

Tradeoffs for Renewable Energy Projects

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Center for the Advancement of Sustainability Innovations



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Energy Policy

In accordance with the Energy Policy Act of 2005, the Energy Independence and Security Acts of 2007; and Executive Orders 13423 (*Strengthening Federal Environmental, Energy, and Transportation Management*) and 13514 (*Federal Leadership in Environment, Energy and Economic Performance*); the U.S. Government is planning to significantly improve its energy management to save taxpayer dollars, to reduce energy use and emissions that contribute to air pollution and global climate change, and to improve “energy security” for our nation.



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Army's Energy Strategy and Plan

(includes five major initiatives)

- Eliminating energy waste in existing facilities
- Increasing energy efficiency in new construction and renovations
- Conserving water resources
- Improving energy security, and
- *Reducing dependence on fossil fuels through increased use of clean, renewable energy that optimizes environmental benefits and sustainability.*



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ENERGY

Regardless of origin, availability and security of both renewable or non-renewable energy sources are affected by four segments of the energy chain:

- (1) resources,
- (2) generation,
- (3) transmission and distribution, and
- (4) the end user.



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Estimated Army Energy Consumption

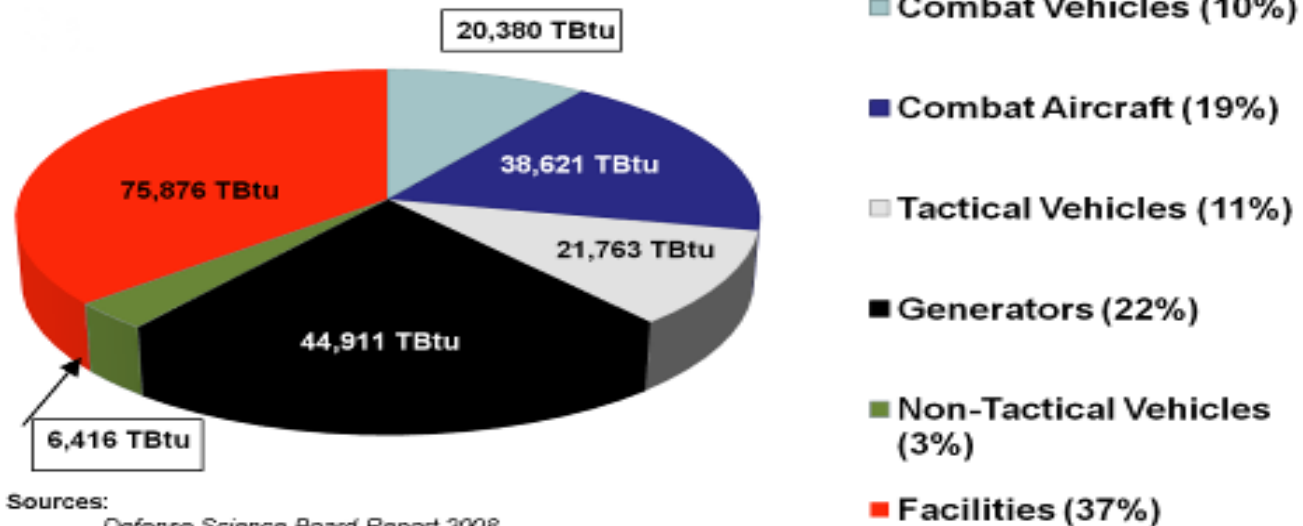
AMERICA'S ARMY:
THE STRENGTH OF THE NATION

ARMY ENERGY SECURITY TASK FORCE



Estimated Wartime Consumption

206.6 Trillion Btu (TBtu)



Sources:

Defense Science Board Report 2008
Army FY 2007 Annual Energy Management Report

LNL-PRES-407681

Leadership



Partnership



Ownership

6



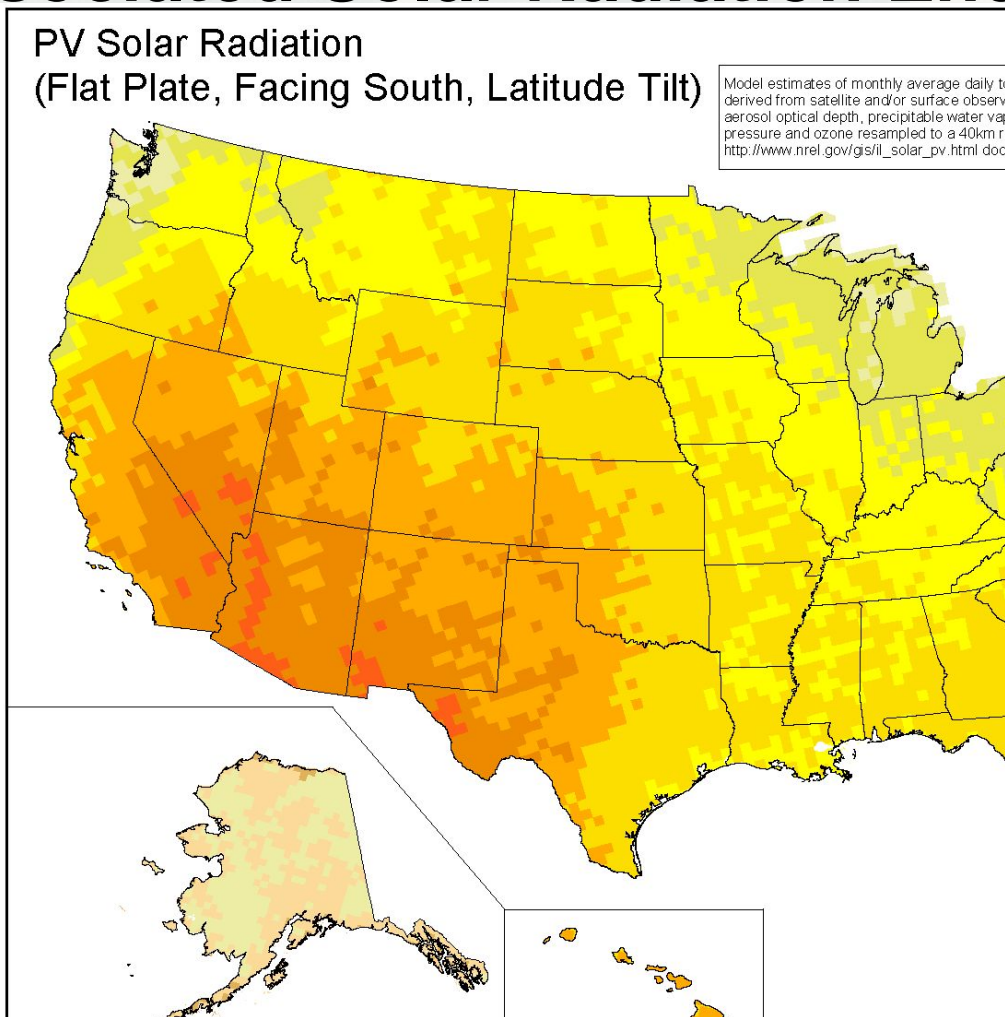
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Renewable Energy Sources

- Solar
- Wind
- Biomass
- Geothermal

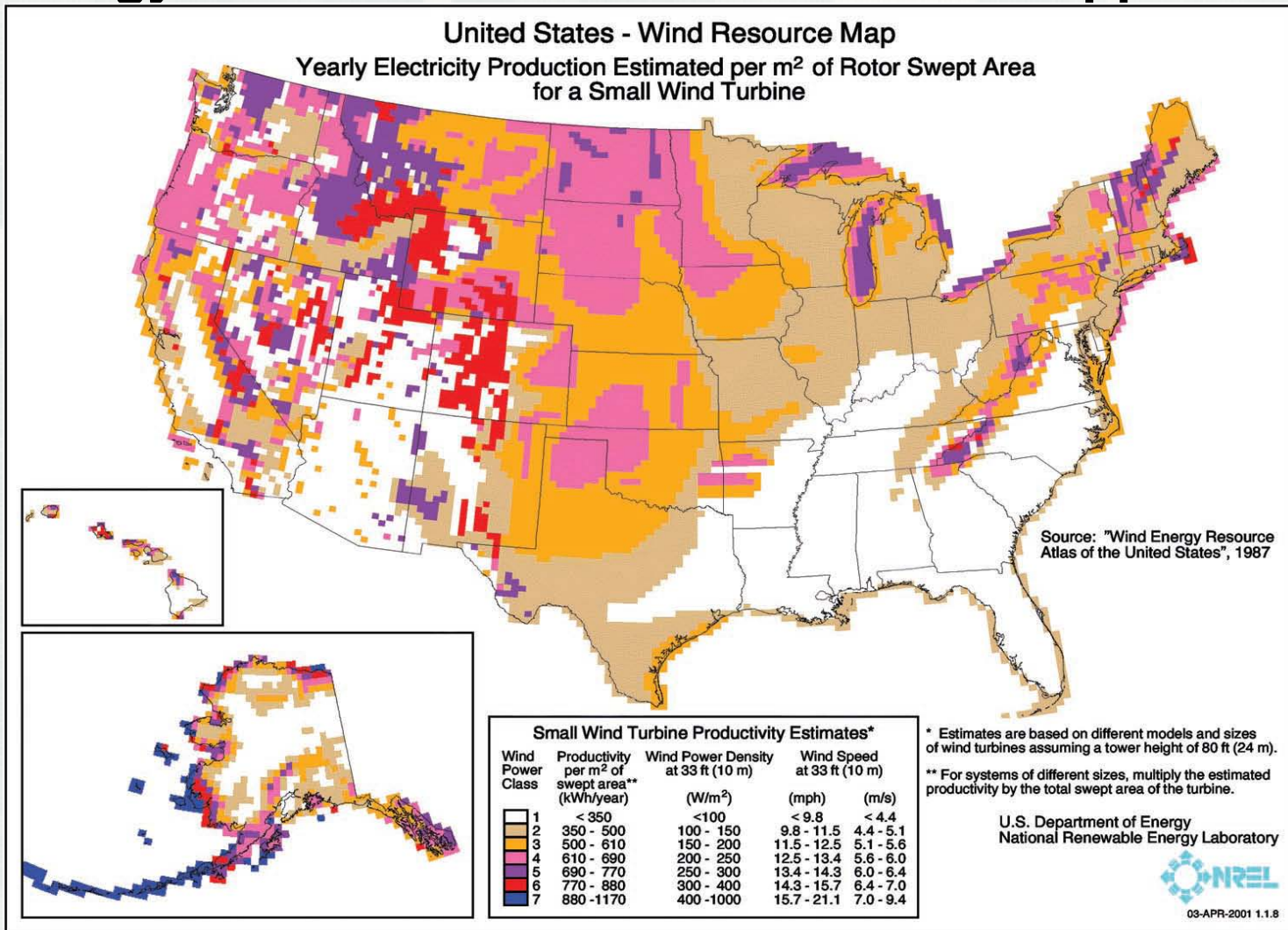


Relative Solar Radiation and Associated Solar Radiation Energy Potential

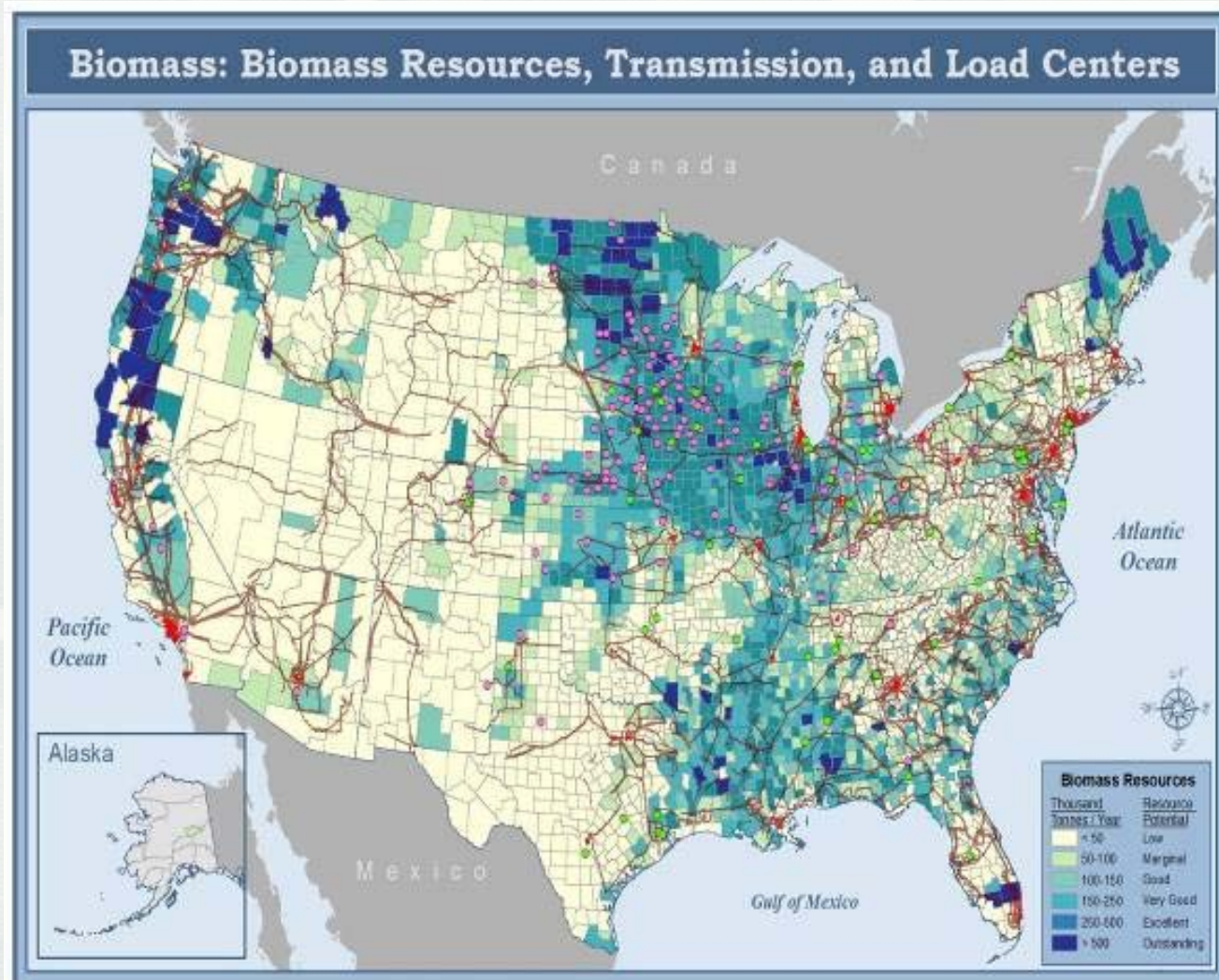


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Map Of Wind Resources And Estimated Potential Electric Energy Production From Small Turbine Applications

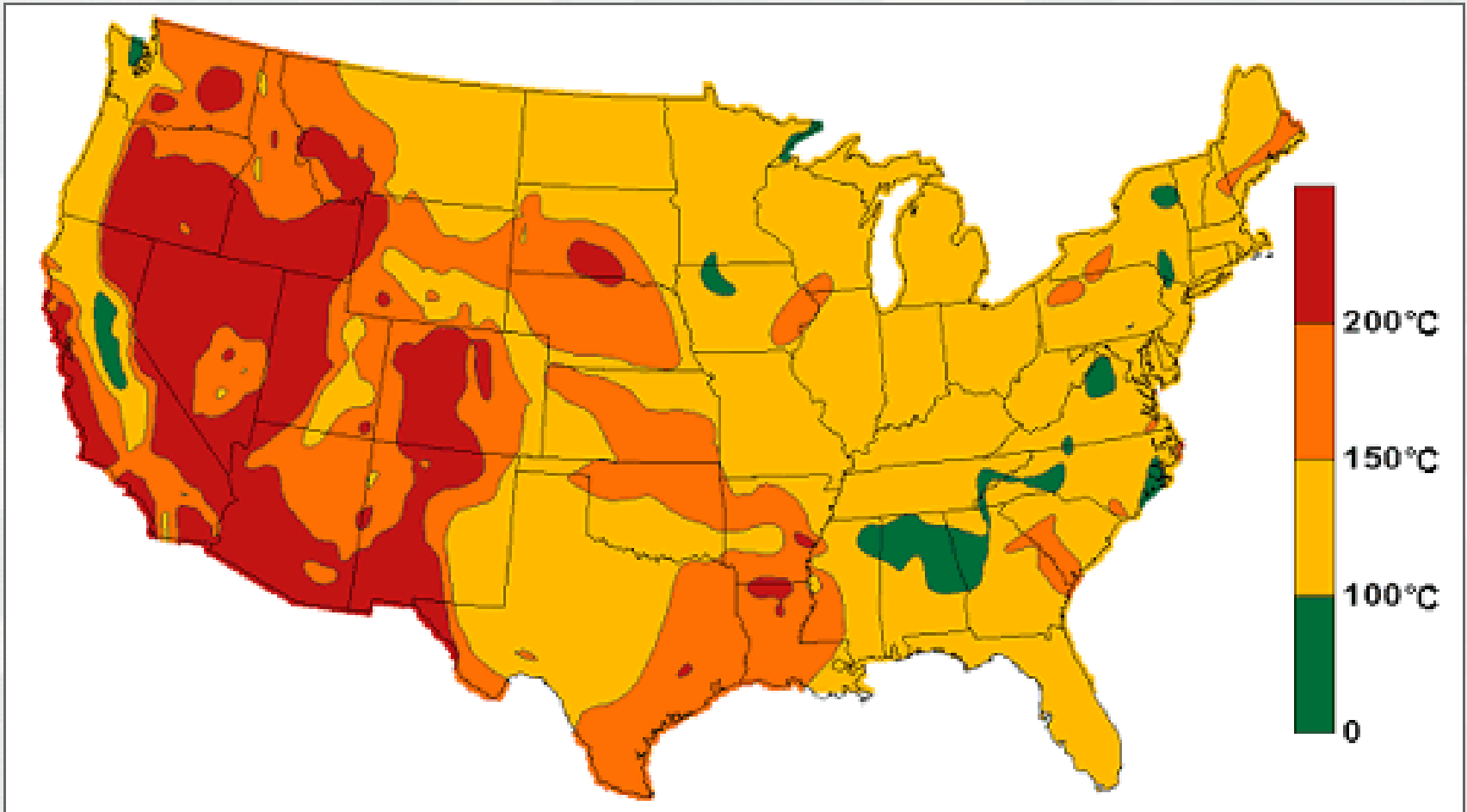


Potential Biomass Resource Areas and Transmissions Centers and Paths



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Generalized Geothermal Resource Potential



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Solar Energy



Solar energy station at Air Force Base



SEGS at Daggett and Kramer Junction, CA.



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Wind Energy

Air Force



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Biomass Conversion



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Geothermal Energy

270-MW Geothermal Electric Power Plant, Navy



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Environmental and Mission Considerations

The development and implementation of renewable energy opportunities, efforts, and projects can present significant challenges in ecosystem management and ecosystem tradeoffs. This is true whether the military services are a proponent, a user, or consumer (or some combination of these roles).



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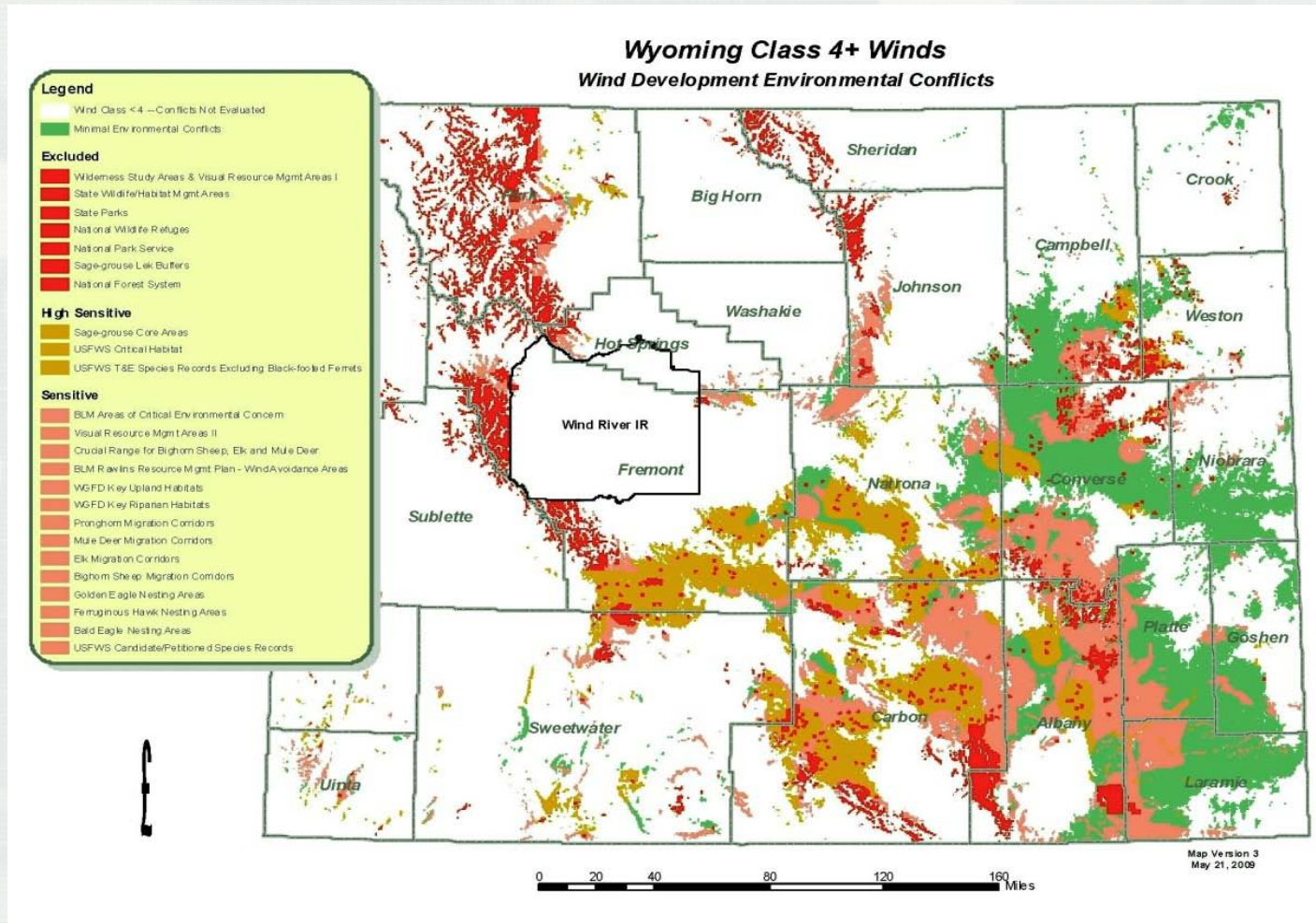
Environmental and Mission Considerations

- **Geology, soils, seismic activity**
 - ▶ Substrate, topography
 - ▶ Erosion – water, wind
 - ▶ Fault lines, earthquake zones
- **Climate**
 - ▶ Cloud cover
 - ▶ Sun, exposure
- **Biology**
 - ▶ Migration, movement
 - ▶ Mortality
 - ▶ Landscape ecology
 - ▶ Vegetative cover
 - ▶ Aquatic, marine



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Example of Renewable Wind Energy Environmental Developmental Conflicts



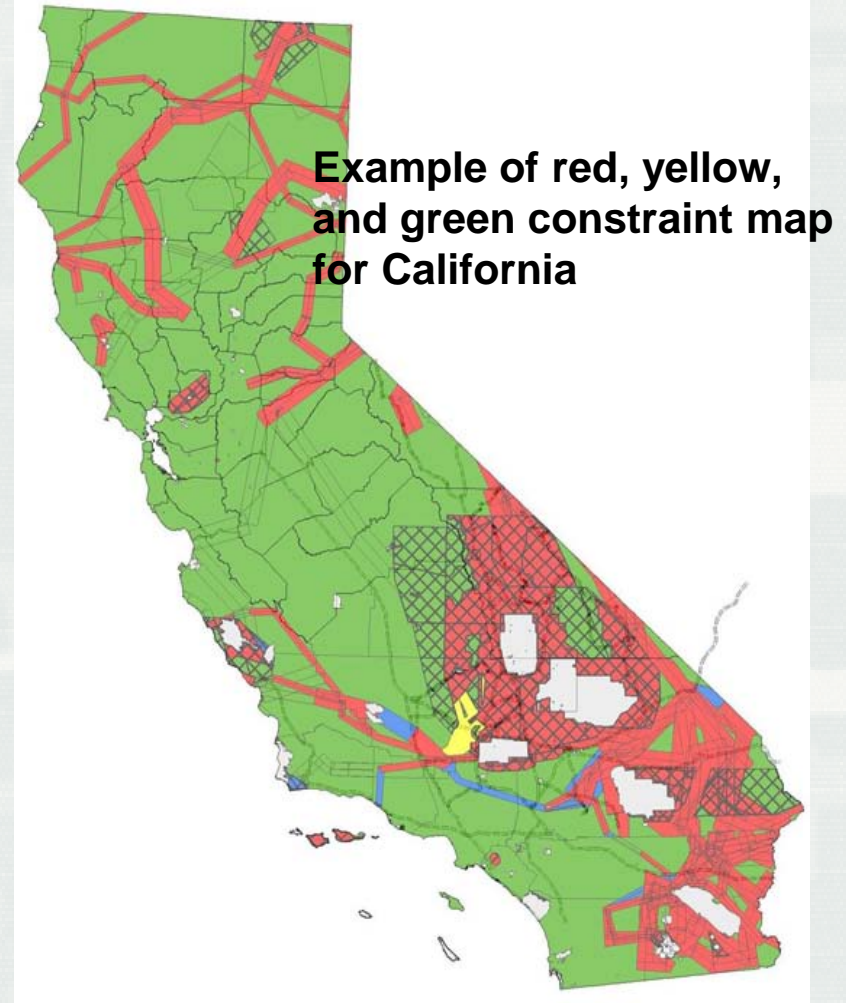
Environmental and Mission Considerations

- **Water resources**
 - ▶ Surface, ground
 - ▶ Quality, volume, seasonality
 - ▶ Demand, use, allocation, distribution, disposal
- **Air quality**
 - ▶ Greenhouse gases (carbon dioxide, carbon monoxide, methane, nitrous oxide)
 - ▶ Combustion (particulate matter, refrigerants (hydrofluorocarbons))
- **Air space**
 - ▶ Military, civilian aircraft flight routes
- **Communications – including radar and sonar**
 - ▶ Reflection of electromagnetic signals, Doppler clutter
 - ▶ Cell phone towers, wireless Internet sites, radio repeater stations



Environmental and Mission Considerations

- **Noise**
 - ▶ Noise Pollution and Abatement Act
 - ▶ Effects unknown
- **Visual**
 - ▶ Example, Nantucket Sound
- **Land use and ownership**
 - ▶ Public, private
-



Private land renewable energy development



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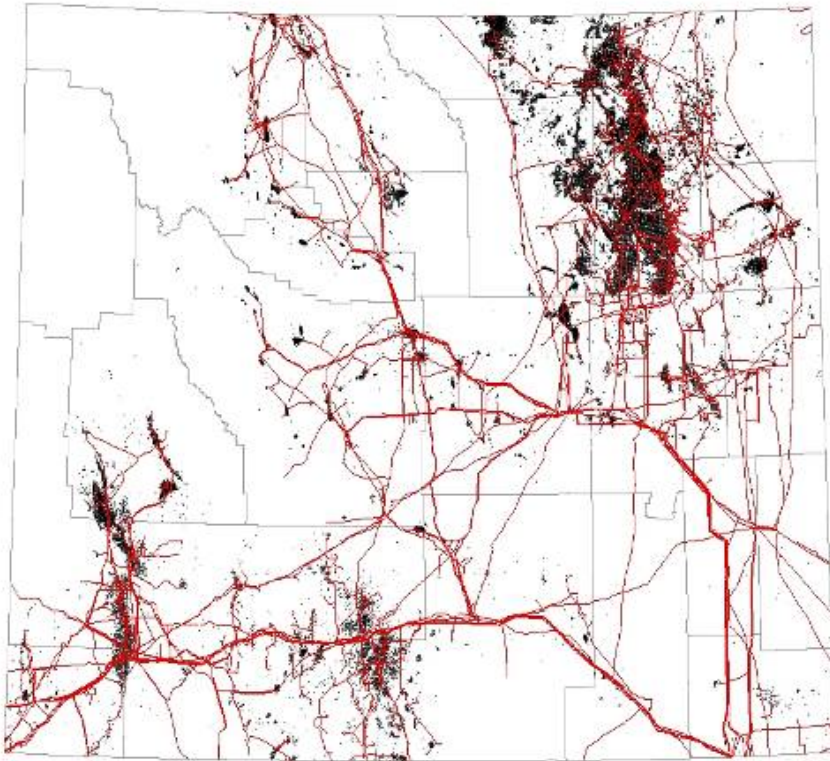
Environmental and Mission Considerations

- Urban growth
 - ▶ Confluence with military installations
 - ▶ Army Compatible Use Buffer Program (ACUB)
 - ▶ Land use change
- Socioeconomic factors
 - ▶ Job creation, job loss
 - ▶ Migration, movement of people
 - ▶ Increased demand for services (police, fire, recreation), housing, schools
 - ▶ Cropland, forestry conversion
- Transportation and utilities
 - ▶ Routes; habitat fragmentation, introduction of hazardous materials, required infrastructure
 - ▶ Private, public ownership



Environmental and Mission Considerations

Example of Transportation and Utilities Impacts



Oil and gas pipeline and well systems in Wyoming



Aerial view of the Jonah Field, WY showing local service roads and other infrastructure



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Environmental and Mission Considerations

- **Cultural resources**
 - ▶ Tribal consultation, coordination
- **Environmental justice**
 - ▶ Minority, low income groups
 - ▶ Renewable energy development along borders
- **Waste management and hazardous materials**
 - ▶ Animal waste (methane generation); solar cells
 - ▶ Water and air quality
 - ▶ Hazardous gases and minerals (arsenic, mercury, ammonia)
- **Recreation**
 - ▶ Land use change; traditional uses
 - ▶ Traditional and historic use

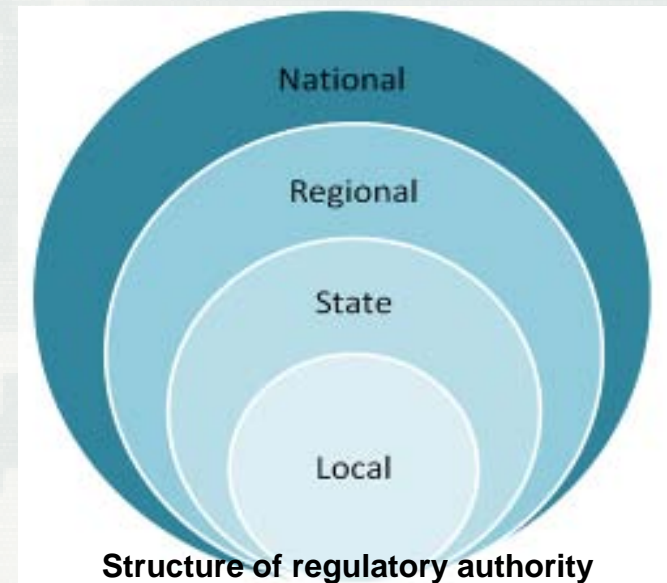


Environmental and Mission Considerations

- Regulatory considerations/authority
 - ▶ Multiple permitting authorities
 - ▶ Differing permitting requirements/criteria

Summary of state delegation of zoning authority

Qualification	Number
States with zoning enabling laws	50
States with state-level zoning authority	2
States with county zoning authority	39
States with town/township zoning authority	13
States with municipal zoning authority	49
Estimated number of local zoning jurisdictions	20,000



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Environmental and Mission Considerations

- Cumulative effects
 - ▶ Human demographics
 - ▶ Different definitions – e.g., NEPA, ESA




Cumulative effects of wind energy development are easy to observe, but difficult to quantify



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Large-scale Renewable Energy Technology vs. Ecosystem Considerations

		Geology, Soils, Seismic Activity	Climate	Biology	Water Resources	Air Quality	Air Space	Communications	Noise	Visual	Land Use and Land Ownership	Cultural Resources	Urban Growth	Socioeconomic Factors	Transportation and Utilities	Environmental Justice	Waste Management and Hazardous Materials	Recreation	Cumulative Effects	Regulatory Considerations/Authority
Solar – PV*			X	X		X				X	X	X	X	X	X	X	X	X	X	X
Solar – Concentrating PV			X	X	X	X				X	X	X	X	X	X	X	X	X	X	X
Solar – Concentrating Thermal Electric*			X	X	X	X				X	X	X	X	X	X	X	X	X	X	X
Wind		X	X	X			X	X	X	X	X	X	X	X	X	X	X	X	X	X
Biomass (Energy Crops and Biofuels)		X	X	X	X						X	X	X	X	X	X	X	X	X	X
Biomass (Waste-to-Energy)				X	X						X	X	X	X	X	X	X	X	X	X
Geothermal		X			X	X				X	X	X	X	X	X	X	X	X	X	X

* There are three major concentrating solar thermal electric technologies that might be considered: (1) parabolic trough (upper left photo), (2) concentrating dish sterling, and (3) power tower.



Generalized Screening for Renewable Energy Projects

Potentially Affected Environmental Resource	Renewable Energy Source			
	Solar	Wind	Biofuel	Geothermal
Military land use	X	X	X	X
Geology, soils, seismic			X	X
Climate	X	X	X	
Biological resources	X	X	X	X
Water resources				X
Air quality			X	X
Air space		X		
Communications		X		
Noise		X		X
Visual	X	X		X
Land use, ownership	X	X	X	X
Cultural resources				
Urban growth	X	X	X	X
Socioeconomic factors	X	X	X	X
Transportation, utilities	X	X	X	X
Environmental justice	X	X	X	X
Waste, hazardous materials			X	X
Recreation	X	X	X	X



Where Do We Go From Here?

- Investigation and research be initiated to better inform decision-makers of the tradeoffs between renewable energy projects and the ecological, mission, and other unintended consequences of these projects.
- These tradeoffs are not well understood and should consider ecosystem services, GHG, energy production, and other criteria as tradeoff measures.
- In addition, long-term studies are needed to address many questions on impacts of renewable energy development or acquisition on ecosystem components, human health and mission capability.
- Some of the impacts may not be apparent in short term studies, and the types of impacts may differ over time as land use intensifies in regions where renewable infrastructure is sited, or where biomass is generated for biofuels.
- These studies are needed to inform and improve the plans and operations for long-term renewable energy projects, to help shape new projects, and to better understand and anticipate the cumulative impacts of multiple projects.
- Issues such as long-term ecosystem impacts, carbon balance from bio-resources, technology evolution, infrastructure degradation, etc. need to be addressed to minimize any negative effects resulting from renewable energy efforts.

