

Designing the Energy Markets of the Future: New Modeling Tools

Electricity Markets and Investment Suite (EMIS)

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Bethany Frew
ESIG Down Under

We need new modeling tools

WHY model wholesale electricity markets?

Markets exist in many locations (**2/3 of load in U.S.** and up to 100% in some countries)

Markets drive operational outcomes and **investment decisions**

Current leading models **do not sufficiently capture** market structure effects

Considerations that add complexity:

- System evolution, especially with growing shares of zero-marginal-cost technologies
- Resource adequacy
- Market mechanism-operations-investment interactions
- Uncertainty over future economic/policy conditions
- Investor risk profiles

e.g., traditional linear programming capacity expansion models (CEMs) assume a central planner minimizing system cost and **inherently guarantee cost recovery**

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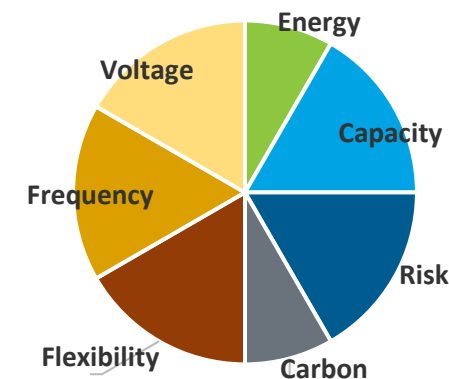
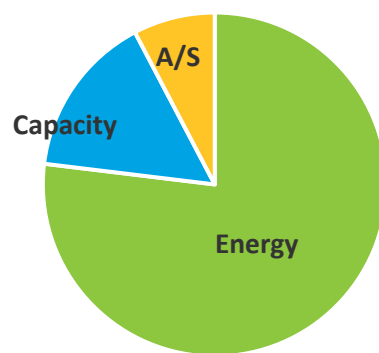
WHAT is NREL doing about this?

Developing a **NEW** market-focused **capacity expansion model**

- Investor heterogeneity & recourse options
- Imperfect information & uncertainty

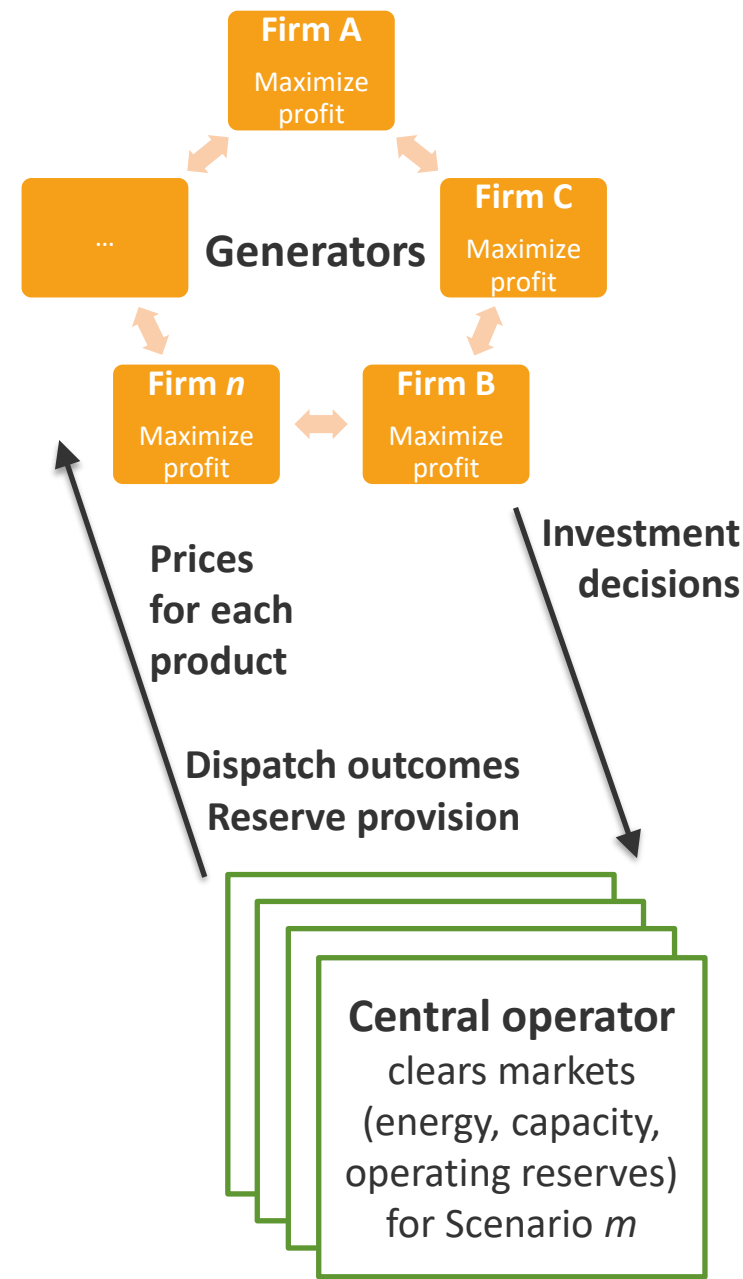
Link with NREL's **Scalable Integrated Infrastructure Planning (SIIP)** modeling framework

Example application: how can markets efficiently support an ever-evolving power grid?



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WHY model wholesale electricity markets?	WHAT is NREL doing about this?	HOW: the EMIS vision
<p>Markets exist in many locations (2/3 of load in U.S. and up to 100% in some countries)</p> <p>Markets drive operational outcomes and investment decisions</p> <p>Current leading models do not sufficiently capture market structure effects</p>	<p>Developing a NEW market-focused capacity expansion model</p> <ul style="list-style-type: none"> – Investor heterogeneity & recourse options – Imperfect information & uncertainty <p>Link with NREL's Scalable Integrated Infrastructure Planning (SIIP) modeling framework</p>	<p>Multiple profit-maximizing investor firms</p> <ul style="list-style-type: none"> – Each with expectation of possible futures <p>Single cost-minimizing operator clearing customizable set of market products</p>



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WHY model wholesale electricity markets?	WHAT is NREL doing about this?	HOW: the EMIS vision	...three model VERSIONS span the spectrum of market and behavior dynamics
<p>Markets exist in many locations (2/3 of load in U.S. and up to 100% in some countries)</p> <p>Markets drive operational outcomes and investment decisions</p> <p>Current leading models do not sufficiently capture market structure effects</p>	<p>Developing a NEW market-focused capacity expansion model</p> <ul style="list-style-type: none"> – Investor heterogeneity & recourse options – Imperfect information & uncertainty <p>Link with NREL's Scalable Integrated Infrastructure Planning (SIIP) modeling framework</p>	<p>Multiple profit-maximizing investor firms</p> <ul style="list-style-type: none"> – Each with expectation of possible futures <p>Single cost-minimizing operator clearing customizable set of market products</p>	<ol style="list-style-type: none"> 1. Idealized Competitive Equilibrium 2. Agent-Based Simulation 3. Approximate Strategic Equilibrium

EMIS full team: Sourabh Dalvi, Bashar Anwar, Gord Stephen, Dave Biagioni, Sean Ericson, and Maxwell Brown

Thank You

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Externalities

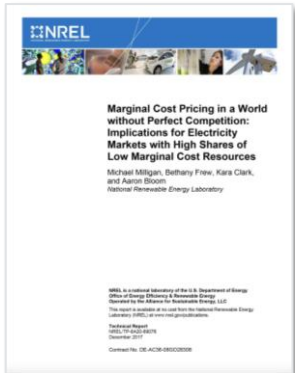
Public good attributes of the network

Ineffective demand curve

Market power

Lack of large-scale storage

Wholesale price caps



“Marginal-cost pricing alone cannot guarantee cost recovery outside of perfect competition, and current electricity market structures have at least six attributes that preclude them from functioning as perfectly competitive markets.”

Source: [Marginal Cost Pricing in a World without Perfect Competition](#)

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