

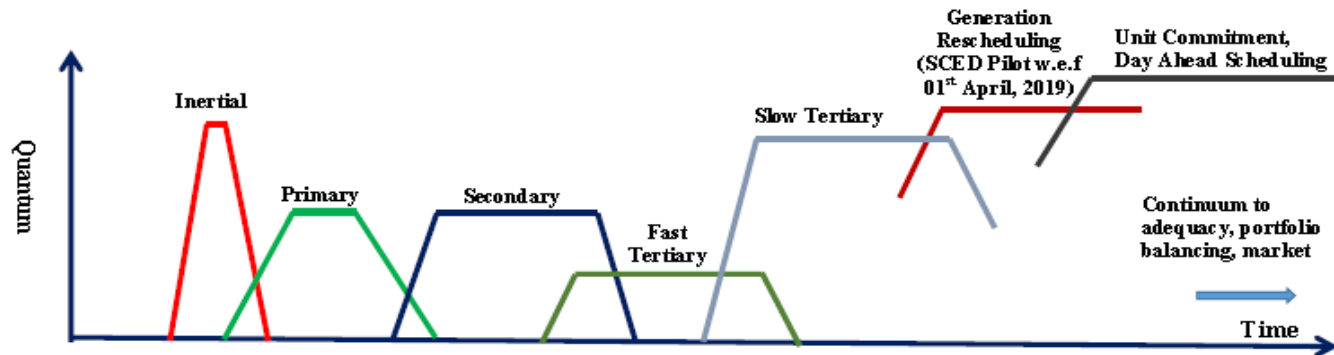
Hydro flexibility in Indian Power System



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Frequency Control and Reserves



Testing of Primary Response awarded and under implementation

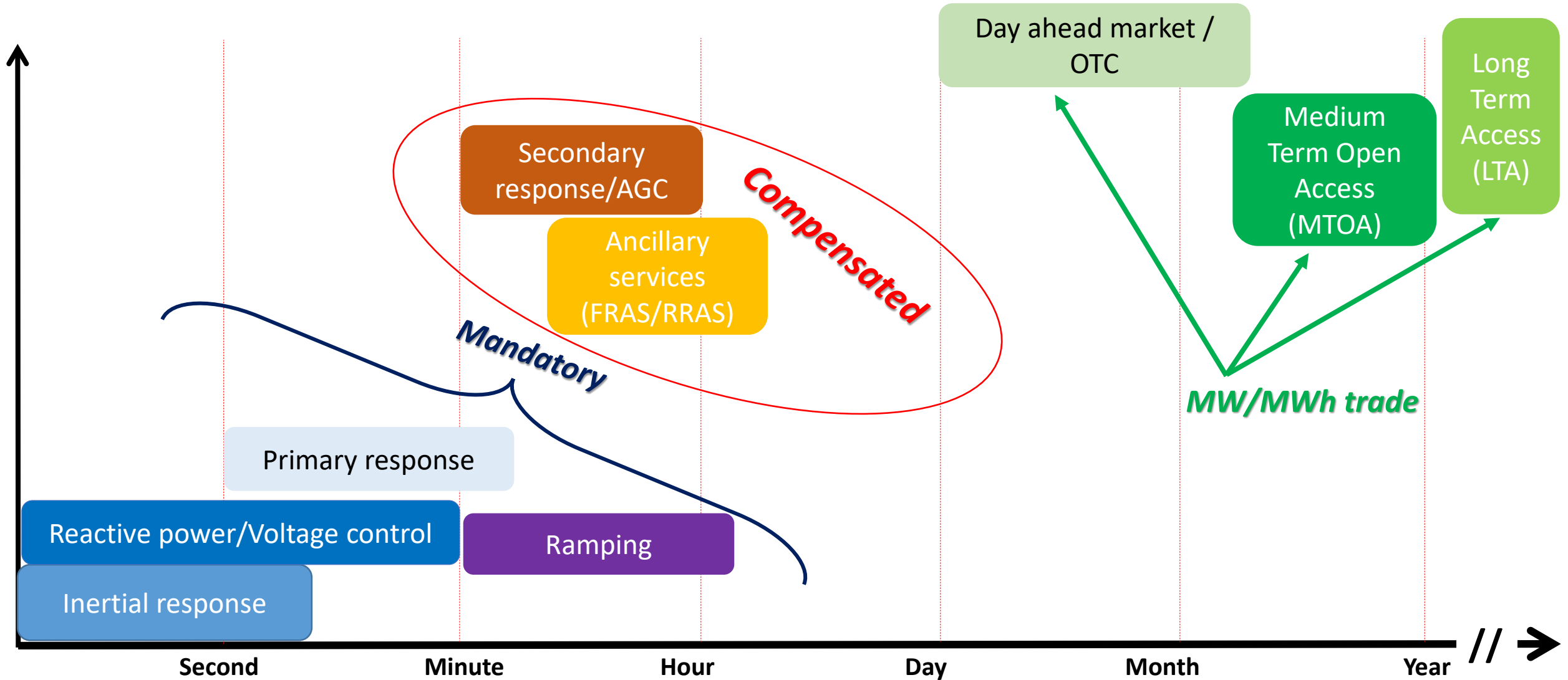
5 pilot projects for Secondary Control through AGC completed; pan-India implementation of ~ 80 GW by FY21

Fast Tertiary - Six month Pilot on Fast Response Ancillary Services for 20 hydro plants with 9 GW capacity completed

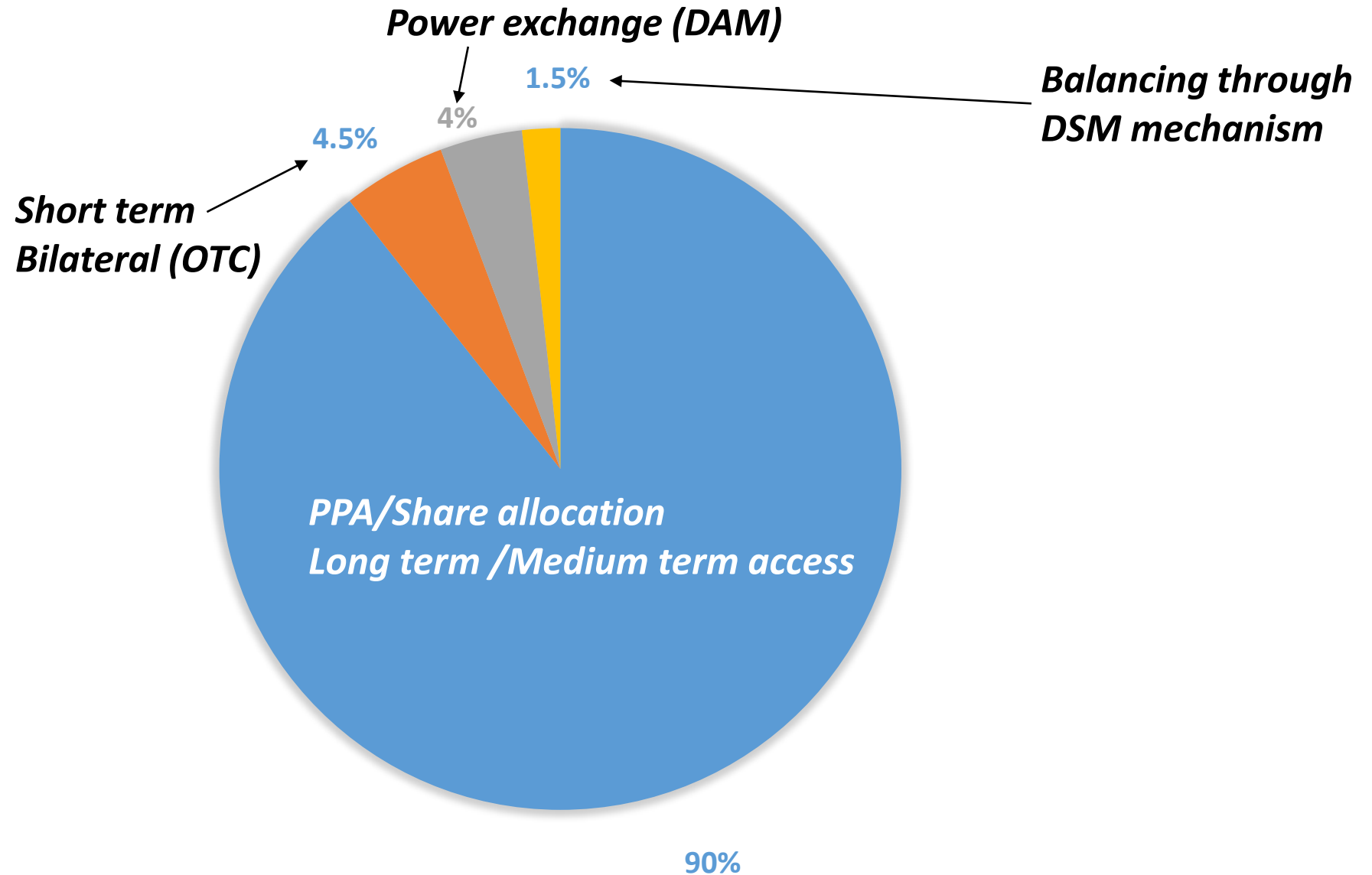
Slow Tertiary - Reserve Regulation Ancillary Services for 62 GW Thermal plants operational since April, 2016

Real-Time Market for Electricity - Amendments to "Grid Code", "Power Market", and "Open Access" Regulations

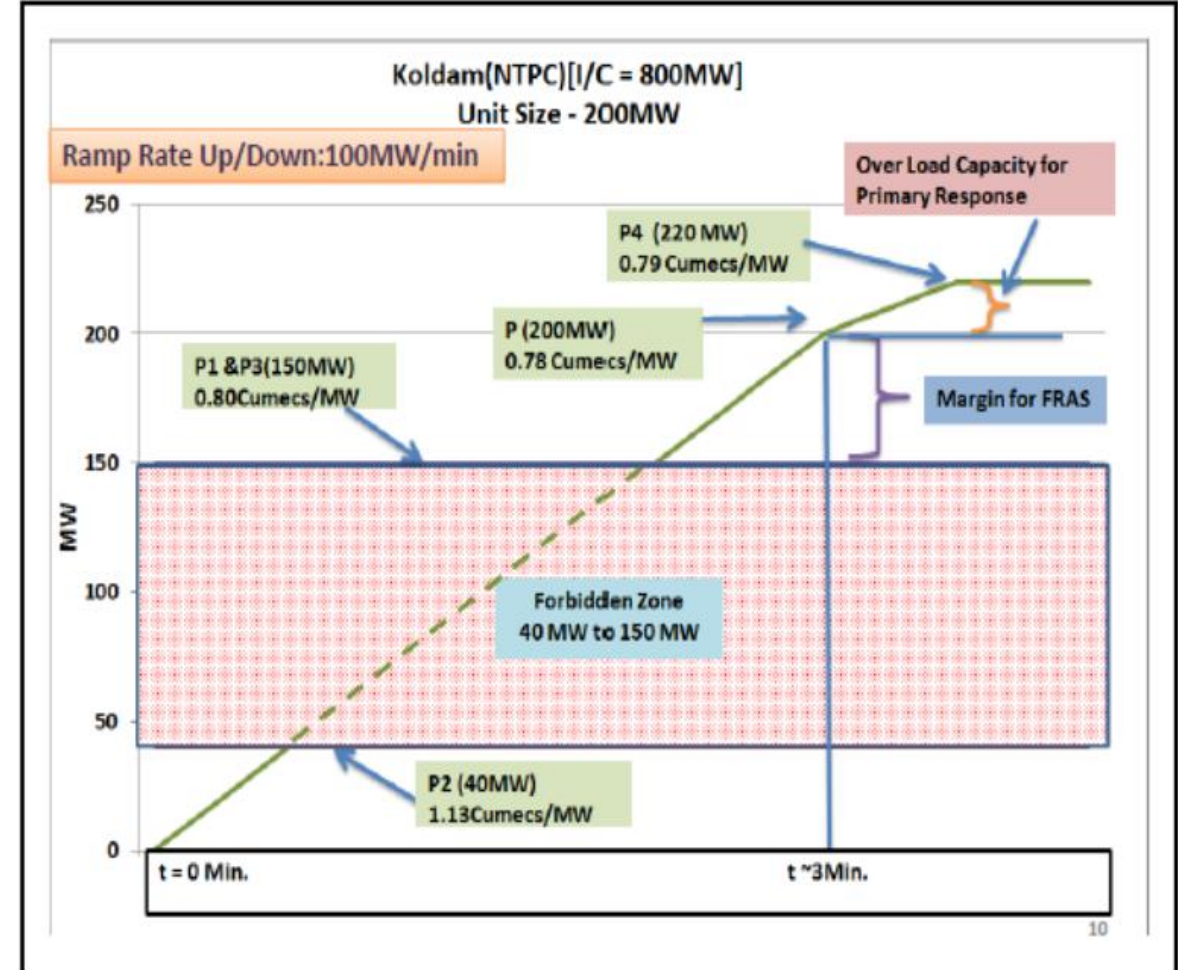
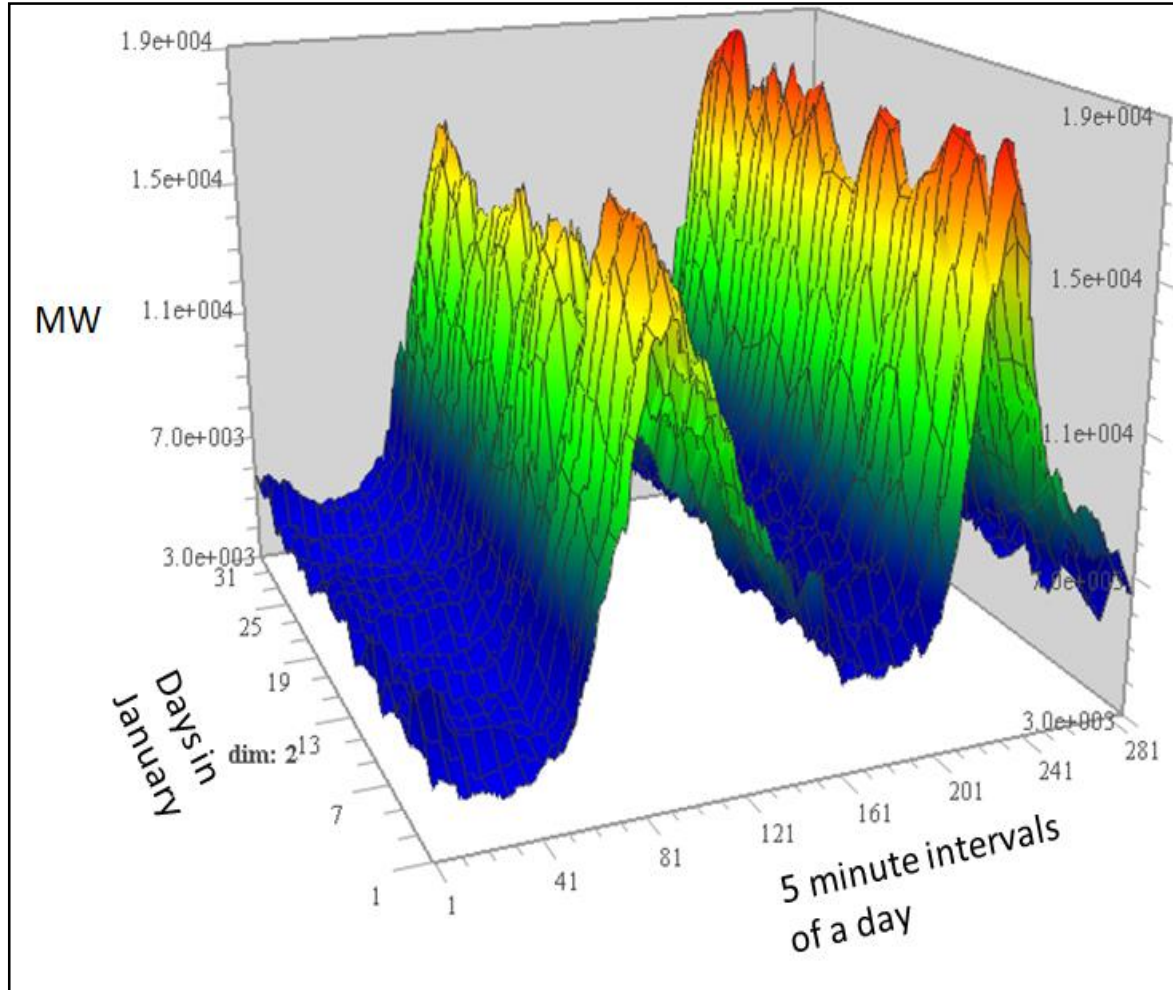
Flexibility



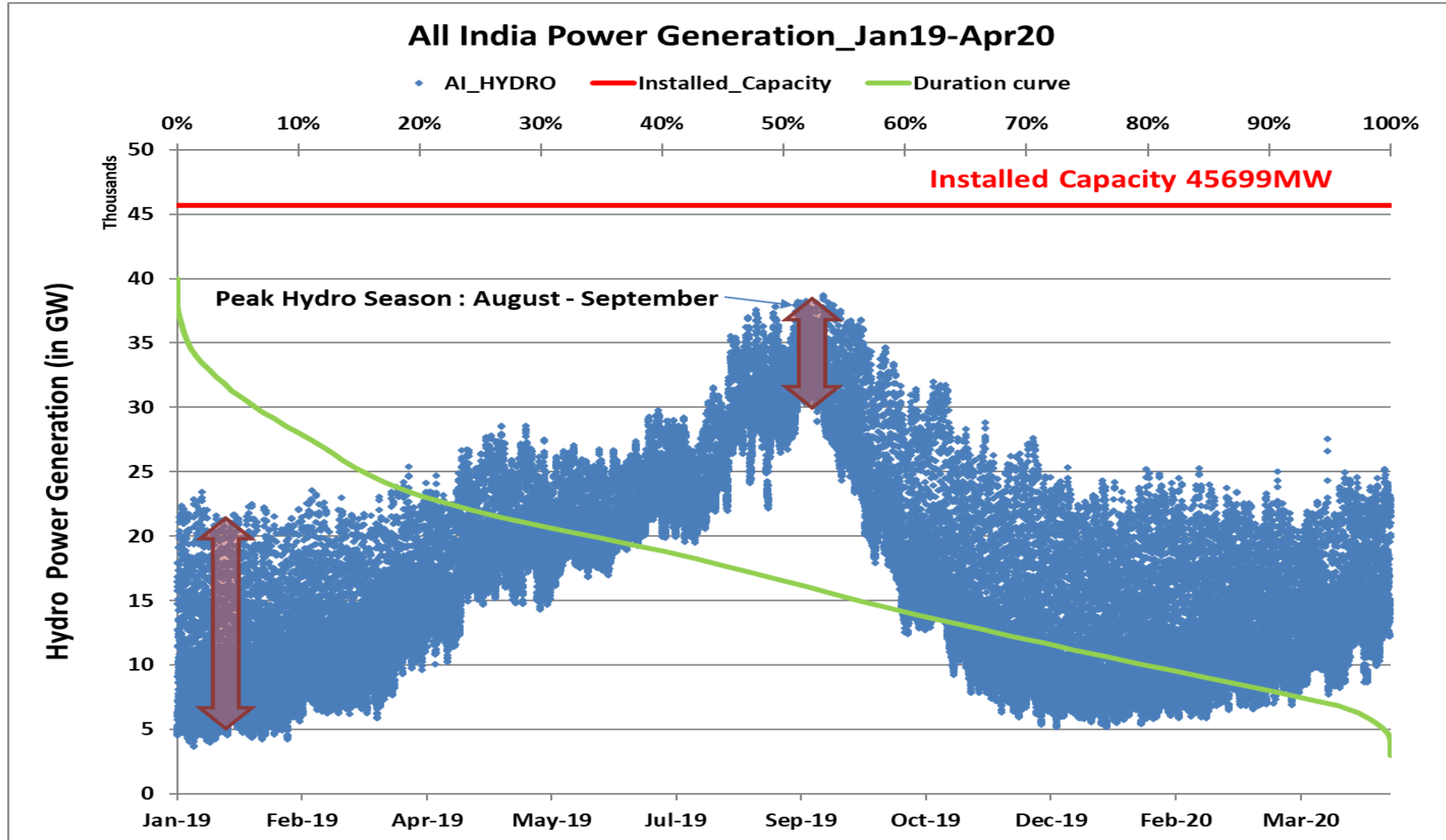
Flexibility: *Hours--Days--Months--Years*



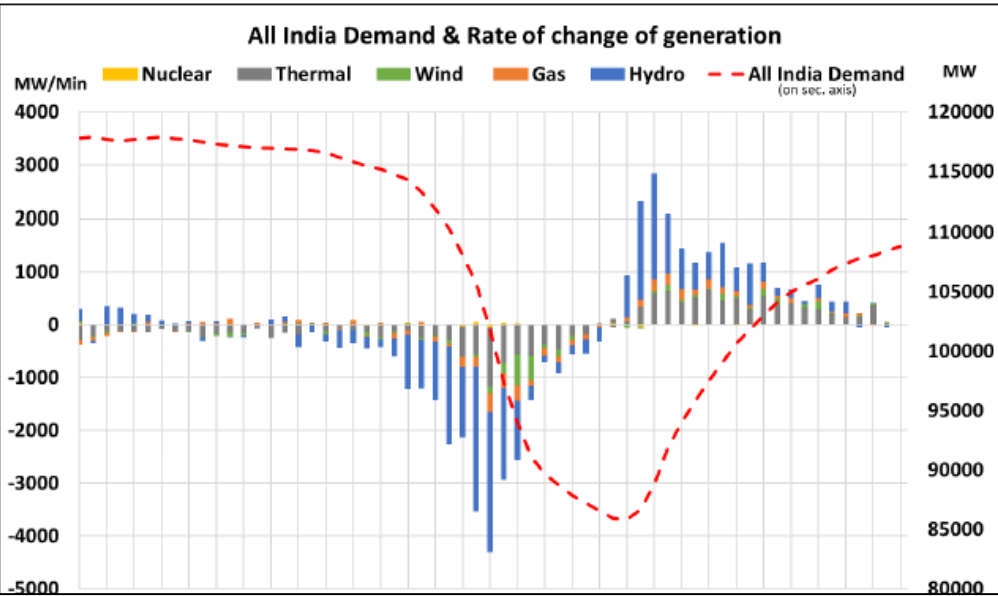
Flexibility: *Harnessing Hydro flexibility*



Hydro – Flexible Resource



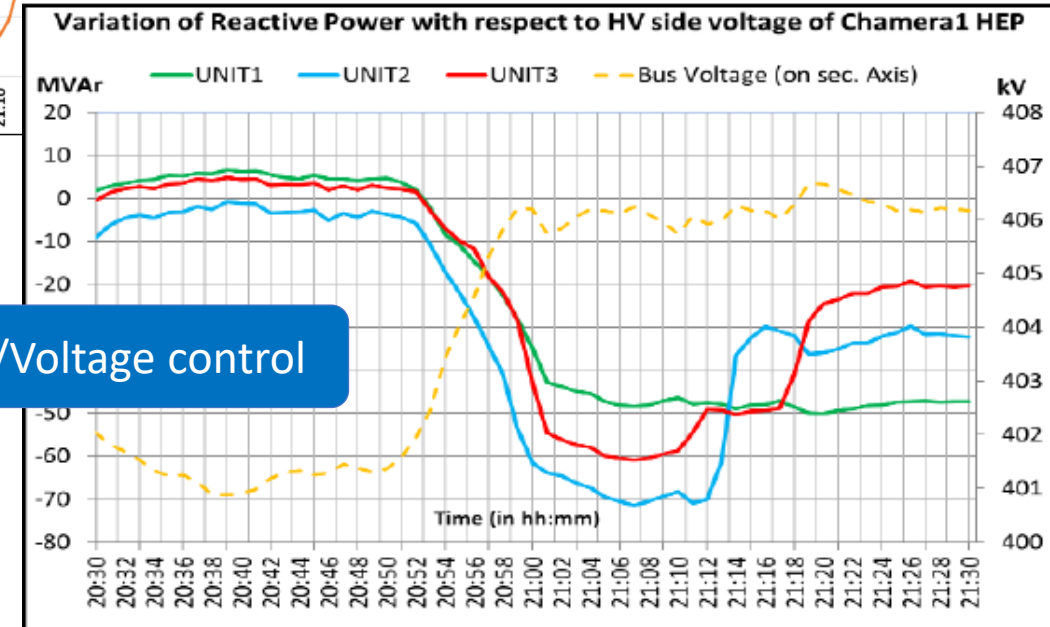
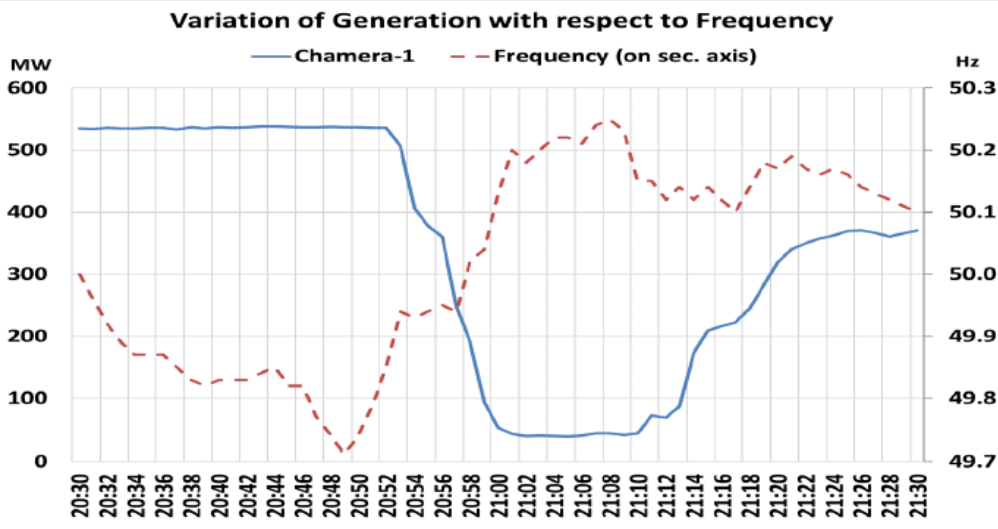
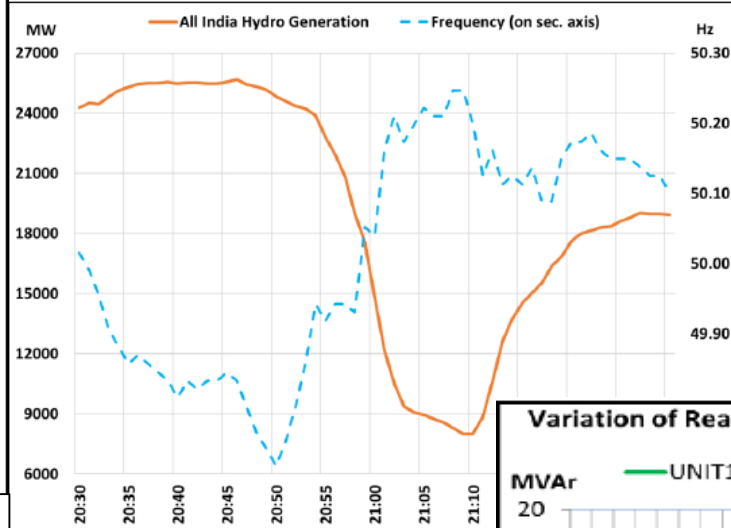
Flexibility: Seconds — Minutes :: Flexibility during 9pm9min event



Ramping



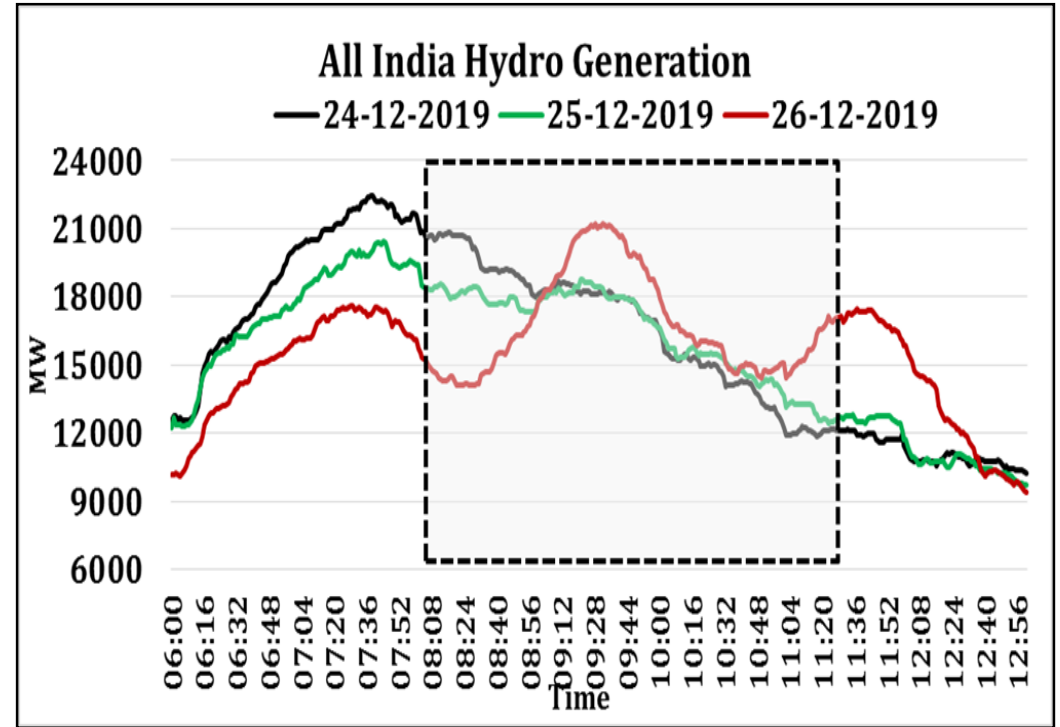
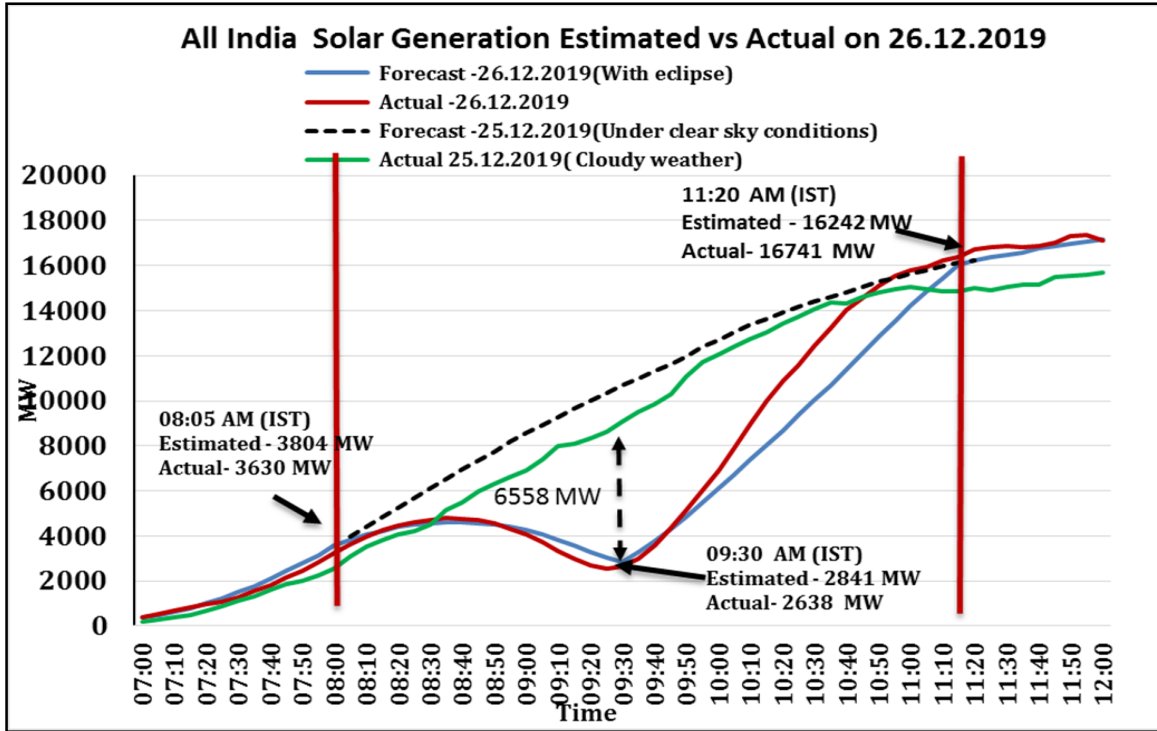
Primary response



Reactive power/Voltage control

Flexibility: Minutes--Hours :: solar eclipse on December 26, 2019

Ramping



Generation variation during Solar eclipse

Hydro generation = 6000 MW - Thermal generation = 2000 MW - Gas based generation = 1000 MW

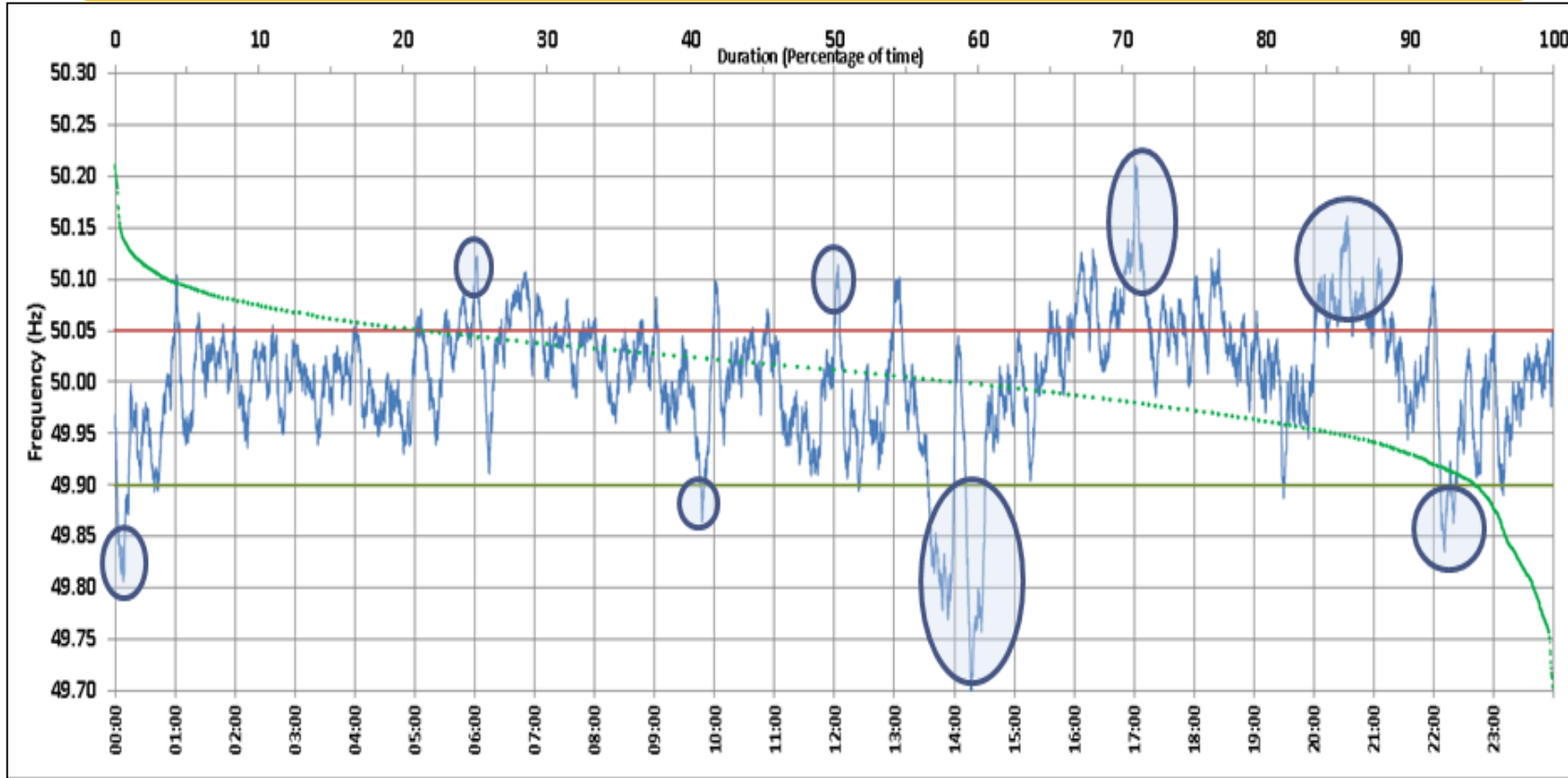
- Approximately 60 – 70 % solar generation was handled by Hydro based generating units.
- No significant variation in frequency during the eclipse period.

Analysis of impact of solar eclipse:

<https://posoco.in/wp-content/uploads/2020/02/Solar-Eclipse-26th-December-2019-Analysis-of-its-impact-on-Indian-Power-System-A-report.pdf>

Flexibility: *Minutes--Hours*

Fast response ancillary services (FRAS) to address sharp fluctuations in frequency



After Secondary response/AGC pilot, scheme to be implemented to cover Hydro generators

Flexibility: *Future*



In view of ongoing large renewable penetration



Maintaining minimum Inertia of the grid



Incentivizing Dynamic VAR support



Enhanced and broader primary/secondary responses



Market based Ancillary services

Thank You!



जल ही जीवन है
Water is life