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100 Percent Renewable Electricity in Sri Lanka by 2050

A UNDP/ADB study

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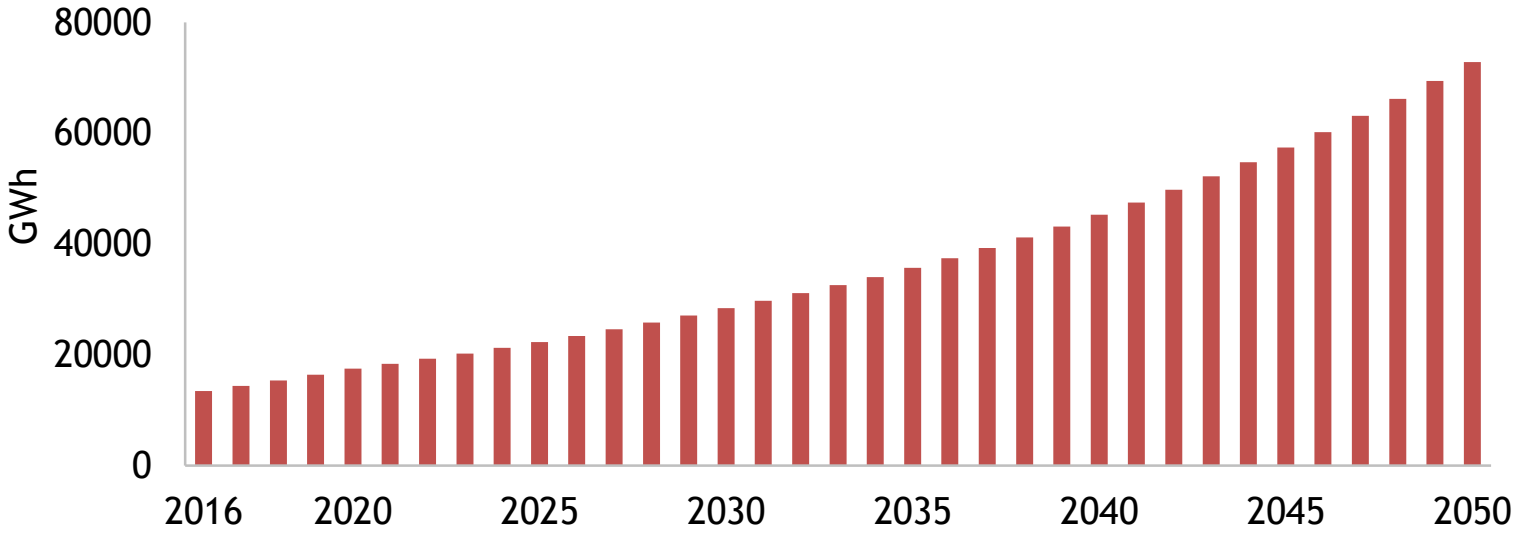
Dr. Milou Beerepoot, Regional Technical Advisor, UNDP

Outline

- Background to the study
- A scenario for 100% RE in Sri Lanka by 2050
  - Assumptions/conditions
  - Projections
  - Balancing and storage requirements
  - Fuel cost savings and investment needs
- De-risking to lower costs of finance
- Conclusions

Background to this study

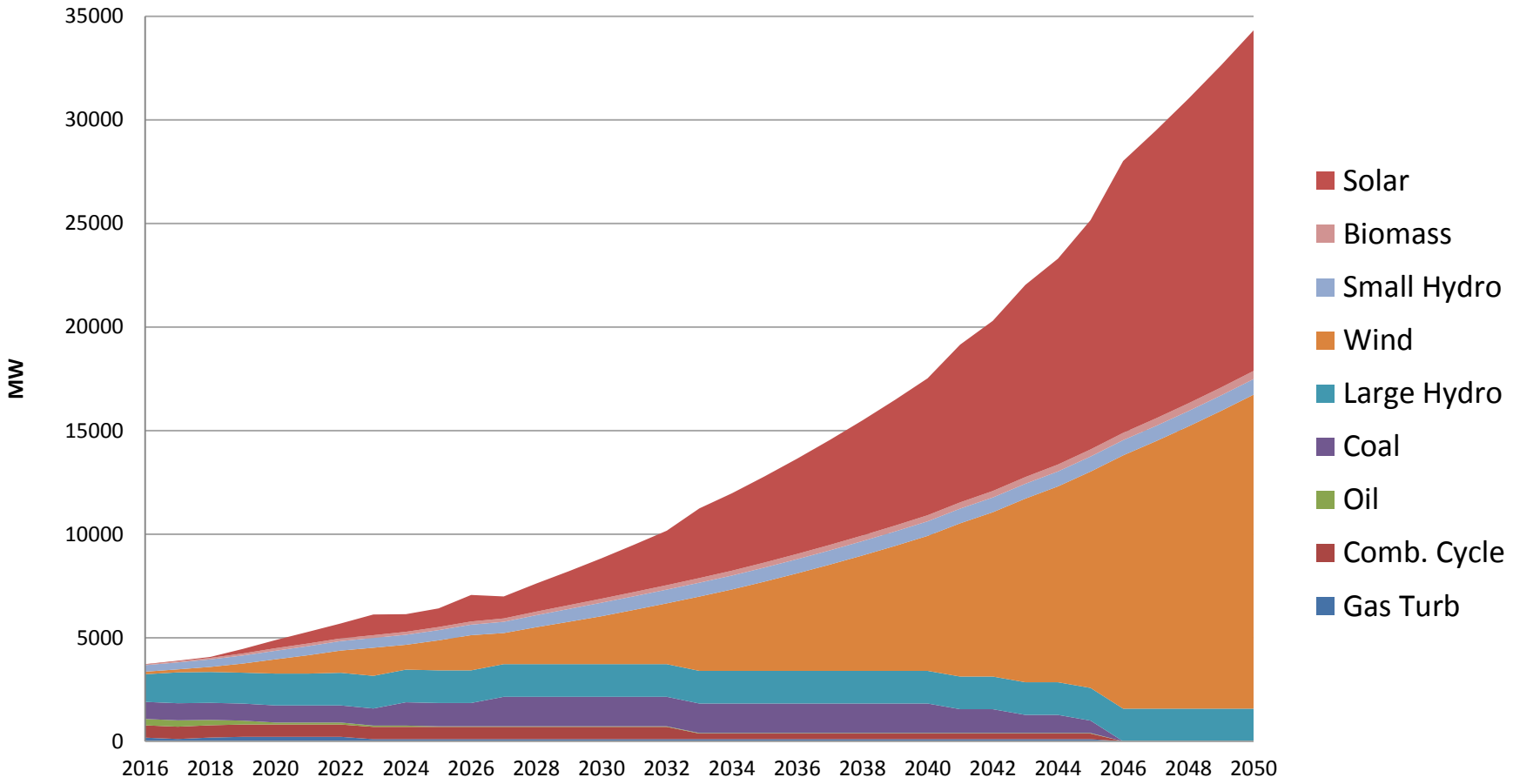


- By 2050, Sri Lanka's electricity demand is likely to **increase five folds** to ~70,000 GWh (from ~14,000 GWh in 2016)
- As part of Sri Lanka Nationally Determined Contributions (NDC) submitted to UNFCCC: **50% RE by 2030**
- As part of Sri Lanka's participation in Climate Vulnerable Forum: **100% RE by 2050**

A 100% RE by 2050 scenario; assumptions

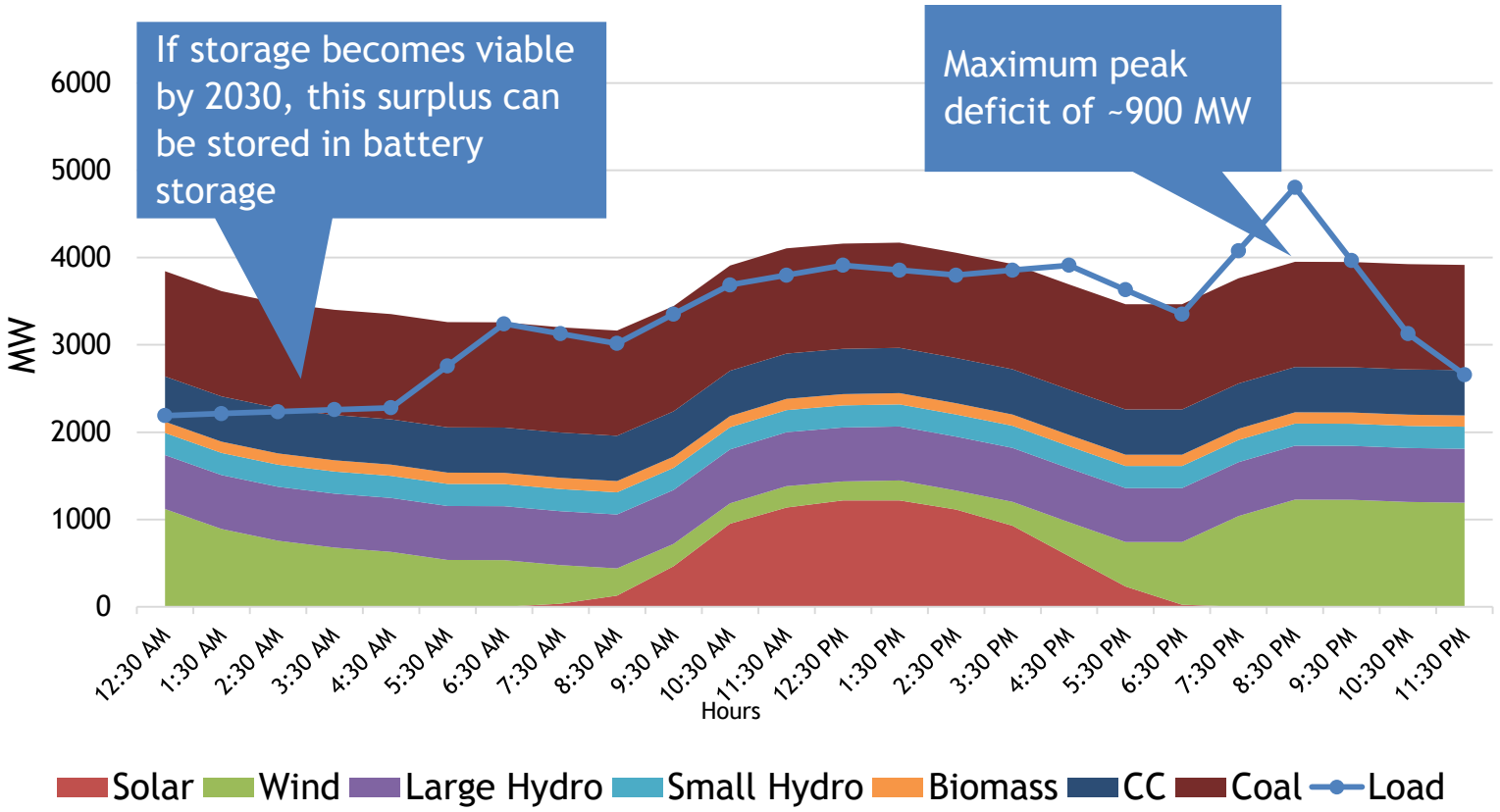
- No energy efficiency, demand side management or load shifting
- Cap on solar of 30% by 2050
- Cap on wind of 50% by 2050
- Two sub-critical coal units (300 MW) added in 2024 and 2027 as planned
- No coal plant commissioned in Tricomalee (1100 MW)

Sri Lanka 100% RE 2050: a scenario



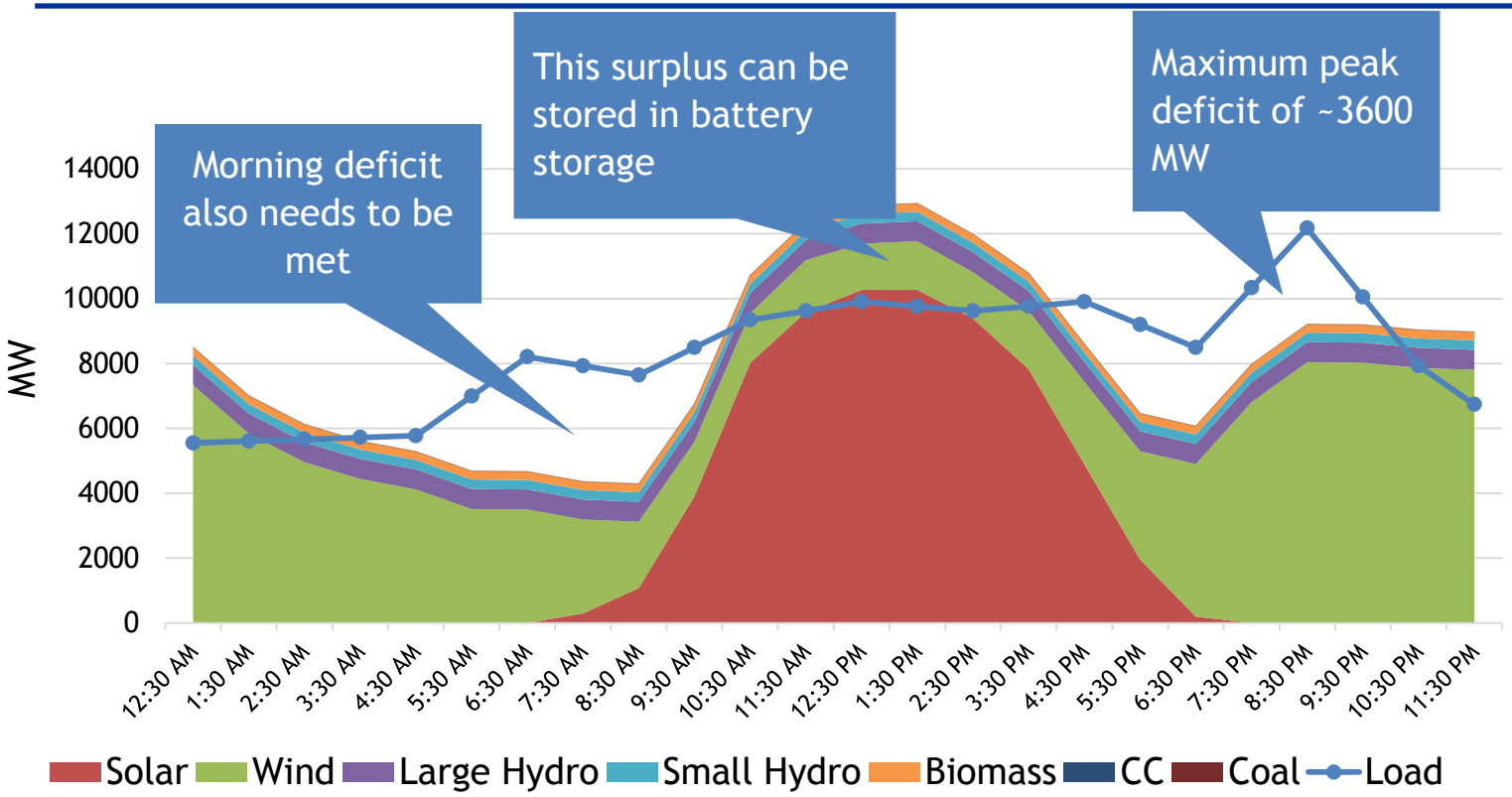
- Solar and wind will dominate the power generation in 2050
- Coal will first increase (2024 & 2027) but phase out after 2040

2030 - Typical daily demand-supply scenario



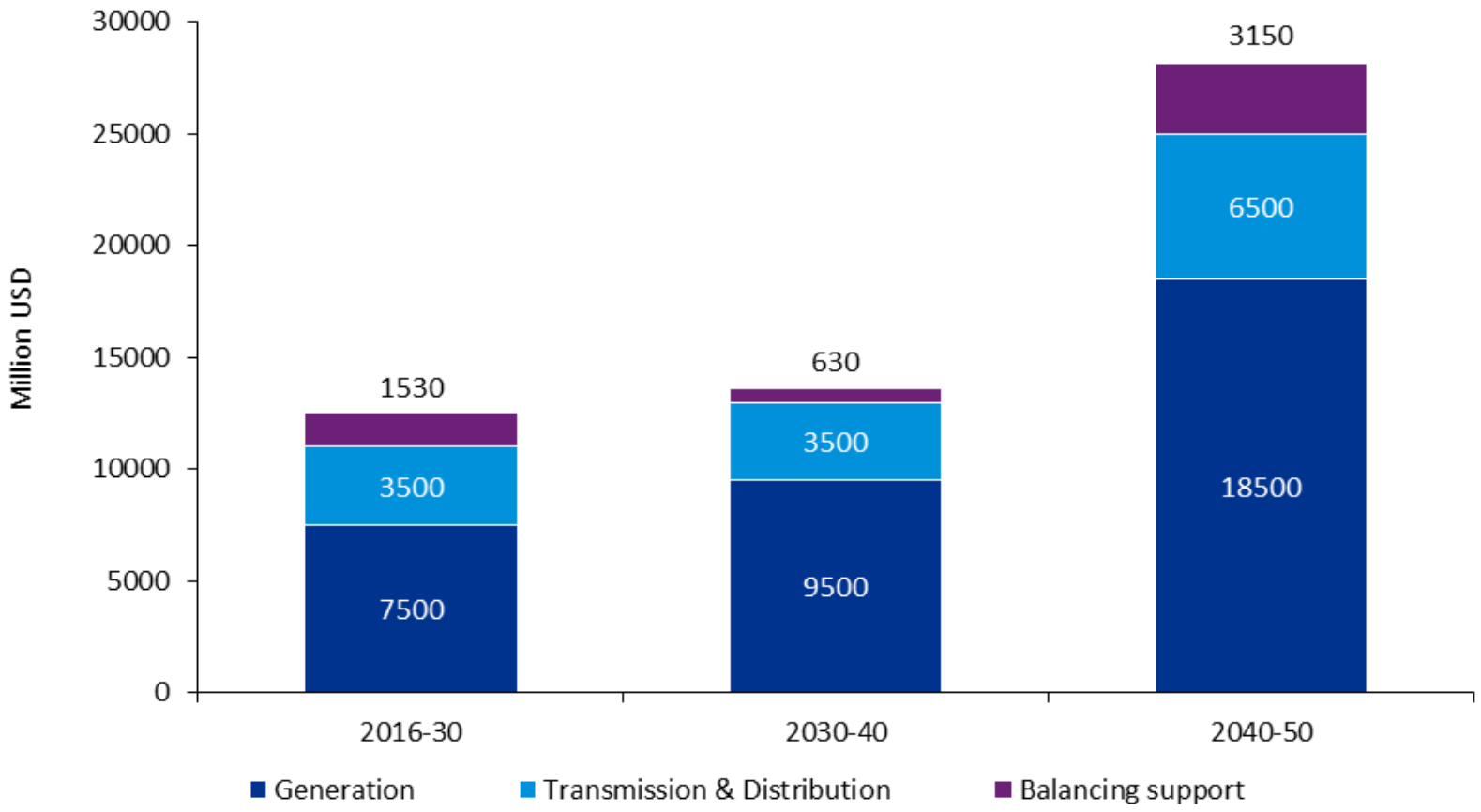
- By 2030, Sri Lanka will need to increase its storage capacity to meet a peak demand deficit of 900 MW
- By 2030, the cost of battery storage is expected to drop significantly, which may trigger a shift in focus to battery storage

2050 - Typical daily demand-supply scenario



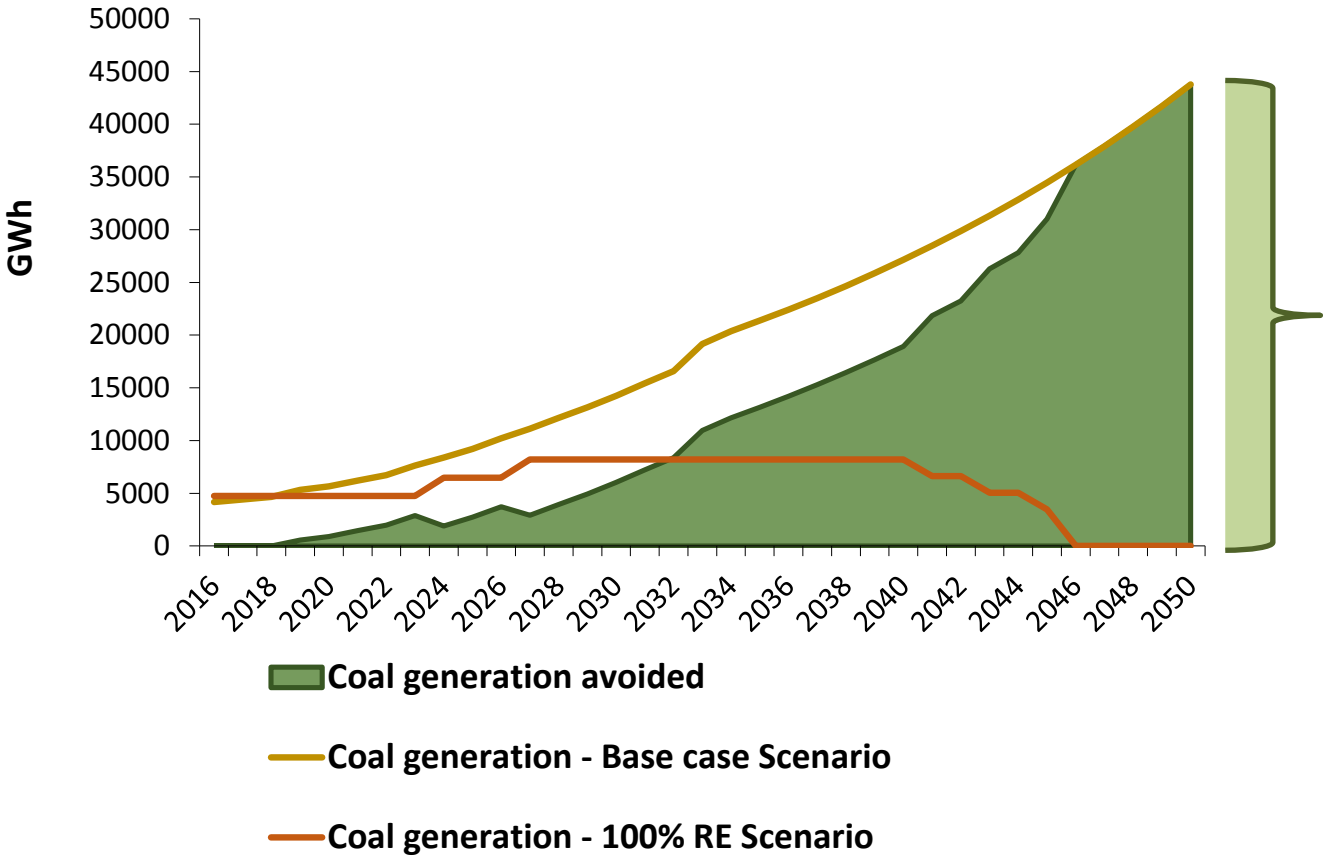
- By 2050, the supply curve will further skew to the middle, storage will become an imperative necessity
- The total storage requirement is expected to be ~15,000 MWh

Investment Need for 100% RE by 2050



- Total costs, not additional costs compared to a baseline scenario (baseline includes increased electricity demand and Trans.&Distr.)
- Highest costs in last decade: cost prediction long term faced with high level of uncertainty

Fuel cost savings



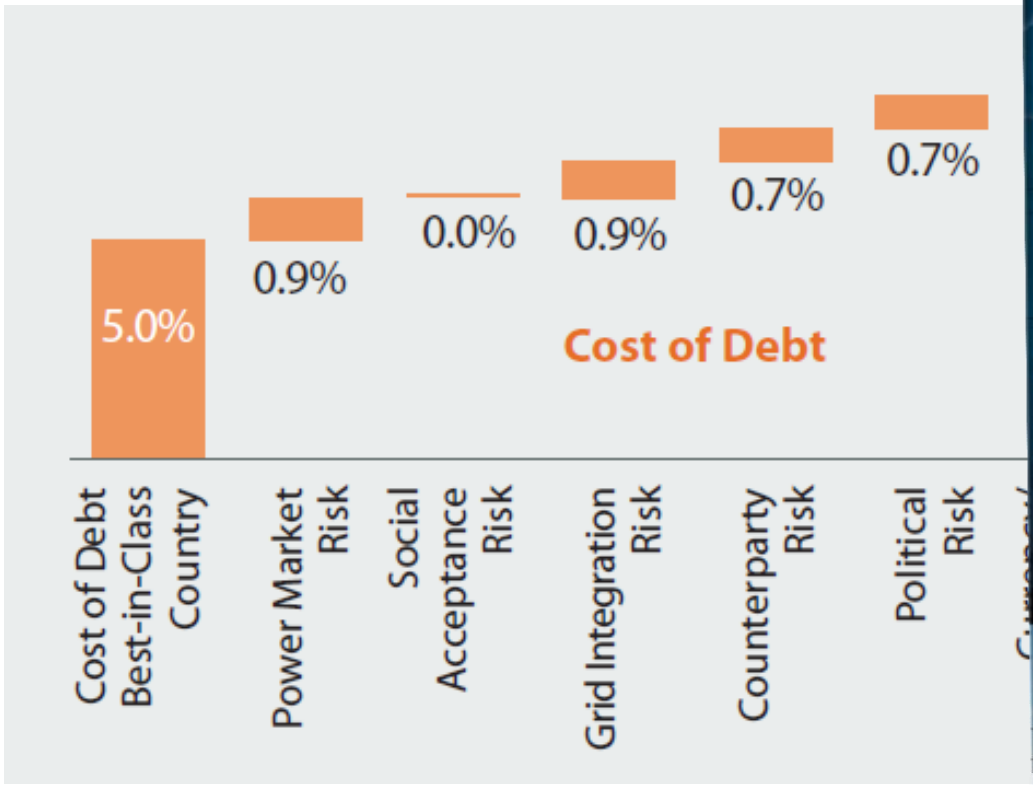
Cumulative fuel cost avoided 2050:

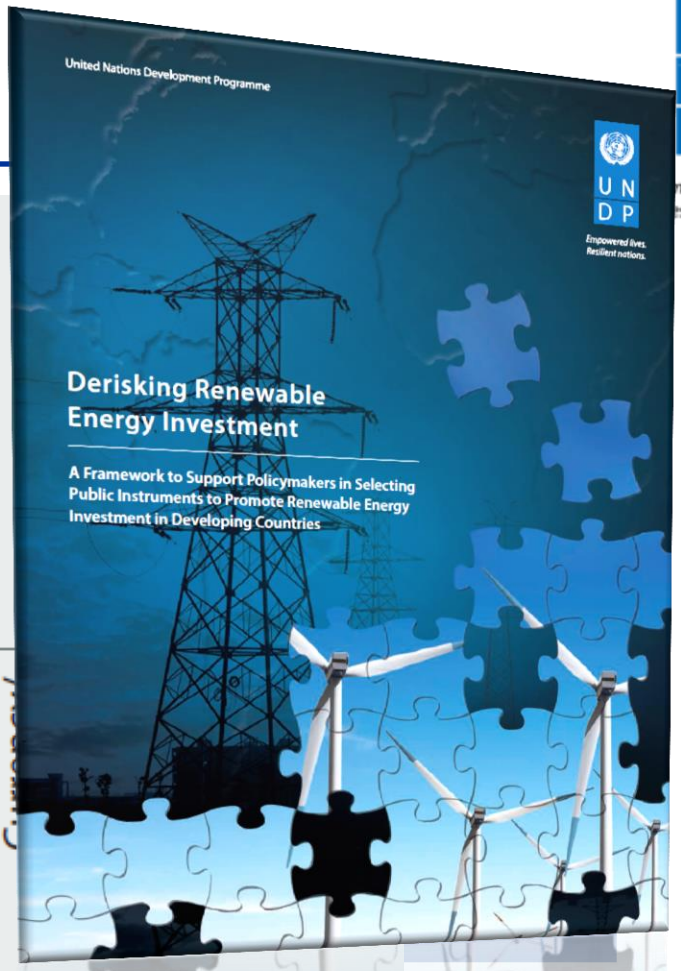
18,500 Million USD*

** Coal price assumed constant, no carbon tax*

- Comparing a scenario of continuous coal based power generation with the 100% RE scenario leads to cumulative fuel cost savings of 18,500 Million USD by 2050, which can cover substantial part of RE investment need

Quantification of risks





- Several risks for institutional investors are adding up to costs of finance
- “De-risking” interventions can reduce risks and lower costs of finance

UNDP's de-risking approach

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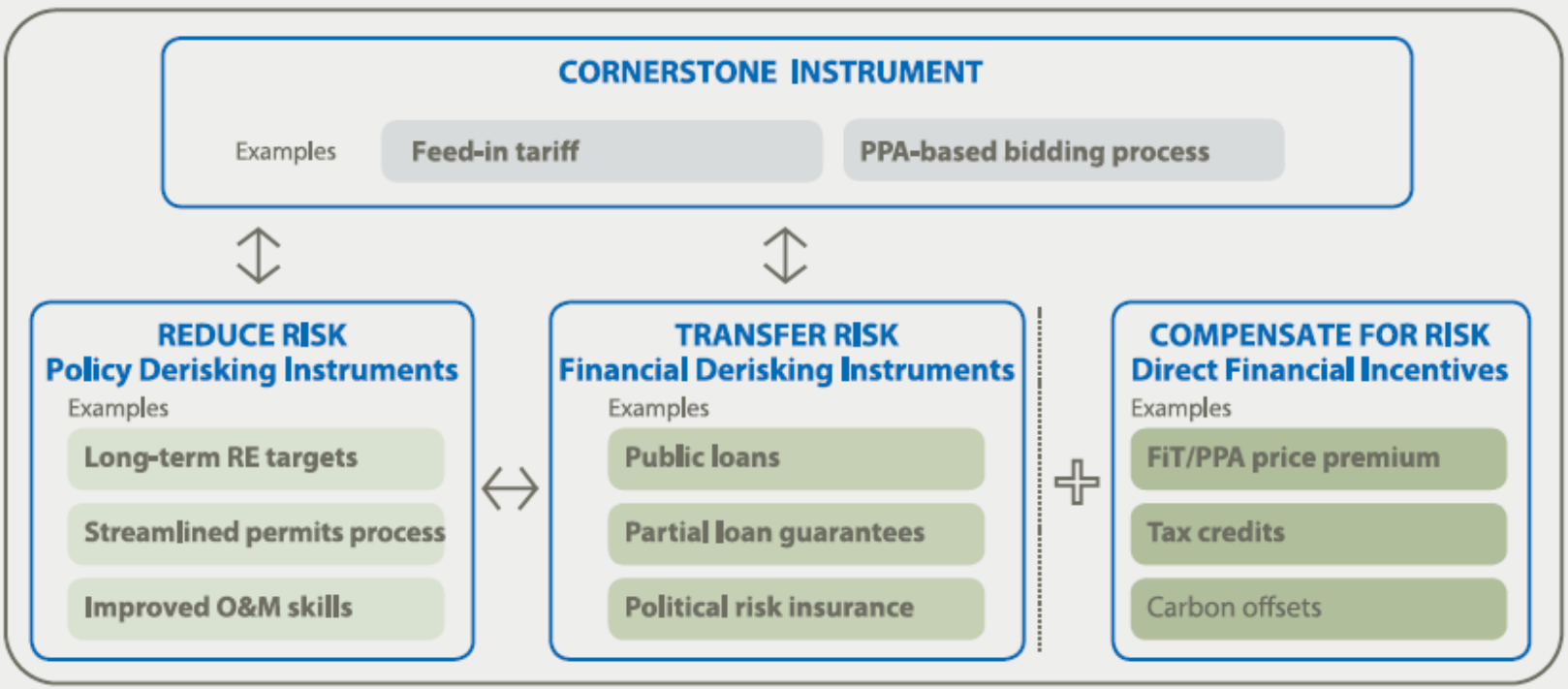
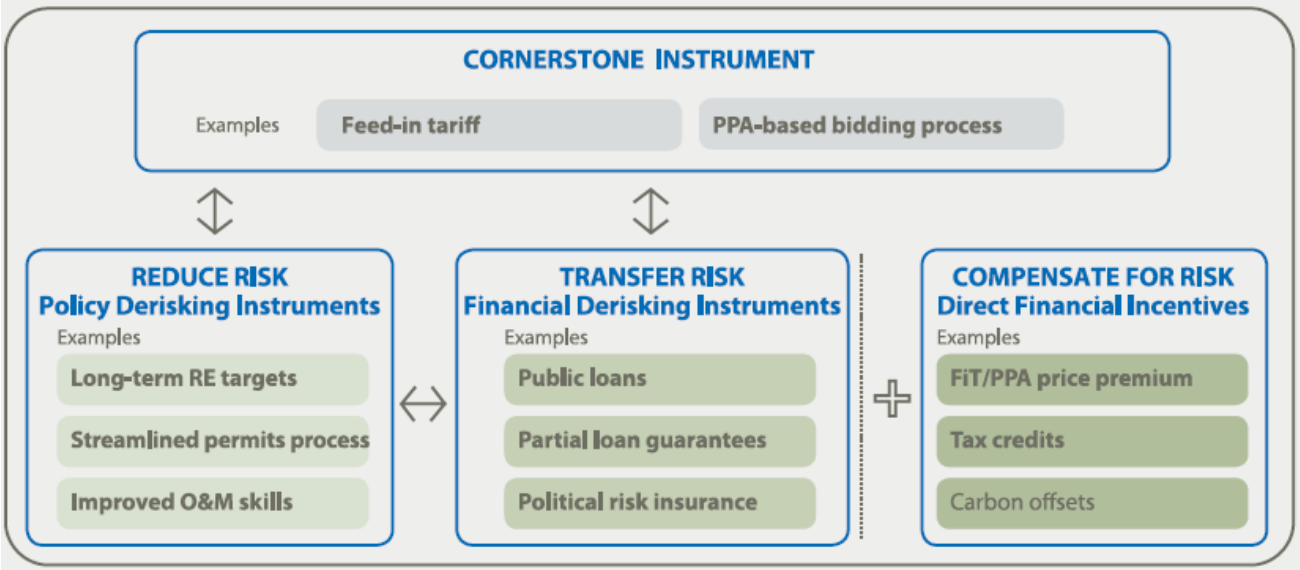


- De-risking: (public) instrument packages that
  - reduce risk,
  - transfer risk or
  - compensate for risk

Cheapest approach

Costly approach

UNDP's de-risking approach



- De-risking in Sri Lanka can consist of:
  - adjusting business model of CEB (remove cross-subsidies)/ power market reform
  - introduce a stable and RE focused policy regime
  - a simpler and comprehensive framework for land acquisition
  - payment security systems to mitigate off-taker risk of PPA's
  - (governmental) currency hedging facility
  - infrastructure debt funds
  - partial credit guarantee for IPPs

Conclusion

- Sri Lanka's commitment to **100% RE** in 2050 is **commendable and possible**
- **Cost reductions** of **solar** energy as well as **storage** solutions will add to feasibility of 100% RE in 2050
- Additional **efforts in energy efficiency** and demand side management will further enhance **feasibility of 100% RE**
- Costs of investments will need further study, de-risking approaches can reduce costs of finance
- De-risking approaches can consist of:
  - ***policy de-risking*** (cheapest approach), e.g. adjusting CEB's business model, power market reform, stable RE policy regime and facilitated land acquisition
  - ***financial de-risking***, e.g. payment security systems, (governmental) currency hedging facility, infrastructure debt funds, partial credit guarantee for IPPs

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Thank you!

Email: milou.beerepoot@undp.org

The 2050, 100 percent Renewable Energy Electricity Generation Scenario

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Demand

2016-34: Demand has been kept the same as estimated by the CEB and reported in "Long Term Generation Expansion Plan 2015-34 (LTGEP)".

2035-50: Electricity demand for 2035-50 is estimated at a CAGR of **4.8 percent**, extrapolated from the 2020-34 CAGR present in the LTGEP.

Plant Load Factor (on average)

Generation Source	PLF (%)	Sources
Gas Turbine	20	SL's performance in 2015.
Oil Based		
Combine Cycle	50	Assumed.
Coal	60	SL's performance in 2014 and 2015.
Large Hydro	40	Historical values of SL.
Small Hydro	39	
Wind	30	Standard off-shore wind PLF.
Biomass	70	CEB assumption.
Solar	17	Standard solar PLF.

Fossil fuel capacity addition

Two sub-critical coal units of 300 MW capacity slated going to be commissioned in 2024 and 2027 respectively (as per the LTGEP) have been retained to be used as base load instead of RE during the initial years of the strategy.

As the strategy proceeds and more RE gets added contribution from these coal units decrease.

The 2050, 100 percent Renewable Energy Electricity Generation Scenario

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Mix of Solar and Wind

Solar: 30% of total demand

Wind: 50% of total demand

Given the relative immaturity of the solar industry in Sri Lanka, a very high concentration of solar energy is likely to pose balancing issues for the grid and until storage facilities have evolved to become commercially viable in Sri Lanka, demand that cannot be met by solar will be primarily catered to through wind.

Other energy sources

Capacity addition of large hydro, small hydro and biomass has been continued as per the capacity additions provided in the long-term generation plan.

Economic savings from fuel cost avoidance

Imported fuel cost: 1550 US cents /GCal

Coal plant Station Heat Rate (SHR): 2400 kCal/kWh

Demand Management and Balancing Requirements

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Load Profile

Sri Lanka's future load curve profile has been assumed to remain the same as in 2015.

Availability Factors for various sources of electricity

Solar and Wind: The most conservative supply profile in the southern states of India has been considered

Hydro: Minimum availability of 40 percent throughout the day has been assumed

Coal and Combine Cycle Plants: Availability factor of 90 percent has been assumed

Profiles for Wind, Solar and Hydro are assumed based on closest available information due to data paucity in Sri Lanka and actual generation may be different from what has been assumed depending on seasonal variability

Auxiliary Power Consumption (APC) Percentages

APC figures are as per industry standard

Investment Requirements

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Capital Costs

Solar: Fraunhofer ISE- Current and future cost of photovoltaics by Agora Energiewende

Wind: India benchmark, IEA Wind Road map

Others: Industry interactions, India benchmark

Year	Capital cost (USD/kW)							
	Solar (Euro/kW)	Solar	Wind	Coal	CC/Gas	Large Hydro	Small Hydro	Biomass
2016	900	1000	1500	1300	1200	1700	2000	1600
2017	900	1000	1500	1300	1200	1700	2000	1600
2018	862	957	1500	1300	1200	1700	2000	1600
2019	823	914	1500	1300	1200	1700	2000	1600
2020	823	914	1500	1300	1200	1700	2000	1600
2021	823	914	1500	1300	1200	1700	2000	1600
2022	823	914	1500	1300	1200	1700	2000	1600
2023	774	859	1500	1300	1200	1700	2000	1600
2024	724	804	1500	1300	1200	1700	2000	1600
2025	724	804	1500	1300	1200	1700	2000	1600
2026	724	804	1500	1300	1200	1700	2000	1600
2027	724	804	1500	1300	1200	1700	2000	1600
2028	688	764	1500	1300	1200	1700	2000	1600
2029	651	723	1500	1300	1200	1700	2000	1600
2030	651	723	1500	1300	1200	1700	2000	1600
2031	651	723	1500	1400	1300	1700	2000	1600
2032	651	723	1500	1400	1300	1700	2000	1600
2033	617	686	1500	1400	1300	1700	2000	1600
2034	583	648	1500	1400	1300	1700	2000	1600
2035	583	648	1500	1400	1300	1700	2000	1600
2036	583	648	1500	1400	1300	1700	2000	1600
2037	583	648	1500	1400	1300	1700	2000	1600
2038	555	616	1500	1400	1300	1700	2000	1600
2039	526	584	1500	1400	1300	1700	2000	1600
2040	526	584	1500	1400	1300	1700	2000	1600
2041	526	584	1500	1400	1300	1700	2000	1600
2042	526	584	1500	1400	1300	1700	2000	1600
2043	503	558	1500	1400	1300	1700	2000	1600
2044	479	532	1500	1400	1300	1700	2000	1600
2045	479	532	1500	1400	1300	1700	2000	1600
2046	479	532	1500	1400	1300	1700	2000	1600
2047	479	532	1500	1400	1300	1700	2000	1600
2048	458	508	1500	1400	1300	1700	2000	1600
2049	436	484	1500	1400	1300	1700	2000	1600
2050	436	484	1500	1400	1300	1700	2000	1600

Investment Requirements

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Transmission Costs

In Sri Lanka, the average incremental cost estimated for transmission infrastructure development is LKR190,000/kW.

Battery Storage Costs

Year	Investment cost (USD/kWh)
2030	140
2040	105
2050	105

U.S. Department of Energy, EV Everywhere Grand Challenge Blueprint.

Available from: https://energy.gov/eere/electricvehicles/about-electric-vehicles.

Pump Storage Costs

Year	Investment cost (USD/kW)
2030	1700
2040	1700
2050	1700