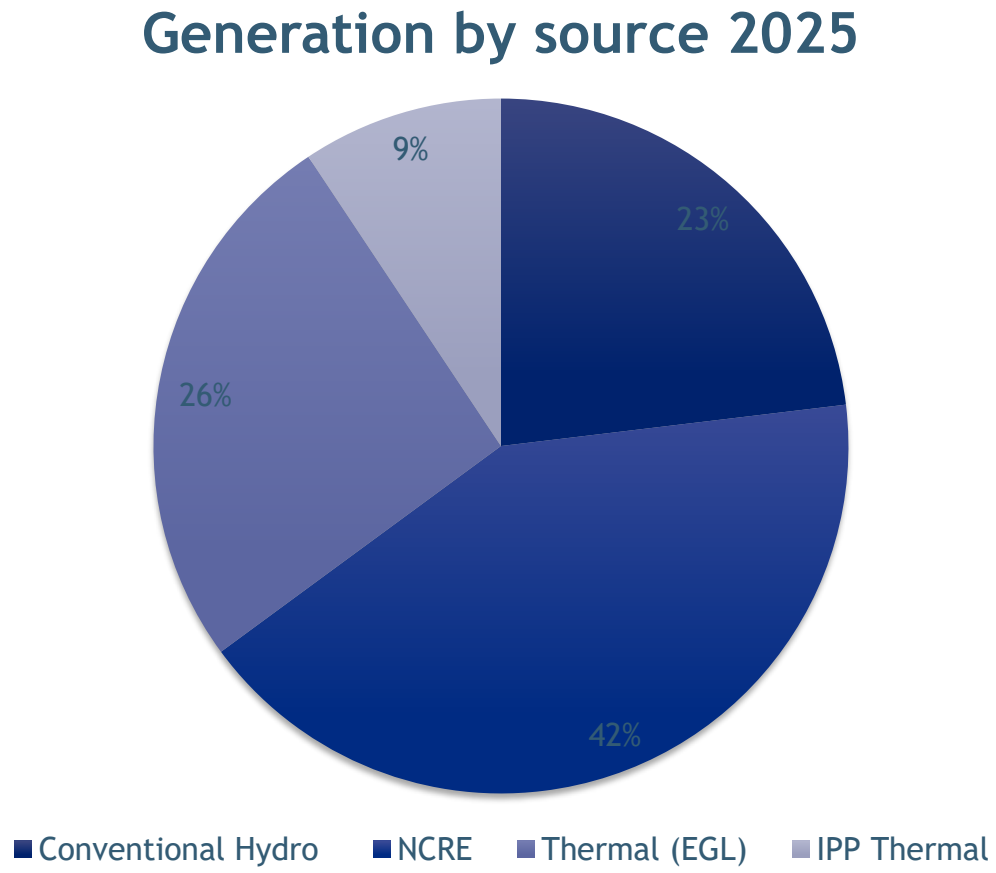
Best Practices in Transmission Planning



Kushan Marambage
Chief Engineer (Transmission Planning)
Power System Planning Branch
National System Operator
Sri Lanka

NSO
National System Operator

Present Generation Capacity of Sri Lanka



Source: NSCC, as at July 2025

Annual Energy Dispatched

Source	Energy (GWh)	Percentage (%)
Major Hydro	5,426	31%
Solar	1688	10%
Grid connected	*257*	
Roof top	*1431*	
Wind	792	5%
Mini Hydro	1,473	8%
Biomass & Other	167	1%
Total RE	**9,546**	**55%**
Thermal Oil	2,336	13%
Thermal Coal	**5,482**	**32%**
Total Thermal	**7,818**	**45%**
Total Generation	**17,364**	

Source : Statistical Digest 2024 CEB
Note : Rooftop solar self consumption estimated

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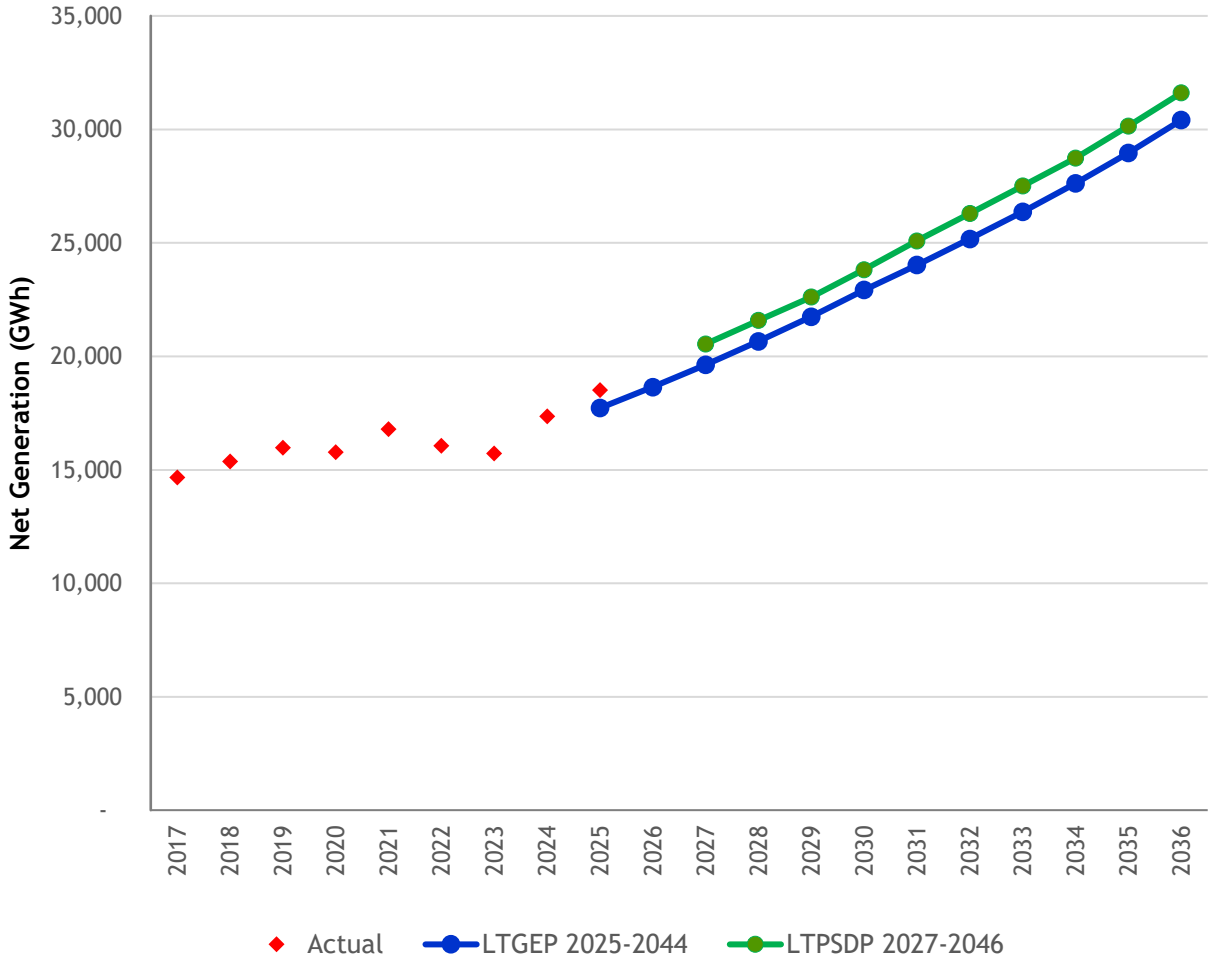
Demand Forecast

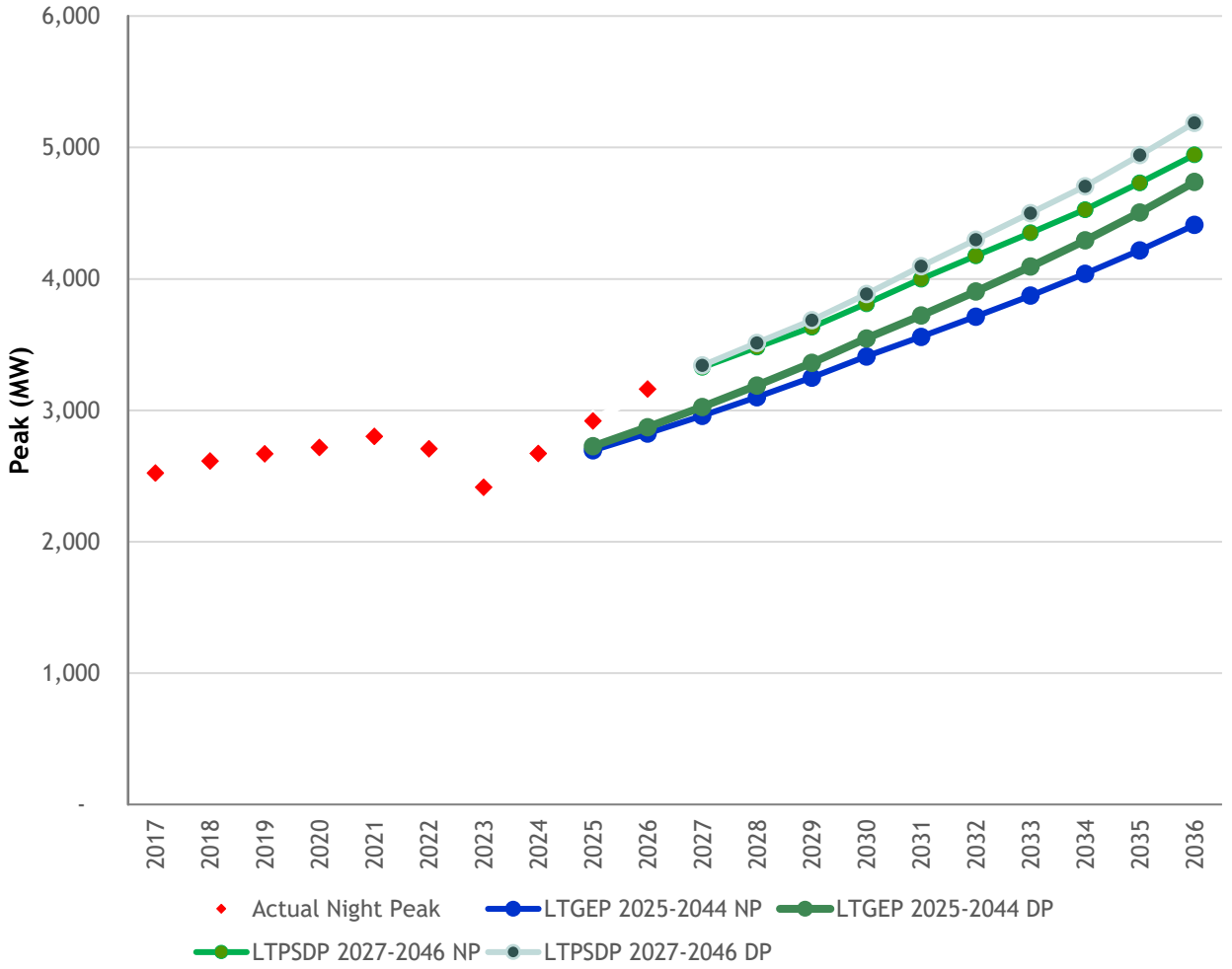
Net Generation

5 Year Average Growth Rate (2027-2031) : 5.1%



Peak

5 Year Average Growth Rate (2027-2031) : NP 4.7%, DP 5.2%



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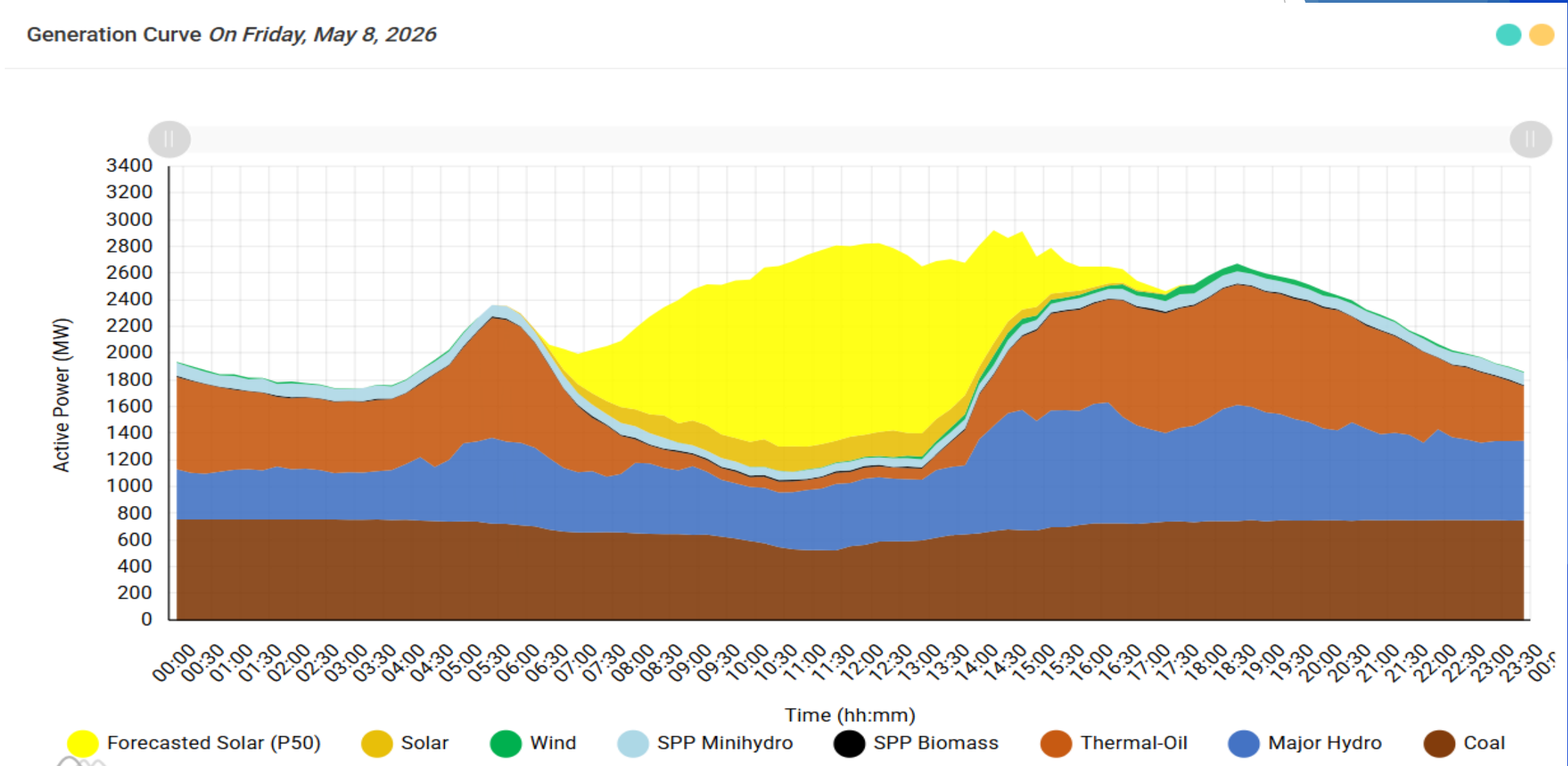
Daily Demand Variation



Source: NSCC, NSO

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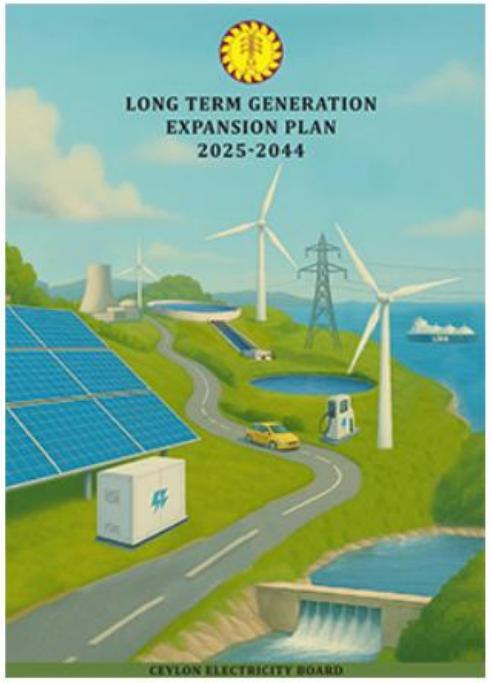
Base Document for Long Term Transmission Development Plan

- Long Term Generation Expansion Plan

- Medium Voltage Distribution Development Plans



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Main Objectives of the Long Term Transmission Development Plan

- To find out the transmission developments required to ensure a reliable and stable power system for the planning horizon
- To determine the investment requirement for the transmission development proposal within the planning horizon

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Preparation of Grid Demand Forecast

- National Power Demand is allocated among the existing grid substations considering the trends of load variation, spot loads and distribution network arrangements
- Overloaded grid substations are identified after considering possible load transferred to adjacent grid substations
- Augmentations and construction of new grid substations are established

This process is repeated until the grid substation demand forecast meet the planning criteria

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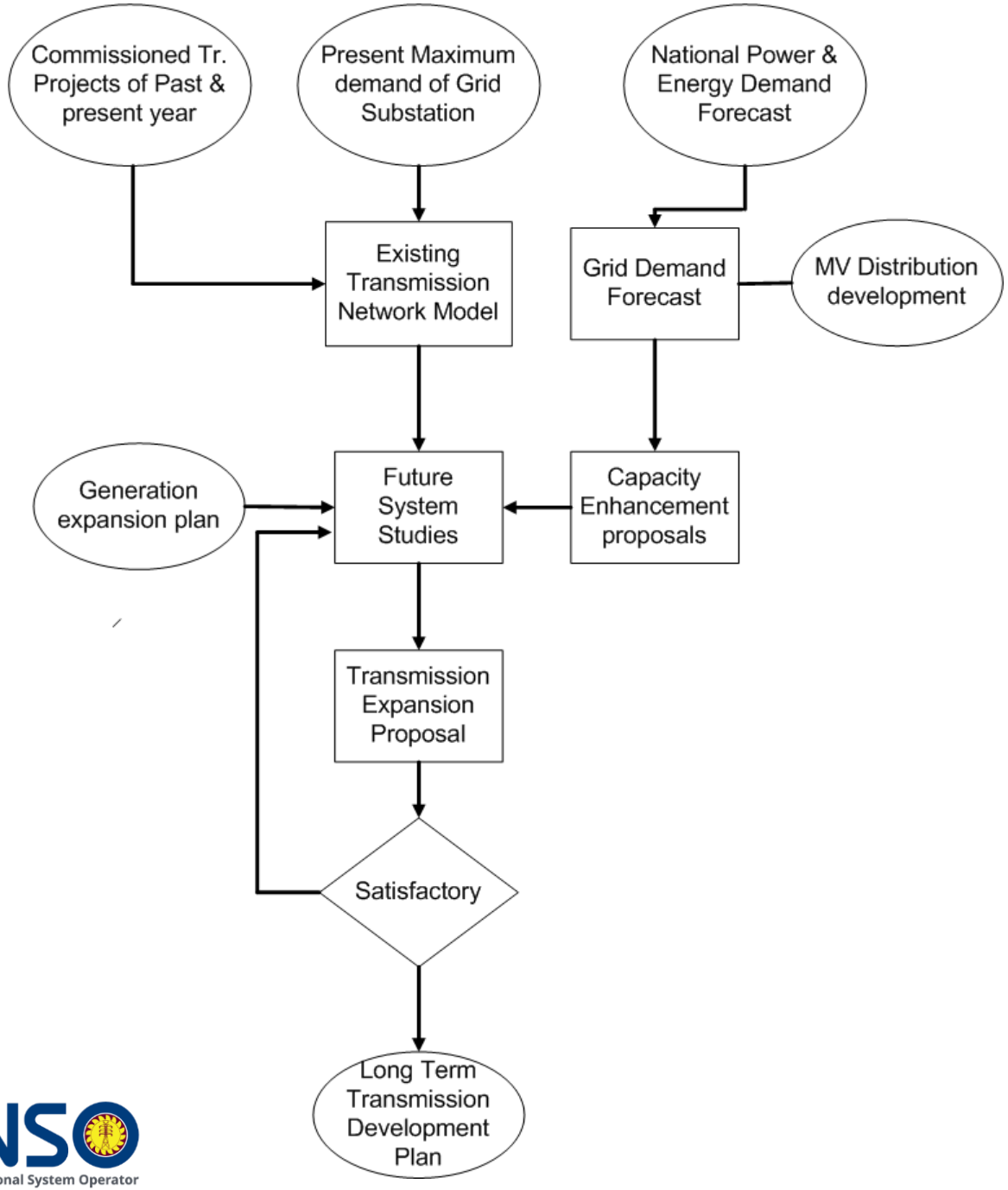

Transmission Planning Procedure

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Planning Criteria

Ensures quality and reliability of supply under normal operating conditions as well as under single contingency conditions

1. Voltage Criteria
2. Thermal Criteria
3. Security Criteria
4. Stability Criteria
5. Short Circuit Criteria

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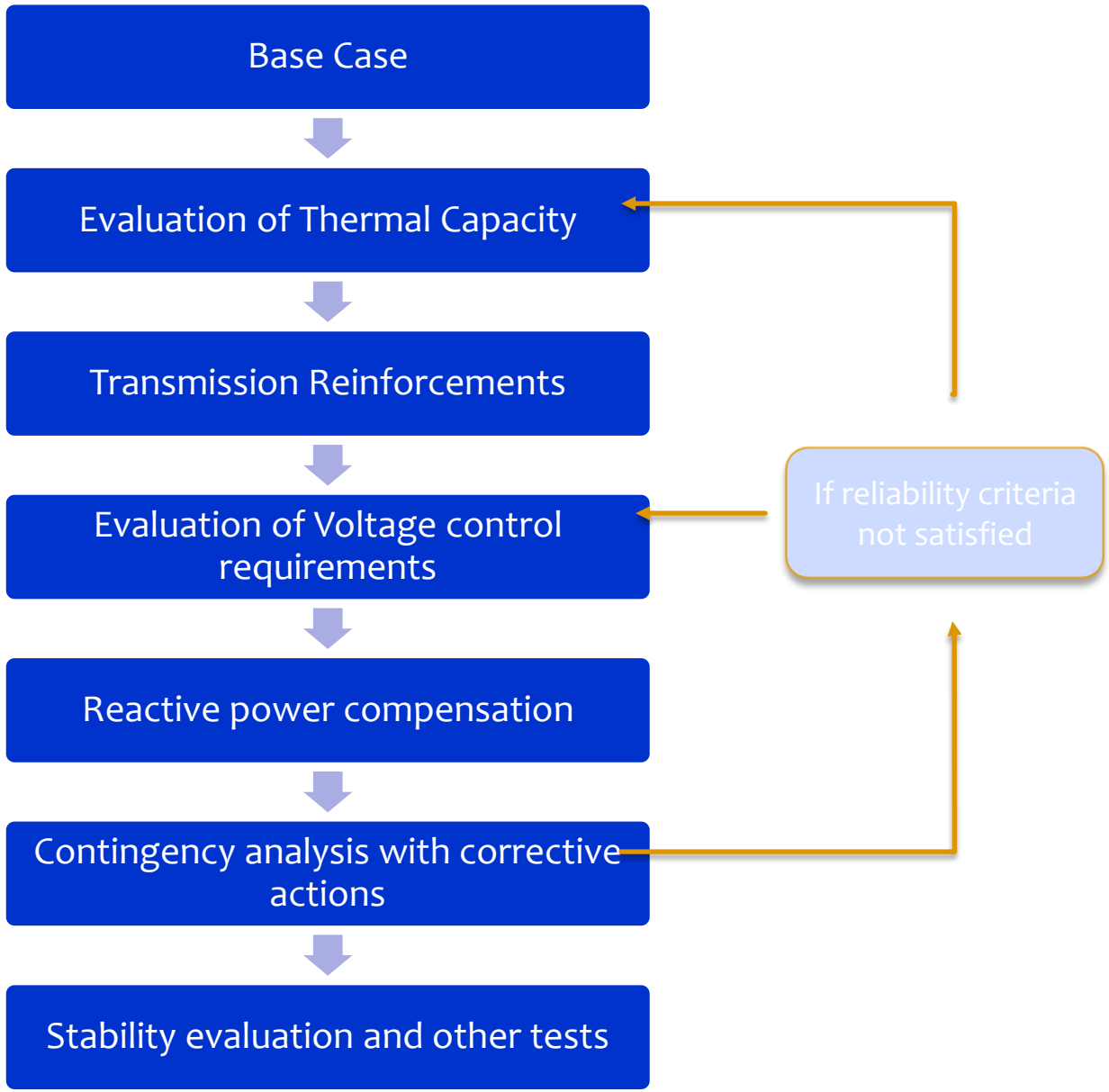

Base Case
Evaluation of Thermal Capacity
Transmission Reinforcements
Evaluation of Voltage control requirements
Reactive power compensation
Contingency analysis with corrective actions
Stability evaluation and other tests
If reliability criteria not satisfied

Transmission Expansion Proposals Identified by System Analysis

	Proposal	F.C (MLKR)	L.C (MLKR)
Proposals for Year 2025			
1	Padukka - Horana 132kV Transmission Line	588	147
Proposals for Year 2028			
2	Vavuniya Grid Substation 220kV Development	4659	960
3	Construction of Samanalawewa-Embilipitiya 132kV Transmission Line with Zebra	1734	1165
4	Construction of New Habarana - Kappalturei 220 kV transmission line	8733	4672
5	Construction of Pannipitiya-Panadura 132kV Transmission Line with 2xZebra	1594	911
6	Construction of Panadura T- Matugama 132kV Transmission Line with 2xZebra	1655	1066
7	Construction of Laxapana - Wimalasurendra 132kV Transmission Line with Zebra	596	242
8	Installation of STATCOM at Padukka 220kV GSS	10589	1142
9	Reconstruction of New Laxapana - Balangoda 132kV Transmission Line with Zebra	2002	1348
10	Capacity enhancement of 132kV Lynx transmission lines to Zebra - Laxapana Complex	1043	644
11	Installation of 75 MVA Synchronous Condenser Unit at Mannar	6306	862
12	Installation of 75 MVA Synchronous Condenser Unit at New Habarana	6306	862

Transmission Expansion Proposals Identified for Meeting Consumer Demand

	Proposal	F.C (MLKR)	L.C (MLKR)
Proposals for Year 2027			
1	Augmentation of Athurugiriya 132/33kV Grid Substation	836	118
Proposals for Year 2028			
2	Construction of Wariyapola 132/33 kV grid substation & Wariyapola-South 220/132kV Switching Station	9,029	2,242
3	Construction of Ekala 132/33kV Grid substation	3,193	699
4	Augmentation of Kesbewa 132/33kV Grid Substation	836	118
5	Augmentation of Aniyakanda 132/33kV Grid Substation	836	118
6	Augmentation of Mannar 220/33kV Grid Substation	1,289	107
Proposals for Year 2029			
7	Construction of Biyagama Zone 132/33 kV grid substation	4,568	1,061
8	Construction of Weligama 132/33 kV grid substation	2,327	450
9	Augmentation of Vavunathiv 132/33kV Grid Substation	836	118
Proposals for Year 2030			
10	Augmentation of Valachchenai 132/33kV Grid Substation	836	118
11	Construction of Colombo G 220/132kV Switching Station	23,557	3,958
12	Construction of Colombo K 132/11kV Grid Substation	7,344	1,660
13	Construction of Sub P (Narahenpita) 132/11kV Grid Substation	7,849	1,660
14	Construction of Sub Q (Town Hall) 132/11kV Grid Substation	3,347	478
15	Replacing the Capacitor Bank at Thulhiriya GSS	146	13
16	Construction of Yakkala 132/33 kV grid substation	3,179	767
17	Construction of Hambantota Port 220/33 kV grid substation	6,932	1,353

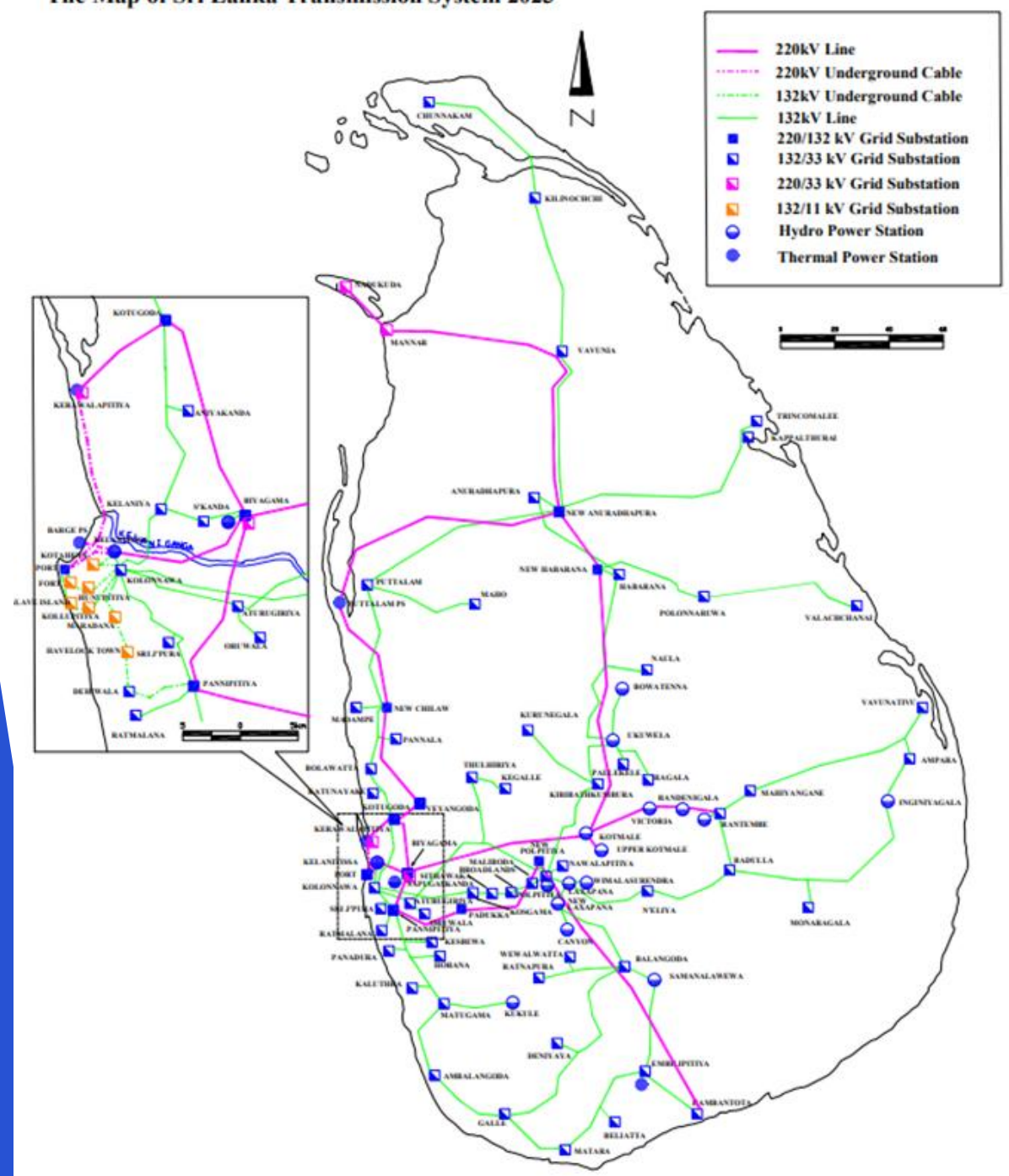
Battery Storage Considered for Grid Support

Location	Total Capacity (MW/MWh)			
	2026	2028	2030	2034
Kolonnawa	100/100	100/100	100/100	100/100
Hambantota		100/400	100/400	100/400
Valachchenai		50/200	50/200	50/200
New Habarana			100/200	200/600
Trincomalee			100/400	100/400
N-Collector				100/400

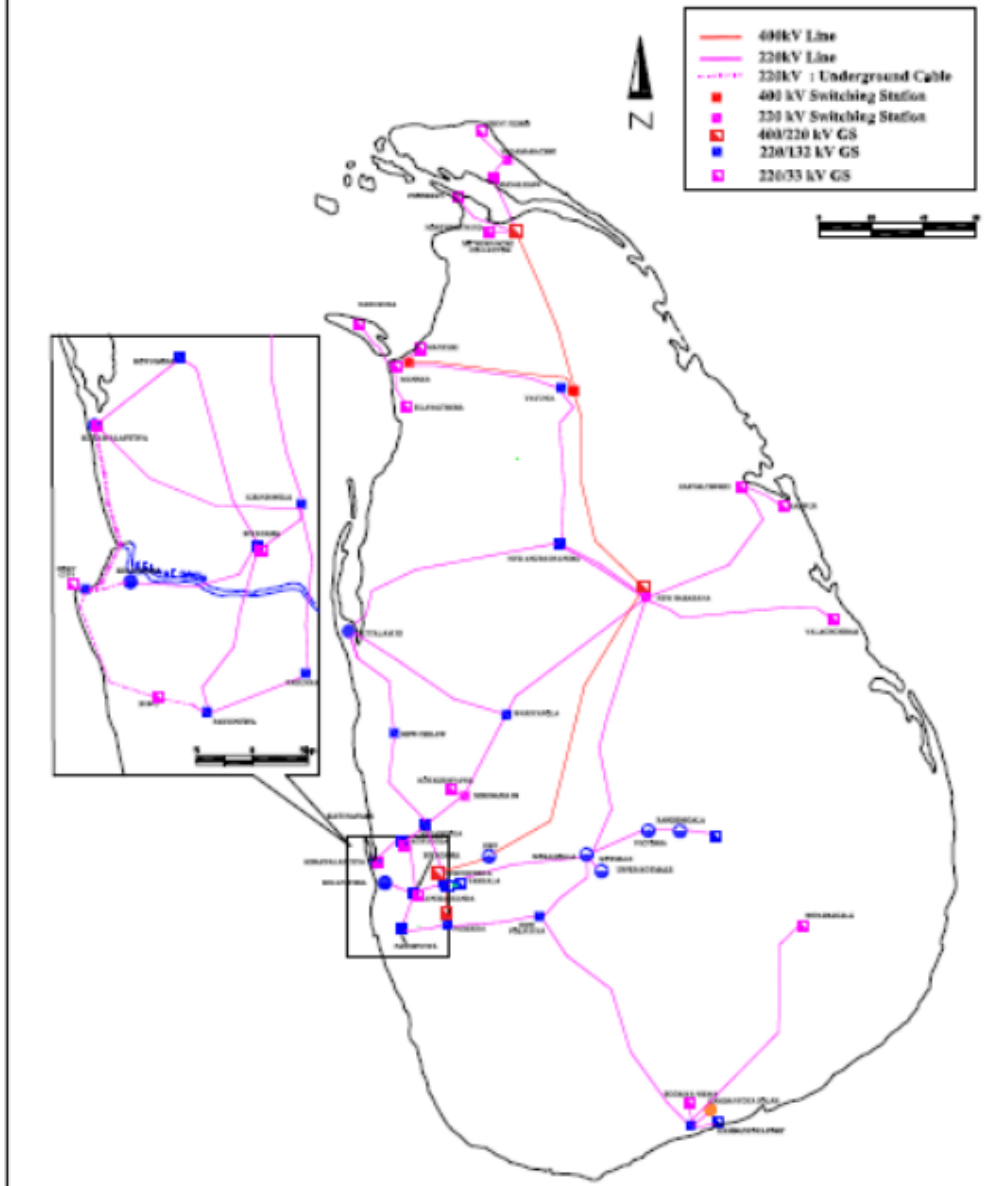
Grid Flexibility Assets

Description	Commissioning Year	Base Cost (MLKR)	
		FC	LC
Installation of STATCOM at Padukka 220kV GSS	2026	10,589	1142
*Installation of 75 MVA Synchronous Condenser Units at Mannar & New Habarana	2028	12,612	1725
Installation of STATCOM at New Kolonnawa 132kV GSS	2030	8,627	1,232
*Installation of 125 MVA Synchronous Condenser Unit at N Collector	2030	12,612	1725

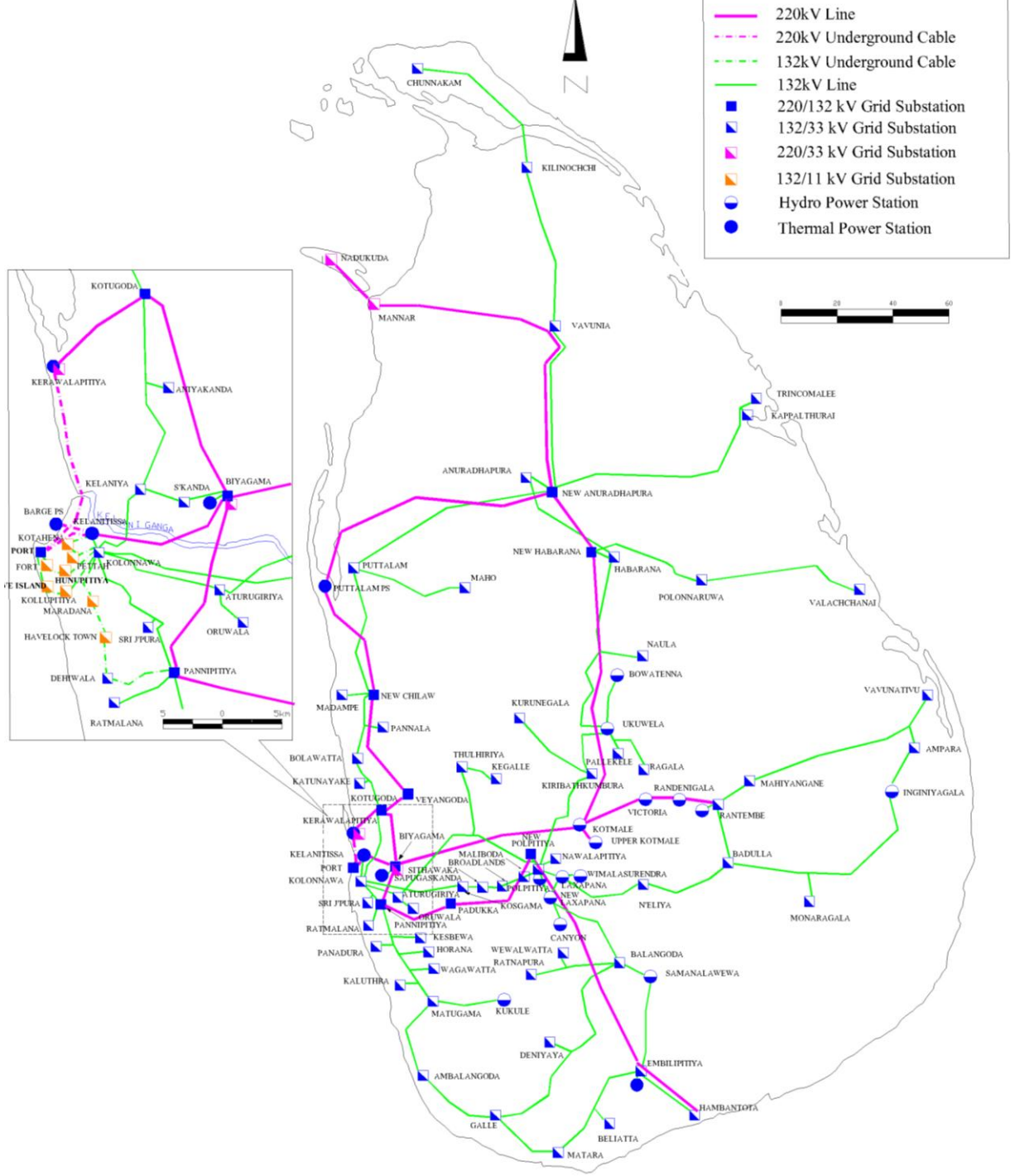
The Map of Sri Lanka Transmission System 2023



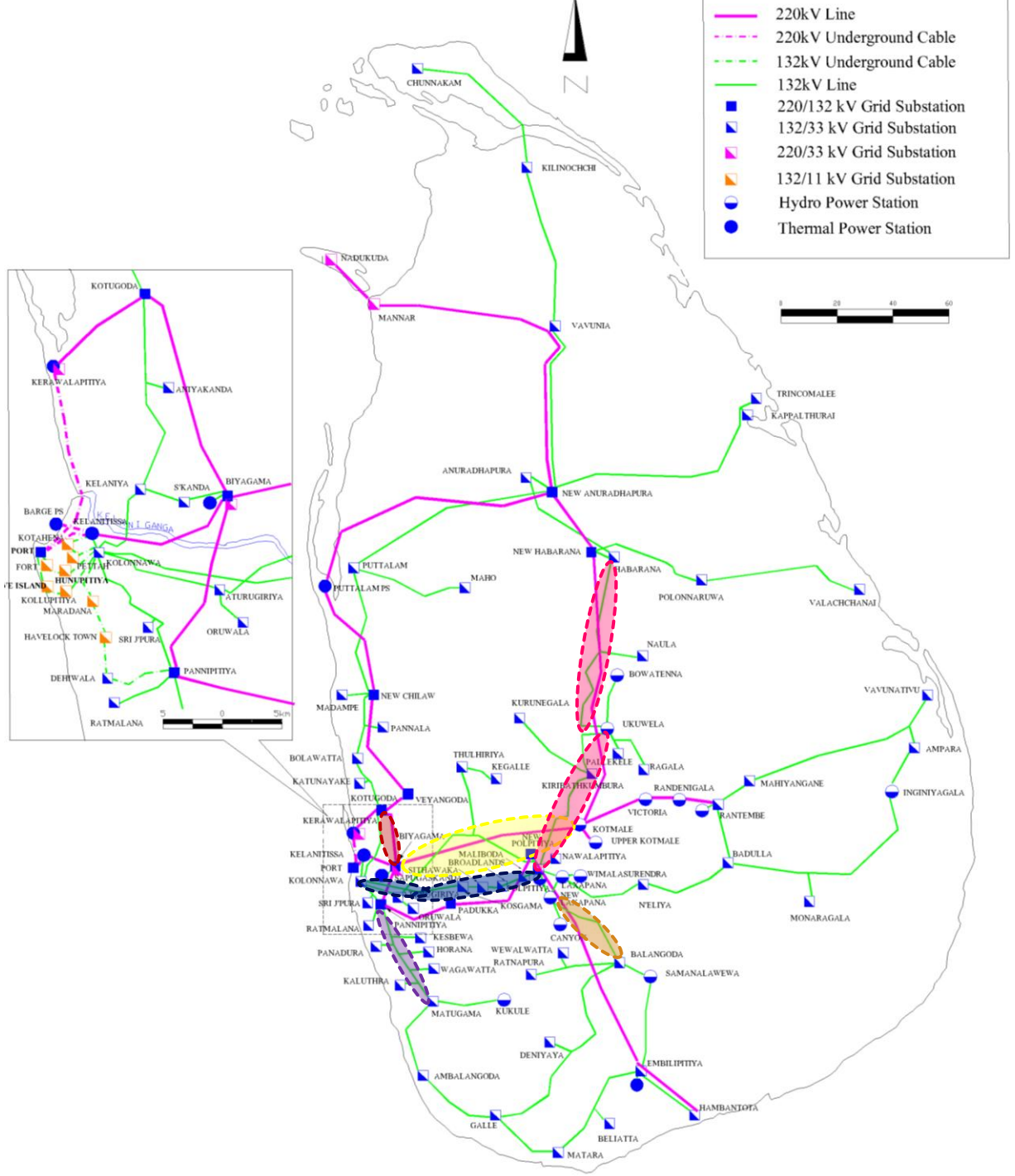
The Map of Sri Lanka Transmission System in Year 2044



Sri Lanka Transmission Network showing transmission constraints



Sri Lanka Transmission Network showing transmission constraints



Existing Critical Transmission Network Issues & Solutions Given

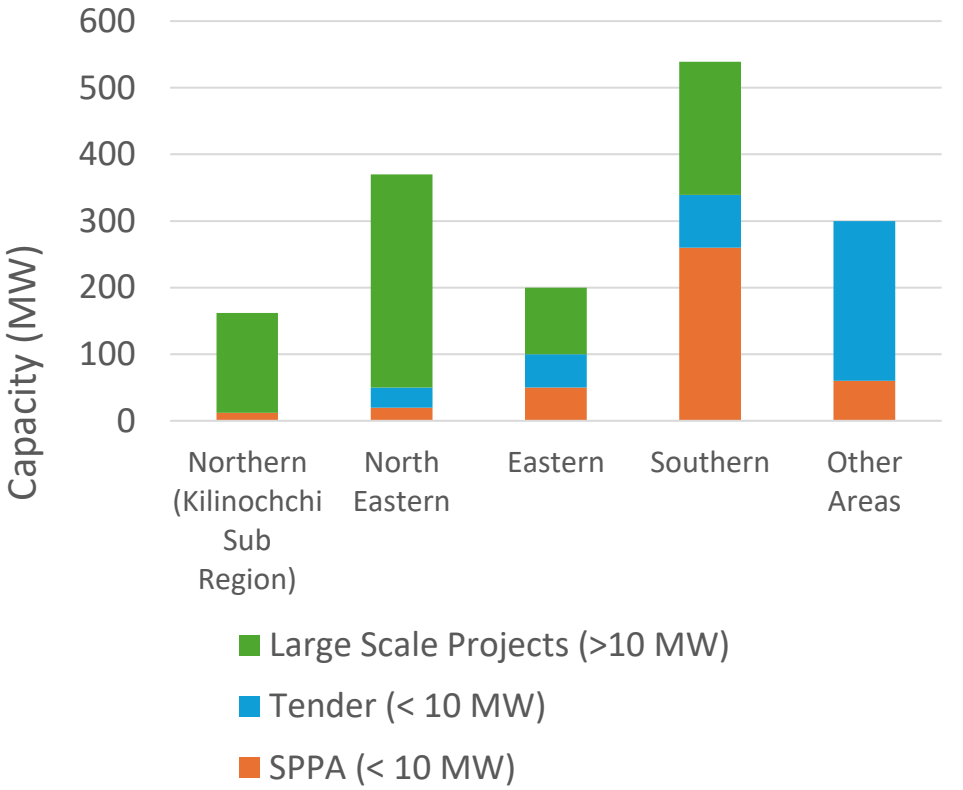
	Constraint	Scenario	Solution
1	Kotmale - Biyagama 220kV Double Circuit Line (Line is 220 kV, 2xzebra, double circuit)	Outage of one circuit of Kotmale Biyagama 220kV Double Circuit Line	Construction of Kotmale – New Polpitiya 220kV transmission line
2	Kotugoda - Biyagama 220 kV Double Circuit Line (Line is 220 kV, 1xzebra, double circuit)	During High thermal dispatch Scenarios	Construction of 220/132 kV, 2x250 MVA Kirindiwela GSS, Kirindiwela-Padukka 400 kV (220 kV initial operation) and Kirindiwela-Veyangoda 220 kV transmission line
3	Pannipitiya-Matugama, 132 kV transmission Line	Heavy loading conditions	Reconstruction of Pannipitiya-Matugama, 132 kV transmission Line

Existing Critical Transmission Network Issues & Solutions Given

	Constraint	Scenario	Solution
4	Pannipitiya 220/132 kV, 2x250 MVA interbus transformer	Outage of one interbus transformer	Construction of Padukka Horana 132 kV transmission Line
5	New Laxapana-Balangoda 132 kV transmission line	During High RE Scenarios	Reconstruction of New Laxapana-Balangoda, 132 kV transmission Line
6	Kolonnawa –Polpitiya, 132 kV, two double circuit lines	Heavy loading conditions	Reconstruction of Kolonnawa – Polpitiya, 132 kV transmission Line
7	Polpitiya –Kiribathkumbura and Ukuwela – Habarana 132 kV, Transmission Lines	During High Hydro Scenarios	Reconstruction of Polpitiya – Kiribathkumbura and Ukuwela – Habarana, 132 kV transmission Line

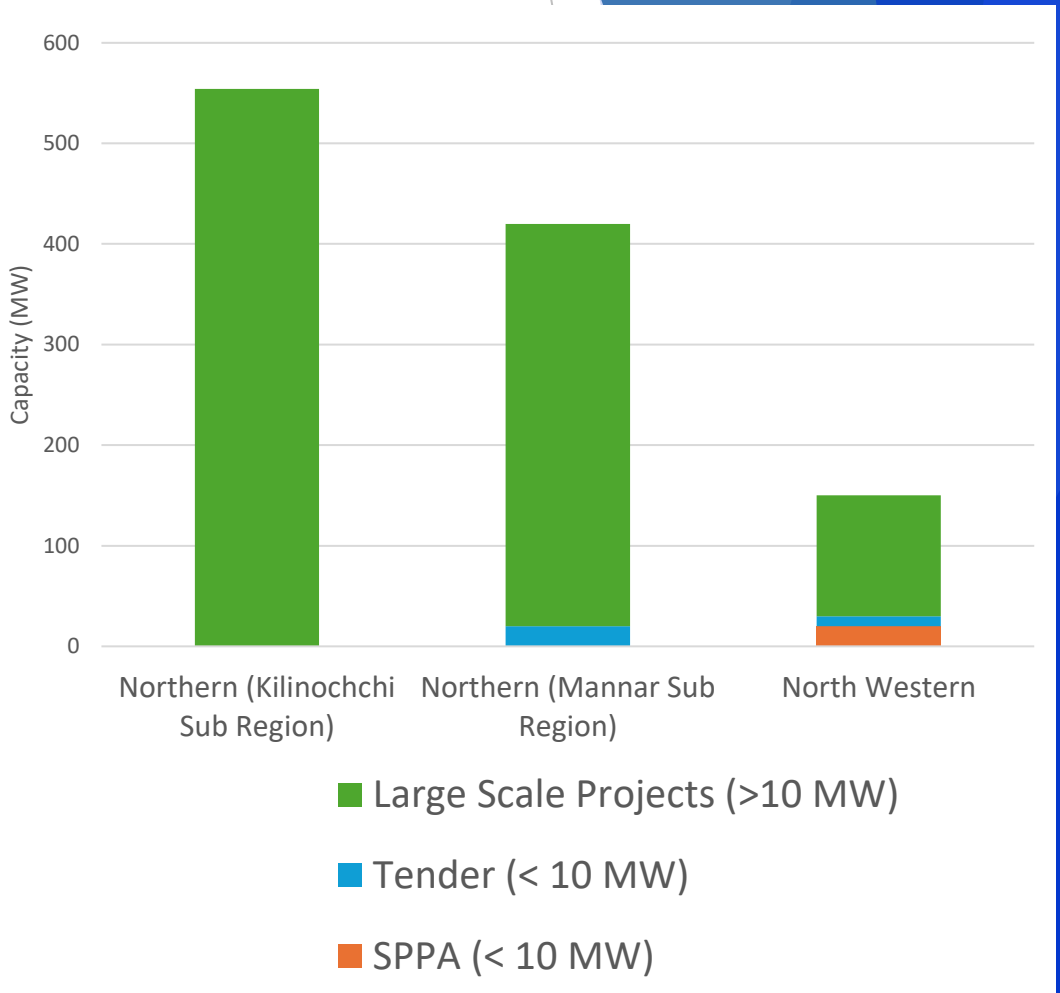
Committed/Identified Grid Scale Solar Projects Considers for Plan

Zone	Project Name/ Project Category	Capacity/ Cumulative Capacity (MW)	Expected year
Northern (Kilinochchi Sub Region)	SPPA (< 10 MW)	12	2025-2026
	Tender (< 10 MW)	-	2025-2026
	Kilinochchi I	50	2029
	Kilinochchi II	100	2031
Northeastern	SPPA (< 10 MW)	20	2025-2026
	Tender (< 10 MW)	30	2025-2026
	Sampur Phase I	50	2028
	Sampur Phase II	70	2029/2030
	Trincomalee I	100	2029/2030
	Trincomalee II	100	2029/2030
Eastern	SPPA (< 10 MW)	50	2025-2026
	Tender (< 10 MW)	50	2025-2026
	Valaichenai	100	2027/2028
Southern	SPPA (< 10 MW)	260	2025-2026
	Tender (< 10 MW)	79	2025-2026
	Siyambalanduwa	100	2026
	Ridiyagama solar (Floating/Ground)	100	2029
Other Areas (Scattered)	SPPA (< 10 MW)	60	2025-2027
	Tender (< 10 MW)	240	2025-2028
Total		1,571	

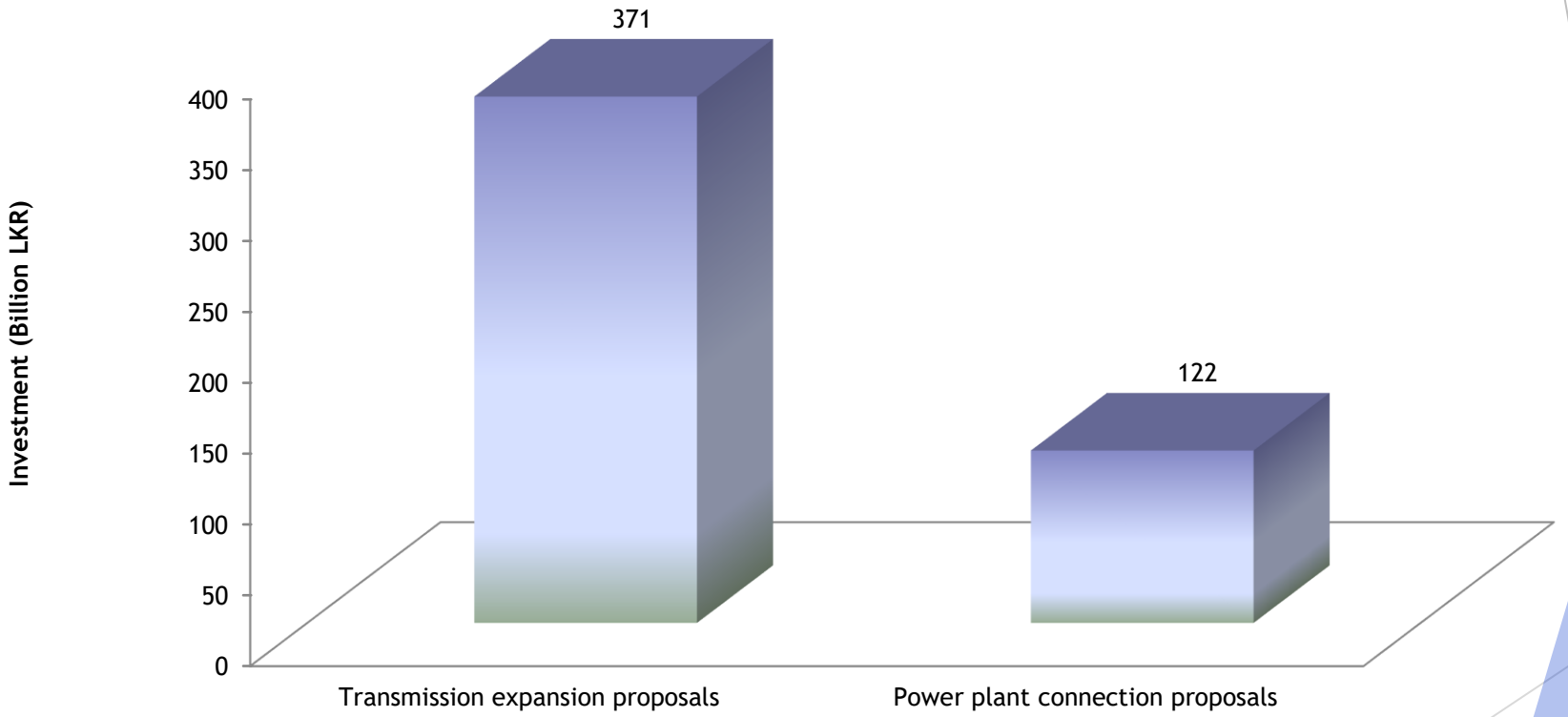


Committed/Identified Grid Scale Wind Projects

Zone	Project Name/ Project Category	Capacity/ Cumulative Capacity (MW)	Expected year
Northern (Kilinochchi Sub Region)	SPPA (< 10 MW)	-	2025-2026
	Tender (< 10 MW)	-	2025-2026
	Pooneryn	234	2030
	Veravil	200	2031
	Karachchi	120	2032
Northern (Mannar Sub Region)	SPPA (< 10 MW)	-	2025-2026
	Tender (< 10 MW)	20	2025-2026
	Mannar Extension	50	2026
	Mannar Phase II	250	2027
	Mullikulam	100	2028
Northwestern	SPPA (< 10 MW)	20	2025-2026
	Tender (< 10 MW)	10	2025-2026
	Kalpitiya	120	2028
Total		1,124	



Total Estimated Investment 2025 -2034 Proposals



Thank you