Engineering Michigan's Future 2017

MSPE Annual Conference

Energy Storage – Keeping the Lights On in Michigan

Chuck Hookham, PE

May 5, 2017

Consumers Energy

Count on Us®

2003 Eastern US “Blackout”

Electricity Basics

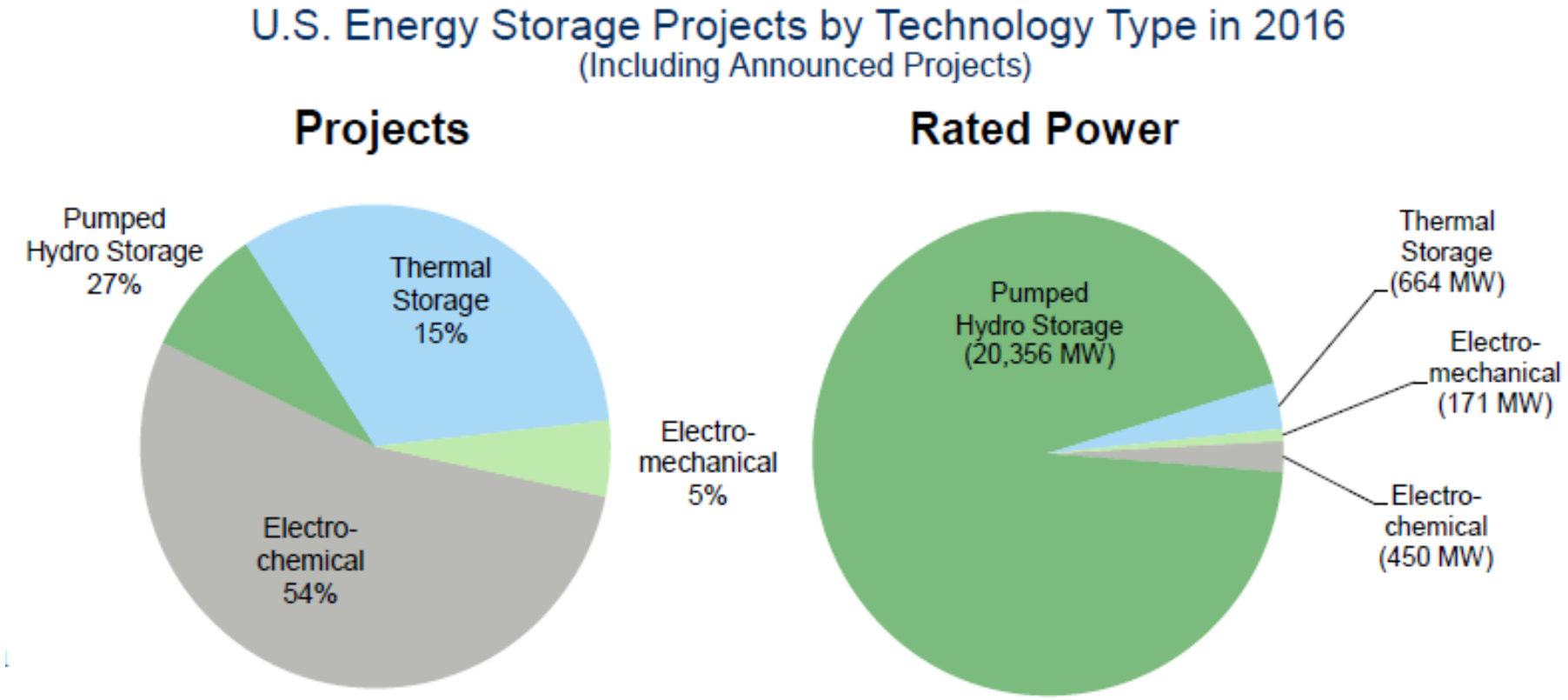
- **Historically, every demand for electricity (e.g., light bulb, motor on) requires an operating generator/wires. Limited to no storage use.**

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

What is "Energy Storage"?

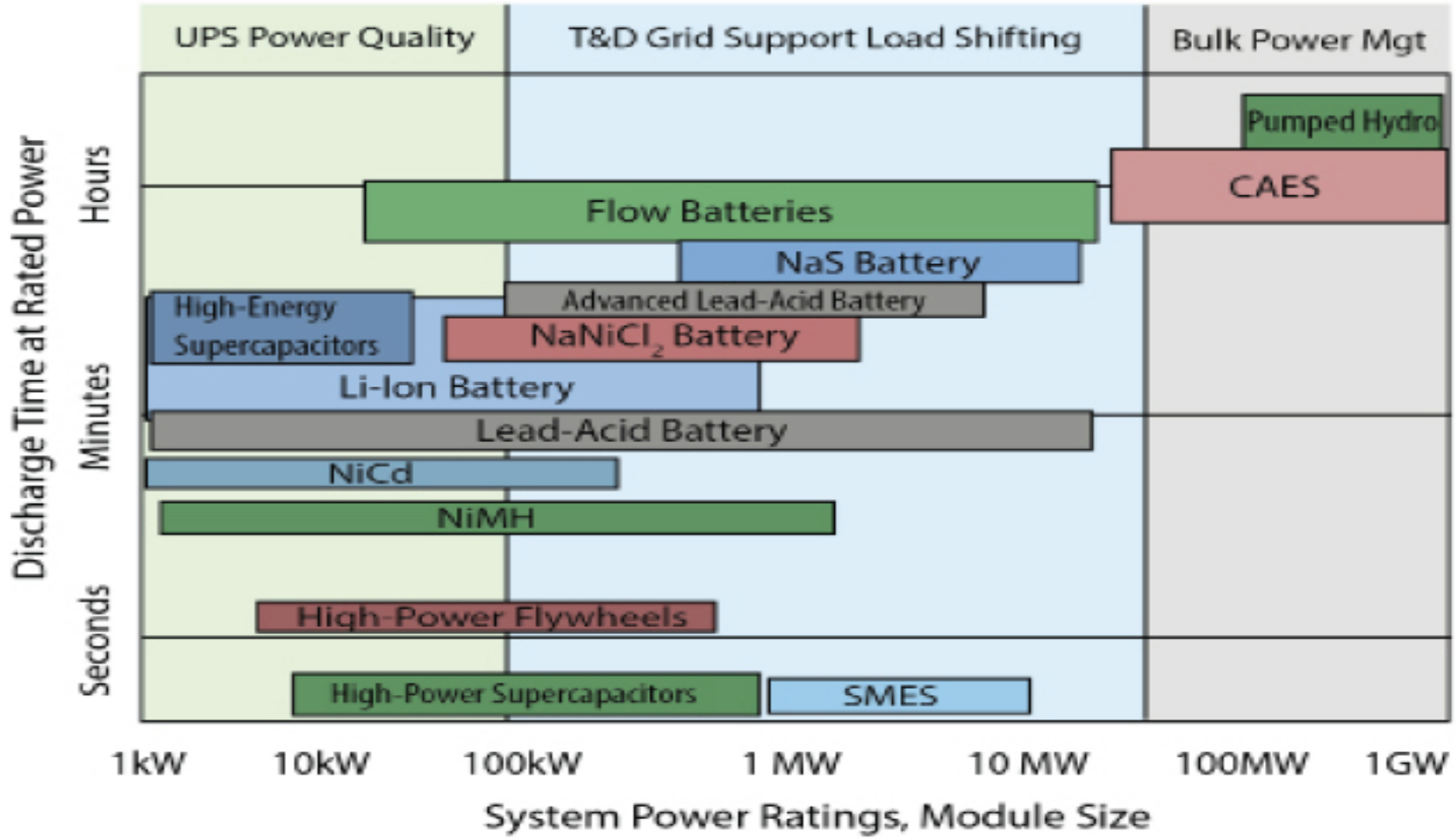
- **Technologies that can defer or store produced energy until demanded later:**
  - **Batteries ("*electrochemical*")**
  - **Thermal Storage (*ice, hot water, CSP*)**
  - **Hydroelectricity (ponds at dam sites)**
  - **Pumped Storage Hydroelectricity**
  - **Compressed Air, Flywheels ("*electromechanical*")**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

Current Energy Storage Balance



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

Energy Storage – Use Cases*

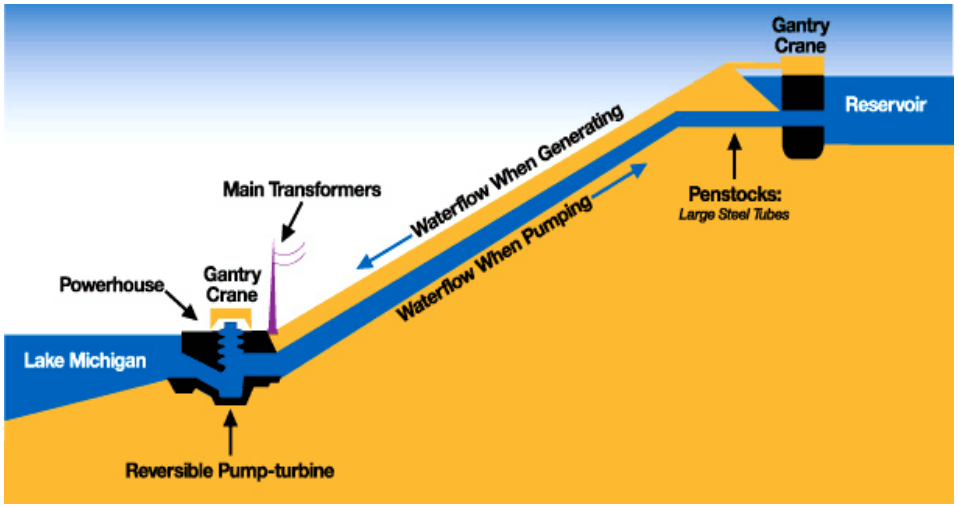


Source: Sandia National Laboratories

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

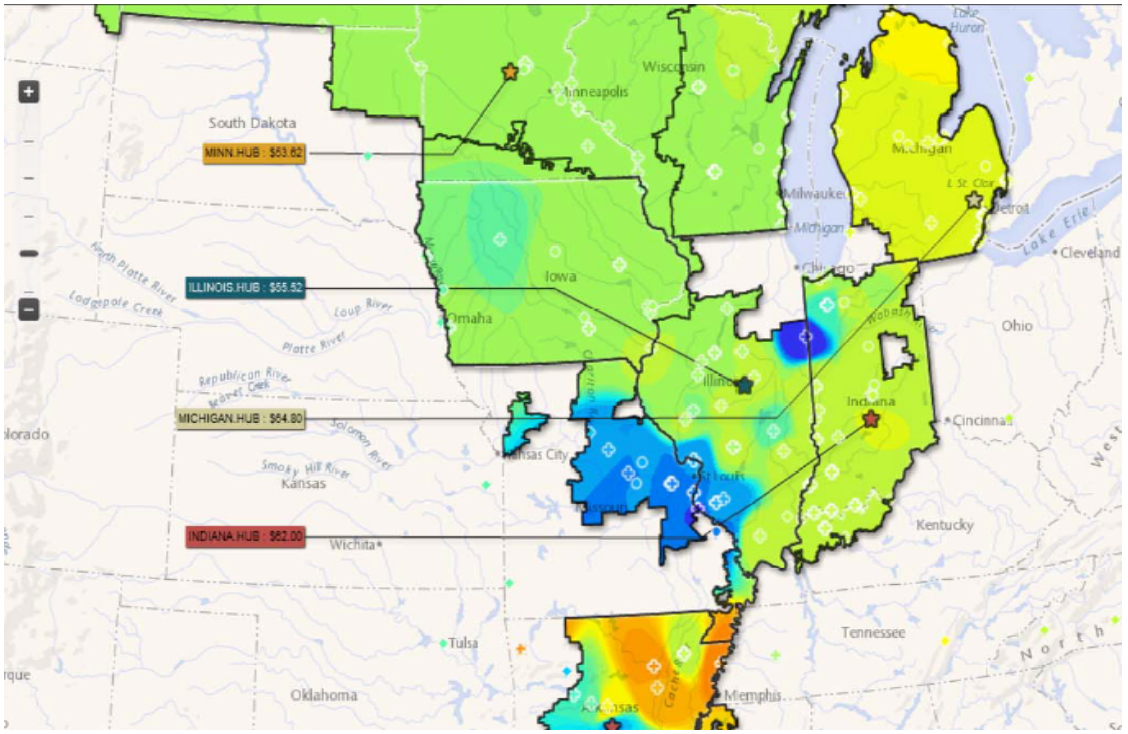
- **Generators:**
  - + Utilities
  - + Municipalities/Cooperatives
  - + Independent Power Producers/Choice
  - + Industrials
- **Transmission Owner** – ITC*
- **Distribution Owners (LSEs):**
  - + Utilities
  - + Municipalities/Cooperatives
- **Regulator:** Public Service Commission
- **Markets**:**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

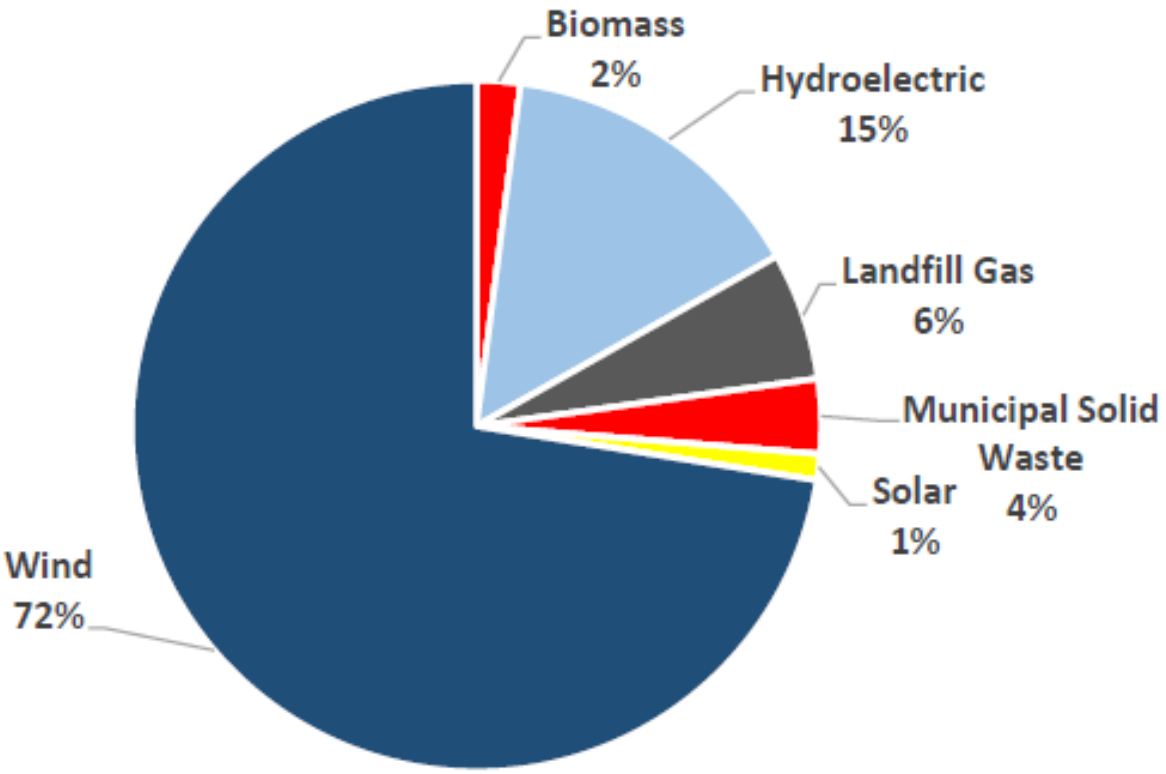
- Primary ES Assets Built in MISO:
  - + Ludington PHS – 1,872 MW (1973)
  - + AES Battery Storage Project in Indianapolis – 20 MW (2016)
- Energy Storage Markets robust in CA, PJM Service Territory, ISO-NE, others. Not MI
- What's the Cause?
  - + Valuation of Attributes (MISO places low value on ancillary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

Why ES?

- 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!

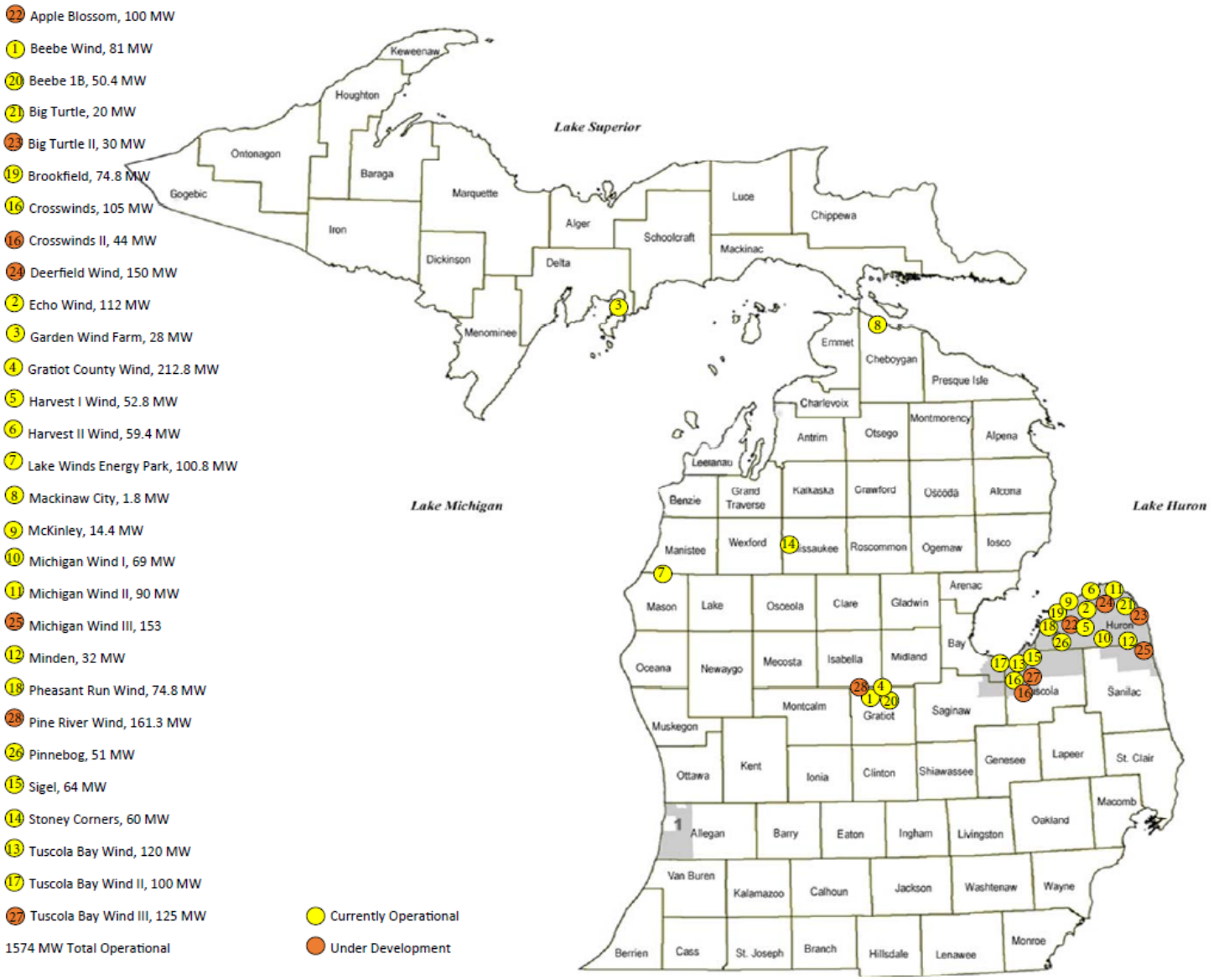
MI Renewable Energy (2016 Data)



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

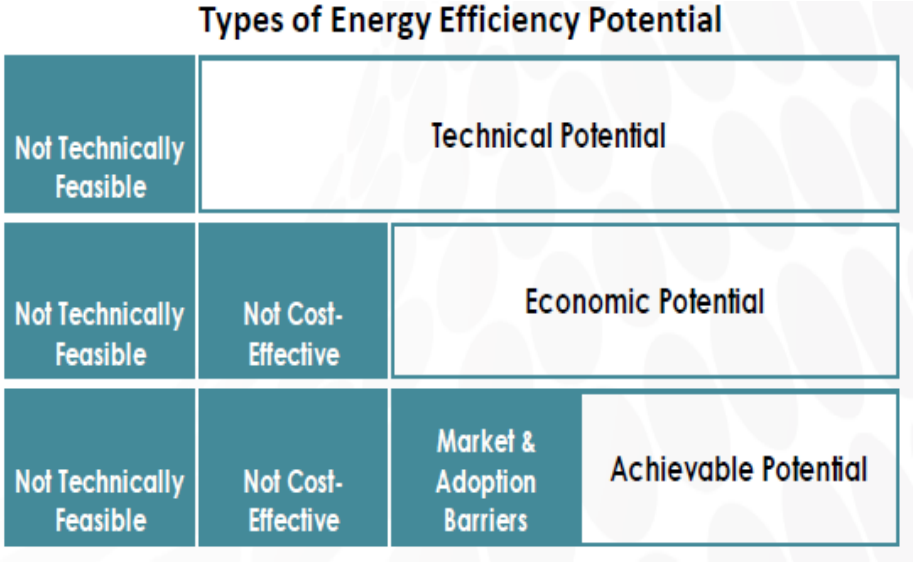
Source: MPSC, "2017 Report on Implementation of PA 295"

Location of MI Renewables

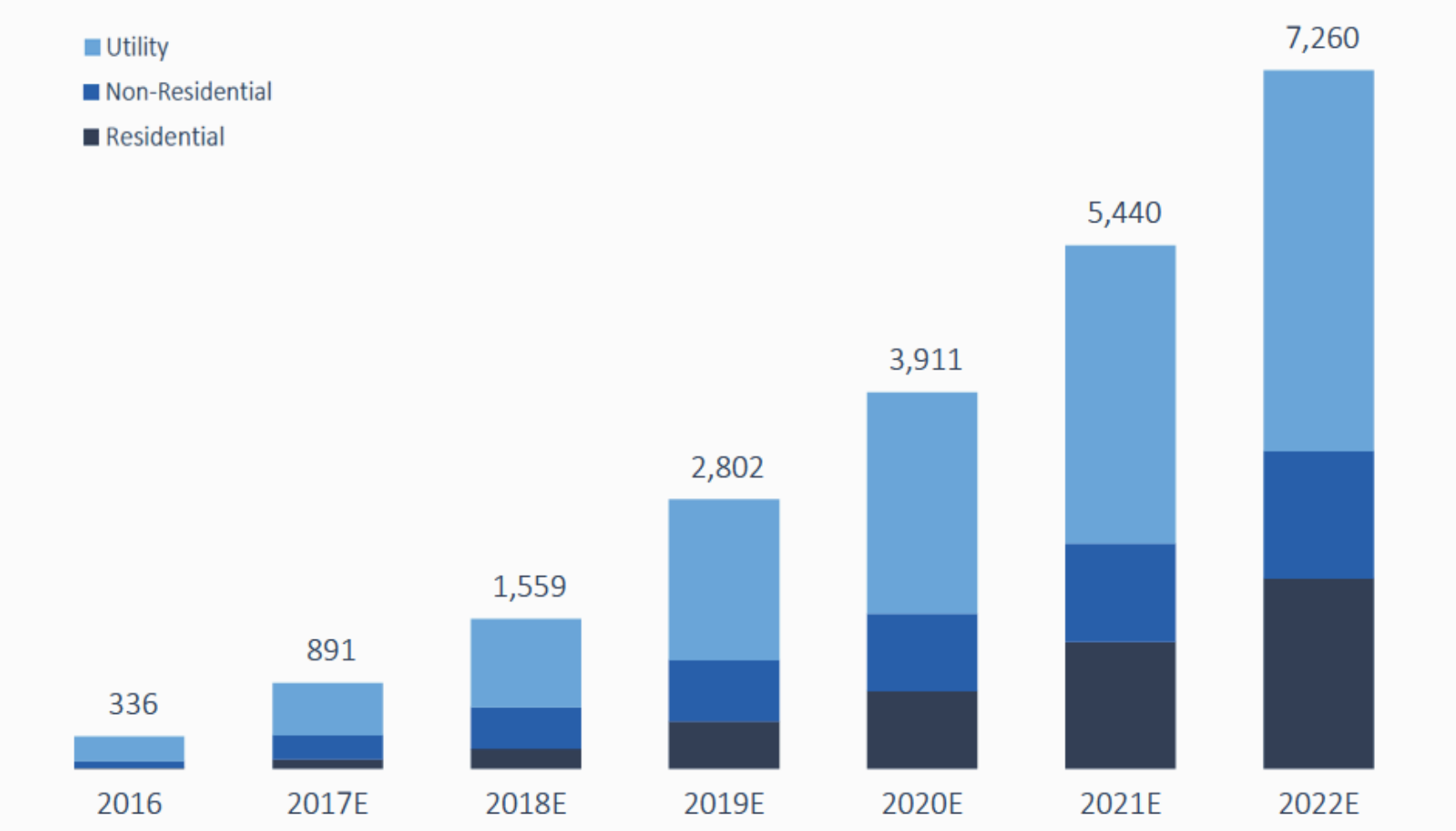


MI Energy Waste Reduction

- 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



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., EHVs), 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!