Distribution System Operator (DSO) Simulation Studio

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Network Optimized Distributed Energy Systems (NODES)
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ProsumerGrid, Inc.

- Startup company from Georgia Tech.
- Team performed ARPA-E GENI ***Distributed Control Architectures*** project (2012-2015).
  - Developed theoretical basis and proved massive decentralized operation of the grid (decentralized PF, OPF, UC, frequency regulation, SE, ATC).

- ProsumerGrid, Inc. formed to develop and commercialize ***next generation software to simulate and coordinate systems with potentially billions of DERs and millions of decision-makers.***

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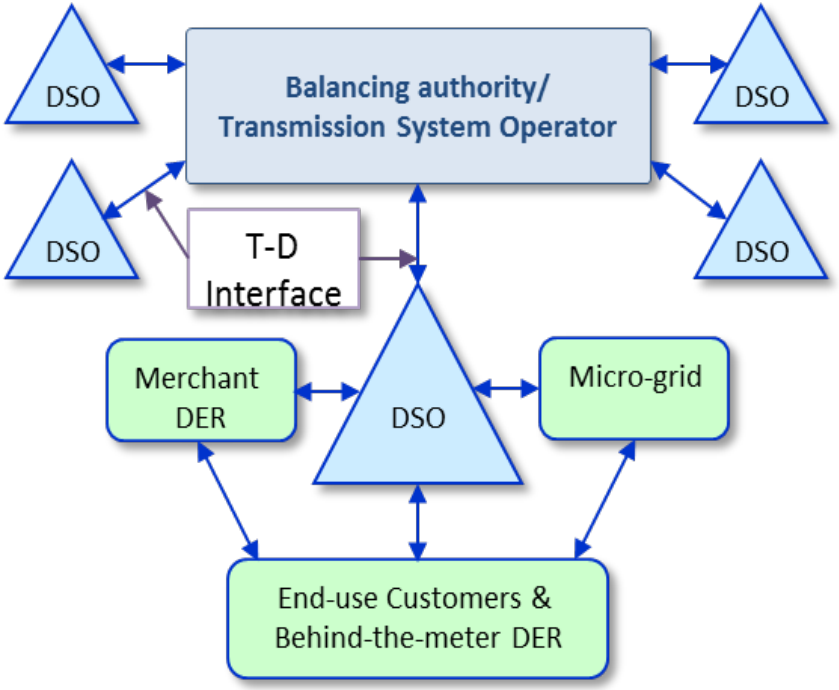
Motivation for DSO Simulation

- The electricity industry has identified ***Distribution System Operators (DSOs)*** and ***Distributed System Platforms (DSPs)*** as critical to realize an electricity grid based on distributed energy resources (DERs), energy services, and active customers.



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Motivation for DSO Simulation

- It is very important to simulate DSOs and DSPs ***before*** they are broadly implemented.
- While there are many great propositions regarding DSOs, a tool that can be used to test those ideas does not exist.
- High-fidelity simulations are needed to ensure robust design.

- DSO/DSP operations will be ***very complex*** and simulation has the following ***challenges***:
  - Underlying decentralized decision making
  - New physical behavior in space and time
  - New information, economic, and management elements
  - Massive number of DERs and decision makers.

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Project Objectives

- This project will develop ***an interactive software tool capable of simulating the operation of emerging DSOs and DSPs at the physical, information, and market levels***.

  – The software will extend state-of-the-art distribution grid solvers with detailed DER models, decentralized optimization, DSO pricing rules, and interactive analytics features.

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DSO Simulation Studio

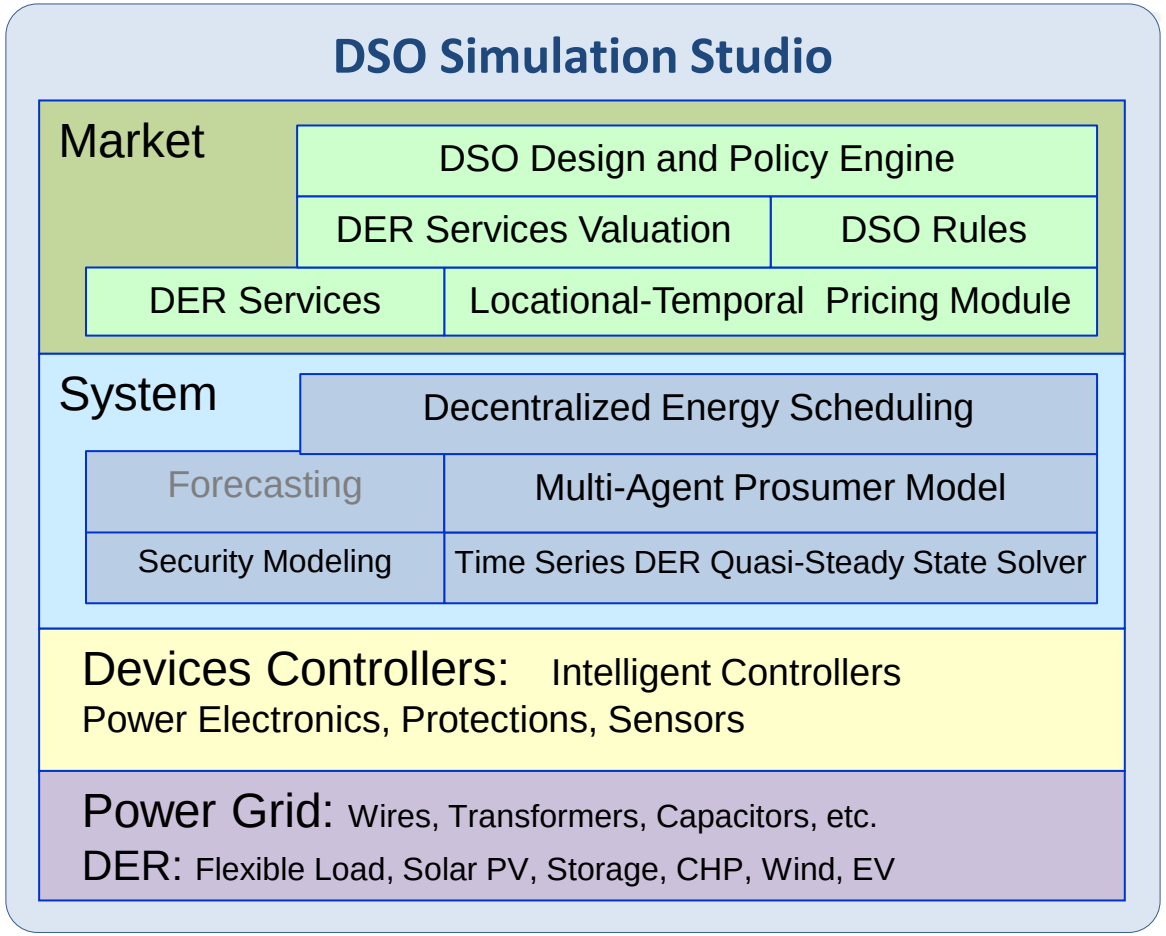
- A Multi-Layer Simulator

Regulators

Market Participants

Utility Engineers

Developers



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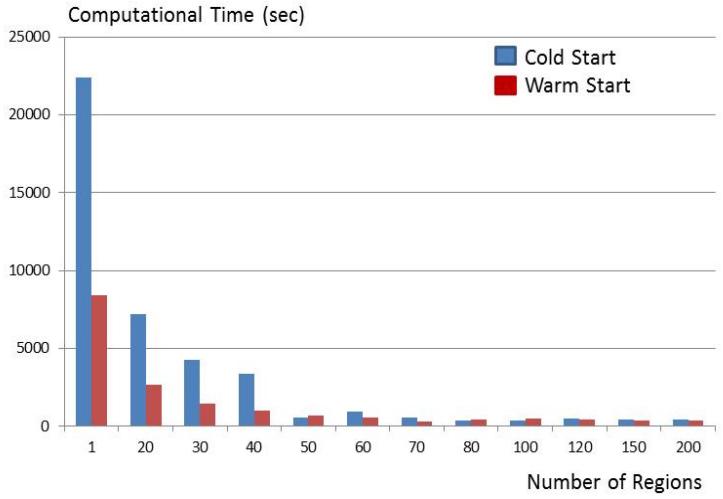
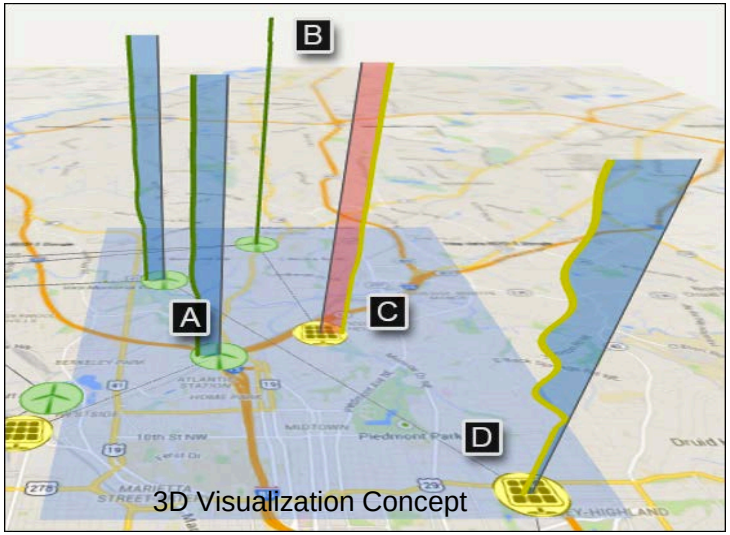
DSO Simulation Studio Unique Features

- Decentralized energy scheduling of DER-rich systems of arbitrary size.
- Explicit modeling of energy services transacted in the DSO.
- Locational and time-vector pricing of P/Q, ancillary, and security services.
- 3D Interactive Visualization
- Analytics and valuation of DER services, DSO rules, and business models.
- Simulation of multi-scale interactions of DSO with up-stream ISO, same level DSOs, and downstream (microgrid, building, and home) prosumer subsystems.





3D Visualization Concept

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Team

- Strategically designed team to address the complexity of DSO/DSP activities.
  - Major DSO/DSP efforts in NY and CA
  - Realistic data, use cases, rules.

- NRECA's Open Modeling Framework (OMF) allows us to leverage existing engineering models and solvers: Milsoft, CYMDIST, GridLab-D, etc.

- Integrate strong expertise in decentralized architectures for control and optimization, federated co-simulation, visualization, analytics, economics, and cloud computing.

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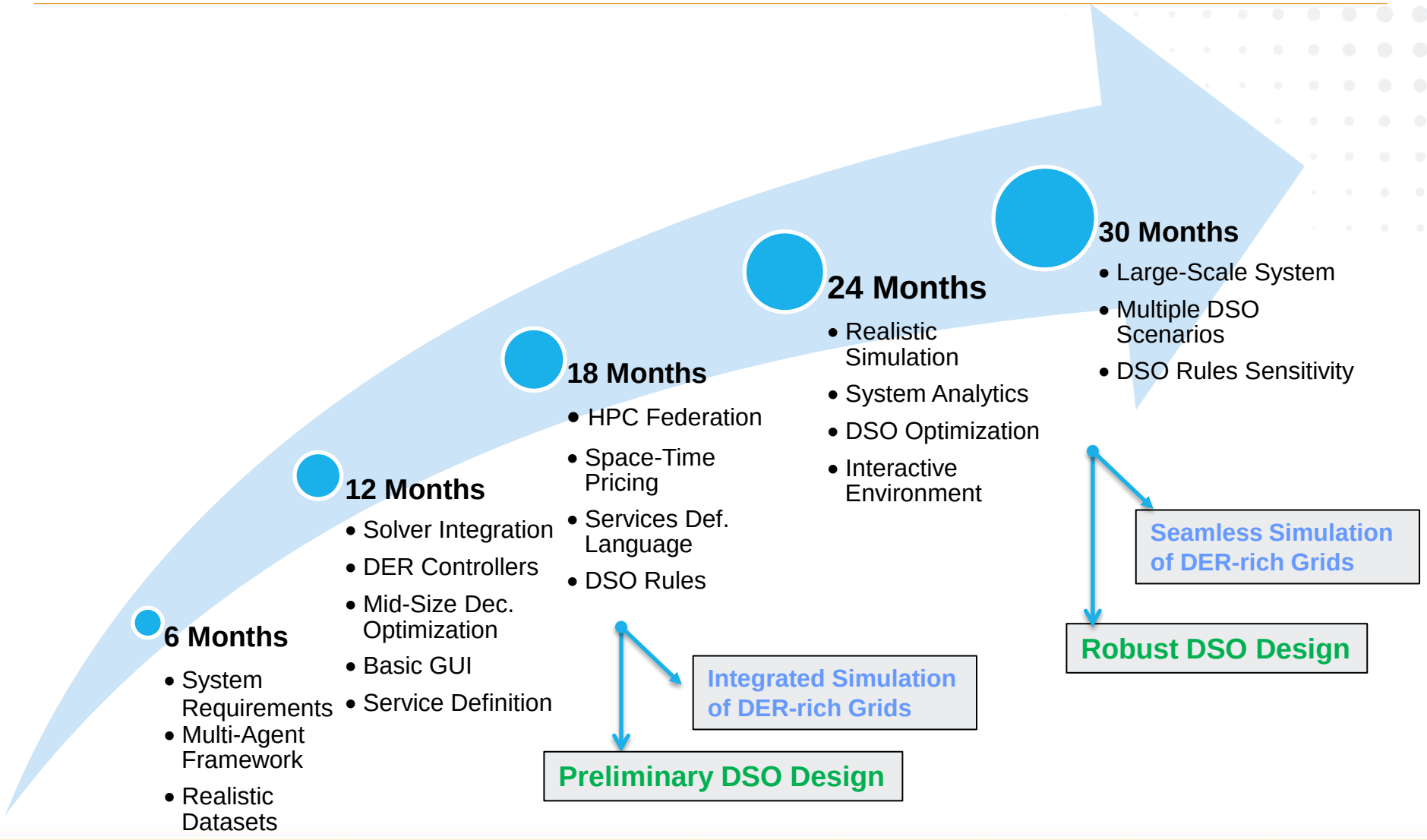
Project Tasks



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Path to Market

- After interviewing more than 100 executives, and engineers of electric utilities, the team found that the existing tools are limited, siloed, and unable to simulate DER-rich systems, many smart grid propositions, and DSO/DSP models.

- This project will fill this ***simulation void*** in the industry.

- ProsumerGrid will commercialize the tool.
  - We expect that initial target customers be utilities and energy providers, but also consultants, academia, and possibly customers.
  - We plan to continue using the NSF's I-Corps Lean startup methodology to validate our value propositions.

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What do we need?

- 1. Make sure that the tools meets the needs.
  - What are your DER simulation needs at the physical, control, information, services, economy, and policy levels?
  - What are the features that the simulator absolutely must have.
- 2. Accelerate development of an urgent tool.
  - We need to hire more people to accelerate development.
- 3. Extend development
  - Examples: Hosting Capacity, Optimal DER Deployment, Cyber Layer

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Impact on NODES program

- NODES projects will build algorithms and advanced control solutions to help the grid evolve into a more automated system.
- Our simulation environment:
  - Could potentially simulate the impact of these algorithms and quantify the costs/benefits of the proposed solutions in a variety of scenarios and environments.
  - Could provide system-wide co-simulation to assess how the NODES solutions benefit the industry.

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Conclusions

- A DSO Simulation Studio would represent a quantum leap in the industry's ability to simulate and manage the complexity of emerging DER-based distribution grids.
- It will support decisions of great criticality and impact, as various states implement DSO/DSPs in the quest to realize a highly distributed, reliable, optimized, and sustainable electricity industry.
- It could be of service to NODES teams in communicating their impact.

Thanks

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