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Energy Systems, Uptime and the Digital Economy

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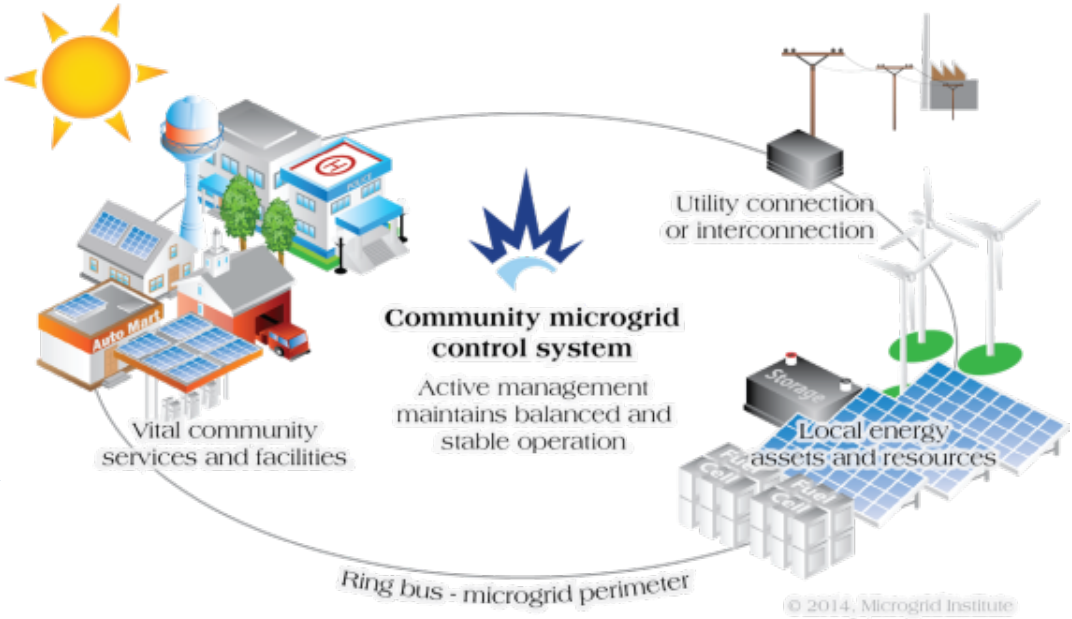
Energy System Implications for IT and IoT

- **Power outages are #1 cause of IT downtime.**
  - Industries lose upwards of $709,000 per IT outage caused by power supply failure (Ponemon Institute).
- **Sectors sensitive to power reliability have the highest employment growth.**
  - Highest Value of Lost Load (VOLL): *Health Care, Finance & Insurance*
    - Will add around 40% of the non-agricultural employment growth nationally by 2026. *Bureau of Labor Statistics*
    - These sectors expected to be major drivers of demand for UPS systems as they increasingly incorporate the internet-of-things (IoT).

What is a Microgrid?

A microgrid is a contained energy system capable of balancing captive supply and demand resources to maintain reliability

- Defined by function, not size
- Incorporates multiple distributed technologies
- ***Maximizes reliability and efficiency***
- Can include other utilities – steam, hot water, chilled water, network connectivity
- May function in "islanded mode" disconnected from larger utility grid



No Power to the People

National Academy of Science Report on Nation's Electricity System

- *"Recommendation 1 to DOE: Improve understanding of customer and society value associated with increased resilience...."*

  September 2017.

So Why the Poor Understanding?

- Complexity of Electricity Pricing.
- Lack of Uniformity in Regulation or Industry Terminology.
- Value of Resiliency Highly Dependent upon Circumstances.

How Can We Value Resiliency?

1. **Avoided Costs:** Maintaining Back Up and Standby Power Systems
   - Diesel Generation
   - Batteries and Uninterruptible Power Supply (UPS) systems
2. **Value of Lost Opportunity**
   - *Value of Lost Load Calculation:*

$$VOLL = \frac{\text{GDP (or Output) for Industry (\$)}}{\text{Electricity Consumption for Industry (kWh)}}$$

3. **Survey:** What Are Commercial End Users Willing to Pay for Enhanced Uptime?

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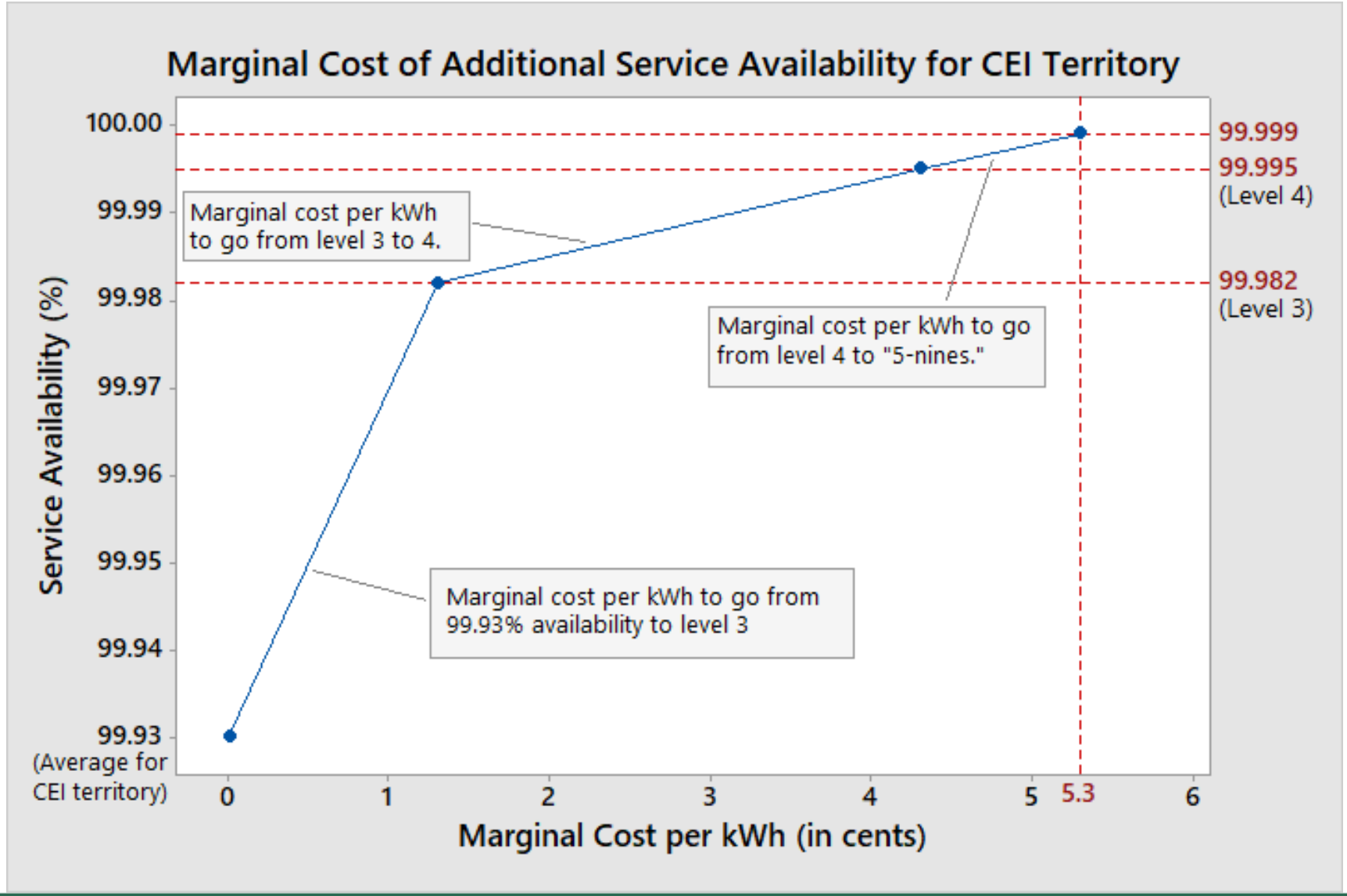
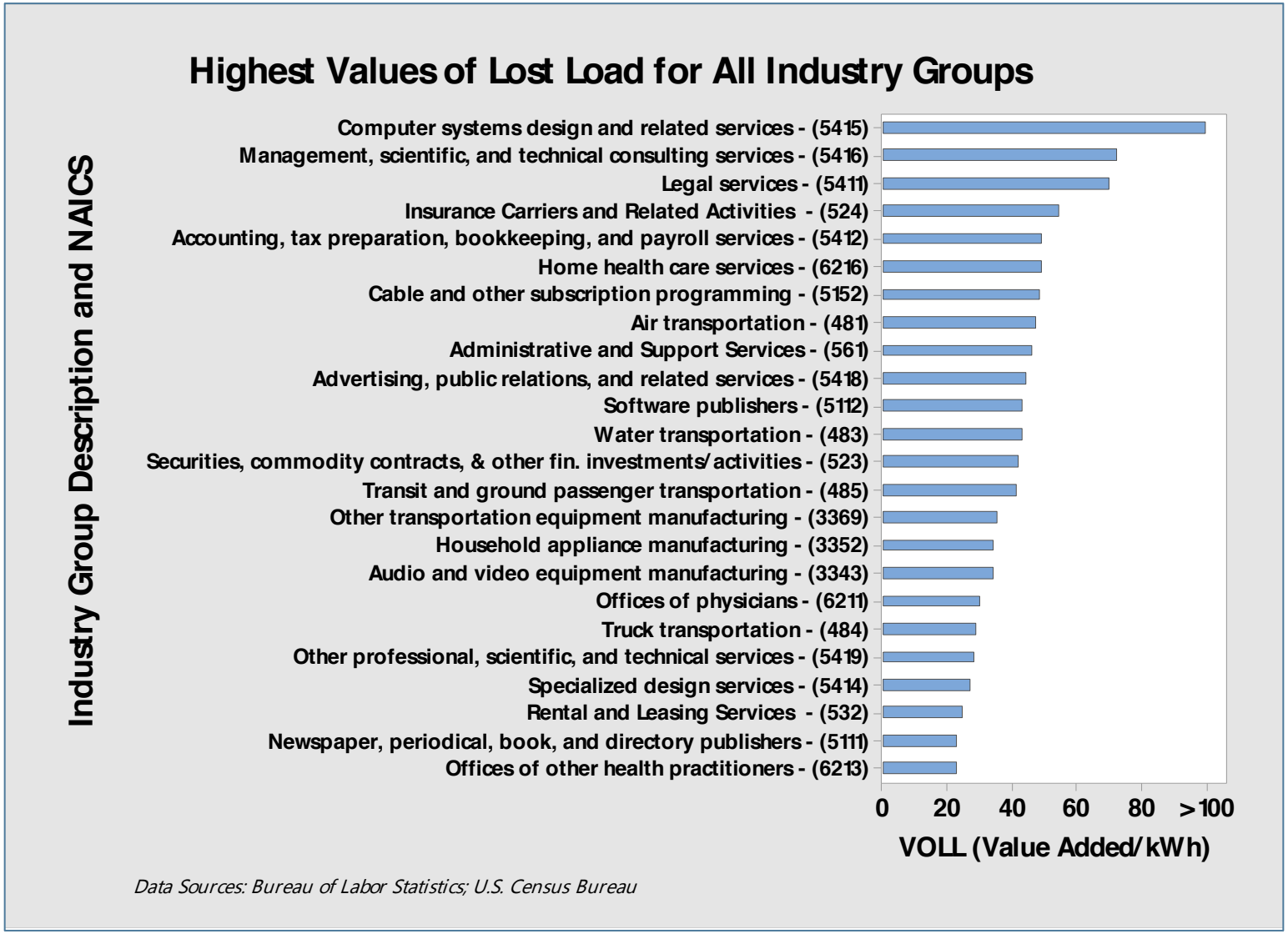
Value Based Upon Avoided Costs



Value Based Upon Lost Production



1 hour outage for 1 MW facility would cost
"Securities and Financial Investment" company $50,000

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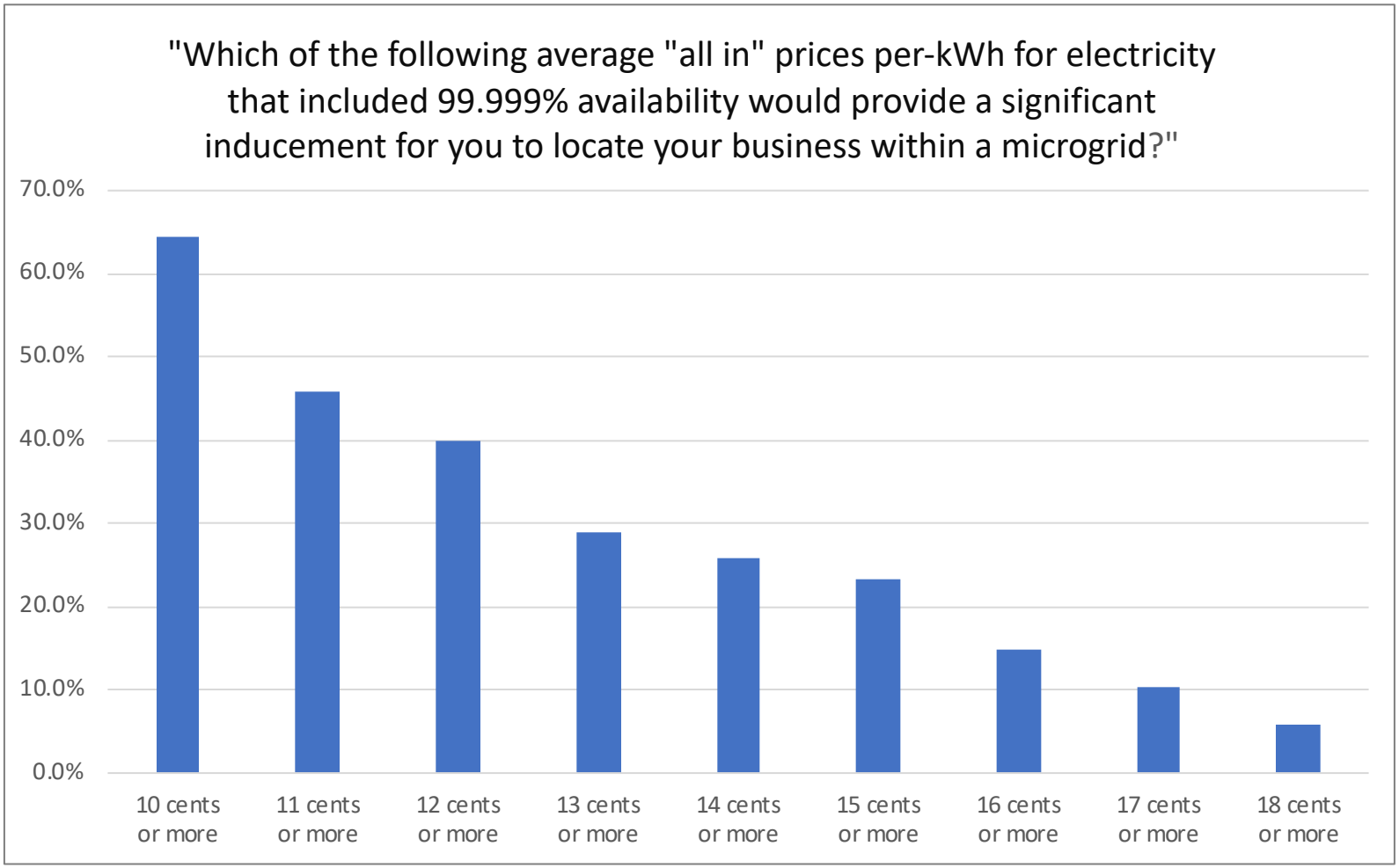
Value Based Upon National Survey of End Users



Who Might Be Interested in Grid Resiliency?

- Universities
- Data and Financial Centers
- Law, Accounting, Consulting Firms
- Hospitals
- Emergency Services
- Food Services
- R&D Companies

Role of Uptime in the new economy: 40% of non-agricultural economic growth projected to be in health, finance and insurance services

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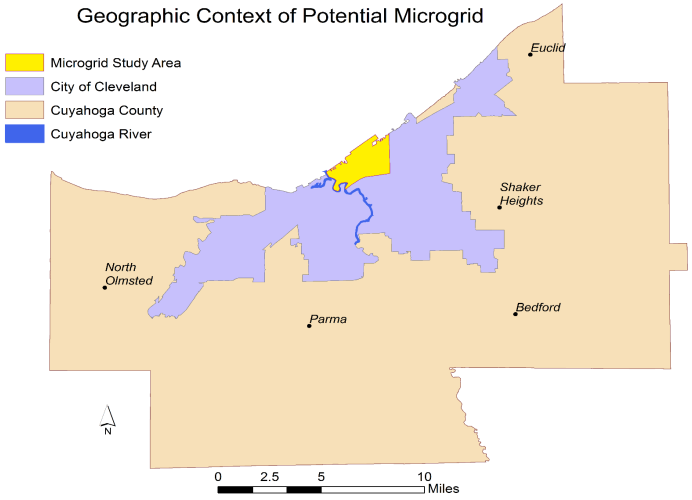
Proposed Downtown Cleveland Microgrid District



- Potential anchor end users
- Ability to leverage existing infrastructure
- Ability to grow both loads and infrastructure
- Economic relevance of areas
- Available land for new infrastructure and end users
- Regulatory compatibility

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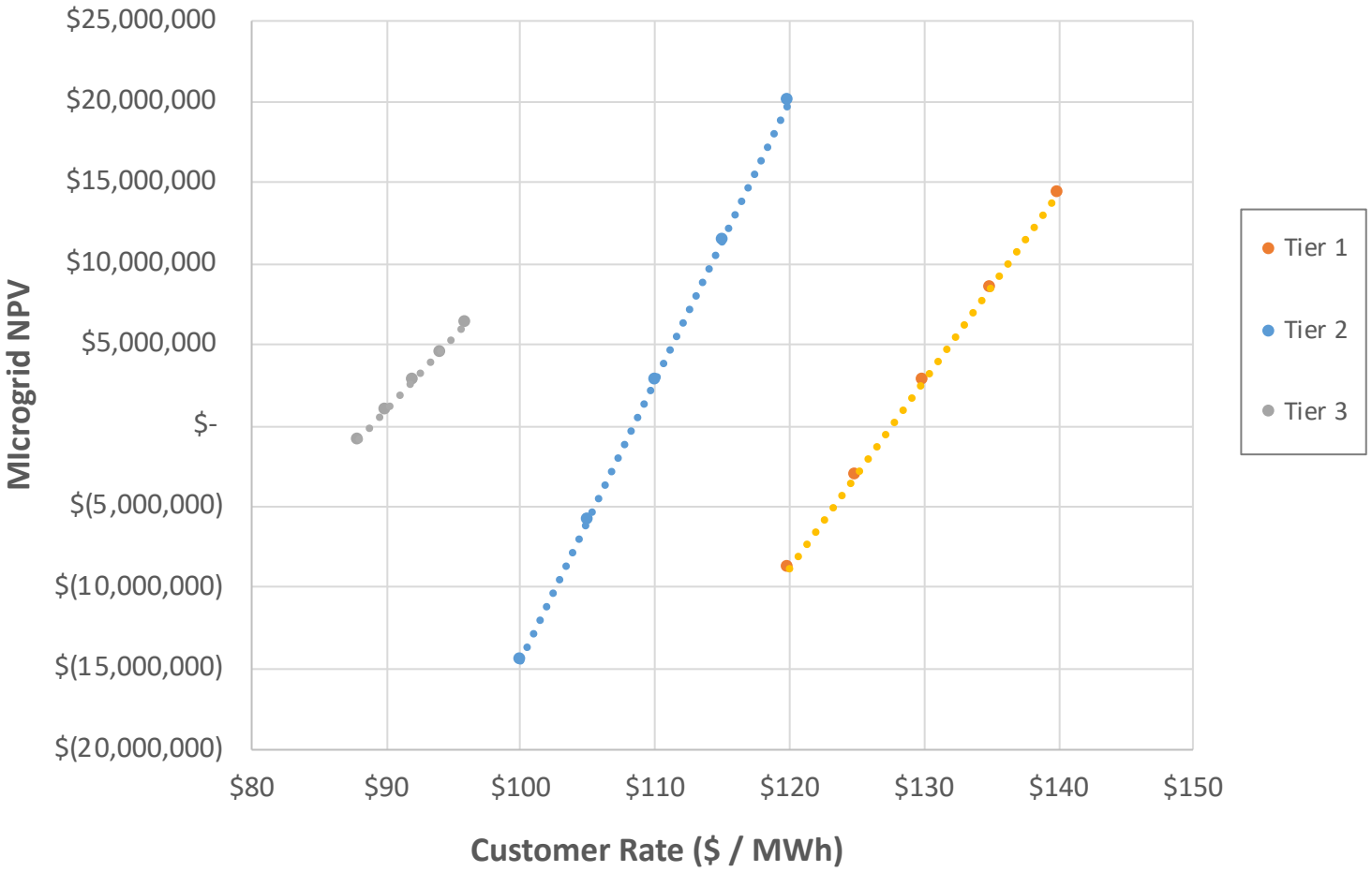
Sensitivity Analysis For Three Tier Customer Rate Structure



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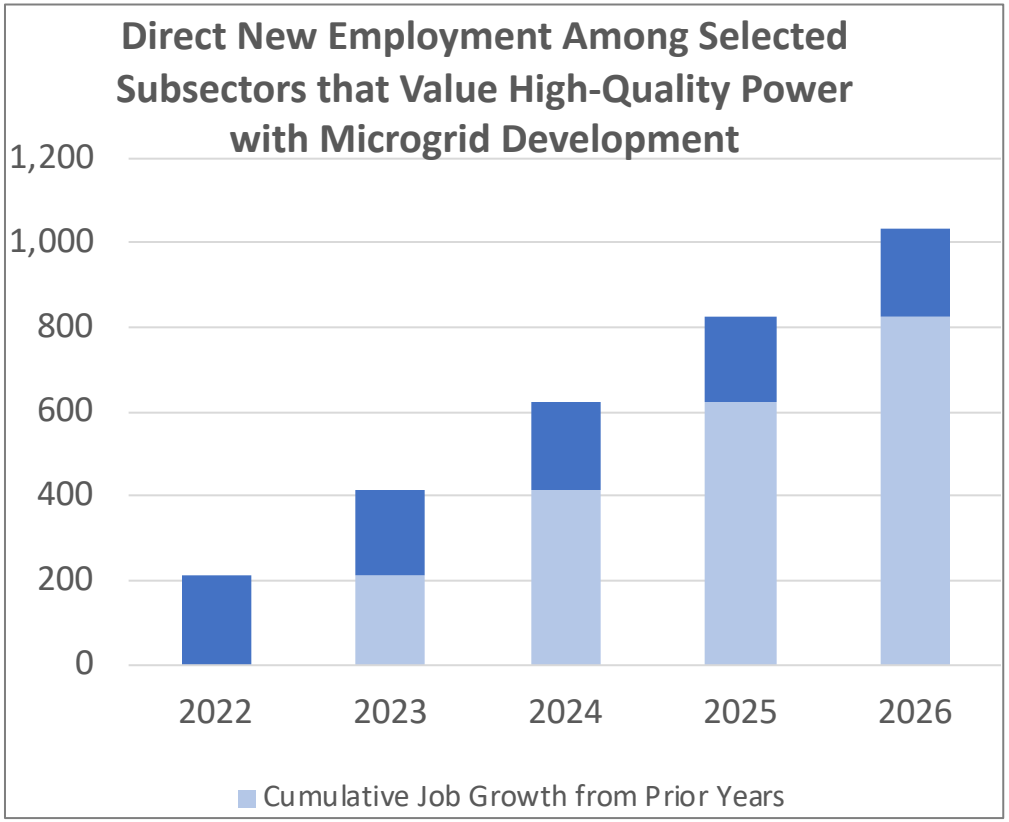
Economic Impact of Microgrid in Downtown Cleveland

Assumptions:

- Direct jobs only
- 20% of 48 MW grid reserved for new development
- Growth in high VOLL subsectors increases from 10 year city average to national average
- Jobs created based upon average per kW per employee for each industry (Census Bureau)



Associated additional earnings of $91 million within the µGrid by 2026.

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"The Economic and Fiscal Impact of a Microgrid in Downtown Cleveland, Ohio" (2018). *Urban Publications*. https://engagedscholarship.csuohio.edu/urban_facpub/1560

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Total Savings Due to Deregulation of Electricity in Ohio 2011-2018 (millions of dollars)

Year	Shopping	SSO Auction	Total
2011	$496.70	$2,395.00	$2,891.70
2012	$443.29	$2,366.00	$2,809.29
2013	$744.11	$2,342.00	$3,086.11
2014	$824.21	$2,380.00	$3,204.21
2015	$645.19	$2,339.00	$2,984.19
2016	$540.77	$2553.90	$3,094.67
2017	$403.59	$2,502.10	$2,905.69
2018	$353.40	$2,612.60	$2,966.05
2011-2018	**$4,451.11**	**$19,490.60**	**$23,941.71**

"Customer Competition Continues to Outperform Traditional Monopoly Regulation" (2019). https://engagedscholarship.csuohio.edu/urban_facpub/1618

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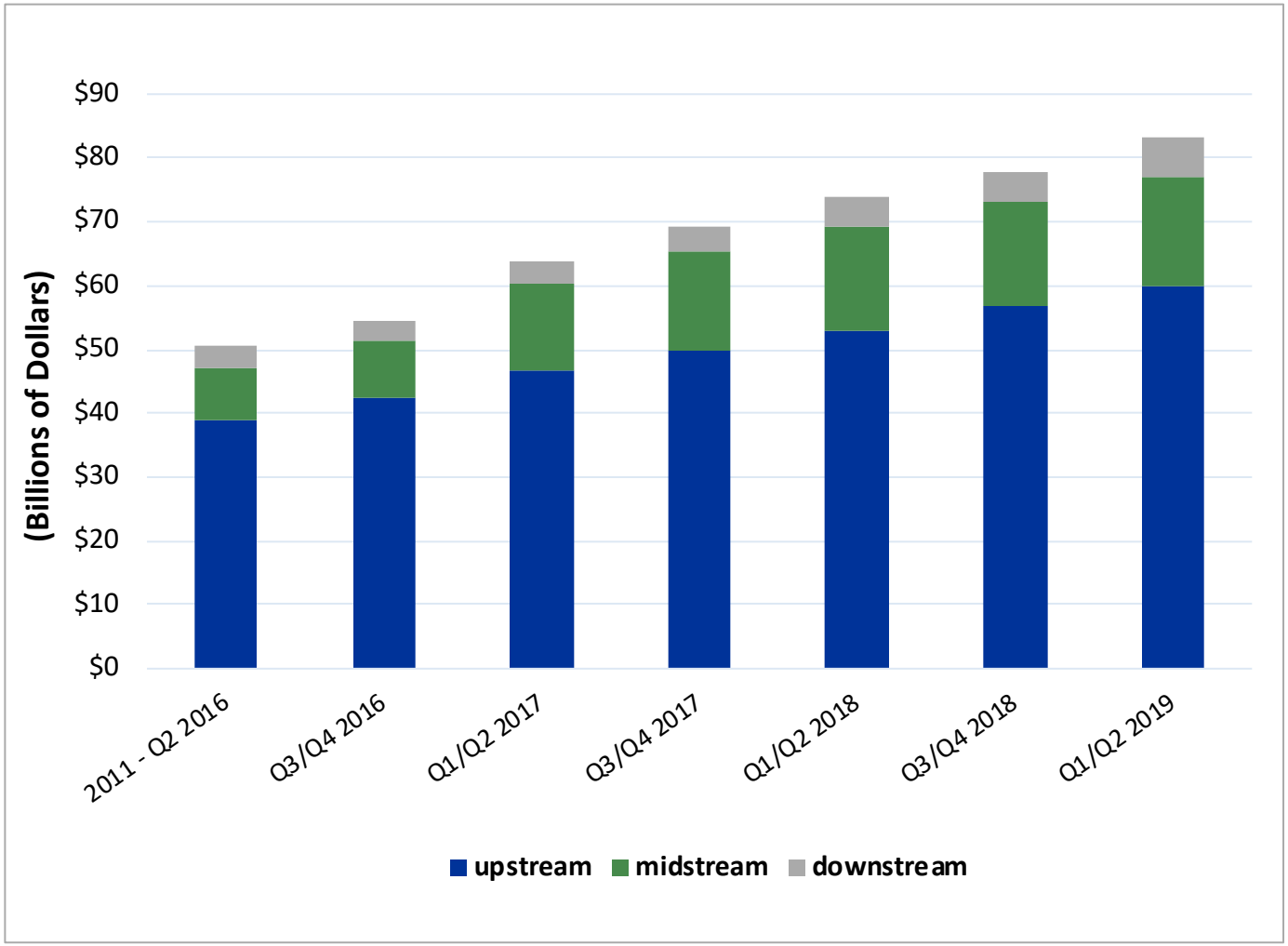
Cumulative Shale Related Investment In Ohio 2011-2019



Shale Investment Dashboard in Ohio Q1 and Q2 2019" (2020). https://engagedscholarship.csuohio.edu/urban_facpub/1659

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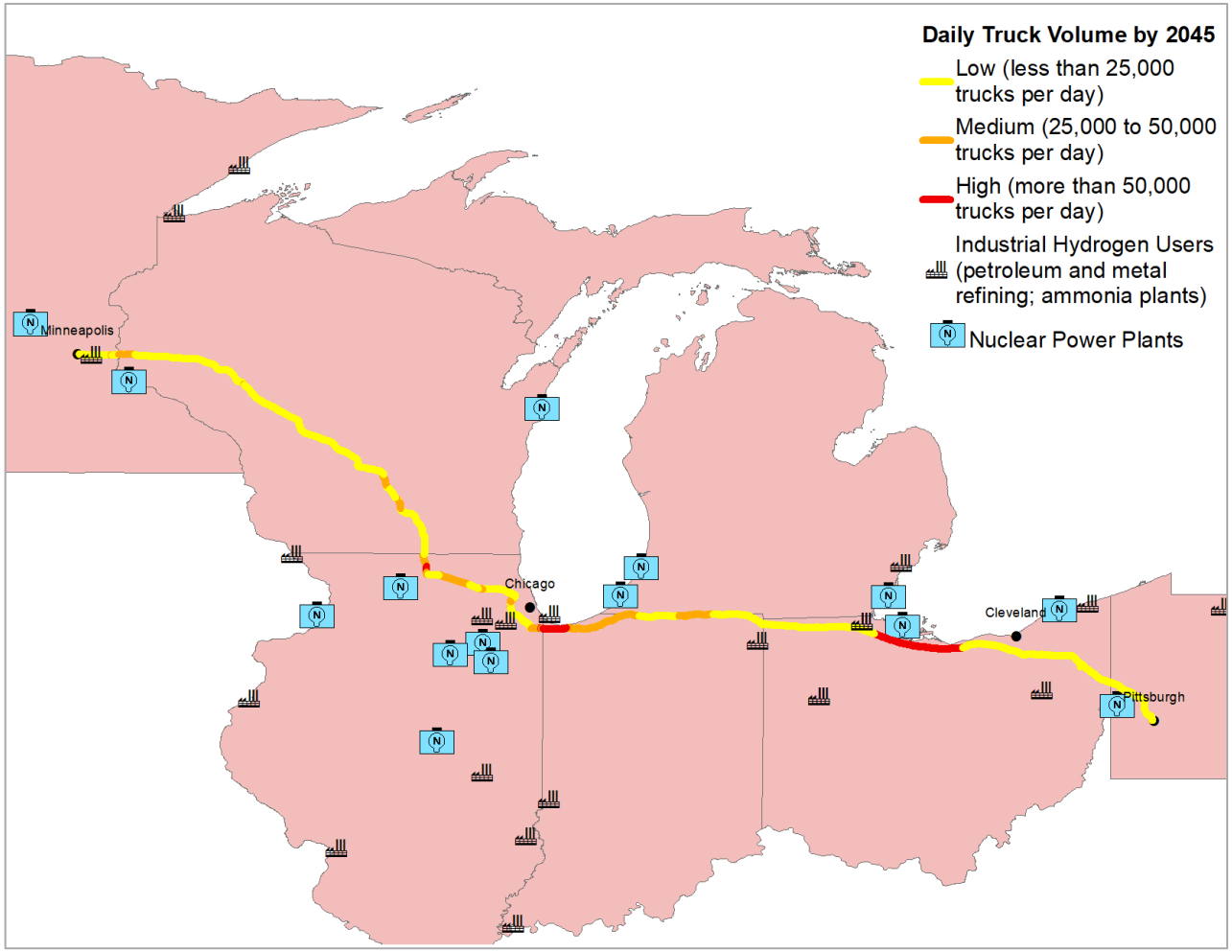
Potential Demanders and Nuclear Fleet Suppliers of Hydrogen in the Midwest



"How the Midwest Can Lead the Hydrogen Economy" (2020). https://engagedscholarship.csuohio.edu/urban_facpub/1656