INTROSPECTIVE SYSTEMS

Intelligent Technology for the Modern Energy Grid

Understanding the Economics of Microgrid Asset Choices

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Presentation Overview

Understanding the Economics of Microgrid Asset Choices

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ABOUT

KAY AIKIN, co-founder,
CEO, Introspective Systems
BEng, Penn State

Introspective Systems

Specializing in complex systems applications

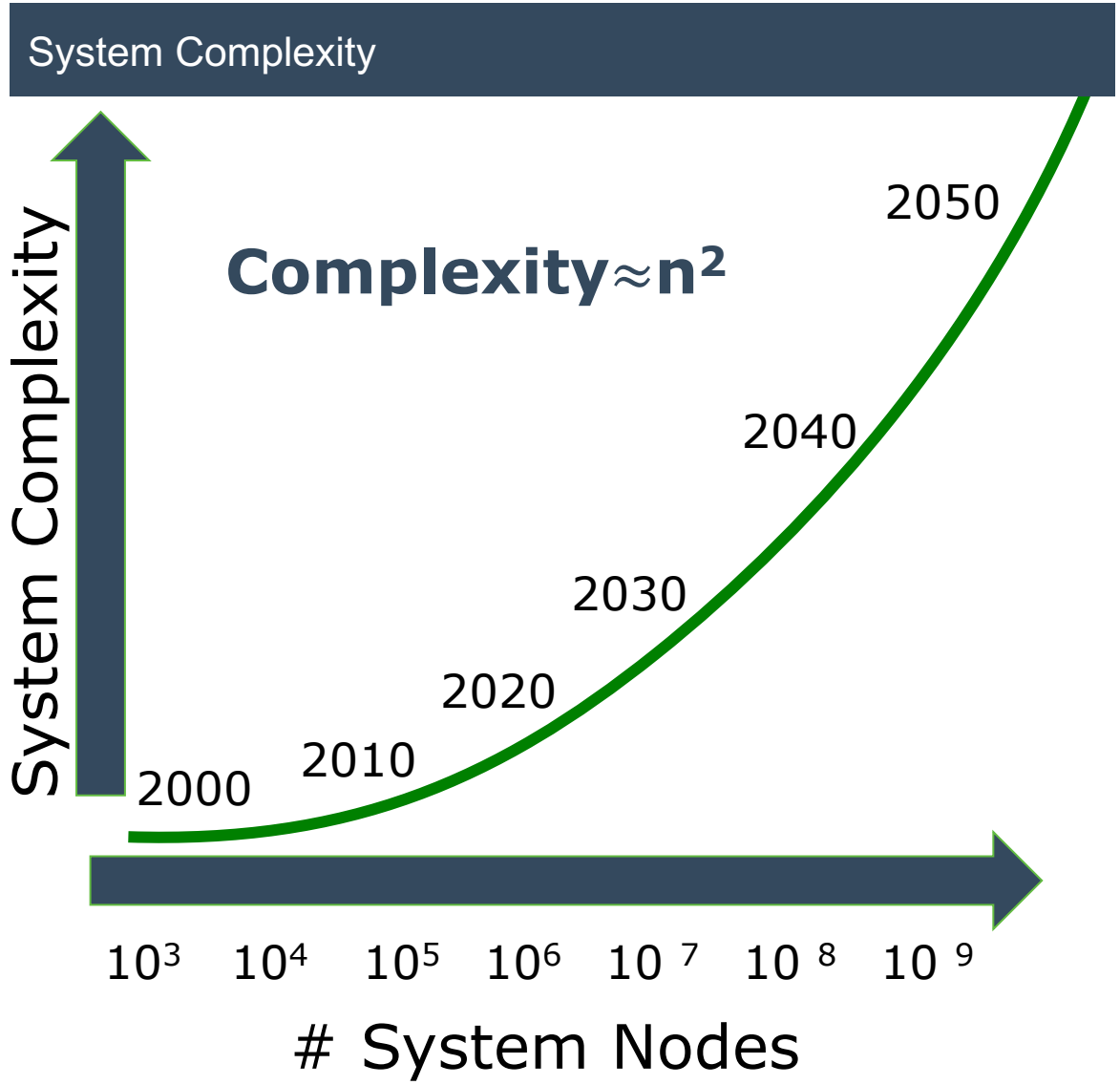
Research and Development

4 Department of Energy (DOE) projects

- Fractal electrical grid architectures
- AI powered Transactive Energy controls
- Smart Ledger value transfer

System Complexity

An explosion of Distributed Energy Resources (DER) is driving the complexity of the grid.



CAPEX Complexity

Asset choices are as complex as technology integration

Capital asset complexity results in mis-allocation of financial resources

Complexity limiting adoption

This complexity is limiting broad value capture in microgrids

Three different stakeholders with very different value functions

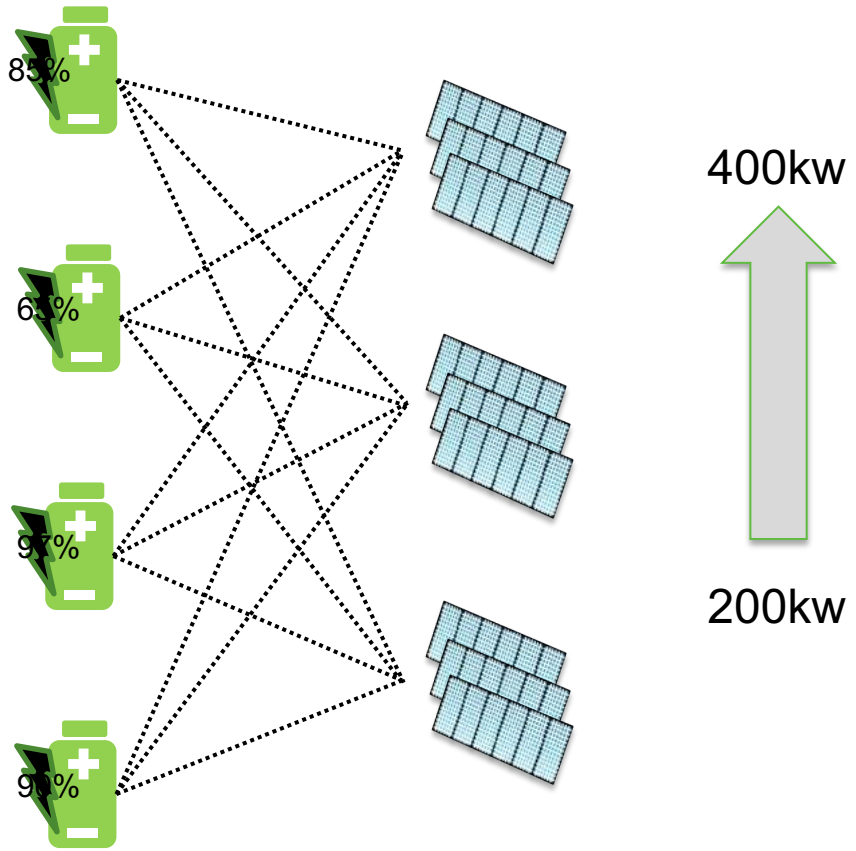
- Financiers
  (1-6 year life time) Metric: IRR
- Utility/microgrid owners
  (10-20 yr. life-time) Metric: Profit
- Consumers
  (30 + yr. life time) Metric: Rate stabilization

Providing a principled approach to reconcile each different stakeholders value function is important to capture broad value

Interactions- Economics and Technology

Asset choices

ESS #1	O&M	$ 3,000
	Lifetime	10 Yr.
	RT Efficiency	85%
	Replacement	$ 35,000
	Capital Cost	$400,000
ESS #2	O&M	$ 12,000
	Lifetime	20 Yr.
	RT Efficiency	65%
	Replacement/yr.	$ 15,000
	Capital Cost	$420,000
ESS #3	O&M	$ 3,000
	Lifetime	30 Yr.
	RT Efficiency	95%
	Replacement/yr.	$ 3,000
	Capital Cost	$500,000
ESS #4	O&M	$ 7,000
	Lifetime	15 Yr.
	RT Efficiency	90%
	Replacement/yr.	$ 8,000
	Capital Cost	$300,000



400kw

200kw

Levelized Cost of Energy

LCOE can often Mislead

LCOE

- blurs the distinction between marginal, O&M and capital costs
- requires a simplified single discount rate
- ignores project risks
- ignores multiple decisionmakers and value functions
- ignores many operating technical assumed lifetimes
- often ignores overall system costs beyond the microgrid

LCOE as a starting point

When comparing different technologies:

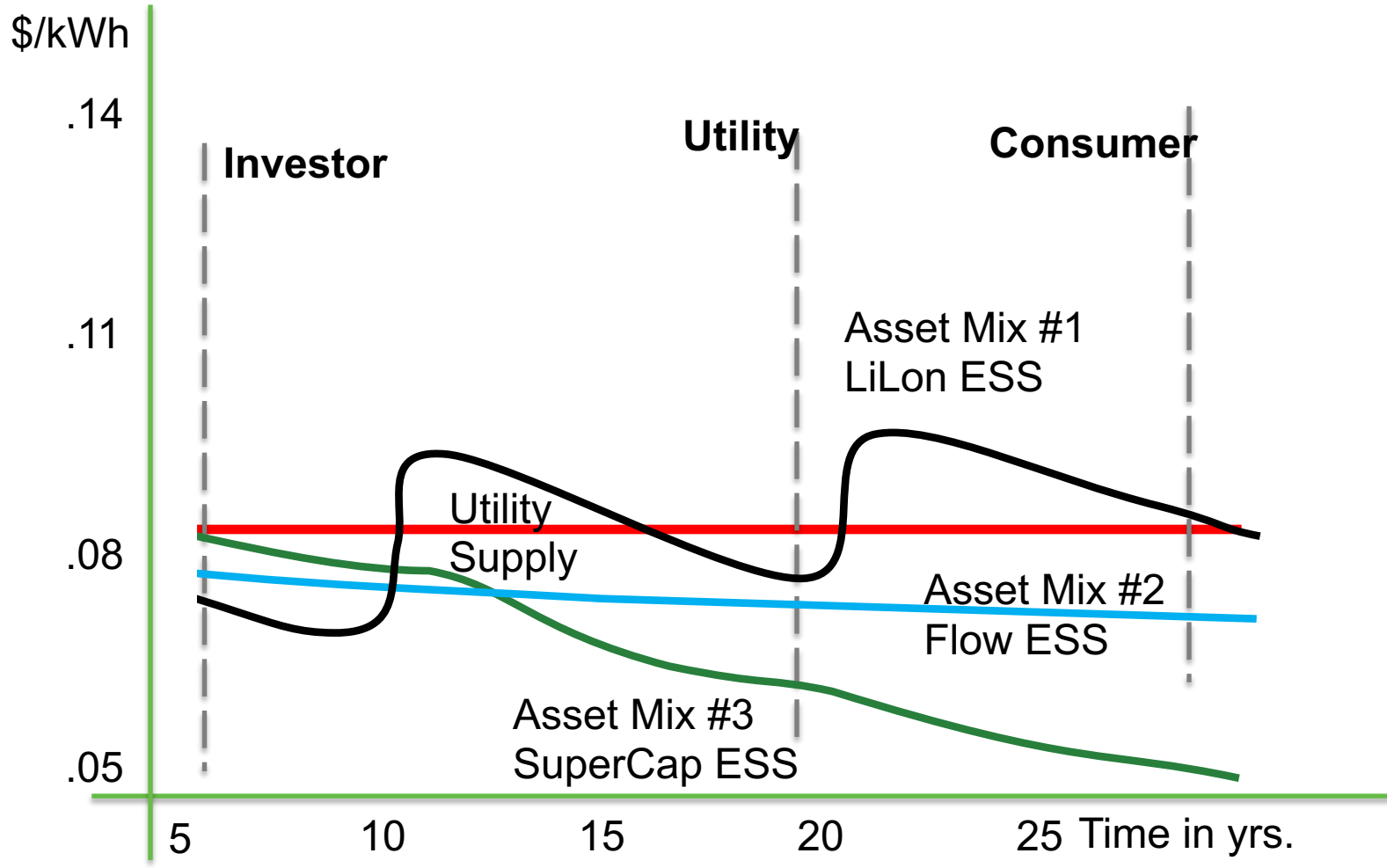
Use LCOE as a starting point to explore more nuanced issues related to cost structures, risks and system impacts

Proposed

Energy-Life Cycle Analysis

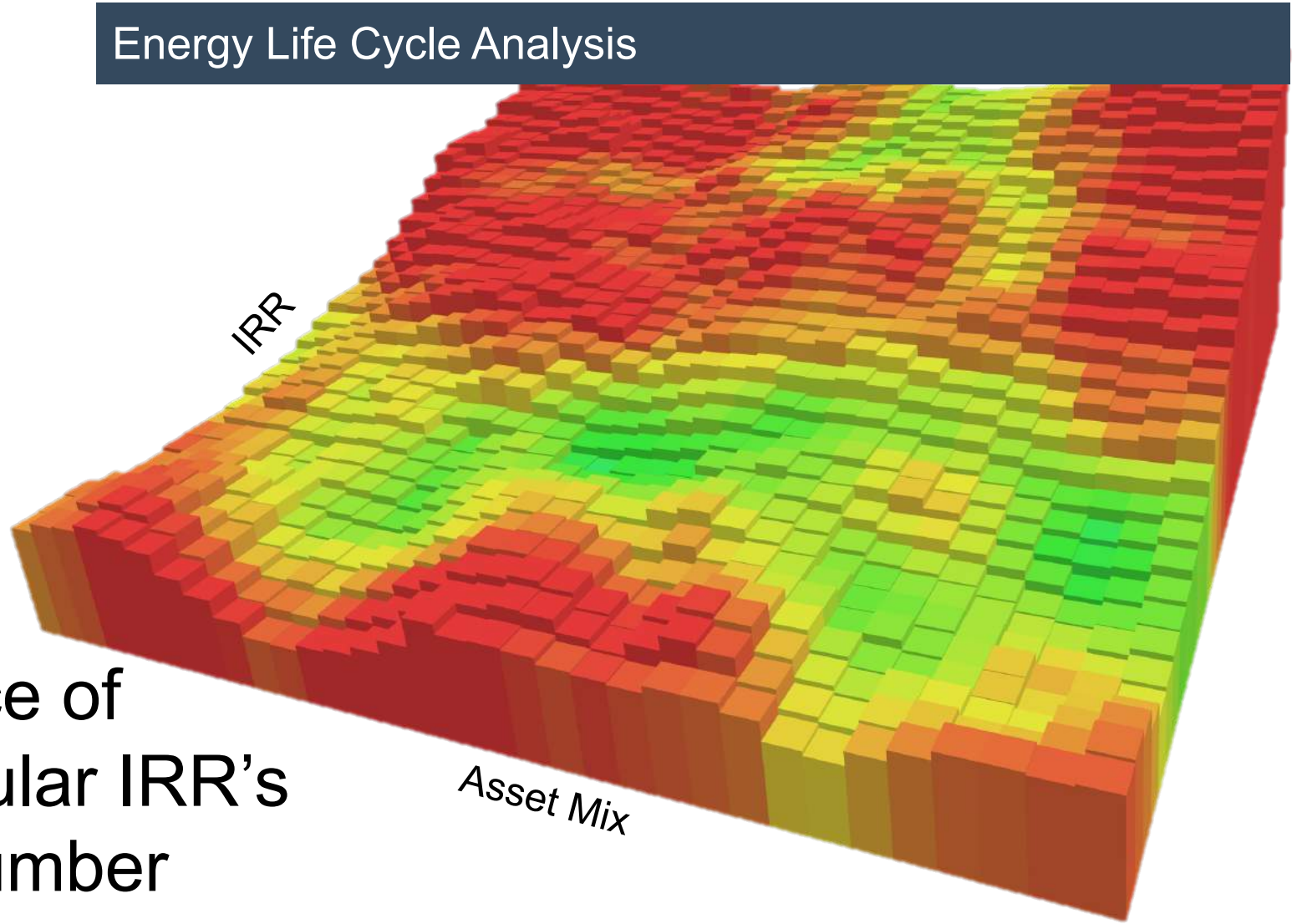
Key to an economic microgrid is maximizing area ($) under utility supplied curve

LCOE ($/kWh) delivered vs. Time With fixed IRR and inflation adjusted



Energy-LCA

Actually more Complex in real-life



Each voxel is a choice of asset mix with particular IRR's resulting in E-LCA number

Microgrid value framework

Proposed economic framework for valuing microgrids providing:

- Method to account for varying asset lifetimes
- Modeling multitude of asset choices
- Time dependent analysis including risks
- Quantifying system uncertainty- sensitivity analysis
- Framework facilitates visualization to explore asset value mixes

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