

Michigan State's Renewable Energy Journey

Wolfgang Bauer

MSU

MICHIGAN STATE

UNIVERSITY



- 
- A satellite map of Michigan is shown in the background. A green callout box with a white border and a tail pointing to the center of the state contains a list of facts. The text is white and bold.
- Largest university in Michigan (> 60,000 students)
 - Founded in 1855
 - 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 co-gen power plant and micro-grid (since 1894)

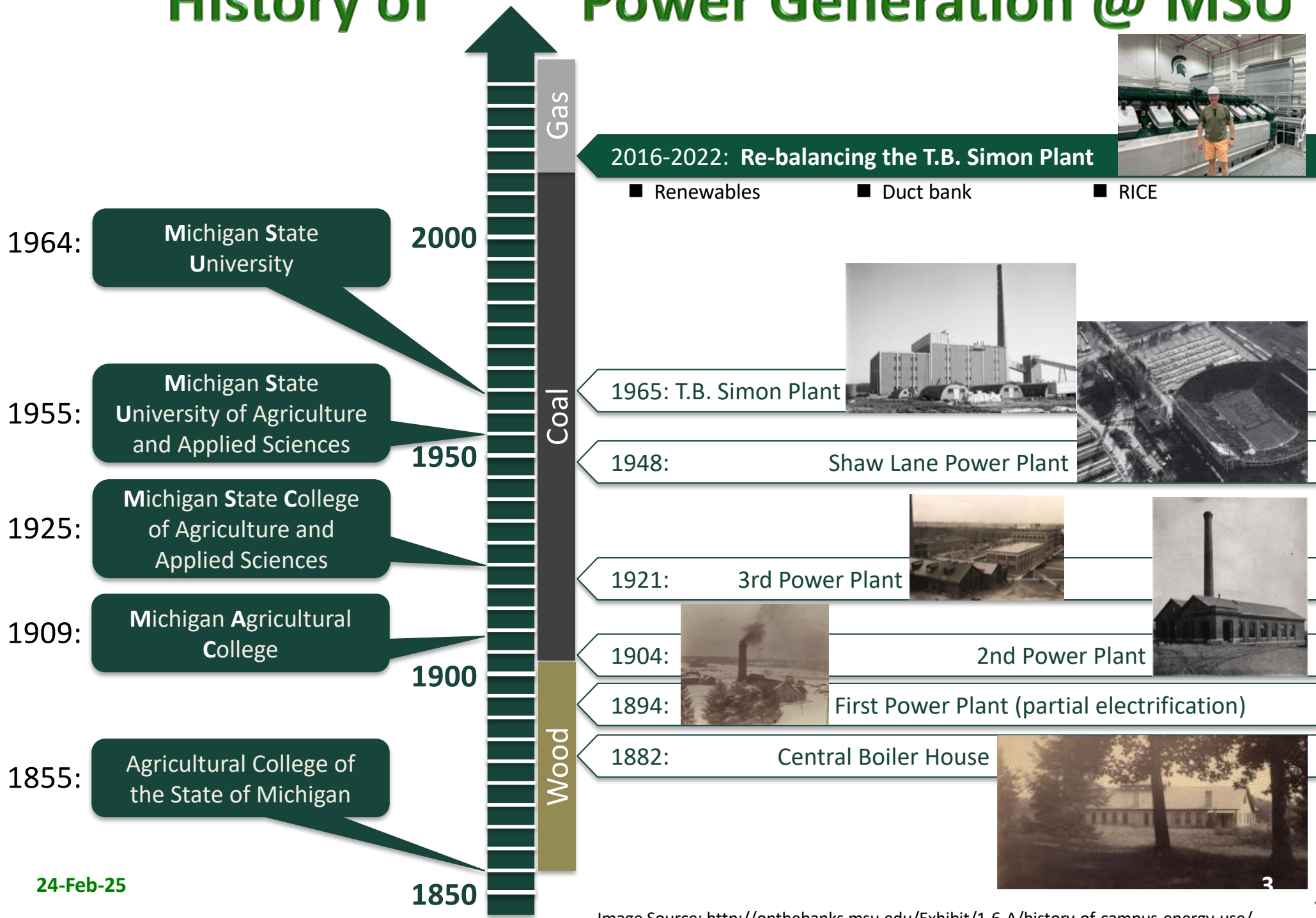
maps.google.com

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History of

Power Generation @ MSU



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Image Source: <http://onthebanks.msu.edu/Exhibit/1-6-A/history-of-campus-energy-use/>

The Theory of Everything

$$E = \$$$

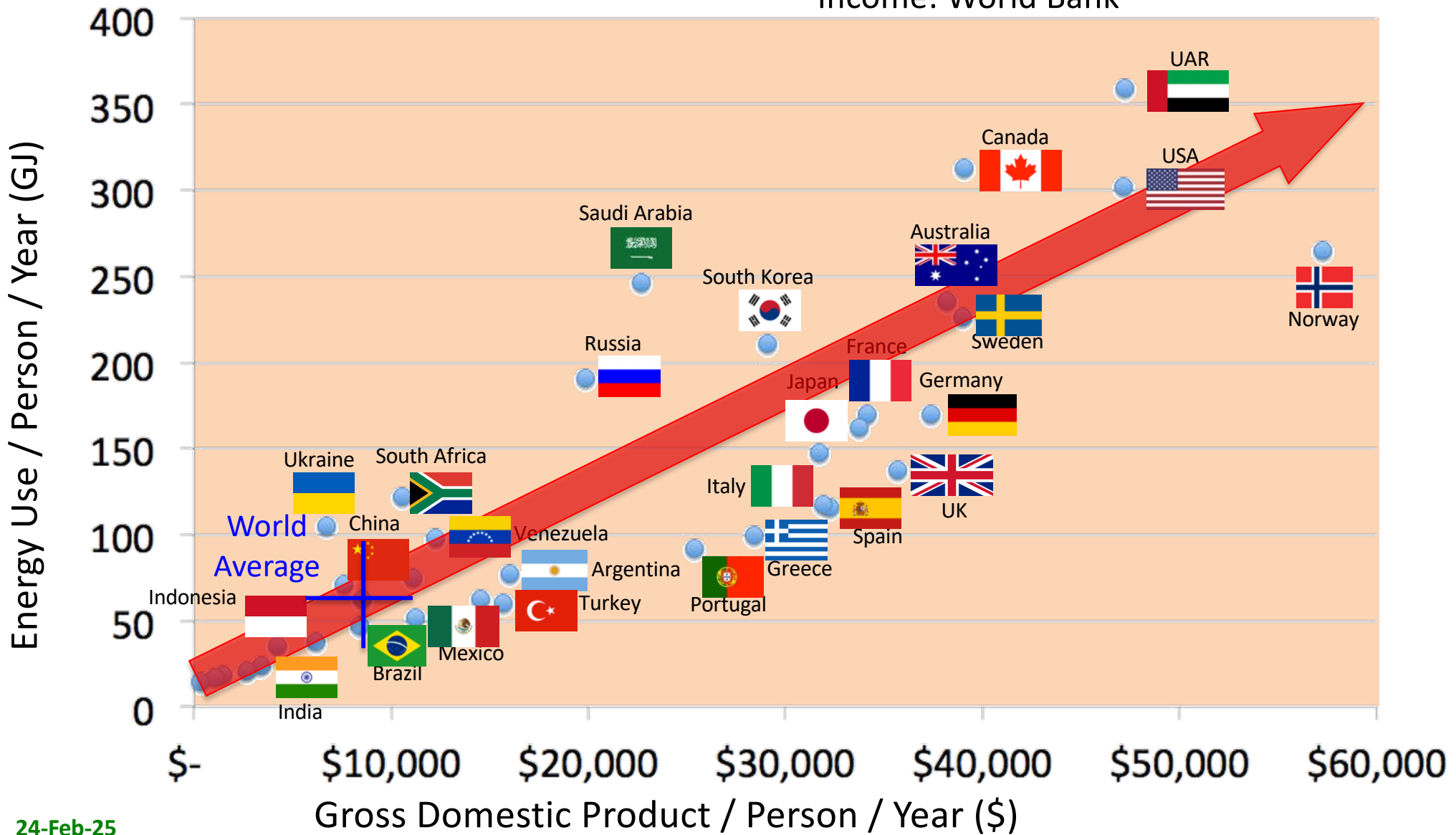


Energy Use & Prosperity

2010 Data

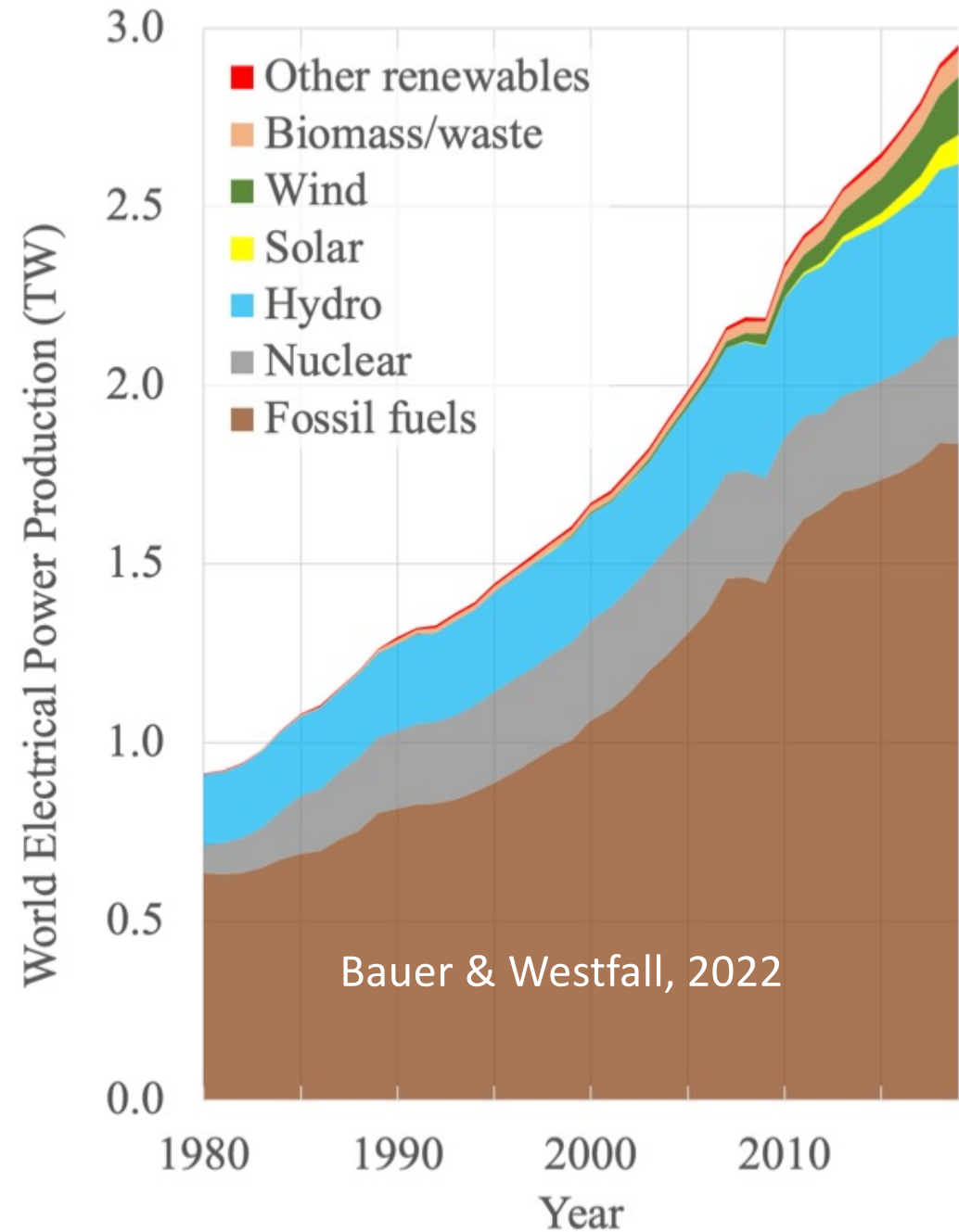
Energy: International Energy Agency

Income: World Bank



Problem

- Most of the world runs on fossil fuels ($E = \$$)!
- Burning fossil fuels emits CO_2 (30 Billion tons/year)
- Main cause of global warming



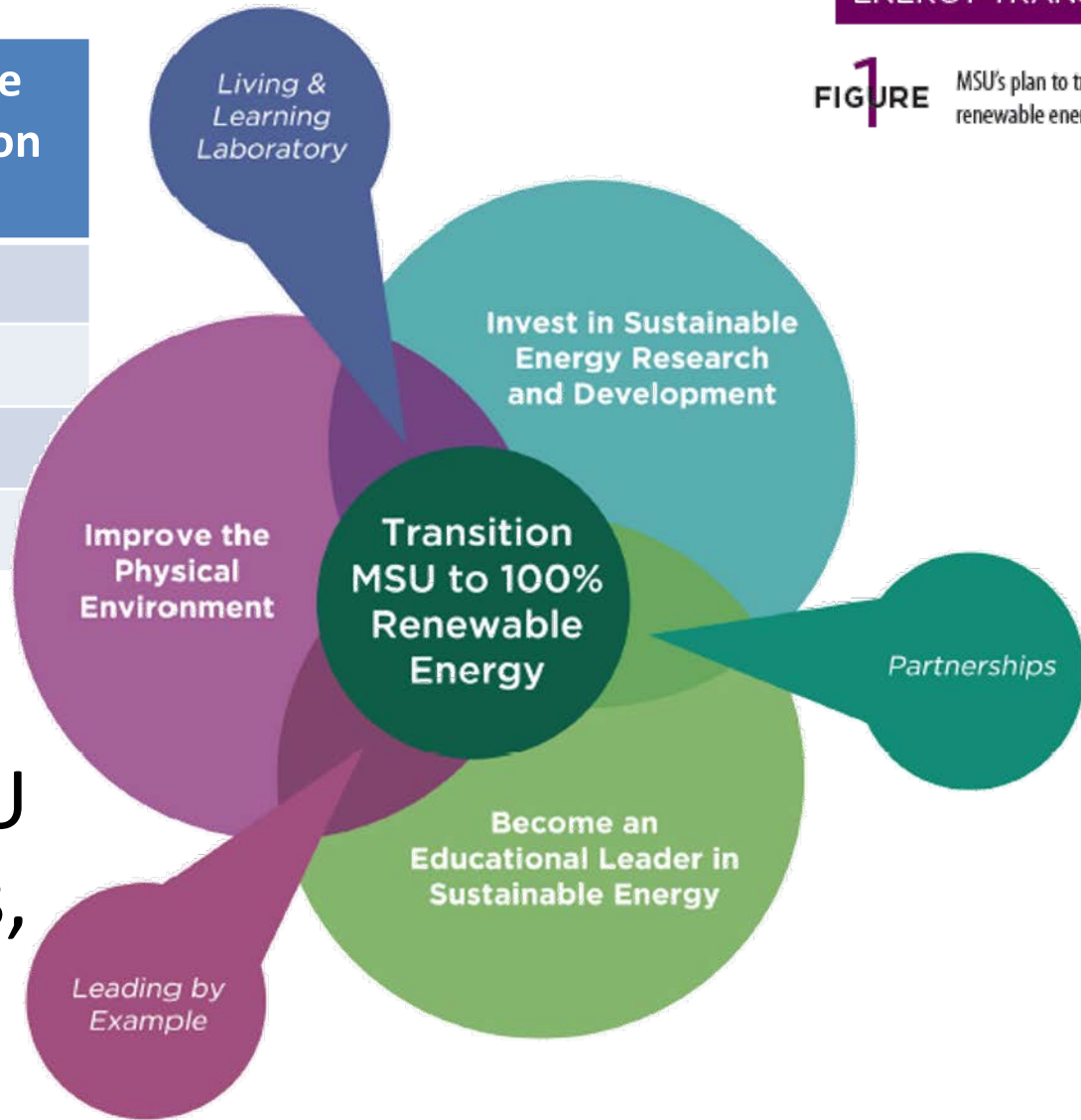
MSU Energy Transition Plan

- Timetable

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

ENERGY TRANSITION PLAN

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



- Approved by MSU Board of Trustees, April 2012



Sustainability / Renewables @ MSU

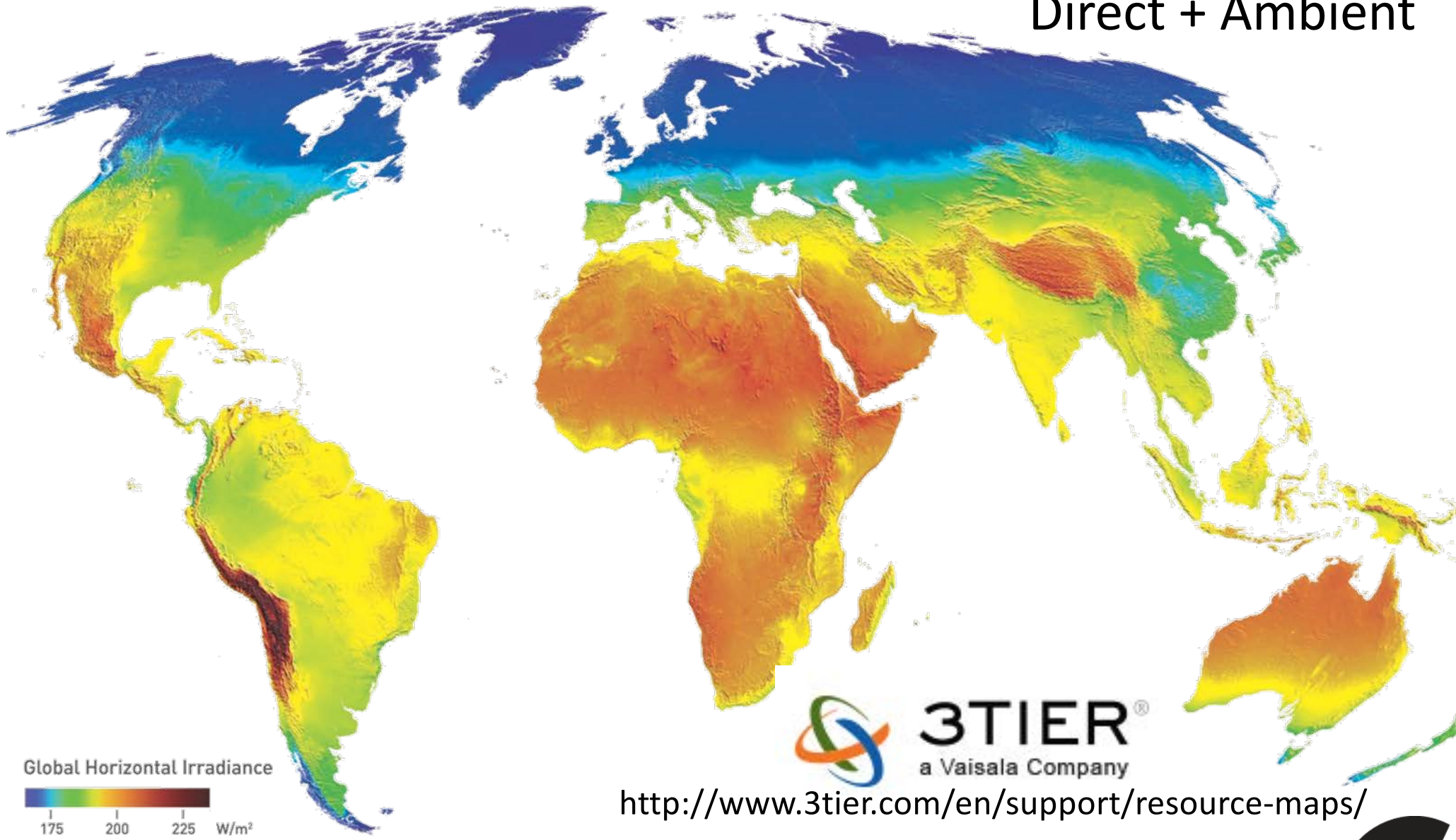


- Recycling center /surplus store
- Organic waste composting facility
- Geo-thermal array
 - Nursing building
- Anaerobic digester
 - Processing of food waste, reduction of artificial fertilizer use, electricity production
- **Solar arrays**
- Demand reduction:
 - **The greenest energy is the energy you do not use!**
 - M\$10/year energy conservation measures
 - DOE Better building challenge
 - DOE Data center challenge
 - Spartan treasure hunts (with GE)



Usable Solar Radiation

Direct + Ambient



Global Horizontal Irradiance
175 200 225 W/m^2

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a Vaisala Company

<http://www.3tier.com/en/support/resource-maps/>

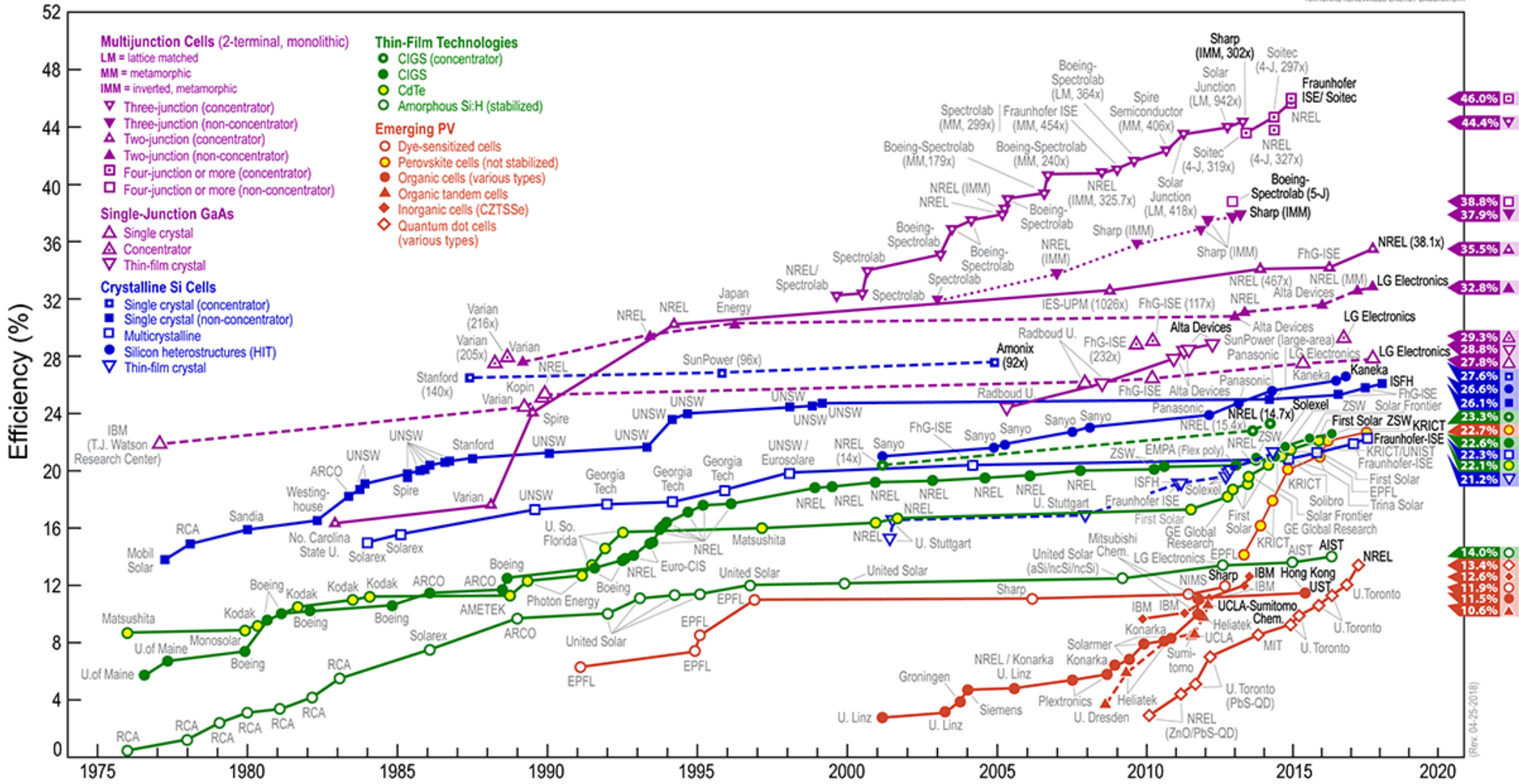
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PV Cells are Getting More Efficient

Best Research-Cell Efficiencies



<https://www.nrel.gov/pv/assets/images/efficiency-chart.png>

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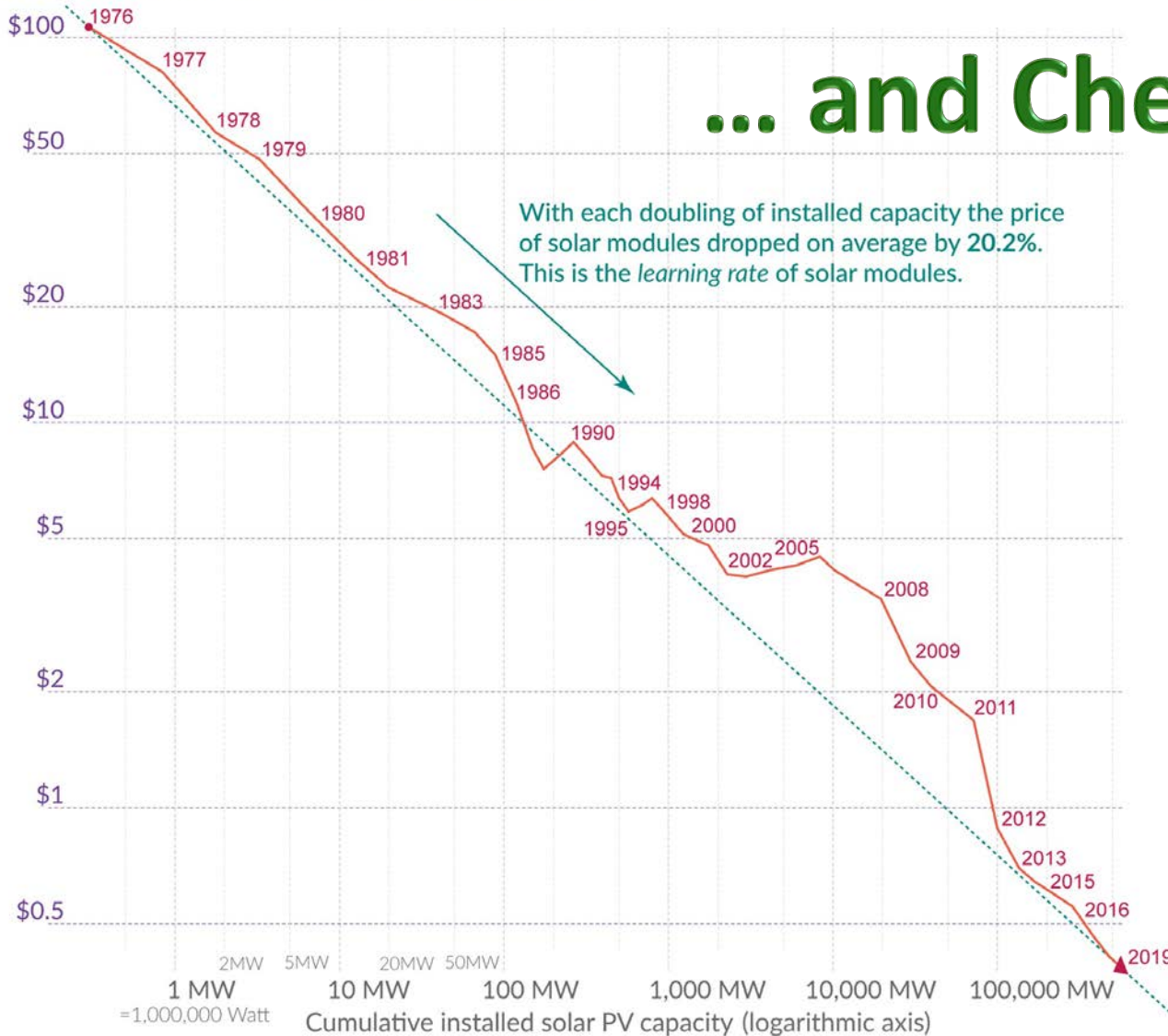


The price of solar modules declined by 99.6% since 1976

Price per Watt of solar photovoltaics (PV) modules (logarithmic axis)
The prices are adjusted for inflation and presented in 2019 US-\$.

https://en.wikipedia.org/wiki/Swanson%27s_law

... and Cheaper



Data: Lafond et al. (2017) and IRENA Database; the reported learning rate is an average over several studies reported by de La Tour et al (2013) in Energy. The rate has remained very similar since then. OurWorldinData.org – Research and data to make progress against the world’s largest problems.

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MSU Solar Carport Arrays

- 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

Power Purchase Agreement with



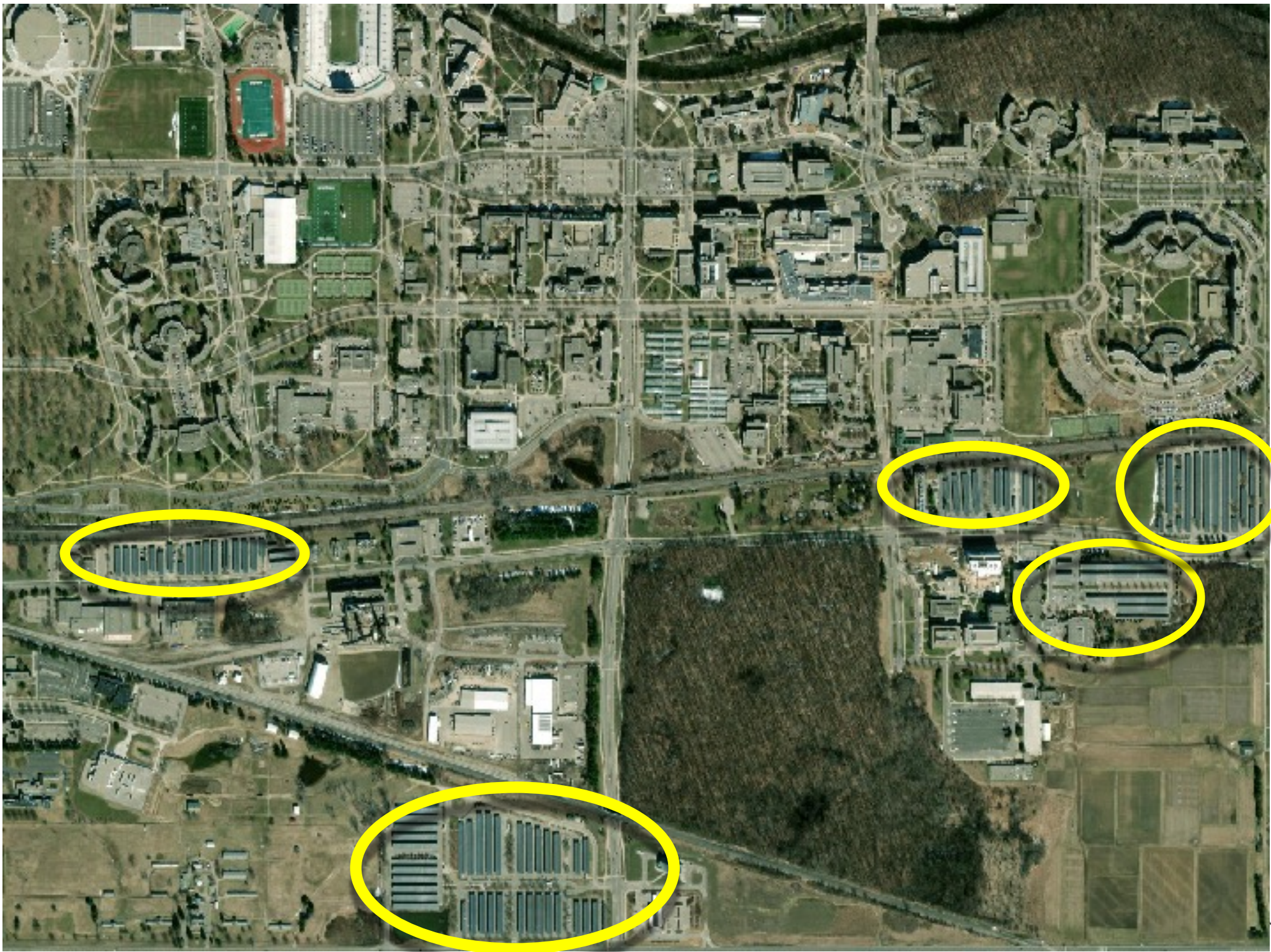
Partnership with



- Will save ~\$10 million in electricity costs for MSU over the 25-year duration of the PPA
- **Green Power** is cheaper than **Brown Power**
- **(Remember: $E = \$$)!**

Site Selection

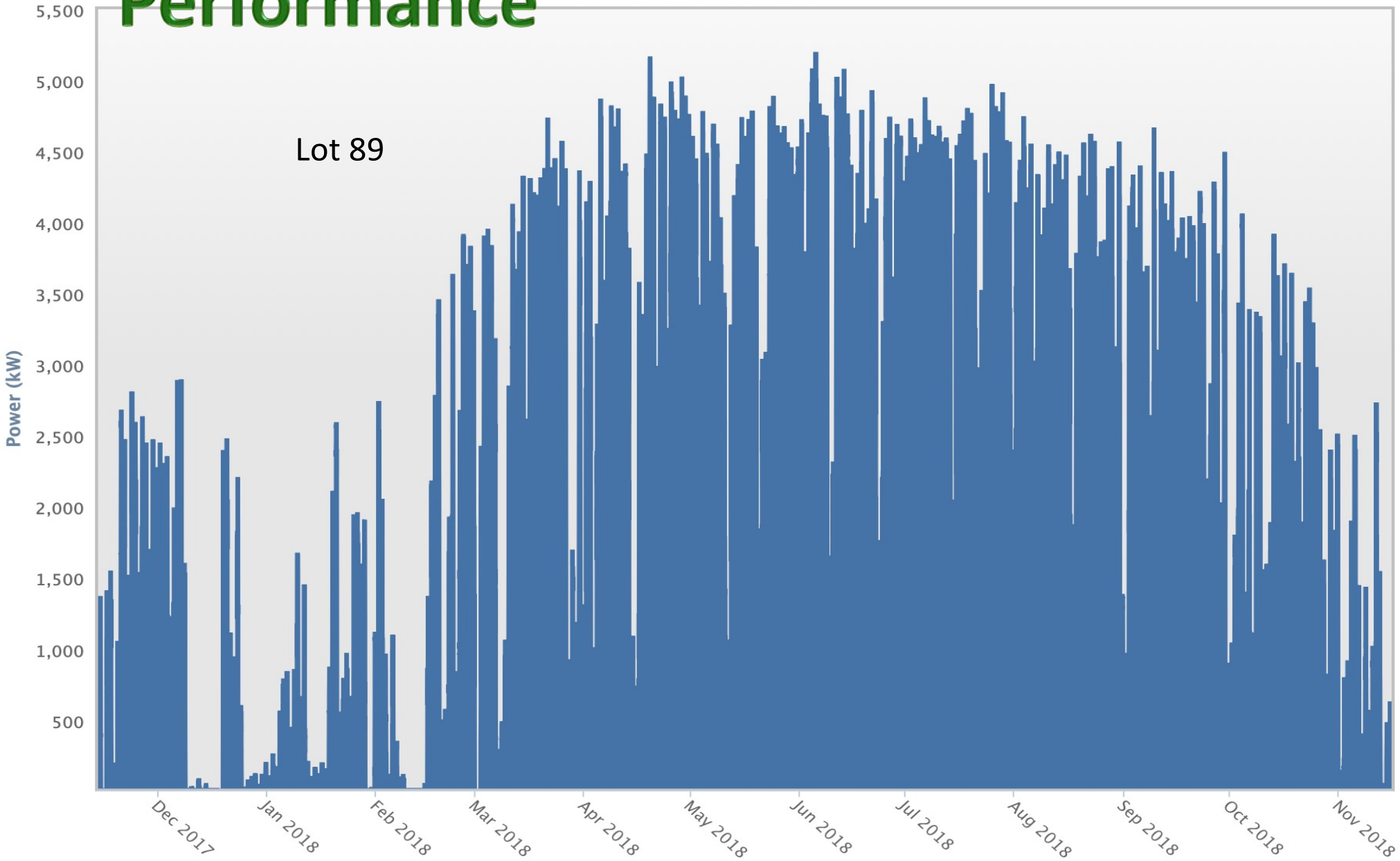




Performance

Power
2017-11-13 to 2018-11-16

Lot 89



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RICE (operational since March '22)

- Reciprocating Internal Combustion Engines
- Fast ramp rate can balance intermittency from solar
- High efficiency
- \$700k fuel saving just last month (remember: $E = \$$)



RICE (operational since March '22)



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Next 20 MW Array

- PPA with NextEra
- contract signed, Dec. 2020
- initiated at SED Renewable Energy Forum, 3 years ago



~100 Acres
of meadows

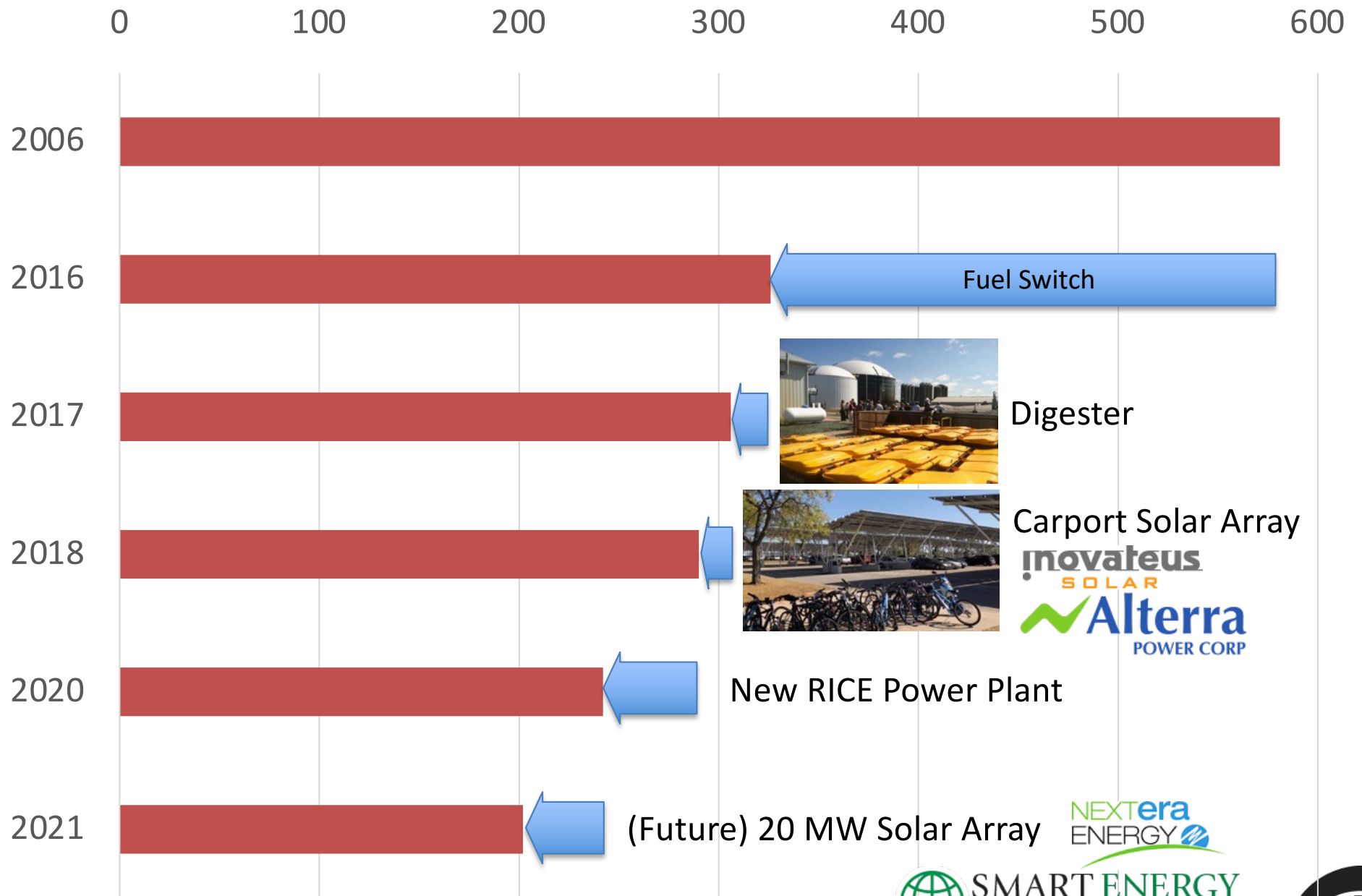
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W. Bauer, MSU

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MSU Emissions: kiloTons of CO₂/ year



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What else?

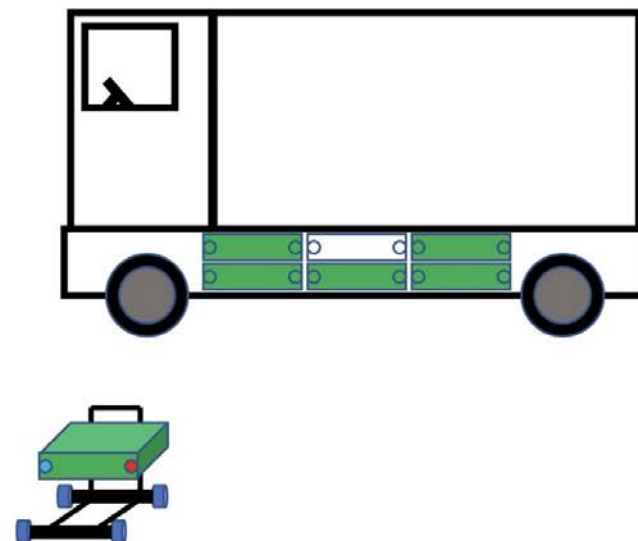
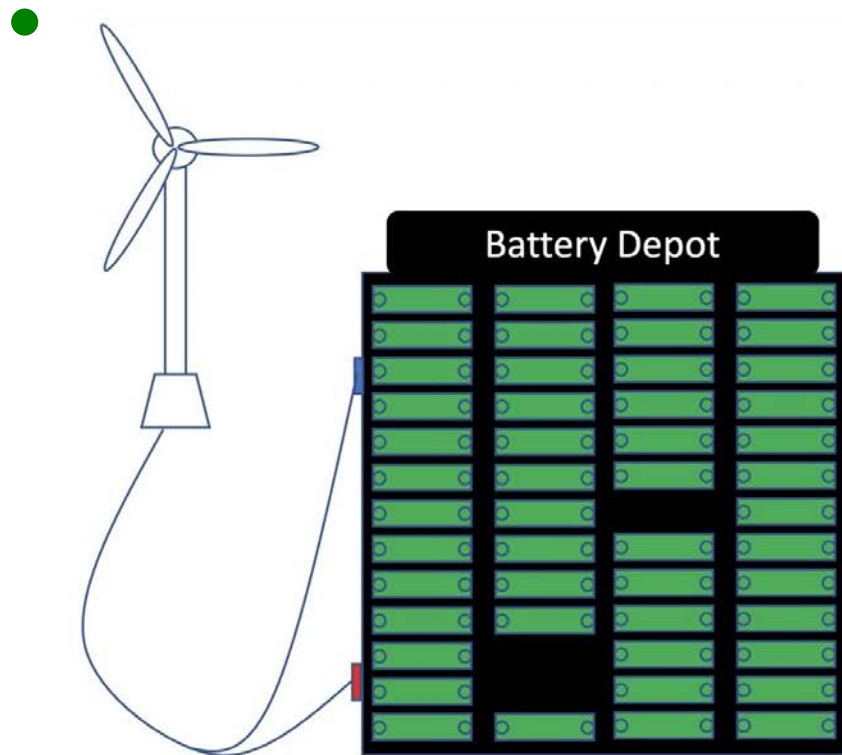
- Geothermal heating ... (looking for proposals)
- Fleet electrification (more to report at SED's Net Zero Forum, Scottsdale, September '22)
 - 370 new electric vehicles this decade (40 this year)
 - Self-driving electric bus



R&D on Swappable Car & Truck Batteries

-  SMART ENERGY DECISIONS column:

<https://www.smartenergydecisions.com/columns/2022/05/23/electric-vehicle-charging-infrastructure-needs-a-fundamental-redesign>



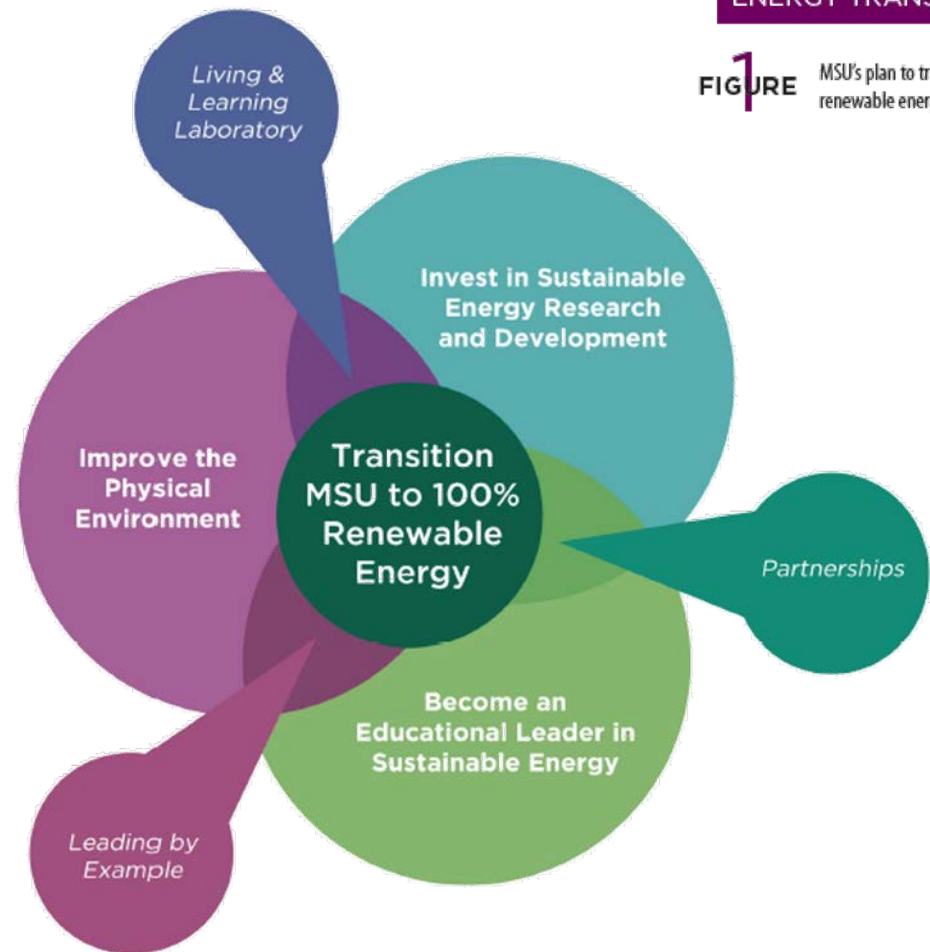
MSU Energy Transition Plan

- We are getting there
-  helped

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ENERGY TRANSITION PLAN

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



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More slides ...

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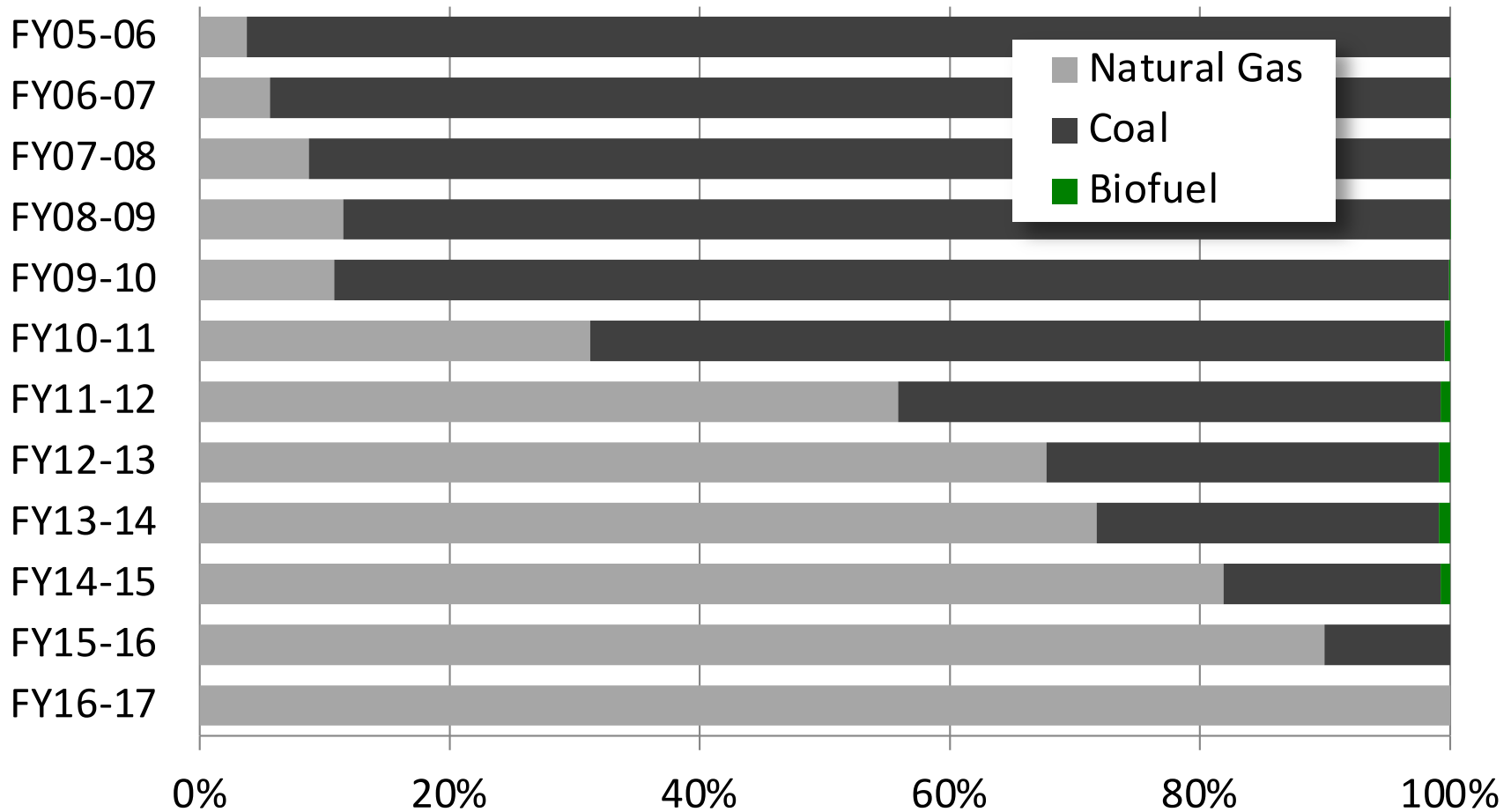


Auxin Solar Petition

Timeline

- 2/8/2022: Auxin Solar Inc. filed a petition with US DOC
- 3/25/2022: Commerce initiated a circumvention investigation
- 4/5/2022: Comments on respondent selection
- 4/20/2022: Thailand and Vietnam Q&V responses due
- 4/21/2022: Malaysia and Cambodia Q&V responses due
- 5/2/2022: Interested parties' one opportunity to submit new factual information and comments on the circumvention request
- 5/16/2022: Requestor's one opportunity to submit factual information and rebuttal comments on the request
- 8/29/2022: Preliminary determination deadline
- 9/12/2022: Comments on the preliminary determination
- 9/19/2022: Rebuttal comments on the preliminary determination
- 1/26/2023: Final determination deadline
- 4/3/2023: Extended deadline for final determination

MSU Fuel Mix



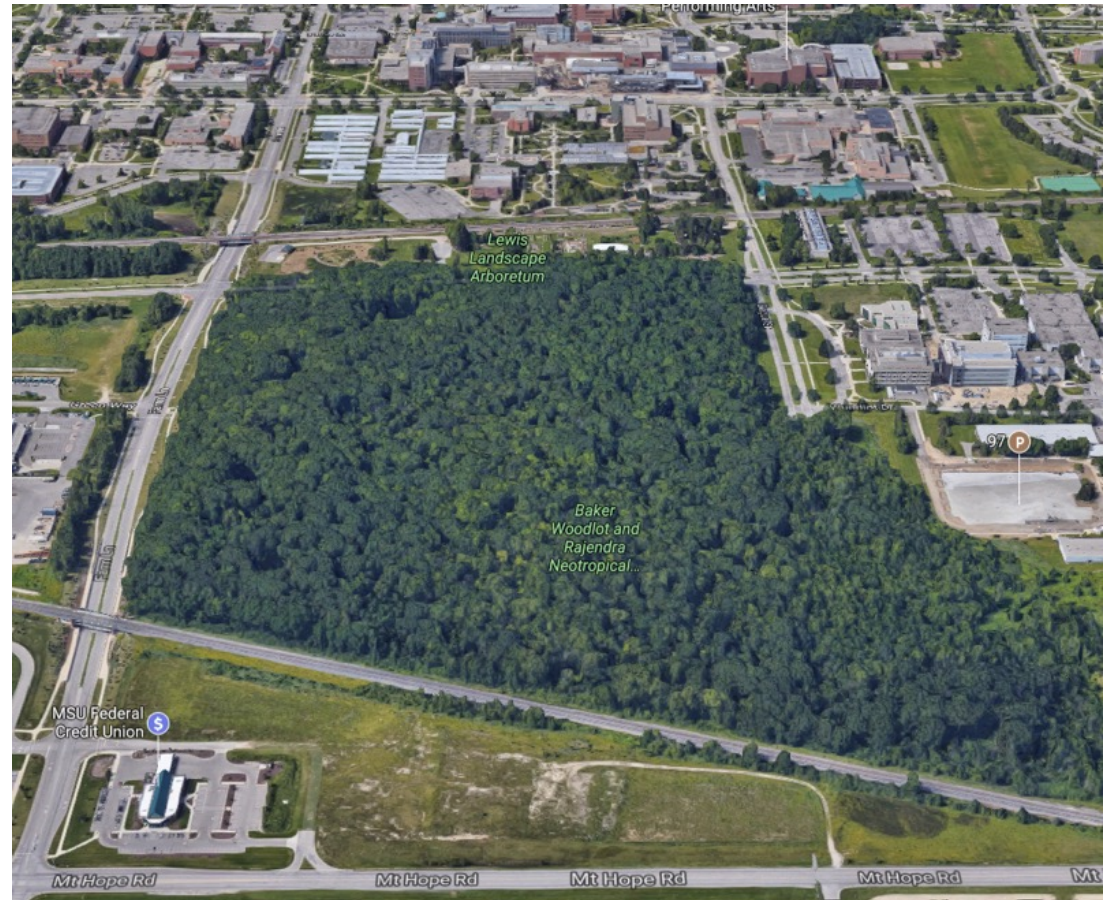
Bituminous coal: 206 pounds of CO₂ per million BTU of fuel

Natural gas: 117 pounds of CO₂ per million BTU of fuel

Fuel switch from coal to gas results in CO₂ emission reductions of ~250,000 metric tons per year!

How many trees?

- 700 trees/acre
- 1000 pounds of CO₂ sequestered during life of a tree
- CO₂ emission reduction due to fuel switch equivalent to planting 10 Baker Woodlots worth of trees *each year*.



Baker Woodlot, MSU: 78 acres

