NREL
NATIONAL RENEWABLE ENERGY LABORATORY

Wind Generation Technology Cost Modeling

Wind Energy Systems Engineering Workshop

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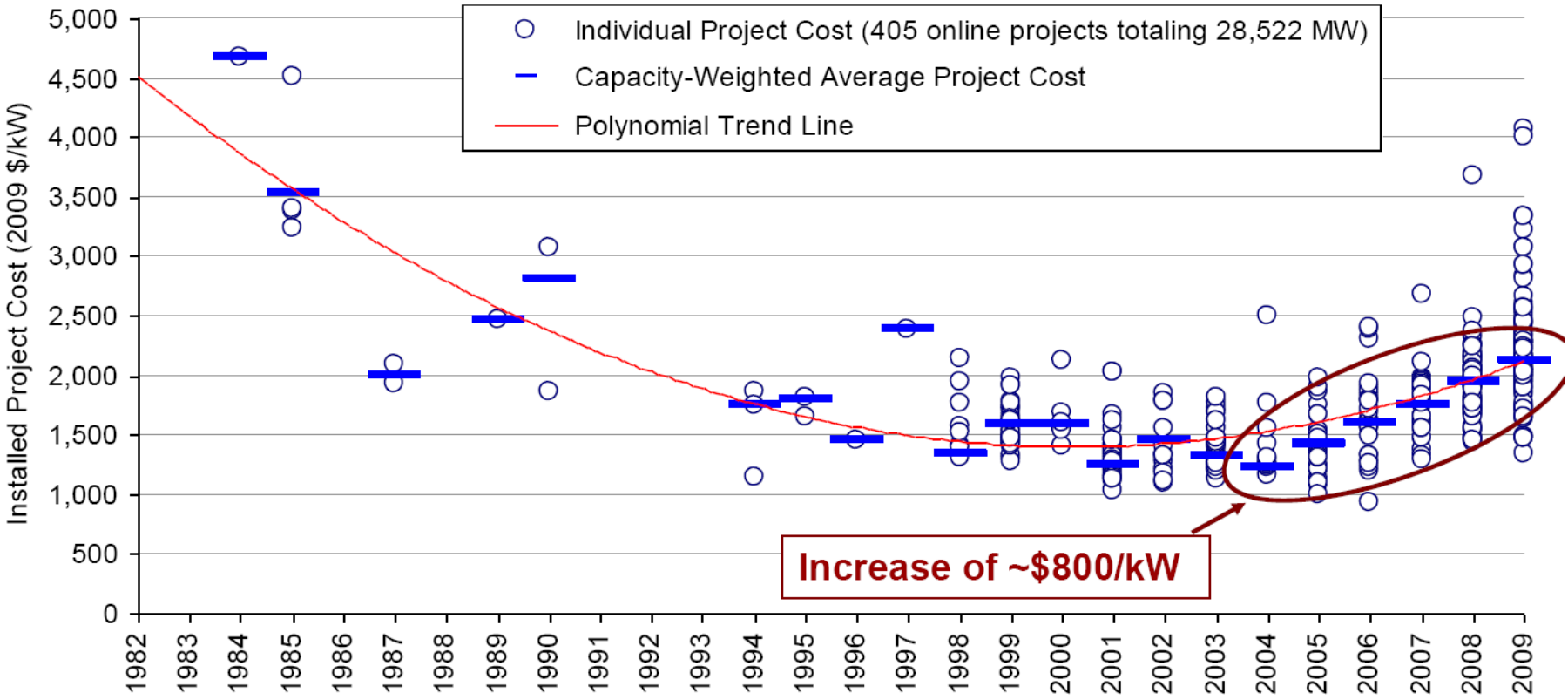
Purpose of Cost Modeling

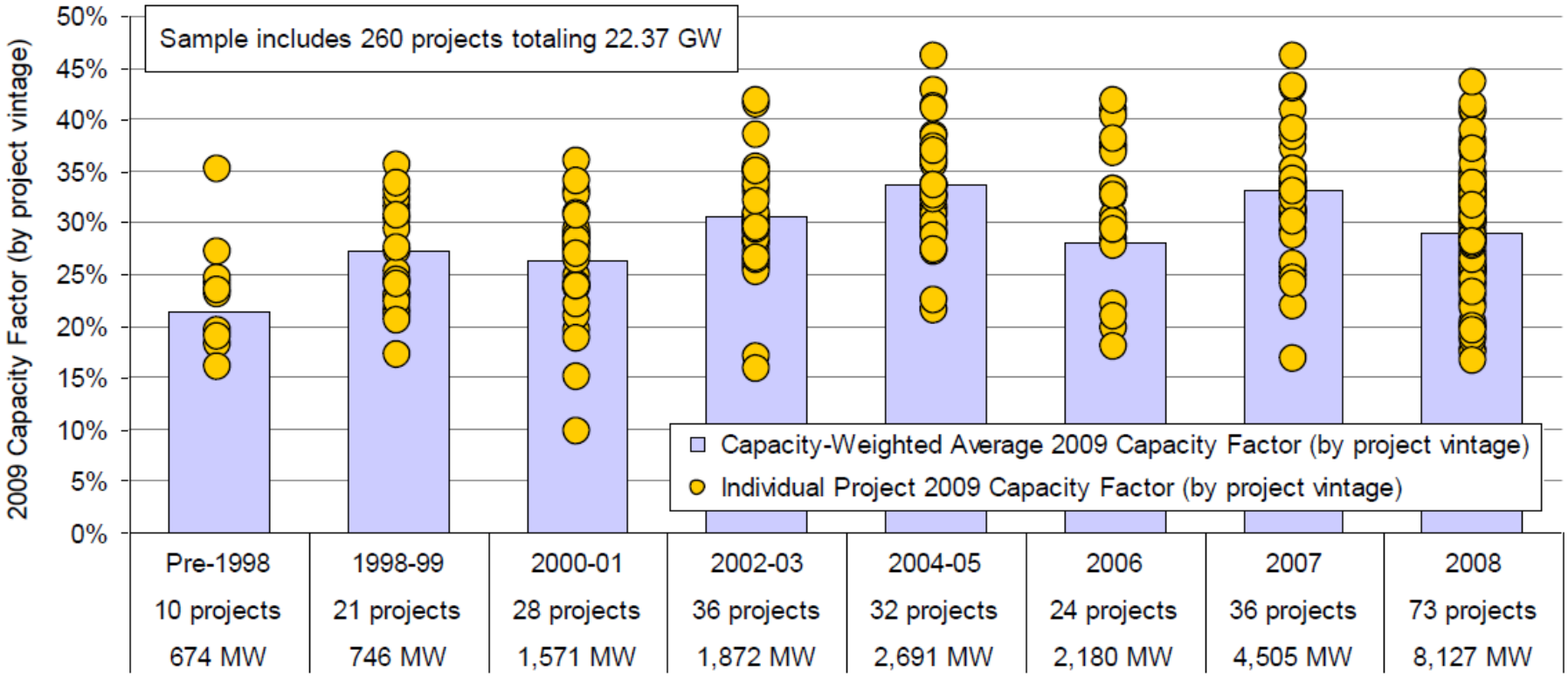
- What is the cost of wind energy today?
- What will be the cost of wind energy tomorrow (or next year, or in 1, 2, or 3 decades)?
- How will future reductions in cost of wind energy be achieved?
- What is the societal benefit associated with future reduction in cost of wind energy?

U.S. Installed Project Cost Increasing



Source: Wiser, R. and M. Bolinger. (2010). *2009 Wind Technologies Market Report.* DOE/GO-102010-3107. U.S. Department of Energy Office of Energy Efficiency and Renewable Energy.

Newer Projects Have Higher Capacity Factors



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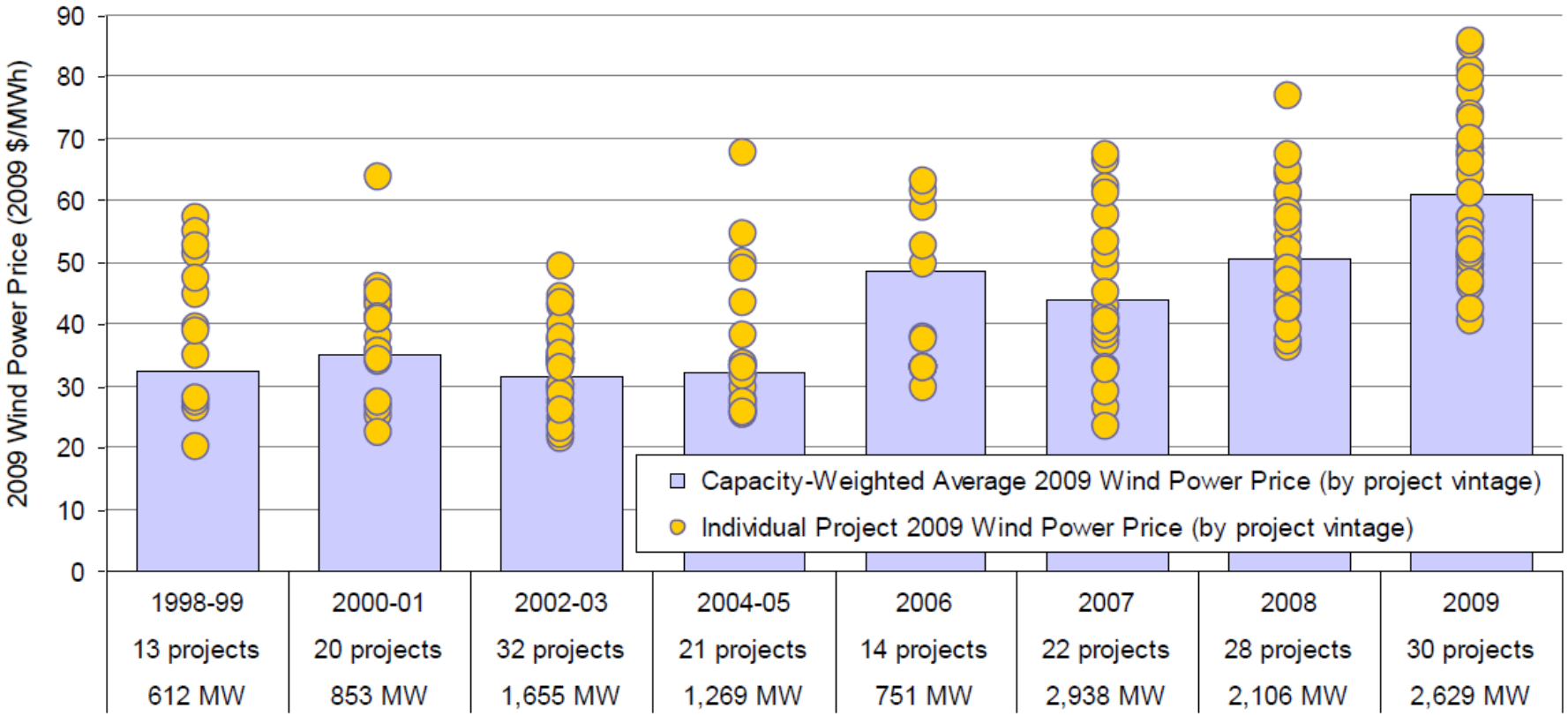
Power Purchase Prices Rising



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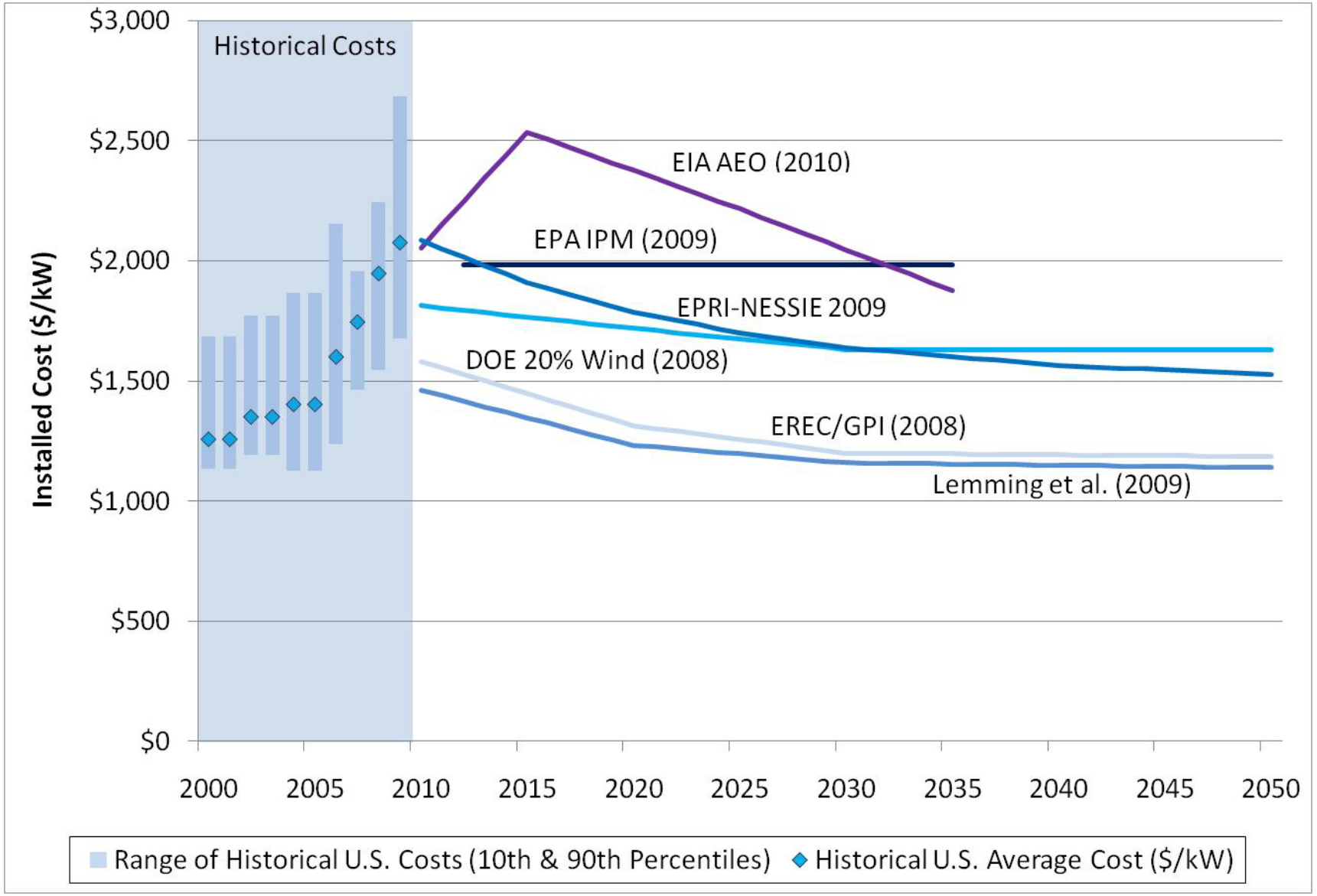
Factors Affecting Cost of Wind Energy

- Commodity prices
- Exchange rates
- Profit margin
- Turbine technology – larger, taller, lighter, more reliable
- Resource relative to transmission access and other considerations
- Policy incentives

Future Cost Projections: Land Based Wind



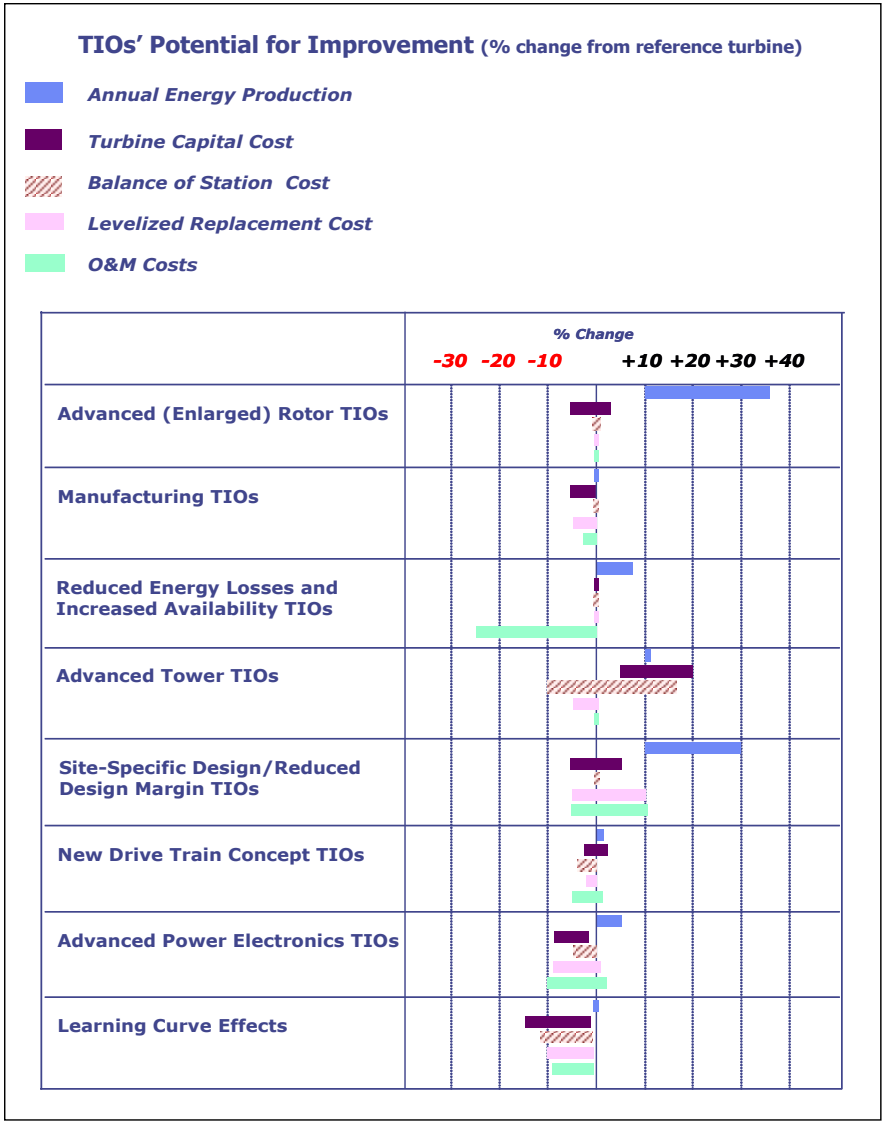
Source: See list of references

Learning Curves

- Describe cost reduction potential as a function of cumulative experience related to cumulative installed capacity
- Do not attempt to identify specific factors that yield cost reductions
- Represent learning by R&D, learning by experience, learning by deployment, learning by doing …

Expert Elicitation

- Survey industry experts for range of possible technology outcomes to achieve future cost reductions
- DOE Risk Analysis project conducted in association with WindPACT analytic studies
- Develop probability distributions associated with various technical outcomes leading to cost projections

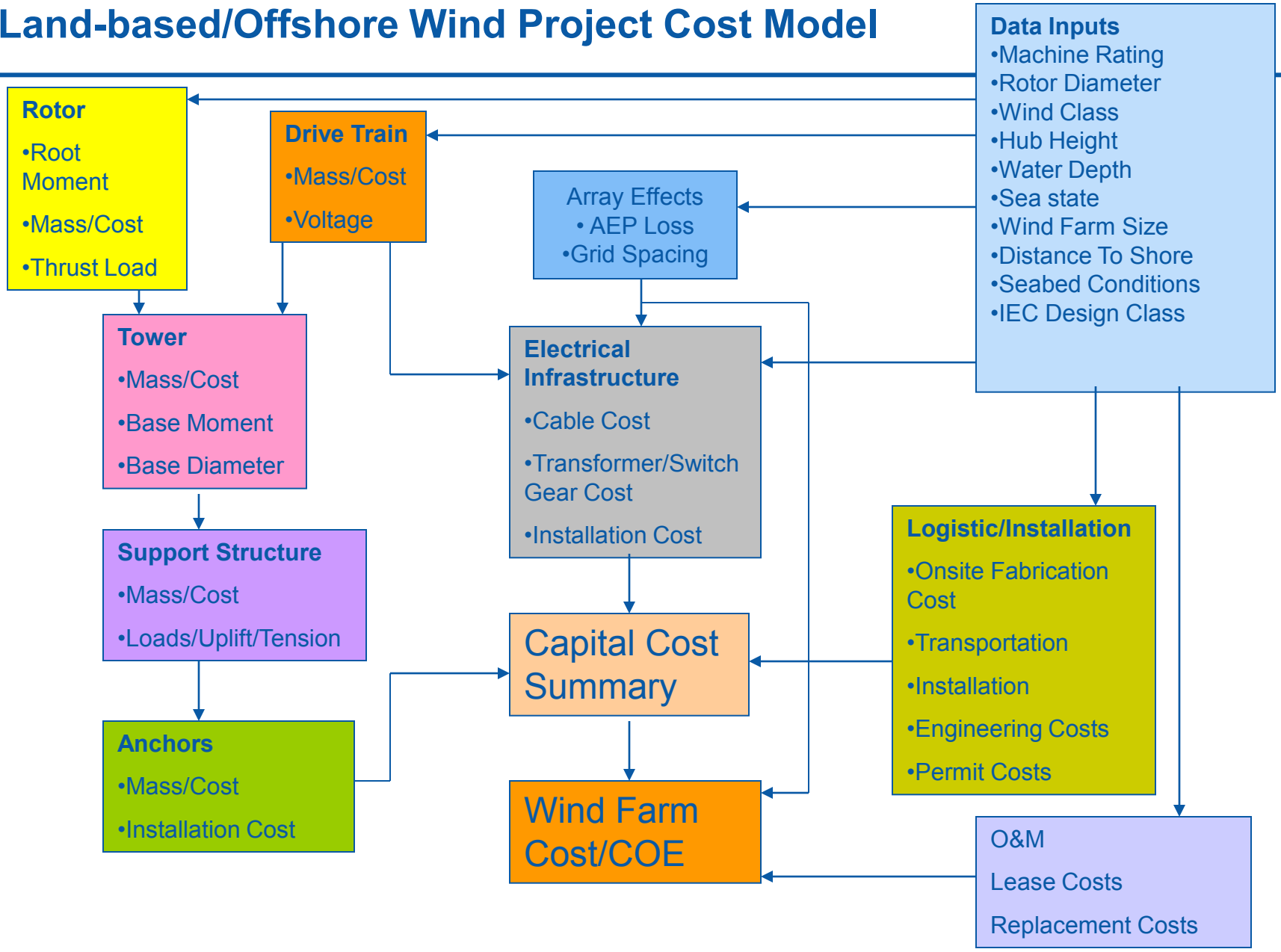


Source: Cohen et al, 2008.

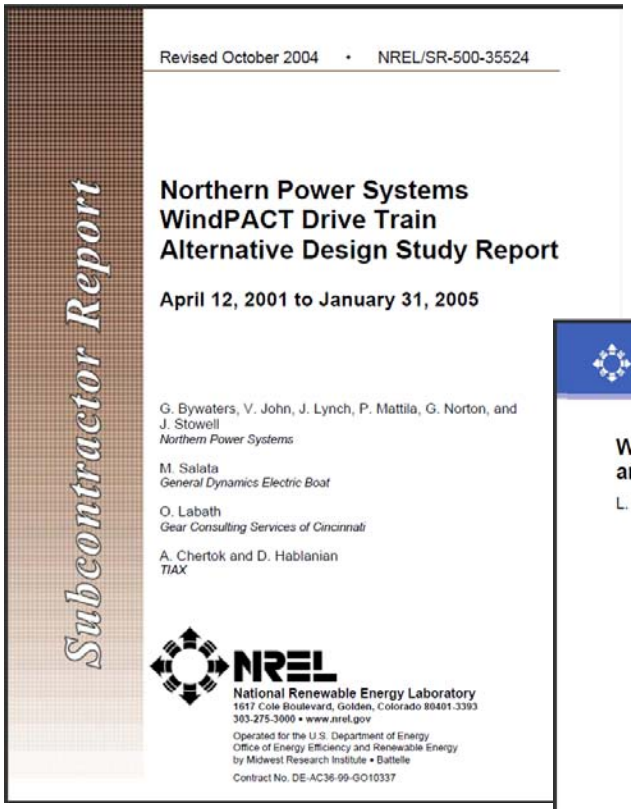
Engineering Model

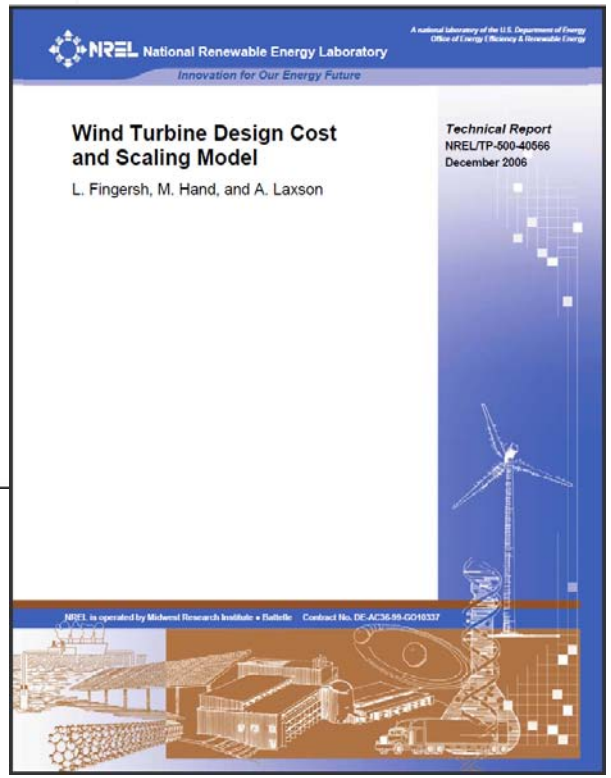
- Bottom-up, component level, system analysis
- Explore anticipated technical innovations to identify most promising pathways
- Requires simplification of complex engineering problems
- Generally does not explicitly represent economy of scale or volume-based cost improvements

Land-based/Offshore Wind Project Cost Model



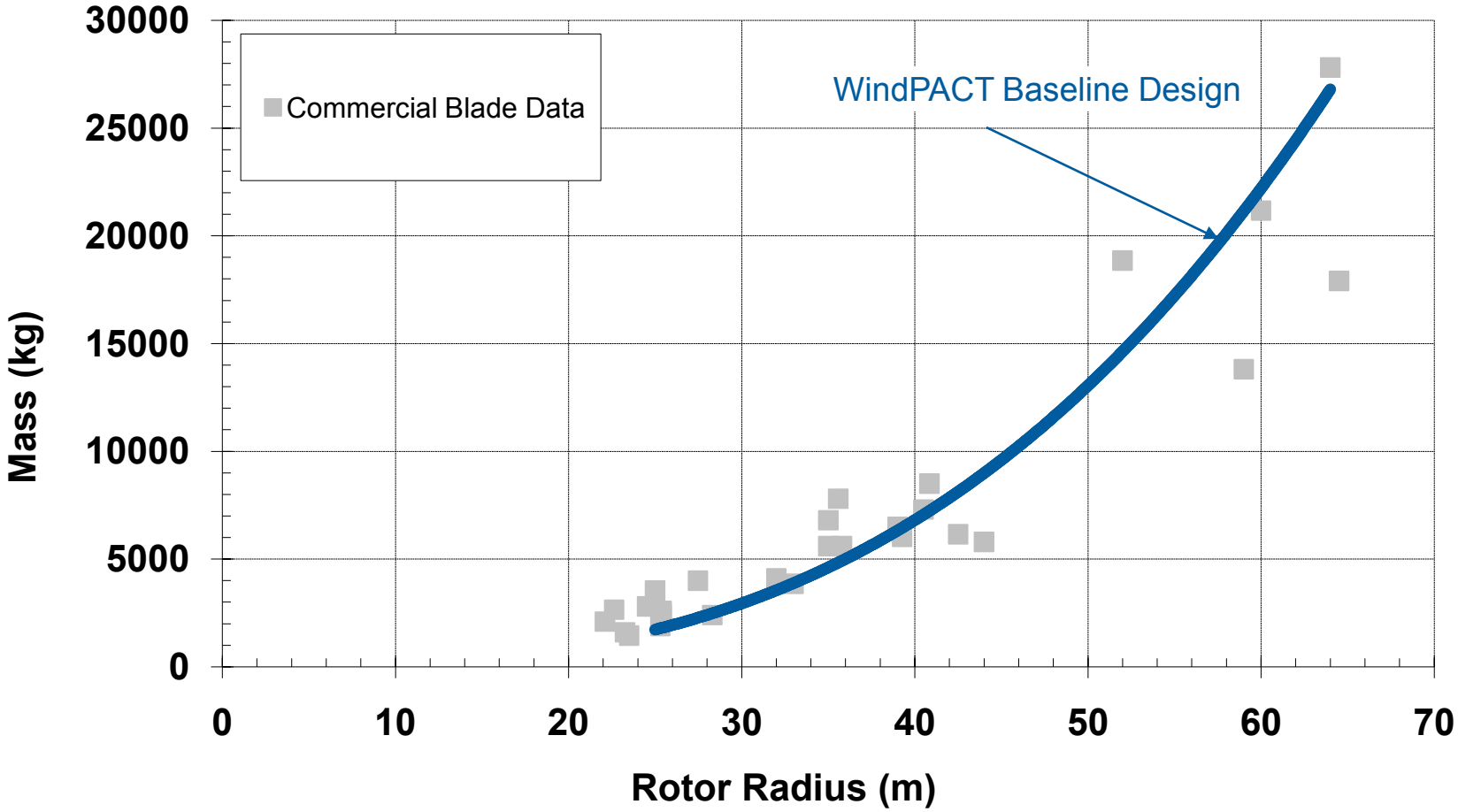
NREL Wind Turbine Design Cost and Scaling Model





- Based on industry data and WindPACT design studies
- Includes Producer Price Indices to account for material price fluctuation
- Spreadsheet model

Wind Turbine Blade Innovation Pathway



Source: Based on Fingersh et al., 2006.

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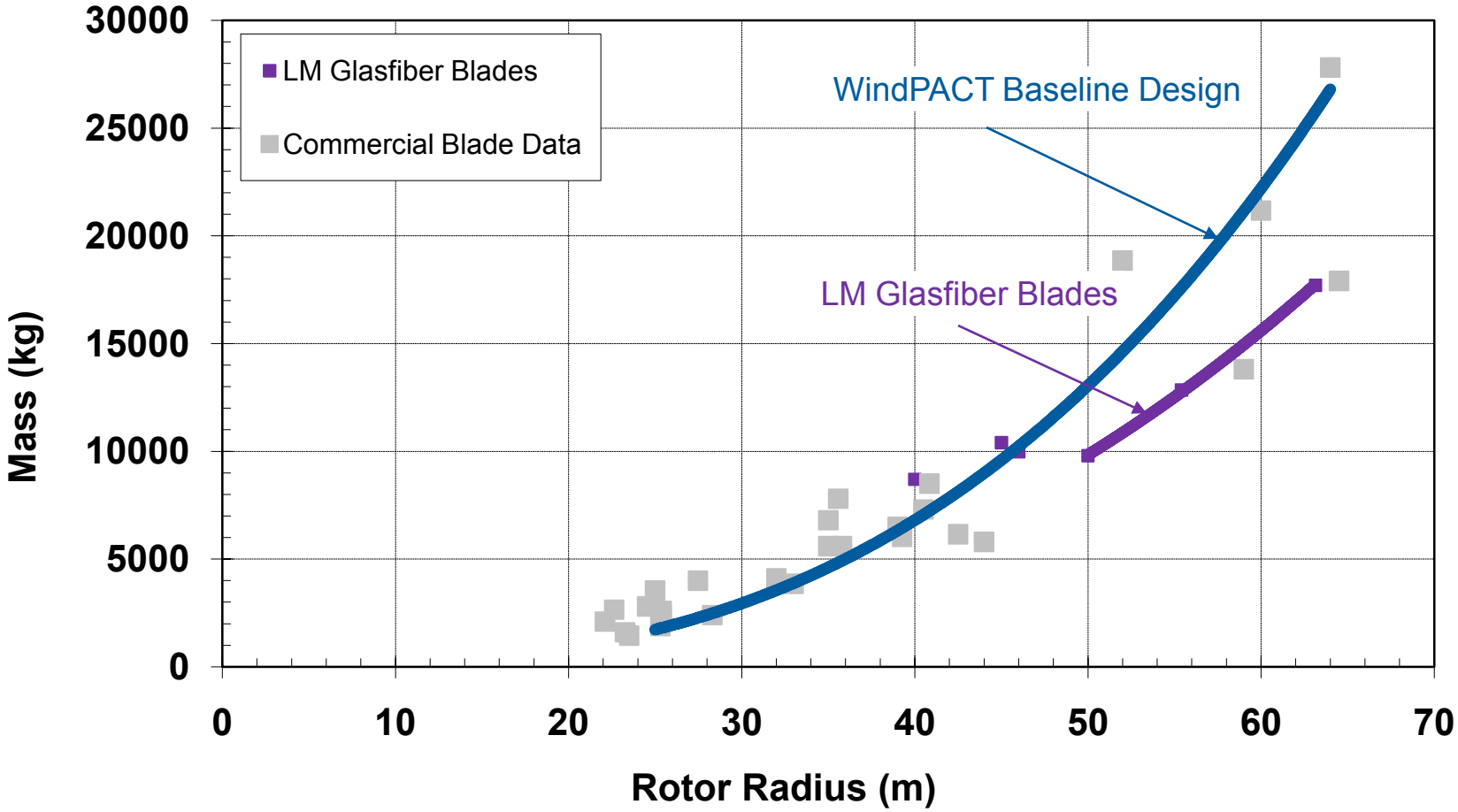

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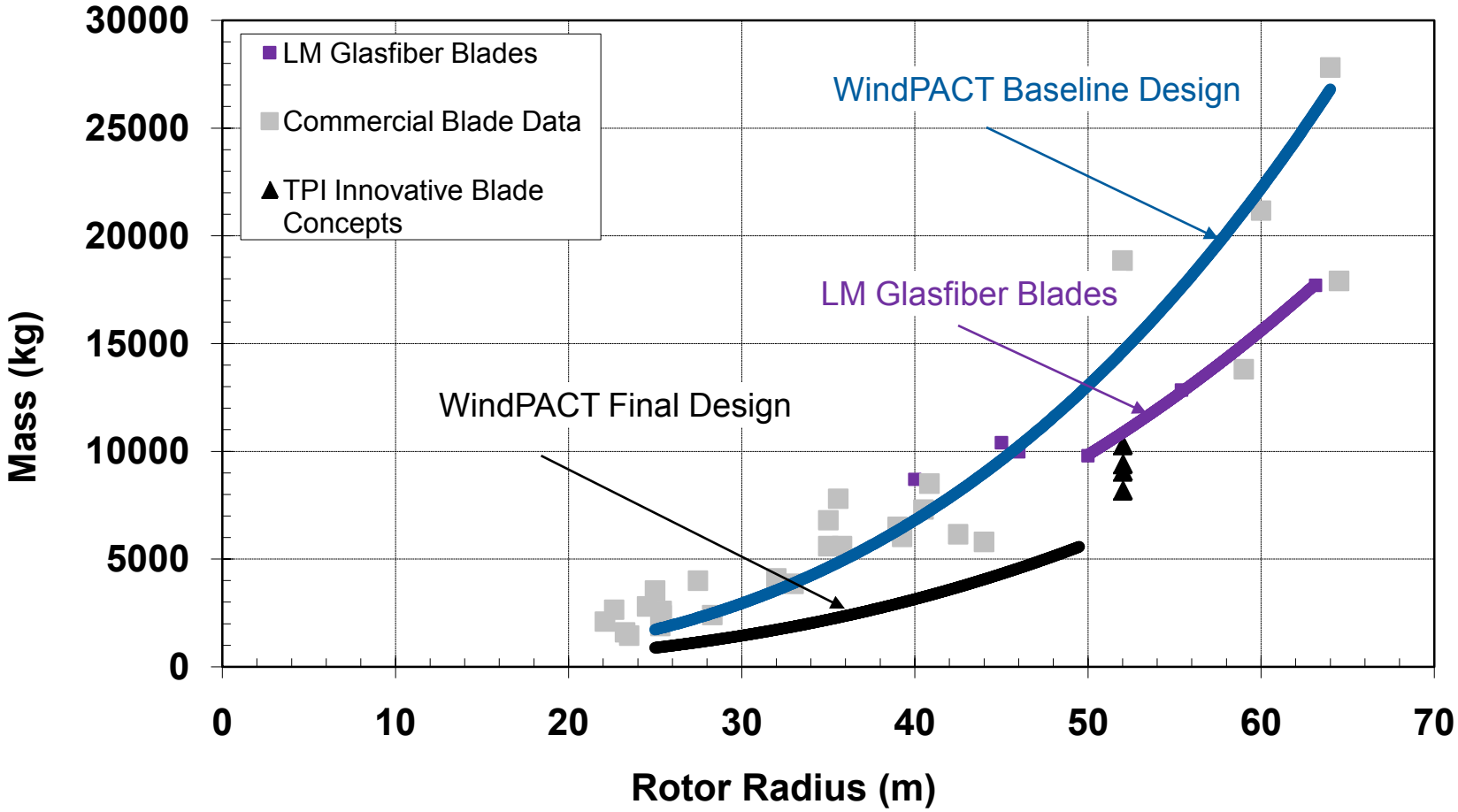

Source: Based on Fingersh et al., 2006.

Conclusions

- Engineering models can evaluate technology innovations
- Cost is a critical element of these models
- System level analysis of technology innovations and associated cost impacts provides input to projections of future wind technology costs
    - Guide both industry and government in R&D investments, development of policy instruments

References

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