Ministry of Industry and Trade

Hợp tác Đức
DEUTSCHE ZUSAMMENARBEIT

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ERAV

Summary of Grid Codes for Facilitating Variable Renewable Energy Integration (Viet Nam)

Within the bilateral cooperation project "Smart Grids for Renewable Energy and Energy Efficiency" (SGREEE) between the German and Vietnamese Government, the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH has supported the Electricity Regulatory Authority of Viet Nam (ERAV) on the "Revision of technical grid codes for facilitating variable renewable energy integration".

After thorough study and consultation process, on 18th November 2019, the Ministry of Industry and Trade (MOIT) has issued Circular 30/2019/TT-BCT on amending and supplementing a number of articles of the existing Grid code (Circular 25/1016/TT-BCT) and Distribution code (Circular 39/2015/TT-BCT) in order to maintain and operate the national power system or power plants, in the most efficient, reliable, economic and secure manner while facilitating variable Renewable Energy (vRE) integration.

In order to provide the audiences with a clear picture of new technical requirements, the SGREEE would summarize and brief on crucial points as below:

Technical requirements for wind and solar power plants connected to transmission network and distribution network from the medium voltage level onwards

1. Active Power operation mode of wind and solar power plants:

- Free generation mode: Operating with the possibly highest generation power
- Generation power control mode: shall be able to limit generation power as commanded by the dispatch instruction (error within ± 01% of rated power)

2. Frequency range of operation

Frequency band	Minimum time
From 47.5 Hz to 48.0 Hz	10 minutes
Over 48 Hz to under 49Hz	30 minutes
From 49 Hz to 51 Hz	Continuous generation
From 51 Hz to 51.5 Hz	30 minutes
Over 51.5 Hz to 52 Hz	01 minute

Table 1: Minimum time to maintain power generation in proportion to frequency bands of the electricity system

3. Reactive power operation mode of wind and solar power plants

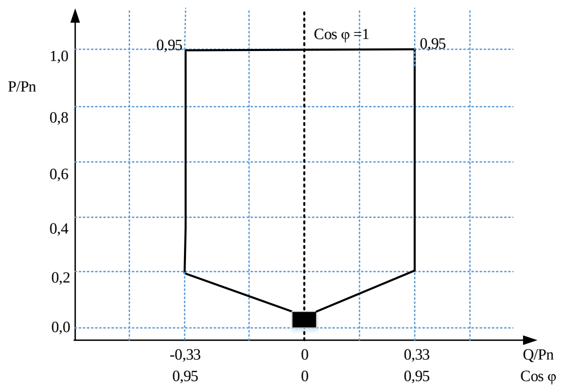

Figure 1. Reactive power characteristics applied for Wind and solar power plants

- If generated active power is greater or equal to 20% of rated power and the voltage at connection point falling within the band of ± 10% nominal power, the power plant shall be capable of making continuous adjustments to reactive power in a power factor from 0.95 (corresponding to reactive power injection mode) to 0.95 (corresponding to reactive power absorption mode).
- If generated active power is less than 20% of rated power, the power plant may reduce ability of absorbing or injecting reactive power in accordance with characteristic of the power plant.

4. Voltage and reactive power control mode

Wind and solar power plants are capable of controlling voltage and reactive power under following modes:

- Voltage control mode by the voltage adjusting droop characteristics (voltage/reactive power characteristic);
- Control mode by the installed value of reactive power;
- Control mode by power factor.

If the voltage at the connection point is within ± 10% of the nominal voltage, the wind and solar power plants shall be able to adjust the voltage at the low voltage side of the step-up transformer with a deviation of no more than ± 0.5% of rated voltage (compared to the installed values of voltage) whenever the reactive power of the generating set is still within the permissible operating band and completed in no more than 05 seconds.

5. Fault ride through behaviors: HVRT & LVRT

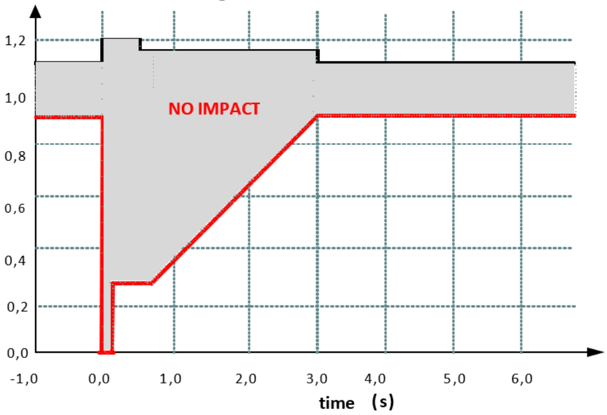

Figure 2. Voltage band for maintaining connection requirements at the connection point

- Voltage from 0.9 pu to under 1.1 pu, wind and solar power plants shall maintain continuous generation;

- Voltage less than 0.3 pu, minimum maintaining time is 0.15 second;

- Voltage between 0.3 pu and under 0.9 pu, minimum maintaining time is calculated by the following formula:

$$T_{min} = 4 \times U - 0.6$$

In which:

+ T_{min} (second): Minimum time to maintain power generation;
+ U (pu): Actual voltage at connection point (pu - per-unit).

- Voltage from 1.1 pu to under 1.15 pu, wind and solar power plants shall maintain generation for 03 seconds;

- Voltage from 1.15 pu to under 1.2 pu, wind and solar power plants shall maintain generation for 0.5 seconds.

Ancillary services

Ancillary services are deployed to maintain electrical energy and power reserves of the electricity system in accordance with operation and electricity system security standards and to ensure minimum expenses in accordance with conditions and obligations of the national electricity system. The system and market operator (SMO) shall be responsible for calculating the demand of ancillary services towards the national electricity system.

Types of ancillary services & technical requirements:

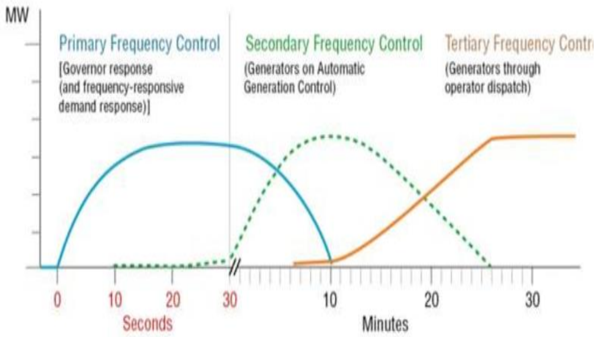

Figure 3. Frequency control level

- **Secondary frequency control** (Secondary Frequency Regulation): Generating sets providing secondary frequency regulation service shall start providing frequency regulation power within 20 seconds after receiving the AGC signal from the electricity system and electricity market operator and supply all registered secondary frequency regulation power within 10 minutes and maintain this power level for at least 15 minutes.

- **Quick - start**: Generating sets providing quick reserve shall increase to the rated power within 25 minutes and maintain at this power level for at least 08 hours.

- **Voltage adjustment**: Generating sets providing voltage adjustment services shall have an ability to change reactive power outside the adjustment band to meet the requirements of the electricity system and electricity market operator.

- **Must-run operation reserves** to ensure electricity system security: Generating units providing must-run operation reserve services to ensure the electricity system security shall be able to increase to the rated power within 01 hour and maintain the minimum rated power level for 08 hours (excluding start time).

- **Black start:** Generating units providing black start service shall be able to self-start from cold state without supplying power from the national electricity system and shall be able to connect and energize the electricity system after successfully starting".

Short-circuit current and fault clearing time

Voltage level	Permissible maximum short - circuit current (kA)	Maximum fault clearing time of main protection (ms)
500 kV	50	80
220 kV	50	100

Table 2. Permissible maximum value of short-circuit current and fault clearing time by main protection

- Main protection of an electrical equipment is of key protection, installed and set to make initial impacts, ensuring selectivity and reliability of impacts and impacting time of the protection system in case of a fault within the scope of protection towards protected equipment.
- For 110 kV busbars of 500 kV, 220 kV substations in the transmission grid, permissible maximum short-circuit current is **40 kA.**

Technical requirements at distribution level

1. Voltage:

Nominal voltage levels in the distribution system include 110 kV, 35 kV, 22 kV, 15 kV, 10 kV, 06 kV and 0.38 kV with Permissible operating voltage deviations:

- At the busbar: + 10% and - 05% against the nominal voltage;
- At the connection point of customers is ± 05%;
- At the connection point of the power plant is + 10% and - 05%.

2. Harmonics:

Voltage harmonic:

Voltage level	Total harmonic distortion (THD)	Individual distortion
110 kV	3.0%	1.5%
Medium voltage	5%	3.0%
Low voltage	8%	5%

Table 3. Permissible maximum level of voltage harmonic distortion

Current harmonics:

Voltage level	Total distortion	Individual distortion
110 kV	3%	2%
Medium, low voltage	5%	4%

Table 4. Permissible maximum current harmonic distortion level for power plant

Voltage level	Total distortion	Individual distortion
110 kV	4%	3.5%
Medium voltage	8%	7%
Low voltage	12% if load is ≥50 kW 20% if load is <50 kW 20% knee <50 kW	10% if load is ≥50 kW 15% if load is <50 kW

Table 5. Permissible maximum current harmonic distortion level for load

3. Flicker severity

Voltage level	Flicker severity limit
110 kV	$P_{st95\%} = 0.80$ $P_{lt95\%} = 0.60$
Medium voltage	$P_{st95\%} = 1.00$ $P_{lt95\%} = 0.80$
Low voltage	$P_{st95\%} = 1.00$ $P_{lt95\%} = 0.80$

Table 6. Maximum permitted flicker severity at all connection points Under normal operating conditions

4. Short - circuit current and fault clearing time

Voltage level	Permissible maximum short - circuit current (kA)	Maximum fault clearing time of main protection (ms)
110 kV	31.5	150
Medium voltage	25	500

Table 7. Permissible maximum short-circuit current and maximum fault clearing time

Requirements for solar power system connected to the low-voltage network

1. Connection power

- The total installed power of the solar power system connected to the low-voltage level of low-voltage substations shall not exceed the installed power of such substation;
- Solar power systems with a power of under **20 kWp** downwards are connected to a **single-phase** or **three-phase** grid as agreed with the electricity distribution unit, electricity distribution unit and retailer;
- Solar power systems with a power of **20 kWp** onwards shall be connected to a **three-phase** grid.

2. Frequency band of operation

Frequency band of the electrical system	Minimum time to maintain
48 Hz to 49 Hz	30 minutes
49 Hz to 51 Hz	Continuous generating
51Hz to 51.5 Hz	30 minutes

Table 8. Minimum time to maintain power generation in proportion to frequency band of electricity system

- When the electricity system's frequency is greater than 50.5 Hz, solar power system with 20kWp onwards shall reduce active power as determined by the following formula:

$$\Delta P = 20 \ x \ P_m \ x \ \frac{50.5 - f_n}{50}$$

In which:
+ ΔP: Level of active power reduction (MW);
+ P_m: Active power corresponding to the point of time prior to power reduction (MW);
+ f_n: Electricity system frequency prior to power reduction (Hz).

3. Voltage band vs generation requirement

- The solar power system shall maintain continuous generation in voltage bands at connection points

Voltage at connection point	Minimum time to maintain
Less than 50% of nominal voltage	Not required
50% to 85% of nominal voltage	2 seconds
85% to 110% of nominal voltage	Continuous generation
110% to 120% of nominal voltage	2 seconds
Greater than 120% of nominal voltage	Not required

Table 9. Minimum time to maintain generating operation corresponding to the voltage bands at the connection points

4. Reactive power control mode

- Solar power systems connected to low-voltage network shall not generate reactive power to the grid and operate in reactive power consumption mode with a power factor (cosφ) greater than 0.98./.



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