Importance of Supporting Infrastructure and Other Factors

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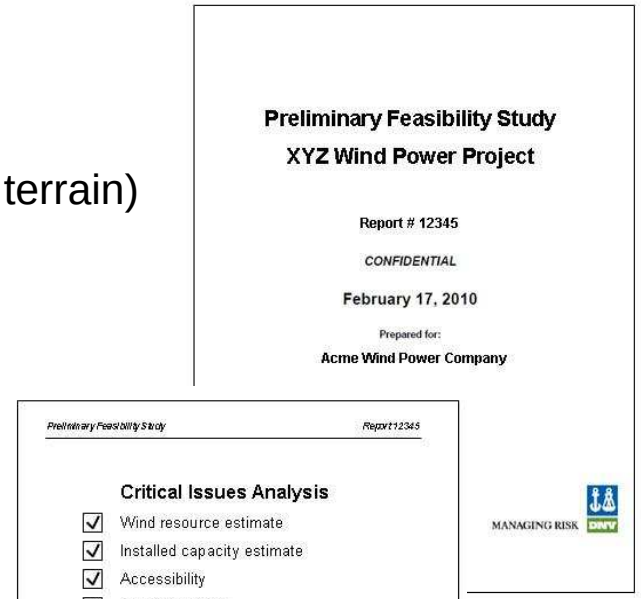
May 2011

MANAGING RISK DNV

Components

- Technical concerns
  - Preliminary wind resource estimate
  - Accessibility and constructability
    (Port, storage, transportation, obstructions, vegetation, terrain)
  - Transmission access
  - Air space (aviation, telecommunications)
- Environmental concerns
  - Avian (birds, bats)
  - Parks, sensitive wildlife habitat, and wetlands
- Cultural concerns
  - Visual impact (photo simulations, shadow flicker)
  - Acoustic analysis
  - Safety setbacks
  - Historic places

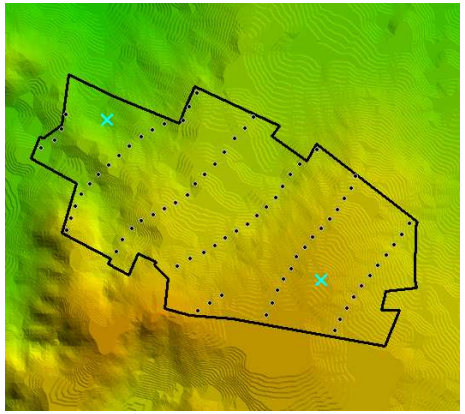

Preliminary Feasibility Study
XYZ Wind Power Project
Report # 12345
CONFIDENTIAL
February 17, 2010
Prepared for:
Acme Wind Power Company
MANAGING RISK DNV

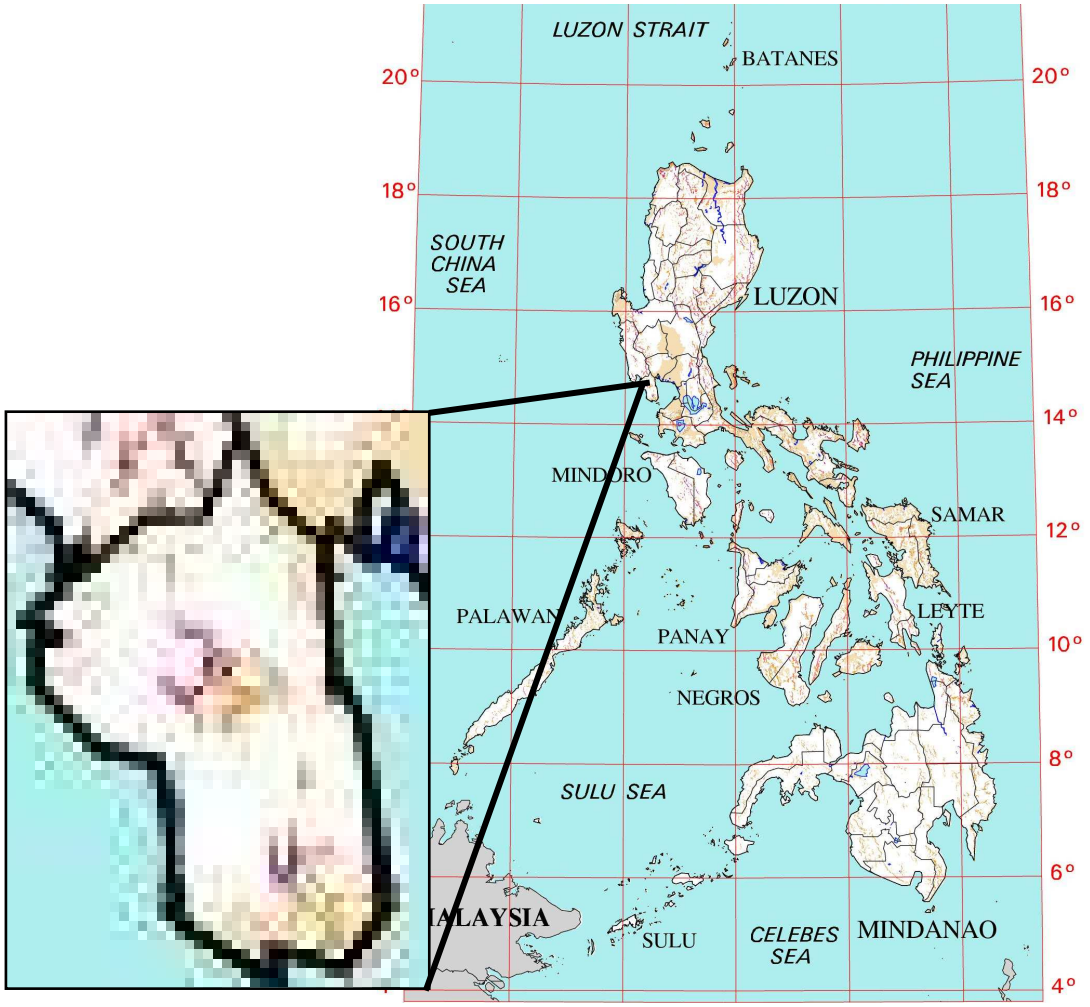

Preliminary Feasibility Study Report 12345
Critical Issues Analysis
- [x] Wind resource estimate
- [x] Installed capacity estimate
- [x] Accessibility
- [x] Constructability
- [x] Transmission
- [x] Preliminary economic analysis
- [x] Avian conflicts
- [x] Sensitive habitat
- [x] Historic and cultural places
- [x] Wetlands
- [x] Aviation
- [x] Telecommunications
- [x] Visual impact analysis
- [x] Acoustic analysis
- [x] Safety setback analysis

DNV Global Energy Concepts Inc. February 17, 2010

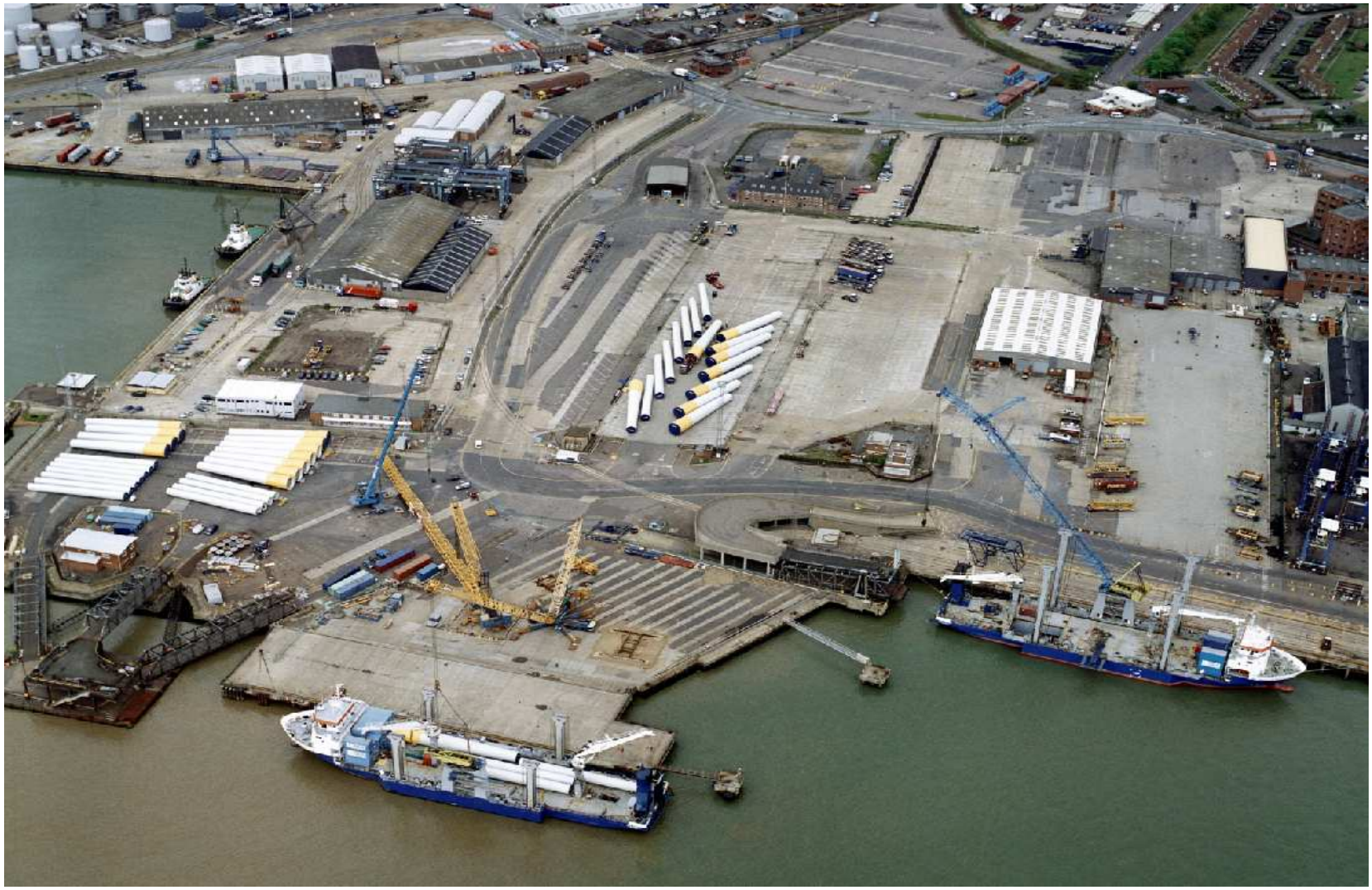
Preliminary wind resource estimate

- Concern: Is the wind resource sufficient? What is the expected range?
- Analysis:
  - Wind maps
  - Existing weather data
  - Local knowledge
- Mitigation:
  - On-site measurements
  - Use satellite date



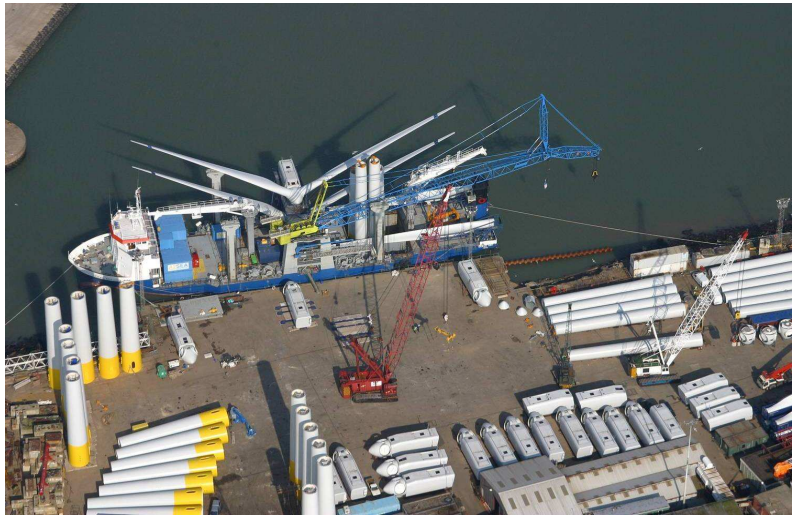


Port Logistics



Delivery and installation for wind farms requires port facilities

- Typical activities during the topside installation
  - Unloading import components (e.g. towers, blades, nacelles) from delivery vessels
  - A laying-down area for products



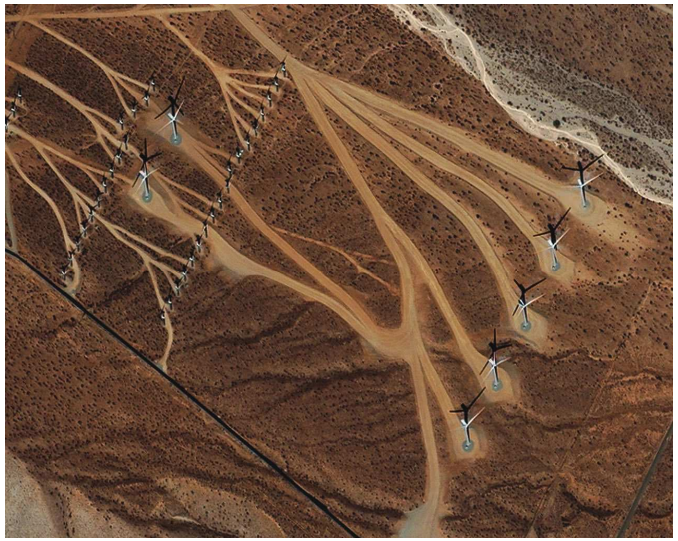
Storage

- Concern: ability to access storage area
- Analysis:
  - Sea -, Rail - and Road Access
  - Land available
  - Soil investigation
  - Power available
- Mitigation:
  - Proper feasibility study
  - Cost analysis of construction

Source: Joel Glickman

Constructability

- Concern: ability to install wind turbines
- Analysis:
  - Terrain assessment
    avoid slopes >10 degrees
  - Available staging area
    150 – 250 ft diameter, cleared and graded
  - Geotechnical (foundation types)
- Mitigation:
  - Proper placement during preliminary turbine layout
  - Cost analysis of construction
    in steep terrain, difficult soils



Source: Joel Glickman

Constructability – Kansas Example

Constructability – India Example

Transportation & Accessibility

- Concern: transporting oversize and overweight components, traffic impacts

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Transportation & Accessibility

- Typical component sizes and weights
  - Blades = 30 – 60 m length
  - Tower sections = up to 4.5 m diameter
  - Nacelle = 60 – 90 tons

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Transportation & Accessibility

- Impact analysis:
  - Route mapping
  - Road condition, width, curvature, inclination, intersections, height restrictions, weight limits
- Mitigation strategies:
  - Alternate delivery routes
  - Temporary widening
  - Roadway modifications
  - Bridge and culvert reinforcement
  - Relocation of utility poles, traffic signs
  - Traffic management plan

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Project Risks Contractor

- Issue:
  - Crane accidence & rebuilding of the roads

- Mitigation strategies:
  - Transport road to be build according to specification

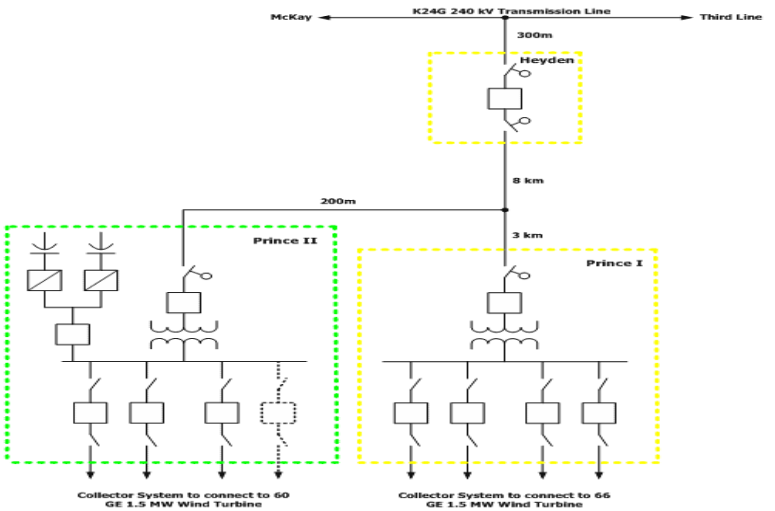
Project Risks Owner

- Issue:
  - Lost wind turbine

- Mitigation strategies:
  - Preventive maintenance

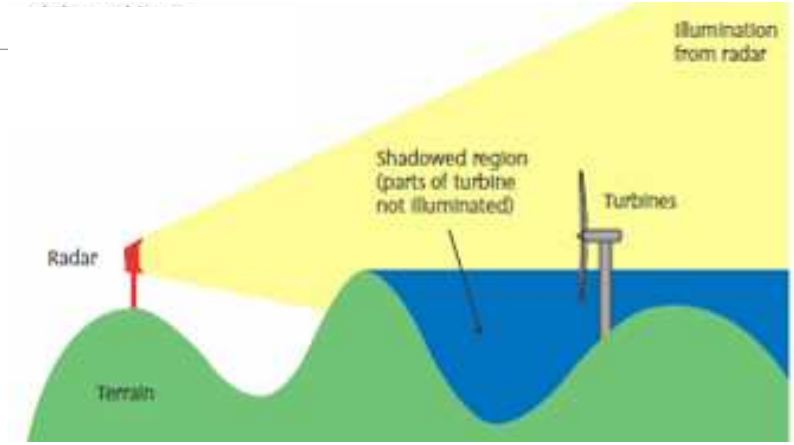
Transmission

- Concern: access and capacity
- Analysis:
  - Mapping, distance to transmission
  - Consultation with transmission provider
  - Cost analysis
- Mitigation strategies:
  - Grid Interconnection Study (GIS)
  - Project relocation
  - Reduce project capacity

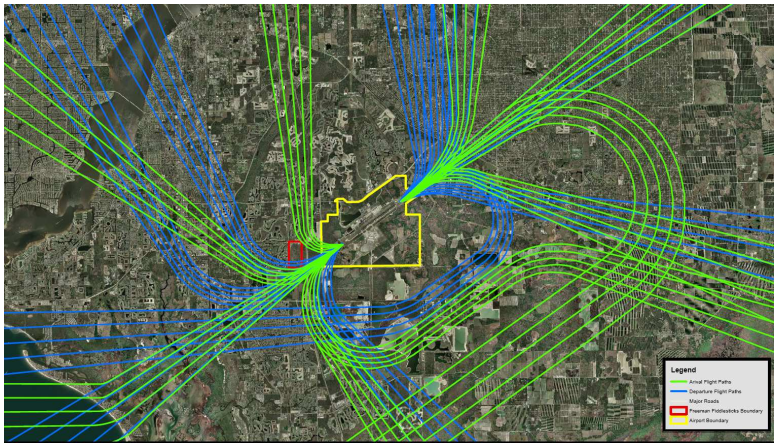


Air Space - Aviation

- Concern: flight safety, national security
- Air navigation concerns:
  - False returns
  - Shadowing of actual aircraft returns
  - Radar clutter
- Impact analysis:
  - Mapping of airports, landing strips, helipads, radar
  - Identify low-flying activity (crop dusting, military training)
- Mitigation strategies:
  - Turbine removal or relocation
  - Radar relocation or upgrades
  - Early consultation with aviation stakeholders



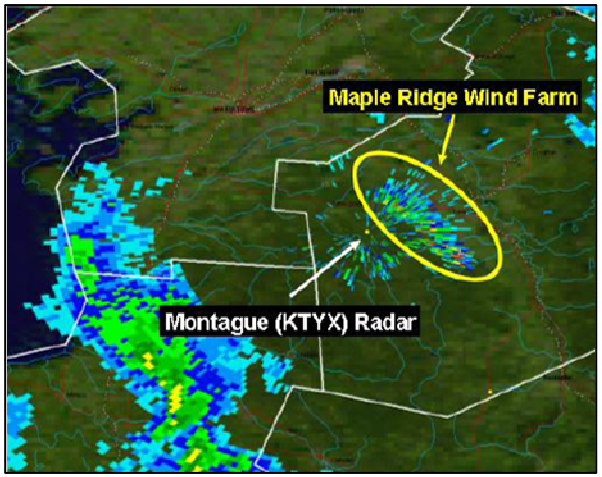
Source: "Wind Energy and Aviation Interests: Interim Guidelines," Working Group for Wind Energy, Defense and Civil Aviation Interests, 2002.



Air Space – Telecommunications

- Concern: physical obstructions can distort signals
- Impact analysis:
  - Identification of communications infrastructure
  - Microwave, radar, off-air television broadcasts, land mobile radio, mobile telephone
  - Agency consultation
  - Signal mapping
- Mitigation strategies:
  - Turbine relocation to avoid line-of-sight signals
  - Add transmitters and receivers
  - Install satellite or cable TV service

Air defense radar unit



Source: Niziol, Thomas. NOAA's National Weather Service- The Lake Breeze, Volume 2, Issue 2 Winter 2006. "The Effect of Wind Power Farms on the Weather Radar"

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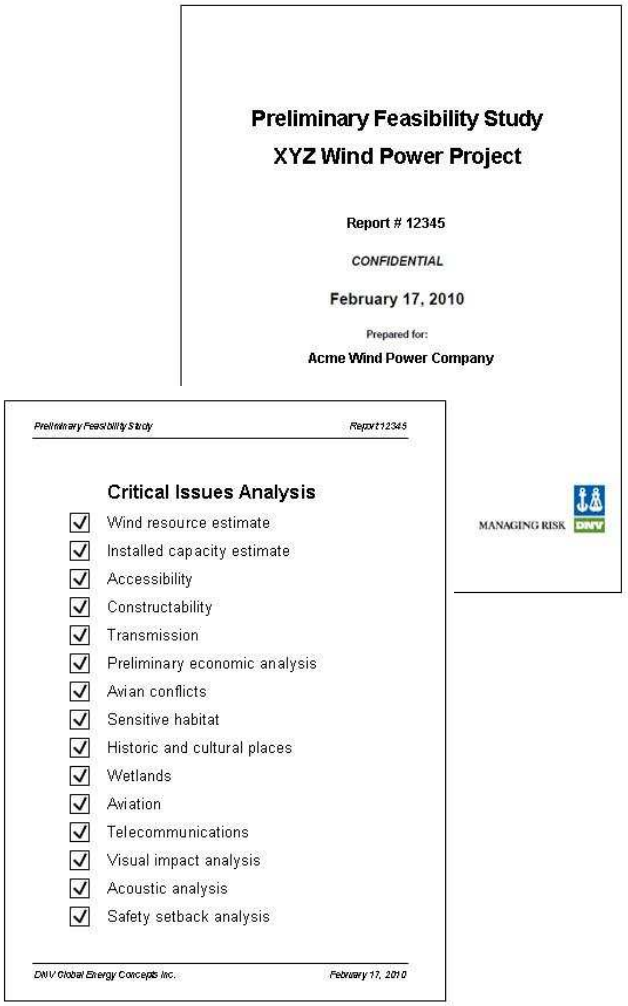

Avian

- Concern: collision, electrocution
- Impact analysis:
  - Field monitoring of bird activity
  - Night-time radar or acoustic surveys
  - Habitat mapping
  - Consultation with local biologists
- Mitigation strategies:
  - Setbacks from bird flight paths, nesting areas
  - Bird diverter devices on met towers, power lines
  - Underground power lines
  - Curtailment during high migratory periods

Red-tailed Hawk killed at the Maple Ridge wind energy facility in northern New York. This is one of five Red-tailed deaths recorded at this wind project in 2007-2008. http://laurakammermeier.com/

Sensitive Wildlife Habitat

- Concern: collisions with vehicles, habitat loss or alteration
- Impact analysis:
  - Field monitoring of wildlife activity
  - Habitat mapping
  - Consultation with local biologists
- Mitigation strategies:
  - Setbacks from known habitat areas and migration routes
  - Speed limits and staff training
  - Habitat restoration
  - Counting and reporting of fatalities

Sage Grouse. Photo source unknown.

Wetlands

- Concern: contamination, loss of wetland
- Impact analysis:
  - Map, aerial photo review
  - Wetland delineation
- Mitigation strategies:
  - Setbacks
  - Erosion control techniques (silt fences, vegetation restoration)
  - Flood control (bridges, culverts, water diversions)
  - Spill prevention and waste management practices
  - Restoration or creation of wetlands within the same watershed

Atlantic City, New Jersey.
Source: http://www.njwind.com/webcam.html

Impsa's Parcque de Parajuru in Brazil
Source: Windpower Monthly February 4, 2010

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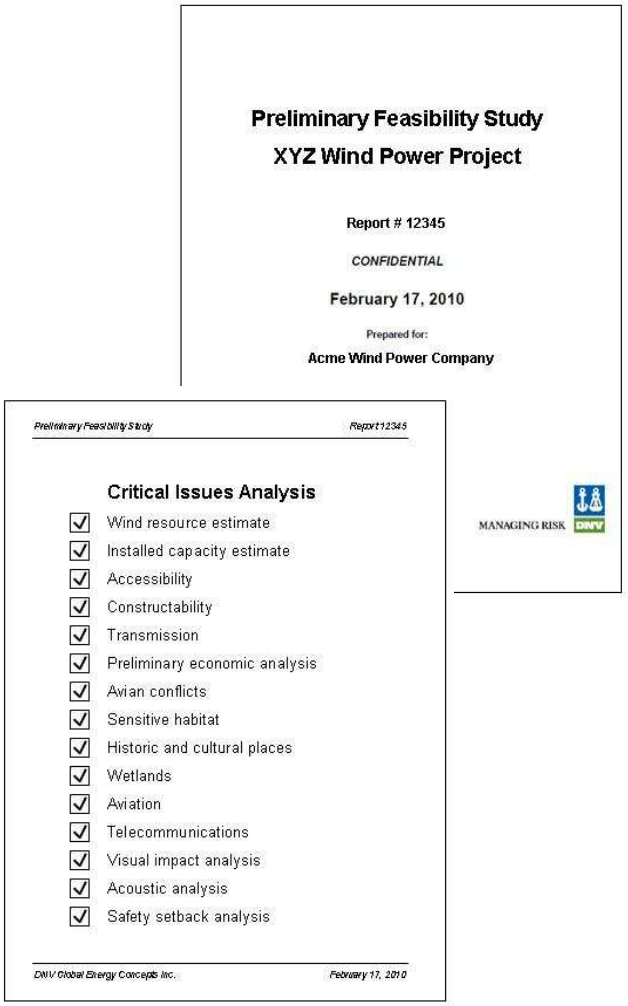


Visual Impact – Photo Simulations

- Concern: adverse aesthetic impacts (highly subjective)
- Impact analysis:
  - Identification of scenic areas
  - Community survey
  - Photo simulations from important vistas
- Mitigation strategies:
  - Turbine relocation
  - Reduced night-time lighting
  - Compensation
  - Underground power collection cables
  - Careful siting of substation and maintenance buildings

Source: ENERCON website

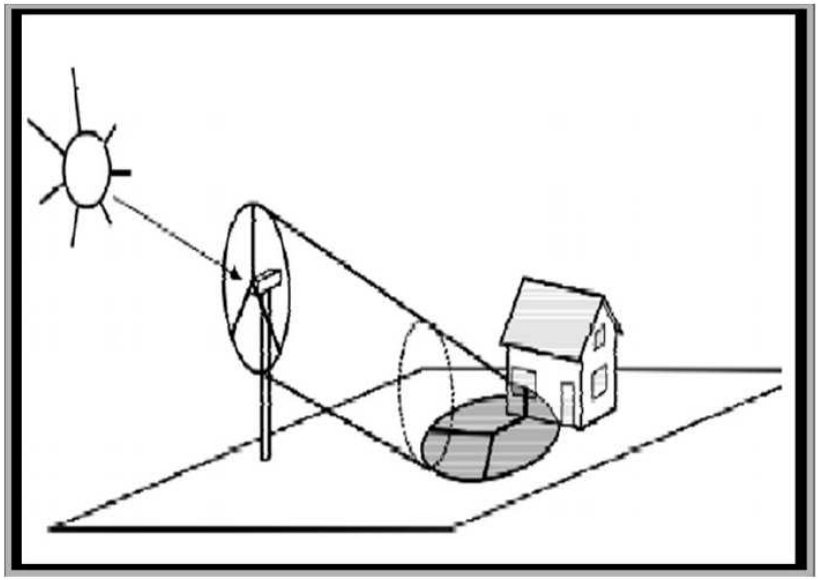
Visual Impact – Photo Simulations

Simulation of a hypothetical wind project at a typical location in the Intermountain West. Simulated turbines are at distances of approximately 1.75 to 3 miles from the observer. Simulation courtesy of Tetra Tech EC, Inc.

Source: AWEA Siting Handbook

Visual Impact – Shadow flicker

- Concern: causes headaches, annoyance, distress
- Impact analysis:
  - Computer-based mapping and modeling
  - Calculation of duration of impact for each receptor
  - Factors: within 300 m, low sun angles, clouds, wind speed & direction, window location, vegetation
- Mitigation strategies:
  - Tree screening
  - Turbine relocation
  - Curtailment
  - Compensation

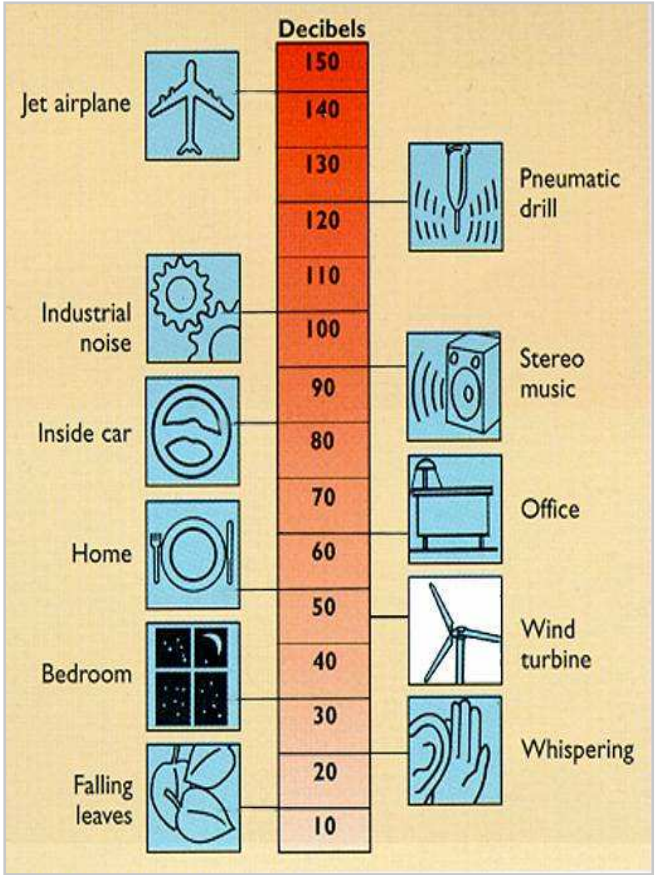


Representation of shadow flicker impact.

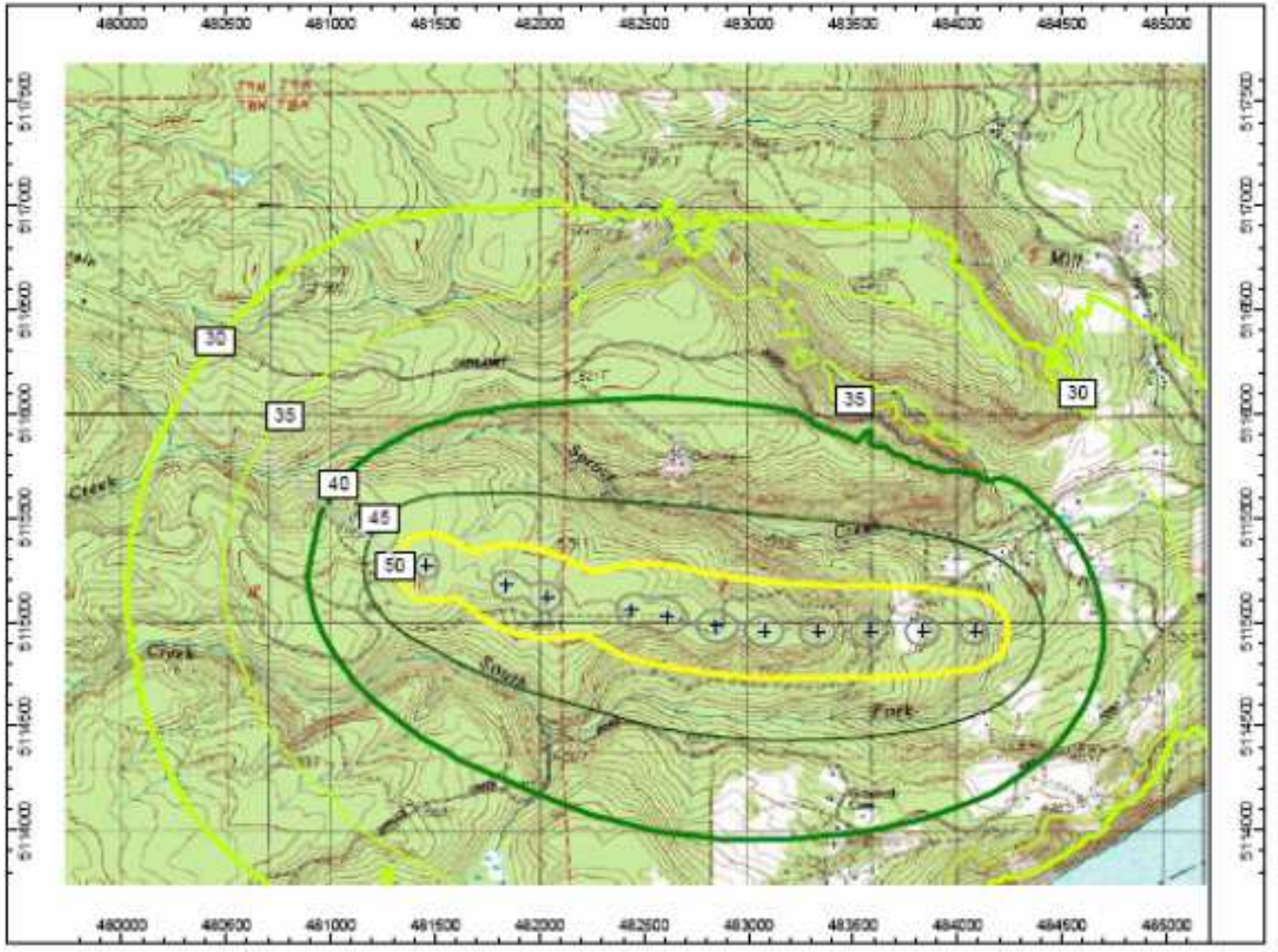
Source: AWEA Siting Handbook

Acoustic Impact

- Concern: noise disturbance (blade “swoosh”, mechanical components)
- Impact analysis:
  - On-site measurements with microphone
  - Sound propagation modeling and mapping
  - Local ordinances
- Mitigation strategies:
  - Tree screening
  - Setbacks, buffer zones
  - Turbine maintenance
  - Compensation



Acoustic Impact – Sound Contour Mapping



Example results from sound contour line model.

Source: AWEA Siting Handbook

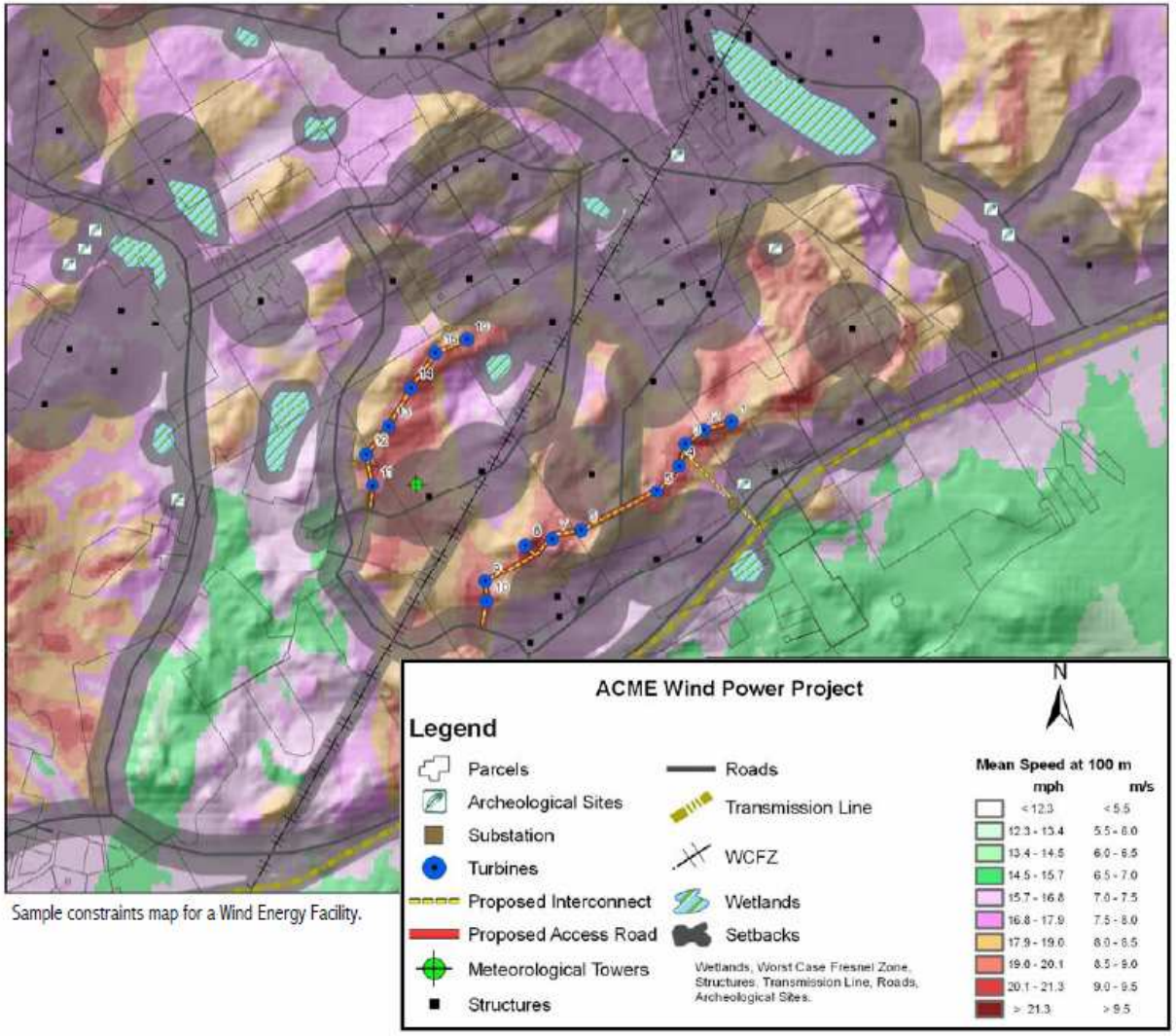
Cultural and Historic Places

- Concern: alteration or impact on cultural character (usually visual, acoustic)
- Impact analysis:
  - Identification and mapping of resources
  - Agency consultation
  - Field studies, local interviews
  - Historic landmarks, archaeological sites, traditional cultural sites
- Mitigation strategies:
  - Setbacks, buffer zones
  - Turbine relocation

Safety Concerns

- Concern: health and safety of public and turbine operators
- Impact analysis:
  - Identification of potential risks
  - Ice shedding, blade throw, tower collapse, fire, lightning
- Mitigation strategies:
  - Setbacks (1 to 3 times maximum tip height)
  - Warning signs
  - Safety and emergency plan

GIS Analysis – Constraints Map

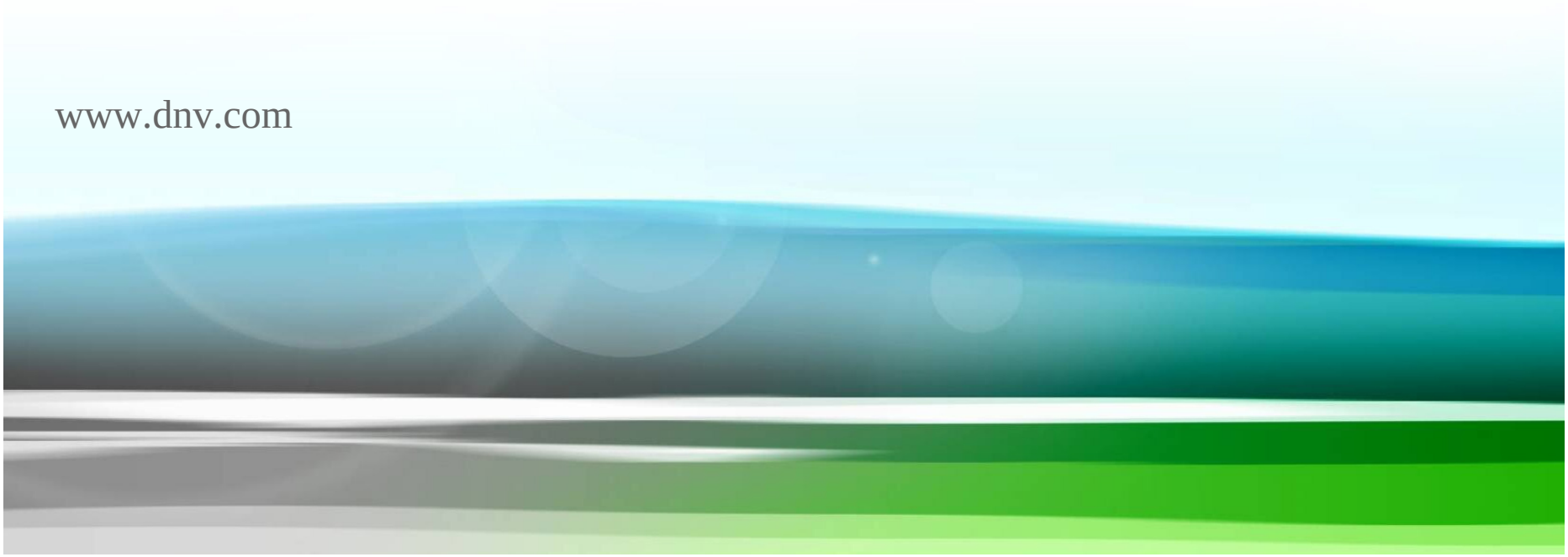


Sample constraints map for a Wind Energy Facility.

Source: AWEA Siting Handbook

Safeguarding life, property and the environment

www.dnv.com



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