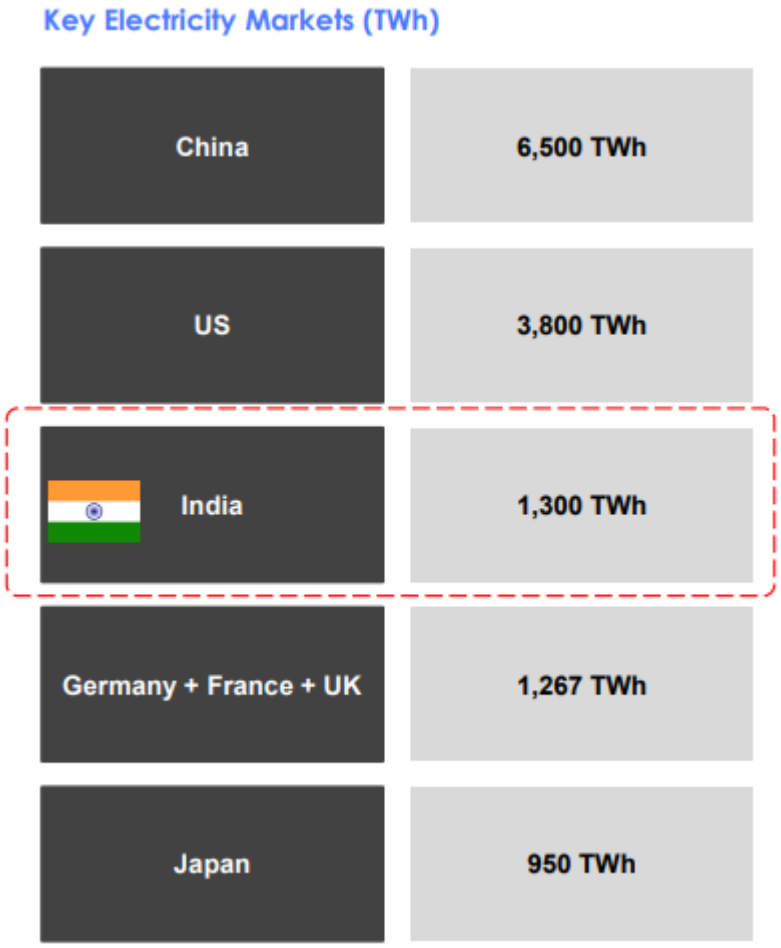
Optimization of Levelized Cost of Green Energy

Speaker: *Srinivas Jampani*

SVP, Strategy, Greenko

Introduction

- Wholistic approach for least-cost, sustainable, reliable "Dispatchable" Green Energy
- Key factors:
  - Indian electricity market design
  - Supply and Demand Stack
  - Supply Chain
  - Paris Agreement / Environmental Goals
  - Technology / Digital solutions
- Levelized cost of Energy (LCOE):
  - Capital costs and time-to-market
  - O&M efficiency
  - Optimized production
  - New innovative Energy Services

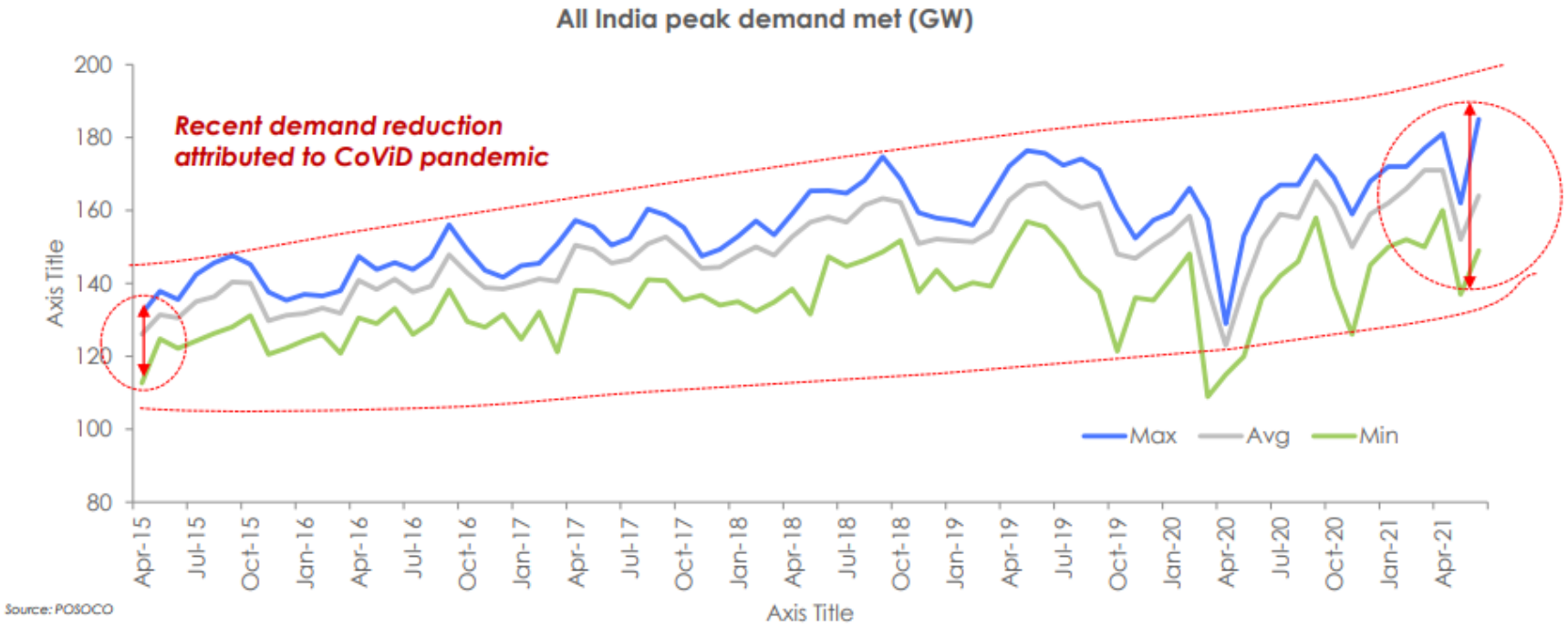


Source: IEA

Key Trends in India

Trend (India)	Power demand	Demand variability
Urbanization: Urban population to double by c2030 (source: World Bank)	✓	✓
Air-conditioning electricity demand: projected to reach ~3X by 2030 (source: BNEF, intra-polated)	✓	✓
Share of Renewables in energy mix: installed capacity to increase to 500 GW by 2030	✓	✓
Climate Change: Avg temp could increase by 4 °C by end of 2nd Millennium (source: World Bank)	✓	✓
Electrification: >50% of primary energy growth by 2030 to be electricity (source: BP Energy Outlook)	✓	✓

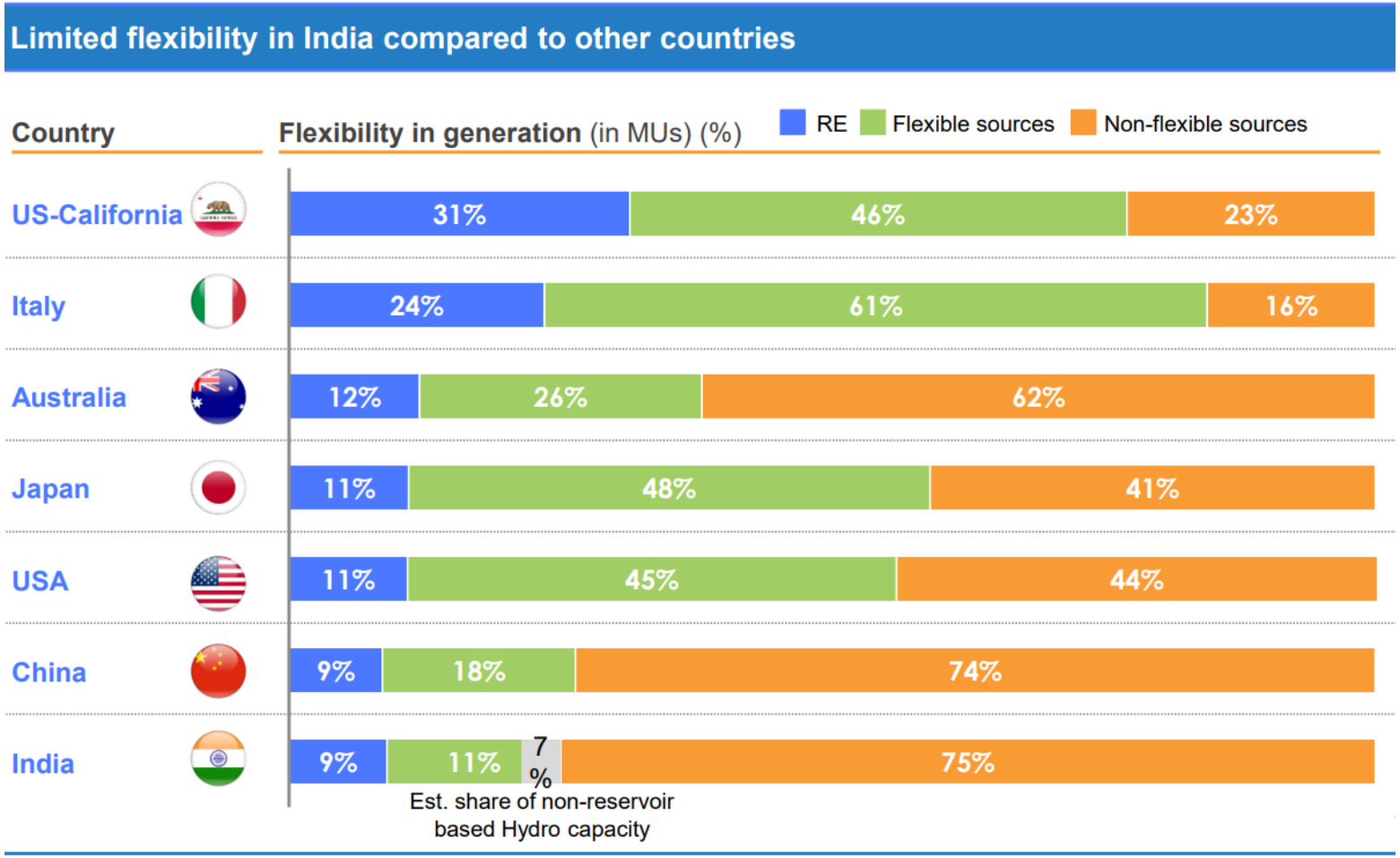
Evolving Demand



- Over the past 5 years (Apr'15 onwards)
  - Max. Demand over the period has increased by **~50 GW with a CAGR of 6%**
  - Avg. yearly Min-Max demand gap has increased by **~17 GW with a CAGR of 14%**
- The gap between maximum and minimum demand witnessed on grid has been increasing consistently making it difficult to operate the grid with just base load power plants

India has limited flexible generation compared to other countries

- India has least flexible capacity and energy storage capacity compared to other major countries despite of one of the most ambitious RE goals
- USA relies on 320GW of combined cycle gas turbines (CCGT) for flexibility powered by cheap, local natural gas supplies
- EU will have over 250GW of CCGTs fuelled by supply partners in US and Russia
- Storage requirements:
  - USA: 60 GW
  - EU: 95 GW
  - China: 130 GW
- India, due to lack of gas infrastructure, will need flexibility from higher storage capacity relative to demand



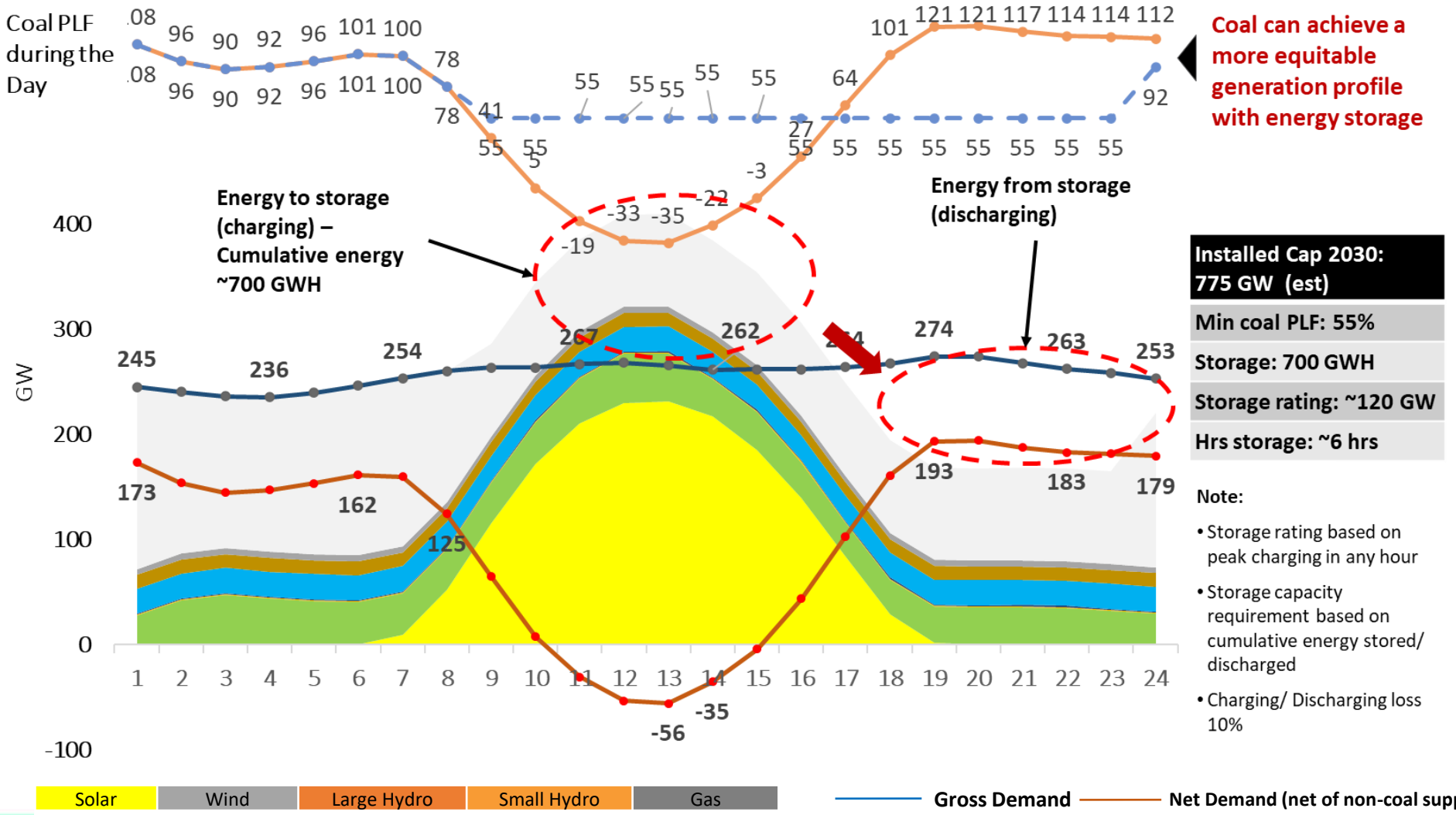
Cost savings from Renewables + Energy Storage

- Storage will be key enabler of RE integration and achieving COP26 goals in least-cost manner
- Storage obviates the need for building thermal capacity to meet morning and evening peak loads, aiding in decarbonizing India's footprint
  - Without storage, India would need a net coal addition of 60 GW by 2030
  - Over 100 GW of coal capacity will operate at PLF of 15%-40% and risk being stranded
  - Coal at 40% PLF costs Rs. 6/kWh, and at 15% PLF rises to Rs. 10/kWh
- Studies suggest RE + Storage systems will reduce average costs by ~8-10% by 2030 against backdrop of strong demand growth

Property	Technology	Actual (2020)	Primary Least Cost (2030)	Low-RE Cost (2030)
Installed Capacity (GW)	Coal	206	229	206
	Natural gas	25	25	25
	Nuclear	7	19	19
	Hydropower	43	62	62
	Wind	38	142	147
	Solar	35	307	385
	Other RE	15	15	15
	Storage	0	63	84
	Total	**369**	**862**	**943**
Average Cost of Generation (Rs/kWh)		**3.90***	**3.59**	**3.50**
Power-Sector CO_2 Emissions (MT/yr)		**1,008**	**1,080**	**981**
Emissions Intensity(kg CO_2/kWh)		**0.82**	**0.47**	**0.41**

CEA 2030 Least Cost Pathway Study: Installed capacity, cost of generation and emissions

Storage enables mitigation of coal operational constraints



Installed Cap 2030: 775 GW (est)
Min coal PLF: 55%
Storage: 700 GWH
Storage rating: ~120 GW
Hrs storage: ~6 hrs

Note:

- Storage rating based on peak charging in any hour
- Storage capacity requirement based on cumulative energy stored/ discharged
- Charging/ Discharging loss 10%

Rethink Indian Energy Markets

Illustrative and not exhaustive

Energy Markets in India

Wholesale energy markets	Capacity Markets	Energy Storage Markets	Ancillary services
Dominated by legacy long term PPAs. *However, the* ***market is and will need to move to bespoke solutions*** *including peak supply, flexible supply, shorter term PPAs, etc.*	***Long Term PPAs*** *with capacity commitment are* ***comparable****; however, the* ***commercial regime*** *(tenure, exit, tariff, etc.) is* ***archaic and will need to incentivize relevant capacity addition*** *(e.g. flexible supply sources)*	***Currently non-existent but making strides;*** *Future includes solutions for peak management, energy shifting, RE integration, and multiple others*	***Ancillary services will have to be expanded*** *beyond existing RRAS services to include innovative products like* ***ramping, fast frequency response, etc.***

Load planning ⟷ Load balancing

Integrated planning, forecasting and Intelligent Renewables + Storage Platform

- Systematic, scientific, data-driven approaches to procuring and selling power on day-to-day basis
  - AI-ML and Econometric based forecasting
  - Least-cost optimization systems
  - Integration with real-time decision support systems
  - Risk management framework
  - Flexible long-term and short-term contract structures

Concluding Remarks

- Dramatic cost reductions and efficiency gains across solar, wind and storage
- Storage will enable India to transition from Low to High Decarbonization scenarios across sectors
- Leverage intelligent software and data analytics to supply 24/7 clean firm energy
- Foster development of new energy products and services on both exchanges and bilateral platforms

Thank You

For discussions/suggestions/queries email: www.indiasmartgrid.org
www.isgw.in
srinivas.j@greenkogroup.com

India Smart Grid Forum
CBIP Building, Malcha Marg,
Chanakyapuri,
Delhi-110021
Website: www.indiasmartgrid.org