Interconnection of wind power onto the Vietnamese power grid

Trung Nam Tran

B.Eng., Ph.D.

Engineering and Operation Dept., Vietnam Electricity

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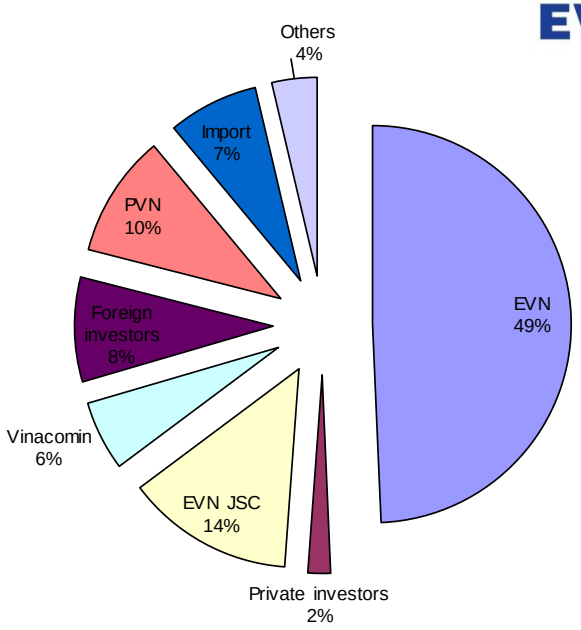
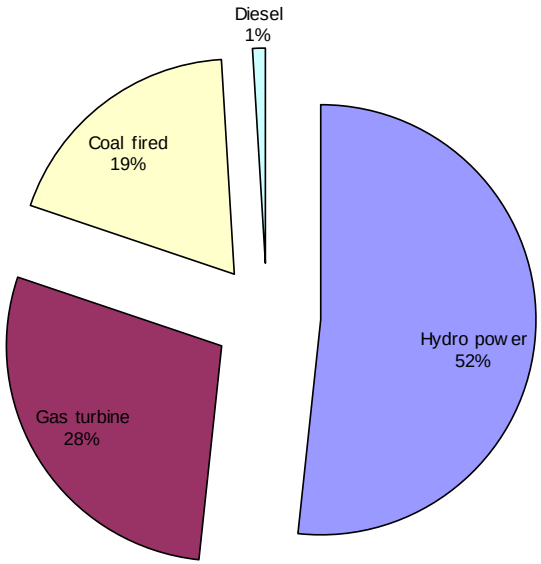
Contents

- Overview of the Vietnamese power system
- Current and future development of wind power in Vietnam
- Studies on impacts and interconnection of wind power onto the power grid
- Future studies

Vietnamese Power System (1)

- Installed generation capacity: 26,926 MW
- Peak demand in 2012: 18,649 MW
- Energy sales in 2012: 120 bil. kWh





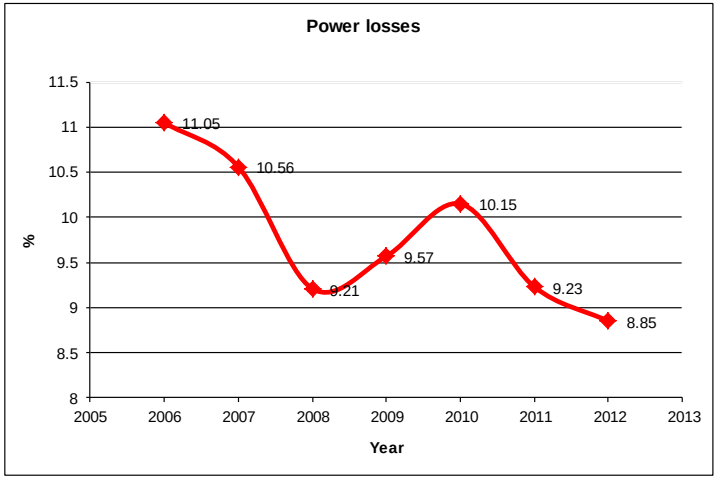
Vietnamese Power System (2)

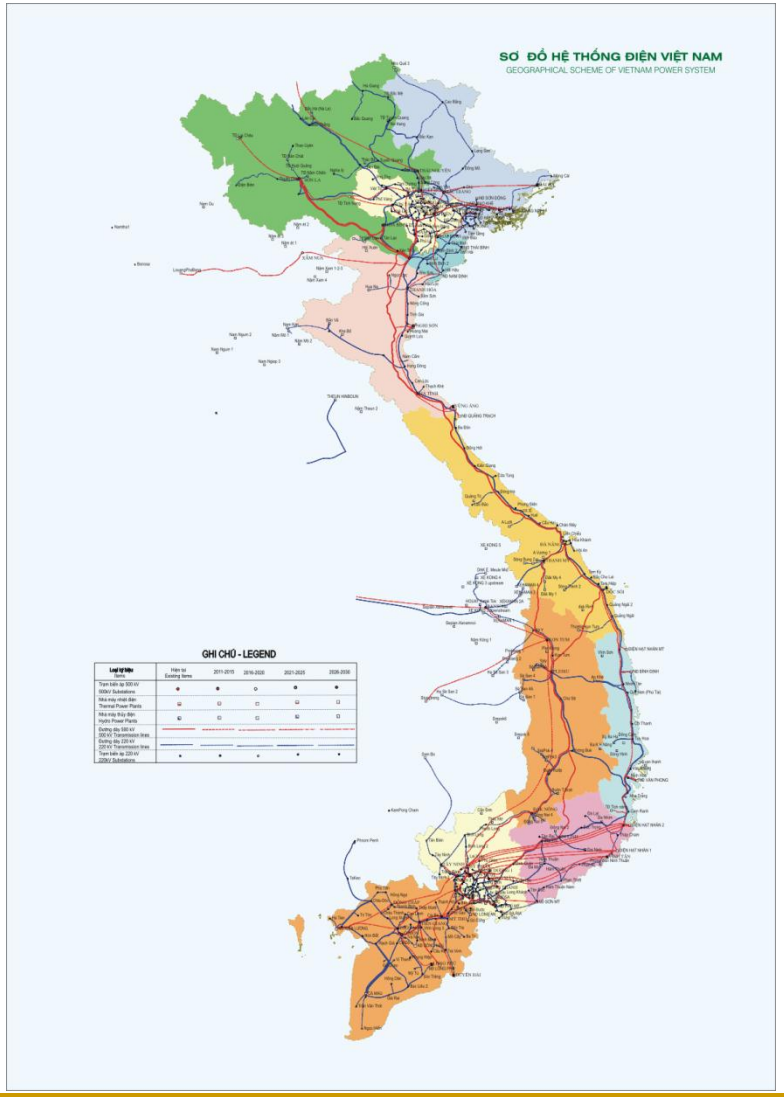
Transmission

	Length (km)	Capacity (MVA)
500 kV	4,437	13,950
220 kV	10,999	25,839
110 kV	13,141	30,284
Medium Vol.	138,971	-
Low Vol.	230,437	-

Distribution

Load dispatch centres: A0, A1, A2, A3





Existing wind power installations

- In operation:
  - Tuy Phong wind farm – 30 MW
    (20 x 1.5 MW)
  - Phu Quy hybrid system – 6 MW
    (3 x 2 MW)
- In construction:
  - Phuong Mai wind farm – 30 MW
    (6 x 2.5 MW by 2012; 6 x 2.5 MW by 2015)
  - Bac Lieu wind farm – 99.2 MW
    (10 x 1.6 MW by 2012)

Wind power development in Vietnam

Year	2011	2020	2030
Wind power installed capacity (MW)	30	1,000	6,200
Wind power from Binh Thuan province (MW)		700	2500
System capacity (MW)	21,000	66,979	137,000
Total wind power ratio	**0.14%**	**1.5%**	**4.5%**
Wind power energy (TWh)		2.31	16.68
Wind energy from Binh Thuan province (TWh)		1.5	5.475
System energy (TWh)		329	695
Total wind energy ratio		**0.7%**	**2.4%**

Collaborative research studies

- Cooperation between EVN and ICASEA
- Component 1: study on wind power impacts on the power system
- Component 2: study on interconnecting wind power to the power system
- Component 3: study on wind power in the electricity market

Wind power impacts (1)

- **Issues of wind power**
  - Availability of Resource
  - Poor Stability Support
  - Voltage Regulation
  - Change in System Fault Levels
  - Power Quality Issues

- **Assessing impacts of wind power to the power system**
  - Constituents of a Wind Integration Study
  - Software Tools for Wind Integration Studies
  - Data Required for Wind Integration Studies

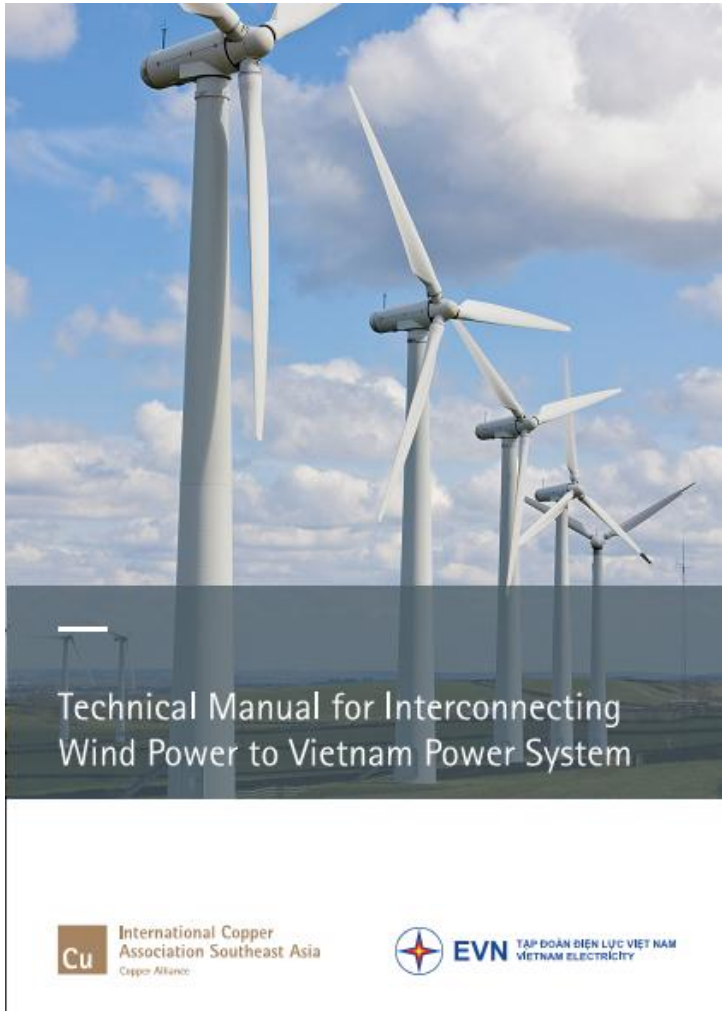
Wind power impacts (2)

- **Remedies to minimise impacts of wind power**
  - Measures to reduce the impacts of wind variability
  - Improving fault performance of wind turbines
  - Reactive power support from wind power plants
  - Meeting transmission capacity needs

Wind power impacts (3)

- **Recommendations**
  - Firm up the master plan for wind power development for a certain planning window and make it an integral part of other planning activities.
  - If not already available, commence on-site wind measurements for areas earmarked by the wind power master plan.
  - Compile all necessary element and operational data of the power system in order to carry out the dynamic simulations of the wind integration study.
  - Specify the capabilities and operational conditions that need to be met by new wind power plants, based on grid codes and experience of other countries, until such time own wind integration studies are conducted.

Wind power interconnection criteria (1)



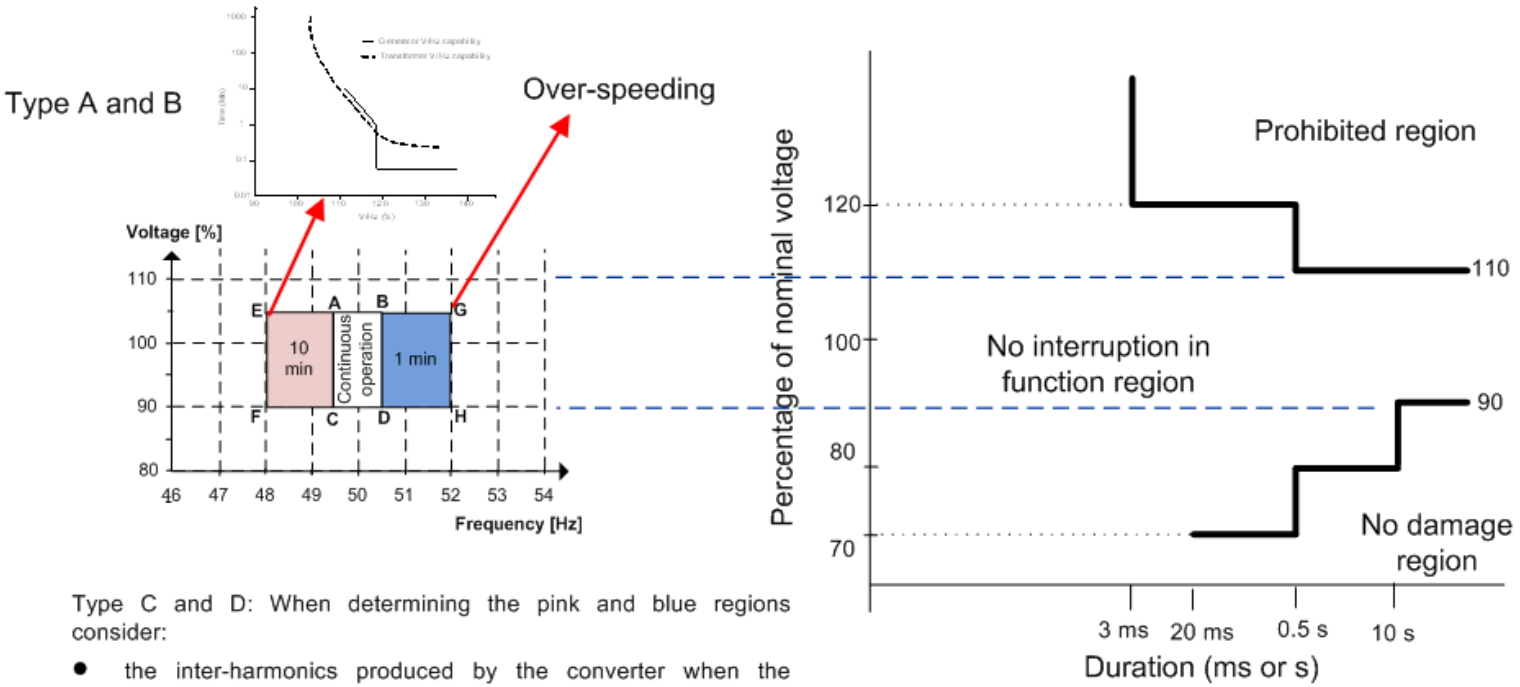
Wind power interconnection criteria (2)

- *Wind connection criteria is only valid up to 5% of wind penetration with respect to system capacity.*
- National regulatory circulars of Vietnam
  - Circular No 12/2010/TT-BCT by MOIT dated 15 April 2010 on transmission system
  - Circular No 32/2010/TT-BCT by MOIT dated 30 July 2010 on distribution system
- Best international practice reviewed here are:
  - Ireland – Distribution code and Grid code
  - Indian Grid code
  - UK – G59, G75 & Grid code
  - Denmark - Generating facilities that are connected below 100 kV and that are connected above 100 kV
  - Germany - Guideline for generating plants' connection to and parallel operation with the medium-voltage network and Grid code
  - Parts of Chinese grid code

Wind power interconnection criteria (3)

Voltage and Frequency

For both DG and Tx connections it is proposed that the nominal voltage and frequency at the POC shall be within the region specified in the following figure



Type C and D: When determining the pink and blue regions consider:

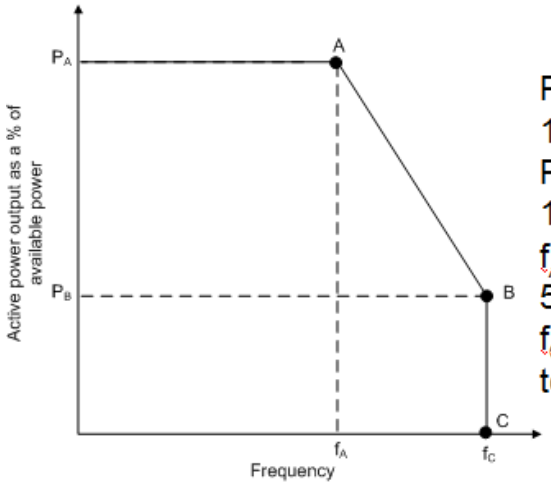
- the inter-harmonics produced by the converter when the frequency deviates from 50 Hz
- tracking capabilities of the PLL that is being used in the controller.

Wind power interconnection criteria (4)

Active power

DG connection code

A wind farm of capacity greater than or equal to 5 MW shall have capability to reduce power upon receiving a command from the TSO and its power output shall reduce with the frequency as shown in Figure

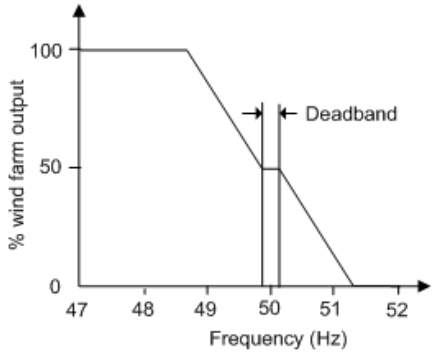


P_A shall be 100%;
P_B shall be 20 – 100%;
f_A shall be 50.5 – 51 Hz;
f_C shall be 50.5 to 52 Hz.

Transmission connection code

All generating units shall be fitted with a fast acting speed governing system to provide frequency response under normal operational conditions

The speed governor shall be capable of accepting raise or lower signals or set-points from SCADA/EMS system of TSO and electricity market, unless this requirement is waived



Wind power interconnection criteria (5)

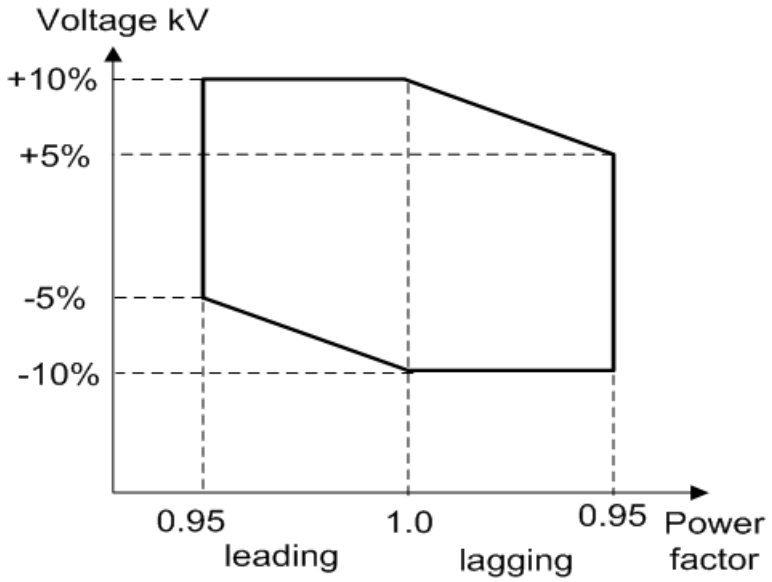
Reactive power

DG connection code

it is recommended to limit the reactive power requirements to local reactive power injection. Therefore the wind farm shall operate within the power factor of 0.95 leading to unity.

Transmission connection code

It is recommended that the wind farm shall fulfill the range of reactive power requirements shown in following figure



Wind power interconnection criteria (6)

Low voltage ride through

DG connection code

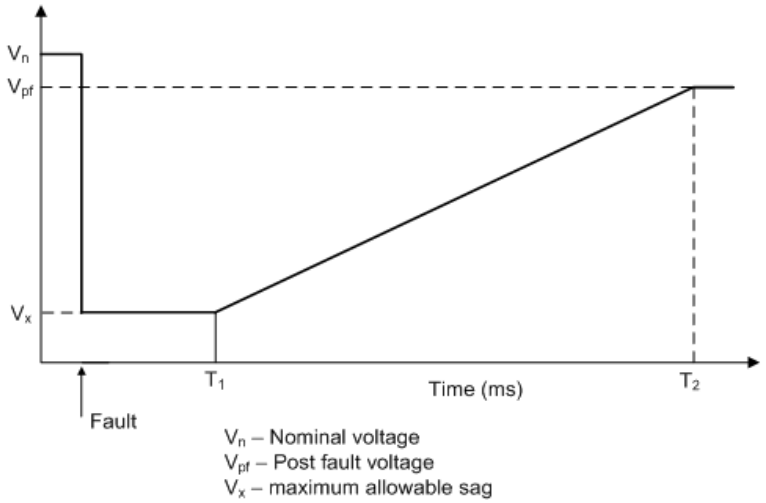
Considering the fact that LVRT capability is mainly included in countries where wind penetration is high or expected to be high in foreseeable future, it is proposed to disconnect the wind farm during a grid fault.

Allowing a WTG to remain connected to the grid
- gives rise to hazardous situations
- degrades grid performance
- could suffer damages to the WTG

The cost of providing extra circuitry to equip WTG with LVRT cannot be justified.

Transmission connection code

In absence of any dynamic studies, the LVRT performance shown in the following figure is suggested. The exact shape should be established by extensive dynamic studies.



Wind power interconnection criteria (7)

Harmonics

DG connection code

Total Harmonic Distortion of the voltage at any Connection Point, shall not exceed these limits that stipulated in the following table:

Voltage level	Total Harmonic Distortion	Individual Distortion
110kV	3%	1.5%
MV and LV	6.5%	3.0%

Transmission connection code

Permission maximum value for the total voltage distortion (Calculate by percent % of nominal voltage) by the components of higher harmonics cause voltage for 110kV, 220kV and 500kV must be less than or equal to 3%.

Wind power interconnection criteria (8)

Flicker

DG connection code

In the normal condition, value of voltage flicker at any connection point does not exceed the limitation value that is stipulated in the following table:

Voltage	Allowed Tolerance
110kV	$P_{st95\%} = 0.80$ $P_{lt95\%} = 0.60$
Medium Voltage	$P_{st95\%} = 1.00$ $P_{lt95\%} = 0.80$

Transmission connection code

The maximum allowable flicker severity in the transmission network specified in the following table

Voltage level	Plt95%	Pst95%
110, 220, 500kV	0.6	0.8

Wind power interconnection criteria (9)

Grounding arrangements

- Neutral grounding of the DNO distribution systems vary from isolated, Peterson coil to direct grounding depending on the voltage levels of the distribution systems.

- To ensure that earth fault protection schemes of the existing distribution systems are not disturbed, a WPGF shall be connected to such distribution systems through a transformer with a suitable vector group to:
  - prevent distribution system earth faults appearing as earth faults on the WPGF side and
  - enable the total earth fault current to flow through DNO's distribution system neutrals

Wind power interconnection criteria (10)

Protection schemes

- All WPGFs are required to install protection schemes to:
  - protect the distribution system from faults originating in the WPGF, which include but not limited to wind turbine, generator, WTG step-up transformer, collector facilities and equipment used to interconnect the WPGF and the distribution system
  - protect the distribution system from the abnormal operating conditions of the WPGF
  - disconnect WPGFs during distribution system faults, and
  - disconnect WPGF when islanding occurs
- All protection schemes of the WPGF shall be fully discriminative with the upstream (DNO) protection schemes

Wind power interconnection criteria (11)

SCADA

- To ensure reliable and secure operation of distribution networks, WPGFs are required to comply with the SCADA requirements as outlined in Circular 32, Clauses 40 and 41.

- It is recommended that WPGFs exceeding 10MW shall provide information related to the wind speeds in addition to those specified in the preceding paragraph.

Wind power interconnection criteria (12)

Communications

- WPGF communications systems shall comply with the Article 40 of Circular 32:
  - Customer using distribution network owns power plants that have capacity not less than 10MW and all 110kV transformer have responsibility for installation Data/Information System in range management and connect to Distributor's data/Information System for data/information communication and transmission proposes in operation system. Customer's devices must be compatible with existing system of distributor.
  - In case of customers out of scope that is stipulated in clause 1 this Article shall has the right to get agreement for installation data/information System that clarify in connection agreement.
  - The Distributors have responsible for investment, management network in own area for power distribution system operation.
  - The Distributors have responsible for providing for Customer using distribution network the requirement on data/information, communication protocol and interface and co-ordination with Customer in testing, verifying and connected information system of customer to their existing data/information system.

Wind power interconnection criteria (13)

Requirements of data made available

- Forecast of wind power production in every month
- Key technical characteristics of the wind generator
- Technical data for electrical equipment in connection points (Switching equipment, Transformers, Reactive compensation equipment, Voltage Transformer (VT)/ Current Transformer (CT), Protection and Control system, Transmission lines and cables related to power connection point)
- Single line diagram of the connection point
- Equipment and their ownership at the connection point
- Authorized officers for operation and safety
- Operational procedures and the parties responsible for operation
- Names of Officers who provided the above information and the dates.

Future work on wind grid interconnection

- **Impact studies of wind power in two high wind potential regions: Binh Thuan and Bac Lieu provinces.**
- **Conduct detailed simulations to complete the wind grid code**
- **Submit to MOIT for approval and promulgation**

Any questions?