Unlocking the Shared Integrated Grid: From Diving Ducks to Digitalization

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Invited Presentation:
Clean Energy Ministerial Power System Flexibility Campaign and IEA Digital Demand-Driven Electricity Networks Initiative
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http://engineering.dartmouth.edu/liines

Presentation Goal

To describe a way forward for *unlocking* a "shared integrated grid"

- **… Following the "Diving Duck"**
- **… Empowering American Communities**
- **… Embracing Dynamic Data-Driven Markets**
- **… In 14 minutes**

Activating the Grid's Periphery ←→ Activating Local Communities!
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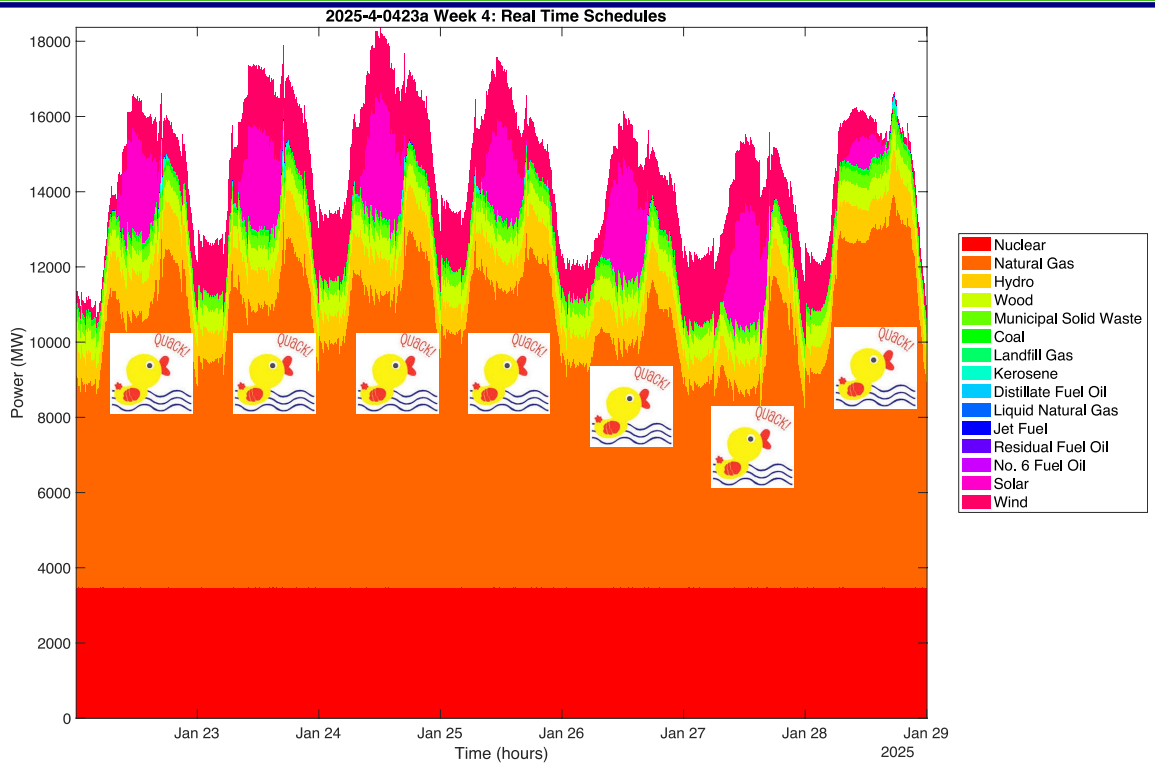
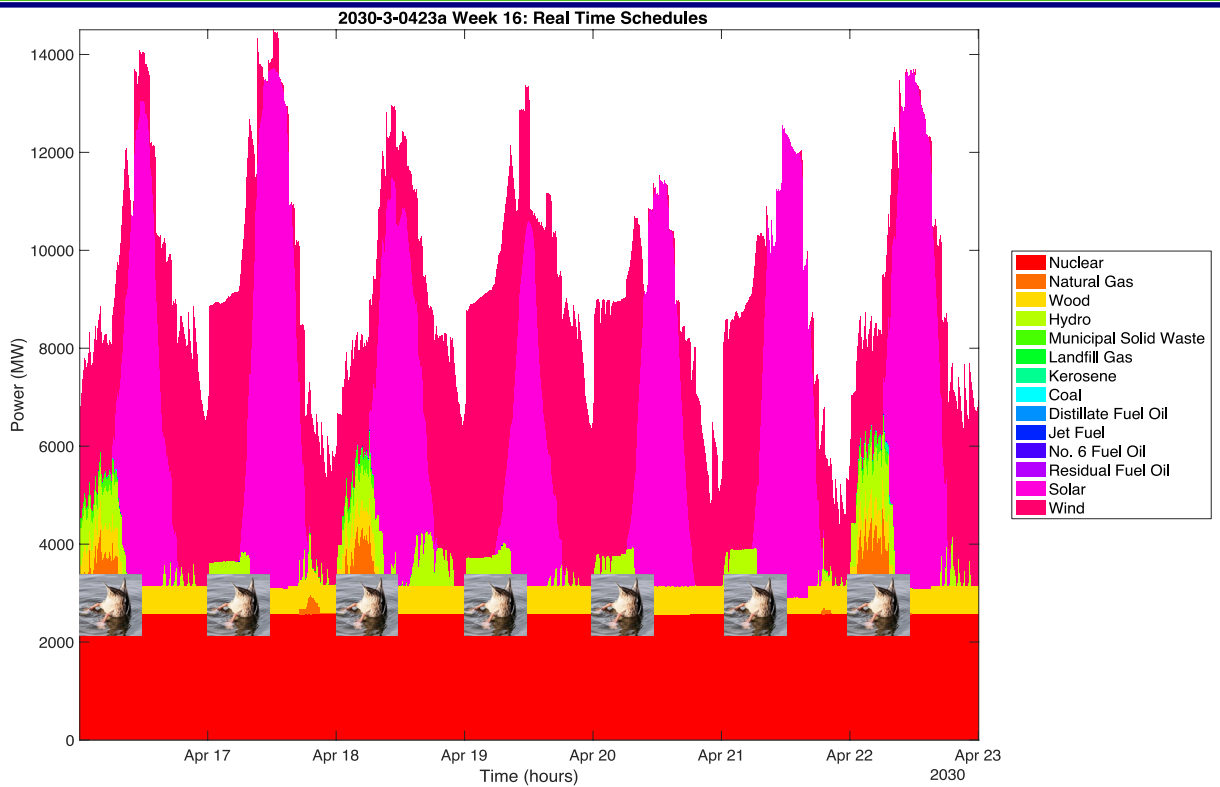
Shared Integrated Grid

ISO-NE Real-Time Energy Market Dispatch: 2025 Conventional



∴ Even in a "business-as-usual" 2025 case, the duck curve appears prominently!

ISO-NE Real-Time Energy Market Dispatch: 2030 High VREs Plus



∴ In a "high renewables" 2030 case, a new "duck-dive" curve appears!

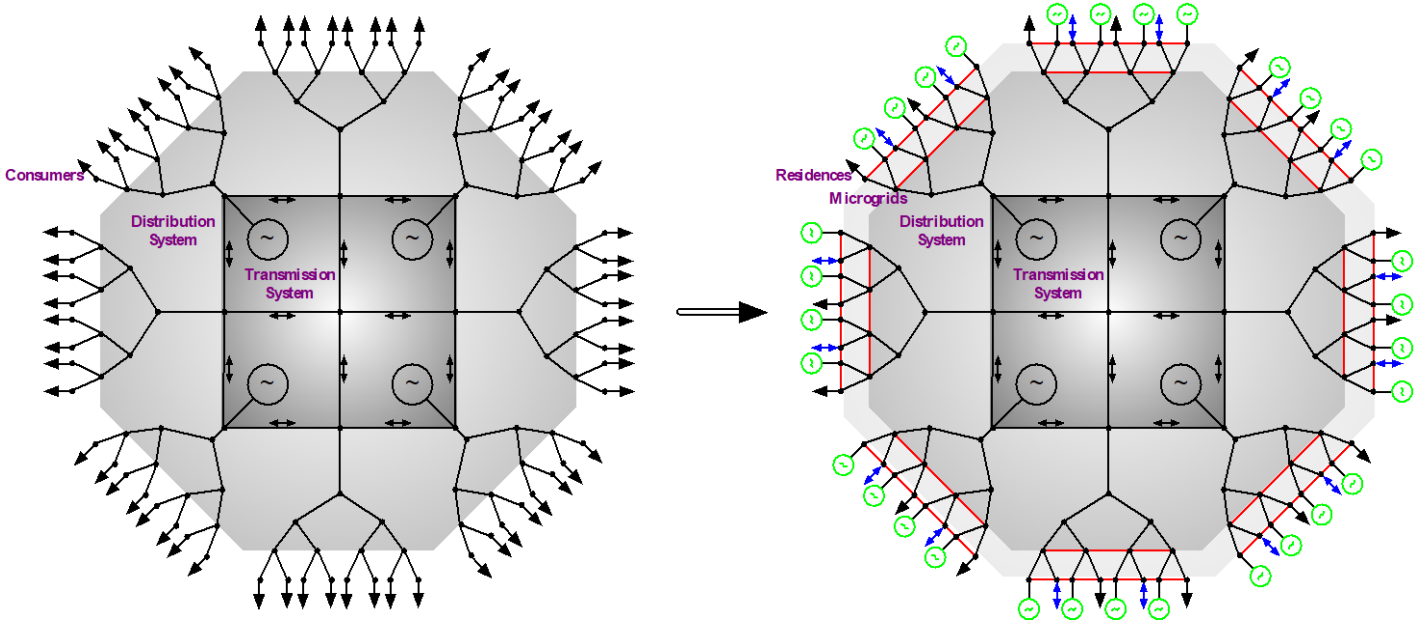
Impact of eIoT-enabled energy-water resources in New England

Table 1: The range of **improvements** caused by coordinated flexible operation of the energy-water nexus.

Balancing Performance	
Average Load Following Reserves	1.24–12.66%
Average Ramping Reserves	5.28–18.35%
Percent Time Curtailed	2.67–10.90%
Percent Time Exhausted Regulation Reserves	0%
Std. Dev. of Imbalances	3.874–6.484%
Environmental Performance	
Total Water Withdrawals	0.65–25.58%
Total Water Consumption	1.03–5.30%
Total CO_2 Emissions	2.10–3.46%
Economic Performance	
Total Day-Ahead Energy Market Production Cost	29.30–68.09M$
Total Real-Time Energy Market Production Cost	19.58–70.83M$

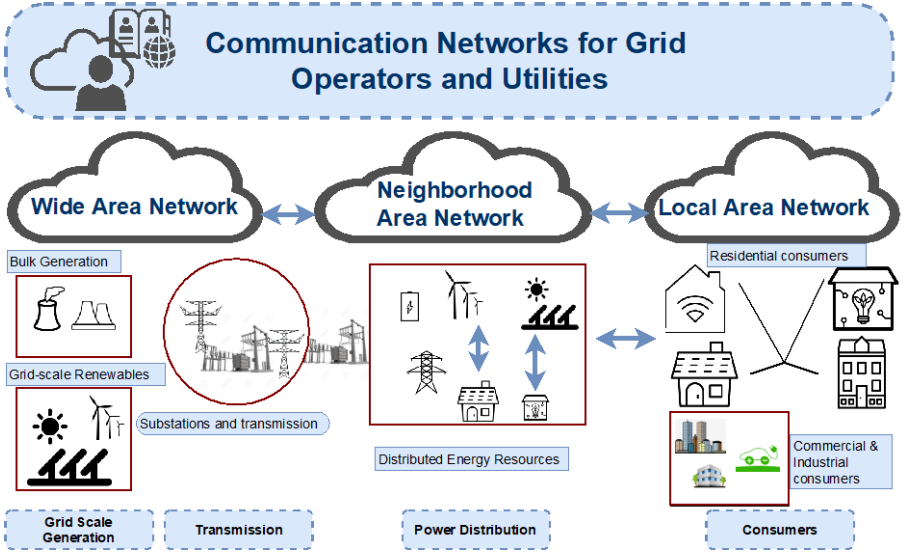
∴ Even a relatively small penetration of eIoT-enabled energy-water resources can have across-the-board synergistic benefits.

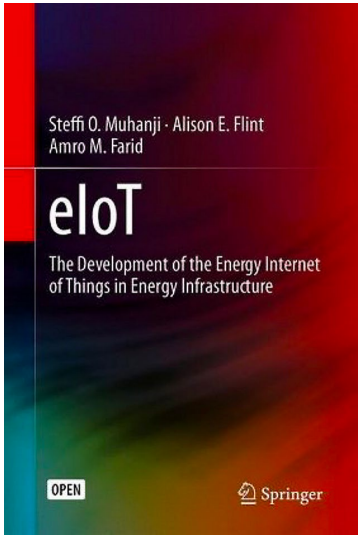
eIoT's Importance: The Transition to an Active Grid Periphery



The integration of distributed energy resources at the grid's periphery implies the adoption of a plethora of network-enabled devices and appliances in an energy Internet of Things.

The Ubiquitous Energy Internet of Things



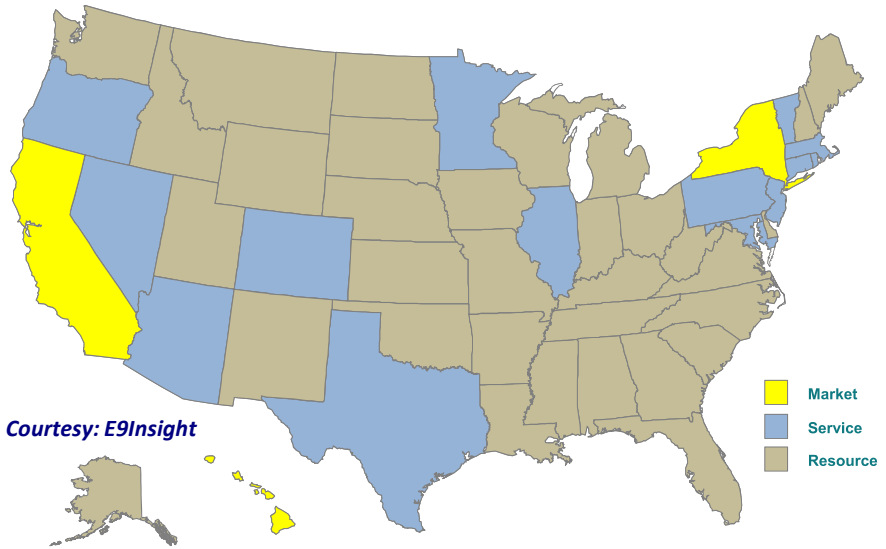


eIoT = network-enabled energy devices in a shared economy

Unlocking the Shared Integrated Grid (#sharedgrid)

Activating the Grid's Periphery ←→ Activating Local Communities!

A Tale of Two Grids: Embrace the Local, Embrace the Heterogeneity

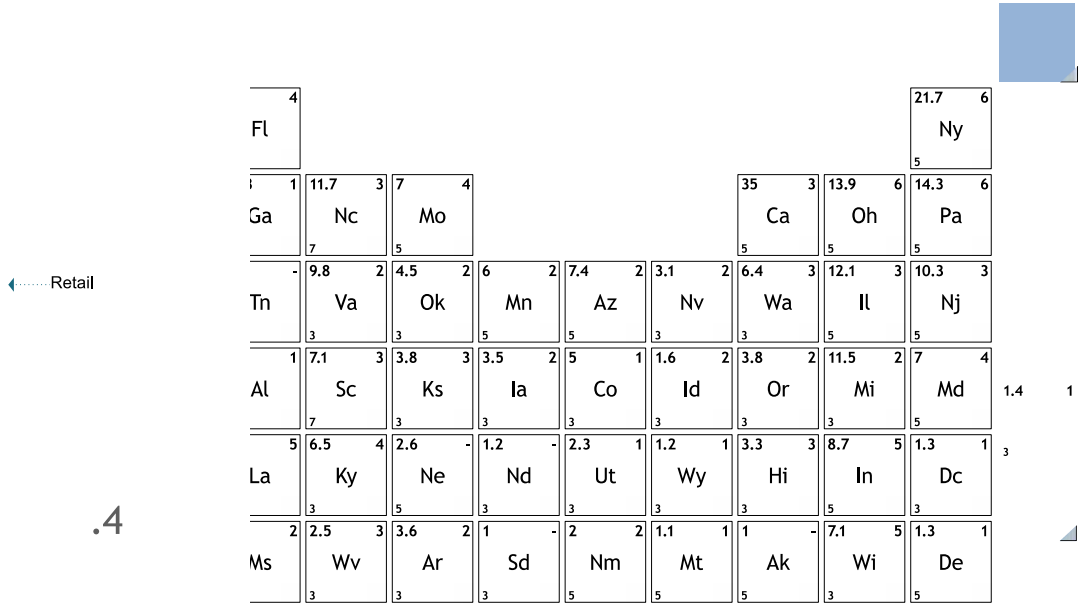


Courtesy: E9Insight

										21.7 6 Ny 5	
1 Ga	11.7 3 Nc 7	7 4 Mo 5					35 3 Ca 5	13.9 6 Oh 5	14.3 6 Pa 5		
- Tn	9.8 2 Va 3	4.5 2 Ok 3	6 2 Mn 5	7.4 2 Az 5	3.1 2 Nv 3	6.4 3 Wa 3	12.1 3 Il 5	10.3 3 Nj 5			
1 Al	7.1 3 Sc 7	3.8 3 Ks 3	3.5 2 Ia 3	5 1 Co 3	1.6 2 Id 3	3.8 2 Or 3	11.5 2 Mi 3	7 4 Md 5	1.4	1	
5 La	6.5 4 Ky 3	2.6 - Ne 5	1.2 - Nd 3	2.3 1 Ut 3	1.2 1 Wy 3	3.3 3 Hi 3	8.7 5 In 5	1.3 1 Dc 3	3		
2 Ms	2.5 3 Wv 3	3.6 2 Ar 3	1 - Sd 3	2 2 Nm 5	1.1 1 Mt 5	1 - Ak 5	7.1 5 Wi 3	1.3 1 De 5			

"On the one hand, there are states where the policy is moving toward more open market solutions, including community ownership, community choice models and auction mechanisms. … On the other, there are states that are more inclined toward expanding the vertical integration (monopoly) model."

A Tale of Two Grids: Embrace the Local, Embrace the Heterogeneity



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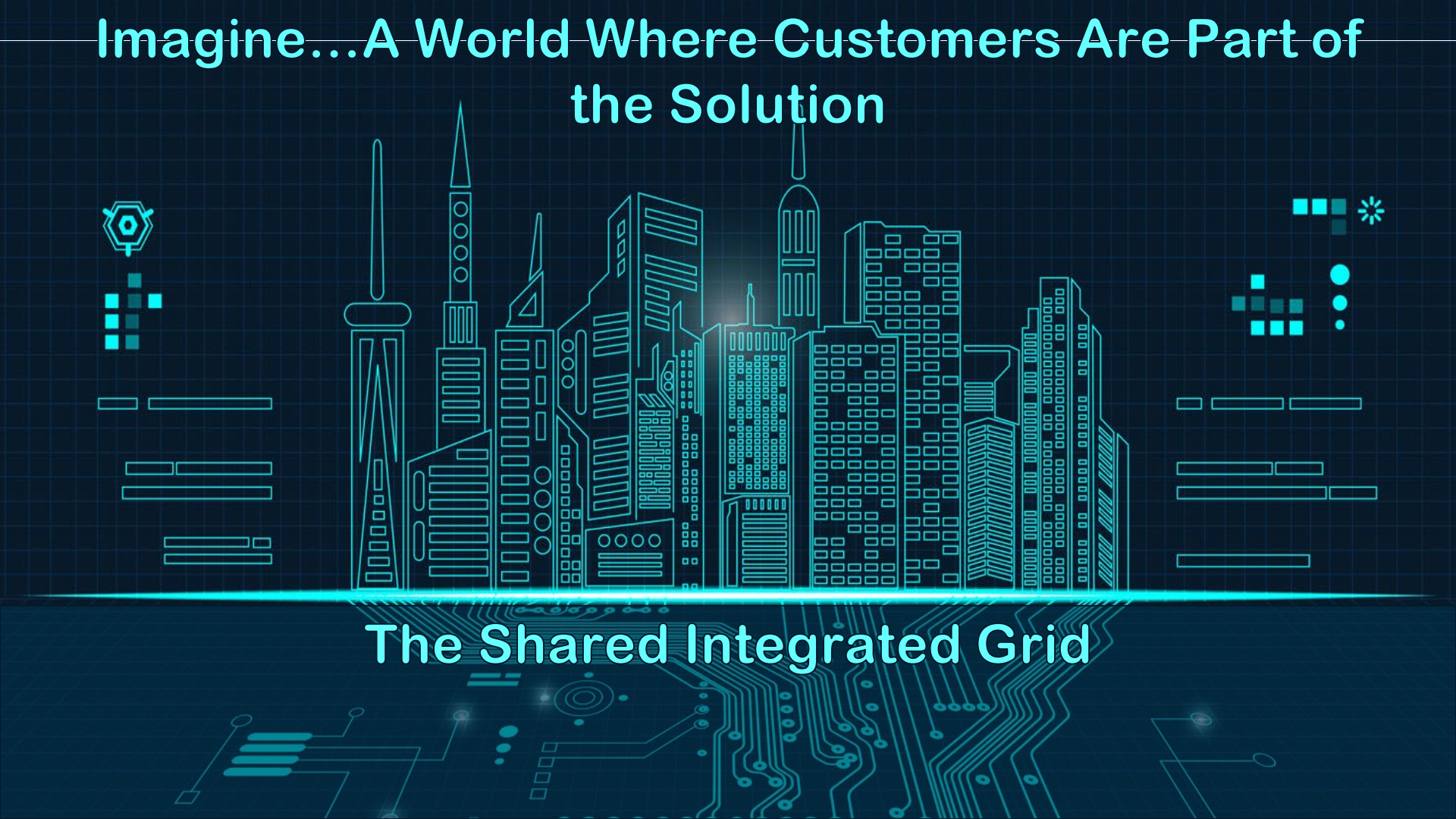
"On the one hand, there are states where the policy is moving toward more open market solutions, including community ownership, community choice models and auction mechanisms. … On the other, there are states that are more inclined toward expanding the vertical integration (monopoly) model."

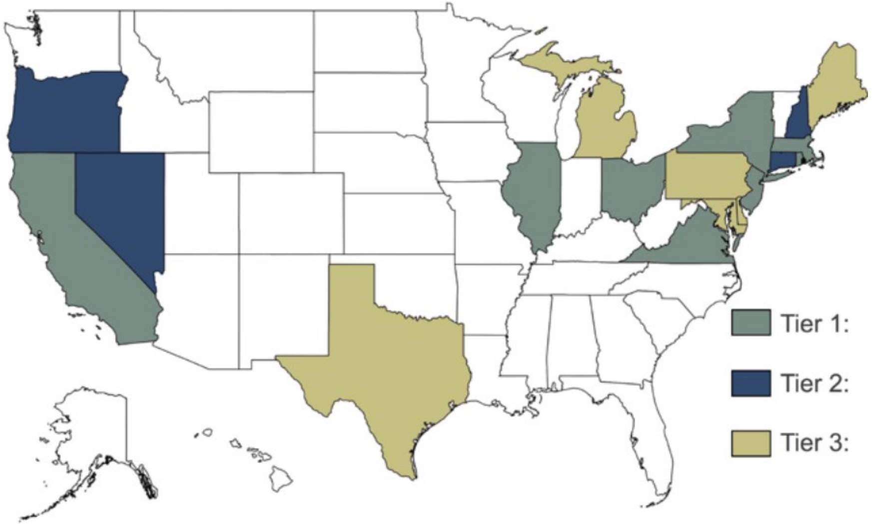
Imagine…A World Where Customers Are Part of the Solution



The Shared Integrated Grid

Community Choice Aggregators: A Vehicle for the Shared Integrated Grid?

750 CCAs serving 1000 American Communities



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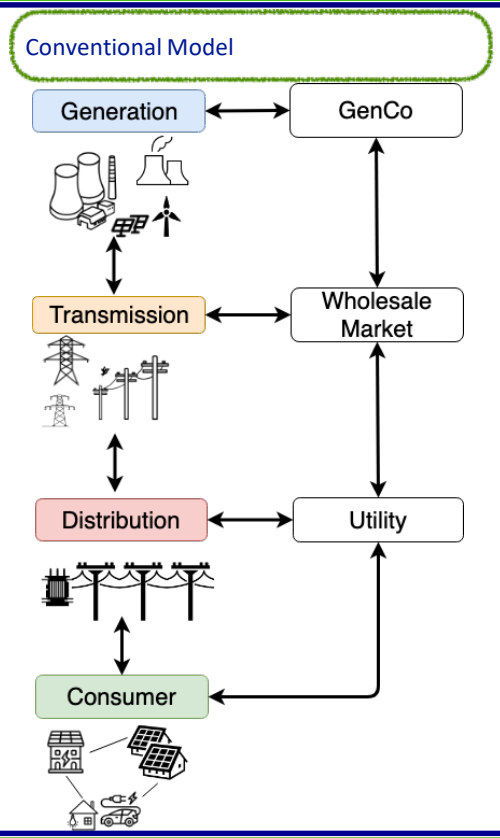
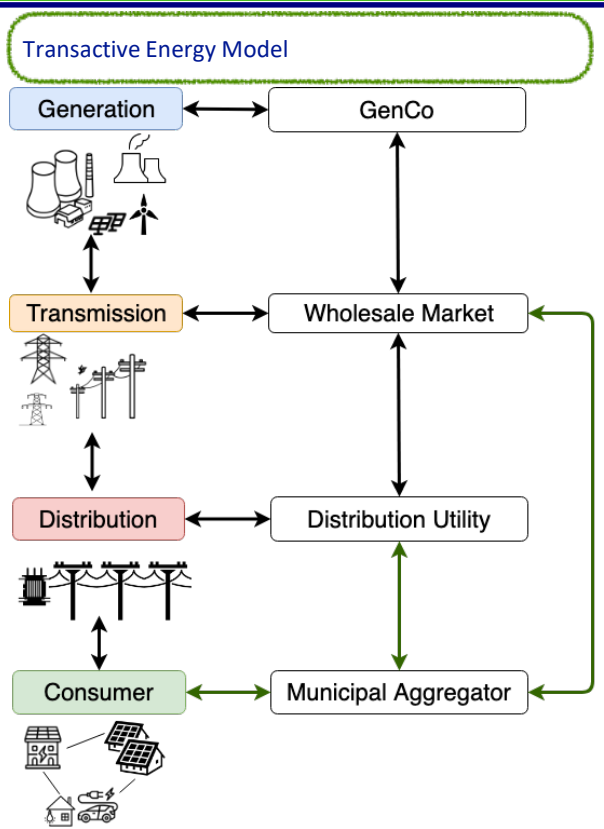
Conventional vs Community Power Aggregator/Transactive Energy





Unlocking Community Power in New Hampshire

In 2019, Gov. Sununu (R) signed SB284 on Community Power Aggregation to RSA 53-E.

It became apparent that many NH stakeholders already wished to participate in a *Shared Integrated Grid*

Participating Municipal members:

1. Bristol (Paul Bemis)
2. Harrisville (Mary Day Mordecai & Ned Hulbert)
3. Hanover (Julia Griffin & April Salas)
4. Lebanon (Clifton Below)
5. Nashua (Doria Brown)
6. Cheshire County (Rod Bouchard)
7. Monadnock Energy Hub (Dori Drachman)

Community support members:

8. Clean Energy New Hampshire (*facilitator*: Henry Herndon)
9. Dartmouth College (*ex officio*: Dr. Amro Farid)
10. Community Choice Partners (*ex officio*: Samuel Golding)

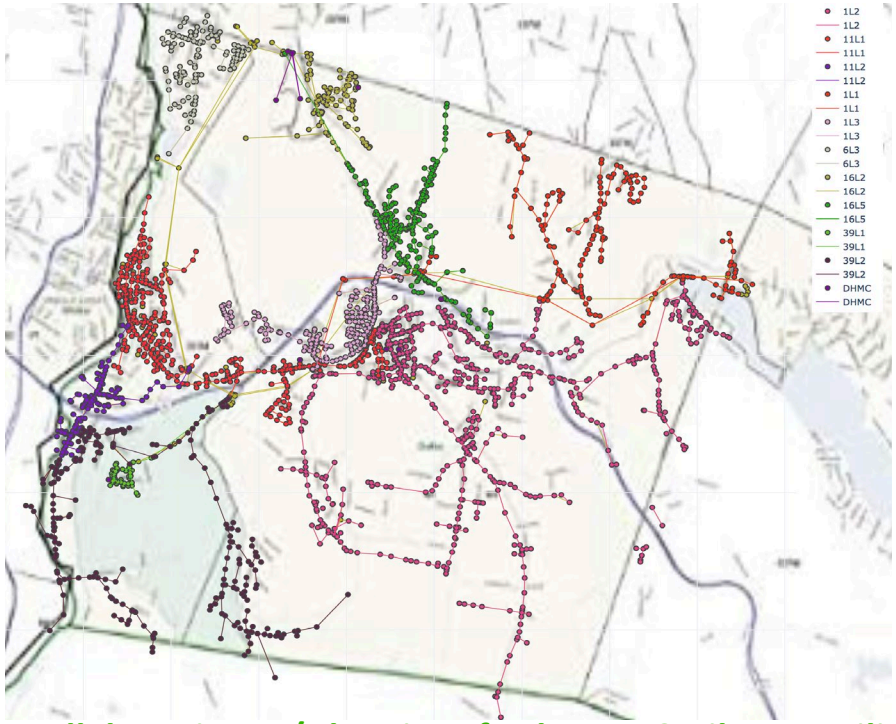
5 Municipalities
~53,000 customers
(7% of market)
~460,000 MWh / yr
~$50 million (supply)

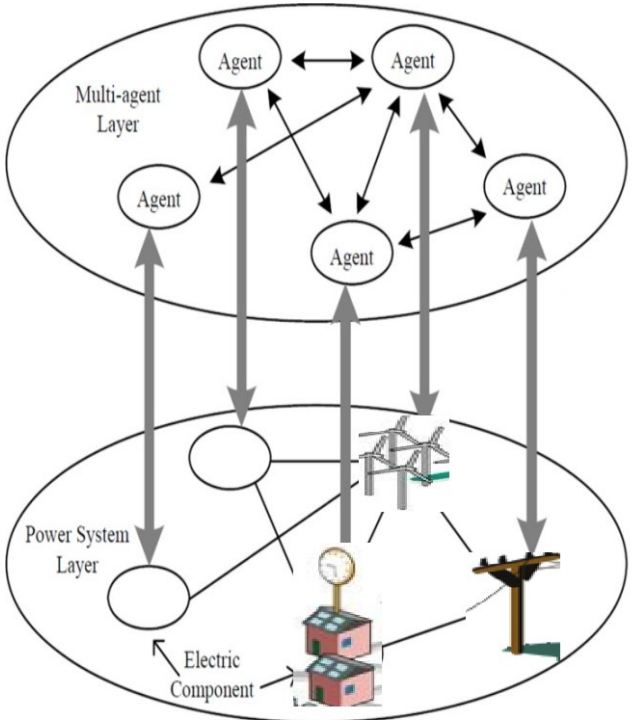
23 Municipalities
~36,000 customers
(5% of market)
~315,000 MWh / yr
~$35 million (supply)

9 Municipalities
~21,000 customers
(3% of market)
~183,000 MWh / yr
~$20 million (supply)

Community Power Coalition of New Hampshire draws from a broad spectrum of NH grid stakeholders. Joint Power Agreement approved by the State Attorney General.

Developing a Real-Time Pricing Transactive Energy Service (RTP-TES) Prototype for Lebanon, NH



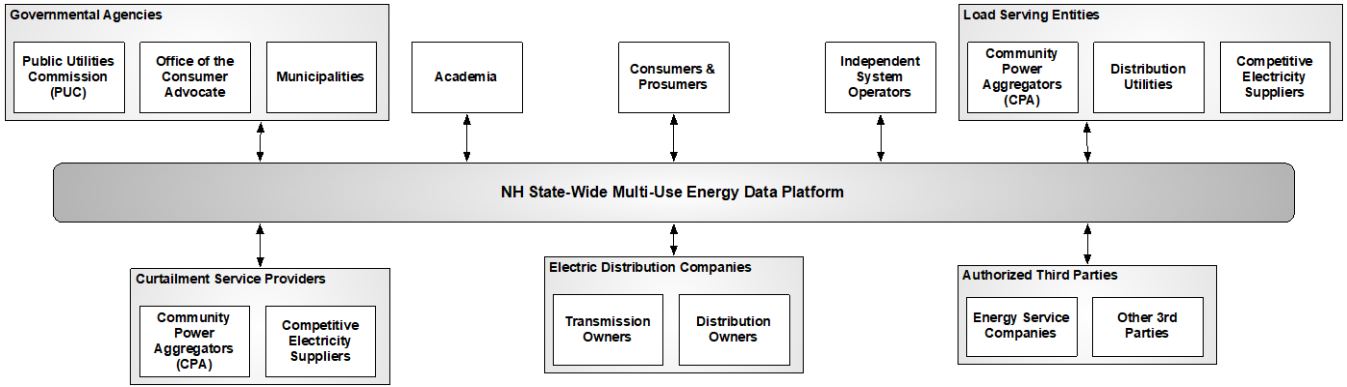


In Collaboration w/ the City of Lebanon & Liberty Utilities, the Dartmouth-LIINES developed a Transactive Energy Service Market Prototype

(support: Irving Institute for Energy & Society)

Envisioning a NH State-Wide Multi-Use Energy Data Platform

In 2019, Gov. Sununu (R) signed SB286 on a Statewide Multi-Use Energy Data Platform.
Data sharing is prerequisite to a *Shared Integrated Grid*.



Q: How might we think about building such an energy data platform? What are we going to have to pay special attention to?

One Answer: Just start coding!

One Answer: Write a Request for Proposals. Outsource it to the lowest bidder!

Your Answer: _____*Write your answer in the chat box*_____

Conclusion: Take Home Points

1. That's One Active Diving Duck! Be Ready to Follow it Around.
2. Activate the Grid Periphery through the energy Internet of Things.
3. Activating the Grid Periphery ←→ Activating Local Communities == Shared Integrated Grid
4. A Tale of Two Grids: Embrace the Heterogeneous Regulatory Landscape
5. Shared Integrated Grid → Real-Time Pricing, Transactive Energy Services, & Energy Data Platforms

Activating the Grid's Periphery ←→ Activating Local Communities!
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Shared Integrated Grid