Understanding renewable energy's role in the energy system

Introduction

By understanding the role of renewable energy projects in the electricity system, councils can better understand and respond to impacts and opportunities from renewable energy developments.

Key points:

Queensland is experiencing increased proponent interest in integrating renewable energy generation and storage into the electricity grid.

Energy storage is becoming an essential part of the system, ensuring electricity is available when and where it is needed. Large-scale storage solutions, such as batteries and pumped hydro, are used to support the grid by storing excess energy during low-demand periods and releasing it during peak demand.

Renewable energy projects present land use, planning and community considerations, including impacts on amenity and local infrastructure. Councils may consider the cumulative impacts of multiple projects in their region, particularly on housing, workforce supply, local services, roads and other infrastructure networks.

The community benefit system applies to the following land uses as defined in the *Planning Regulation 2017*:

- Wind farms
- Solar farms with a maximum instantaneous output of 1 megawatt (MW) or more
- Battery storage facilities with a maximum instantaneous output of 50MW or more.

Renewable energy components

Renewable energy projects can include both generation and storage infrastructure. These systems connect to the transmission network.

Transport of Electricity

1. Generator
Produces electricity.

2. Generator Transformer
Converts low voltage electricity to high voltage for efficient transport.

3. Transmission Lines
Carry electricity long distances.

4. Distribution Transformer
Converts high voltage electricity to low voltage for distribution.

5. Distribution Lines
Carry low voltage electricity to consumer.

6. Homes, Offices and Factories
Use electricity for lighting and heating and to power appliances.

Councils have an important role to play in shaping infrastructure delivery in their regions, including renewable energy projects. With a focus on their community's needs, councils can guide how the impacts of renewable energy projects can be managed or mitigated and the best approach for project proponents to deliver community benefits.

Generation

Renewable energy generation assets include large-scale solar and wind farms. These systems consist of various components, including solar photovoltaic (PV) panels, wind turbines, inverters, control facilities and substations, all working together to generate and deliver electricity to the grid.

Solar farms use PV panels to harness sunlight and convert it into electricity. These panels are typically mounted on fixed-tilt structures or tracking systems that follow the sun's movement to maximise energy capture throughout the day. Solar farms require relatively flat land, often in rural or regional locations, to accommodate the panels and associated infrastructure.

Wind farms use turbines to convert the kinetic energy of wind into electricity. Each turbine consists of large blades mounted on a tower, which rotate when wind passes through them. The rotation drives a generator housed within the turbine, producing electricity. Wind farms are typically located in areas with consistent and strong wind resources, such as coastal regions, open plains or elevated terrain.

Storage

Storage facilities play a vital role in improving grid reliability by dispatching energy on demand when the sun does not shine or the wind is not blowing.

Types of storage facilities include:

Battery energy storage systems store electricity for use during periods of low generation or high demand, addressing the variability of renewable energy sources like solar and wind. They can be co-located with renewable generation facilities or developed as standalone infrastructure assets. In addition to supporting renewable integration, battery storage facilities provide critical grid support services. This includes frequency regulation to stabilise the supply and demand of electricity, voltage support to maintain safe voltage levels and peak shaving to reduce strain during high demand periods.

Pumped hydro energy storage (PHES) uses two reservoirs at different elevations to store energy by pumping water uphill during periods of low demand and releasing it to generate electricity during peak demand. PHES provides long-duration storage, enhances grid stability and offers black start capabilities (ability to restart after a blackout without drawing power from the grid), making it a key solution for balancing renewable energy sources like solar and wind.

Transmission network

Transmission infrastructure is critical to the energy system as it connects electricity generation sites to consumers. Queensland's transmission network is owned and operated by Powerlink Queensland (Powerlink), a government-owned corporation.

Transmission lines often span multiple council areas. Key components include:

High-voltage power lines which transport electricity over long distances with minimal energy loss.

Substations which convert electricity to suitable voltages for distribution to homes and businesses. For renewable energy projects, substations may increase the voltage of electricity generated for efficient transportation or decrease the voltage for local distribution.

Planning and developing transmission infrastructure is a major challenge in the shift to decentralised energy systems. The cost of transmission in a decentralised system depends on the existing transmission lines, including their capacity and location. New transmission lines will be needed to transport power from generation sites to substations where it is converted for local distribution.

For more information on Queensland's transmission network visit **Powerlink's website.**

Additional infrastructure considerations

Alongside renewable energy generation and transmission components, additional enabling infrastructure is essential for the delivery and operation of renewable energy assets. These supporting assets ensure that renewable energy projects are constructed resourcefully, effectively integrated into the energy network and are well maintained over time. Additional infrastructure components may include:

- **Distribution networks** are the lower-voltage systems that deliver electricity from substations to end users, such as homes, businesses and industries. These networks include power lines, poles, transformers and other equipment that ensure electricity is safely and efficiently distributed to meet local energy demands.
- New or upgraded local or state **road infrastructure** may be required to transport heavy machinery, turbine components, solar panels and other materials to energy project sites. These upgrades are particularly important in remote or rural areas where existing roads may not be suitable for large vehicles. Improved roads provide ongoing access for maintenance and operational activities.
- **Onsite concrete batching facilities** are used to produce large quantities of concrete required for constructing turbine foundations, solar panel mounts and other infrastructure. These facilities reduce transportation costs and delays by ensuring that concrete is mixed and delivered locally, meeting the specific needs of the project.
- Adequate **water and sewerage** infrastructure supports the construction and operational workforce at energy project sites. This includes providing potable water for workers, water for construction activities (such as dust suppression or concrete mixing) and sewage systems to manage wastewater generated onsite.
- Effective **waste management** systems handle various types of waste generated during the construction and operation of renewable energy projects. This includes managing construction waste (such as packaging materials, scrap metal), spoil (excavated soil or rock) and general waste from workforce activities.
- Temporary or permanent **workforce accommodation and other infrastructure** is often required for construction and operational workers. Worker accommodation may be established on-site or at separate locations that provide a separation from construction activities and access to existing services and facilities.

Councils are encouraged to be ready to engage with proponents early in the project lifecycle to understand the project, support assessment of local impacts and negotiate community benefits before key project decisions are locked in.