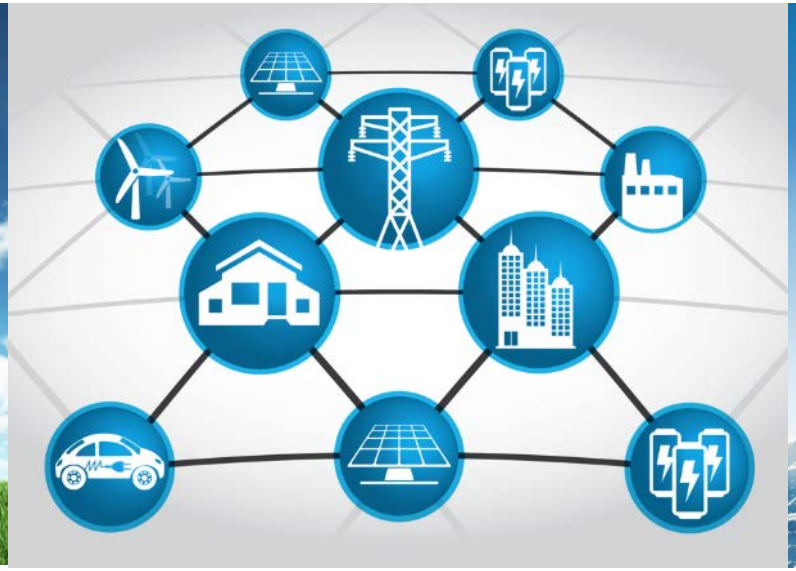
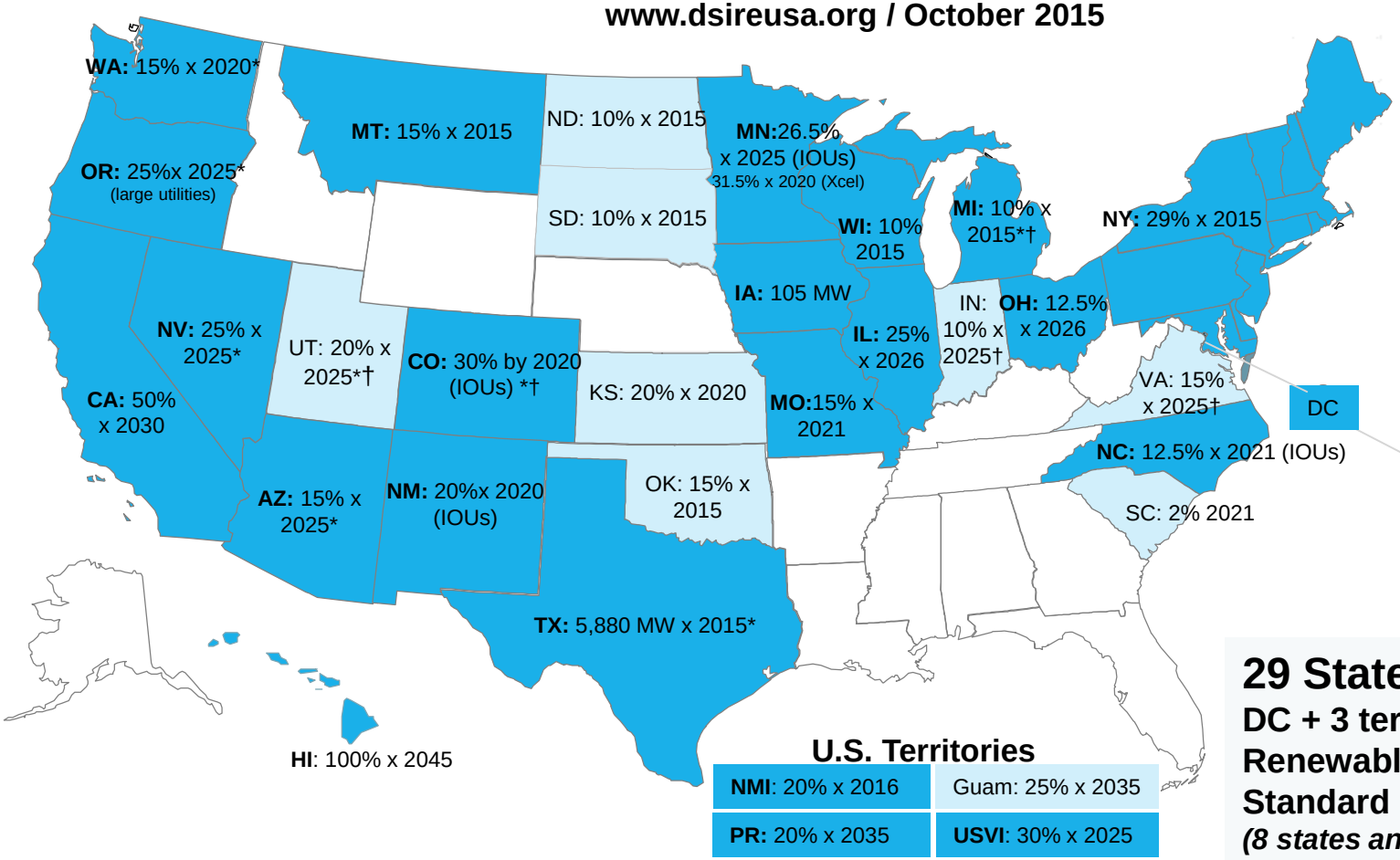
NODES: Controlling the Grid Edge

Program Director: Dr. Sonja Glavaski



Consumers Want Renewables

www.dsireusa.org / October 2015



ME: 40% x 2017
NH: 24.8 x 2025
VT: 75% x 2032
MA: 15% x 2020(new resources) 6.03% x 2016 (existing resources)
RI: 14.5% x 2019
CT: 27% x 2020
NJ: 20.38% RE x 2020 + 4.1% solar by 2027
PA: 18% x 2021†
DE: 25% x 2026*
MD: 20% x 2022
DC: 20% x 2020

U.S. Territories

NMI: 20% x 2016	Guam: 25% x 2035
PR: 20% x 2035	**USVI**: 30% x 2025

29 States + Washington DC + 3 territories have a Renewable Portfolio Standard
(8 states and 1 territories have renewable portfolio goals)

Renewable portfolio standard
Renewable portfolio goal

* Extra credit for solar or customer-sited renewables
† Includes non-renewable alternative resources

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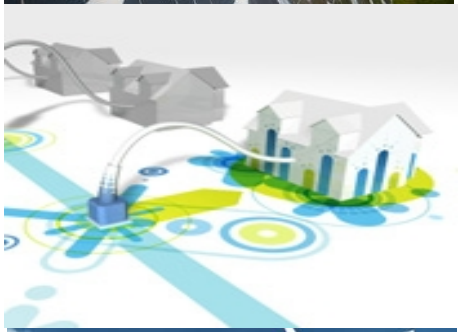
CHANGING WHAT'S POSSIBLE

Challenges with Renewables Grid Integration

Dispatched generation → **Intermittent DG**

Predictable load → **Variable Net-Load**

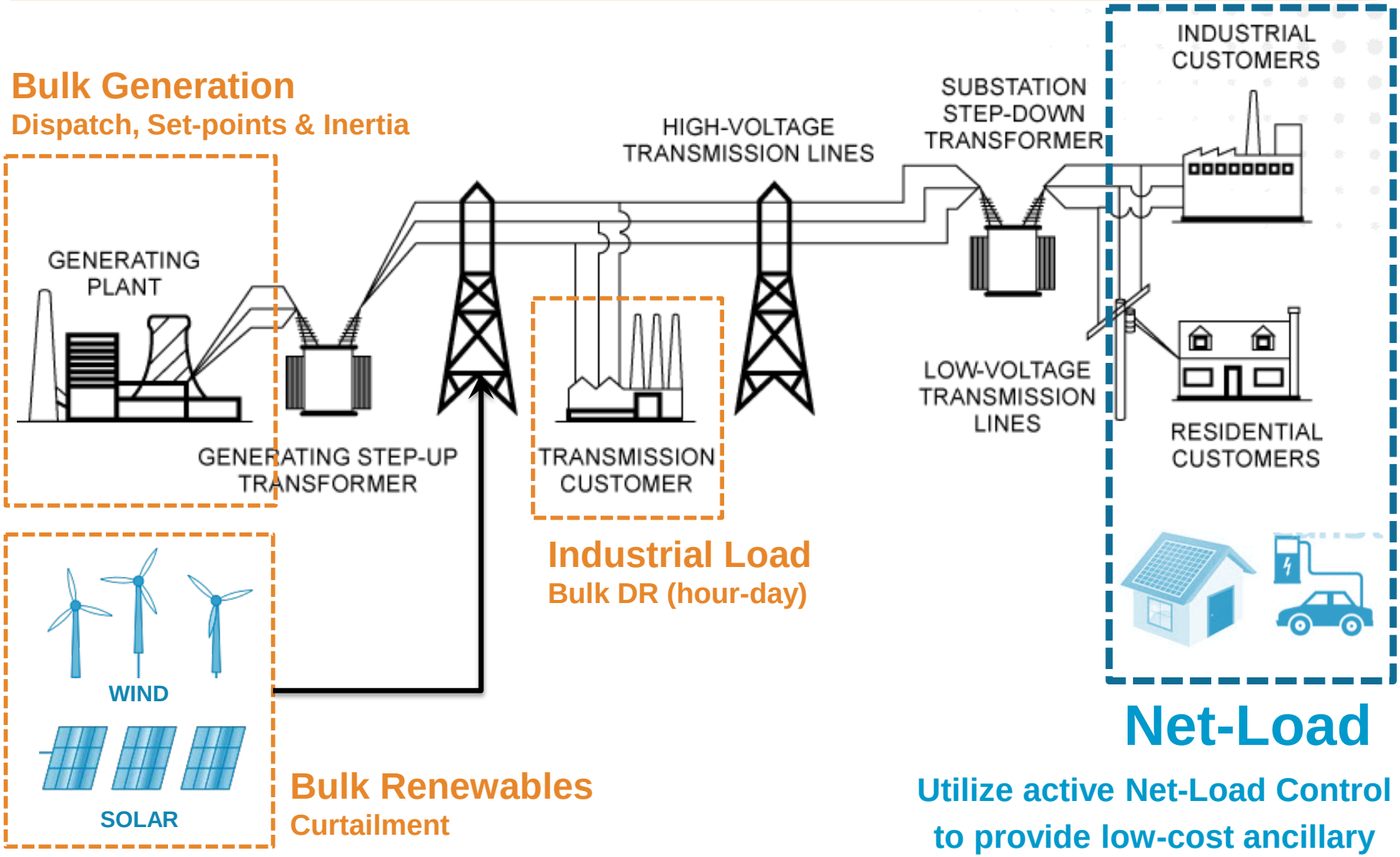


Capacity available → **Capacity constrained**

Renewables penetration is limited (< 30%) because of lack of capability to reliably and affordably manage its variability

If we can actively control Net-Load, 50% renewables integration is possible.

What do we want to control?

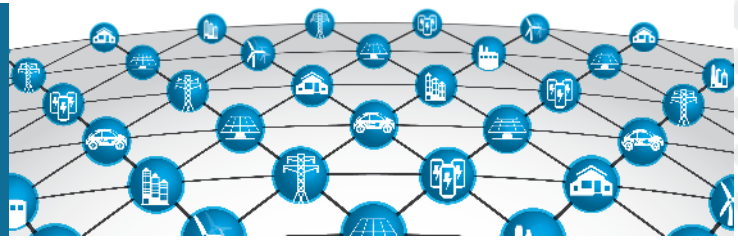


Net-Load

Utilize active Net-Load Control to provide low-cost ancillary services at different time-scales

NODES

Network Optimized Distributed Energy Systems



Mission

Reliably manage dynamic changes in the grid by leveraging flexible load and Distributed Energy Resources' (DERs) capability to provide ancillary services to the electric grid at different time scales.

Goals

- Enable renewables penetration at > 50%
- Improve overall grid efficiency and reliability
- Reduce CO_2 emissions (renewables ↑, reserves ↓)
- Increase penetration of Distributed Generation (DG)

Technical Challenges

- Dispatching both bulk and distributed generation
- Proactively shaping load over different time scales
- Coordinating consumers and generation operation
- Distributed management of heterogeneous resources
- Guaranteeing customers' QoS

Year	2015
Projects	12
Anticipated Investment	$33 Million

Project Categories	Response Time	Ramp Time	Duration
C1: Synthetic Frequency Reserves	< 2 sec	< 8 sec	> 30 sec
C2: Synthetic Regulating Reserves	< 5 sec	< 5 min	> 30 min
C3: Synthetic Ramping Reserves	< 10 min	< 30 min	> 3 hr

Category 1: Synthetic Frequency Reserves

Objective

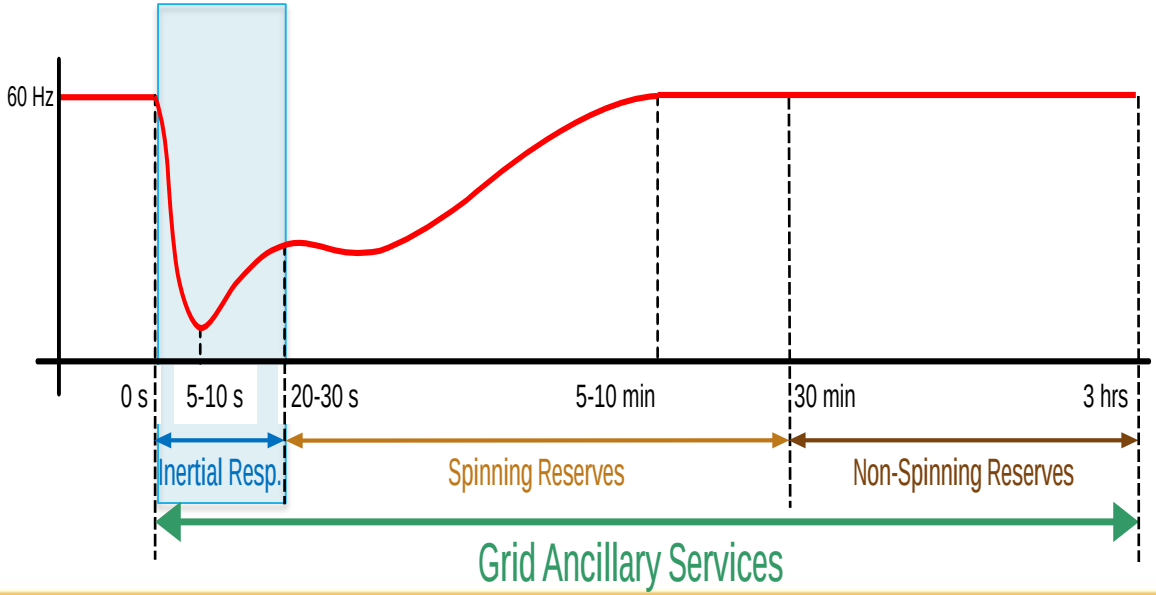
- Increase “inertia” in the system

Approach

- Loads & DERs providing inertial response while synched to locally measured frequency

Challenges

- Stability of the system
- Response speed



Category 2: Synthetic Regulating Reserves

Objective

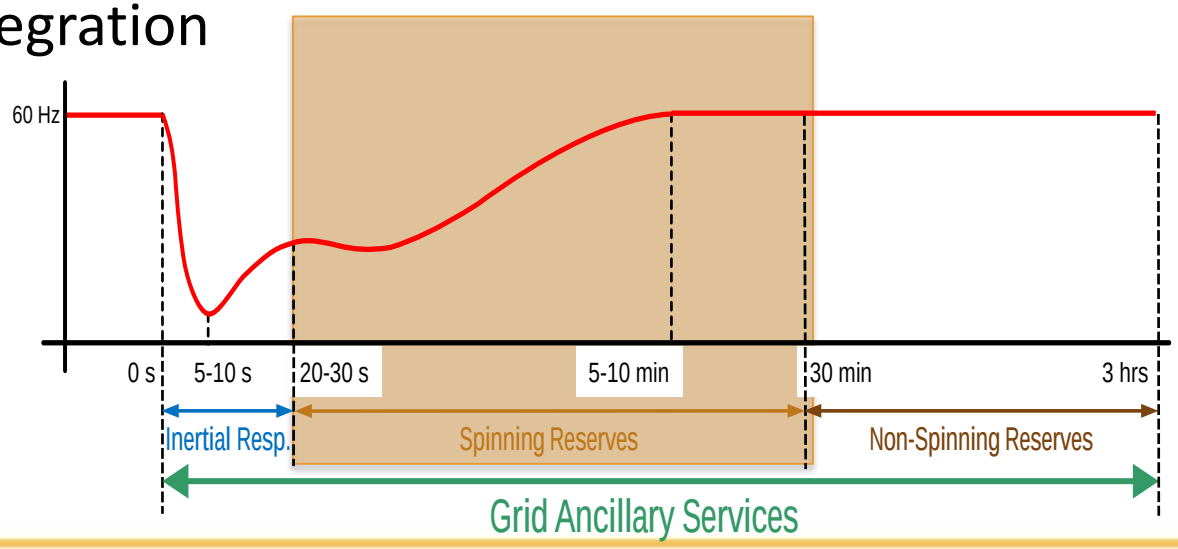
- Support frequency recovery/stability

Approach

- Coordinate loads & DERs to adjust Net-Load magnitude & time shift

Challenges

- Peer-to-peer communication & optimal performance trade-off
- Heterogeneous DERs integration



Category 3: Synthetic Ramping Reserves

Objective

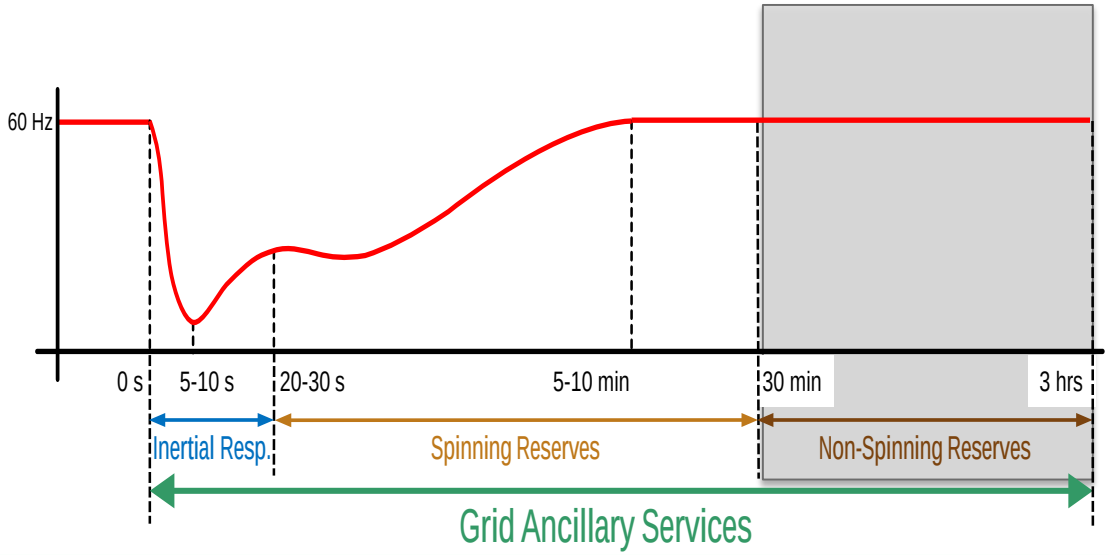
- Coordinated long term shifting of load with thermal/electric storage, and non-critical load

Approach

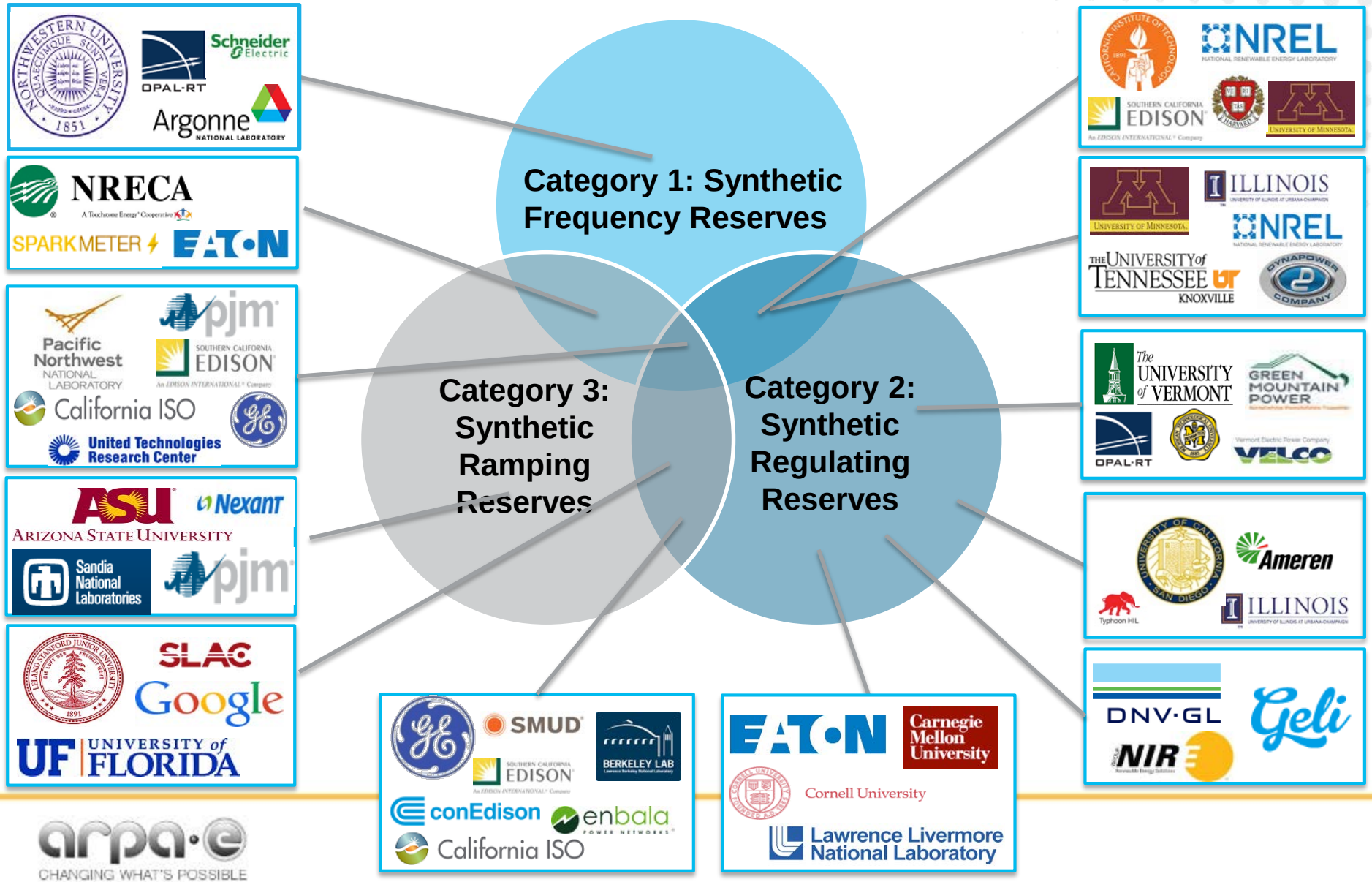
- Forecast the loads & capacity of aggregated DERs
- Supervisory control for generation-load balancing

Challenges

- Modeling populations of controlled loads & DERs
- Guaranteed aggregate Net-Load performance



NODES Project Teams



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CHANGING WHAT'S POSSIBLE

Next Steps

Engage Industry

Recruit Industrial Advisory Board (IAB) Members for teams

Address Technology Needs

Develop grid management & control technology enabling large scale flexible loads & DERs integration

Demonstrate Novel Capabilities

Validate solutions in HIL & Large Scale Simulation

Commercialize Technology

Work with teams & IABs on technology to market plans and strategies

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NODES Projects Portfolio

Lead Organization	UVM	UCSD	ASU	Stanford	GE	NREL	PNNL	UMN	NWU	Eaton	DNV-GL	NRECA
Proposed Technical Contribution												
Architecture	Y			Y		Y	Y	Y	Y	Y	Y	Y
Control Algorithms	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
Modeling	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Optimization	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y		
Markets			Y		Y		Y				Y	
Managed DERs												
HVAC	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	
Water Heaters	Y	Y				Y	Y	Y	Y	Y	Y	Y
Lighting		Y		Y	Y						Y	
Plug-in Load			Y	Y			Y	Y	Y			Y
Water pumps, Irrigation		Y		Y					Y			
EVs	Y	Y	Y		Y	Y	Y		Y	Y	Y	
CHP				Y								
Storage	Y	Y	Y	Y		Y	Y	Y	Y	Y	Y	
Renewables												
Bulk (Wind/Solar)	Y	Y	Y		Y				Y		Y	
DG (PV)	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Validation												
HiL	Y	Y		Y	Y	Y	Y	Y	Y	Y	Y	Y
Large-scale Simulation	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y	Y