

CONNECTING RENEWABLE ENERGY SOURCES TO THE ELECTRO-POWER NETWORK

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Abstract

The aim of this article is to bring together issues related to the connection of renewable energy sources to the power grid. The principles of connecting the production sources described in this article apply practically to any renewable source for which the final product is electricity. Recent changes to the Energy Law in micro and small installations have also been considered, as well as the impact of these changes on the connection process.

Key words

electrical grid, connection, RES, biogas plant

Introduction

Every investor planning to build and operate a renewable energy source (RES) should determine what energy product will be produced and how it will be used. This energy will most often be available in the form of heat transferred by the energy factor¹ or electricity. In most cases, this will be electricity because energy in this form is easy to delivery to consumers, even at great distances.

A renewable energy source is a device that converts a renewable resource into electricity. This transformation may take place by mechanical, thermal, or photovoltaic means. In broader terms, the *source of RES* is an assembly consisting of a generator and auxiliary equipment needed to energy connected by a common electrical installation. The energy available at the output of this system is the utility energy for further use.

Utility energy can be used to power nearby devices and buildings, or it can be fed into a professional power grid, making it possible for other users to use it. There is also a mixed variant, such as the energy we use to feed our own devices, and the surplus part over our own needs is introduced into the professional network. The intention to introduce energy into the professional network will make the investor a potential user of the power system, enabling the introduction of energy from the RES to the network of this system, while maintaining continuity and reliability of reception. In other words, the power system will accept any amount of energy that falls within the technical capabilities of the system.

Classification of installations

The main parameter characterizing the renewable energy source, in addition to the type of primary energy used for generation, is the power of generating devices. This power refers to a single production device or a set of several such devices, for example, operating in a location and supplying the same group of receiving devices².

New concepts concerning renewable sources of energy have been introduced to the Energy Law (hereafter "act") through an amendment dated 26 July, 2013 [2]³. While in the old act there is only a definition of RES, after the amendment a partial categorization of sources appeared. The following concepts (Art.3 of the act) were introduced:

- Micro-installation – a renewable energy source, with a total installed electrical power of no more than 40 kW, connected to a power grid with a nominal voltage of less than 110 kV;
- Small installation – a renewable energy source, with a total installed electric power of more than 40 kW and not more than 200 kW, connected to a power grid with a nominal voltage of less than 110 kV.

¹ e.g. water, steam, air

² an example is a wind farm or a photovoltaic farm

³ effective from 11 September 2013

Based on the above distinction and other provisions of the act⁴, RES can be classified as follows:

- micro-installation;
- small installation;
- renewable energy source, with a total installed electric power of more than 200 kW and not more than 5 MW;
- renewable energy source, with a total installed electrical capacity of more than 5 MW;
- other renewable sources.

This classification is helpful in determining support for a particular source, both from the grid connection and others, such as the possibility of purchasing the produced energy or obtaining green certificates.

The concept of biogas requires a separate explanation, specifically biogas as an energy source used to produce electricity. Due to the definitions contained in the act, we can distinguish two types of biogas:

- *Biogas*, such as that from landfills and generated in the process of draining or treating sewage or decomposition of stored plant and animal matter;
- *Agricultural biogas* as a gaseous fuel obtained by methane fermentation of agricultural raw materials, byproducts of agriculture, liquid or solid animal excrement, by-products or residues from the processing of agricultural products or forest biomass.

This classification was introduced for the agricultural biogas production support system. This support is available to manufacturers listed in the register of energy companies that engage in the production of agricultural biogas and are operated by the Agricultural Market Agency⁵. It consists of the ability to obtain certificates of agricultural biogas origin if the biogas is injected into the gas company's grid or electricity, or if heat is produced from this biogas. In the case of gas injection into the gas grid, it is necessary to connect to this grid. Connections are made by Gas System Operators (GSO) on the same basis as when connected to the power grid.

Connecting to the power grid

For a source of RES to start using a particular power system, it must be connected to it. In accordance with Art. 7 of the act, connections to the public grid are made by network companies dealing with the distribution of electricity through these grids, called Distribution System Operators (DSO), due to the duties they perform. The DSO provides a distribution service mainly consisting of ensuring the continuity and reliability of the supply or receipt of energy solely based on an agreement. The manufacturer or energy producer does not charge any fees for the use of the grid, unless it draws energy from this grid, such as for its own use, if there is insufficient production in its own source.

The term "connection" means the process by which a facility is connected to this grid. The connection is made by means of a section or network element used to connect an entity's equipment, installation or network with the required connection power, with the remainder of the network of the power company providing the network service for the connecting entity. The connection links the place of connection to the place of delivery/receipt of energy.

The location of the connection point is always chosen by the network company. This location most often does not meet the investor's expectations in this regard. The investor assumes that the place will be as close as possible to the source, and that the networking company chooses it with technical reasons in mind. Divergences can be significant, depending on the power of the source and the availability of a grid with the right voltage for power output.

The process of connection to the power grid can be divided into the following stages:

Stage 1 - Choosing the grid to which connection will be possible

In the case of newly constructed installations, it is necessary to identify the power company (network) to whose grid the facility can be connected. In practice, it is most likely to be connected to one of the large power companies such as PGE, Tauron, Energa, or Enea. It is also possible to connect to the grids of local distributors such as

⁴ e.g. Art. 7 (8) of the Energy Law makes the connection fee dependent on the power of the source

⁵ in accordance with Art.9p (2).

larger industrial plants or infrastructure companies. According to the amendment of the Energy Law [2], until 28-08-2014, distribution and connection services may be provided by undertakings having an appropriate license for the distribution or transmission of energy. After this date, connections can only be made to companies that have acquired the DSO status [3]. Information on operating DSOs should be provided by a local government unit, such as the commune.

In the case of existing receiving installations that do not contain a generated source or RES, the source can be connected either through this installation or by using an existing connection. In the first case, the source is indirectly connected to the grid, while in the second it is directly connected.

Stage 2 - notifying the network company of the intention to be connected

Determining whether the intended RES meets the following criteria depends on if it falls within the definition of micro-installation, if the entity applying for connection to the source is the end user⁶, or if the connection for which the entity is applying is no greater than the connection power specified in the issued connection conditions.

In this case, the connection to the network is made based on the application for connection to the micro-installation submitted in the power company to the grid to which it is to be connected.

Connections based on the application are made after the installation of appropriate protection systems and measurement and settlement systems. The cost of installation of the protection system and the measurement and settlement system is borne by the electricity distribution system operator.

The application referred to above includes the designation of the applicant for the connection of the micro-installation and the identification of the type and power of the micro-installation. It also includes information necessary to ensure that the technical and operational requirements of the micro-installation are met.

The following declaration should be included in the application:

"Aware of criminal liability for submitting a false statement under Art. 233 § 6 of the Act of 6 June 1997 - Criminal Code, I declare that I have legal title to the property on which the investment is planned and to the micro-installation and specified in the notification."

This clause replaces the body's instruction of criminal liability for making false testimony.

In other cases, the connection to the distribution network is made based on a grid connection agreement, where it is necessary to obtain connection conditions.

Requesting a network company to determine the technical conditions of connection by submitting a *"Request for definition of network connection conditions"*, whose template is specified and made available by this company⁷.

The Application is enclosed with the following:

- a) A document confirming the applicant's legal title to use the property or facility in which the connected equipment and installations will be used, including a map and an extract from the land register;
- b) A development plan or situational sketch showing the location of the facility in which the connected equipment and installations will be used, in relation to the existing network and the location of the neighboring facilities;
- c) An extract and drawing from the local spatial development plan or, in the absence of such a plan, a decision on the land development and development conditions for the property specified in the application, if required by the spatial planning and zoning regulations. The extract and drawing from the local spatial development plan or the decision on the land development and development conditions *should*

⁶ The end user is the recipient consuming energy solely for own needs. Energy is not sent to other entities or resold.

⁷ Network Companies use different templates and nomenclature of applications depending on the type of connected object (recipient/source) while maintaining the division of the connected entity into connection groups

- confirm the admissibility of the location of a given energy source in the area covered by the planned investment, which is included in the application for determining the conditions of connection;*
- d) The technical parameters, motion and operating characteristics of the connected production equipment and networks and installations.

In addition, the future manufacturer who connects the source based on an attachment agreement shall make an advance payment for the connection in the amount of PLN 30 gross per kilowatt of the connection power specified in the request for determination of the connection conditions if he or she is applying for connection to a network with a voltage higher than 1 kV.

Step 3 - Defining the conditions of connection by the network company.

Based on the application and the submitted documents, the network company issues connection conditions within 30 days if the voltage is not higher than 1 kV and 150 days in other cases. The issued terms are valid for two years from the date of their receipt. The network company may refuse to issue connection conditions due to the lack of technical or economic conditions. In the case of connecting energy sources, the refusal to issue conditions is most often technical in nature, due to the state of the network or the already issued conditions for other sources in the given location. Economic considerations usually concern the cost-effectiveness of constructing or expanding a network to connect an object. If the reason for refusal to issue the terms of connection are economic considerations, the connected entity may agree with the network company as to the amount of the connection fee at which the connection may be made.

At present, it is possible to define a different size of the connection power than is apparent from the application. In earlier regulations, such a request was rejected for technical reasons. Art. 7 sec. 8d³ of the Act stipulates that in the absence of technical or economic connection conditions for the connection power specified in the application, the network company shall notify the applicant of the available connection capacity for which the conditions can be met. If the entity, within 30 days from the date of receipt of the notification has agreed to such connection capacity, the network company issues the conditions of connection. If the entity has not agreed to such connection capacity, the network company refuses to issue the conditions of connection.

The timing of the issue is suspended until consent has been obtained from the applicant for connection.

Released connection conditions include, among others, an indication of the place of connection, place of delivery/receipt of energy together with the scope of necessary network changes related to the connection and technical information on the connection. In addition, the requirements for measuring systems are defined. It is worth mentioning here that the RES Manufacturers have measuring and billing systems installed at the place of delivery/reception of energy and on the terminals of the generator to confirm the amount of renewable energy produced [4].

The network company is obliged to specify in the connection conditions the expected schedule of connection of the renewable energy source, considering the various stages of the network expansion as well as the compilation of the planned work.

Stage 4 - Conclusion of a network connection agreement

If the applicant decides to implement the connection in accordance with the technical conditions issued during their validity, it shall conclude *a Network Connection Agreement*, the draft of which was attached to the issued conditions. The subject of the agreement is the connection of the installation of the generating source belonging to the manufacturer (connected entity) to the network of the network company. This agreement includes, among others, the commitments of the parties in terms of the connection, dates of implementation, the amount of the connection fee and the manner of its settlement, as well as the scope of works necessary for the connection. The contract is accompanied by the issued terms of connection and confirmation of the legal title to the object.

The place of delivery for the network company is the end of the network and for the recipient, the start of the installation. Therefore, the connection is carried out by both parties to the agreement. The network company carries it out within the scope of the connection (from the point of connection to the place of delivery), and the connected entity within its own installation and network (from the location of equipment to the place of delivery).

Stage 5 - Payment of connection fees

Fees for connection to the network are derived from the provisions of the Energy Law. According to Art. 7 sec. 8 of the Act, the network company charges the following fees for connection of RES sources:

- Connection of micro-installation fees are not charged;
- For a connection of a source that is not a micro-installation, with installed power of not more than 5 MW, half the fee determined based on the actual expenditure on the connection is charged;
- For a connection of source which is not a micro-installation, with installed power of more than 5 MW, the fee determined based on the actual expenditure on the connection is charged.

The settlement of the connection fee shall be accounted for by the advance payment, if it was required.

Step 6 - Realization of connection

The connection agreement is the basis for commencement of design and construction work related to the connection of the object to the network, both on the side of the network company and the manufacturer. Based on the conditions given, both parties shall proceed to develop appropriate projects, carry out the necessary documentation, obtain the necessary permits and undertake the obligations arising from the connection agreement. The work carried out must be completed by appropriate technical commissioning, which confirms that the manufacturer is ready to connect to the network and the network company is ready to connect the manufacturer. It is also the manufacturer's responsibility to make the property available for the purposes of construction of connection.

The completion of the contract is the commissioning of the work done in the scope of construction and measurement and protection, as well as settlement. Activation of the connection (voltage supply and physical connection of the manufacturer's installation to the network) is possible only after the conclusion of the contract for the provision of distribution services and installation and commissioning of measurement and settlement systems.

Using the power grid

Terminating the connection process resulting in a physical network connection is the beginning of using the power system. The connected entity must formally regulate the cooperation with the network company. For this purpose, the manufacturer does the following:

- Commit to comply with the provisions of the Distributive Network Exploitation and Operating Instructions;
- Conclude an Agreement for Energy Distribution Services (energy manufacturer) with a network company. This agreement allows the transmission of energy produced in the source using networks to this company. In addition, this agreement regulates the obligations of the parties within the implementation of energy sales and trade balancing agreements concluded by the manufacturer's participation in the balancing mechanism.
- Agree with the network company regarding the detailed rules for cooperation within the motion and operation of installation and equipment belonging to the manufacturer, and regarding cooperation with the network of this company.
- Conclude with the energy seller an energy purchase agreement to cover its own needs of the generation, installation or collection by other connected equipment, or receiving if the generation itself is insufficient. In this case, the manufacturer becomes the recipient and is obliged to conclude a distribution services agreement (energy recipient), guaranteeing the supply of purchased energy. The manufacturer shall be liable for the settlement for the distribution service rendered based on the applicable tariffs.

Employment of qualified people

According to the regulation for operating the equipment [6], with the operation of power generation equipment connected to the national power grid, regardless of the rated voltage and the cooperating systems, works may only be carried out by qualified personnel. These qualifications in supervision and performance should be confirmed by the appropriate qualification certificate.

Compliance with the above requirements is possible when the manufacturer employs qualified people or concludes an appropriate operating agreement with the entity providing such services.

Motion co-operation manual

Each manufacturer, regardless of its manufacturing technology, conducts motion and exploitation of its power equipment cooperating with the network of the network company.

The subject of the manual is the definition of rules, methods of communication, and motion co-operation between the motion and operation personnel of the power plant operating on the command and authority of the owner of the facility and the dispatching services of the network company during normal and emergency working conditions of power equipment. It also specifies administrative and operational affiliation of the equipment, as well as the type and scope of authorization of the power engineering staff of the parties.

This manual is intended for employees who organize and carry out maintenance and motion operations on the manufacturer's equipment during normal operation, emergency conditions, test motion, and tests. This manual is also intended for the networking company's services in the area of motion cooperation with power plant staff.

The manual includes:

- Technical characteristics of the power plant
- Operational limit and property boundary
- Operative (mobile) affiliation of devices
- Station access rules
- Connection operations
- Rules for transmitting and recording motion commands
- Description of the procedure for carrying out emergency works
- Description of the procedure for carrying out planned works
- Connectivity and contact persons

Conclusion

Due to the universality of the process, the principles set out in the article can also be used to connect recipients or to join other operators, such as gas or heat, to the grid.

At present, both network companies and future manufacturers are waiting for the amendment of the system regulation [5], in the scope of adapting the detailed provisions to the amendment of the act. The amended or new system regulation should systematize many issues related, among others, with micro-installations, as the current provisions of the regulation are contrary to the provisions of the law.

Bibliography

[1] Energy Law Act (Journal of Laws of 2012, item 1059 and of 2013 item 984)

[2] Act dated 16 July 2013 on amending the Energy Law act and some other acts (Journal of Laws of 2013 item 984)

[3] ANNOUNCEMENT of the President of the Energy Regulatory Office (no. 33/2013) on the amendment of some provisions of the Energy Law Act concerning the distribution system operator and storage system operator, Warsaw, 23 October 2013

[4] Regulation of the Minister of Economy of August 14, 2008 on the detailed scope of obligations for the obtainment and presentation for remission of certificates of origin, payment of the substitute fee, purchase of electricity and heat generated from renewable energy sources and the obligation to confirm the data concerning the amount of electricity generated from a renewable energy source (Dz. of Laws of 28 August 2008)

[5] Ordinance of the Minister of Economy of 4 May 2007 on detailed conditions of functioning of the power system (Journal of Laws of 29 May 2007, as amended)

[6] Ordinance of the Minister of Economy, Labor and Social Policy on detailed rules for determining qualifications by persons operating equipment, installations and networks of 28 April 2003 (Journal of Laws No. 89, item 828)