A silhouette of a wind turbine is positioned on the right side of the slide, set against a background of a sunset sky with a gradient from blue at the top to orange and yellow at the bottom. The turbine's tower, nacelle, and three blades are clearly visible.

An Overview of the Wind Power Project Development Process and Siting Considerations

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The 6 Key Elements of a Successful Wind Project

- Wind – 1 mph difference is make or break
- Land – need willing landowners
- Permits –wildlife and NIMBY issues
- Transmission (capacity and proximity)
- Buyer (Power Purchase Agreement)
- Financing – need all 5 above to get it





6 Key Elements

- Need ALL 6 elements to build a project
- The lack of any one kills a project
- Unlike natural gas, coal or nuclear power plants, we can not transport our “fuel” (wind) to a desirable location – we have to go to where the resource is
- Rate of return is set by capital markets- it is not a question of “how much can we make?” but rather, “can this project get built?”

Sequence of Development Process

- The sequence of evaluating each element varies by site, but often the order is:
 - Wind – evaluate the resource
 - Land – are landowners interested?
 - Permits –initial review of permitting issues
 - Transmission –capacity; cost
 - Buyer – general market; specific buyer(s)
 - Financing- based on all of the above



Developer Sensitivity re. Confidentiality

- At early stages of a project, confidentiality is a very real business issue for us
 - Agencies subject to FOIA/state sunshine laws
 - Fierce competition for best sites and land
 - Until you know you plan to proceed with developing a site, don't want to waste scarce time and resources debating potential impact questions
- Cause of great deal of miscommunication and mistrust between developers and wildlife agencies/advocates.
- The closer to actually applying for permits, developer should be willing to discuss details

Key Siting Considerations

- Wind - is the most absolute requirement –
 - Energy is function of cube of wind speed
 - Avg. wind speeds of 16-19 mph in most areas
 - At higher altitudes, air density drops- requires a higher wind speed for same output
 - Depends on region's market price for power
 - No mitigation for low wind speed!



Viability Very Sensitive to Wind Speed

Price Versus Wind



Key Siting Considerations

- Land - Owners must be willing-
 - Can't build without land.
 - Need large, contiguous parcels.
 - Compatible land uses - e.g. ranching, dry land (un-irrigated) agriculture, open space
 - Developers do not have power of eminent domain.





Key Siting Considerations

- Transmission-

- Typically connect to 115/230/345 kV lines
- Must have capacity available
- Feeder lines typically < 5 - 10 miles
- Ability to finance feeder lines, upgrades depends on project size and economics. Bigger projects with better winds can afford longer feeder lines and more upgrades
- Long feeder lines may be difficult and expensive to acquire and permit

Key Siting Considerations

- Market - Must have a buyer for power
 - Most, but not all, areas of the country have growing need for power
 - RPS and other policies drive demand
 - This typically dictates the region more than the individual site (i.e. ND vs. NY)
 - Closely related to transmission – who owns the lines, where do they go, etc.



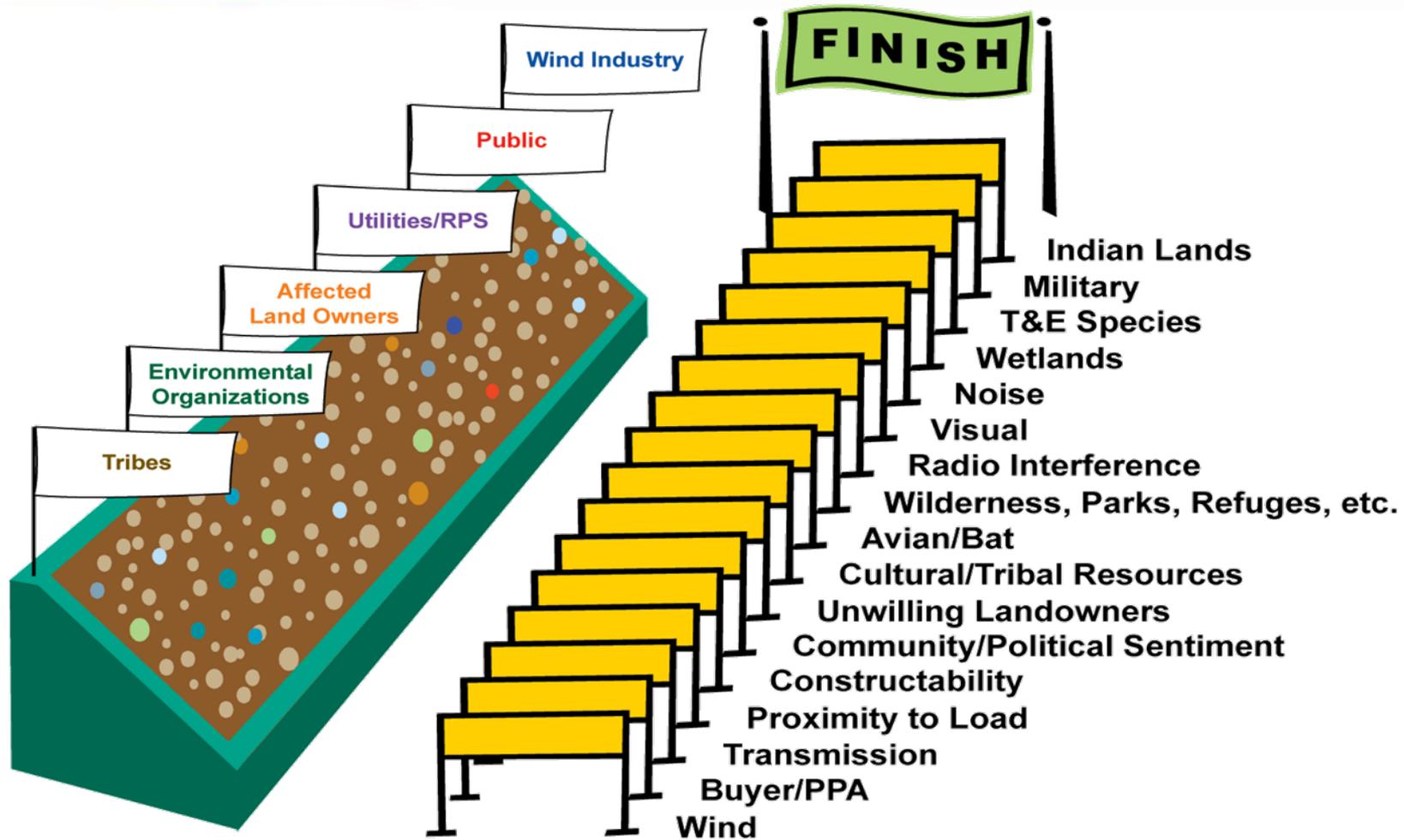
Key Siting Considerations

- Permits and Environmental-
 - Wildlife impacts is typically the top issue
 - But- many issues and stakeholders to address- potentially conflicting interests to reconcile (e.g. wildlife, NIMBY, archeological)
 - Different agencies and advocates have different agendas and concerns
 - Developer has to strike a balance among all





Wind Project Siting Challenges/Hurdles



Developers



Federal, State, Local Agencies

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What Else is Required?

- Site must be accessible – must be able to deliver and erect turbines over 400' tall
- Need adequate level ground around each turbine site – crane pads, laydown areas
- Need adequate spacing between rows of turbines – 1/3 to 1/2 mile



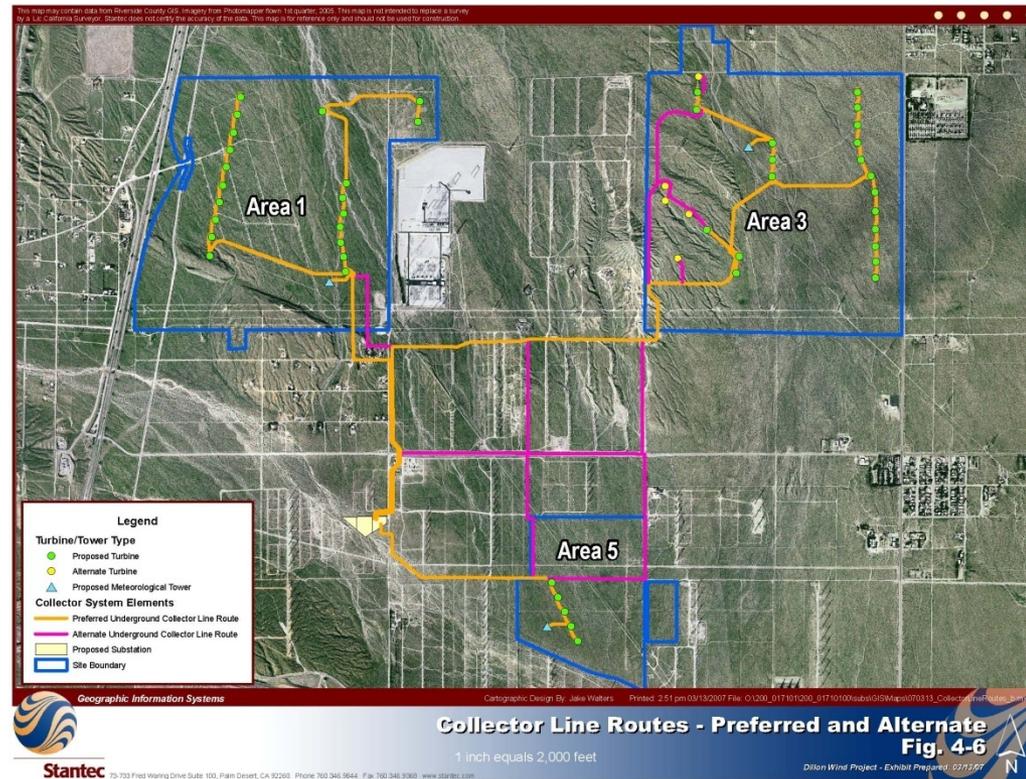
A photograph of a white wind turbine against a bright blue sky with scattered white clouds. The turbine's tower and nacelle are visible, with three blades extending outwards. In the background, another smaller wind turbine is visible. The bottom of the image is a solid green horizontal bar.

Wind Energy Facilities and Construction Sequence



Project Facilities

- Access Roads – Gravel roads linking wind turbine strings to existing roads.
- Electrical Collection System – Cables that electrically connect wind turbines to the project substation.
- Project Substation – Steps up project generation to interconnection voltage.
- Operations & Maintenance Building – Houses central office, computer systems for facility operations, equipment storage and maintenance areas.





Construction Sequence

- Roads
- Foundation
- Wind Turbine Generator
 - Tower
 - Setting the generator
 - Rotor assembly
- Electrical Collector System





Road Construction

Grading

- Prepare road for construction

Drainage

- Install culverts, fords at drainage areas



Road Construction (cont.)

Install Base Material:

- Place geo-fabric or Geo-Grid on top of compacted 16 to 20 foot wide road sub-grade.
- Place 6 to 8 inches of gravel over road surface.
- Finish road profile slightly above natural grade with a 2% crown in the center to promote drainage.
- Construct shoulders with a maximum of 2% side slope for crane travel (reclaimed after construction).





Turbine Foundations

Tower Pier Foundation with Spreadfooter

- Footing: 50-80 ft diameter, 4ft depth with taper.
- Pier: 16-20 ft diameter, 3ft height.
- Apron: Compacted area over footing diameter with 6 in rock surface.

Construction:

- Excavation depth to ~8ft and +50ft base elevation.
- Mud Mat – 2 to 4 inches lean concrete.
- Rebar cage and anchor bolts cage.
- Concrete (5000 psi) formed and poured in two lifts.
- Backfill with native soil



Turbine Foundations



Tower Erection

- The 80-meter turbine tower is composed of four cylindrical steel sections.
- The four tower sections are typically unloaded adjacent to each wind turbine foundation to minimize handling of these heavy steel components.
- Each tower section weighs between 35 and 50 tons.





Tower Erection

- The lower tower section is set first. A flange on the bottom of this 15' diameter section allows it to be bolted to the top of the foundation pedestal.
- After the tower sections are set, the nacelle is raised and bolted to the top of the tower.
- A 2 megawatt class turbine nacelle weighs over 100 tons.





Tower Erection

- The rotor assembly is erected last.
- The rotor consists of three blades and a hub that mount on the front of the nacelle.
- Typically, the blades and hub are assembled on the ground and then raised as a single unit, called the rotor, and attached to the nacelle.





Collector Cable Construction





Collector Substation





Collector Substation





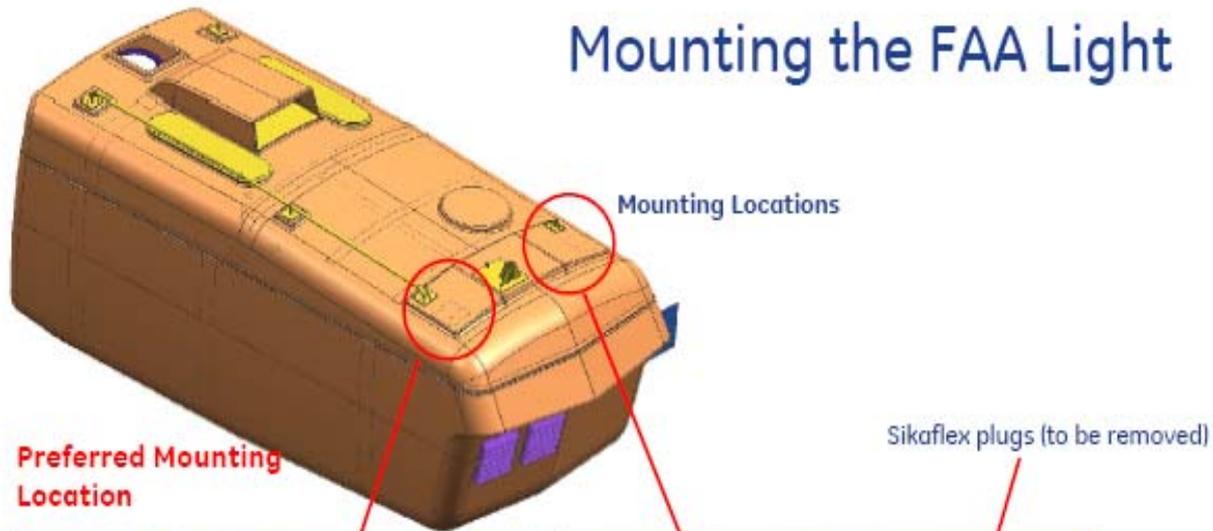
O&M Building



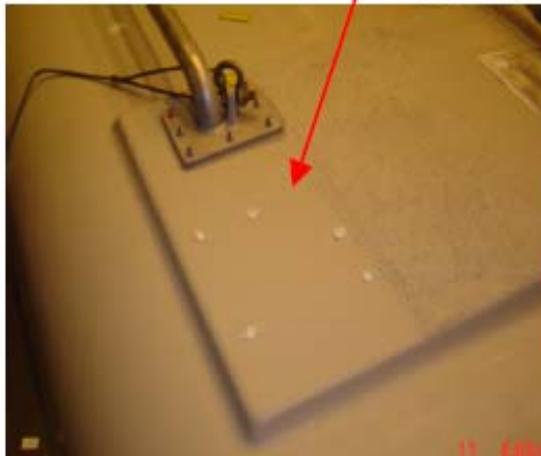


FAA Lights

Mounting the FAA Light



For illustrative purposes only

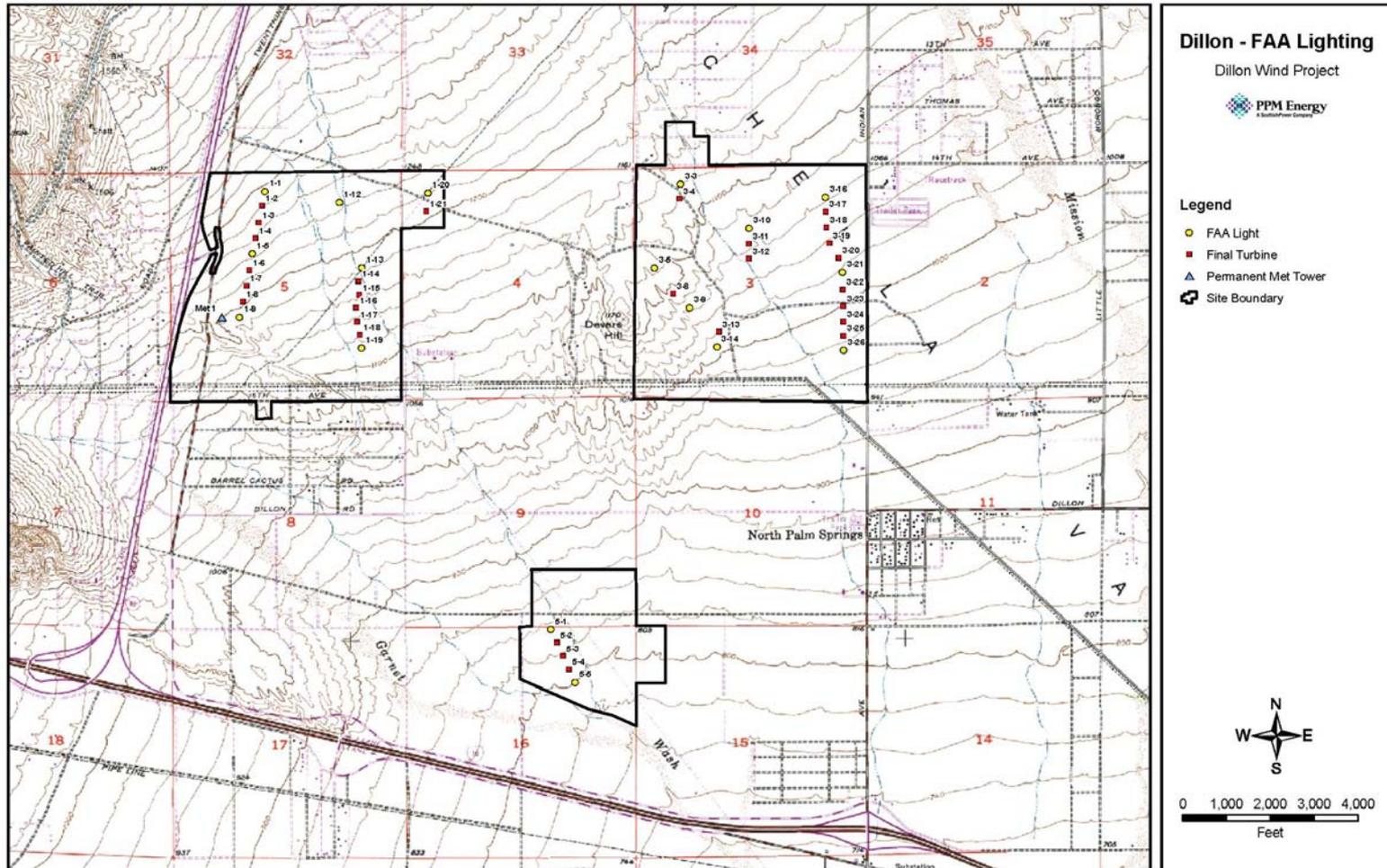


Bracket Assembly Schedule (Top->Down):

- FAA Light
 - Bolts, Nuts, Washers - Light to Bracket
 - Bracket
 - Sikaflex Bed
 - Bolts, Washers - Bracket to Nacelle
- Installation Notes:



FAA Lights



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