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Session : Energy Technologies and Standardization Landscape

Grid Modernization: Role of IEEE 1547-2018 and IEEE 2800-2022 Supporting Renewable Energy Targets and Adaptation to Indian Requirements

Presented By

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Standards in Smart ENERGY TECHNOLOGIES

Interoperability:

- Standards allow devices, systems, and components from different manufacturers to seamlessly communicate and interact within the smart energy system.

Cybersecurity Protocols:

- Smart systems rely on digital communications, which are vulnerable to cyberattacks. Established security standards helps protect from unauthorized access, data breaches and hacking.

Operational Safety:

- Standards define safety requirements for the operation, maintenance, and installation of smart energy systems which helps prevent malfunctions, accidents, and electrical hazards.

Data Accuracy and Consistency:

- With different devices and sensors generating vast amounts of data, standardizing data recording, transmission and interpreted makes monitoring and control easy.

Grid Integration of Renewables:

- Standards ensure that distributed energy resources (DERs) like solar panels, wind turbines and battery storage systems can connect to the grid without causing disruptions.

Scalability and Flexibility:

- Standards provide a foundation for the evolution and expansion of smart grids, enabling the integration of new technologies over time without disrupting existing systems.

Cost Efficiency:

- Standardized systems benefit from economies of scale, reducing manufacturing and implementation costs, making smart grid technologies more affordable.

Regulatory Compliance:

- Governments and regulatory bodies often mandate compliance with specific standards to ensure that smart energy systems are safe, reliable and secure.

IS 18968: 2025/IEEE 1547-2018: DER-Grid Integration Features

- The IS 18968:2025 standard offers numerous benefits for Distributed Energy Resources (DER) and grid integration by providing clear guidelines and technical requirements for DER interconnection with the grid. Here are the key benefits:

1. Enhanced Grid Stability and Reliability

- Support for Voltage and Frequency regulation
- Ride-Through Capability

2. Increased DER Penetration

- Scalability
- Flexible Grid Management

3. Improved Power Quality

- Harmonic Control and Power Quality

4. Support for Microgrids and Resilience

- Anti-Islanding Protection
- Resilience

5. Better Grid Operator Control and Monitoring

- Interoperability and Communication
- Remote Settings Adjustment

IS 18968: 2025/IEEE 1547-2018: DER-Grid Integration Features

6. Economic and Environmental Benefits

- Cost Savings:.
- Increased Renewable Energy Integration:

7. Consistency and Simplification

- Consistent set of technical requirements
- Uniform Testing and Certification:.

8. Enhanced Safety for Utility Workers and the Public

- Anti-Islanding Protection:
- Coordinated Protection Schemes.

9. Future-Proofing the Grid

- Adaptability:
- Integration of Advanced Technologies

In summary, IS 18968: 2025/IEEE 1547-2018 enhances the integration of DERs into the grid by improving reliability, scalability, and safety while enabling greater renewable energy deployment and supporting grid modernization efforts.

IEEE 2800-2022: DER-Grid Integration Features

The IEEE 2800-2022 standard offers significant benefits for the integration of inverter-based resources (IBRs), such as large-scale solar, wind, and energy storage systems, into the transmission-level grid.

1. **Enhanced Grid Stability and Reliability**
2. **Facilitates High Renewable Energy Penetration**
3. **Improved Power Quality**
4. **Increased Operational Flexibility**
5. **Enhanced Grid Resilience**
6. **Lower Integration Costs**
7. **Facilitates Advanced Grid Services**
8. **Better Coordination and Communication**
9. **Supports Future-Proofing of the Grid**
10. **Economic and Environmental Benefits**
11. **Improved Safety and Security**

In summary, IEEE 2800-2022 provides a comprehensive framework for integrating transmission-level DERs, enhancing grid stability, reliability, and resilience. It supports the large-scale adoption of renewable energy while reducing integration costs, improving power quality, and helping meet global sustainability goals

Adaption of IEEE 1547-2018, INDIA Specific Changes

Frequency: The frequency of 60 Hz in the IEEE 1547 standard can be referred as 50 Hz

The 1547 is applicable for voltage ranges from 1 KV to 35 KV. Voltages followed at the distribution system in India are 11 kV and 33 kV. Hence the standard applies to India with no changes in voltage.

Table 2 – Applicable voltages when PCC is located at low voltage

The row "Single phase 120/240 V" shall be referred as follows:

Single phase	Line to neutral – for 230 V DER units
Three Phase	Line to line – for 440 V DER units

Table 3 – Minimum measurement and calculation accuracy requirements for manufacturers

The row "Frequency" shall be referred as follows:

Frequency	10 mHz	50 cycles	40Hz to 55Hz	100 mHz	5 cycles	40Hz to 55Hz

Table 4 Enter Service Criteria for DER of Category I, Category II, and Category III

(*Clause* 4.10.2)

Sl No.	Enter Service Criteria		Default Settings	Ranges of Allowable Settings
	Permit Service		Enabled	Enabled/Disabled
(1)	(2)		(3)	(4)
i)	Applicable voltage within range	Minimum value	≥ 0.9 p.u.	0.8 p.u. to 0.9 p.u.
ii)		Maximum value	≤ 1.1 p.u.	1.1 p.u. to 1.2 p.u.
iii)	Frequency within Range	Minimum value	≥ 49.5 Hz	49.0 Hz to 49.9 Hz
iv)		Maximum value	≤ 50.1 Hz	50.1 Hz to 51.0 Hz

Adaption of IEEE 1547-2018, INDIA Specific Changes

Table 3 Minimum Measurement and Calculation Accuracy Requirements for Manufacturers[a]
(*Clause* 4.4)

Sl. No.	Time Frame	Steady-State Measurements			Transient Measurements		
	Parameter	Minimum Measurement Accuracy	Measurement Window	Range	Minimum Measurement Accuracy	Measurement Window	Range
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
i)	Voltage, RMS	(± 1 % V_{nom})	10 cycles	0.5 p.u. to 1.2 p.u.	(± 2% V_{nom})	5 cycles	0.5 p.u. to 1.2 p.u.
ii)	Frequency[b]	10 mHz	50 cycles	40 Hz to 55 Hz	100 mHz	5 cycles	40 Hz to 55 Hz
iii)	Active Power	(± 5 % S_{rated})	10 cycles	0.2 p.u. <P <1.0 p.u.	Not required	N/A	N/A
iv)	Reactive Power	(± 5 % S_{rated})	10 cycles	0.2 p.u. <P <1.0 p.u.	Not required	N/A	N/A
v)	Time	1 % of measured duration	N/A	5 s to 600 s	2 cycles	N/A	100 ms < 5 s

[a] A three-phase transformer or a bank of single-phase transformers may be used for three-phase systems.
b Including delta with mid tap connection (grounded or ungrounded).
[a] Measurement accuracy requirements specified in this table are applicable for voltage THD < 2.5 percent and individual voltage harmonics <1.5 percent.
[b] Accuracy requirements for frequency are applicable only when the fundamental voltage is greater than 30 percent of the nominal voltage.

Table 7 Minimum Reactive Power Injection and Absorption Capability

(*Clause* 5.2)

Sl No.	Injection Capability as % of Nameplate Apparent Power (kVA) Rating	Absorption Capability as % of Nameplate Apparent Power (kVa) Rating
i)	60	60

Table 11, Table 12 and Table 13 DER Response (Shall Trip) to Abnormal Voltages for DER of Abnormal Operating Performance

Sl No.	Shall Trip Function	Ranges of Allowable Settings	
		Voltage (P.U. of Nominal Voltage)	Clearing Time (S)
(1)	(2)	(3)	(4)
i)	Overvoltage	V > 1.1	2 s
ii)	Undervoltage	V < 0.8	2 s

6.5.1 Mandatory frequency tripping requirements

Table 18 – DER response (shall trip) to abnormal frequencies for DER of abnormal operating performance Category I, Category II, and Category III

The table shall be referred as the following:

Shall trip function	Default settings		Ranges of allowable settings	
	Frequency (Hz)	Clearing time (s)	Frequency (Hz)	Clearing time (s)
OF	52.0	0.16	50.05 - 52.0	0.16-1000
UF	47.5	0.16	47.5 - 48.8	0.16-1000

6.5.2 frequency disturbance ride-through requirements

This complete sub-section clause shall be referred as the following:

The DER shall continue normal operation for frequency changes in the 47.5 Hz to 52 Hz frequency range. For Over Frequency (OF) events in the 50.05 Hz to 52.0 Hz, the DER shall continue operating and shall adjust the generated power to additional requirements of the Central Electricity Authority (CEA). In the absence of Central Electricity Authority requirements, the DER operator shall operate according to the requirements of the connected Area EPS, distribution license.

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Links/References (If any)