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ENSURE SAFETY OF FIRE PREVENTION AND FIRE FIGHTING FOR RENEWABLE ENERGY FACILITIES IN VIETNAM

Abstract. Renewable energy is one of the topics that always attract much attention of researchers and scientists because of its need and necessity for socio-economic development. In Vietnam too, renewable energy has been developing more and more strongly, thereby posing many opportunities and challenges for fire prevention and fighting safety. The article researches and analyzes theoretically about the structure, working principle, characteristics of fires at renewable energy facilities; on that basis, propose solutions to contribute to ensuring the safety of fire prevention and fighting for this type of facility in the coming time.

Keywords: fire prevention and fighting; renewable energy facilities; Vietnam.

1. Asking the problem

Renewable energy is a form of energy that is generated from natural processes and is continuously replenished including sunlight, geothermal, wind, tides, water and various forms of biomass [1]. These energy sources are not exhausted and are continuously regenerated, in which, solar power and wind power are the most popular and fastest growing types. Wind power is generated by wind turbines with giant propellers mounted on top of the tower, while solar power is generated from converting sunlight into electricity by using Solar panels connected to each other. The rapid growth in the number of renewable energy projects requires state management agencies to quickly complete the system of relevant legal corridors, especially regulations and standards on assurance of renewable energy safety in this field, in which the assurance of fire prevention and fighting safety plays a particularly important position.

2. Structure and operating principle

2.1. Solar power facility

Solar battery system converts energy from sunlight into direct current and then converted into alternating current through inverter (inverter) connected to the grid. The main components of this system include solar panels, inverters, racks, and a performance monitoring system. Of the above components, solar panels have the highest fire risk. The solar panel consists of many photovoltaic cells with a pure silicon main component, bonded by glass panels, EVA polymer adhesive, TPT backplate, heat-resistant aluminum frame and circuit junction box [1].

2.2. Wind power facility

Current wind turbines are divided into two types: vertical axis and horizontal axis, in which horizontal axis wind turbine with 3 blades is the most popular type today. The structure of a wind turbine consists of different parts such as: propeller, generator, gear, gearbox, brake, controller, electrical wiring system, ... The generating

units are housed in the cavity and placed on top of the pylon. Wind energy will cause the blades to rotate around the rotor connected to the main shaft, causing the drive spindle to rotate the generator shaft to generate electricity [1].

3. Hazardous nature and causes of fire and explosion

3.1. Solar power facility

The cause of solar panel fires can be caused by arcing that occurs during photovoltaic energy conversion, such as hot spots, cracks, and aging reduces power generation and damages the batteries, leading to overheating and fire. A hotspot is a local high temperature area on the panel. The occurrence of hot spots can be caused by the quality of photovoltaic cells, improper installation, lack of maintenance, shading or leaves, bird droppings, etc. In addition, the cause of the fire may be due to the contact of parts in the electrical network, parts of equipment that are not qualified, lightning strikes in the area where the equipment is located, causing the voltage of the system to increase suddenly beyond allowable threshold to cause current conflicts.

3.2. Wind power facility

Wind turbines consist of many different parts such as propellers, generator turbines, gears, gearboxes, brake units, controllers, wiring systems, support posts... The generating units are housed in the turbine and placed on top of the pylon. This is the place with the highest risk of fire in the wind turbine system because the inside of the turbine contains equipment that is easy to generate heat, ignite and catch fire. If a heat source is present, a fire can break out, which, along with the high, well-ventilated conditions, will cause the fire to quickly spread to cover the entire turbine. In addition, the area at the base of the tower (where the wires are connected, elec-

trical monitoring equipment is placed, and the entire wind turbine tower is controlled) is also a location prone to fire.

The cause of wind turbine fire can be caused by objective factors such as lightning, wind, and storm. However, through the fact that many fires have occurred due to electrical, mechanical or human subjective factors such as: Links are broken due to strong vibrations; short circuit; discharge in the transformer; electrical equipment is overloaded; failure of the control system; ... The useful life of the wind turbine, the geographical location where the wind turbine is located are important factors leading to the risks, the possibility of fire incidents and the extent of fire development. In places with hot and dry climates, cables, transformers, enclosure components and control cabinets are susceptible to damage, posing a potential risk of failure.

4. Characteristics of a renewable energy facility fire

4.1. For a solar power facility fire

Due to the built-in thermal energy, when the solar panels burn, the fire quickly develops, producing a lot of smoke and toxic gases that are dangerous to humans and the environment, typically substances: Cadmium telluride, Arsenide gallium; phosphorus; Boron; ...

The panels are usually installed firmly on the roof, when a fire occurs, it can block the entrances and access to the roof to extinguish the fire. The prolonged burning process can generate secondary phenomena such as equipment explosion, which makes firefighting work more risky and dangerous. On the other hand, because the system is installed on the roof, it will increase the weight, the prolonged burning process, under the influence of the heat source will lose the integrity and bearing capacity of the structure, leading to

roof collapse. Debris from burnt panels can fly away, causing damage, danger to people or creating new fires around.

4.2. For wind power facility fire

With operational characteristics, wind turbines must be built in geographical areas with strong and stable winds, complex geographical conditions such as the coast, sandy beaches or on high mountain slopes, with limited traffic. Wind turbine tower systems are usually over 60 m high, so if a fire occurs, there will be many favorable factors that cause the fire to develop. In case the automatic fire prevention and extinguishing devices do not work, the fire will spread to cover the entire turbine.

The most dangerous feature of a wind turbine fire is that the blades continue to rotate, which causes the fire to quickly develop into a large fire. When the fire spreads to the fan blades or the burning parts are destroyed and deployed, it can cause the burning pieces of equipment to fly away, causing new fires around such as forest fires, field fires and works and equipment in the area. It is more dangerous to threaten the safety of firefighters who are on duty on the ground.

5. Some solutions

5.1. Prevention solution

– When designing and building renewable energy plants, they must comply with the technical requirements of the industry to ensure the distance and have construction solutions such as the grounding system, lightning protection system for the plant as well as the turbines wind power, solar cell facilities to minimize the risk of being struck by lightning causing fire and explosion [2]. For rooftop solar power systems installed at civil works, it is necessary to seriously implement fire prevention and fighting safety solutions according to the instructions of the Fire

Prevention and Fighting Police agency before installation, build [4];

– The process of operation and use must strictly comply with the instructions and rules for operating structures, equipment, technological and technical systems for equipment systems; regularly monitor and maintain equipment during operation, if there is a problem, it must be repaired and remedied promptly;

– The technological equipment used must ensure the quality in terms of mechanical strength, fire resistance, heat resistance, tightness in accordance with the specified technical criteria. Working machinery and equipment must be safe against fire and explosion; During operation, measures must be taken to minimize the generation of heat sources, sparks due to friction or impact. Hot surfaces of equipment and ducts should be insulated with insulation;

– Design and equip automatic fire extinguishing systems in suitable areas such as at substations, operators, monitoring and control stations, inverter stations, wind turbines and other construction works relevant, ensuring timely fire fight at the time of occurrence of incidents. At the same time, strictly implement regulations on equipment for fire prevention and fighting [3].

– Ensure safety corridors for power grids and safety corridors for these facilities; avoid external factors affecting the facility, and at the same time limit the impact if an incident occurs at these facilities to the neighboring areas.

5.2. Fire fight solutions

– For a solar power facility fire:

+ When the fire fighting organization has to quickly notify the electricity unit or solar battery service provider to cut off the power and pay close attention to the use of water to fight the fire. The fire brigade should ask the electrical technician

to determine if voltage exists on the panels and or between the inverters connected to the grid? In case of electricity, how much voltage and amperage must be determined? In developed countries, it is mandatory for houses to install solar panel systems to have a diagram showing the location of the emergency breaker for firefighters.

+ In case of newly developed, less complicated, small-scale fires: Use fire extinguishing powder or CO₂ to extinguish the fire; In case the fire has developed and spread: It is necessary to organize a combination of protective cooling measures and prevent the fire from spreading to neighboring works and equipment by spraying water in distributed mode. In order to effectively extinguish the fire, it is necessary to deploy fire-fighting formations using specialized fire extinguishing agents that can extinguish electrical equipment fires such as F500EA with 3% phase rate, CAFS technology firefighting foam in low mode. spray dry foam, technology foam 1–7. In addition, currently on the market, there are a number of specialized fire extinguishing agents that can be used to extinguish a solar cell fire effectively and safely.

+ For a fire at a wind power facility: When the fire brigade is present, it is necessary to quickly request the establishment's electrical technician to follow the technical process of the facility to disconnect the burning wind turbine from the fire general system; at the same time, implement a test measure to determine whether it is possible to generate electricity on the device. Depending on the actual topographical characteristics of the location of the wind turbines, appropriate fire fight measures shall be applied, specifically:

In case a fire occurs on a generator turbine or tower body: If it is possible to access it directly from the ground, use motorized vehicles such as

ladder trucks, crane trucks, etc. to bring the fire fight mausoleum to approach and extinguish the fire. In case of inaccessibility, the fire fight solution that can be applied in this case is to use fire-fighting aircraft to spray fire extinguishing agents from the air; at the same time, proactively implement measures to prevent fire spread and plans to be ready to extinguish fires caused by falling debris causing fires such as forest fires, field fires, works and equipment on the surface soil.

In case a fire occurs at the foot of the wind turbine tower: Use fire extinguishing powder or CO₂ to extinguish the fire if a new, small-scale fire arises. In case the fire has developed and spread, it is necessary to deploy a fire fighting squad using specialized fire extinguishing agents that can extinguish electrical equipment fires such as F500EA with 3% phase ratio, CAFS technology firefighting foam in dry foam spray mode, technology foam 1–7; In addition, it is necessary to combine cooling to prevent fire spread if there are equipment and adjacent works at the foot of the tower by distributed sprinklers.

Automatic fire extinguishing system can be divided into 2 levels for protection: For electrical equipment of turbines and towers (using heat-absorbing extinguishing agent – 3M Novectm1230); For mechanical equipment of the establishment and work items with electrical equipment of the establishment (fire extinguishing agent – CO₂).

5.3. Safety solution when fighting fire

– When fighting a fire at a solar power facility: Forces directly involved in fire fight access must be equipped with specialized fire fight clothing and are not capable of conducting electricity, use an isolating gas mask to protect the system respiratory inhalation of toxic substances. In case it is necessary to move to the roof, it is necessary to

determine the bearing capacity of the house, the work is still guaranteed, there is no risk of deformation or collapse. It can be accessed indirectly through neighboring buildings, houses or motorized vehicles such as ladder trucks, crane trucks, forklifts ... to spray fire extinguishing agents. Use water spray in the appropriate mode to prevent the risk of explosion of electrical equipment, to prevent electric shock, which is dangerous to the fire fighting force;

– When fighting a fire at a wind power facility: Forces participating in fire fight must ensure a safe distance and have plans and measures to prevent accidents caused by destroyed turbine equipment parts falling and splashing out, turbine tower structural collapse may occur, caus-

ing unsafety. Use water spray in the appropriate mode to prevent the risk of explosion of electrical equipment, to prevent electric shock, which is dangerous to the fire fighting force.

6. Conclusion

The development of renewable energy to replace traditional energy is an inevitable trend of today's modern society. Therefore, the urgent solution for the management authorities is to quickly complete the system of legal corridors and legal documents related to renewable electricity in order to national energy security standards. At the same time, it is necessary to propose measures and solutions to ensure absolute safety in fire prevention and fighting for renewable energy projects to keep up with the development trend of this field.

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