

# BATTERY ENERGY STORAGE SYSTEM- DRAFT GUIDELINES



Presented by

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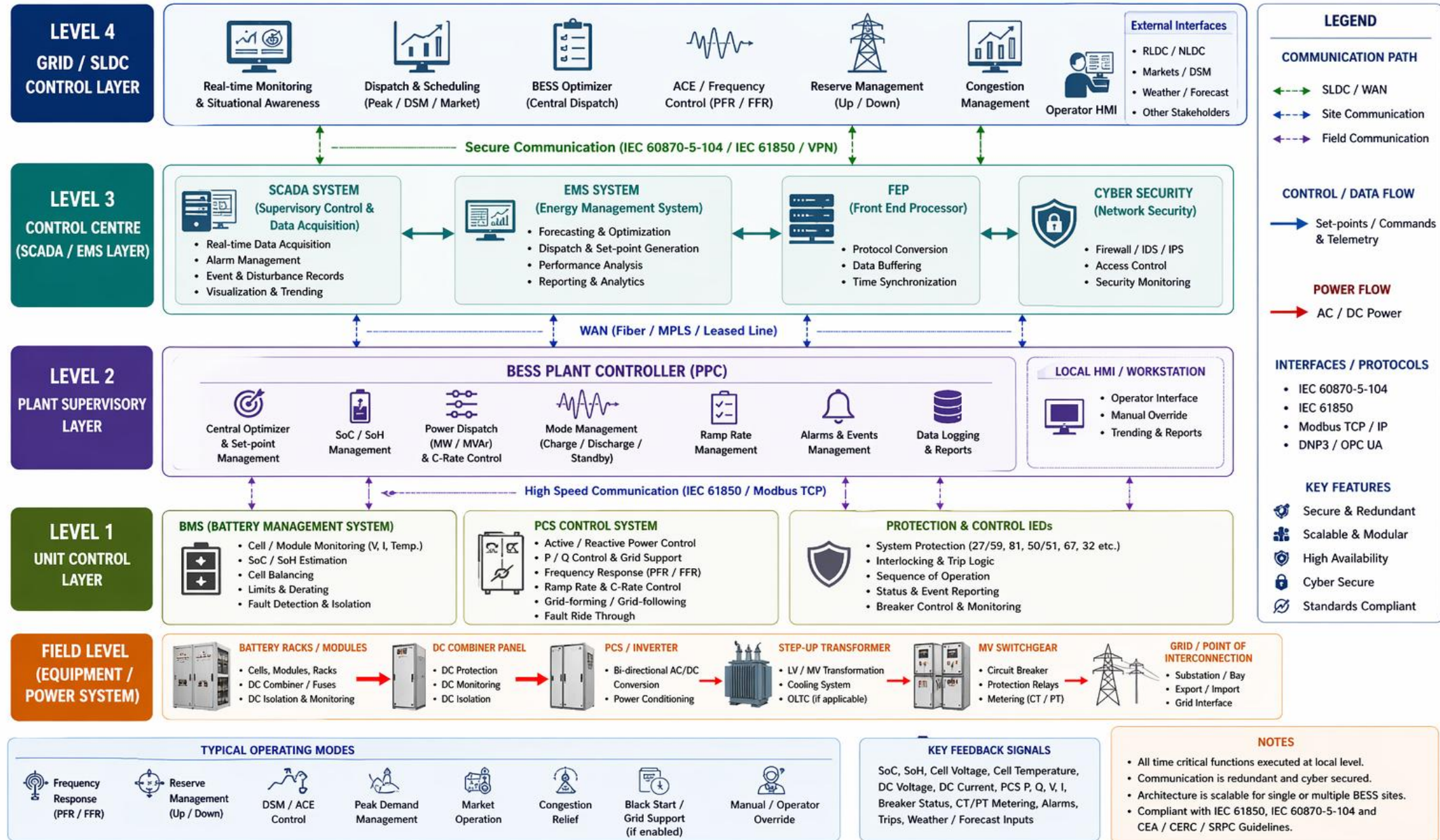
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# BATTERY ENERGY STORAGE SYSTEM (BESS) – CONTROL & COMMUNICATION ARCHITECTURE

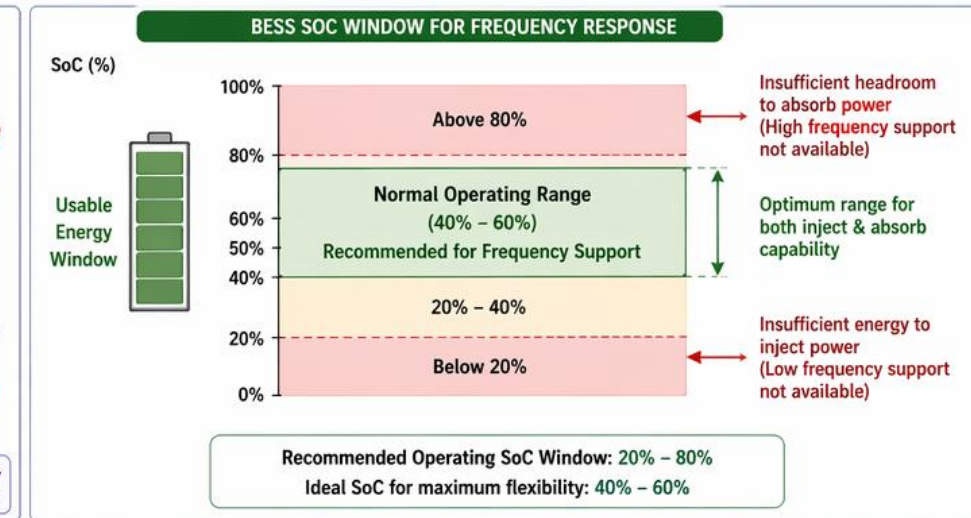
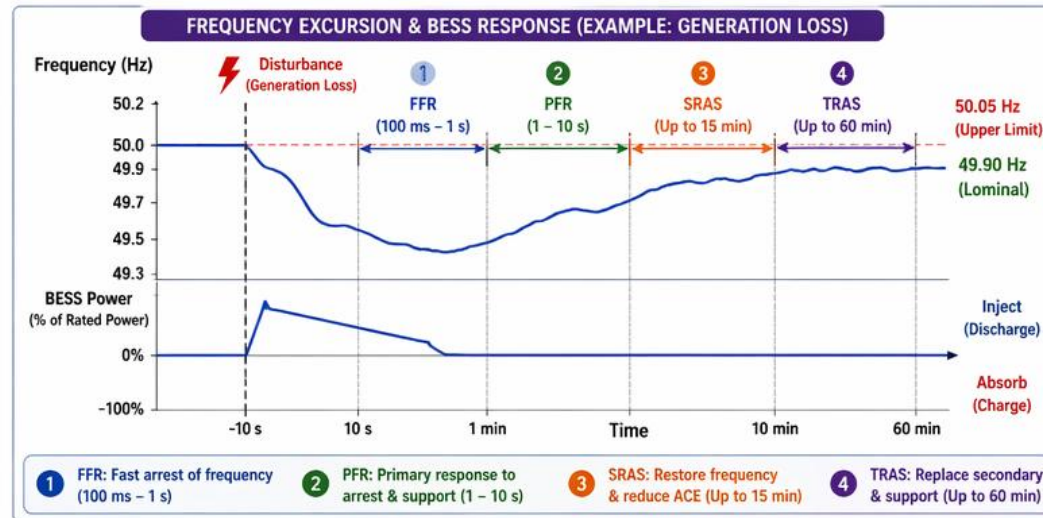
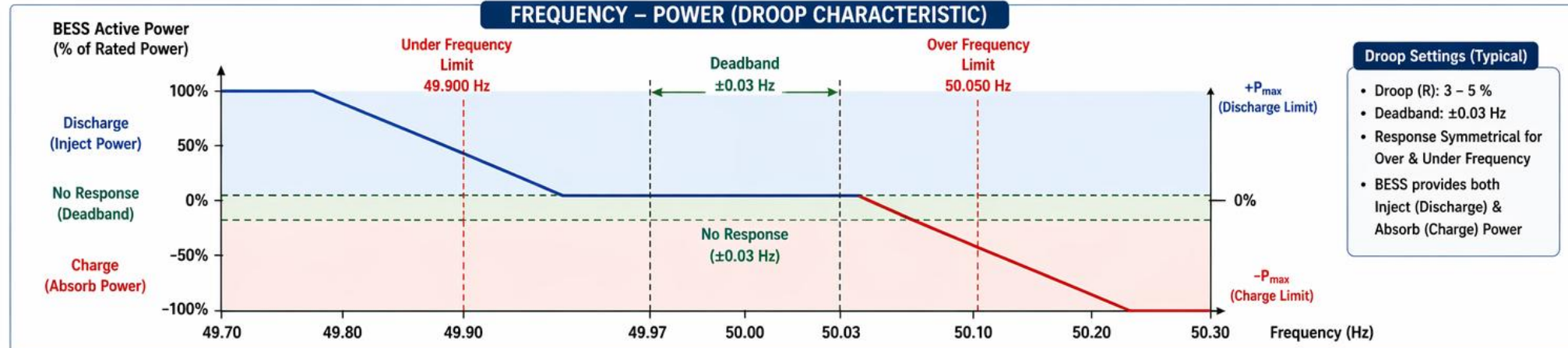
Hierarchical Control Structure from SLDC to Field Level





# BESS FREQUENCY RESPONSE – PFR & FFR (AS PER INDIAN GRID CODE)

Nominal Frequency: 50.000 Hz | Allowable Operating Band: 49.900 – 50.050 Hz



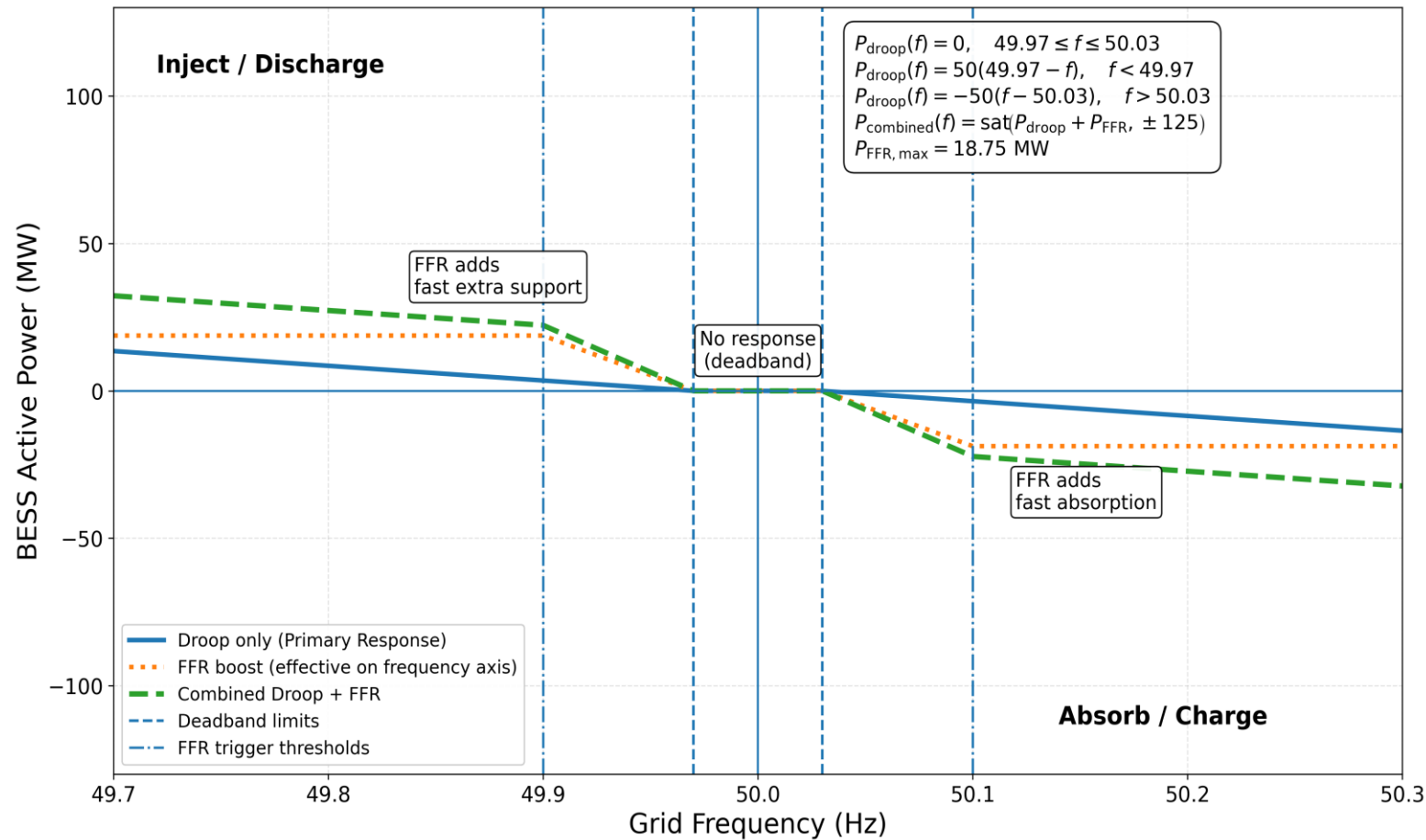
BESS ADVANTAGE FOR FREQUENCY RESPONSE				
Millisecond Response	High Accuracy Power Control	Droop / Frequency-Watt Characteristic	Inject & Absorb Power	Sustained Support with Proper SoC Management

OPTIMUM RESERVE (TYPICAL GUIDANCE)			
Primary Reserve (PRAS)	Secondary Reserve (SRAS)	Tertiary Reserve (TRAS)	SoC Margin
10% – 15% of BESS Rated Power (Immediate – 45 s)	15% – 25% of BESS Rated Power (Upto 15 min)	20% – 30% of BESS Rated Power (Upto 60 min)	20% – 80% (Use mid SoC 40% – 60% for best flexibility)

Reference: Indian Electricity Grid Code (IEGC), 2023 – Regulation: 74 (Frequency Control & Reserves) | FFR is mandatory for IBRs as per CEA Connectivity Regulations.

# PRIMARY RESPONSE & FAST FREQUENCY RESPONSE

125 MW BESS – Combined Droop + FFR Response on Frequency Axis

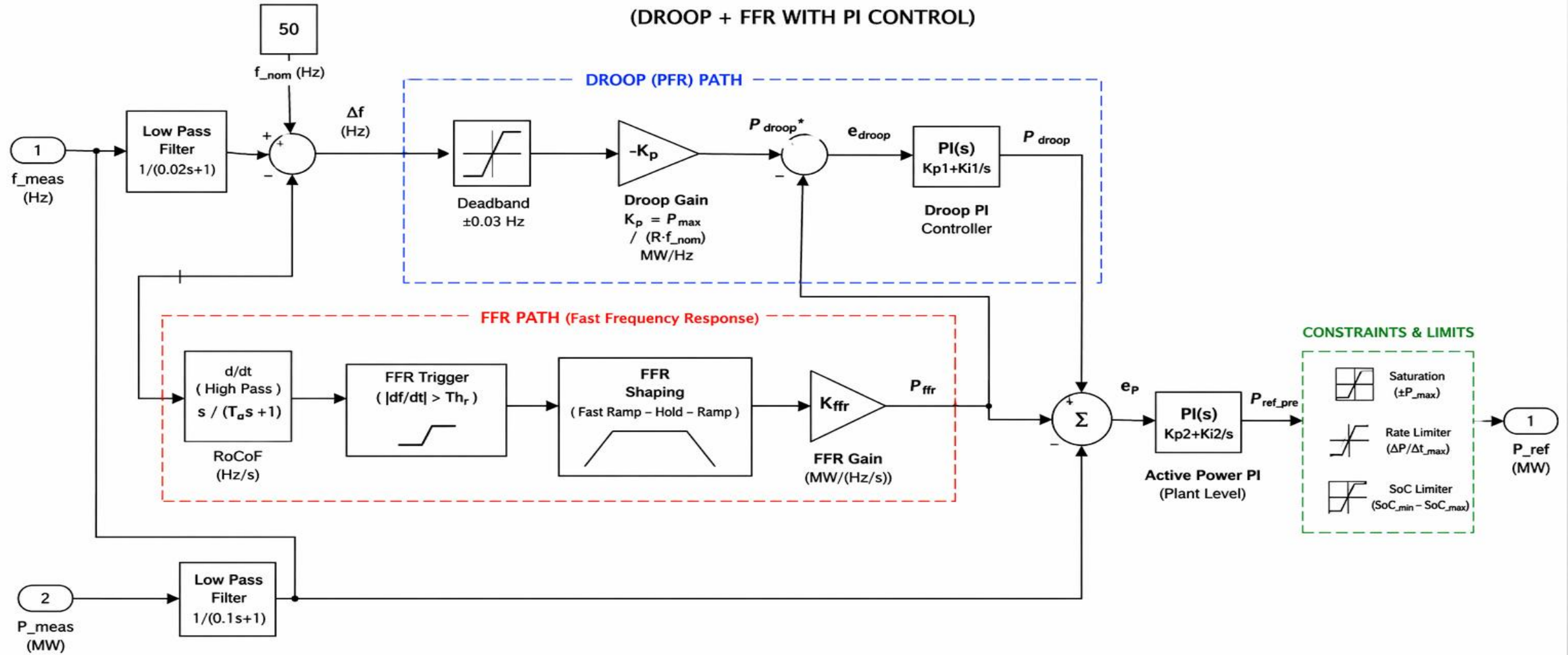


- Around the nominal frequency of 50 Hz, there is a deadband (49.97–50.03 Hz) where the BESS does not respond
- Once the frequency moves outside this band, the droop control (PFR) starts acting first in a proportional manner. Further the frequency deviates, the more power the BESS injects (for low frequency) or absorbs (for high frequency), following a linear slope (50 MW/Hz for 5% droop).
- On top of this, the FFR component adds a fast, additional “boost” when the frequency deviation becomes more severe (for example below ~49.9 Hz or above ~50.1 Hz in the graph). Unlike droop, which increases gradually, FFR acts almost instantaneously and injects a fixed extra power (about 18.75 MW) to quickly arrest the frequency decline or rise.



# BESS ACTIVE POWER CONTROLLER

(DROOP + FFR WITH PI CONTROL)



## PARAMETERS (Example)

$P_{max} = 125$ MW	Deadband = $\pm 0.03$ Hz	PI Gains (Example):
$f_{nom} = 50$ Hz	RoCoF Threshold $Th_r = 0.5$ Hz/s	Droop PI $\rightarrow K_{p1} = 10, K_{i1} = 5$
$R$ (droop) = 5 % $\rightarrow K_p = P_{max} / (R \cdot f_{nom}) = 50$ MW/Hz	$K_{ffr} = 37.5$ MW/(Hz/s) (Example)	Power PI $\rightarrow K_{p2} = 5, K_{i2} = 10$

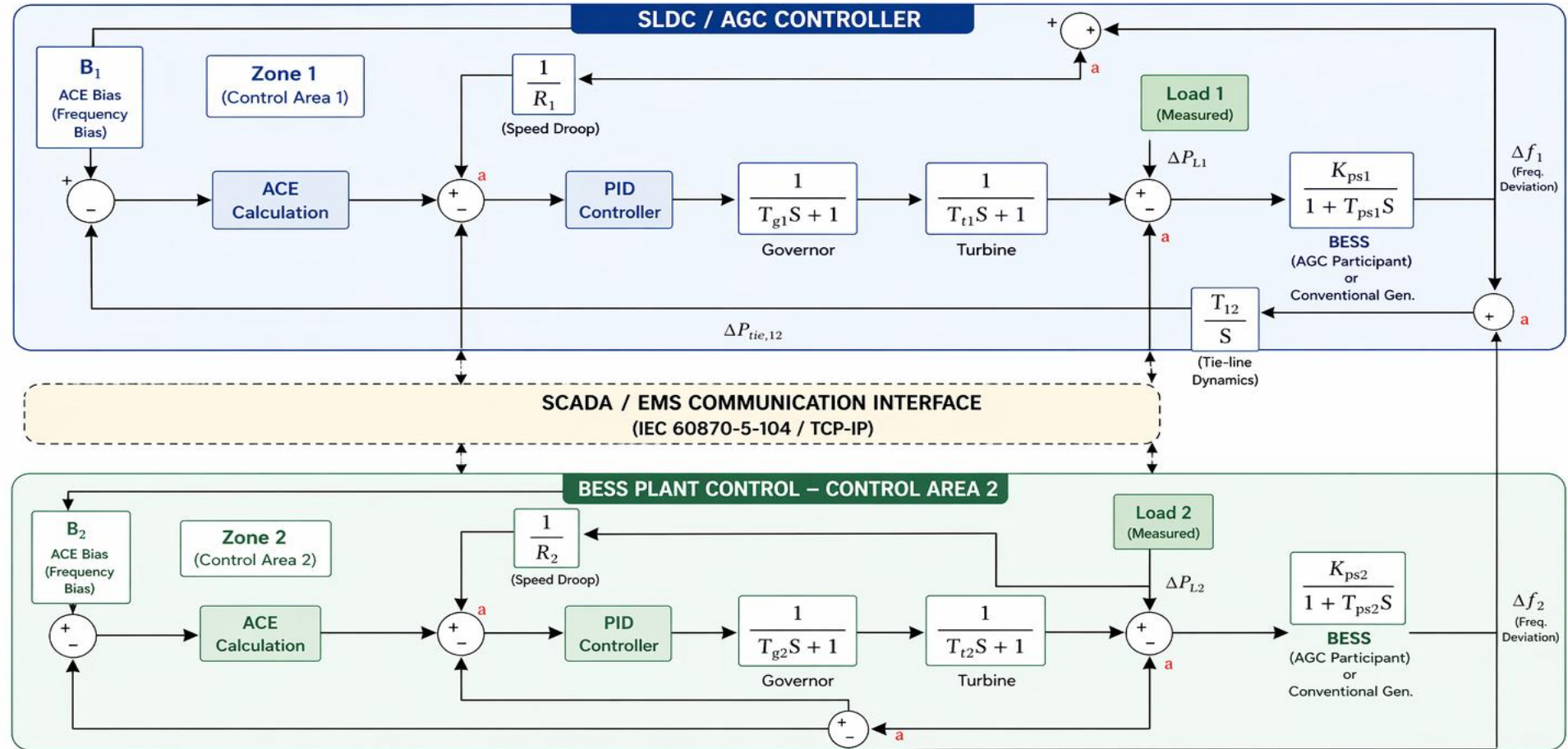
## LEGEND

- Signal Flow
- - - Droop (PFR) Path
- - - FFR Path
- - - Constraints



# Automatic generation control

## AGC CONTROL ARCHITECTURE FOR BESS



### LEGEND

- $a$  AGC Signal
- $\oplus$  Summing Point
- $\rightarrow$  Control / Signal Flow
- $\leftrightarrow$  Communication Link

### TERMS

- ACE : Area Control Error
- $B$  : Frequency Bias Factor
- $R$  : Speed Droop (Hz/MW)
- $T_g$  : Governor Time Constant
- $T_t$  : Turbine Time Constant
- $K_{ps}$  : Power System Gain
- $T_{ps}$  : Power System Time Constant
- $\Delta f$  : Frequency Deviation (Hz)
- $\Delta P_{tie}$  : Tie-line Power Deviation (MW)
- $\Delta P_L$  : Load Change (MW)

### BESS AGC INTERFACE


- Receives AGC Setpoint ( $\Delta P_{AGC}$ ) from SLDC EMS
- Adjusts Active Power (Charge / Discharge)
- Fast response ( $< 2$  Seconds)
- Supports Up & Down Regulation

### FEATURES

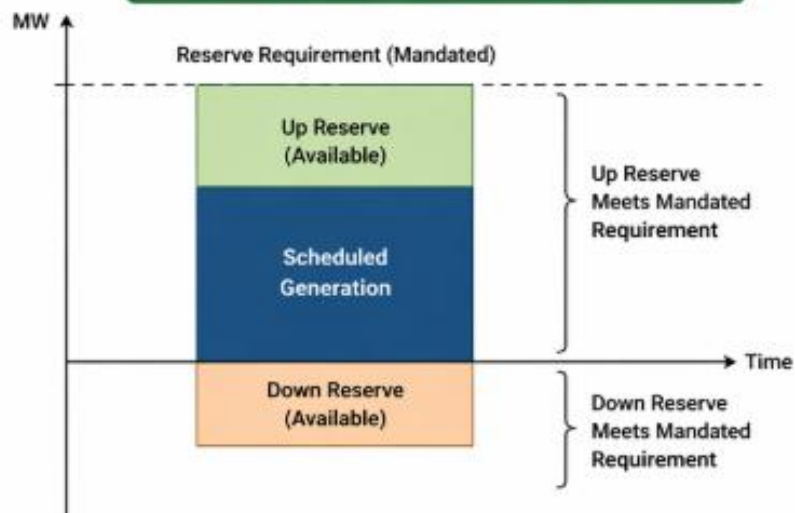
- Real-time frequency & tie-line monitoring
- Automatic generation control via ACE
- Coordinated control between areas
- BESS provides fast, precise regulation
- Improves frequency stability & reliability

# RESERVE MANAGEMENT

If the Control Area is having less than mandated reserves it can be used for maintaining the Up/down reserves as applicable.

 These reserves should not be normally scheduled and used by System Operator to meet the contingencies.

## 1. NORMAL CONDITION – RESERVES ADEQUATE



Adequate up/down reserves are available.  
Not used for meeting contingencies.

## 2. RESERVE SHORTFALL – RESERVES INSUFFICIENT



If reserves are less than mandated, available resources in the Control Area may be used only to maintain the required up/down reserves.  
These reserves should not be normally scheduled or used by the System Operator to meet contingencies.

### Legend



### Key Points

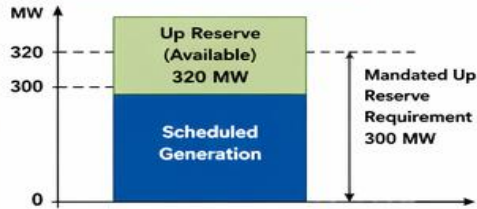
- Maintain mandated Up/Down reserves at all times.
- Use internal resources only when reserves are less than mandated.
- Do not schedule or use these reserves for normal operations.



# RESERVE MANAGEMENT – NORMAL CONDITION, RESERVE SHORTFALL & MYLATTI 125 MW BESS UTILIZATION (UPDATED LOGIC)

## 1. NORMAL CONDITION – RESERVES ADEQUATE

### UP RESERVE (Adequate)

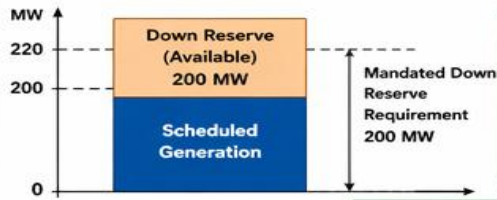


#### CALCULATION

Mandated Up Reserve Requirement = 300 MW  
Available Up Reserve (from Generators) = 320 MW  
Surplus Up Reserve  
=  $320 - 300 = 20 \text{ MW}$

✓ System secure – Surplus Up Reserve = 20 MW

### DOWN RESERVE (Adequate)



#### CALCULATION

Mandated Down Reserve Requirement = 200 MW  
Available Down Reserve (from Generators) = 220 MW  
Surplus Down Reserve  
=  $220 - 200 = 20 \text{ MW}$

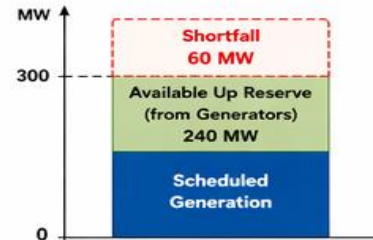
✓ System secure – Surplus Down Reserve = 20 MW



System is secure in both directions. Reserves are adequate. MYLATTI BESS is **NOT** obligated for reserve and can be used for DSM, market operations, peak support, etc., as per SLDC schedule.

## 2. RESERVE SHORTFALL CONDITION – DEFICIENCY AND CORRECTION USING MYLATTI 125 MW BESS

### A. UP RESERVE SHORTFALL



#### CALCULATION

Mandated Up Reserve Requirement = 300 MW  
Available Up Reserve (from Generators) = 240 MW  
Up Reserve Shortfall  
=  $300 - 240 = 60 \text{ MW}$

#### CORRECTION USING MYLATTI BESS

SLDC instruction: Keep 60 MW of MYLATTI BESS capacity available as Up Reserve.  
Effective Up Reserve  
=  $240 + 60 = 300 \text{ MW}$   
(Requirement Restored)

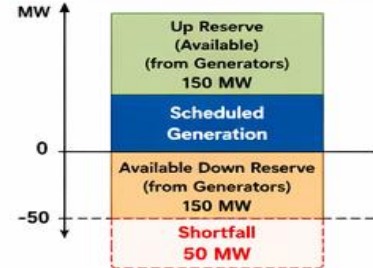
#### MYLATTI BESS – UP RESERVE USAGE

BESS Capacity (AC) = 125 MW  
Up Reserve Earmarked = 60 MW  
Remaining Available Capacity  
=  $125 - 60 = 65 \text{ MW}$

#### IMPORTANT NOTES

- Only 65 MW can be used for other controlled uses such as DSM, market operation, peak support, etc.
- 60 MW is reserved for contingency and must be instantly available.

### B. DOWN RESERVE SHORTFALL



#### CALCULATION

Mandated Down Reserve Requirement = 200 MW  
Available Down Reserve (from Generators) = 150 MW  
Down Reserve Shortfall  
=  $200 - 150 = 50 \text{ MW}$

#### CORRECTION USING MYLATTI BESS

SLDC instruction: Keep 50 MW charging headroom of MYLATTI BESS available as Down Reserve (absorption capability).  
Effective Down Reserve  
=  $150 + 50 = 200 \text{ MW}$   
(Requirement Restored)

#### MYLATTI BESS – DOWN RESERVE USAGE

Down Reserve Earmarked (charging headroom) = 50 MW

- BESS should not be kept near full charge.
- Maintain SoC in mid-range (40% – 60%) so that 50 MW charging power is available when required.
- This 50 MW headroom is reserved for contingency absorption.

## 3. PRACTICAL COMBINED EXAMPLE FOR MYLATTI 125 MW BESS

### SLDC REQUIRES MYLATTI BESS TO MAINTAIN:

- Up Reserve = 50 MW
- Down Reserve = 30 MW

Total Reserve Margin to be kept aside  
=  $50 + 30 = 80 \text{ MW}$

### BESS CAPACITY ALLOCATION

BESS Total Capacity (AC) = 125 MW  
Total Reserve Margin (Up + Down) = 80 MW  
Remaining Capacity for Other Uses  
=  $125 - 80 = 45 \text{ MW}$

### MEANING

Only 45 MW can be used for normal energy-related functions (DSM, market operation, peak support, etc.), subject to SoC and SLDC instructions.  
80 MW remains reserved for grid security.

### KEY TAKEAWAY



Reserved capacity is **NOT** for normal energy operations. It is a safety margin for contingency support, ensuring reliability, frequency stability, and grid security.

## 4. WHEN CONTINGENCY OCCURS



## 5. IMPORTANT OPERATING PRINCIPLES

- Reserves are dynamic and based on real-time grid conditions.
- BESS response is activated only when reserve shortfall exists or during real-time events.
- Reserves are not used for routine scheduling, market arbitrage, or peak shaving when shortfall exists.
- SoC must be maintained in mid-range (40% – 60%) for bi-directional readiness.
- SLDC instructions and CEA / SRPC guidelines to be strictly followed.

## 6. MYLATTI 125 MW BESS SUMMARY

BESS Rating (AC)	125 MW / 500 MWh
PCS Capacity (AC)	137.5 MVA ( $24 \times 5 \text{ MVA} + 7 \times 2.5 \text{ MVA}$ )
Usable for Grid Support	Up to 125 MW (subject to reserve obligation & SoC)
Role in Grid	Reserve Provider   Frequency Support   Peak Support   Market Operations



MYLATTI  
125 MW BESS



**CORE MESSAGE:** MYLATTI 125 MW BESS acts as a flexible and reliable reserve resource, ensuring grid security while also enabling optimal utilization for energy operations based on SLDC instructions.



# DSM (Deviation Settlement Mechanism) / ACE (Area Control Error)

## DSM / ACE MANAGEMENT USING MYLATTI 125 MW BESS – OPERATING PHILOSOPHY, CALCULATIONS & EXAMPLES

### 1. WHAT DSM / ACE MEANS (OPERATIONALLY)

- DSM (Deviation Settlement Mechanism)  
→ financial penalty for deviating from schedule
- ACE (Area Control Error) → real-time control signal

$$ACE = (P_{\text{actual}} - P_{\text{schedule}}) + B \cdot (f - 50)$$

Where:

- $P_{\text{actual}} - P_{\text{schedule}}$  → tie-line / power imbalance
- $B$  → frequency bias (MW/Hz)
- $f$  → system frequency (Hz)

$ACE > 0$  → excess generation → need to absorb power (BESS charges)

$ACE < 0$  → deficit → need to inject power (BESS discharges)

### 2. ROLE OF MYLATTI 125 MW BESS

BESS is used to:

- ✓ Reduce DSM penalties
- ✓ Maintain ACE close to zero
- ✓ Improve frequency stability



MYLATTI  
125 MW BESS

Acts as fast balancing resource

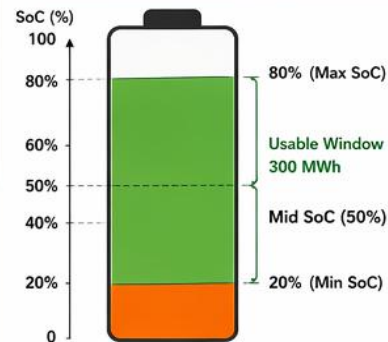
### 3. KEY CONCEPT: SOC OPERATING WINDOW

Assume MYLATTI:

- Energy capacity = 500 MWh
- SoC limits:  $SOC_{\min} = 20\%$ ,  $SOC_{\max} = 80\%$

Usable energy window:

$$E_{\text{usable}} = (80 - 20)\% \times 500 \\ = 60\% \times 500 = 300 \text{ MWh}$$



Maintain SoC in mid-range (40% – 60%)  
to enable both charge & discharge capability

### 4. BESS RESPONSE BASED ON ACE / DSM VOLUME LIMITS

#### A. FIRST VOLUME LIMIT (Mild ACE / DSM)

Rule: BESS moves SoC toward mid-point (50%)

► Mid SoC Calculation:

$$SOC_{\text{mid}} = \frac{SOC_{\text{max}} + SOC_{\text{min}}}{2} \\ = \frac{80 + 20}{2} = 50\%$$

► Example:

- Current SoC = 70%
- Target = 50%
- Energy to discharge:  
 $(70 - 50)\% \times 500 = 20\% \times 500 = 100 \text{ MWh}$

► Operation:

Use low C-rate (say 0.25C)

$$P = 0.25 \times 125 = 31.25 \text{ MW}$$

► Time required:

$$t = \frac{100}{31.25} \approx 3.2 \text{ hours}$$

✓ Meaning:

- Smooth correction
- No aggressive action
- Maintain flexibility

#### B. SECOND VOLUME LIMIT (Moderate ACE / DSM)

Rule: BESS counters ACE with moderate power (medium C-rate)

► Example:

$$ACE = -80 \text{ MW (deficit)}$$

► Use:

$$P_{\text{BESS}} \approx 0.5C = 0.5 \times 125 \\ = 62.5 \text{ MW}$$

► Effect:

Remaining imbalance:

$$80 - 62.5 = 17.5 \text{ MW}$$

→ Remaining handled by:

- generators
- AGC

► Energy usage:

For 15 minutes (0.25 hr):

$$E = 62.5 \times 0.25 = 15.6 \text{ MWh}$$

✓ Meaning:

- Faster correction
- Still controlled
- Avoids full discharge

#### C. BEYOND SECOND LIMIT (Severe ACE / Contingency)

Rule: Use maximum C-rate (full power)

► Example:

$$ACE = -150 \text{ MW}$$

► BESS output:

$$P = 125 \text{ MW (full)}$$

► Remaining:

$$150 - 125 = 25 \text{ MW}$$

► Energy usage:

For 10 minutes ( $\frac{10}{60}$  hr):

$$E = 125 \times \frac{10}{60} = 20.8 \text{ MWh}$$

✓ Meaning:

- Emergency action
- Frequency support critical
- Prevents:
  - grid collapse
  - load shedding

### 7. COMBINED CONTROL PHILOSOPHY

Condition	ACE Level	BESS Action	C-rate
Mild	Small ACE ( $ ACE  < 30 \text{ MW}$ )	Move SoC to 50% (SoC balancing)	Low (0.2 – 0.3C)
Moderate	Medium ACE (30 – 100 MW)	Counter partially (Moderate response)	Medium (0.4 – 0.6C)
Severe	High ACE ( $ ACE  > 100 \text{ MW}$ )	Full response (Max power)	High (1C)

### 8. PRACTICAL MYLATTI STRATEGY

1 Maintain SoC

$$40\% \leq SOC \leq 60\%$$



2 Monitor ACE

- ACE < 30 MW → Mild
- 30 – 100 MW → Moderate
- $|ACE| > 100 \text{ MW}$  → Severe



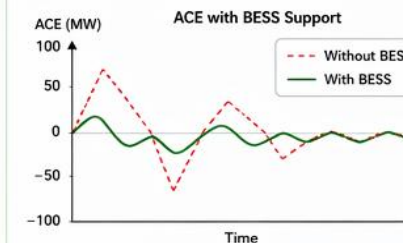
3 Dispatch BESS

$$P_{\text{BESS}} = f(ACE, SOC, \text{limits})$$

Subject to: Power limits, SoC limits, ramp rate, SLDC instructions

### 9. WHY THIS APPROACH WORKS

- Avoids unnecessary battery cycling
- Preserves energy for contingencies
- Minimizes DSM penalty
- Improves frequency control



KEY  
TAKEAWAY



MYLATTI 125 MW BESS operates in a staged ACE control mode:  
Mild deviations are managed through SoC balancing, moderate deviations through partial response, and severe deviations through full power injection, ensuring optimal DSM performance while preserving battery availability for contingencies.



BESS Capacity  
125 MW / 500 MWh



Usable Energy Window  
300 MWh  
(20% – 80% SoC)



Mid SoC Target  
50%



SoC Operating Window  
40% – 60%  
(Recommended)



# PEAK DEMAND MANAGEMENT USING MYLATTI 125 MW / 500 MWh BESS



SLDC may finalise the input energy and output energy schedules for BESS block wise to meet the peak demand period considering the **Aux Consumption**, **RTE**, **C rate** etc.

## 1. CONCEPT



**MYLATTI**  
125 MW / 500 MWh BESS

Charge (Store Energy)  
during Off-Peak / Low  
Demand Period

Discharge (Supply Energy)  
during Peak / High  
Demand Period

**OBJECTIVES**

- ✓ Reduce peak demand on the grid
- ✓ Avoid grid overloading and DSM penalty
- ✓ Flatten load curve
- ✓ Optimize energy usage and operating cost

## 2. KEY FACTORS CONSIDERED BY SLDC

Auxiliary Consumption (Aux)  
≈ 2% of input energy

Round Trip Efficiency (RTE)  
≈ 90%

C-rate Limits (Charge / Discharge Power Limits)

State of Charge (SoC) Limits (Operational Range)

## 3. MYLATTI BESS – TECHNICAL DETAILS

BESS Rating (AC)	125 MW / 500 MWh
PCS Capacity (AC)	137.5 MVA (24 × 5 MVA + 7 × 2.5 MVA)
Usable Energy	500 MWh (Full Usable)
Round Trip Efficiency (RTE)	90%
Aux Consumption	≈ 2% of input energy
SoC Operating Range	0% – 100% (Full Usable)
Max Charge / Discharge Power	125 MW
Duration at Full Power	4 Hours (500 MWh / 125 MW)

## 4. USABLE ENERGY CALCULATION

BESS Rating = 125 MW / 500 MWh (Full Usable)

At Full Power Discharge:

$$\text{Energy Supplied} = \text{Power} \times \text{Time} = 125 \text{ MW} \times 4 \text{ h} = 500 \text{ MWh}$$

## 5. CHARGING ENERGY REQUIREMENT (WITH LOSSES)

Energy required to be delivered during peak ( $E_{\text{out}}$ ) = 500 MWh

Considering RTE = 90%

Energy to be charged ( $E_{\text{in}}$ , w/o Aux) =  $500 / 0.90 = 555.6 \text{ MWh}$

Including Aux Consumption (2%)

Total Input Energy ( $E_{\text{total}}$ ) =  $555.6 \times 1.02 \approx 567 \text{ MWh}$

≈ 567 MWh input energy is required to deliver 500 MWh during peak.

## 6. CHARGING SCHEDULE (OFF-PEAK EXAMPLE)

Assume Off-peak charging window = 6 hours  
(e.g., 00:00 – 06:00)

Required Charging Power

$$P_{\text{charge}} = \frac{E_{\text{total}}}{\text{Charging Duration}}$$
$$= \frac{567 \text{ MWh}}{6 \text{ h}} \approx 94.5 \text{ MW}$$

Check C-rate (Assume 500 MWh capacity)

$$\text{Charge C-rate} = \frac{94.5}{500} = 0.19\text{C}$$

Within typical operational limit (≤ 0.5C to 1C)

## 7. DISCHARGE SCHEDULE (PEAK EXAMPLE)

Assume Peak period = 4 hours (e.g., 18:00 – 22:00)

Discharge Power

$$P_{\text{discharge}} = \frac{E_{\text{out}}}{\text{Peak Duration}}$$
$$= \frac{500 \text{ MWh}}{4 \text{ h}} = 125 \text{ MW}$$

Check C-rate

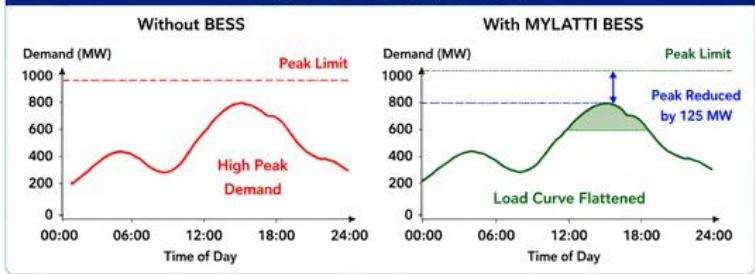
$$\text{Discharge C-rate} = \frac{125}{0.25\text{C}}$$

Within typical operational limit (≤ 0.5C to 1C)

## 8. BLOCK-WISE SCHEDULE EXAMPLE (15-MIN INTERVALS)

Time Block	Period	Operation	Power (MW)	Energy in Block (MWh)	Cumulative SoC (MWh)
00:00 – 06:00	Off-Peak	Charging	≈ 95	≈ 23.8	0 → 500
06:00 – 18:00	Day Time	Idle / Reserve / Market	0 to variable	–	Maintain 100%
18:00 – 22:00	Peak	Discharging	125	31.25	500 → 0
22:00 – 24:00	Night	Idle / Reserve	0 to variable	–	At minimum
Total				500 MWh discharged during peak	

## 9. IMPACT ON LOAD CURVE



## 10. IMPORTANT NOTES

- BESS will always maintain SoC limits as per SLDC instructions. (Typically 0% – 100% for full usable projects).
- Schedule may change based on grid conditions, reserve requirements, and market signals.
- In the event of reserve shortfall or frequency issues, BESS may be diverted from peak shaving to grid support.
- SLDC / CEA / SRPC guidelines and real-time directions will be strictly followed.

## 11. SUMMARY

Deliver 125 MW for 4 hours during peak

500 MWh usable energy supplied

Peak demand reduced by up to 125 MW

Helps in DSM, reduces penalty and grid stress

Efficient, reliable and grid supportive operation

## 12. KEY TAKEAWAY

MYLATTI 125 MW / 500 MWh BESS can deliver full 125 MW for 4 hours during peak period, subject to SoC availability, RTE, Aux consumption, C-rate limits and SLDC instructions.





# MARKET OPERATION

## BESS OPERATION – FIRST VOLUME LIMIT OF DSM OR SMALL ACE



During the first volume limit of DSM or some defined quantum of ACE,  
BESS can operate as per likely DSM Rates.

### 1. FIRST VOLUME LIMIT

Small DSM deviation  
or  
Small ACE



$|ACE| \leq \text{Threshold}_1$   
(Low deviation zone)

### 2. ECONOMIC DECISION BASED ON DSM RATES



BESS decides whether to  
**Inject** / **Absorb** / **Do nothing**

### 3. POSSIBLE BESS ACTIONS



**DEFICIT ( $ACE < 0$ ) & DSM PRICE HIGH**

- BESS Discharges (Injects Power)  
→ Reduce deviation and avoid penalty



**DEFICIT ( $ACE < 0$ ) & DSM PRICE LOW**

- BESS may not respond aggressively
- Conserve SoC for critical events



**SURPLUS ( $ACE > 0$ ) & DSM PRICE LOW / NEGATIVE**

- BESS Charges (Absorbs Power)
- Utilize surplus energy economically

### 4. LAYERED RESPONSE STRATEGY

**SMALL DEVIATION**  
(First Volume Limit)



Economic Operation  
(DSM Rate Based)

**MODERATE DEVIATION**



Partial Correction  
(Balanced Response)

**LARGE DEVIATION**



Full Correction  
(System Security Priority)

### 5. BENEFITS

- ✓ Optimizes operation based on DSM prices
- ✓ Avoids unnecessary battery cycling
- ✓ Reduces DSM cost and penalties
- ✓ Preserves SoC for critical events
- ✓ Ensures system flexibility and reliability



BESS acts as an economically optimized balancing resource in the first volume limit,  
and as a strong support resource when deviations become larger.

# CONGESTION DEPLOYMENT BY RLDC/NLDC

## DURING CONGESTION DEPLOYMENT BY RLDC/NLDC



### BESS TO COUNTER CONGESTION AT **HIGHEST C RATE**



#### CONGESTION IDENTIFIED BY RLDC/NLDC

When any transmission corridor/element is overloaded or forecasted to overload.

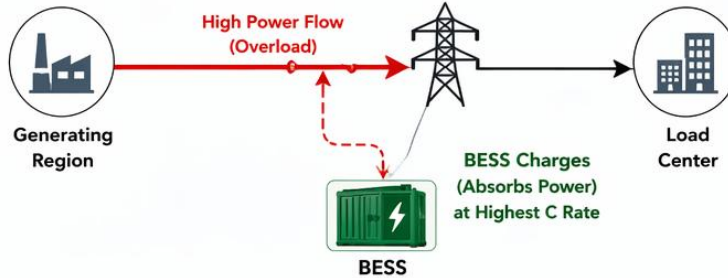


#### BESS DEPLOYMENT INSTRUCTION

BESS is instructed to counter congestion by operating at **HIGHEST C RATE**.

#### CASE 1: CONGESTION DUE TO EXCESS POWER FLOW

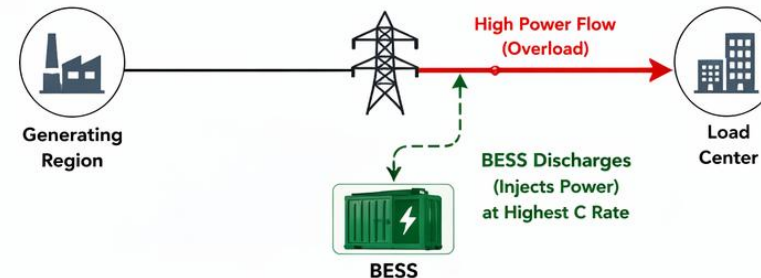
(Over-generation / High Flow)



BESS absorbs power locally at maximum C-rate to reduce flow on the congested corridor.

#### CASE 2: CONGESTION DUE TO POWER DEFICIT / REVERSE FLOW

(Under-generation / Low Local Supply)



BESS injects power locally at maximum C-rate to reduce dependency on congested corridor.

#### KEY POINTS

- ✓ Deployed on real-time instruction of RLDC/NLDC.
- ✓ BESS responds at highest C-rate (maximum charge or discharge power).
- ✓ Fast response relieves congestion and prevents line tripping.
- ✓ Operates irrespective of SoC band, within available energy and technical limits.

#### HIGHEST C RATE – EXAMPLE

⚡ BESS Capacity (AC)	125 MW
🕒 Max C-Rate	1C
🕒 Highest C-Rate Power	125 MW
🕒 Sustained for	as per SoC & energy availability

#### OUTCOME / BENEFITS

- ✓ Immediate congestion relief.
- ✓ Improves transfer capability of the network.
- ✓ Enhances grid reliability and security.
- ✓ Supports optimal utilization of transmission assets.
- ✓ Enables real-time decision and fast corrective action.



BESS acts as a fast and flexible resource to counter congestion by operating at **HIGHEST C RATE** as per RLDC/NLDC instructions to ensure grid security and system reliability.

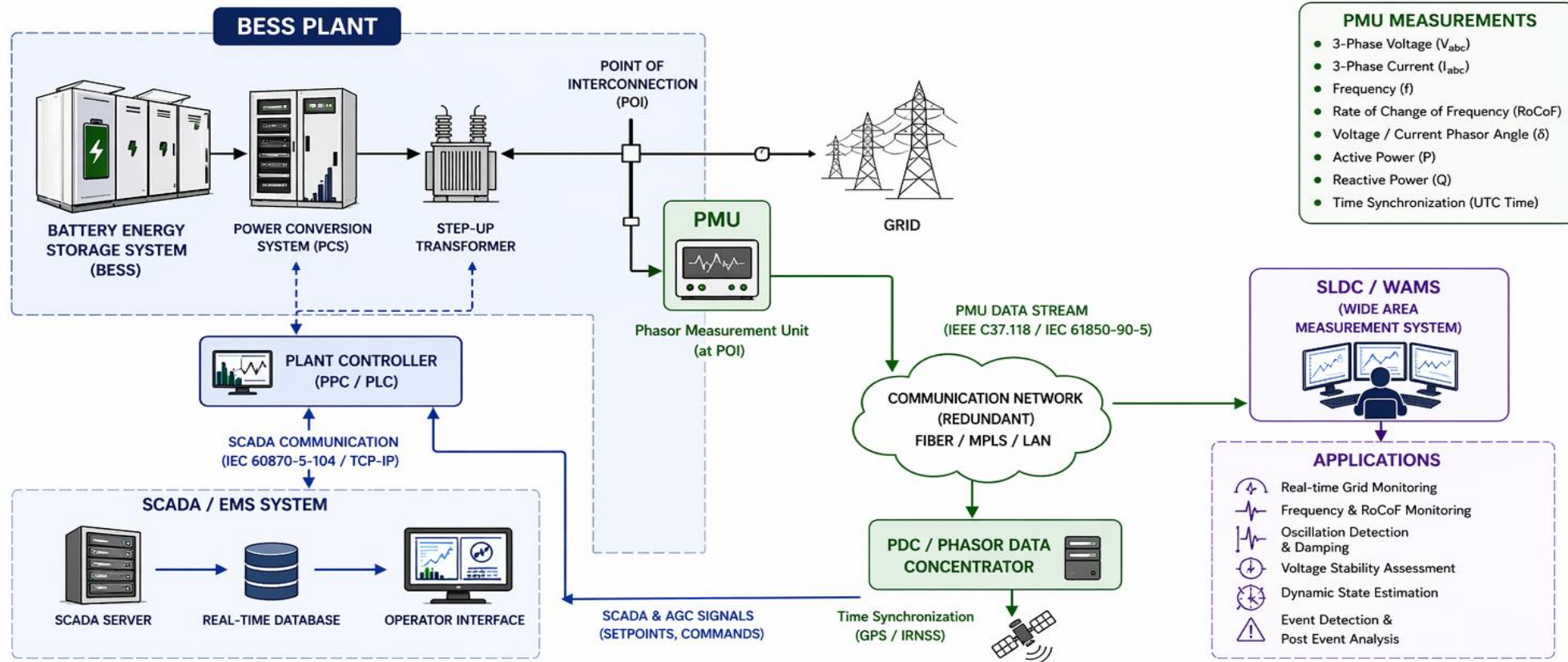




# PHASOR MEASUREMENT UNIT

## PMU INTEGRATION WITH BESS – ARCHITECTURE

High Speed, Time Synchronised Monitoring for Real-time Grid Visibility



### KEY FEATURES

- ✓ High speed (25/50 samples per second)
- ✓ Time synchronized using GPS / F1RNSS
- ✓ Wide area visibility and situational awareness
- ✓ Supports AGC, protection & stability analysis
- ✓ Helps in fast decision making and system security

### DATA FLOW SUMMARY

- PMU Data Flow (High Speed Phasor Data)
- SCADA / AGC Data Flow (Commands & Telemetry)
- Control & Monitoring within BESS Plant

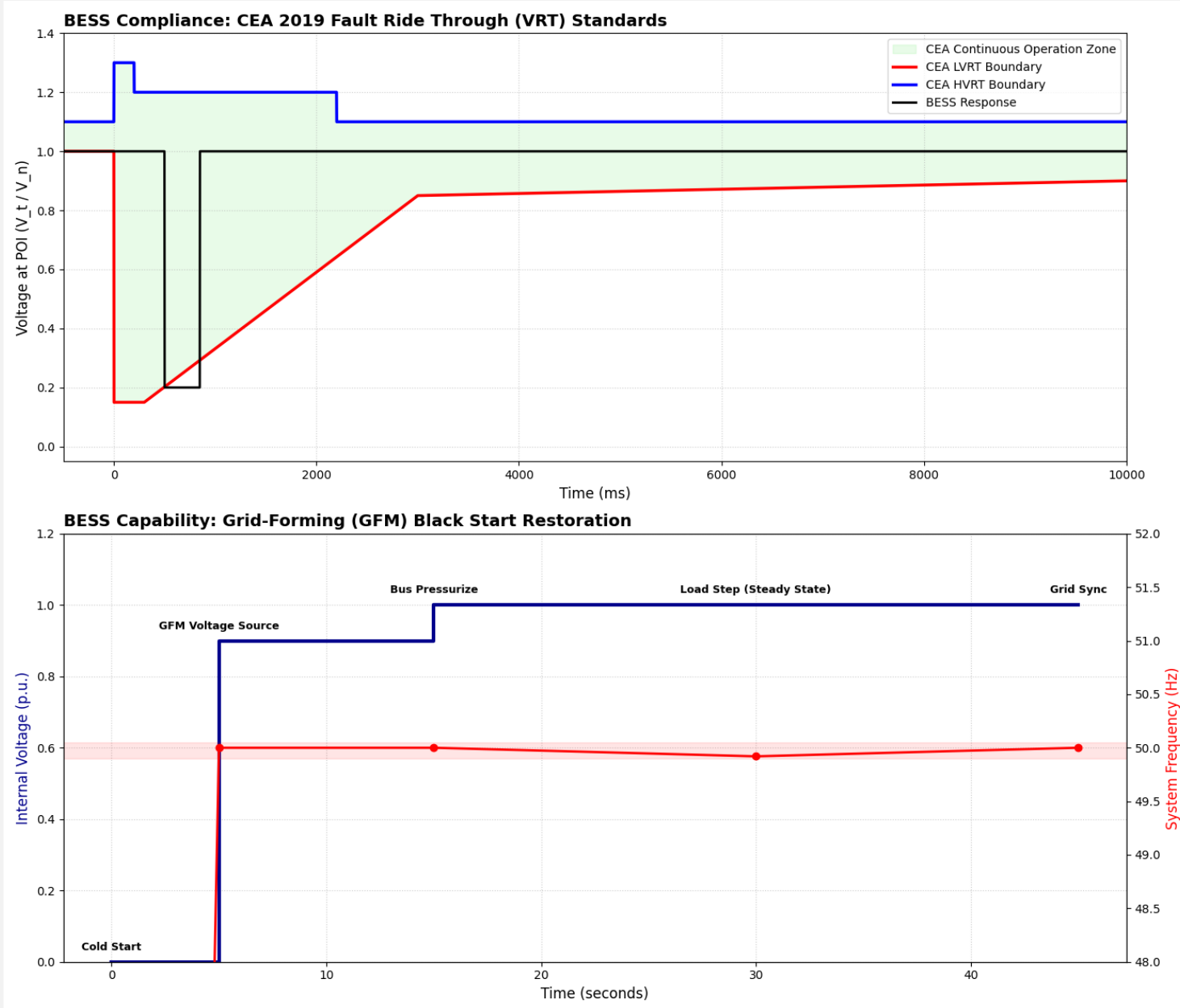
### STANDARDS & PROTOCOLS

- PMU Data Format : IEEE C37.118
- Communication : IEC 61850-90-5 / TCP-IP
- SCADA Protocol : IEC 60870-5-104
- Time Sync Source : GPS / IRNSS

### LEGEND

- PMU Data
- SCADA / AGC Data
- Internal Control / Monitoring
- Circuit Breaker / Isolator

# FAULT RIDE THROUGH





# CONGESTION DEPLOYMENT BY RLDC/NLDC

## EVACUATION / TRANSMISSION CONSTRAINT

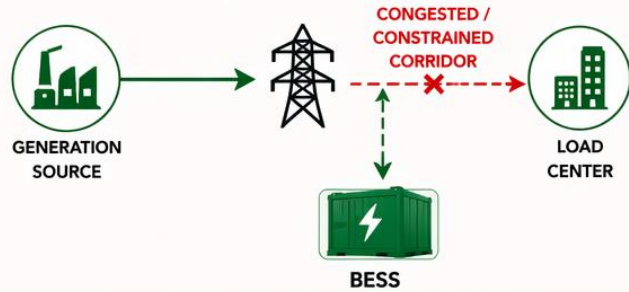


BESS deployed to handle evacuation constraint or transmission constraint should **primarily handle the constraint**.

If constraint is not there in real time it can be **used for other purpose**.

### 1. CONSTRAINT EXISTS (REAL TIME)

BESS PRIORITIZED TO HANDLE CONSTRAINT

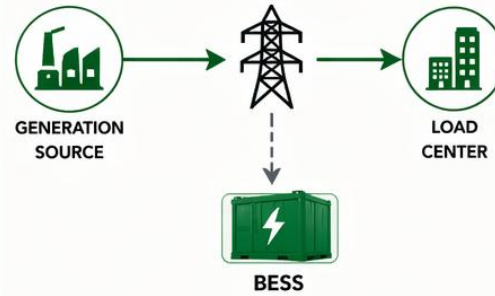


BESS charges (absorbs) or discharges (injects) power at required level to relieve the constraint.

**PRIMARY OBJECTIVE: HANDLE THE CONSTRAINT**

### 2. NO CONSTRAINT IN REAL TIME

BESS CAN BE USED FOR OTHER PURPOSES



#### POSSIBLE USES

- Peak Shaving
- Market Operations
- Reserve Provision
- DSM Support
- Other Grid Support



When no constraint is observed in real time, BESS can be utilized for other operational needs.

### 3. KEY OPERATING PRINCIPLES



#### Constraint Handling is the Primary Priority

BESS will be dispatched first to manage evacuation / transmission constraints.



#### Real-Time Assessment

Constraint status is continuously monitored in real time by SLDC/RLDC.



#### Dynamic Re-Purposing

When constraint is not present, BESS can be re-allocated to other uses.



#### System Security & Reliability

Ensures efficient utilization of BESS while maintaining grid security.



#### Optimal Utilization

Maximizes the value of BESS by prioritizing grid needs and enabling flexibility.



BESS will always prioritize evacuation/transmission constraint handling.  
If no constraint exists in real time, it can be optimally used for other grid operations.

# SYSTEM OPERATION

## MANUAL ENTRY BY SYSTEM OPERATOR & CENTRALIZED BESS OPTIMISATION



BESS should be able to run to **manual entry by System Operator**.  
As States are going for multiple BESS at various location the BESS despatch needs to be **centrally managed** through **BESS optimiser at SLDC** to avoid counter dispatches among BESS.

### 1. MANUAL ENTRY BY SYSTEM OPERATOR



System Operator

Operator can manually enter:

- Charge / Discharge Power (MW)
- Schedule (Time block wise)
- Mode of Operation
- Priority / Objective
- Any other instruction



BESS Executes  
as per Manual Entry

### 2. CENTRALIZED DISPATCH THROUGH BESS OPTIMISER AT SLDC



BESS - 1  
Location A



BESS - 2  
Location B



BESS - N  
Location N

SLDC  
BESS OPTIMISER

- Data Aggregation
- Optimisation Engine
- Constraint Handling
- Schedule Generation

Coordinated Dispatch



Avoids counter  
dispatches among  
BESS

### 3. BESS MAY BE DEPLOYED TO VARIOUS COMBINATIONS OF OBJECTIVES



Peak Demand  
Management



ACE  
Management



Congestion  
Management



Market Based  
Operation



Reserve  
Provision

...

Any other  
operational  
objective

### 4. OPTIMISATION FRAMEWORK

Define Objective Function(s)

- ✓ Peak Demand Management + ACE
- ✓ Peak Demand Management + Market Based
- ✓ Congestion Management + Reserve Provision
- ✓ Other combinations as required

Optimiser Processing

- Maximizes benefit / minimizes cost
- Considers multiple objectives
- Finds optimal schedules for all BESS
- Respects technical & operational constraints

Outputs



Optimal Schedules  
(Charge / Discharge)  
for all BESS  
(Time block wise)

### 5. LIMITING CONSTRAINTS CONSIDERED IN OPTIMISATION



BESS Technical Limits

- Power (MW) Limits
- Energy (MWh) / SoC Limits
- Ramp Rate / C-rate Limits



Operational Constraints

- Min / Max SoC
- Min Up/Down Time
- Efficiency / Aux Losses



Time & Schedule Constraints

- Time block duration
- Must-run commitments
- Availability windows



Grid Constraints

- Transmission limits
- Congestion limits
- Security constraints



Policy / Market Constraints

- DSM / Market rules
- Reserve requirements
- Regulatory directives



OBJECTIVE

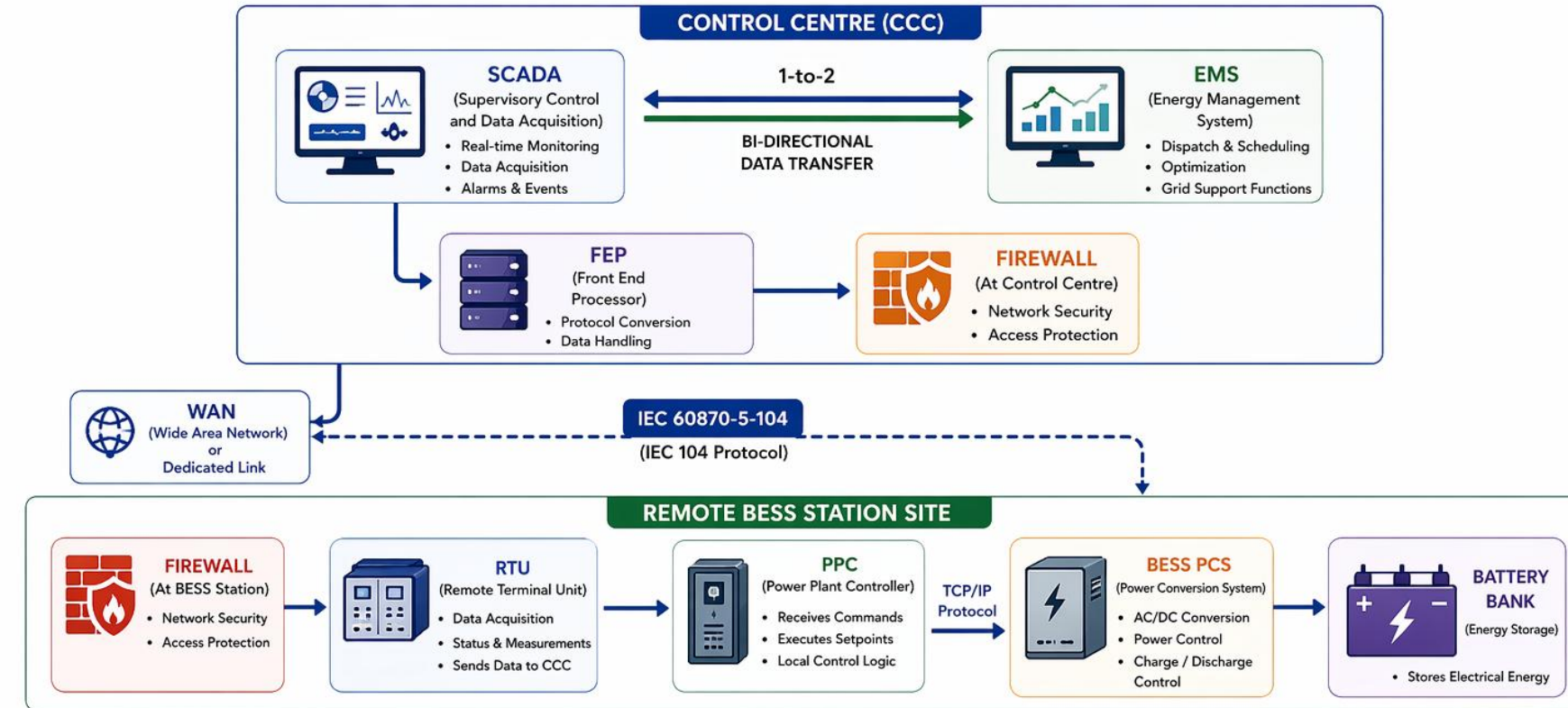
Ensure **optimal, coordinated and reliable** operation of all BESS across the State through **centralized optimisation**, operator oversight and **objective-based dispatch** while respecting all limiting constraints.



# COMMUNICATION ARCHITECTURE

## BESS INTEGRATION COMMUNICATION ARCHITECTURE

Secure, Reliable and Standardized Communication for Monitoring and Control of BESS



### DATA FLOW

- Telemetry / Status / Alarms / Measurements (From BESS to Control Centre)
- Control Commands / Setpoints / Dispatch (From Control Centre to BESS)

### KEY FEATURES

- Secure Communication
- Real-time Monitoring & Control
- Standard Protocol (IEC 104)
- Cyber Security at Both Ends
- Reliable & Fast Response

### COMMUNICATION PROTOCOLS

- IEC 60870-5-104 (IEC 104)**
  - Between Control Centre and BESS Station (RTU)
- TCP/IP Protocol**
  - Between RTU, PPC, PCS and BESS Equipment



This architecture enables **secure bi-directional communication** between SLDC Control Centre and BESS Stations, ensuring reliable monitoring, control and efficient operation of BESS for grid support.

*Thank  
you!*