IEc

Estimating the Economic Resiliency Benefits of Community Microgrids

Study Sponsored by:
NY Prize Program
NYSERDA

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Presentation Overview

- Study Background and Objectives
- Overview of Economic Impact Analysis
- Pilot Test Approach and Results
- Model Demonstration
- Discussion

Study Background

- Power outages can have a variety of social and economic consequences:
  - Access to critical services
  - Human health and safety
  - Disruptions to business activity, transportation, and communications
- In 2014, the NY State Governor’s Office of Storm Recovery announced a $17 billion strategy to enhance the ability of infrastructure to withstand severe weather events.
- NY Prize - $40 million competition to support development of community microgrids.
- IEc worked with NYSERDA to develop tools and methods to help evaluate costs and benefits of candidate microgrid projects.

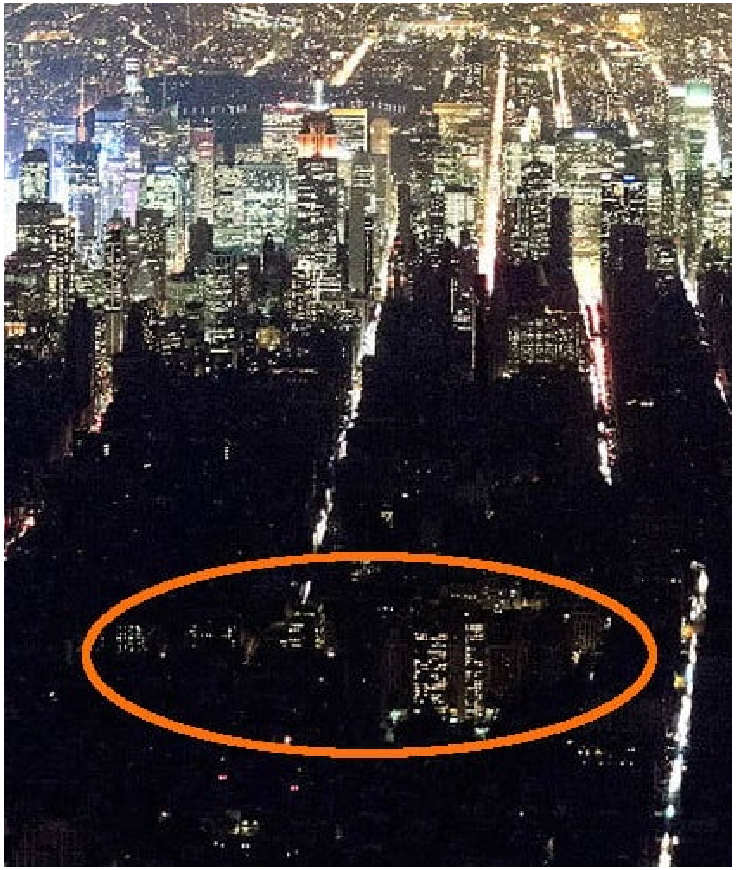


Photo Credit: Engineering News

Study Objectives

- Methods and studies exist valuing the resiliency benefits:
  - Energy generation and capacity cost savings
  - Reliability improvements
  - Avoided environmental damages
  - Social welfare benefits
- EPRI (2017) identified methods for providing additional perspective on resiliency benefits, including economic impact modeling (e.g., employment, sales, GDP, etc.).
- This study focused on developing and pilot testing methods to evaluate the potential regional economic benefits of a microgrid in sustaining economic activity during an extended outage.

Economic Impact Analysis

- Economic impact analysis measures changes in economic activity.
- Metrics are indicators of economic productivity presented either by sector or in the aggregate across a specified region, including:
  - Economic output (revenue)
  - Value-added (GDP)
  - Income
  - Employment
  - Tax impacts
- Economic impact models estimate the **multiplier effects** (ripple effects) associated with a “shock” to an economy. The multiplier effects reflect impacts to multiple economic sectors that are linked through the supply chain.

General Approach for Pilot Test

1. Select project for pilot test
2. Define outage scenario
3. Estimate direct impacts (inputs to IMPLAN model)
4. Employ IMPLAN model to calculate multiplier effects
5. Outage scenario modeling options
6. Interpret results:
   - Uncertainty
   - Scalability
   - Transferability

Pilot Study Site: Rockville Centre (Nassau County, NY)

Facilities served by the RVC project support at least 8,000 employees and $1.2 billion in annual output

Facility Type	Number in Microgrid
Non-EMS Medical	5
Hospital and EMS Medical	11
Government	4
Police	1
Fire	2
Water	3
Commercial	519
Traffic Signals	15
Residential	2,962

Photo Credit: rvcny.gov

Scenario Development

Model 3, 5, and 7-day outages as the likely impact of a major storm

SIMPLE REPRESENTATION:

Without the microgrid: Assume 100% loss in economic activity during an outage

With the microgrid: Assume the facilities would retain full service and continue operations

IMPLAN Model

- I/O Model: IMpact Analysis for PLANning (**IMPLAN**)
- Regional impact model commonly used by state and federal agencies for policy planning and evaluation purposes
- Also commonly applied in power outage literature
- Draws upon BEA and BLS data, among other sources
- Translates changes in expenditures into changes in demand for inputs from interrelated industries
- Functions are linear, results are scalable

Modeling Approach

MODEL INPUT

- **Direct effects:** Changes in economic activity by particular industry as a result of a change in demand for (i.e., sales of) the goods and services the industry provides.

MODEL OUTPUT

- **Indirect effects:** Changes in the output of industries that supply goods and services to those industries directly affected.
- **Induced effects:** Changes in household consumption arising from changes in employment and associated income that result from direct and indirect effects.

Metrics:

- Employment
- Labor Income
- Value Added
- Output

IMPLAN Inputs

Inputs calculated as **changes in output** for affected businesses:

Data Sources:

- **U.S. Census data for Nassau County:** Assign commercial businesses to economic sectors. This assumes the distribution of commercial activity county-wide is representative of RVC.
- **IMPLAN data:** Total annual output and employment for affected sectors.

Assumptions:

- Estimate daily economic activity assuming economic activity evenly distributed over time.
- For simple representation model, assume total loss of this contribution (i.e., a complete shutdown of affected facilities during a 1-day outage).
- Scale results for the 3, 5, or 7-day outage.

Economic Impacts of a 1-Day Outage, 100% Economic Activity Loss

Study Area (Nassau County):

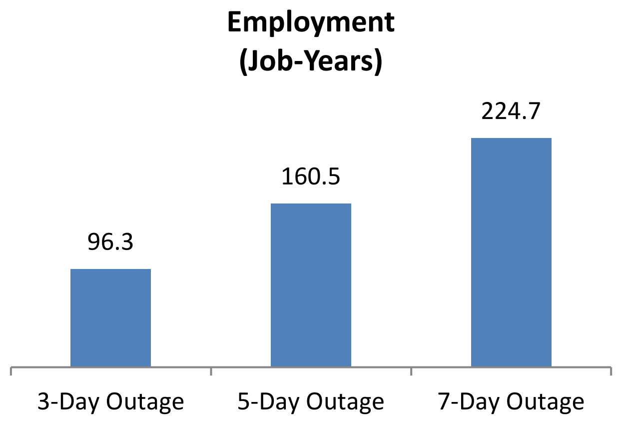
Impact Type	Average Annual Employment (Job-Years)	Labor Income	Total Value Added	Output
Direct Effect	18.5	$1,016,028	$1,801,497	$2,878,631
Indirect Effect	7.0	$416,186	$704,062	$1,188,481
Induced Effect	6.6	$354,718	$618,039	$965,535
Total Effect	**32.1**	**$1,786,932**	**$3,123,597**	**$5,032,647**

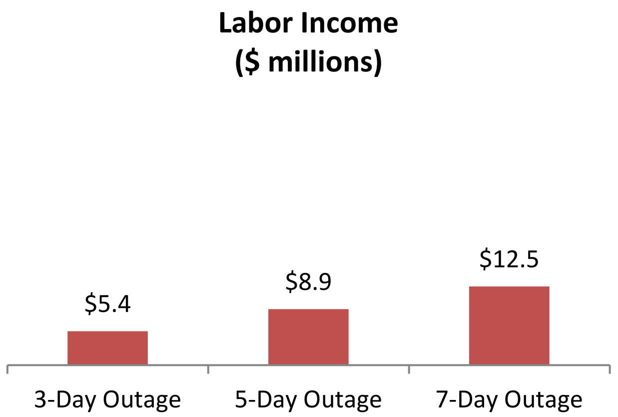
Rest of NY State:

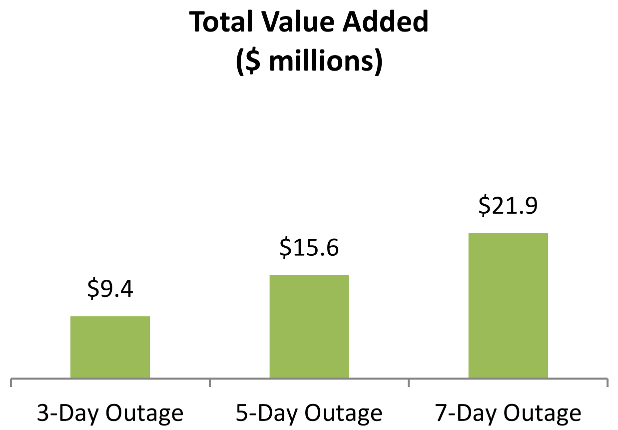
Impact Type	Average Annual Employment (Job-Years)	Labor Income	Total Value Added	Output
Direct Effect	0.0	$0	$0	$0
Indirect Effect	0.7	$66,929	$115,424	$198,470
Induced Effect	0.5	$32,837	$56,923	$94,020
Total Effect	**1.2**	**$99,766**	**$172,348**	**$292,490**

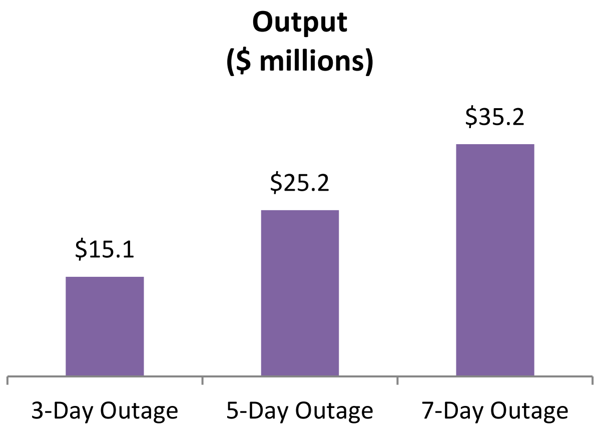
Scaled Results for Additional Outage Scenarios

Total impacts for 3, 5, and 7-day outages, assuming 100% economic activity loss:









Outage Scenario Modeling Options

- Do not have to assume 100% economic activity loss for the entire outage.

- To reflect outage scenario, break outage into multiple "outage periods," with each period having a unique:

  Recovery Factor = % of all businesses with power.

  Resiliency Factor = % of normal economic output maintained by businesses without power OR % of lost economic output businesses can recover following the outage event.

- Each outage period can then be assigned an overall economic activity level.

  Overall Economic Activity Level = % Recovery + [% Resiliency * (1 - % Recovery)]

Overall Economic Activity Level

		Resiliency Factor										
		0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
Recovery Factor	0%	0%	10%	20%	30%	40%	50%	60%	70%	80%	90%	100%
	10%	10%	19%	28%	37%	46%	55%	64%	73%	82%	91%	100%
	20%	20%	28%	36%	44%	52%	60%	68%	76%	84%	92%	100%
	30%	30%	37%	44%	51%	58%	65%	72%	79%	86%	93%	100%
	40%	40%	46%	52%	58%	64%	70%	76%	82%	88%	94%	100%
	50%	50%	55%	60%	65%	70%	75%	80%	85%	90%	95%	100%
	60%	60%	64%	68%	72%	76%	80%	84%	88%	92%	96%	100%
	70%	70%	73%	76%	79%	82%	85%	88%	91%	94%	97%	100%
	80%	80%	82%	84%	86%	88%	90%	92%	94%	96%	98%	100%
	90%	90%	91%	92%	93%	94%	95%	96%	97%	98%	99%	100%
	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%

Outage Scenario Modeling Options (Cont.)

- Developed a spreadsheet tool that facilitates modeling of different outage scenarios.
- The tool calculates a **weighted average economic activity loss** based on the duration and overall economic activity level (EAL) for each outage period.

$$\text{Weighted Average Economic Activity Loss} = \Sigma\ [\text{Duration} * (1 - \%\ \text{EAL})]$$

Outage Period	Outage Duration (Days)	% Overall Economic Activity Level	% Recovery Factor	% Resiliency Factor
#1	3	0%	0%	0%
#2	2	50%	50%	0%
#3	2	63%	50%	25%
Total	**7**	--	--	--

4.75	Weighted Average Economic Activity Loss (Days)

Scenario Results – Sensitivity Analysis

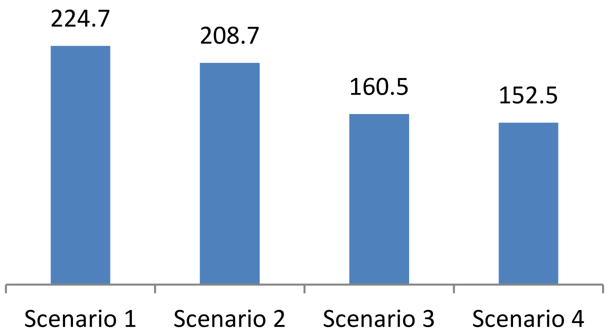
Sensitivity analysis for 7-day outage, assuming:

Outage Scenario	Weighted Average Economic Activity Loss (Days)	Description
Scenario 1	7.00	Assume 100% economic activity loss.
Scenario 2	6.50	Assume after five days, 25% resiliency factor.
Scenario 3	5.00	Assume after three days, 50% recovery factor.
Scenario 4	4.75	Assume after three days, 50% recovery factor; and after five days, 25% resiliency factor.

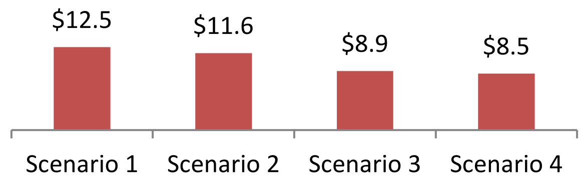
Scenario Results – Sensitivity Analysis (Cont.)

Total impacts for 7-day outage scenarios (study area):

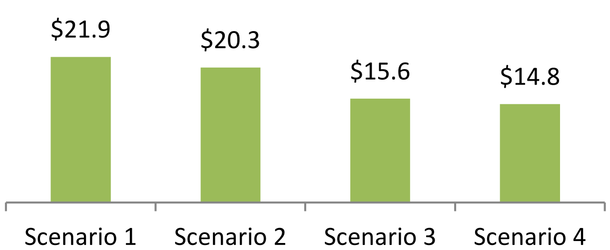
Employment (Job-Years)



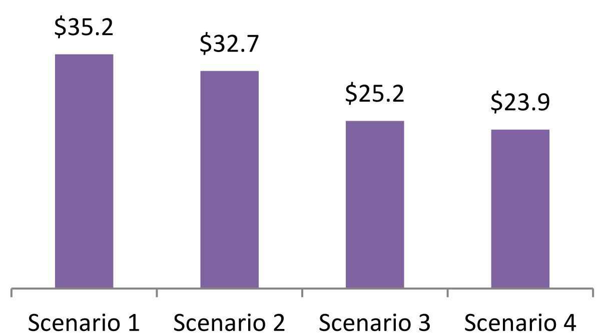
Labor Income ($ millions)



Total Value Added ($ millions)



Output ($ millions)



Lessons Learned

- **Characterization of affected businesses:**
  - Focus is on commercial and industrial business as opposed to government institutions and critical services (fire, police).
  - Ideally rely on data on specific economic sectors of the facilities served by the microgrid.
- **Assumptions regarding proportionality of losses:**
  - Approach assumes economic productivity for businesses is distributed evenly over time and that productivity losses are proportional to the duration of an outage.
  - Model can build in flexibility to integrate resiliency and recovery factors; however, data are limited to inform the assumptions for these factors.
- **Assumptions regarding efficacy of microgrid in avoiding outages:**
  - Case study assumes microgrid would avert outages and economic losses.

Opportunities

- Method is replicable.
- Most useful for site that support commercial and industrial enterprises.
- Flows of dollars in markets and jobs are relatively straightforward metrics that the general public understands.
- Modeling approach is flexible in accounting for uncertainty with respect to resiliency and recovery factors. However, additional research on resiliency factors by sector would improve the analysis.

Acknowledgements

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