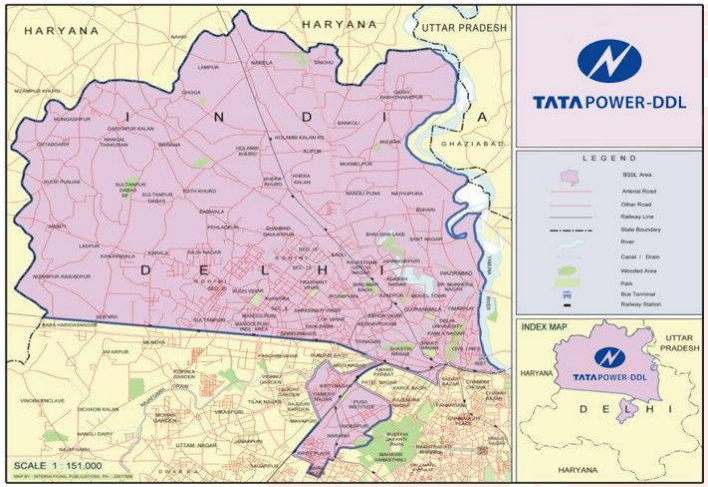
An initiative to address Power Quality Issue

Preparedness for distributed Solar Net Metering on grid stability

About Tata Power-DDL

More than 15 MW Rooftop Solar Project installed in Consumer Premises & own Buildings



One of the Most Successful Private Power Distribution Utility

License Area: North and North West Delhi (510 sq. km)
License Period : 25 years

Parameter	Unit	July '02	March'17	% change
OPERATIONAL PERFORMANCE				
AT&C Losses	%	53.1	8.59	85%
System Reliability – ASAI -Availability Index	%	70	99.51	41%
Transformer Failure Rate	%	11	0.84	90%
Peak Load	MW	930	1791	85%
Length of Network	Ckt. Km	6750	15378	128%
Street Light Functionality	%	40	99.41	150%
CONSUMER RELATED PERFORMANCE				
New Connection Energization Time	Days	51.8	5	90%
Meter Replacement Time	Days	25	5	80%
Provisional Billing	%	15	0.86	94%
Defective Bills	%	6	0.13	98%
Bill Complaint Resolution	Days	45	4	91%
Mean Time to Repair Faults	Hours	11	1.50	87%
Call Center Performance - Service Level	%	-	95	
Payment Collection Avenues	Nos.	20	6725	33525%
Consumer Satisfaction Index	%	-	90	
OTHERS				
Capex (Cumm)	Rs. Crs	1210	6393	428%
Consumers	Count	7 Lacs	15.8 Lacs	126%
Employees	Count	5600	3537	37%

Certifications : ISO 9001, 14001, 27001, 22301, 31000 ; SA 8000 ; OHSAS 18001
UN Global Compact Reporting

Why Grid Connected Roof Top

Nation

- Less imported fossil fuels
- Reduces requirement of land for addition of capacities
- Tap Solar Potential ; cleaner source

Consumers

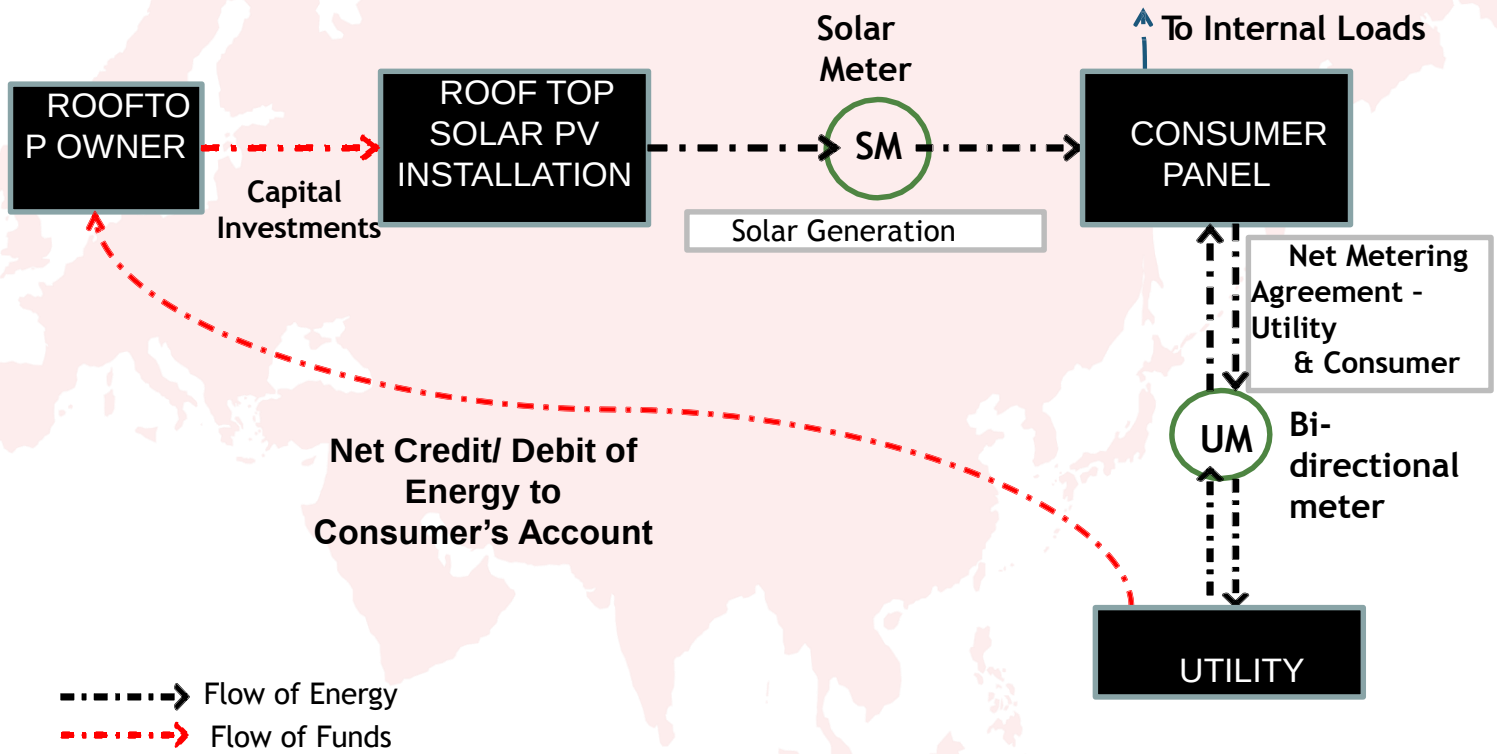
- Reduces the dependency on grid power,
- Long term reliable power source with certainty on energy prices
- The ease of connectivity with the consumer premises particularly in net-metered arrangement
- Financial benefit as one time investment provides 25 years' solar generation with Income Tax benefit.

Discoms

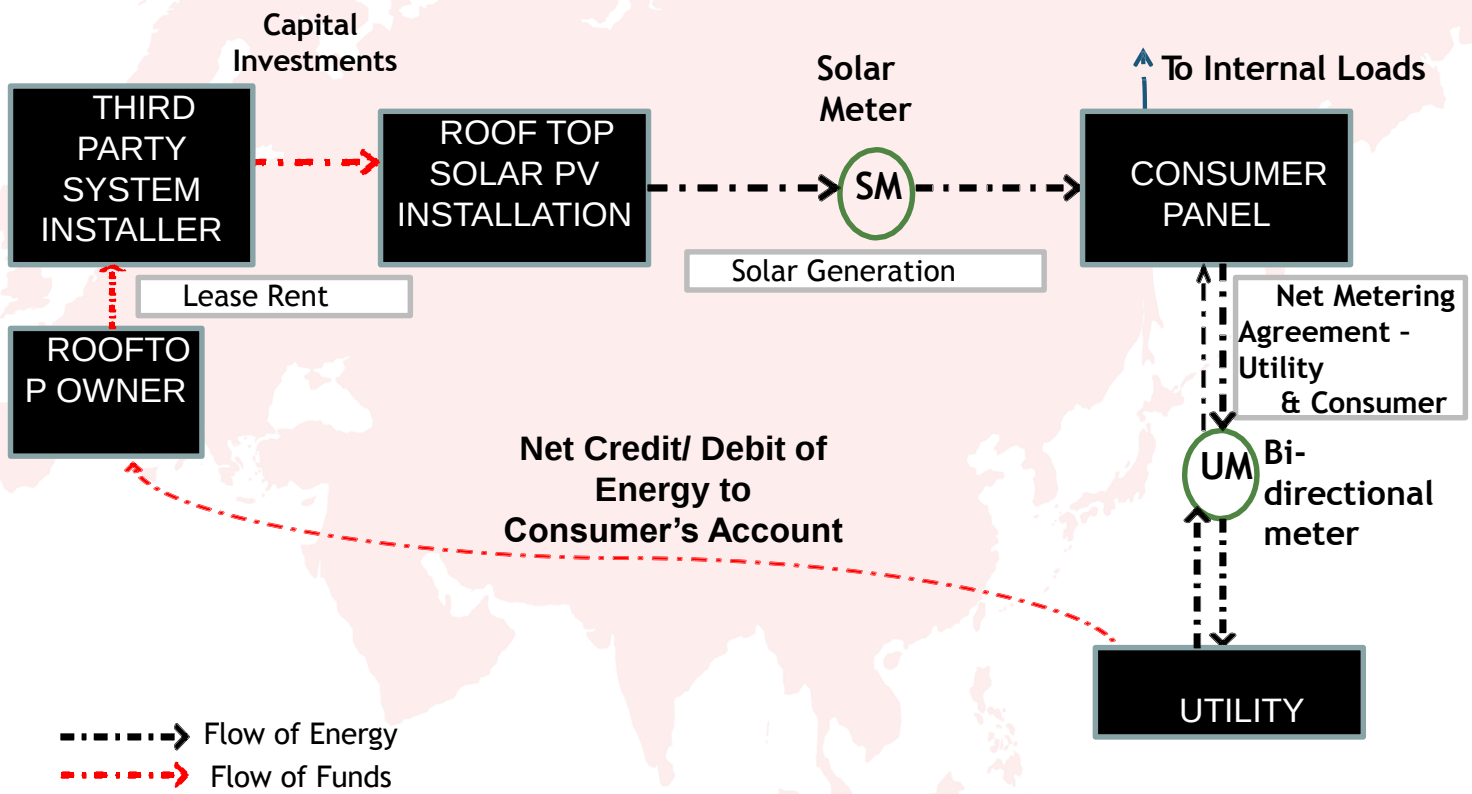
- Manage Demand
- Reduces T&D Losses: strong rationale for rooftop solar projects in India, where the national average of T&D losses hover at close to 30%
- Self-replication potential is very high for rooftop projects.

JNNSM and state solar policies have been successful in kick-starting the development of utility scale solar power projects in India, the small scale rooftop solar segment is in a stage of development in India.

Self Owned Rooftop Solar Model



Third Party Owned Rooftop Solar Model



Role of Discom

- In the Value Chain of Rooftop Solar, Discom can play an important role in Project Development, Installation and Operation & Maintenance Stages
- Project Development Stage
  - Proactive assessment of RTS absorption at LT Feeder, DT and 11 kV
  - Help consumer in Tendering stage and ensure right equipment capable of meeting grid coordination requirements is installed
  - Help consumer/developer in assessing the benefits
- Installation
  - Facilitate timely Technical Clearances
- Operation and Maintenance
  - Monitor generation data and use for Power Scheduling and Performance Management services
  - Meter Reading, Billing and Collection services
  - System Protection coordination

Challenges of Large Scale Rooftop Solar

- Grid is a collective resource
- Large Scale Rooftop Solar a Multi Stakeholder Optimization, not a private option/decision
- RTS along with benefits, also brings certain responsibilities.
  - RTS will replace conventional generators to some extent, hence should be able to take over grid support role too
  - Cost Optimization should include life cycle costs and not just Capex.
- Performance of RTS and Inverter is as critical to the grid as it is to the owner
- Discom has to be proactive and must be prepared for various scenarios and consider RTS as a tool for providing supply
- Discom has to evolve into a role of System Operator from the current Network Maintenance and Power Procurement role

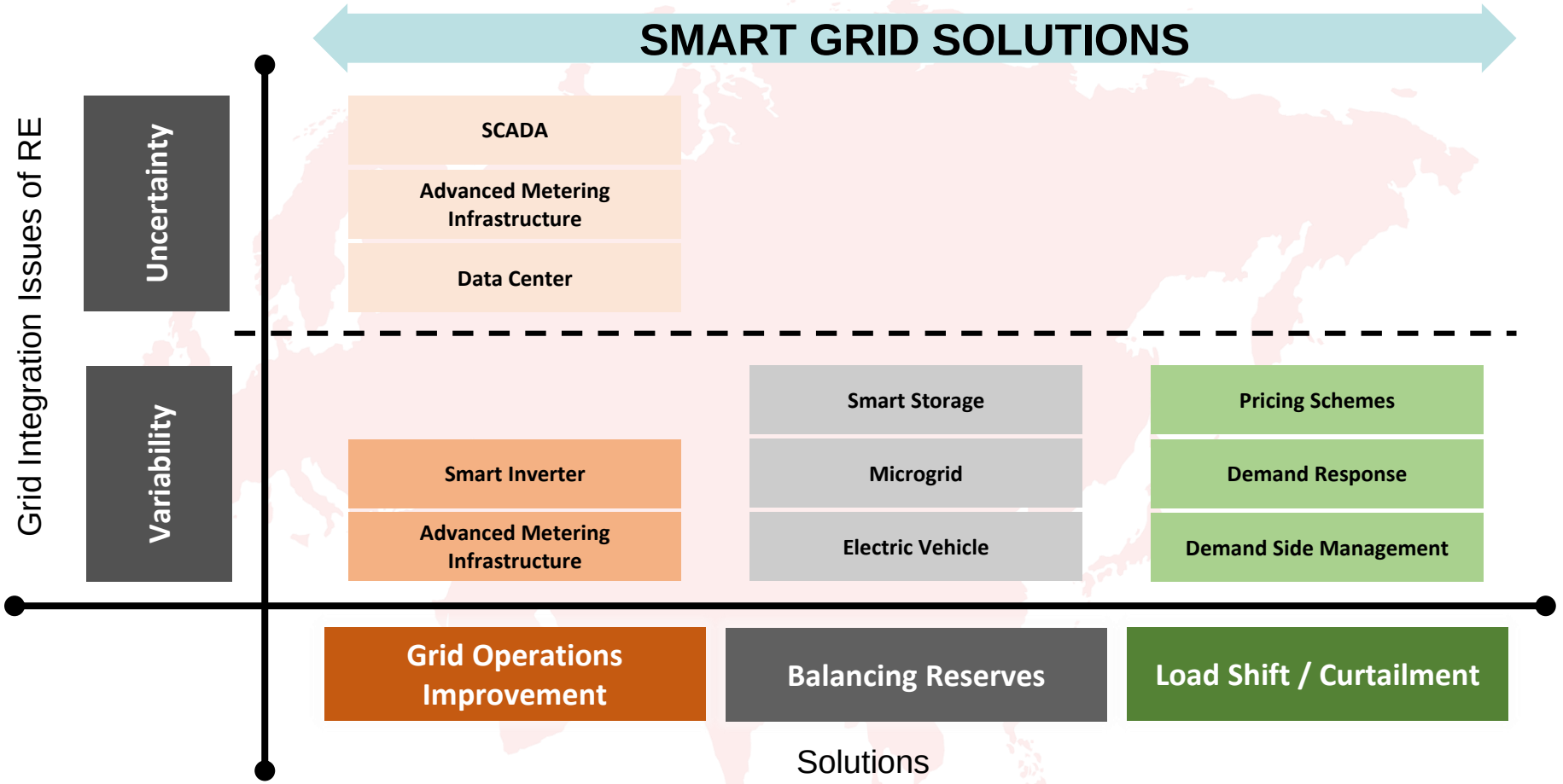
Impact of Solar Injection on Network (Technical)

- Voltage Imbalance
- Voltage Instability
- Voltage Rise
- Reverse Power Flow
- Increase in Losses
- Protection Issues
- Impact on system stability due to anti-islanding protection feature
- Impact on system stability due to weather fluctuations

Impact of Solar Injection on Network (Non Technical)

- **Power Management on Real Time**
  - Absence of accurate forecasting mechanisms
  - Absence of alternatives to meet the contingencies of infirm power flow
  - High cost of alternative solutions
- **Commercial Impact**
  - Increasing burden on bottom of pyramid consumers due to cross subsidizing consumers moving to solar
  - Long Term PPAs fixed costs still to be borne
  - Consumers are already tariff sensitive
  - Already burgeoning Regulatory Assets

Smart Grid Technologies Supporting Solar Integration



- Issues of variability and uncertainty can be solved using improved measures in grid operations, enabling balancing reserves and implementing load shifting/curtailment techniques.
- Smart grids through it various applications helps in seamless RE integration by enabling the above solutions.

TPDDL Smart Grid Initiatives..

Advanced Distributed Management System (ADMS)

Unified SCADA, DMS & OMS for better efficiency in monitoring & control

Enterprise Geographical Information System (GIS)

Standards based integration possible with other IT /OT applications

Integrated Communication Technologies (ICT)

For meeting communication requirements of smart grid

Business Intelligence(BI)

Advanced Data analytics (DA) based on advanced Mathematical & Statistical modelling

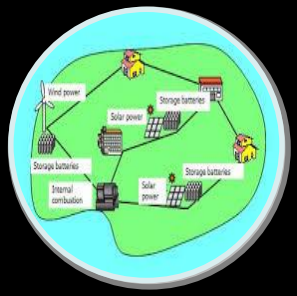
AMI & ESB

Smart Metering for consumers having bulk consumption and Distributed Energy Resources

Distributed Energy Resources Portfolio in TPDDL

Grid Connected Rooftop Solar

400 MW potential in TPDDL area



Automated Demand Response

Potential identified for Bulk Consumers in Pilot Project for 200 Consumers

Energy Storage

Explore utility level Energy Storage options with 10 MW Pilot Project alongwith AES

Micro Grid

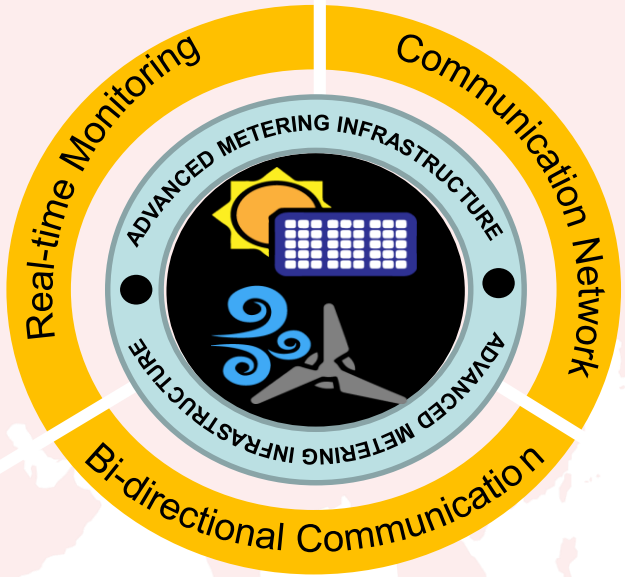
Both Rural as well as Urban Micro-Grid feasibility to be examined – Bihar Pilot Project

Advanced Metering Infrastructure

AMI enables accurate data gathering, establishes two-way communication channel between consumer and utility and enables demand response programs, all of which facilitate grid integration of RE

Measurement of RE Output

- AMI enables monitoring of RE generation
- Gathered data can be analyzed for designing incentive schemes
- Information related to customer benefits can be relayed to Home Energy Management Systems



Distributed Automation (DA) Integration

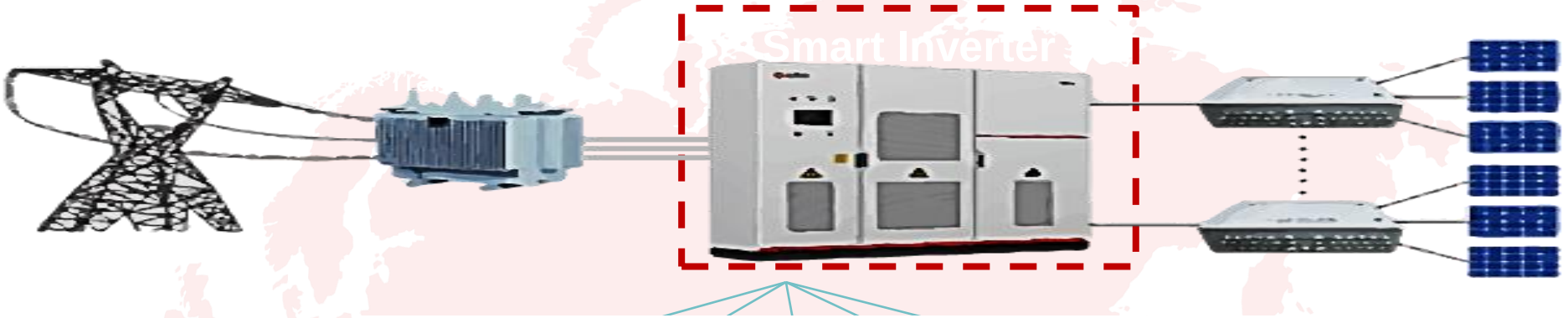
- AMI provides communication channel to enable automated control techniques for optimizing power distribution
- DA to help in managing RE variability, power ramping of reserve generators and bi-directional power flows.
- Smart inverter can be controlled for efficient management of RE sources.

Dynamic Pricing and Demand Response

- AMI enables Demand Response and other load shifting/curtailment programs to cater the variability in RE generation.

Smart Inverters

Smart Inverters when used for interfacing RE sources with the electricity grid can enable mitigation of several integration challenges namely transient, grid voltage fluctuations (“flicker”), steady-state grid voltage problems, frequency deviations etc.



1 Volt-VAR Reactive Control

- Regulation of voltage by injecting VARs which is a function of grid voltage
- Inverter can regulate on its own or on command of grid operator

2 Event Ride-through

- Brief fluctuations of voltage and frequency can be resolved by inverter
- During RE fluctuations, inverter remains online resulting in no disruptions of RE supply

3 Grid Monitoring

- Smart inverters can monitor grid voltage, frequency, current and phase angle
- Collected information can be sent to grid operators

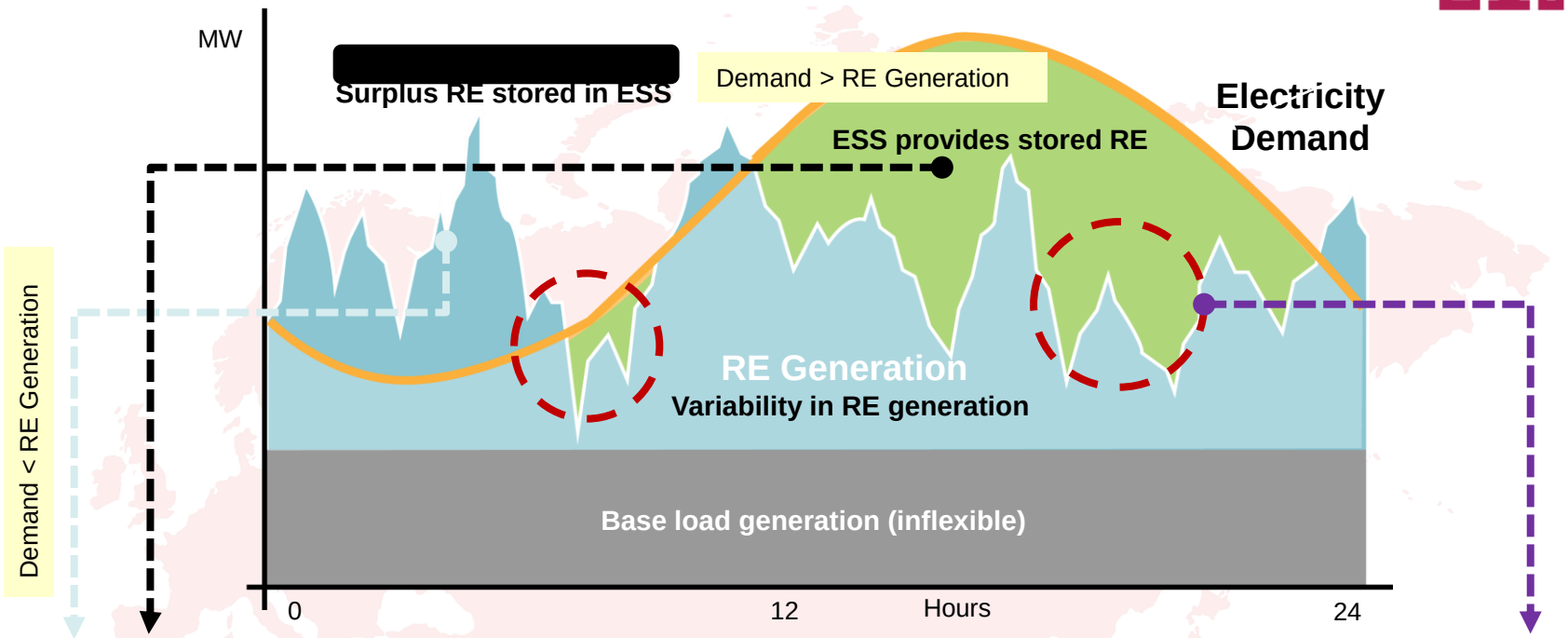
4 High-Freq. Power Reduction

- Reduction of power from RE sources when the grid frequency reached a specific higher threshold value
- This function of smart inverters helps in maintaining grid stability

5 Ramp-rate Control

- Smart inverters can be controlled to limit the rate at which power from RE ramps up or down
- Control of ramp-rate ensures grid stability

Energy Storage System (ESS)



Demand – Supply Management

- ESS charges in case of low demand and stores RE for later usage
- ESS discharges in case of high demand to balance the demand and uses stored RE
- Smart grid communication infrastructure is used in managing this charging and discharging of ESS

Frequency Fluctuations Management

- Changes in frequency are induced by variability of RE generation
- Smart grid enables fast automated response to these fluctuations by controlling ESS
- Time and rate of charge/discharge of ESS are managed to counter frequency fluctuations

Micro-grids

A Microgrid can function in “islanding” mode during grid outages in order to ensure continuity of supply from RE sources

Renewable sources of energy generation

- Wind
- Bio Energy
- Solar energy
- Small hydro (if available)

Conventional sources of energy generation

- Main grid
- Diesel generators
- Gas Turbines

Automation, Control and monitoring systems

- Advance metering infrastructure
- Control systems
- Automation software – Load and generation balancing
- Charge controllers
- Sensors
- Optimization system based on performance matrices (economics, carbon footprint, reliability, etc.)

Storage Systems

- Fuel cells
- Battery Banks
- Pumped Storage (if available)

Applicable Loads

- Domestic
- Commercial
- Industrial
- Within Campus – Hostel, Administrative Block, Academic Block, Laboratory, Kitchen etc

- **Variability** is managed by microgrid controller through voltage and frequency control
- **Uncertainty** of RE generation is managed by microgrid controller. It uses forecasting techniques to optimize the electricity generation. This forecasting is based on demand data, solar profile and weather predictions.
- **Energy storage** helps in load balancing and managing brief fluctuations in RE generation. In case of excess of RE generation, the energy is stored in energy storage resources which can be later utilized in managing the fluctuations in RE generation.

THANKS