

# Energy Storage – Keeping the Lights On in Michigan

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**Consumers Energy**

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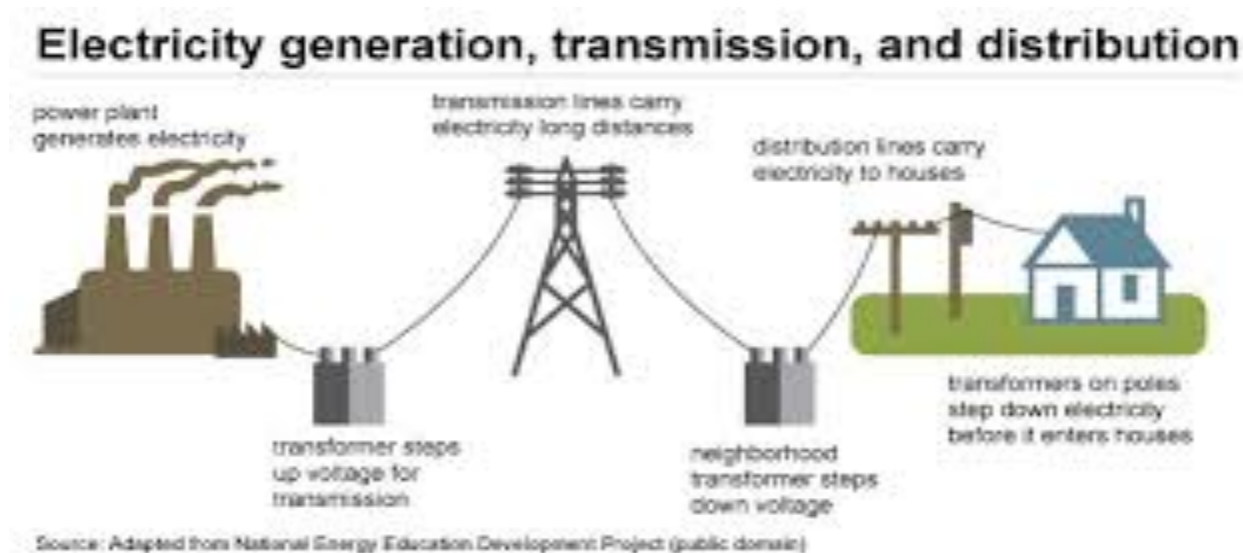
# 2003 Eastern US "Blackout"

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# Electricity Basics

- **Historically, every demand for electricity (e.g., light bulb, motor on) requires an operating generator/wires. Limited to no storage use.**



- **Voltage, frequency maintained in tight bands**
- **1st Energy Storage – Benjamin Franklin - 1748**

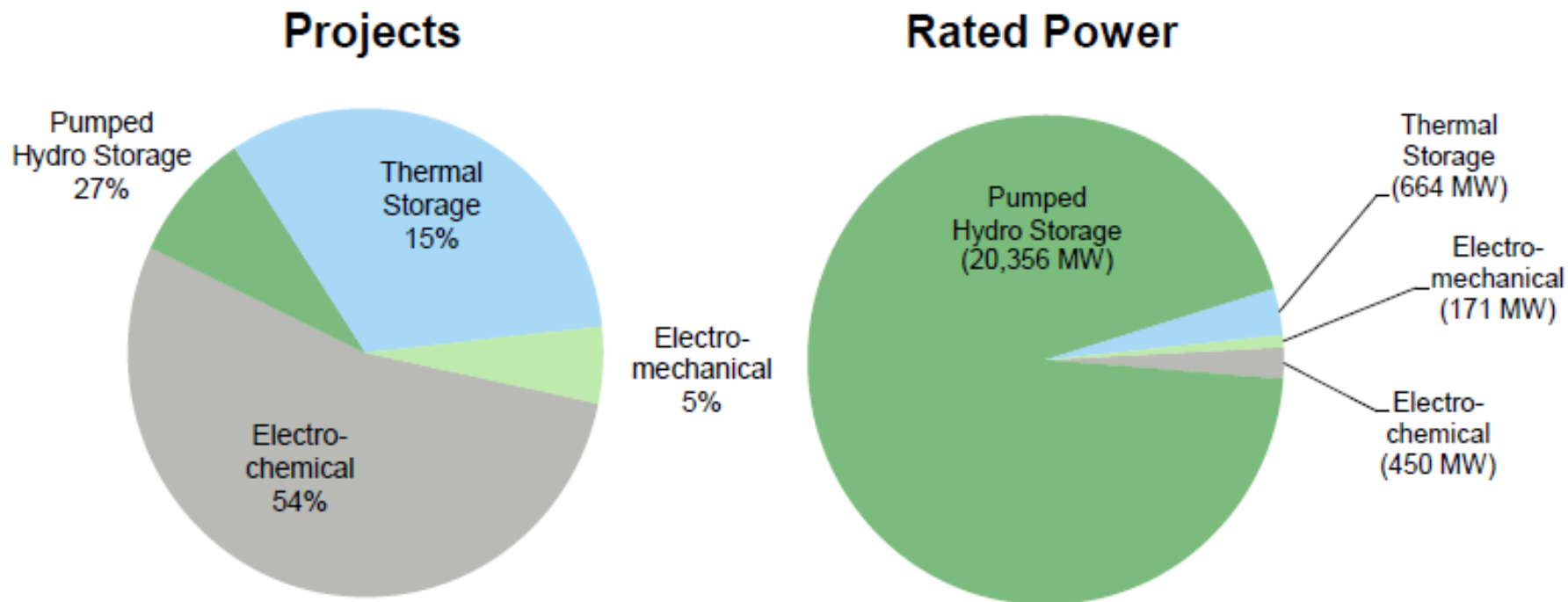
# What is “Energy Storage”?

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- **Technologies that can defer or store produced energy until demanded later:**
  - **Batteries (“*electrochemical*”)**
  - **Thermal Storage (*ice, hot water, CSP*)**
  - **Hydroelectricity (ponds at dam sites)**
  - **Pumped Storage Hydroelectricity**
  - **Compressed Air, Flywheels (“*electromechanical*”)**
  - **Others (supercapacitors, SMES)**
  
- **Why?**

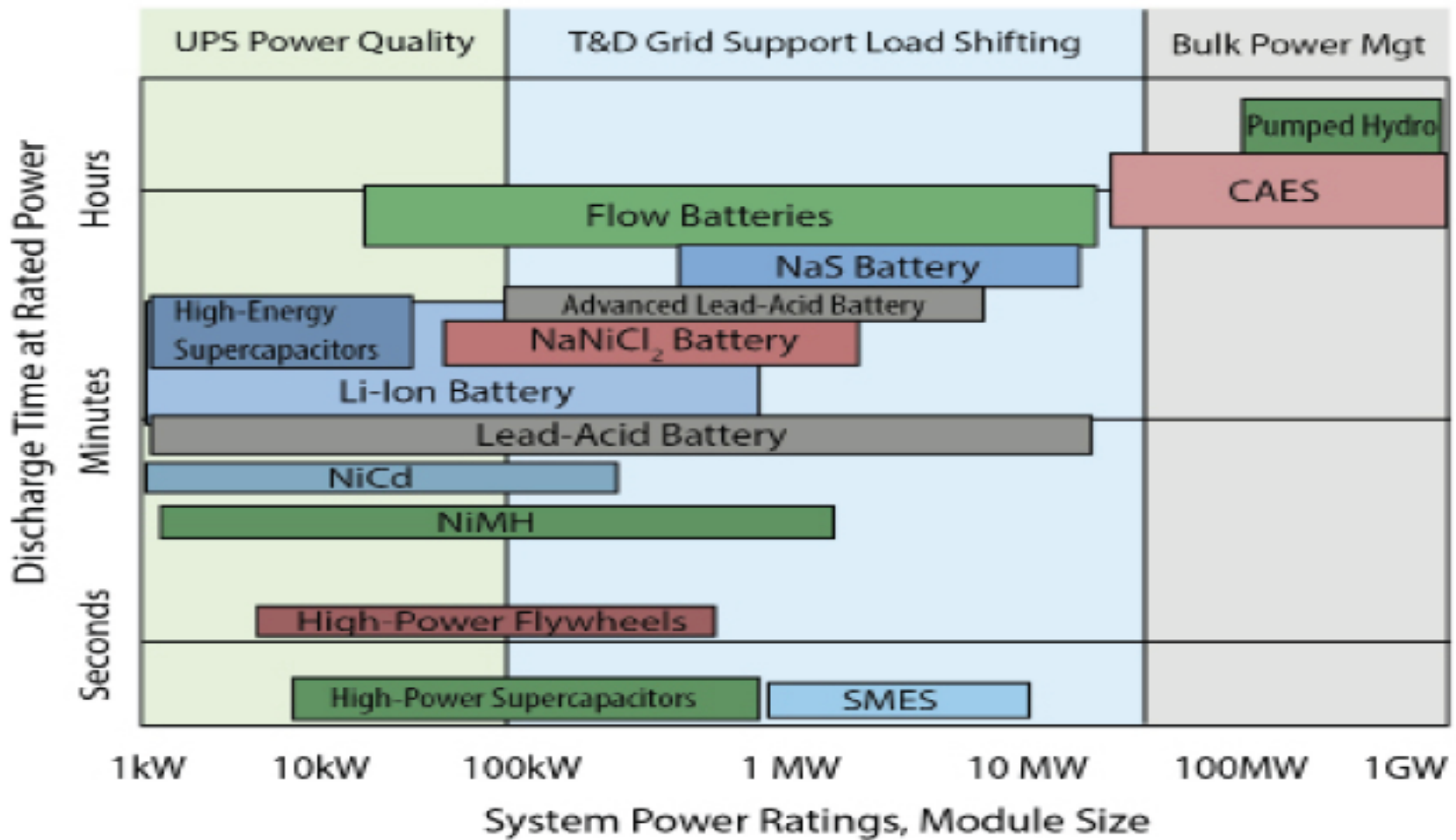
# Current Energy Storage Balance

U.S. Energy Storage Projects by Technology Type in 2016  
(Including Announced Projects)



Source: U.S. Department of Energy, "Global Energy Storage Database", 2016

# Energy Storage – Use Cases\*



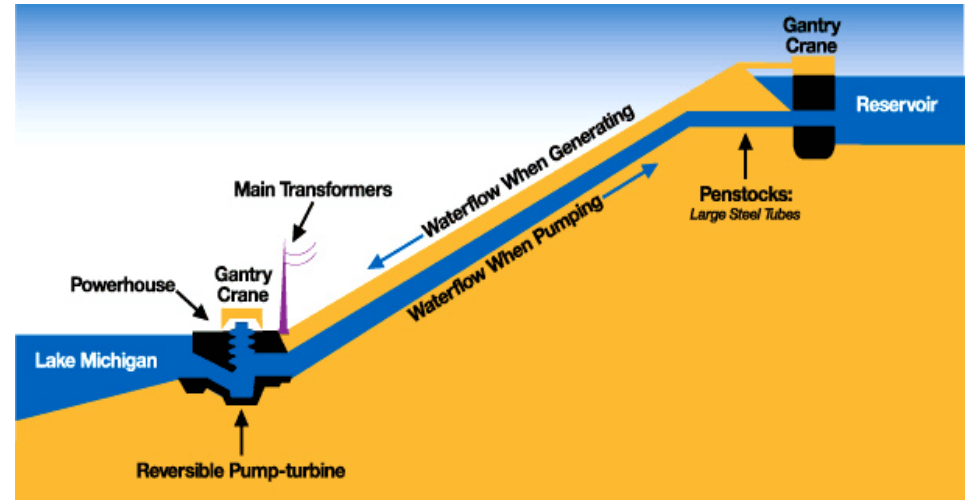
Source: Sandia National Laboratories



# Large Scale Energy Storage – Panacea?

## Pumped hydro (PHS)

- **94% of total US Storage Capacity**
- **Bath County in VA at 3003 MW is world's largest; Ludington will soon be #4**
- **Annually, PHS generates (net) -5.501 GWh in US**



# Michigan's Power Participants

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- **Generators:**
  - + Utilities
  - + Municipalities/Cooperatives
  - + Independent Power Producers/Choice
  - + Industrials
- **Transmission Owner – ITC\***
- **Distribution Owners (LSEs):**
  - + Utilities
  - + Municipalities/Cooperatives
- **Regulator:** Public Service Commission
- **Markets\*\*:** MISO, PJM

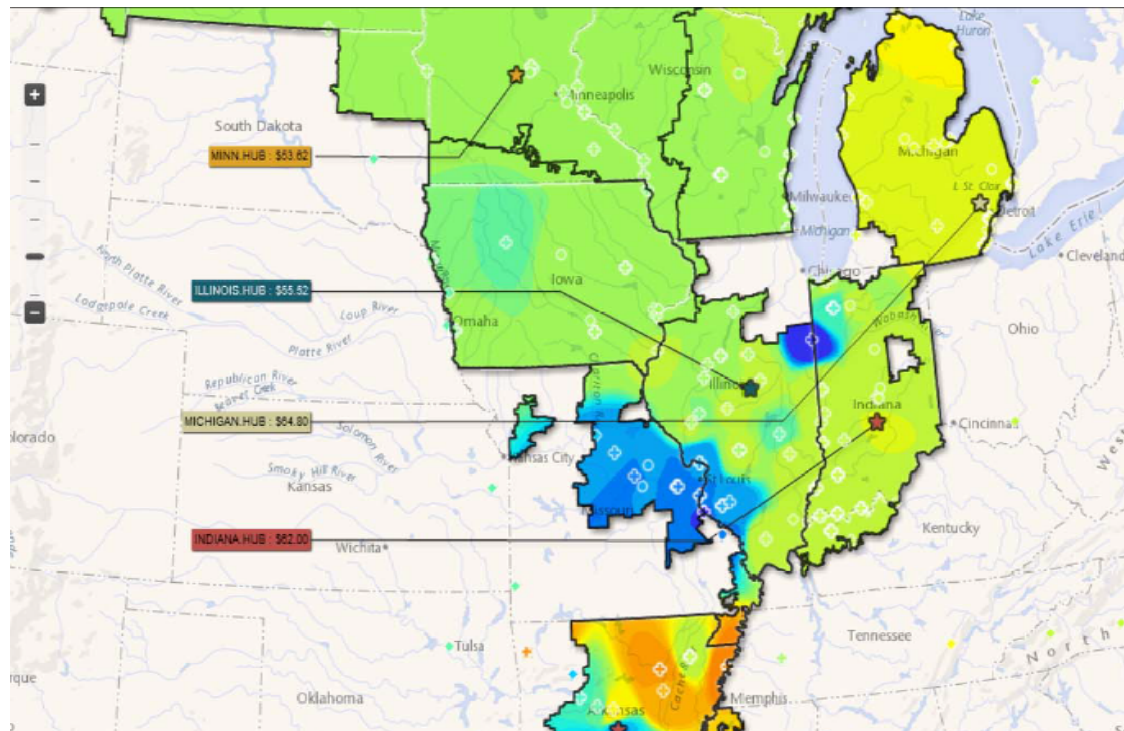
\* Transmission separated under MI Public Act 141 of 2000

\*\* By Federal Energy Regulatory Commission (1996); MISO Markets and responsibility for reliability/reserves began on April 1, 2005



# MISO Grid Marketplace Basics

- **Generators** sell power to MISO (some power sold via PPA's to utilities) on day-ahead, real time, and ancillary basis
- **LSEs** buy power to meet customer needs from MISO



# Grid Energy Storage in MISO, Others

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- Primary ES Assets Built in MISO:
  - + Ludington PHS – 1,872 MW (1973)
  - + AES Battery Storage Project in Indianapolis – 20 MW (2016)
- Energy Storage Markets robust in CA, PJM Service Territory, ISO-NE, others. Not MI
- What's the Cause?
  - + Valuation of Attributes (MISO places low value on ancillary service; batteries costly for only “energy”)
  - + Increasing Benefits from Batteries (multiple Use Cases expanding)

# Why ES?

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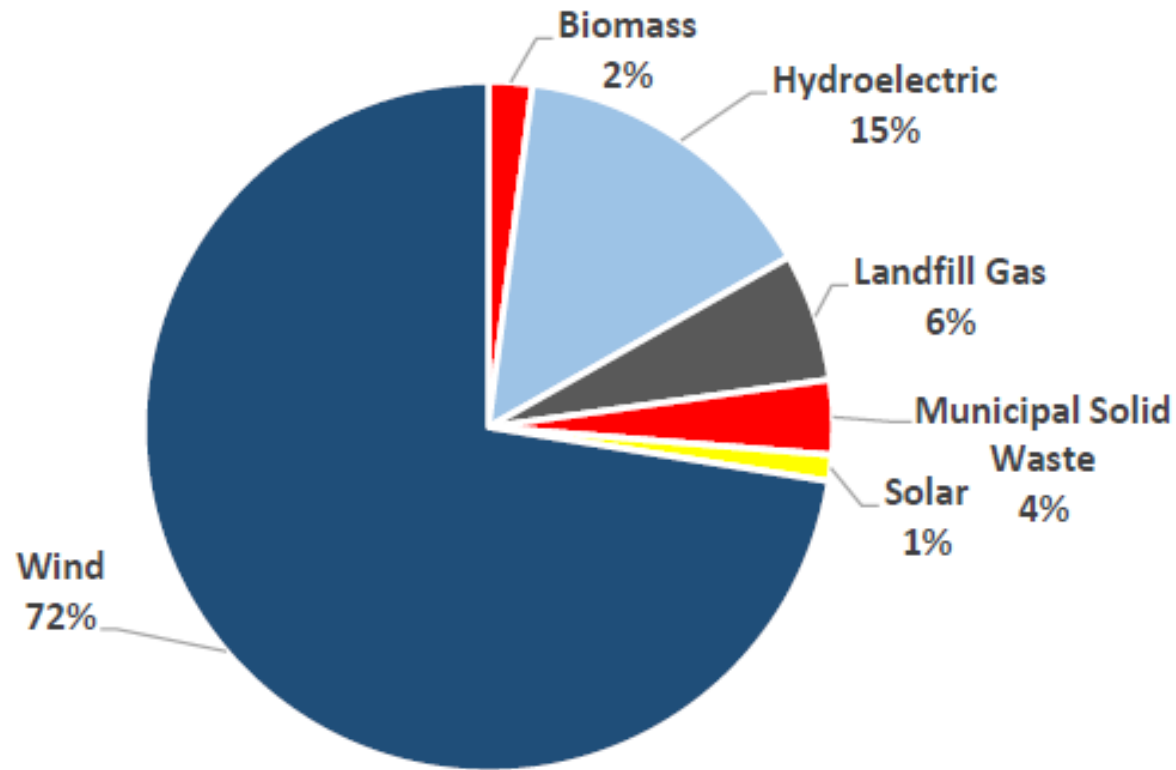
- Reliability and Resilience to Delivered Power
- Grid Benefits
- Behind-the-meter benefits (microgrids)
- Renewables benefits
- Energy waste reduction benefits



While WTGs and PV panels are visible, ES containers at nearby substations are not!



# MI Renewable Energy (2016 Data)



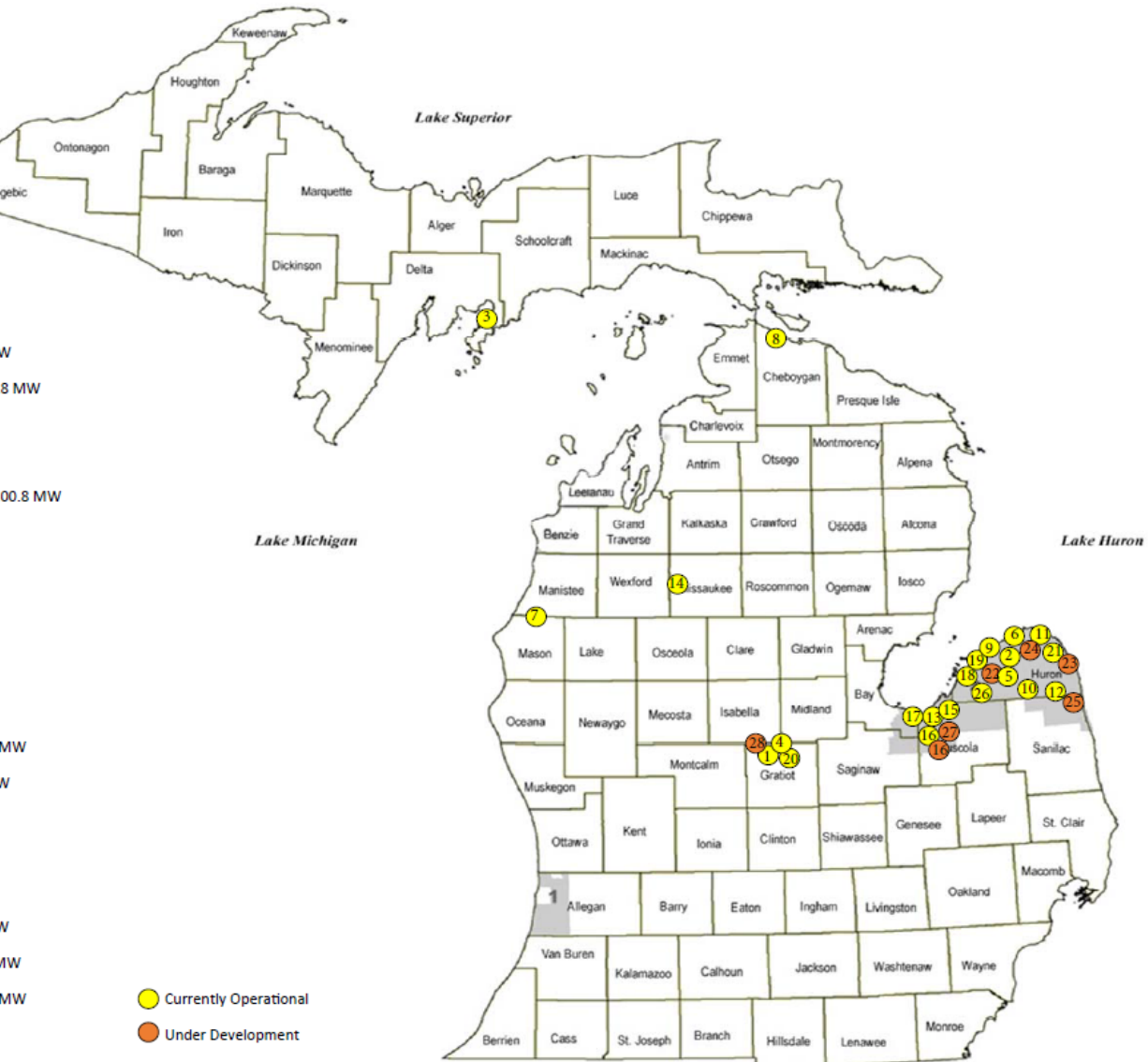
74% of nominally 2,500 MW total are “intermittent”; ES can smooth

Source: MPSC, “2017 Report on Implementation of PA 295”

# Location of MI Renewables

- 23 Apple Blossom, 100 MW
  - 1 Beebe Wind, 81 MW
  - 21 Beebe 1B, 50.4 MW
  - 21 Big Turtle, 20 MW
  - 23 Big Turtle II, 30 MW
  - 19 Brookfield, 74.8 MW
  - 16 Crosswinds, 105 MW
  - 16 Crosswinds II, 44 MW
  - 24 Deerfield Wind, 150 MW
  - 2 Echo Wind, 112 MW
  - 3 Garden Wind Farm, 28 MW
  - 4 Gratiot County Wind, 212.8 MW
  - 5 Harvest I Wind, 52.8 MW
  - 6 Harvest II Wind, 59.4 MW
  - 7 Lake Winds Energy Park, 100.8 MW
  - 8 Mackinaw City, 1.8 MW
  - 9 McKinley, 14.4 MW
  - 10 Michigan Wind I, 69 MW
  - 11 Michigan Wind II, 90 MW
  - 25 Michigan Wind III, 153
  - 12 Minden, 32 MW
  - 18 Pheasant Run Wind, 74.8 MW
  - 28 Pine River Wind, 161.3 MW
  - 26 Pinnebog, 51 MW
  - 15 Sigel, 64 MW
  - 14 Stoney Corners, 60 MW
  - 13 Tuscola Bay Wind, 120 MW
  - 17 Tuscola Bay Wind II, 100 MW
  - 27 Tuscola Bay Wind III, 125 MW
- 1574 MW Total Operational

● Currently Operational  
● Under Development



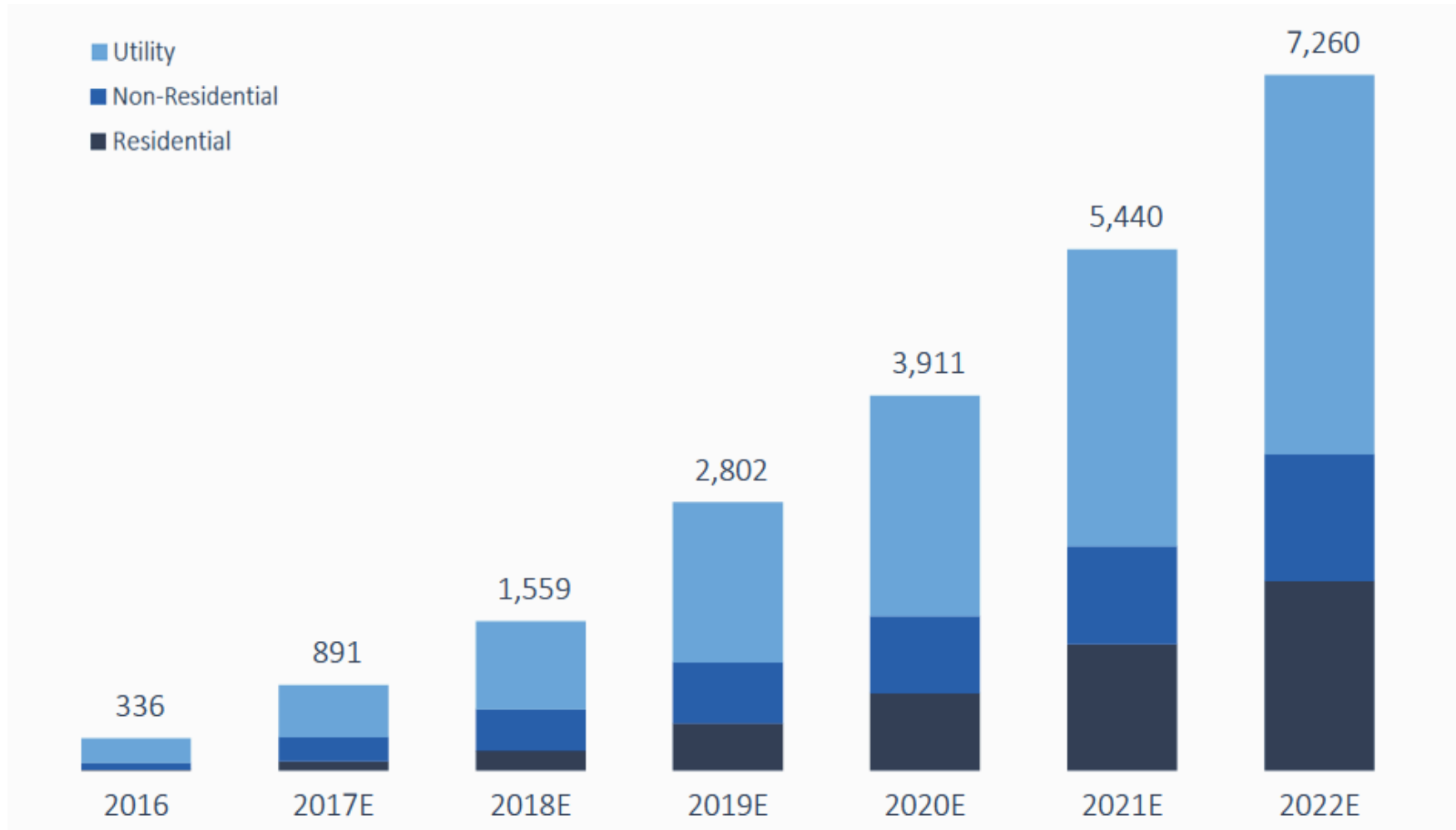
# MI Energy Waste Reduction

- Also termed “energy efficiency”
- Per Michigan Agency for Energy, utilities and state have saved over \$4 billion since 2008 via “waste reduction”
- Significant potential – utilities focused on economical/incremental savings
- ES can be used:
  - + Demand response
  - + DG/Microgrids
  - + Others

Types of Energy Efficiency Potential

|                          |                     |                            |                      |
|--------------------------|---------------------|----------------------------|----------------------|
| Not Technically Feasible | Technical Potential |                            |                      |
| Not Technically Feasible | Not Cost-Effective  | Economic Potential         |                      |
| Not Technically Feasible | Not Cost-Effective  | Market & Adoption Barriers | Achievable Potential |

# Energy Storage Growth



Source: GreenTech Media (GTM)(2017)



# Where Are We Headed?

- DTE, CEC both using “pilot projects” to evaluate benefits and gain experience.
- Value proposition today limited, but many specific ES use cases make sense (microgrids, renewables smoothing, T&D deferral)
- “Keeping the lights on” critical to MI; projects which make sense (e.g., Ludington, microgrid), support technology gains (e.g., EHV), enhance grid resilience (e.g., smart grid), & enhance quality of life to residents/business, and climate.



# Concluding Remarks

- Please contact me or Consumers Energy with any questions you might have!
- Please take advantage of opportunity to visit our Innovation Center in Jackson!

**Thank you!**

