

Michigan State University's Energy Transition Plan for a Sustainable Green Energy Future

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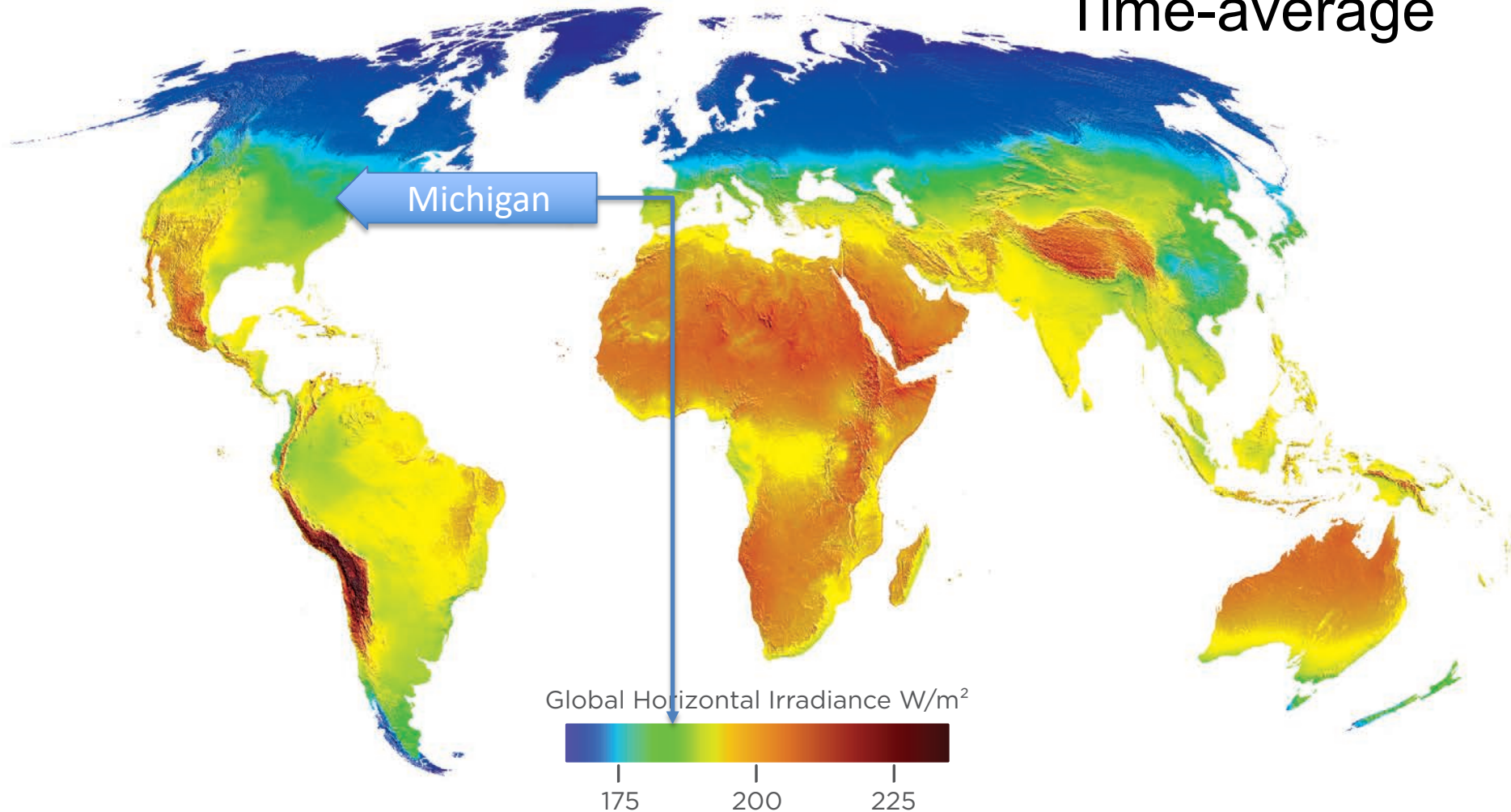
The Energy And Environment Foundation
Global Water Award 2020
November 10, 2020 | Delhi-India



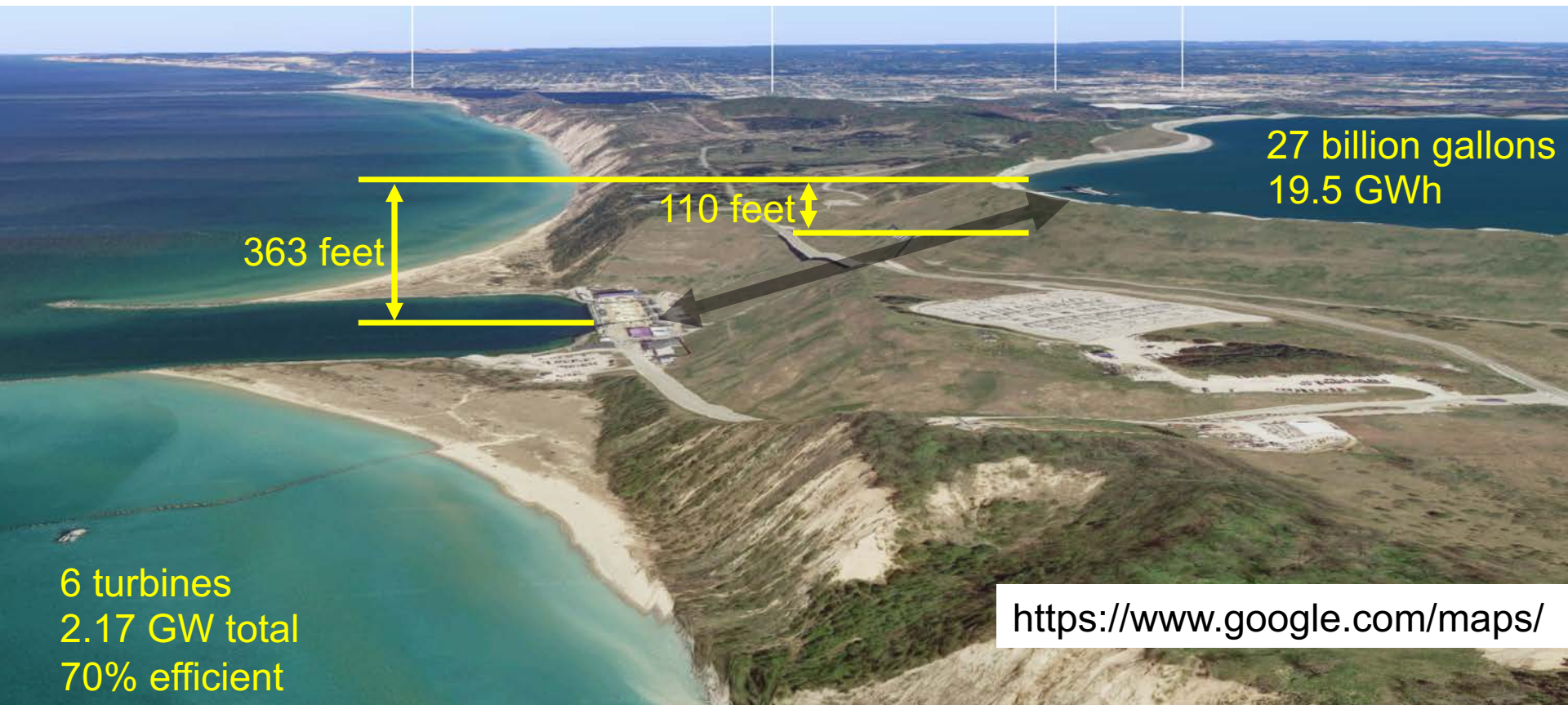
- **$E = \$$**
 - Energy is money
 - Residential customers in MI: 1 kWh = \$0.15
- Environmental sustainability must also mean fiscal sustainability
 - Energy conservation, properly done, pays for itself
 - The **greenest** energy is the energy we don't consume
- Renewables (hydro, solar, wind) use **free** fuel
 - + Almost inexhaustible: *5,000 times* all human demand

VAISALA

Direct + Ambient
Time-average

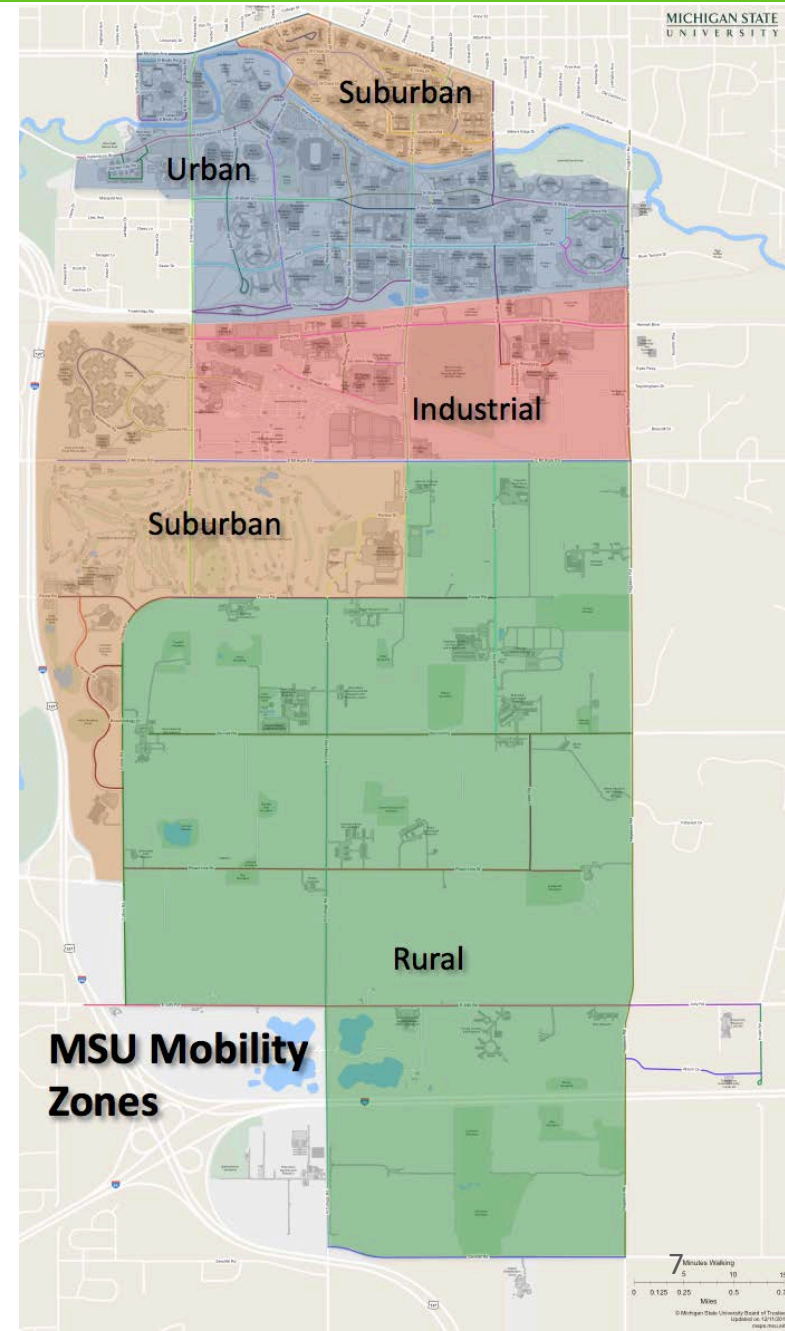


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 - + Almost inexhaustible: *5,000 times* all human demand
 - Intermittent
- Energy storage is essential
 - Yes, batteries. But also pumped hydro, compressed gas, ...
 - Hydrogen/methane from electrolytic splitting of water



- Largest university in Michigan (> 50,000 students)
- Member of American Association of Universities
- Top-100 university in the World
- Land-grant university with 21 km² contiguous campus
- Living-learning-lab with own power plant and micro-grid

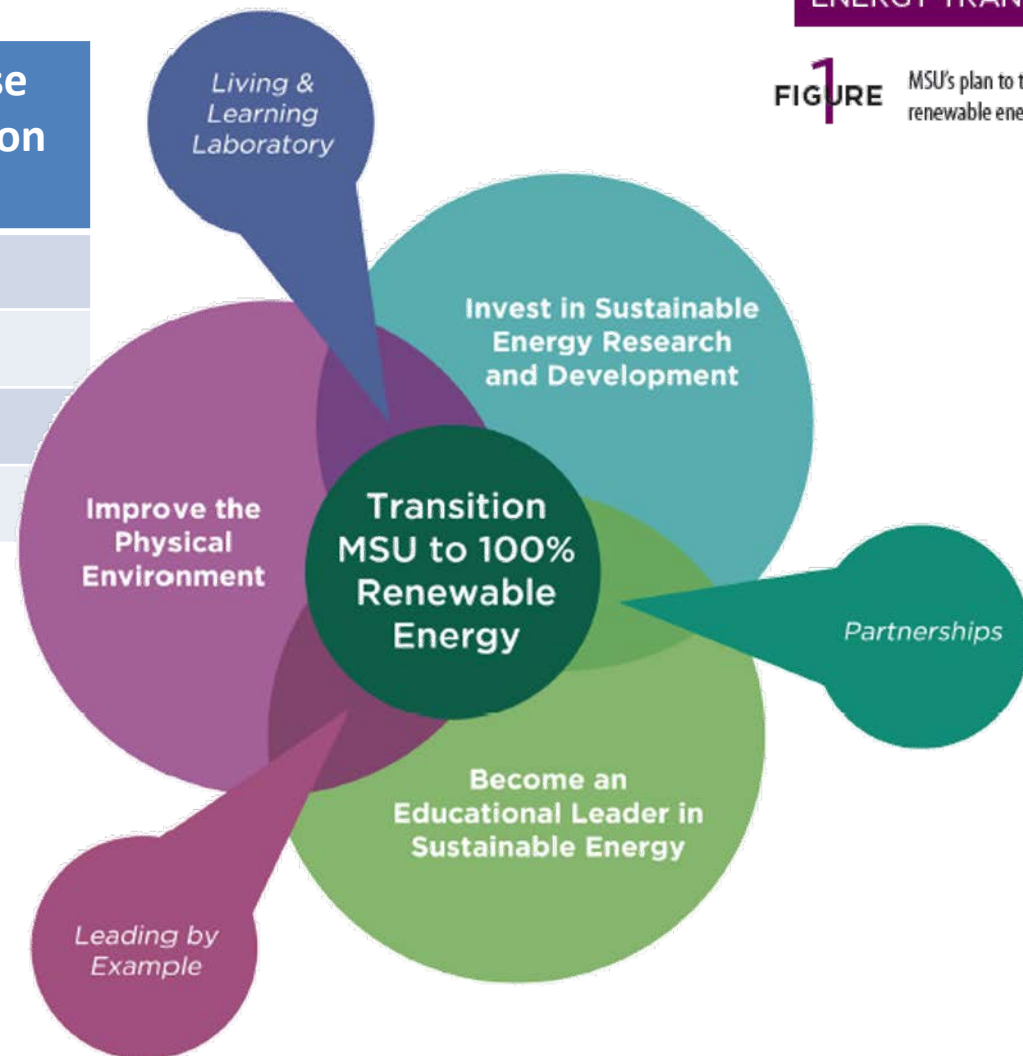
- 21 km² contiguous campus
- Ideal testing ground for Connected Automated Vehicles
 - Vastly different driving conditions
 - All seasons
 - Own police force
 - Traffic intersections equipped with cameras and RSUs
 - Automated Bus Consortium testing site
- Ideal testing ground for Smart Micro-Grid technology
 - Own power plant
 - Own water system
- Model for Smart City of the future



- Timetable

Year	Campus Renewable Energy	Greenhouse Gas Emission Reduction
2015	15%	30%
2020	20%	45%
2025	25%	55%
2030	40%	65%

- Approved by MSU Board of Trustees, April 2012



ENERGY TRANSITION PLAN

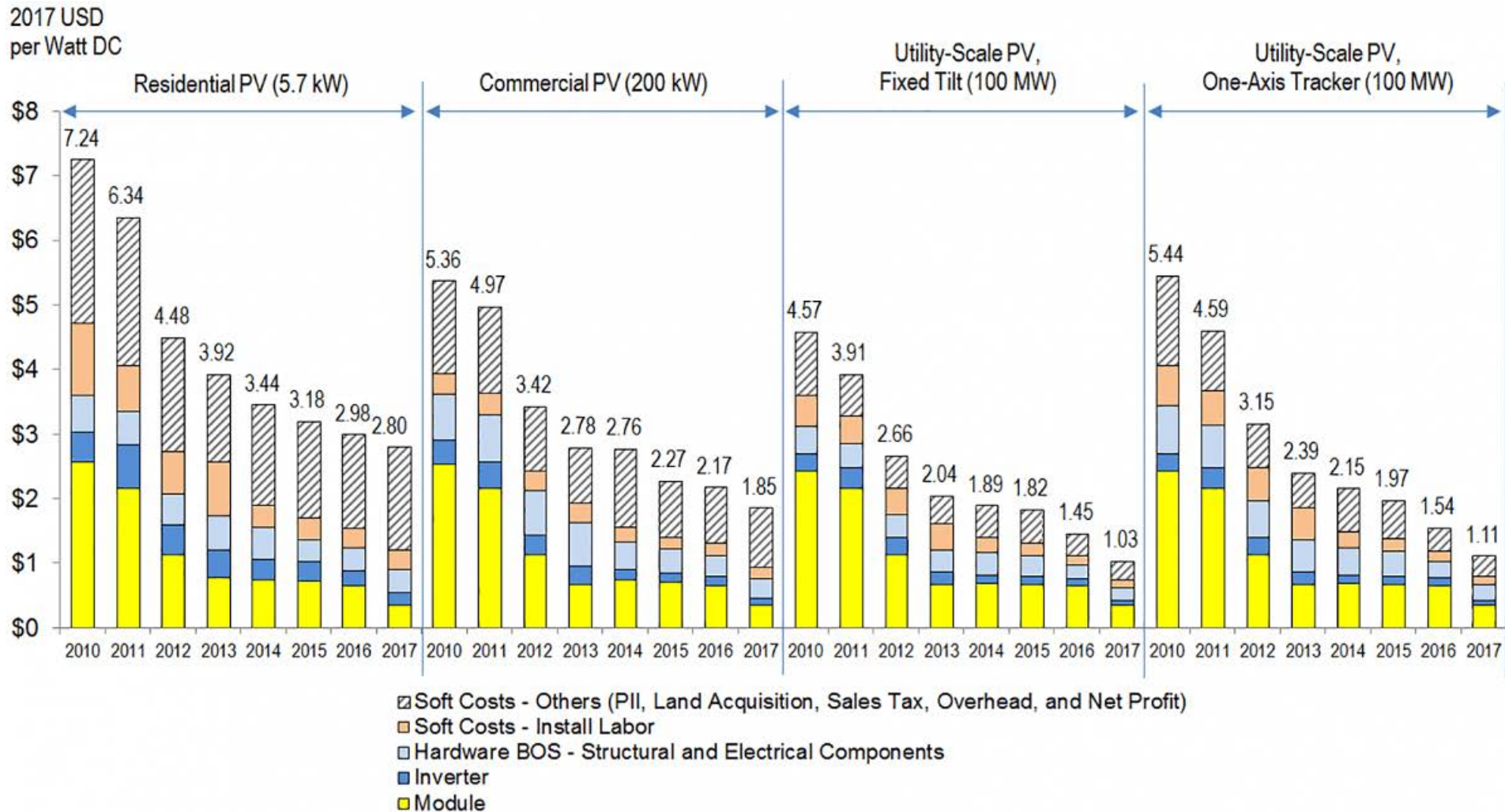
FIGURE 1 MSU's plan to transition to 100% renewable energy

- Recycling center /surplus store
- Organic waste composting facility
- Geo-thermal array
 - Nursing building
- Anaerobic digester
 - Processing of food waste, reduction of artificial fertilizer use, electricity production
- Solar arrays
- Demand reduction
 - M\$5-10/year energy conservation measures
 - Better building challenge
 - Data center challenge
 - Spartan treasure hunts

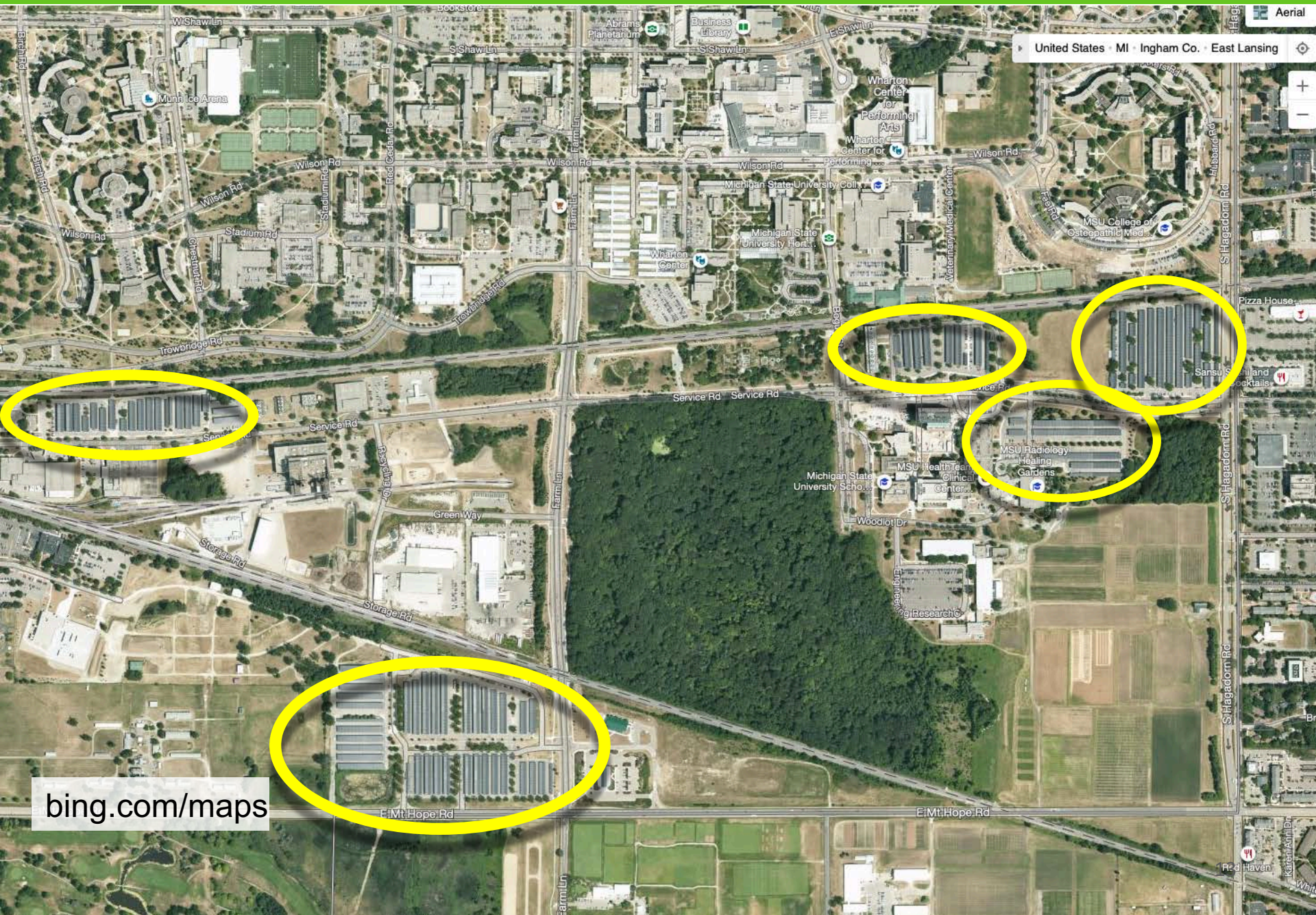


- Solar panels are becoming more and more efficient
- ... and cheaper

NREL PV system cost benchmark summary (inflation adjusted), 2010–2017



- Solar panel are becoming more and more efficient
- ... and cheaper
- Power Purchase Agreement (PPA)
 - Investors provide capital and earn returns
 - Solar developer builds the solar array (or wind farm ...)
 - Buyer signs long term contract to purchase generated electricity (10 years, 20 years, 30 years, ...)
- Current lowest prices (*BloombergNEF*, April 2, 2020)
 - Wind (Sweden): **3.05** cent/kWh
 - Solar (Spain): **3.53** cent/kWh
- Michigan: **Property tax means an effective cost adder of ~20%**
 - House Bills 4465 and 4069 and Senate Bill 47 reinstate the property tax exemption for renewable energy systems, but only up to 150 kW (Gov. Whitmer signed bills in Nov. 2019)



bing.com/maps

Dimensions

- 5,000 parking spots
- 45 acres of parking lots
- 40,000 solar panels
- 13.4 MW dc peak power
- 10.5 MW ac peak power
- 15,000 MWh/year of solar energy



- Will save ~\$10 million in electricity costs for MSU over the 25-year duration of the PPA
- **Green Power** is cheaper than **Brown Power**

Finished Product (2017)

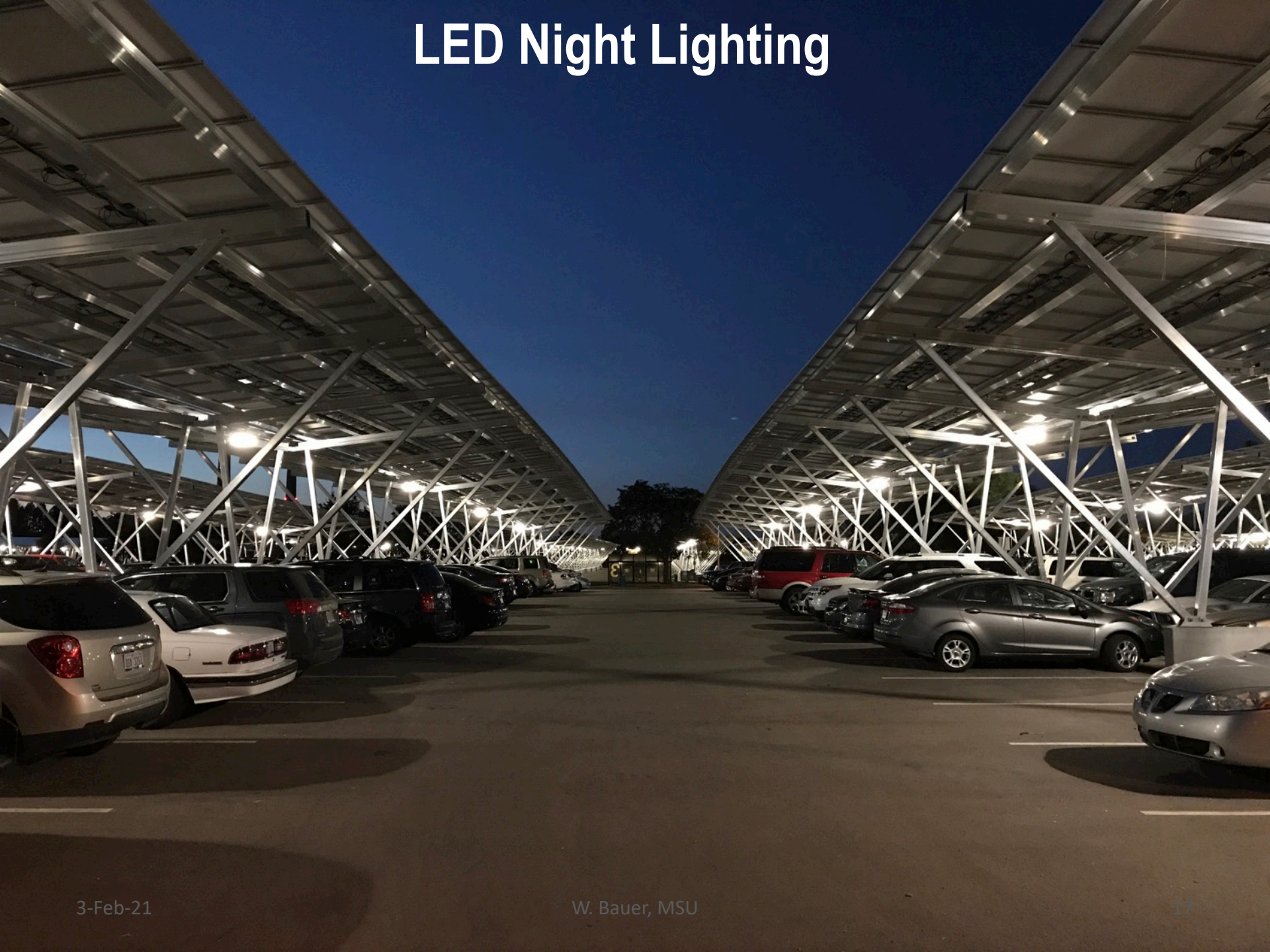
18% of MSU peak power demand, 5% of MSU total annual energy



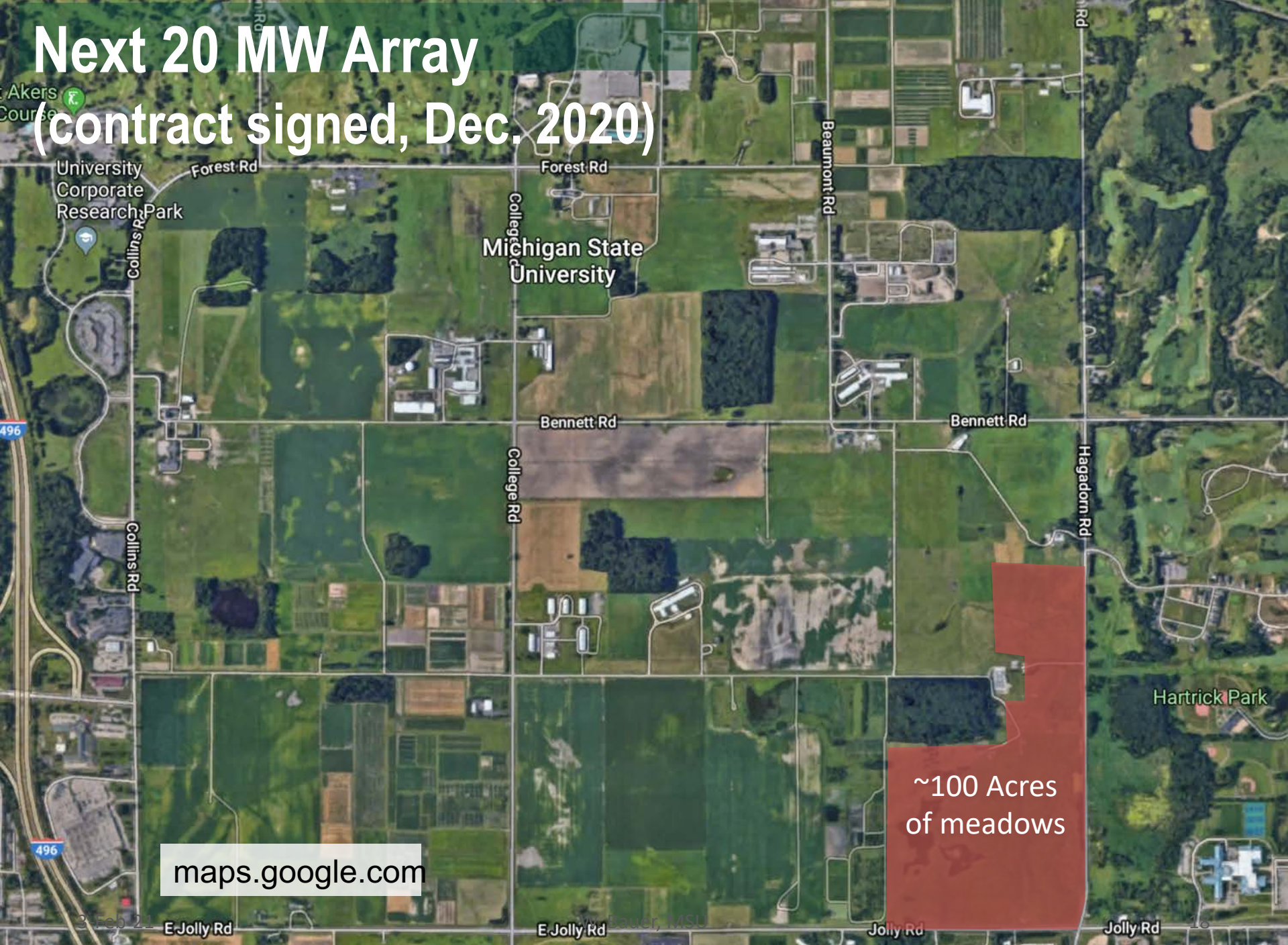
Largest solar carport array in North America



LED Night Lighting



Next 20 MW Array (contract signed, Dec. 2020)



~100 Acres
of meadows

maps.google.com



<https://www.princeton.edu/news/2018/06/28/sheep-shear-maintenance-princetons-solar-field>

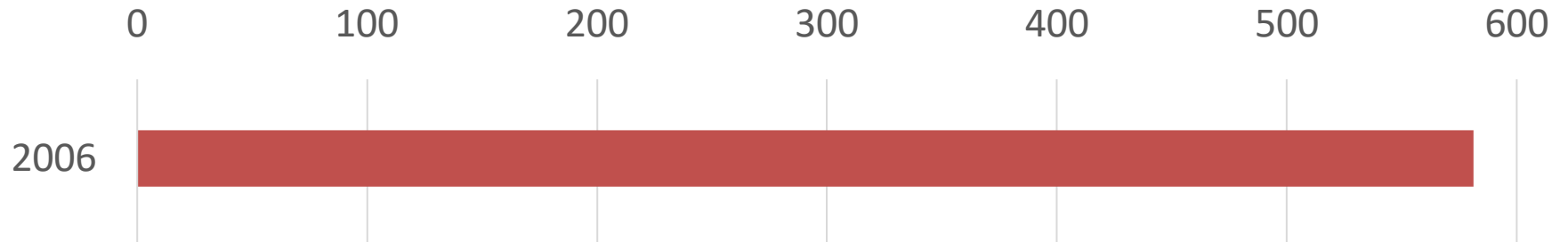
Sheep Grazing Meadow



<https://denison.edu/news-events/featured/131013>

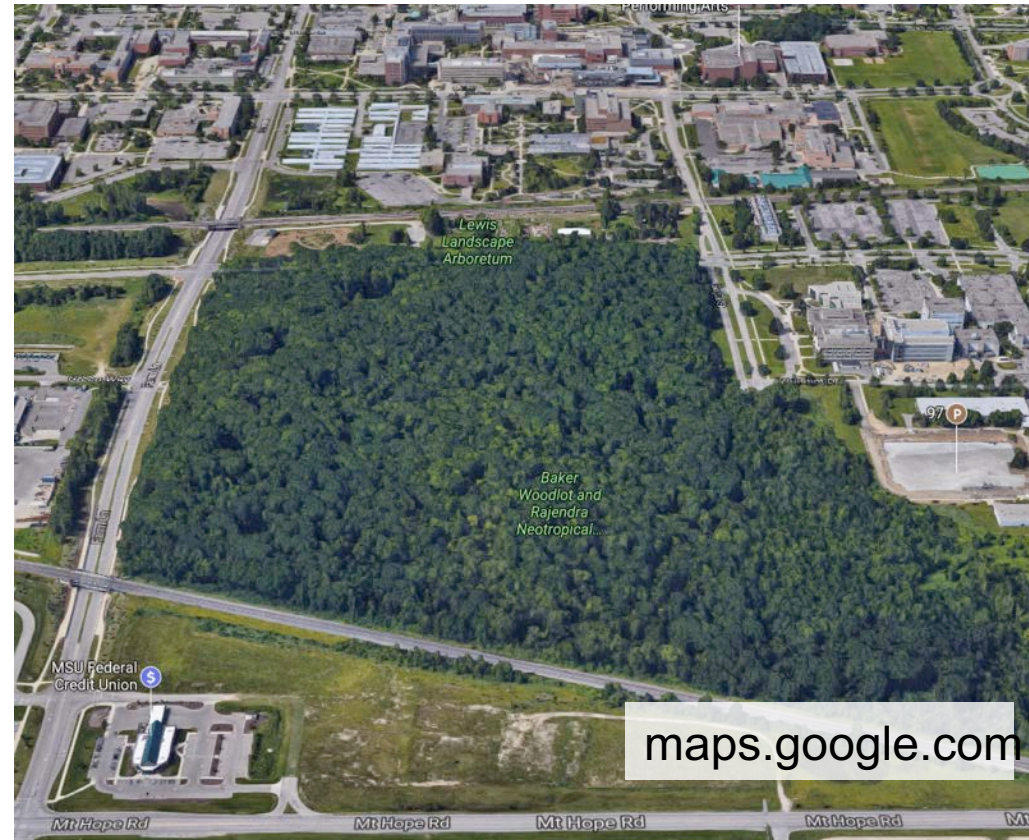
Wildflower/Pollinator Habitat

MSU Emissions: kiloTons of CO₂/ year



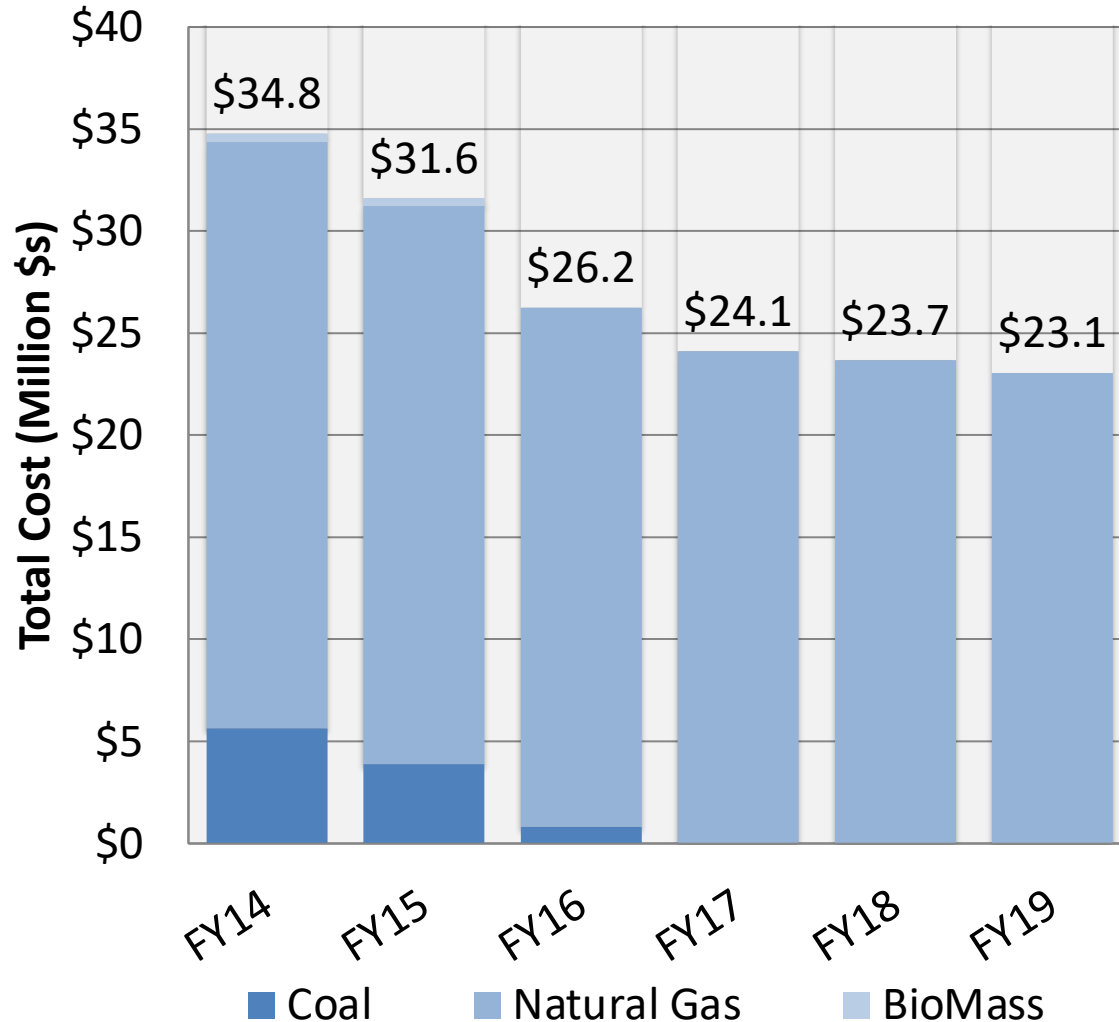
How many trees?

- 700 trees/acre
- 1000 pounds of CO₂ sequestered during life of a tree
- Total CO₂ emission reduction equivalent to planting 14 Baker Woodlots of trees (> 800,000 trees) *each year*.



Baker Woodlot, MSU:
78 acres (~ 320,000 m²)
~55,000 trees

Purchased Coal, Natural Gas and Biomass Costs



**34% cost reduction
since FY14!**

**New Solar Array will
save ~\$50 Million
during next 25 years**

**True
Sustainability:
Saving Money
while Saving
the Planet**



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