

# Technical challenges and opportunities to repowering

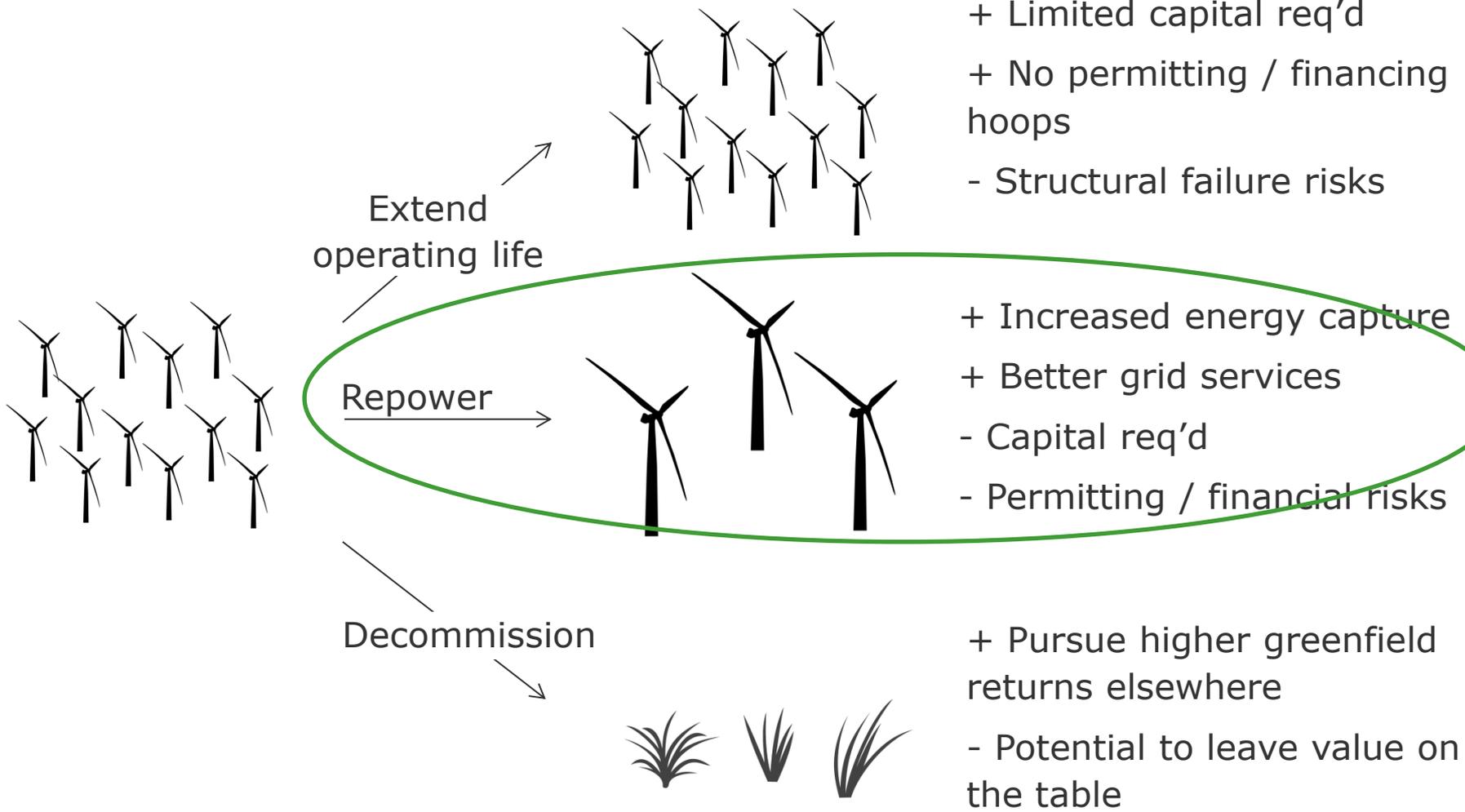
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# End of life: A question of competing options



- + Limited capital req'd
- + No permitting / financing hoops
- Structural failure risks

- + Increased energy capture
- + Better grid services
- Capital req'd
- Permitting / financial risks

- + Pursue higher greenfield returns elsewhere
- Potential to leave value on the table

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# Environmental impacts

- Barriers to repowering:
  - Some environmental issues lessened with new technology, some are amplified
  - Challenges with permitting particularly where endangered species live or environmental damage has occurred<sup>1</sup>
- R&D needs:
  - Statewide research into environmental impacts of modern turbines
  - Statewide ordinance guidance or recommended practices for counties
    - Streamlined permitting procedures
  - Species ID technology to inform turbine shut-downs



<sup>1</sup> Lantz, E., et. al. Repowering Financial Feasibility, Decision Drivers and Supply Chain Effects. NREL 2013

# Reduce cost of energy for repowered projects

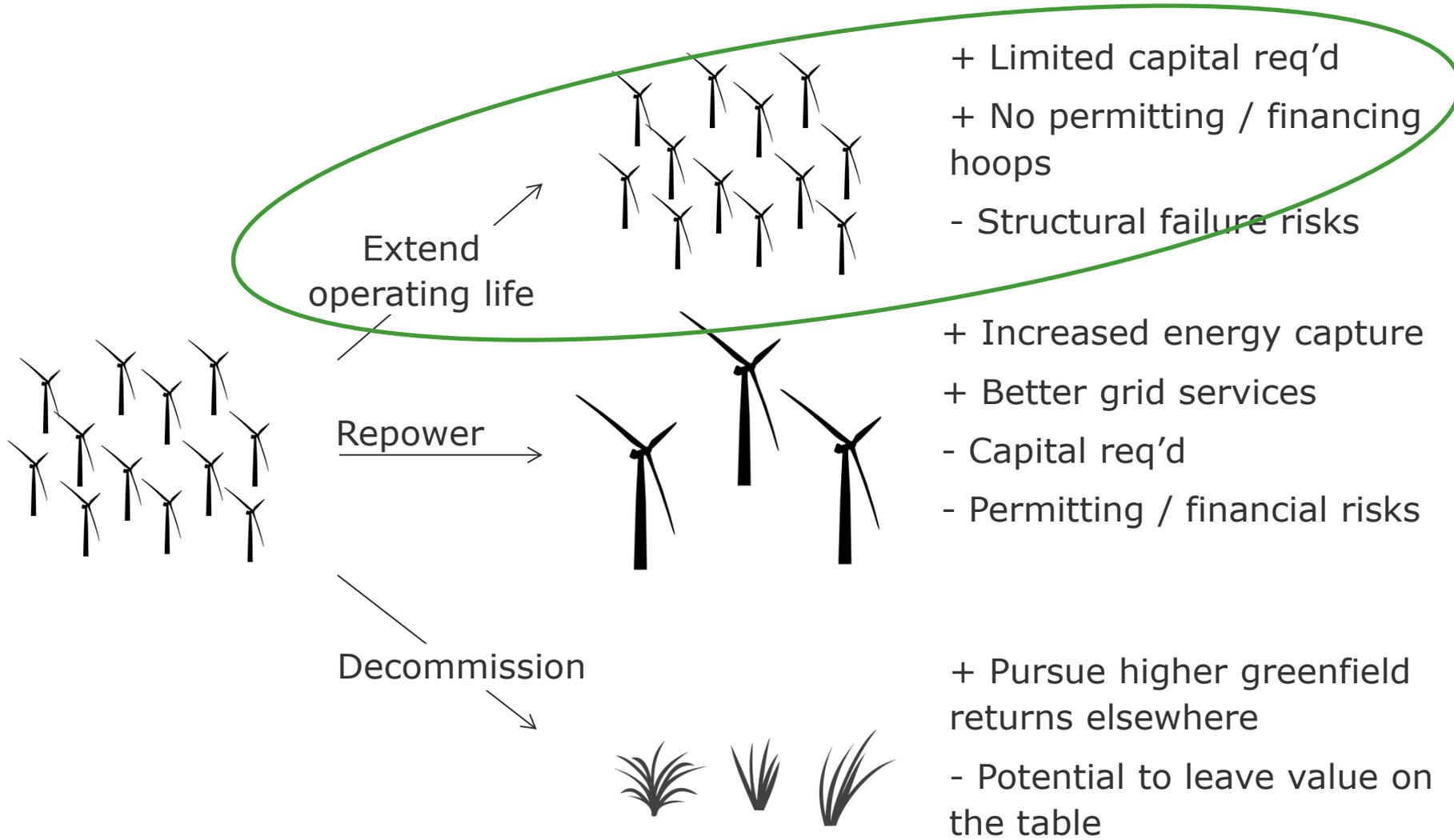
- Barrier to repowering: cost of wind energy
- Lesson from Germany:
  - 4.5 euro/MWh on top of normal feed-in-tariff for repowering
  - 35% of country's 2014 wind installations were repowering efforts
- R&D solutions to reduce COE in lieu of direct financial support:
  - DOE Wind Vision Report<sup>2</sup> for specific recommendations
  - R&D areas targeting 5-yr horizon with highest potential impact for California:
    - High risk/high reward concepts: very large rotors, very tall towers
    - Grid integration
    - Reliability measures
    - Advanced controls solutions
    - Transportation (including modular technologies)



2 Wind Vision: A New Era for Wind Power in the United States. US DOE March 2015

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# End of life: A question of competing complementary options



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# Extending operating life

- Complementary path to repowering:
  - Find ways to maximize energy output without compromising safe operation
  - Keep existing turbines running to bridge gap to future period of lower cost wind
- Technical challenges:
  - Access to design and operating data on older turbines
  - Inspection and refurbishment know-how to curb structural failure
  - Supply chain for major components
- R&D needs:
  - Testing approaches to characterize turbine design
  - Development of risk based inspections and repairs
  - On-line condition monitoring of foundations and components
  - R&D for generic component designs that can be applied across turbine models
  - Component upgrades: Larger rotors combined with modern controls



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# Summary

- *Barriers:*
  - Cost of energy
  - Environmental permitting
- *Opportunities:*
  - Life extension
  - Upgrading existing turbines
  
- *Recommended R&D initiatives*
  - Life extension solutions
  - Environmental impact solutions
  - Technology to reduce cost of wind energy



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# Thank you!

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