# Distributed Wind for Agricultural Applications

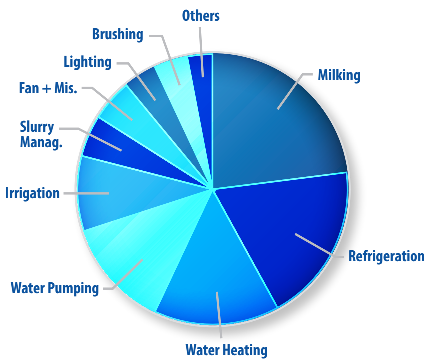
*Flexibility in agricultural loads can adapt to the variability of distributed wind, but high costs of extended power interruptions necessitate intentional design of backup power options.*

Wind technologies are often overlooked as distributed generation resources. Distributed wind projects can use a wide range of turbine sizes from the small kilowatt scale up to multi-megawatt units interconnected on the distribution side of the electric grid. Distributed wind can serve a variety of functions both in front-of-the-meter and behind-the-meter applications to contribute to local energy and resilience needs. Learn how this resource can support agricultural applications below.

## Energy Needs for Agriculture

Agricultural loads will vary depending on the application, but they are more likely to see seasonal variation compared to other load types based on harvesting cycles, and less likely to see daily variations between weekends and weekdays based on the consistent needs to support the growing processes.

Agricultural loads have high demands for energy resilience as they are essential to the food production chain. Livestock and farming have unique power consumption requirements, including sprinklers and water pumps, livestock or crop heating, cooling, and ventilation, greehhouse maintenance, milking equipment, and onsite processing equipment.




*Distribution of electricity requirements for dairy farm operations [2].*

Unlike certain industrial or commercial loads, agricultural loads do not depend on completely uninterrupted power, but rather on ensuring that there are no extended outages (hours to days) to interrupt continuous processes. While activities need to happen regularly, delays of minutes, or even hours in some cases, is unlikely to affect productivity.

As the length of power outages increases, the costs can quickly add up. A three-day power outage in Germany following a blizzard in 2005 forced farmers to heat livestock facilities with on-site generators. Some farms without functioning backup energy lost all their livestock within hours of disconnection [3]. During the 2021 winter storm in Texas, milk processing plants reported being at full capacity without the ability to pasteurize the milk [4]. In South Africa, rolling blackouts were blamed for the death of 50,000 chickens, valued at $93,300 due to ventilation systems turning off [5].

These impacts are felt well beyond the agricultural sector. As crops in the Rio Grande Valley in Texas froze during the 2021 winter storm, shortages rippled across food pantries in a time of high need, as grocery stores were also closed due to lack of power. Even school districts had to limit meal distribution [4].

In the long term, as production comes to a standstill, facilities risk falling out of compliance with safety standards. For greenhouses, salvaging plants and returning to profitability can take months to years to achieve. In many cases, thin profit margins mean that recovery following power loss is longer than greenhouse operators can sustain [6].

## Why Distributed Wind?

Agricultural loads are classified as industrial by the U.S. Energy Information Administration. While they make up just 4% of industrial energy use in the U.S., they utilize approximately 52% of U.S. land base [7,8].

*A 25 kW wind turbine serving Champion Valley Feedyard, a cattle operation in Yuma, CO, undergoes maintenance [1].*

As such, agricultural areas not only make up a critical portion of rural land use, but also have high potential to support on site energy generation like distributed wind, which by nature requires access to wind resource that can be harder to achieve in more urban areas. Additionally, the footprint of wind turbines is smaller than solar panels for the same power capacity, minimizing impact to other farm operations.

Many agricultural business owners have their own on-site power production, either fuel-powered emergency generators, which are mandatory for certain applications, or renewable power resources. In some regions, cattle and pig breeding companies are required by law to have emergency power generators and sufficient reserve fuel [3].

On-site renewable energy is a good candidate to provide backup power for agricultural loads, assuming the infrastructure is set up to enable islanding and microgrid formation. Due to higher levels of flexibility around interruptions, they may be able to rely on wind alone, reducing or eliminating the need for storage, which can be a costly component of a hybrid generation solution. Renewable solutions can also help agricultural producers meet corporate clean energy goals.

Depending on the market, it may also be possible to bid into ancillary service markets using inverter functionalities to support grid stability. Consideration of all the potential uses of distributed wind, both in normal operating conditions and resilience scenarios, can help maximize the value of the project and help justify the investment.

## When Is Distributed Wind the Right Choice for an Agricultural Application?

There are a few key things to evaluate to decide if distributed wind is a good candidate to support agricultural loads:

### Is there sufficient wind resource?

Before investing in distributed wind, a study should be conducted to determine if the wind resource is sufficient to generate the expected energy over the course of a year.

*Wind turbines can create a microclimate that helps regulate temperature, humidity, and air movement, enhancing pollination, disrupting pests, and reducing soil erosion. [10,11].*

The Wind Integration National Dataset (WIND) Toolkit is a good place to start. For smaller projects, modeled data may be enough to assess feasibility. Larger turbines may justify meteorological tower measurements.

### Can the turbine(s) be sited locally on agricultural land?

Land use, building obstructions, terrain and siting permits must be considered to decide whether it is feasible to place a turbine in a location where it can connect to the local distribution system and serve the intended loads. One report found that farmers could continue to use about 95% of the land surrounding turbines, requiring far smaller footprints than solar PV for the same energy output [9]. Tools Assessing Performance (TAP) for Distributed Wind provides computational resources to assess siting constraints with local obstacles.

### Will wind turbines impact agricultural activities?

Agrivoltaics, the practice of agricultural production, such as crop or livestock production, underneath or adjacent to solar panels, are a growing solution to help decarbonize the energy sector, but there is untapped potential for distributed wind in agriculture too. Emerging research is showing that distributed wind can have agricultural benefits as well, and similar land-lease agreements could help farmers maximize use of their land. Research at Iowa State University showed that turbines take some of the wind energy blowing over crops, decreasing the speed but increasing turbulence [12]. This causes greater interaction between the wind and crops, which helps increase evaporation from the crop. This is good for disease prevention, and turbines pump air into the soil, moving carbon dioxide up from the soil so more is available for photosynthesis. While more research is needed in this area, wind energy has potential cross-cutting benefits to the agriculture community.

### Is there feeder capacity for renewable generation?

Feeder capacity may be limited by power line sizing, transformer sizing, local regulation, or other constraints. The local utility can help determine if wind capacity can be added to a particular feeder.

## Additional Resources

DOE's new Rural and Agricultural Income & Savings from Renewable Energy (RAISE) Initiative is focused on helping farmers cut costs and increase income from clean energy. Through RAISE, USDA has set an initial goal of helping 400 individual farmers deploy smaller-scale wind projects using USDA's Rural Energy for America Program funding.

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