

# Marine Hydrokinetic Energy Regulators Workshop: Lessons from Wind



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**Washington, DC**  
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# Then...



705-megawatt Tehachapi Pass Wind Farm. *Photo by David Hicks, NREL 18455-C*

- Limited early acceptance and understanding of potential impacts
- Limited engagement with local stakeholders
- High degree of corporate green energy complex and mistrust.

- Large numbers of small wind turbines installed in tightly packed rows
- Limited deployment experience with high deployment drive
- High corporate turnover



Red-tail hawk taking off from a non-working wind turbine in Altamont Pass, California. *Photo by Shawn Smallwood, NREL 17329*

# Now...

- Much larger wind turbines with wide spacing
- Widely dispersed installations
- Much more experience in siting and deployment
- Smaller number of industry leaders



Cedar Creek Wind Farm in Grover, Colorado. *Photo by Dennis Schroeder, NREL 30590*

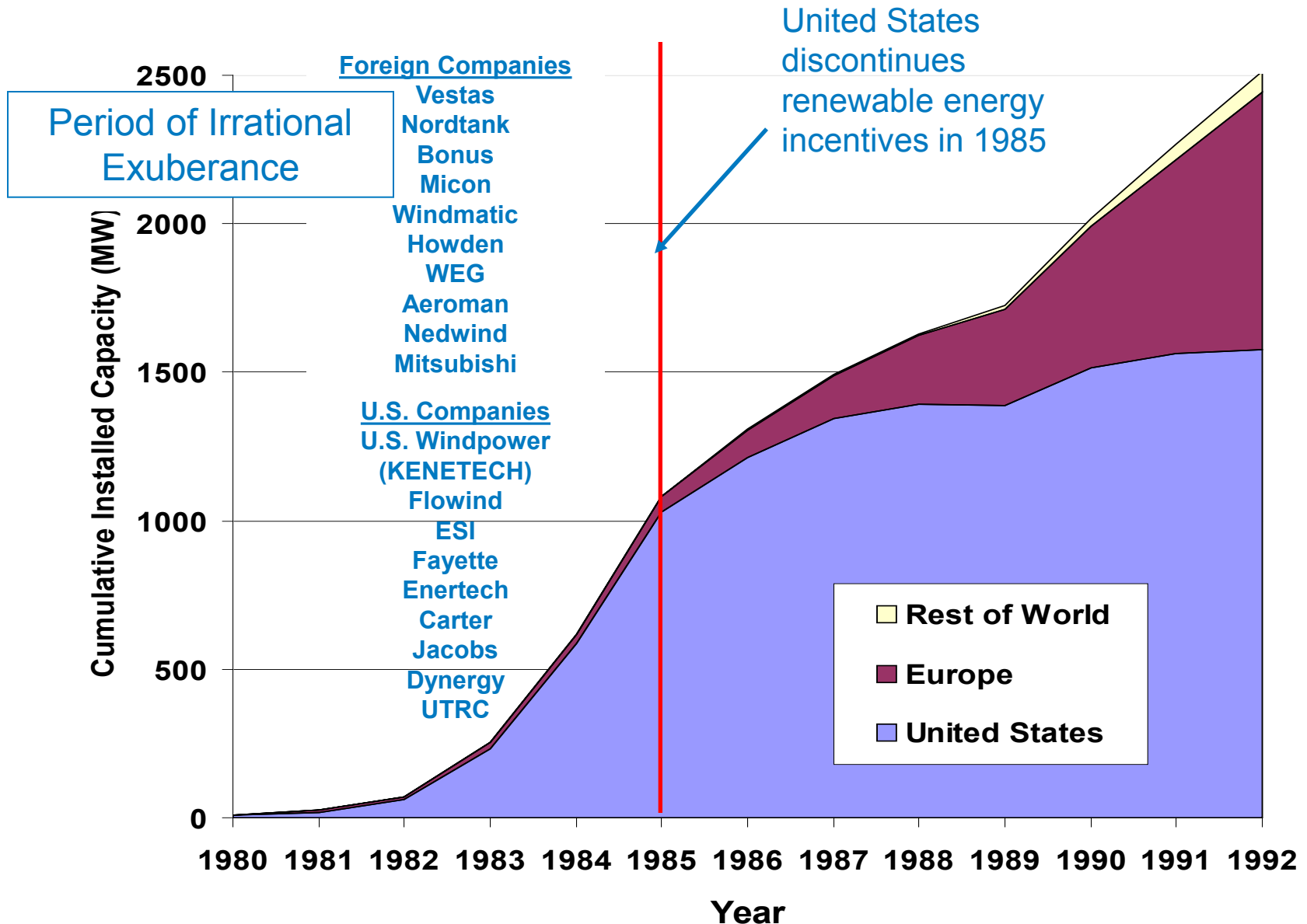


Forward Wind Energy Center in Fond du Lac and Dodge Counties, Wisconsin. *Photo by Ruth Baranowski, NREL 21208*

- Much better understanding of potential impacts (but still improving)
- Expanded engagement with local stakeholders
- Better-defined regulations
- Expanded collaboration among industry, environmental, and regulatory communities.

# First Decade of Wind Energy

10,000 turbines (about 1 gigawatt) were installed in California by 1985



# Lessons Learned

- **Use a collaborative approach involving the key stakeholders.**
  - Engage early and often with all parties represented – build trust and collaboration
  - Share data on impacts while respecting IP and issues around sharing
  - Employ quantitative, science-based methods with independent, science-based oversight
  - Good examples: Bats and Wind Energy Cooperative and American Wind Wildlife Institute.
- **Technology needs to evolve to become competitive.**
  - Controlled, small-scale testing allows technology advances.
- **Use baseline studies to measure and prioritize impacts to wildlife.**
  - Developing an “understanding” of impacts from single units is very hard to do; a solid number of units (up to 100?) with enough geographic diversity to allow analysis is required.
- **Look at avoidance and mitigation options early in the process.**
  - Utilize biological and device engineering capabilities to develop lower-impact devices or new avoidance and mitigation solutions
  - Support and fund field-testing of mitigation options.
- **Company size and market potential make a huge difference.**
- **A strong federal role exists in supporting ongoing science, education, and collaboration.**
  - An independent third-party collaborator
  - Ability to look across the whole industry.



# Bats and Wind Energy Cooperative



## Broad Oversight Committee

- American Wind Energy Association
- U. S. Fish and Wildlife Service
- U.S. Department of Energy
- National Renewable Energy Laboratory
- Bat Conservation International
- U.S. Geological Survey.

## Scientific Advisory Committee

## Technical Advisory Committee

## Partners and Funders

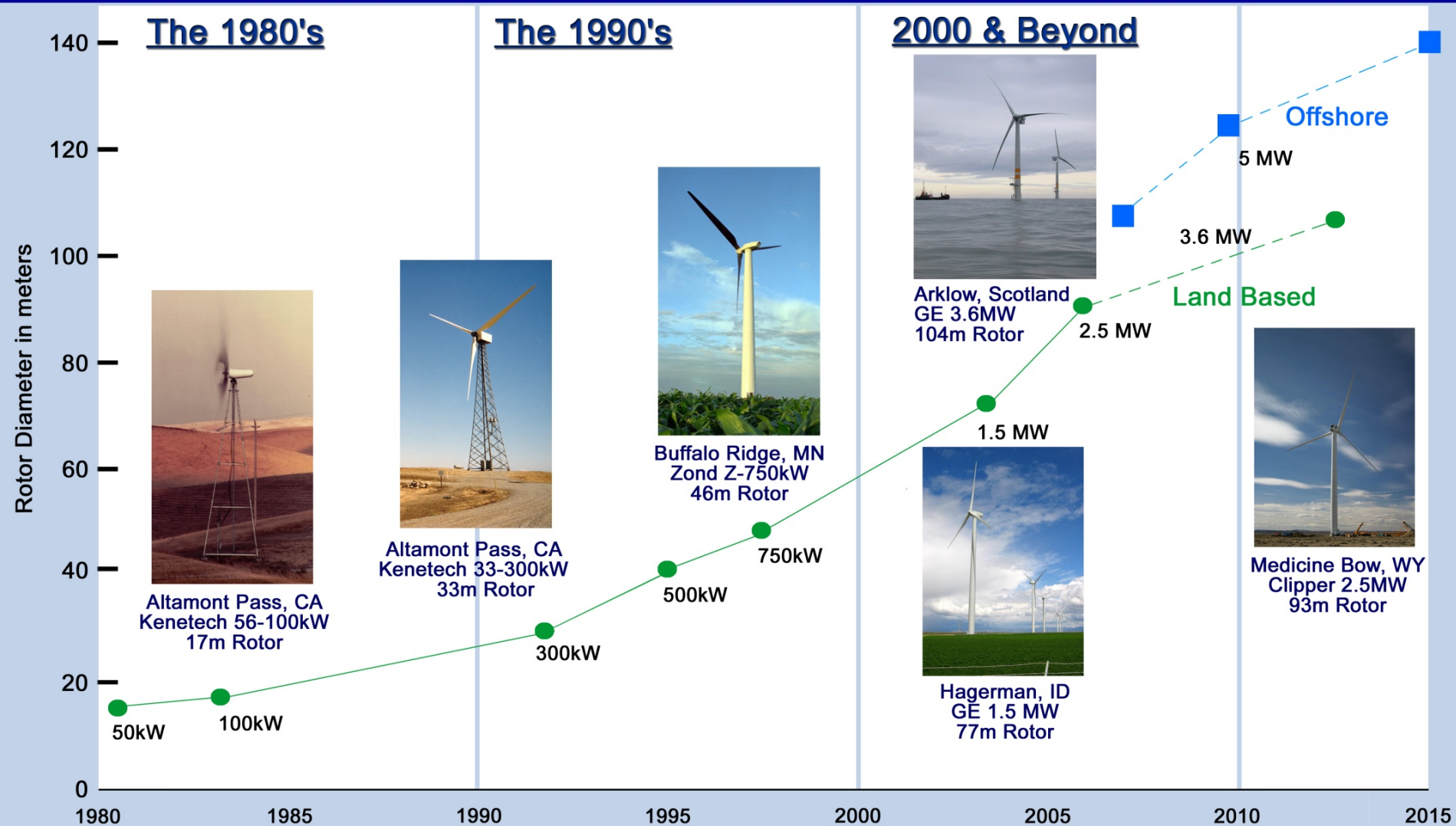
- Acciona
- Adele M. Thomas Charitable Foundation, Inc.
- AES Wind Generation
- American Wind Energy Association
- American Wind Wildlife Institute
- Bass Foundation
- BP Alternative Energy
- Beneficia Foundation
- Clipper Windpower
- Community Foundation for the Alleghenies
- Department of Energy
- Donors to Bat Conservation International
- Duke Energy
- Edison Mission
- Edward Gorey Charitable Trust
- Energy and Environmental Ventures II, LLC
- Erdman Family Foundation
- First Wind
- Gamesa
- General Electric
- Horizon Wind Energy (formerly Zilkha Renewable Energy)
- Iberdrola Renewables (formerly PPM Energy)
- Invenery
- Massachusetts Technology Collaborative
- Merrill Foundation
- National Fish and Wildlife Foundation
- National Renewable Energy Laboratory
- NedPower
- New York State Energy Research and Development Authority
- NextEra Energy Resources (formerly FPL Energy)
- Noble Environmental
- Offield Family Foundation
- PPM Atlantic Renewable
- Rhode Island Renewable Energy Fund
- Suzlon
- The Hulebak-Rodricks Foundation
- The Leo Model Foundation, Inc.
- The New York Community Trust
- Trans Alta Corporation
- TRF - Sustainable Development Fund
- U.S. Fish and Wildlife Service
- U.S. Forest Service
- U.S. Wind Force
- Vestas
- Wiancko Charitable Foundation Inc.

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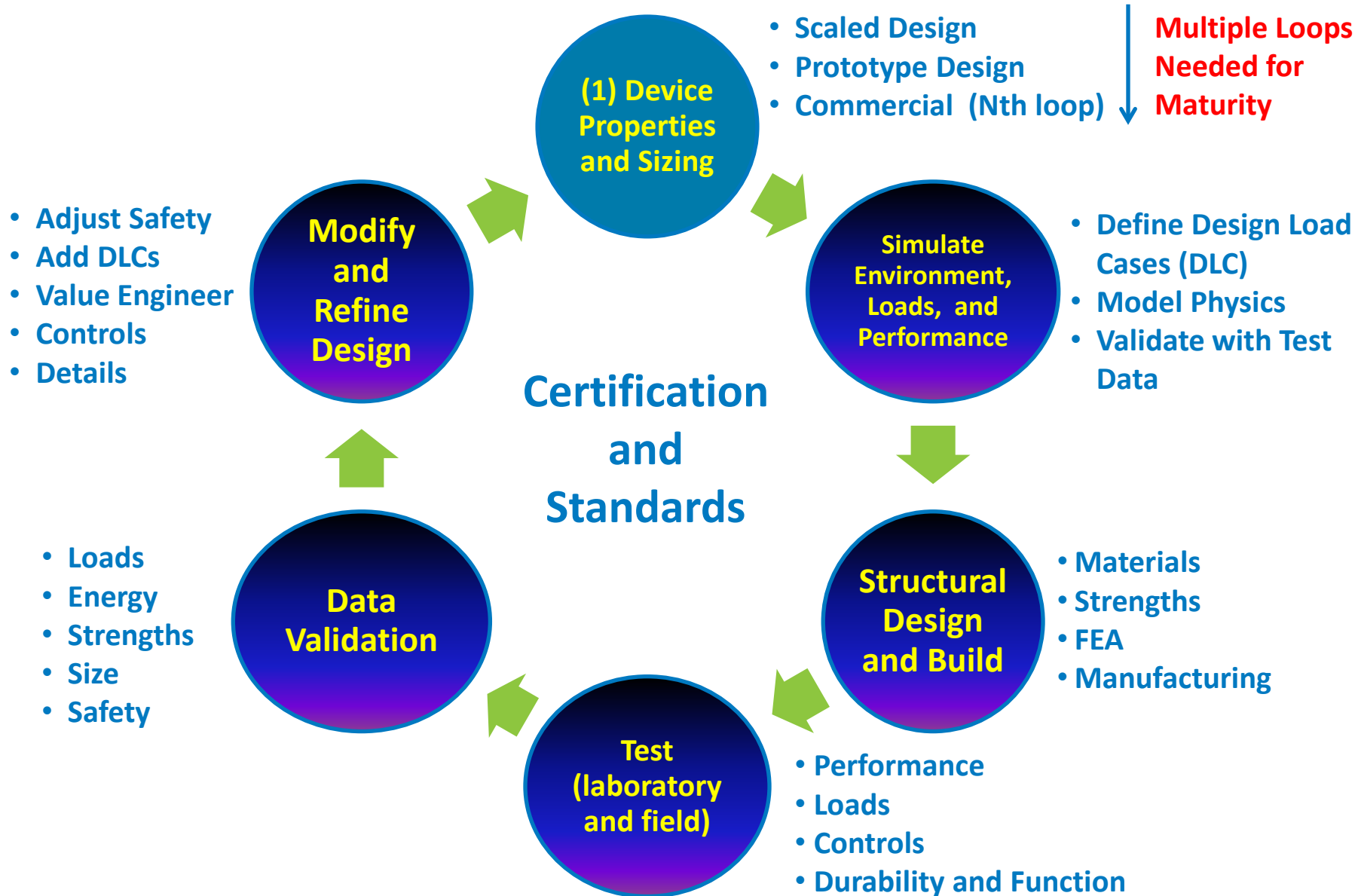
# The Technology Has Evolved over Time

## Evolution of U.S. Commercial Wind Technology



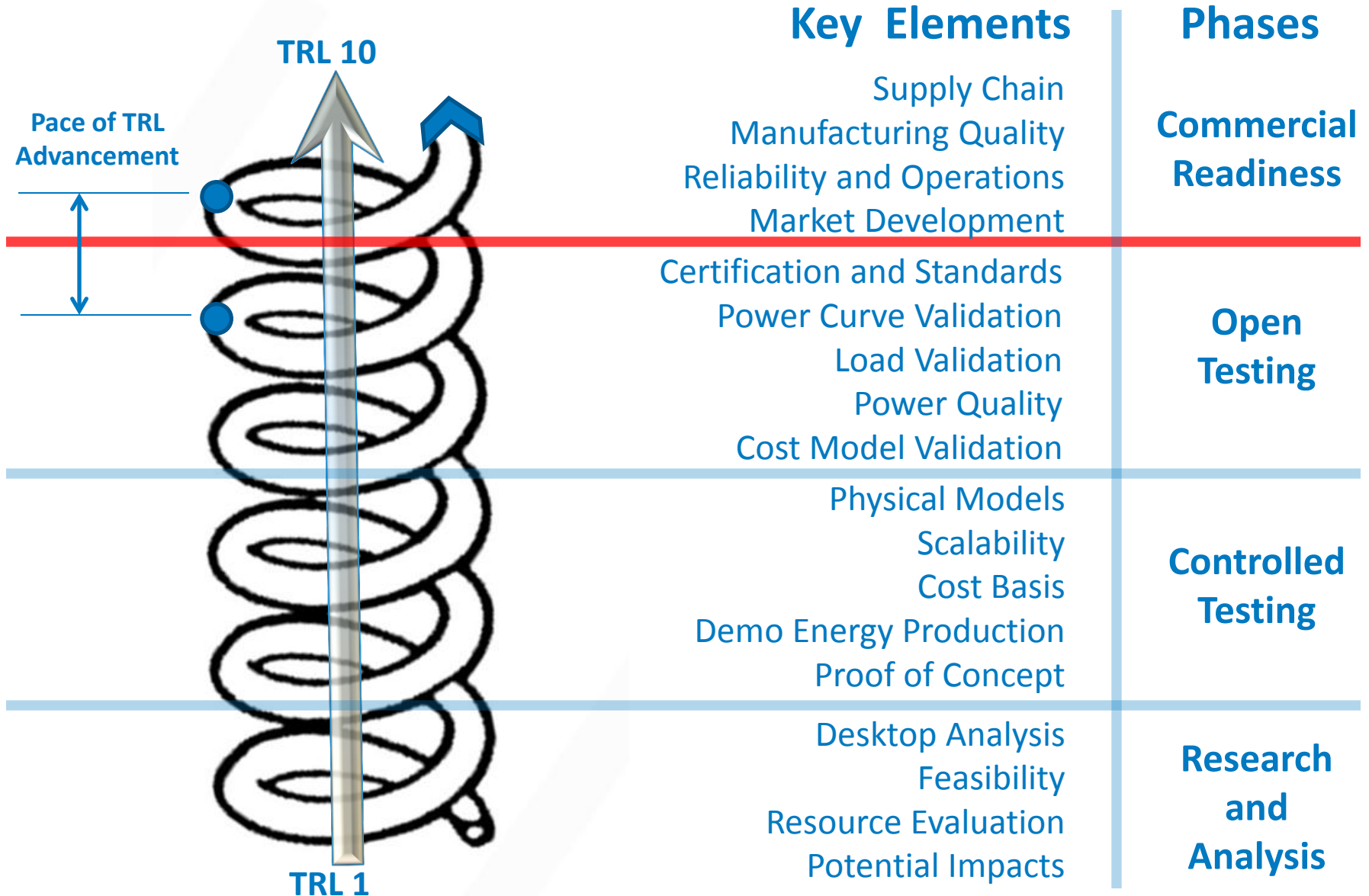


# Design Loop Process to Maximize Advancement



# Rapid TRL Advancement through Effective Design Loop Iterations

(Design, Simulate, Build, Test, Validate, Refine, Implement, Maintain Repeat)



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# The Industry Continues to Learn about Bat Impacts



*Photo from Velaia (ParisPeking) (Flickr)*

- Initial notice of extensive bat impacts in 2001-2, 30 years after initial deployments in California
- Impacts first noticed in projects in Appalachian Mountains; industry remained quiet
- Bat Conservation International formed the Bats and Wind Energy Cooperative in 2003
- Ongoing assessments revealed a national (and international) issue
- Research continues to develop an understanding of the root cause as well as siting, avoidance, and mitigation options.

Figure 2: Summary of All Bird Mortality Rates at Various Wind Energy Facilities\*

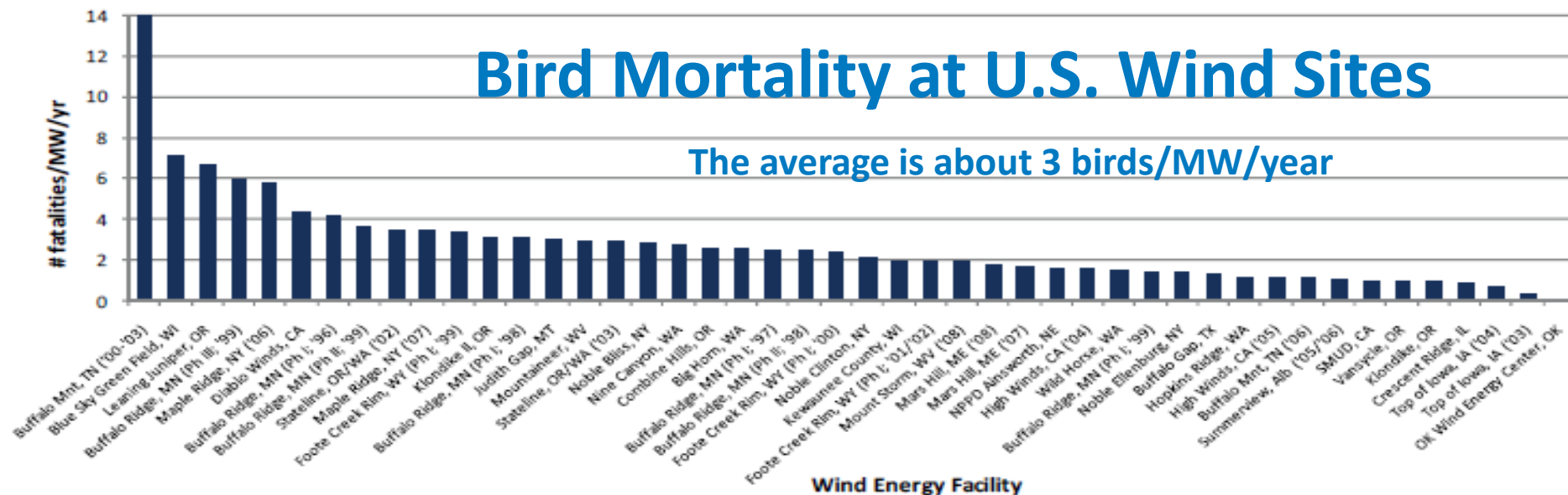
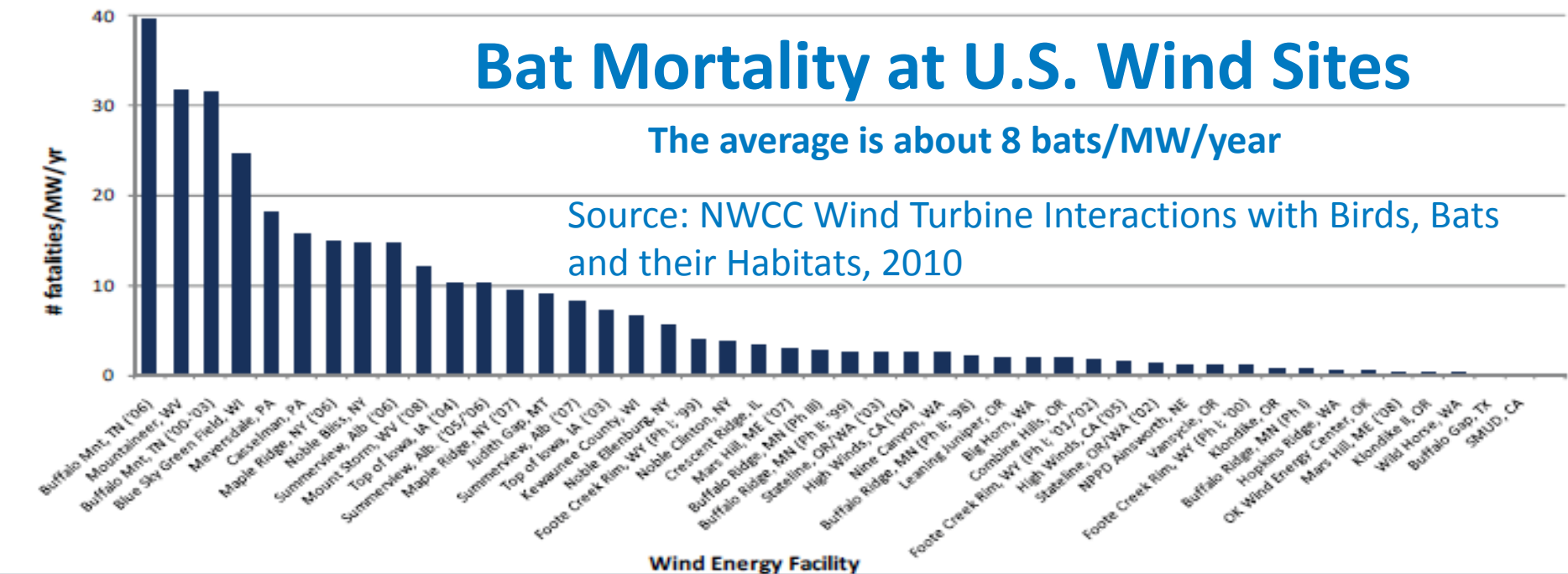


Figure 3: Summary of Bat Mortality Rates at Various Wind Energy Facilities\*





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# Impact of Different System Designs

## Older Technology



19-meter diameter blades on a 100-kW turbine.

*Photo by Lee Jay Fingersh, NREL 16392*

## Current Generation Scale



Clipper 2.5-MW wind turbine with a 93-meter diameter. *Photo by Alan Laxson, NREL 13886*

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# Industry Market Differences

## MHK

- Small companies
- Diverse technology
- Short timeframe needs
- Lack of a defined market.



OPT PowerBuoy®.  
*Photo from Ocean Power  
Technologies, NREL 22857*

## Offshore Wind

- Large, diverse companies
- “Understood” technology
- Long development lead times
- Understood market potential.



REpower 5-MW test turbine.  
*Photo from Gary Norton, NREL 27360*

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*Photo by Dennis Schroeder, NREL 18891-C*

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