2014 Tribal Renewable Energy Webinar Series

Questions and Answers

"Renewable and Energy Efficiency Market Update" Webinar
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Speakers: Kristen Ardani, Amy Hollander, Randy Hunsberger, Robi Robichaud, and Kermit Witherbee from the National Renewable Energy Laboratory (NREL)

Attendees: 159

Q: In developing off-grid solar systems for community scale, how much more expensive is solar photovoltaics (PV) with battery backup than going with grid connected solar PV?

A: For PV battery backup storage, it could double system costs if going completely off grid. However, if the system is grid connected PV, with battery backup should the grid fail, or uses batteries for other ancillary services, that is a different cost scenario. For complete off-grid battery backup the cost varies depending on how remote the area is. Off-grid solar systems can be cheaper than extending power lines in certain remote areas. Consider off-gird if you're more than 100 yards from the grid. The costs of overhead transmission lines range from $174,000 per mile (for rural construction) to $11 million per mile (for urban construction). For power line cost see the *Out of Sight, Out of Mind 2012* report from the Edison Electric Institute: http://www.eei.org/issuesandpolicy/electricreliability/undergrounding/Documents/UndergroundReport.pdf

For a grid-tied battery backup for a residential small scale system, consider this example. An average home with an electric bill of $100/month, for instance, consumes ~625 kilowatt-hours (kWh) of power a month (assuming a grid price of $0.16/kWh). That averages around 20 kWh/day of power. Sufficient good-quality batteries to carry that load for just 2 days are priced at approximately $25,000 (as of May 2014). Realistically, a battery-backup system is only designed to support emergency loads (e.g., water pump, refrigerator, or perhaps a freezer) for short periods of time, but even so, the cost reaches approximately $20,000 of additional cost for a short-term grid-tied battery backup solution. Further limitations of a system are the battery life. Current lead acid batteries mostly have a 10-year life.

While the above example can provide backup power for a few days, for true energy security batteries, even a large battery investment will require a generator to be totally secure. The cost of a backup generator depends on system size.

For a community, it seems that micro-grids would provide a more viable, cost effective option, depending how far the community is from a sub-station and other utility services.

Q: In assessing a site for wind turbines, how much geographic area can be assessed using a sodar instrument?

A: Sodar is used to assess the wind in a given area. It is most commonly used to augment data being collected by a "met tower" that is fixed in one location. Sodar is NOT typically used alone in conducting a wind assessment and at this time, banks will not finance a project based only on sodar data. The advantage of the sodar is that it can be moved to various locations to help determine and map locations with the best wind. How much area can be assessed by a sodar really depends on what the terrain and wind patterns are like. You can assess a much larger swath of land in the flats of North Dakota than in the Rocky or Appalachian Mountains.

There are no established industry standards for assessment distance covered by a met tower or sodar in the wind industry. There are no hard and fast rules as there are always at least a few “it depends” types of factors for any project/site that does not fit easily within set rules or parameters. These factors include: terrain variability (mountains, hills, ridges, canyons, etc.); vegetation (barren desert, grassland, crops, forested, etc.); wind variability vertically, horizontally, and temporally; wind farm size and turbine spacing; seasonal variation, etc.

All of these factors play a role in defining the most cost effective approaches for initial assessment activities. Though there are commonalities, every site is different. Additionally, there are also differences in how wind farm developers and meteorologists might approach a specific site depending on anticipated project size, anticipated timeline, available funding for assessment, availability of and distance to transmission, etc.

There are some useful data points from several sources:

- NREL Wind Assessment Page: http://www.nrel.gov/wind/resource_assessment.html
- WINDExchange “Small Wind Site Assessment: Wind Powering America Lessons Learned”: http://apps2.eere.energy.gov/wind/windexchange/filter_detail.asp?itemid=3896
- WINDExchange Wind Resource Maps: http://apps2.eere.energy.gov/wind/windexchange/windmaps/
- American Wind Energy Association (AWEA) *Wind Energy Siting Handbook* (includes multiple site types with some wind focus): http://awea.files.cms-plus.com/AWEA_Siting_Handbook_Feb2008.pdf
- Other AWEA Resources and Publications: http://www.awea.org/Issues/Content.aspx?ItemNumber=5726
- Windustry Community Wind Toolbox, “Wind Resource Assessment”: http://www.windustry.org/community-wind/toolbox/chapter-4-wind-resource-assessment

Tower Distribution.[1] The location and distribution of meteorological towers within a project area are designed to minimize the uncertainty of the wind resource at potential turbine locations. Important considerations that are taken into account during the tower siting process include, but are not limited to, the following:

- Similarity or representativeness of the terrain to the larger project area
- Ability to capture the diversity of conditions experienced by future turbines
- Distance to future turbines, if the turbine layout is known
- Multiple masts, if needed.

Also noteworthy are rough distance recommendations for met tower coverage from AWS, taken from their book, “Wind Resource Assessment – A Practical Guide to Developing a Wind Project”[2]. As shown in Table 1 below, the guidance varies considerably even in the same type of terrain, (i.e., low and high range from 20,000 to 50,000 acres in generally flat terrain with uniform surface roughness). Moving down through the table, the terrain becomes more complex (varied in topographical features such as mountains, hills, ridges, canyons, etc., and vegetation covers) and the recommended coverage distance shrinks overall. Though not explicitly stated in the AWS book, it is assumed from context that the guidance pertains to the industry standard 60 meter (m) met tower.

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[1] *Wind Resource Assessment Handbook*, Ibid, Section 2-3.
[2] Brower, M. and all, *Wind Resource Assessment - A Practical Guide to Developing a Wind Project*, P. 31, Table 3-2, A John Wiley & Sons, Inc., Hoboken NJ, 2012.

Table 1. Recommended Monitoring Mast Distribution Based Upon Site Terrain Complexity[3]

Project site	Terrain and land cover	Maximum recommended distance between any proposed turbine location and nearest mast * (km)
Simple	Generally flat with unifrom surface roughness	5 - 8
Moderately Complex	Examples include inland site with gently rolling hills, coastal site with uniform distance from shore, single ridgeline perpendicular to prevailing wind	3 - 5
Very Complex	Steep geometrically complex ridgelines, coastal site with more varying distance from shore, or heavily forested	1 - 3

* Assumes meteorological mast is located within proposed turbine array area.

Based on this assumption, it is also reasonable to assume that an 80-100 m met tower might have an increased coverage range, but there are no such estimates in the book nor is there an industry standard that pertains to this. What an 80-100 m met would afford is real wind speed data close to turbine hub height, instead of relying on extrapolated values from 40, 50, and 60 m levels.

The AWS distance recommendations are converted to square kilometers (km2), square miles (mi2), and acres as shown in Table 2 below. Again, it is also reasonable to assume that an 80-100 m met tower might have an increased coverage range, but there are no industry standards or protocols.

Table 2. Area Conversion of AWS Guidelines for Met Tower Coverage

Project site	Maximum recommended distance between a proposed turbine location and mast *		Area conversion of maximum recommended distance ***		
	km	mi **	km^2	mi^2	acres
Simple	5 - 8	3 - 5	25 - 64	10 - 25	20 - 50,000
Moderately Complex	3 - 5	2 - 3	9 - 25	3 - 10	7 - 20,000
Very Complex	1 - 3	1 - 2	1 - 9	0 - 3	1 - 7,000

* Assumes meteorological mast is located within proposed turbine array area.

** Rounded to nearest mile

*** Assumes area is a circle with radius from green-shaded middle columns

Q: What is the best renewable energy in tribal Native American communities/localities?

A: The best renewable energy depends on the local geographical resources in relation to sun, wind, rivers (hydro), geothermal, or biomass that is cost competitive with the current cost of electricity. Also, a mix of the renewable resources can provide year-round energy as the seasons supply different resources.

[3] Brower et al, Ibid.

The resource is usually measured against the competing cost of electricity. For example, even if the solar resource is equal in Massachusetts and Idaho, the cost of competing electricity is probably much higher in Massachusetts than in Idaho, which has an abundance of low-cost hydropower, so the Tribe in Massachusetts would probably have better economics for solar than Tribe in Idaho.

Everyone has solar, but to greater and lesser degrees. For example it would require more about 2.4 more times the PV to power a house in Seattle, Washington, because of limited resources, versus a home in Phoenix, Arizona. However the house in Phoenix may use more air conditioning so an increased amount of solar may be necessary.

Solar PV costs tend to scale in a relatively linear manner, so the cost range is predictable: as one moves from 10 kW to 10 megawatts (MW), costs come down a bit with increased system size.

Not every location has wind, geothermal, biomass, or micro-hydro. Some locations do not have a viable wind resource given the cost of electricity. In areas with good wind (mean wind speed of 7-8 meters per second [m/s] at 80 m), wind can be very cost effective if at the right scale. The economics of wind improves greatly when a project calls for multiple turbines (three or more) sized at 1.5 MW or more.

Energy efficiency in buildings is still the most economical and fastest way to achieve energy savings, make buildings more comfortable, increase air quality and reduce air pollution.

Q: Have any wind turbines been destroyed by high wind events such as tornados or hurricanes?

A: Extreme weather events will cause destruction on all types of structures. There are design and testing standards to help protect the environment and the area around wind turbines. Other useful data points are available to help plan for safe wind installations:

- NREL Wind Assessment Page: http://www.nrel.gov/wind/resource_assessment.html
- WINDExchange “Small Wind Site Assessment: Wind Powering America Lessons Learned”: http://apps2.eere.energy.gov/wind/windexchange/filter_detail.asp?itemid=3896
- WINDExchange Wind Resource Maps: http://apps2.eere.energy.gov/wind/windexchange/windmaps/
- American Wind Energy Association (AWEA) *Wind Energy Siting Handbook* (includes multiple site types with some wind focus): http://awea.files.cms-plus.com/AWEA_Siting_Handbook_Feb2008.pdf
- Other AWEA Resources and Publications: http://www.awea.org/Issues/Content.aspx?ItemNumber=5726
- Windustry Community Wind Toolbox, “Wind Resource Assessment”: http://www.windustry.org/community-wind/toolbox/chapter-4-wind-resource-assessment

Q: How cost effective is wind power for Tribes?

A: There are multiple factors that must be considered when evaluating wind as a suitable energy source. Among the key factors are: wind resource; environmental permitting (time and cost); electrical interconnection (time and cost); community acceptance; size and number of suitable turbines (larger turbines [1.5 MW and greater] and larger projects [10 MW and greater] tend to have better economics than smaller projects).

Some locations do not have a viable wind resource given the cost of electricity. In areas with good wind (mean wind speed of 7-8 m/s at 80 m), wind will likely be the most cost effective renewable energy generation to consider, even though it is intermittent.

One example is a site in Maine with average wind, a strong economy, and a high cost of electricity at $0.17/kWh. Compare this to a site in North Dakota with great wind and inexpensive electricity at $0.04/kWh. Wind is far superior in North Dakota, but economics is far superior in Maine. Most entities look at the overall economics as the main driver. Jobs can also determine if a wind farm is better than a solar farm, which has less maintenance.

Q: How much can building heat and hot water reduce energy costs at the community scale?

A: Energy efficiency includes evaluating a building's heat and hot water systems. As a package, energy efficiency is still the most cost effective and quickest way to reduce energy use, and it has multiple non-energy benefits such as increased safety, air quality, and comfort. Having an energy audit done by a certified energy auditor could reveal hidden savings opportunities, especially in heating and hot water systems. Comfort air issues can also be resolved with insulation and heating and air conditioning operating and delivery systems. Examples of an energy efficiency package include:

- An energy audit by a certified energy auditor that uses Combustion Appliance Zone (CAZ) testing, infrared camera images, and a blower door to diagnose safe building energy efficiency
- Retrocommissioning of heating and cooling units (larger buildings)
- Upgrades to high efficient heating and cooling equipment if retrocommissioning identifies failures
- Insulation and air sealing using zonal pressure testing (homes or smaller buildings)
- Lighting conversions to LEDs
- Appliance upgrade recommendations.

Other Links to Helpful Resources

There are many resources available to help Tribes decide which renewable resource is best for them. These include:

- The DOE Office of Indian Energy offers education and training on project development and financing and renewable energy fundamentals and an Energy Resource Library.
- Tribal-specific renewable energy curriculum developed by the DOE Office of Indian Energy can be accessed any time on the National Training Education Resource website.
- Basic information on the types of renewable energy, as well as tools and resources for assessing renewable energy potential, are available on the NREL website.
- Energy 101 videos developed by the DOE Office of Energy Efficiency and Renewable Energy provide short, basic overviews of the various types of renewable energy.
- The DOE Office of Indian Energy and Tribal Energy Program offer up to 40 hours of in-depth technical assistance for federally recognized Indian Tribes, tribal energy resource development organizations, and other organized tribal groups and communities to advance tribal renewable energy and energy efficiency projects.

Answers are provided by the National Renewable Energy Laboratory. If you have additional questions, email indianenergy@hq.doe.gov. The Tribal Renewable Energy Webinar Series is sponsored by the DOE Office of Indian Energy, Tribal Energy Program, and Western Area Power Administration.