# Integrating wildlife considerations into wind energy systems engineering

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# **Integrating wildlife considerations** into wind energy systems engineering

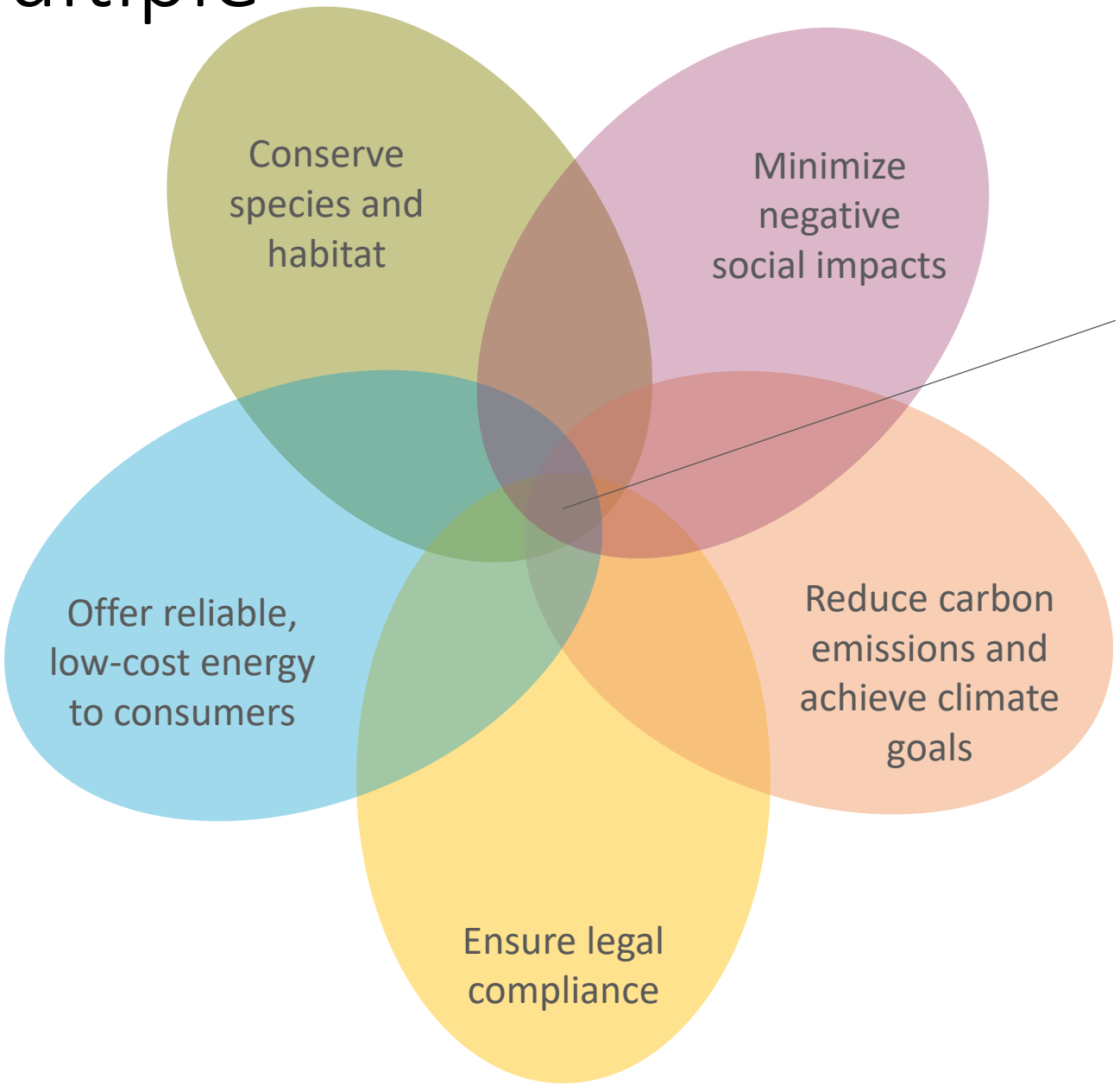
## Systems Engineering Offers

- A holistic approach to addressing stakeholder interests
- Methods to incorporate numerous requirements and objectives into an analytical framework that allows us to
  - weigh trade offs
  - identify synergies
  - uncover balanced, cost-effective solutions.

## But…

- Emphasis has been on improving the technical and economic performance of wind turbines/plants.
- Systems engineering applied to wind energy has, almost without exception, omitted environmental considerations.

# Balancing Multiple Objectives




*Requires careful, and intentional balance*

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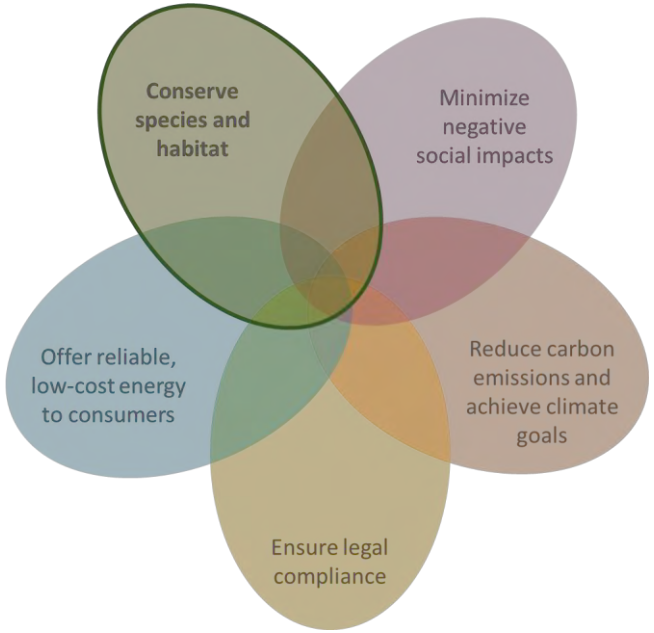
# Environmental Impacts

## Direct removal

Removing individuals from a population (e.g., fatality from collisions)

↓

Potential for population level effects




## Habitat Alteration and Loss

Habitat is degraded or no longer available

↓

Cascading deleterious effects

**To achieve our green objective, we need to minimize these impacts.**

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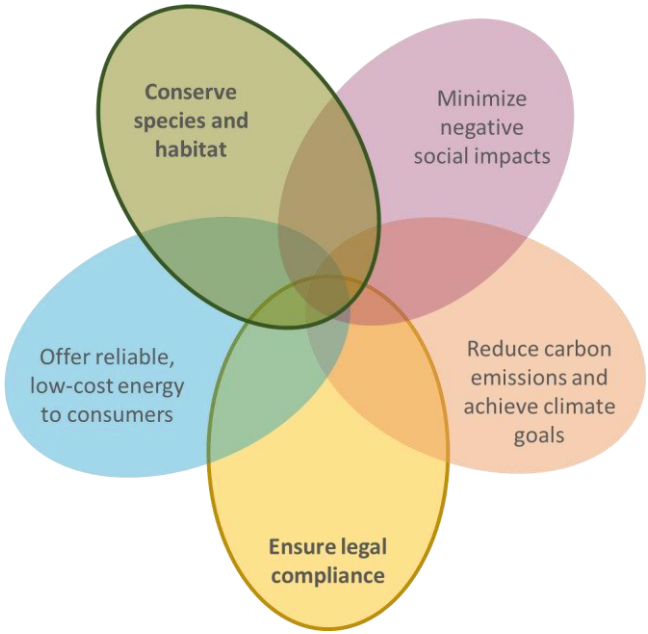


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**These impacts must be managed to satisfy the requirements of laws enacted to protect and sustain natural resources.**

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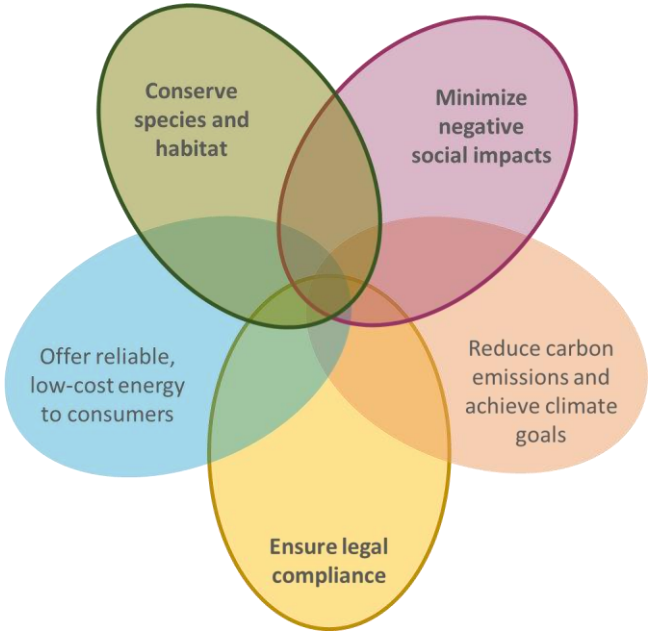


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Cascading deleterious effects

**These laws reflect the values of the public – i.e., stakeholder interests.**

**People LOVE wildlife and wild places.**

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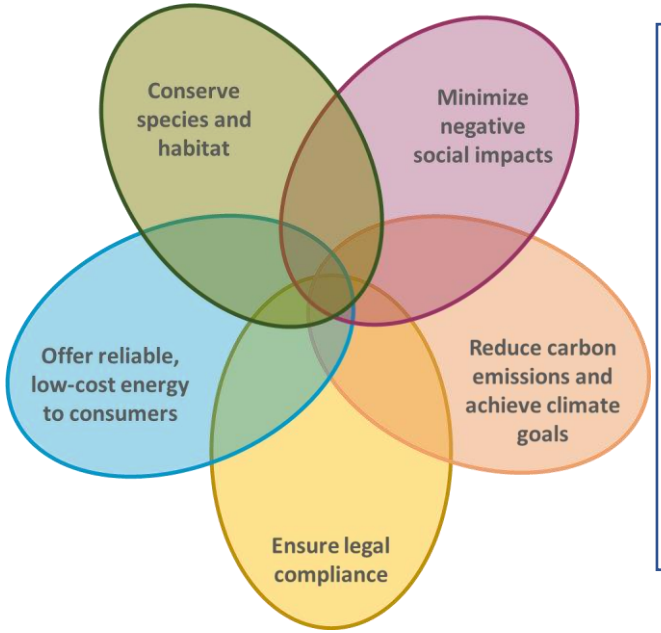


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Cascading deleterious effects

**Ignoring these first 3 objectives introduces obstacles to achieving the remaining 2.**

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# Settlement Agreements

**What are they?** Legal, corrective action that occurs when a company is found guilty of illegal take of protected species.

## There are 4:

- Altamont Wind Resource Area (2010)
- Campbell Hill and Top of the World projects (2013)
- Seven Mile Hill and Glenrock/Rolling Hills projects (2014)
- Cedar Springs I, II and III  projects (2022)

## What are the outcomes?

- Millions of dollars in m
- Millions of dollar
- Communit
- Probat
- D
- ntation of a
- iance plan
- gation research
- ocure take permits

They are expensive and no fun.

***Erode public acceptance.***

State of California Department of Justice (2010); U.S. Department of Justice (2013, 2014, 2022)

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# Incidental Take Permits

**To avoid Settlement Agreements, companies operating in the U.S. are often motivated to obtain incidental take permits for protected species.**

- In depth environmental review
- Time consuming
- Compliance monitoring
- Mitigation to ensure null effect to sensitive species
  - Avoidance
  - Minimization
  - Compensatory mitigation

| Identified Under | Taxonomic Groups | Number of Species |
|---|---|---|
| Federal Endangered Species List | All Animals | 727 |
| Federal Endangered Species List | All Plants | 939 |
| Migratory Bird Treaty Act | Migratory birds | 1000+ |
| Bald and Golden Eagle Protection Act | Bald and Golden Eagles | 2 |
| State Species of Greatest Conservation Need | Plants and animals | 16,420 |

https://www.fws.gov/law/bald-and-golden-eagle-protection-act
https://www.fws.gov/law/migratory-bird-treaty-act-1918

https://www1.usgs.gov/csas/swap/
https://ecos.fws.gov/ecp/report/species-listings-by-tax-group-totals

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# Mitigating Impacts

## Siting

- Place wind plants or individual turbines where they won't have a negative effect.

## Curtailment

- Turn off some or all turbines during periods of presumed risk.

## Deterrents

- Visual or auditory signals to dissuade volant wildlife from approaching.

## Compensatory Mitigation

- (Most common) Conservation of lands offsite that will benefit impacted populations.

Very hard to impossible (at least right now).

Aftermarket solutions.

Unknown costs – especially cost of implementation and maintenance.

Defacto exclusion area.

Current extent of mitigation lands unknown.

***None of this feeds back into design. Trade-offs are unexplored. Opportunity costs are not quantified.***

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# Scaling up the problem: IMPACTS

***This is no insignificant change in context. This requires a paradigm shift in how we consider and approach the problem.***

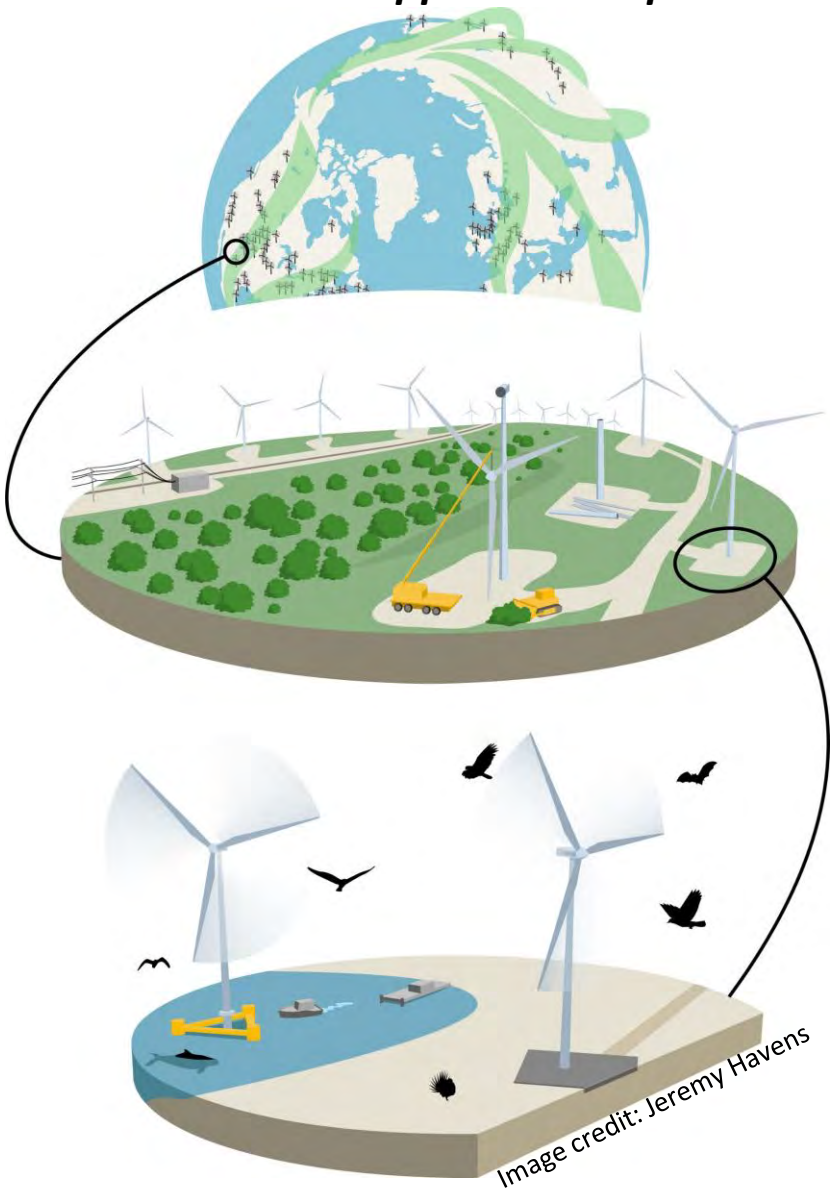

Image credit: Jeremy Havens

- Species exposed and cumulative impacts to their populations
- Impacted habitats and cumulative acres of impacted lands and offshore areas
- Cumulative rotor swept area and run time

As more wind is deployed, the harder it will be to find opportunities to avoid conflicts.

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# Scaling up the problem: MITIGATION

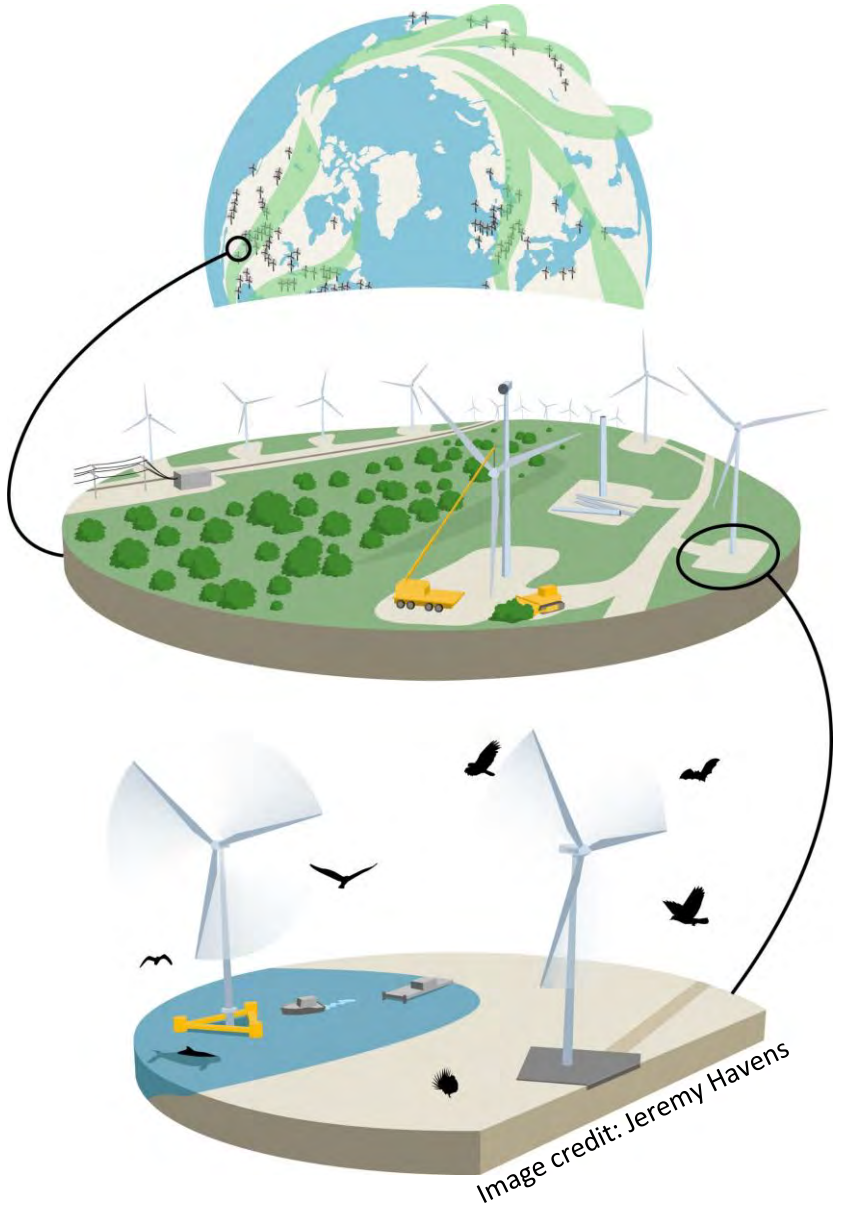

Image credit: Jeremy Havens

- Cumulative acres of mitigation lands and other exclusion areas.
- O&M costs for hosting aftermarket solutions
- Cumulative curtailment hours

***We need solutions that reduce impact/MWh commensurate with increase in deployment.***

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# Scaling up the problem: MORTALITY

| Species | Reduction in mortality from curtailment |
|---|---|
| All bat | 62% |
| **Hoary bat** | **48%** |
| Eastern red bat | 52% |
| Silver haired bats | 66% |

Whitby et al. 2021

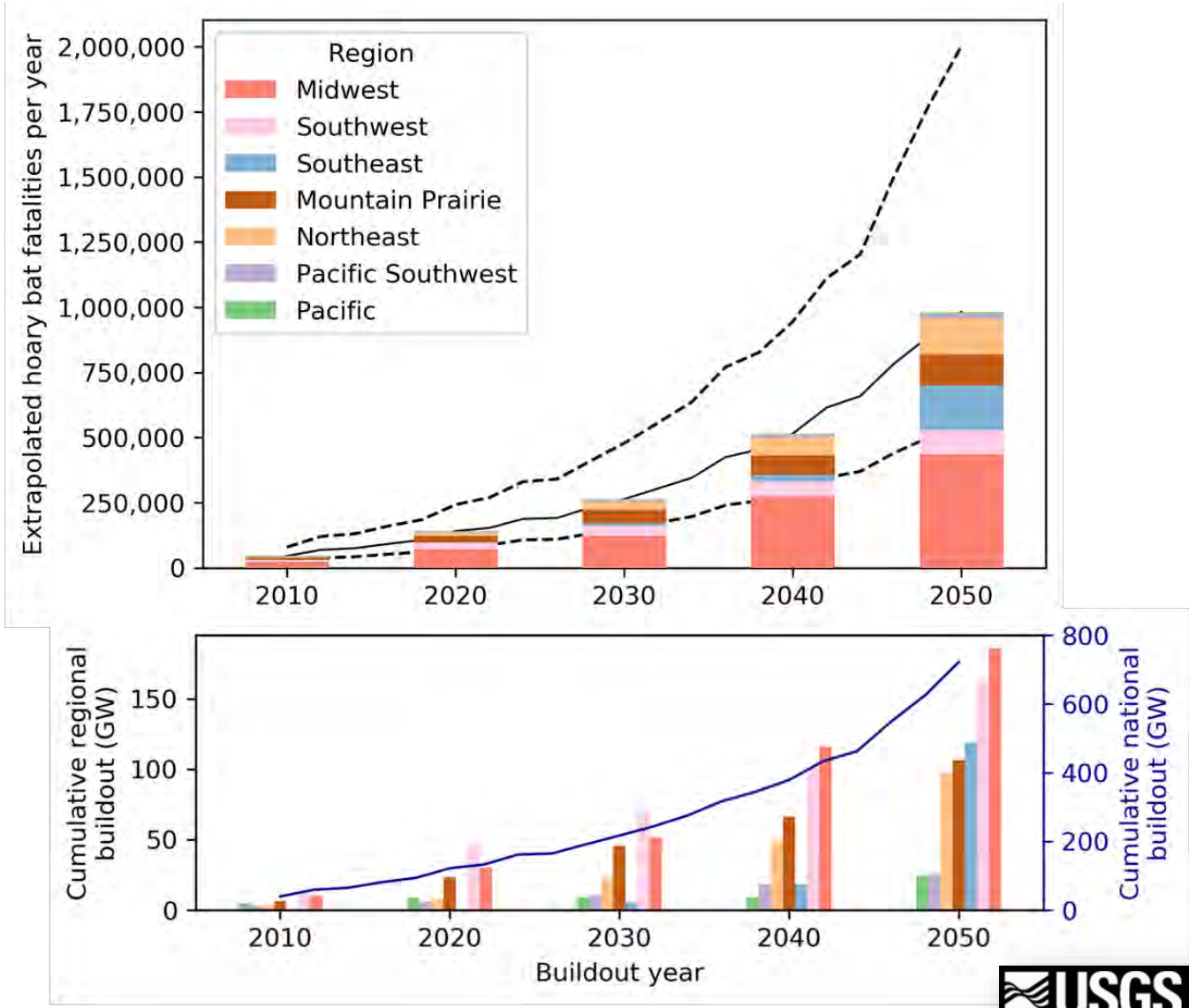


Image credit: Dylan Harrison-Atlas, NREL

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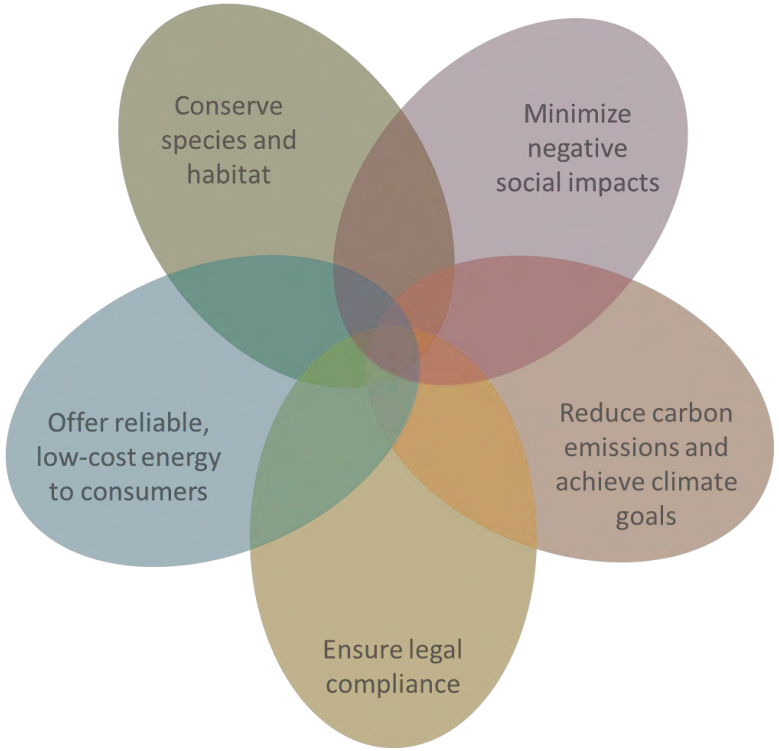
# Need for systems-level research capability

- All of this has the potential to influence how wind energy is deployed and operated.
- We don’t really understand how or to what degree, let alone, how to optimize the system for these requirements.
  - Environmental conservation requirements and objectives have not been considered as part of wind energy optimizations.
- Unlocking the *deployment* potential of wind energy requires
  - Understanding impacts at very high penetration scenarios
  - Quantitative methods to highlight vulnerabilities and influential levers
  - Means to weigh trade-offs throughout the life-cycle and identify synergies for balanced, cost-effective solutions.

# Opportunity for optimization

- Account for critical environmental objectives and constraints up front
- Clarify how conservation measures translate into
  - Altered power curves
  - Plant layouts
  - Control strategies
  - AEP
  - ROI on capital and soft costs
- Reveal opportunities to optimize
  - Turbine technology
  - Site selection
  - Plant design



# Optimization: Turbine Design and Controls

- Turbines trending toward lower rate power for low wind speed areas
- Some of our most biodiverse habitats that include declining bat populations
- Bat collisions typically occur during low wind speeds
- Greater opportunity for collisions and AEP losses from curtailment
  - Impact financial viability?

# Optimization: Turbine Design and Controls

- Bolster deployment potential and maximize ROI on turbine capital costs by including requirements for minimization as design variables.
  - Additional sensors
  - Data acquisition
  - Equipment
  - Control requirements
- Potential synergies between
  - Wake steering and curtailment
  - Consensus wind speed measurements
  - Additional approaches to reduce mistakes and increase reliability of minimization solutions

# It’s time for healthy disruption

- Time to rethink how we approach these problems
- The status quo supports very (very, very) slow progress
- Taking a systems level approach allows us to weigh trade offs and elucidate opportunity costs throughout the life-cycle
- Move beyond one site at a time to build a wealth of knowledge that allows us to in turn, develop optimized solutions that are customized for each site
- Every energy source has impacts. If we do not also extend this work to all energy types, we run the risk of simply displacing impact.

# Thank You

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*Troy Gipps*

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