An Overview of UP Energy with Suggestions on Task Force Priorities

September 14, 2020

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All data behind this presentation are publicly available. Key sources include U.S. EIA, U.S. Census Bureau, NREL, MPSC, MDOT, Lazard, and previous presentations made to the U.P. Energy Task Force.

Acknowledgments to Katherine Cima and David Gard for their help in developing this material.

The UP Energy Task Force (UPETF) was created by Executive Order No. 2019-14. The charge to the Task Force according to section 2(a) of the Executive Order is to:

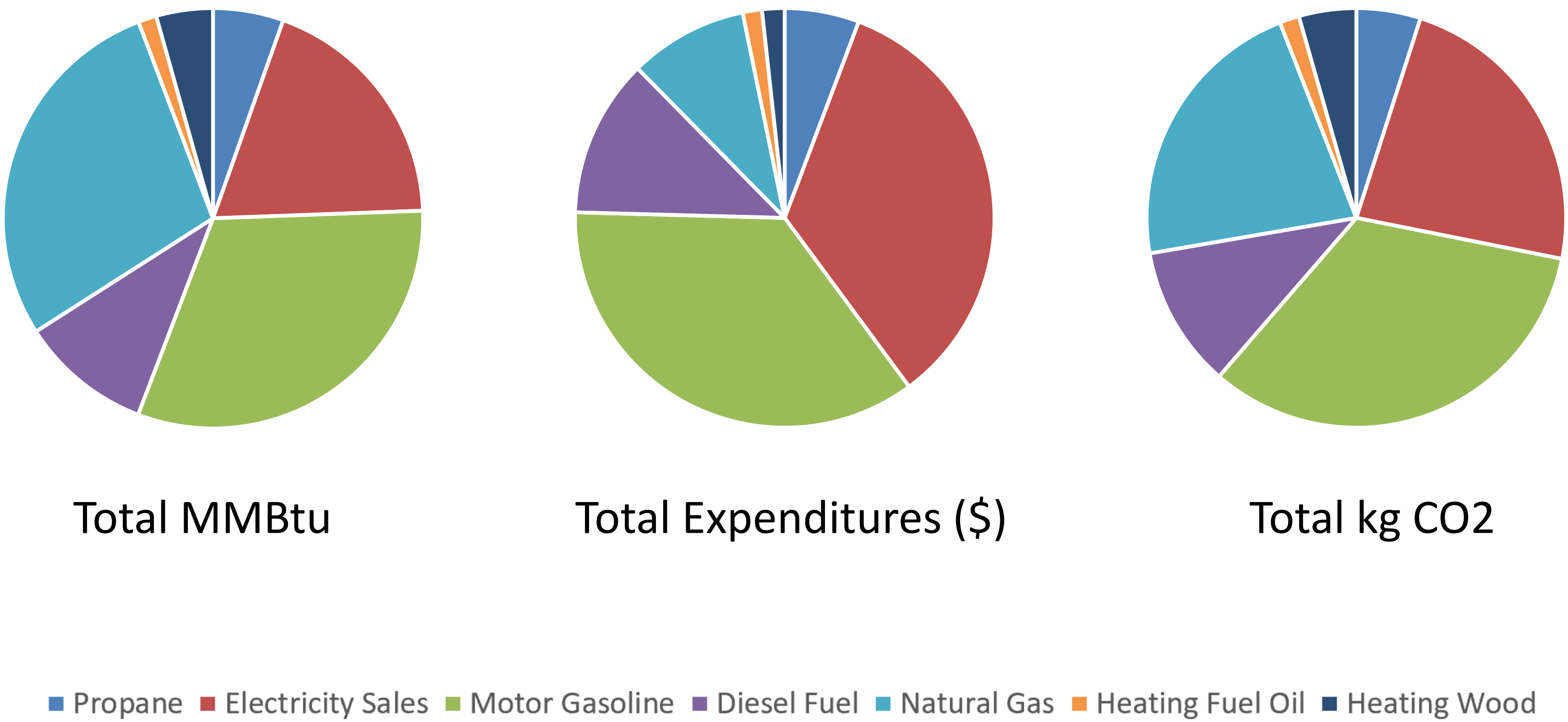
- Assess the UP's overall energy needs and how they are currently being met.
- Formulate alternative solutions for meeting the UP's energy needs, with a focus on security, reliability, affordability, and environmental soundness. This shall include, but is not limited to, alternative means to supply the energy sources currently used by UP residents, and alternatives to those energy sources.
- Identify and evaluate potential changes that could occur to energy supply and distribution in the UP; the economic, environmental, and other impacts of such changes; and the alternatives for meeting the UP's energy needs in response to such changes.

Estimated Customer Count by Sector

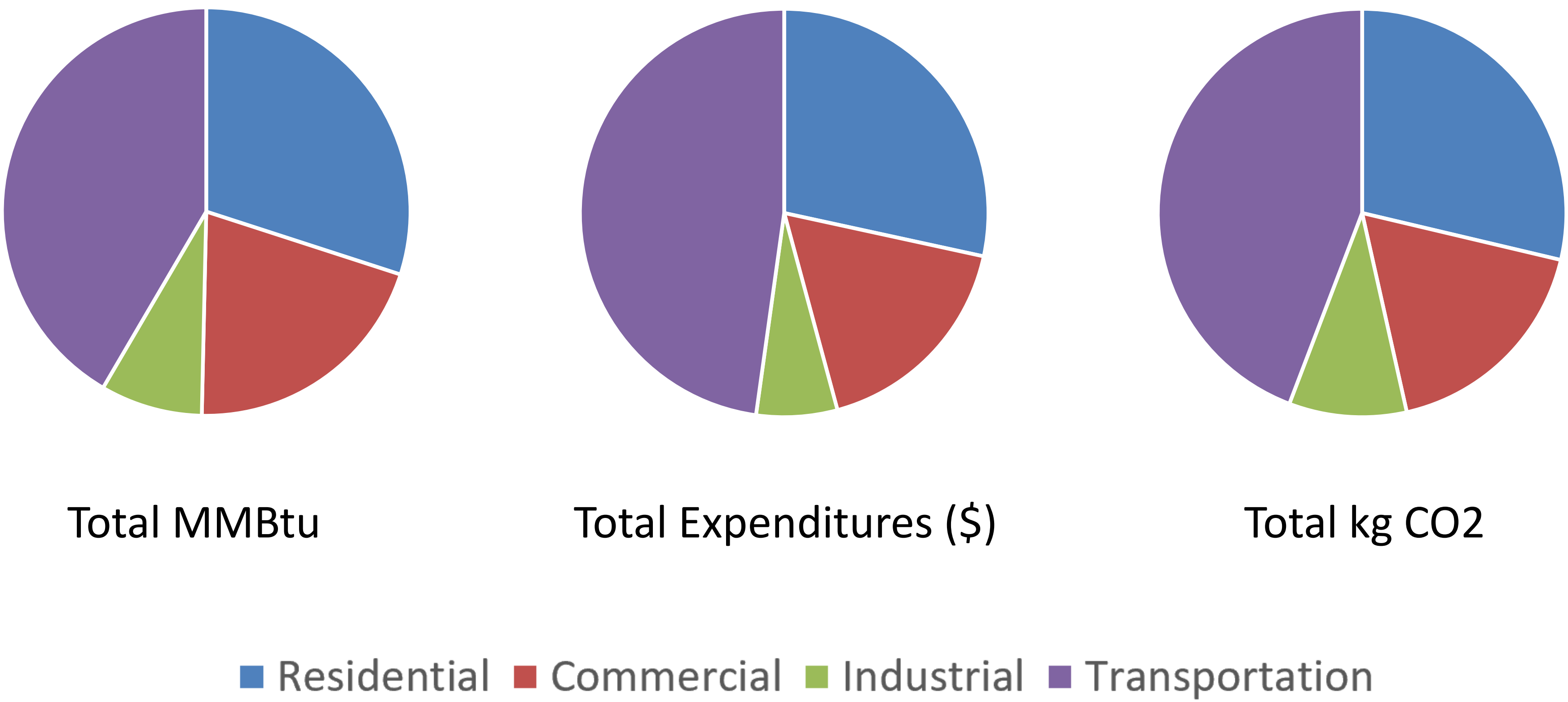
Fuel Type	Residential	Commercial	Industrial*
Electricity	166,647	25,013	152
Fuel Oil	3,849	1,742	
Natural Gas	71,401	18,918	
Propane	22,600	1,494	
Wood	12,790	2,489	

**Note: This table does not reflect fuels used for industrial Cogen*

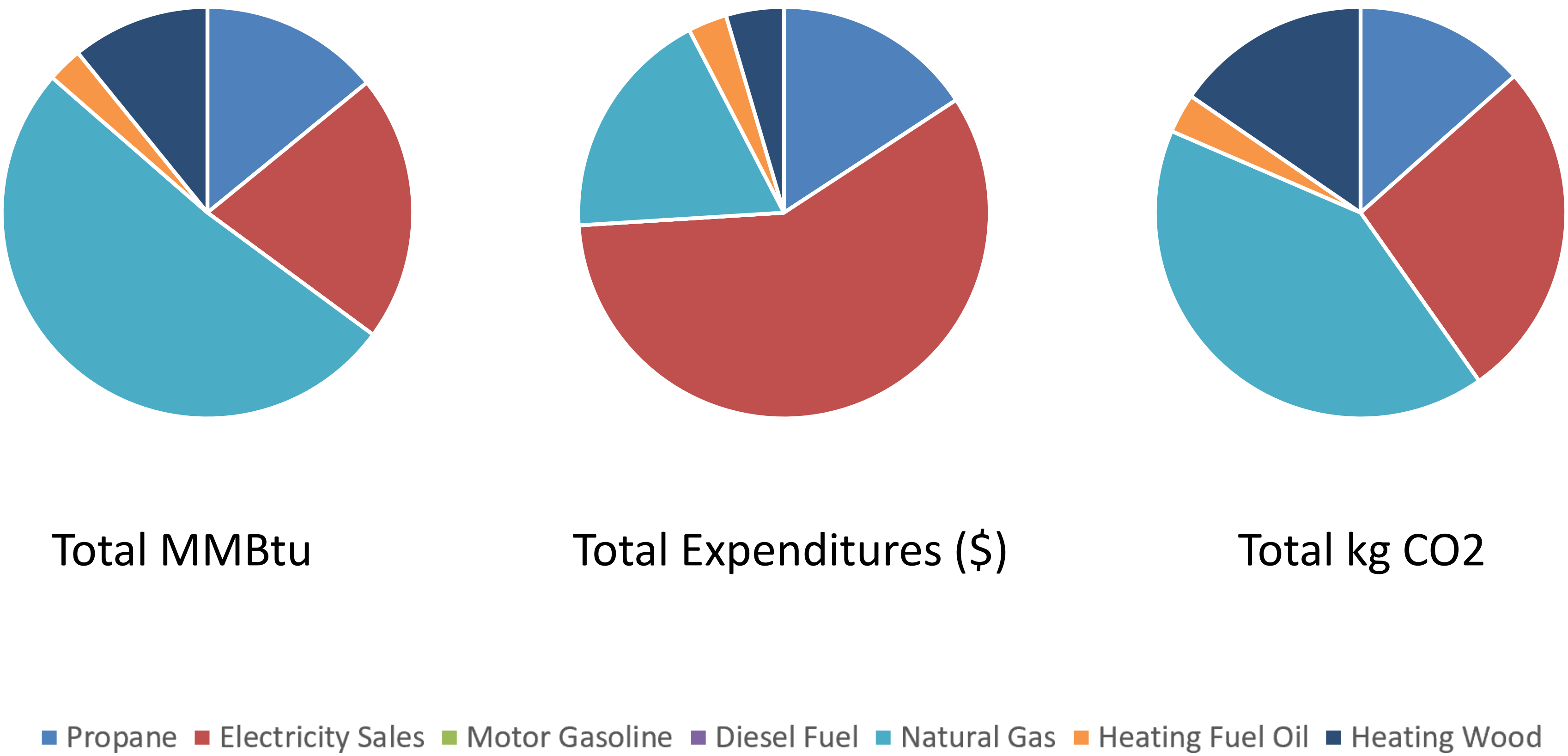
UP Energy End Use by Fuel Type
(All Sectors except Electrical Generation)



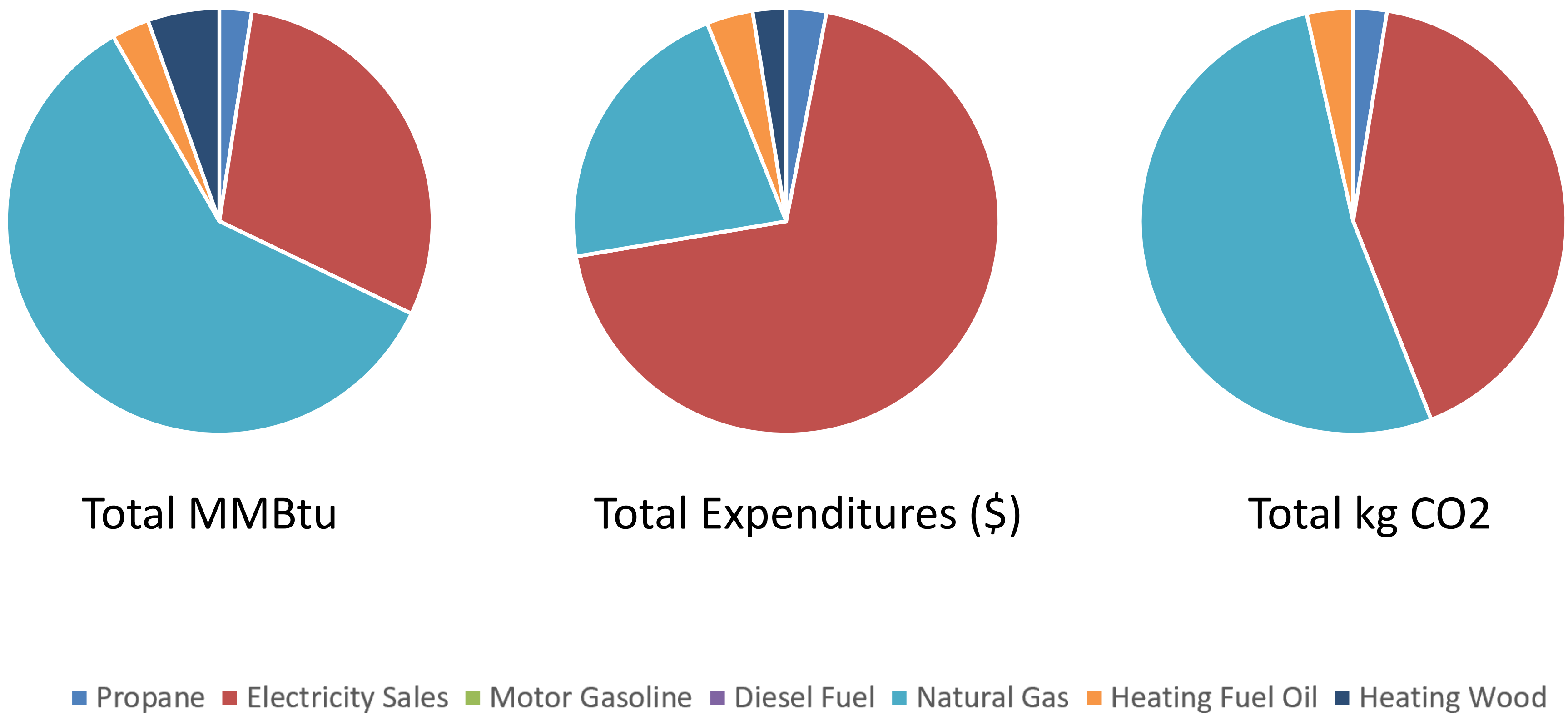
UP Energy End Use by Sector (Measured at Customer)



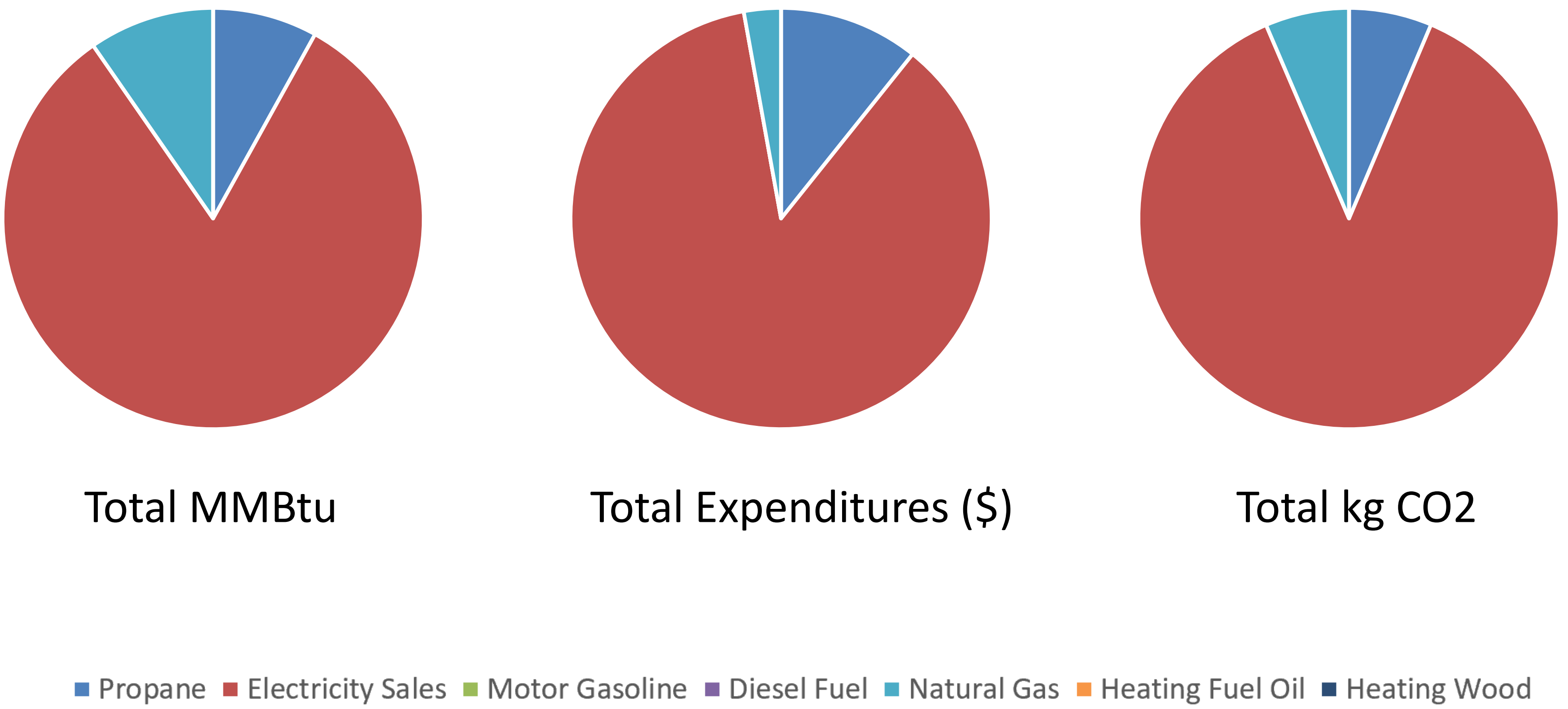
UP Energy Residential End Use by Fuel Type (Measured at Customer)



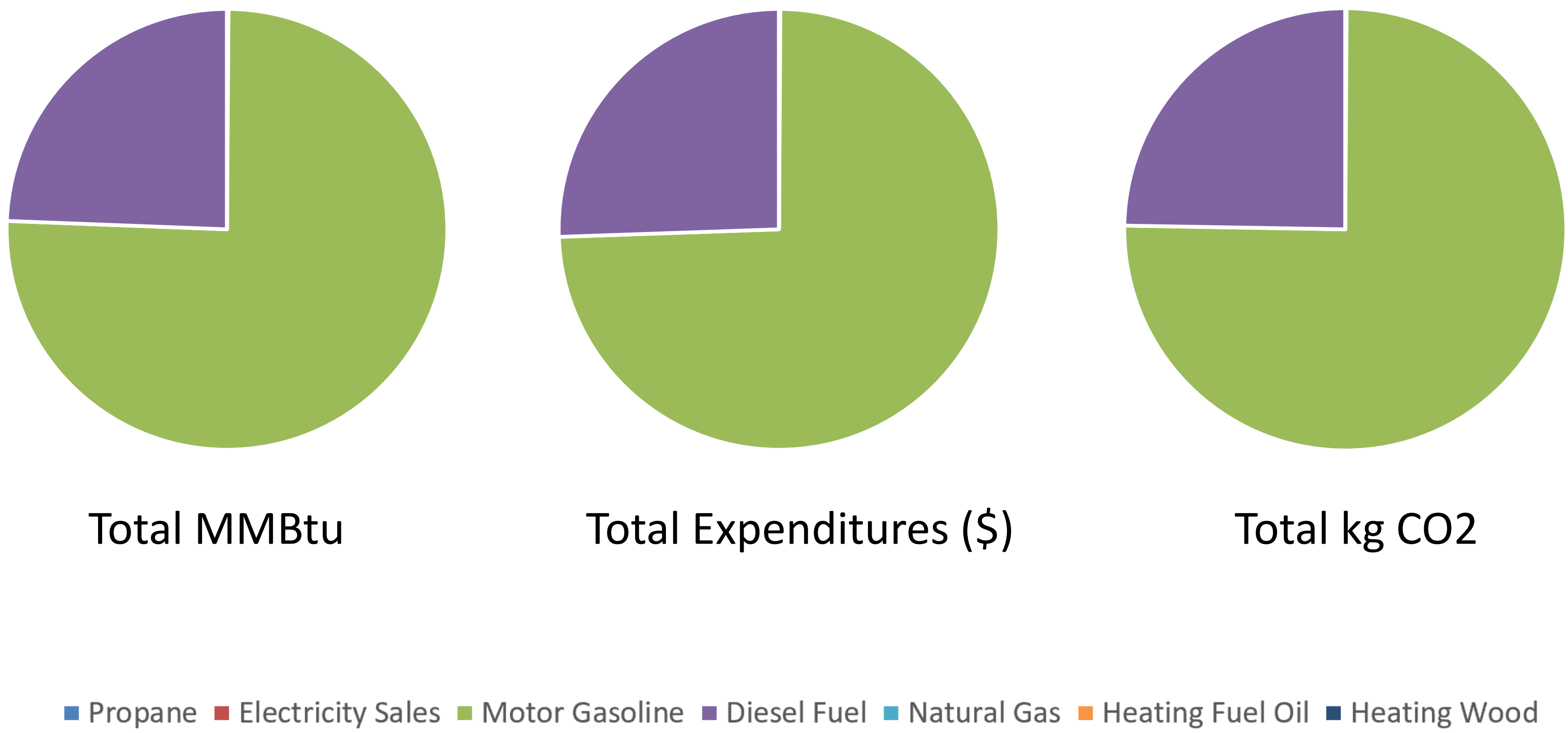
UP Energy Commercial End Use by Fuel Type (Measured at Customer)



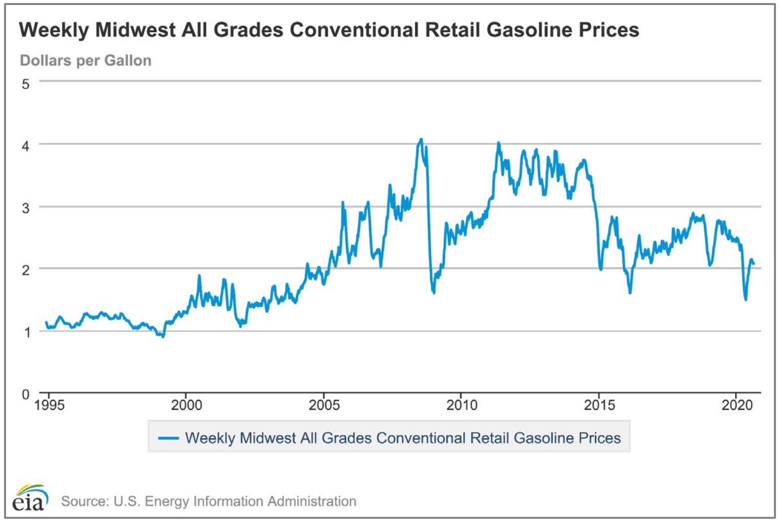
UP Energy Industrial End Use by Fuel Type (Measured at Customer Excluding Fuels Used to Generate Electricity)

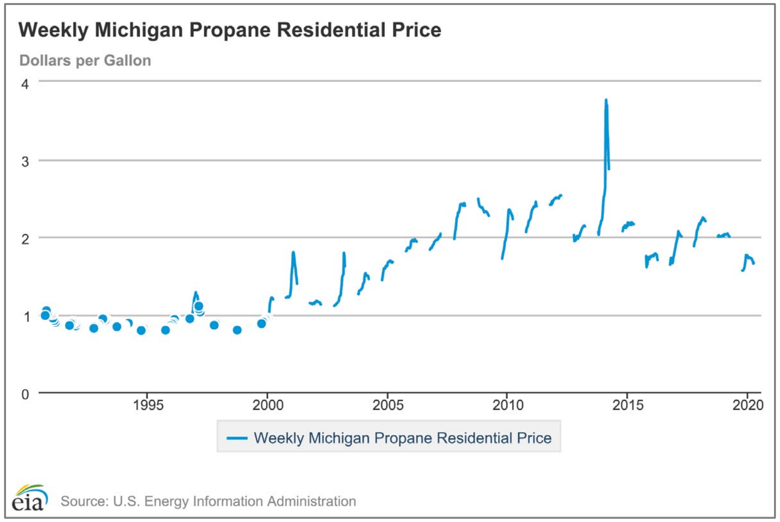


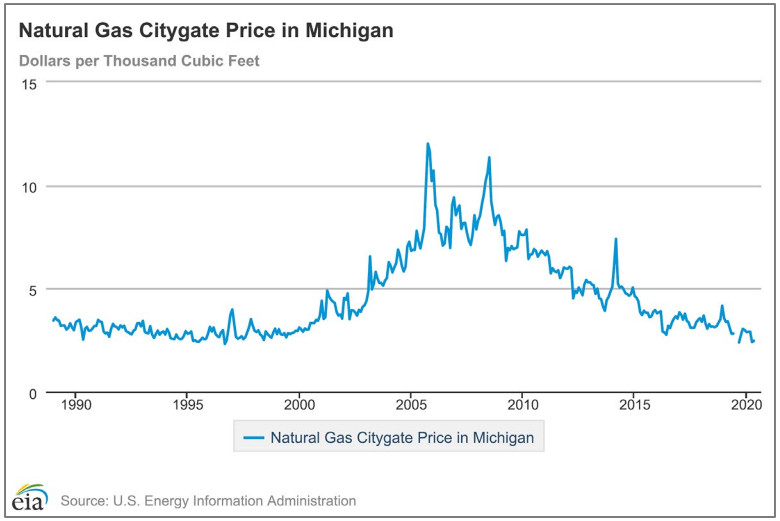
UP Energy End Use by Fuel Type (Transportation)

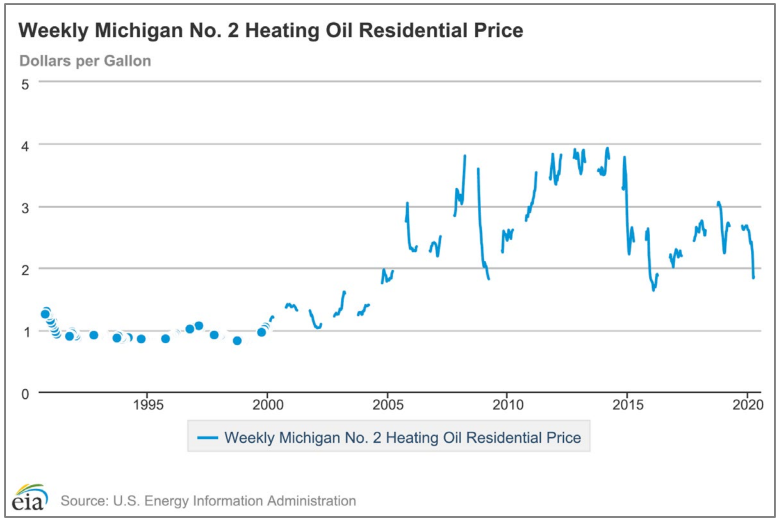


Fossil Fuel Price Volatility

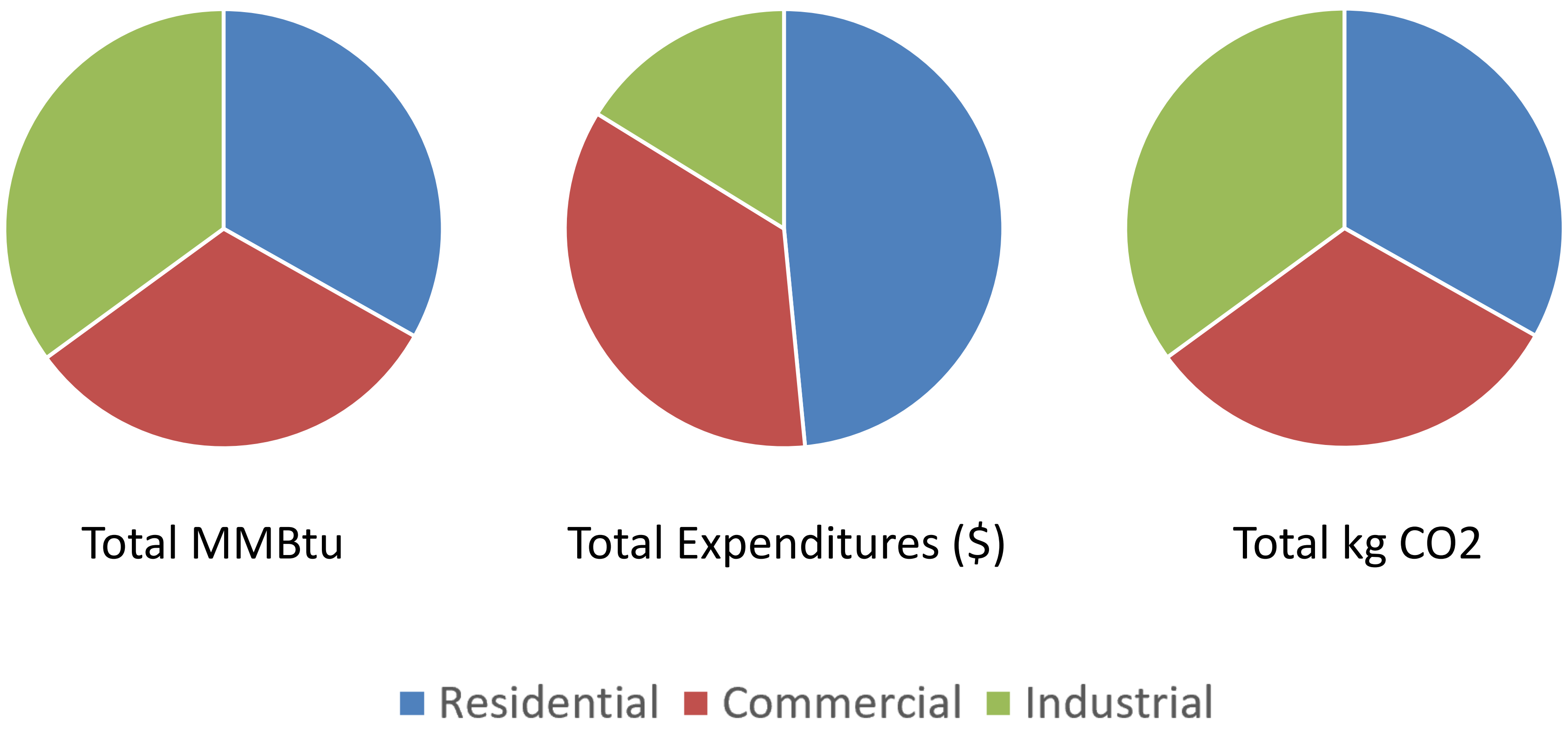






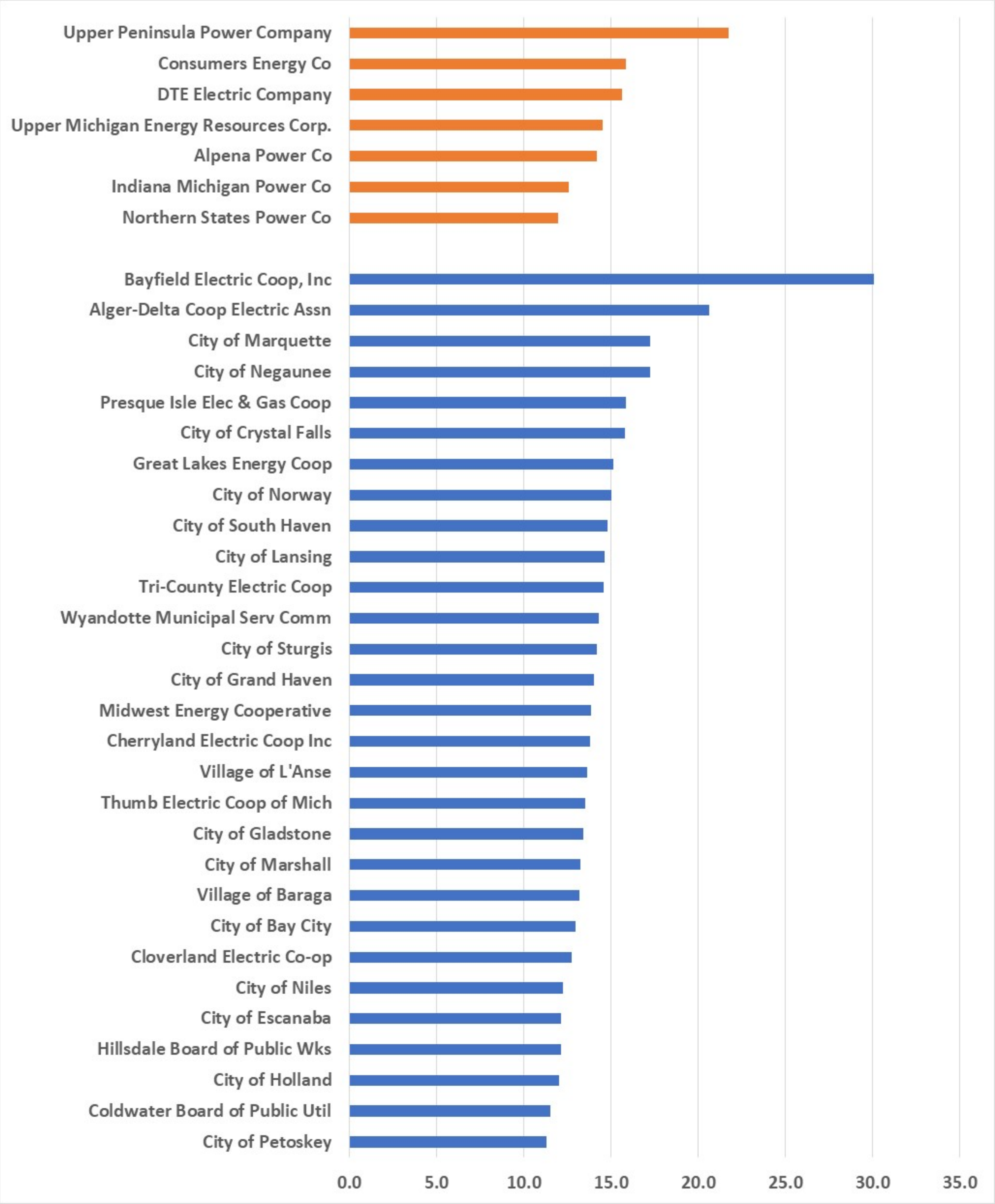


UP Electricity Sales by Sector



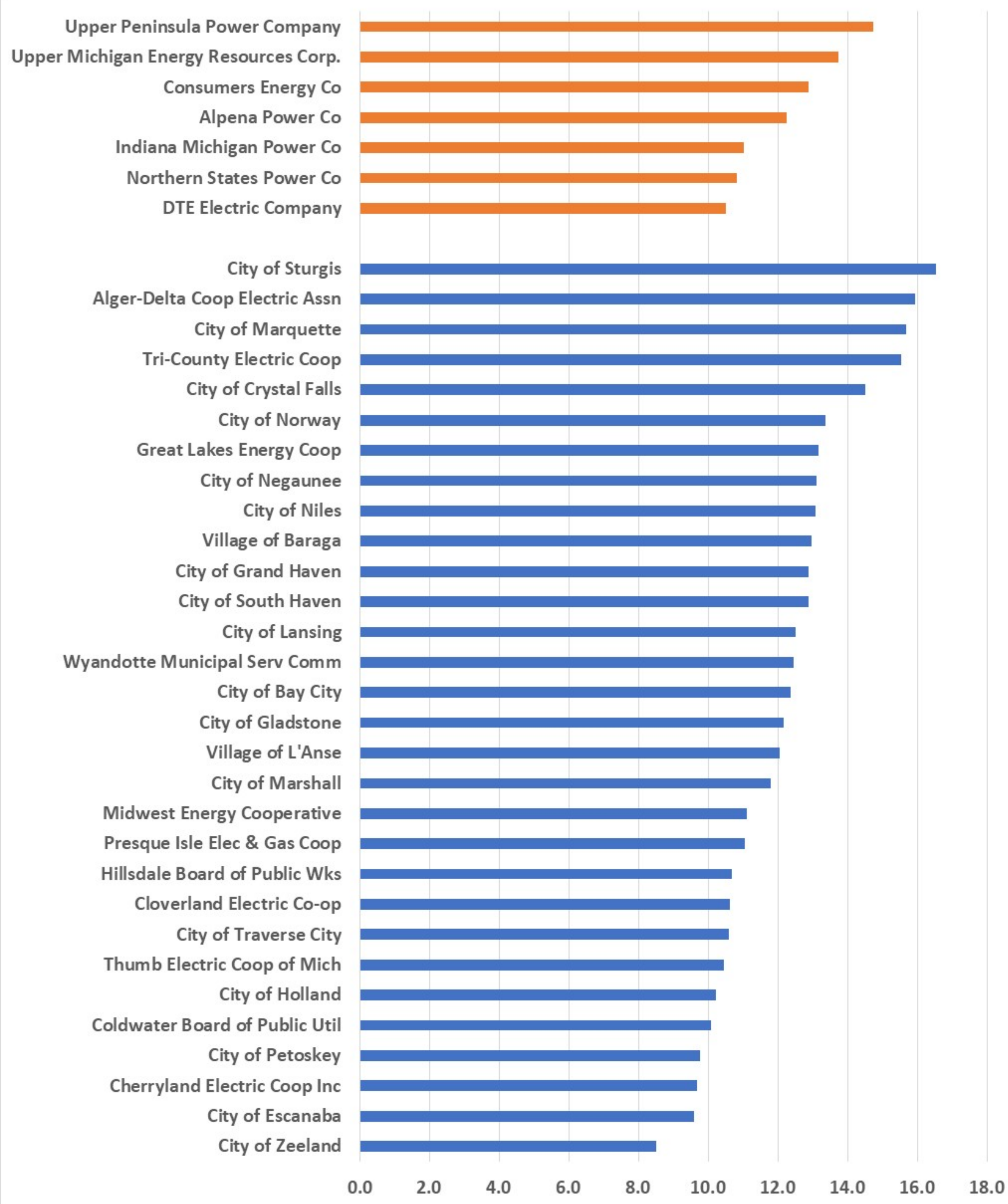
Average Price of Electricity (cents/kWh)

Residential Sector, 2018



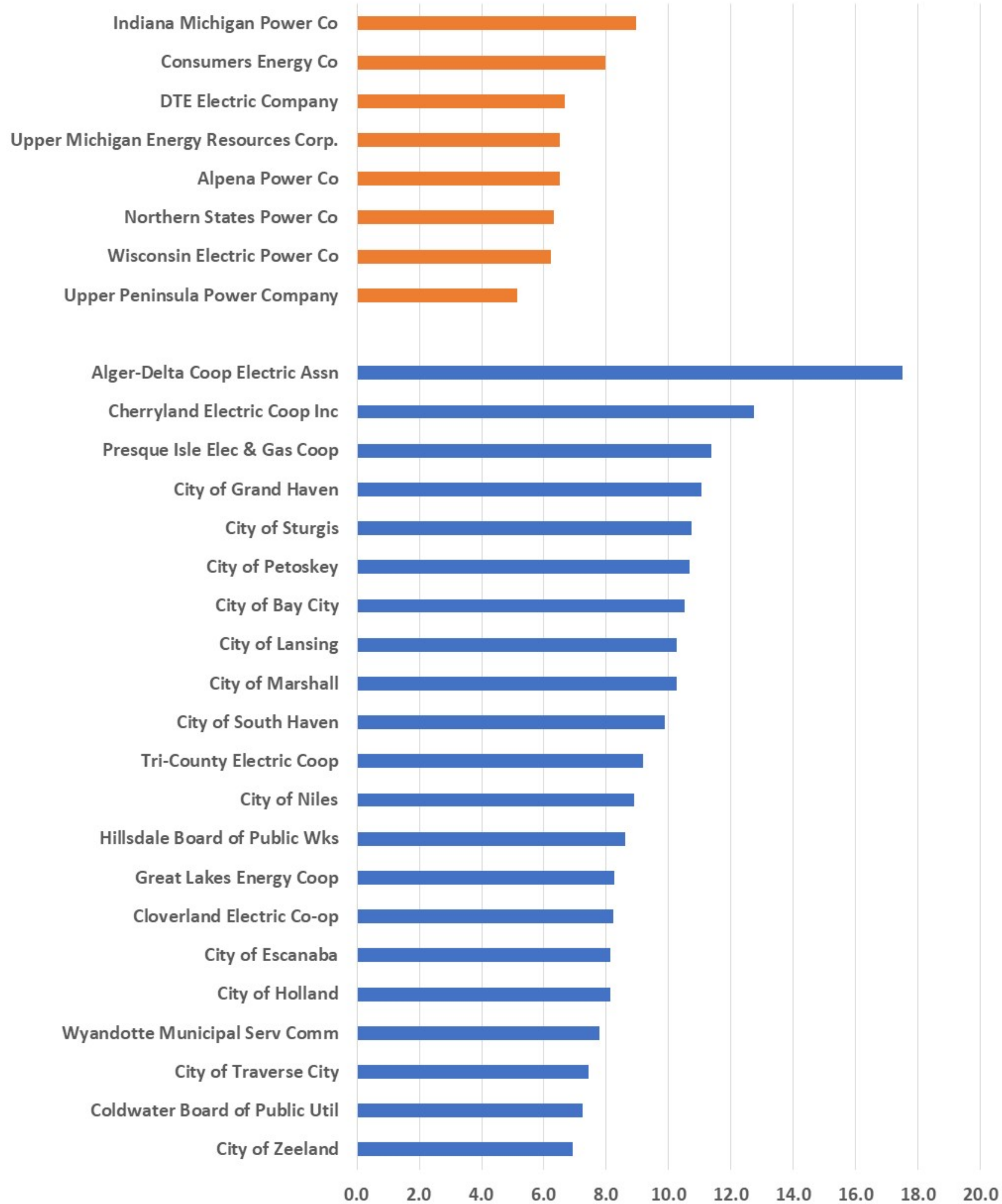
Average Price of Electricity (cents/kWh)

Commercial Sector, 2018



Average Price of Electricity (cents/kWh)

Industrial Sector, 2018

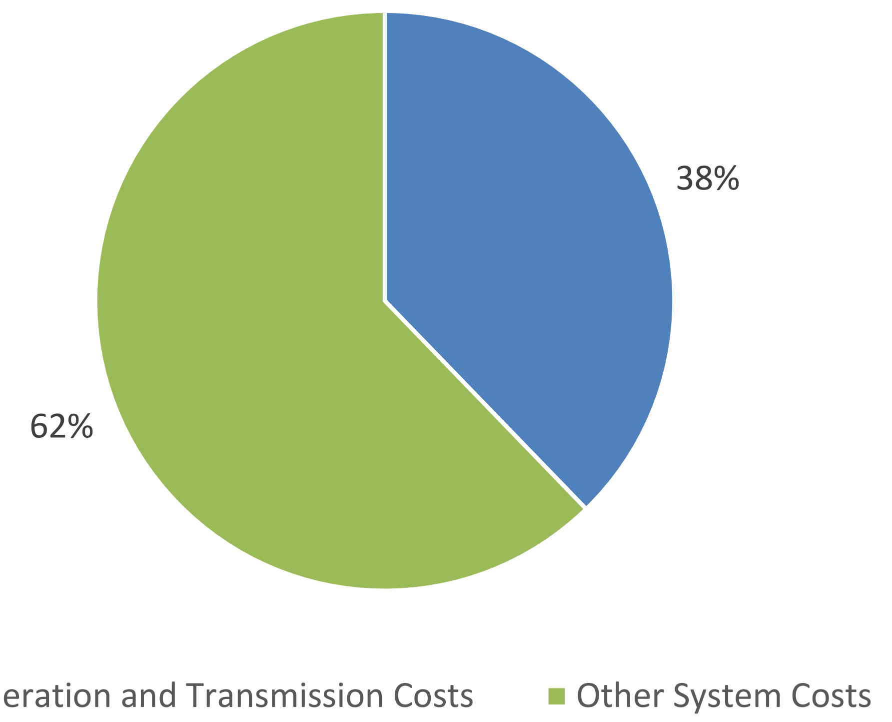


Cost of Electricity

Not all UP Electricity is Expensive:

- Industrial rates are comparatively low
- Some UP utilities have competitive residential and commercial rates. Others are very high.
- High cost is not caused by far-flung distribution (UPPCO vs Cloverland)

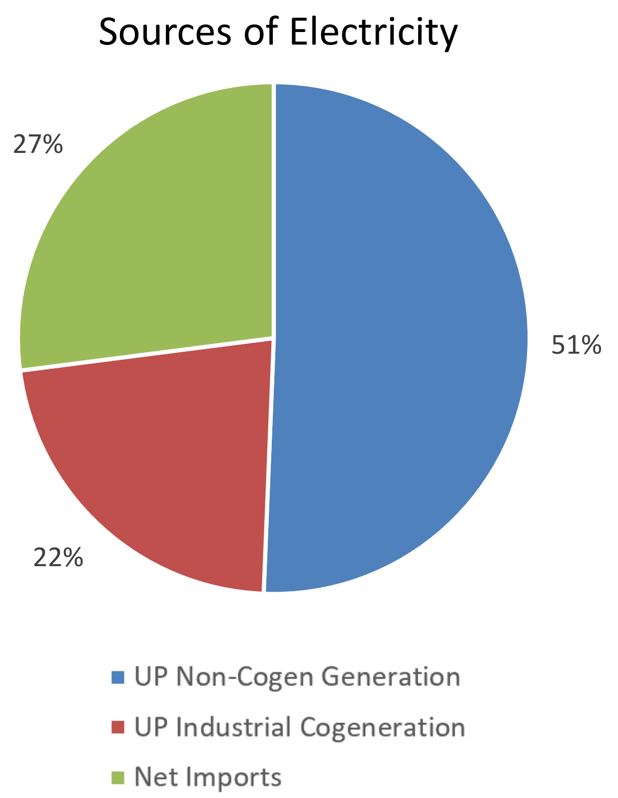
U.P. Electricity Cost Structure

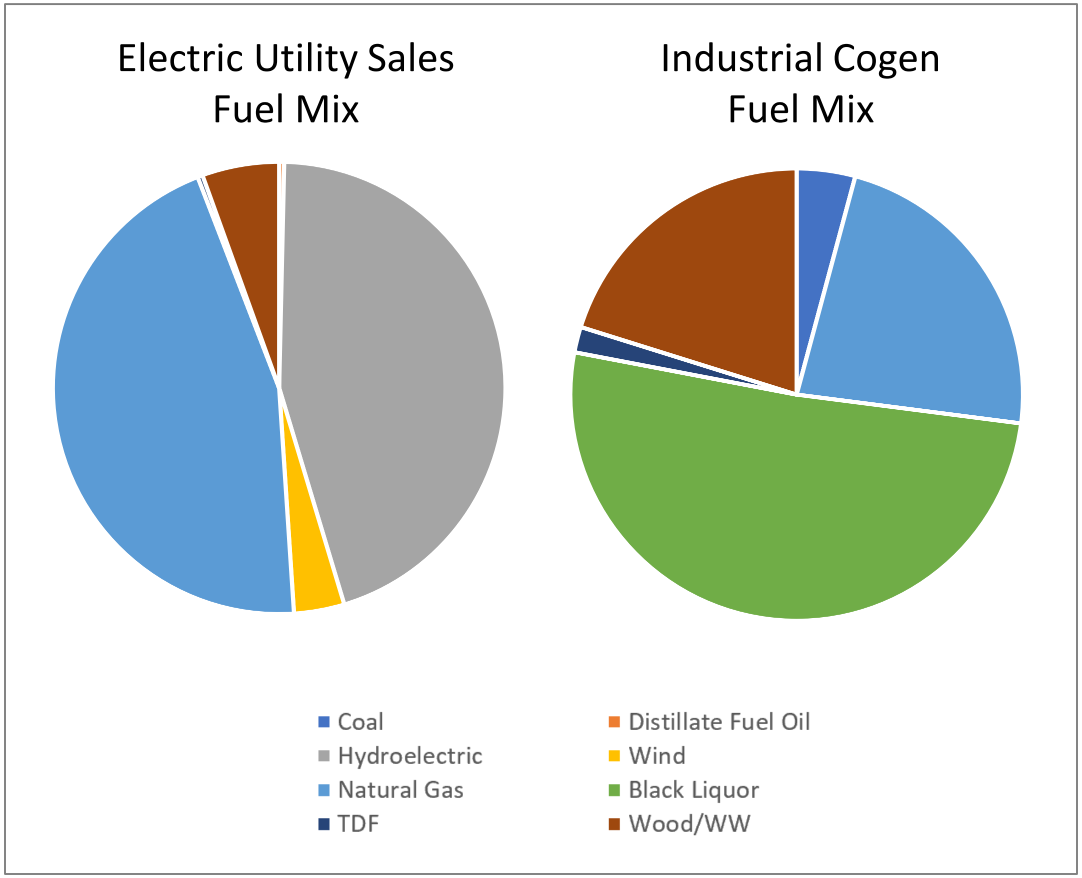


(@ 4.16 cents/kWh average)

Data sources: EIA-861 (2018), U-20227, U-20229

UP Electricity Supply

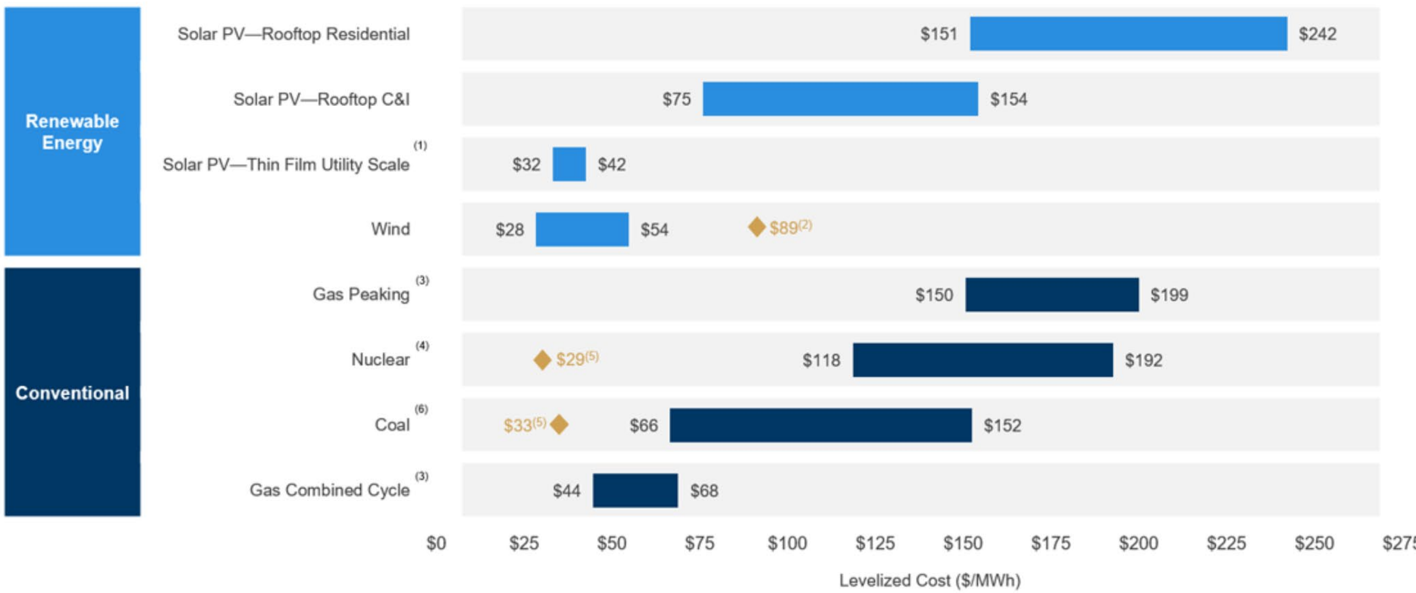




LCOE Comparison: Unsubsidized Analysis

Levelized Cost of Energy Comparison—Unsubsidized Analysis

Selected renewable energy generation technologies are cost-competitive with conventional generation technologies under certain circumstances



Source: Lazard estimates.

Note: Here and throughout this presentation, unless otherwise indicated, the analysis assumes 60% debt at 8% interest rate and 40% equity at 12% cost. Please see page titled "Levelized Cost of Energy Comparison—Sensitivity to Cost of Capital" for cost of capital sensitivities. These results are not intended to represent any particular geography. Please see page titled "Solar PV versus Gas Peaking and Wind versus CCGT—Global Markets" for regional sensitives to selected technologies.

(1) Unless otherwise indicated herein, the low end represents a single-axis tracking system and the high end represents a fixed-tilt system.

(2) Represents the estimated implied midpoint of the LCOE of offshore wind, assuming a capital cost range of approximately $2.33 – $3.53 per watt.

(3) The fuel cost assumption for Lazard's global, unsubsidized analysis for gas-fired generation resources is $3.45/MMBTU.

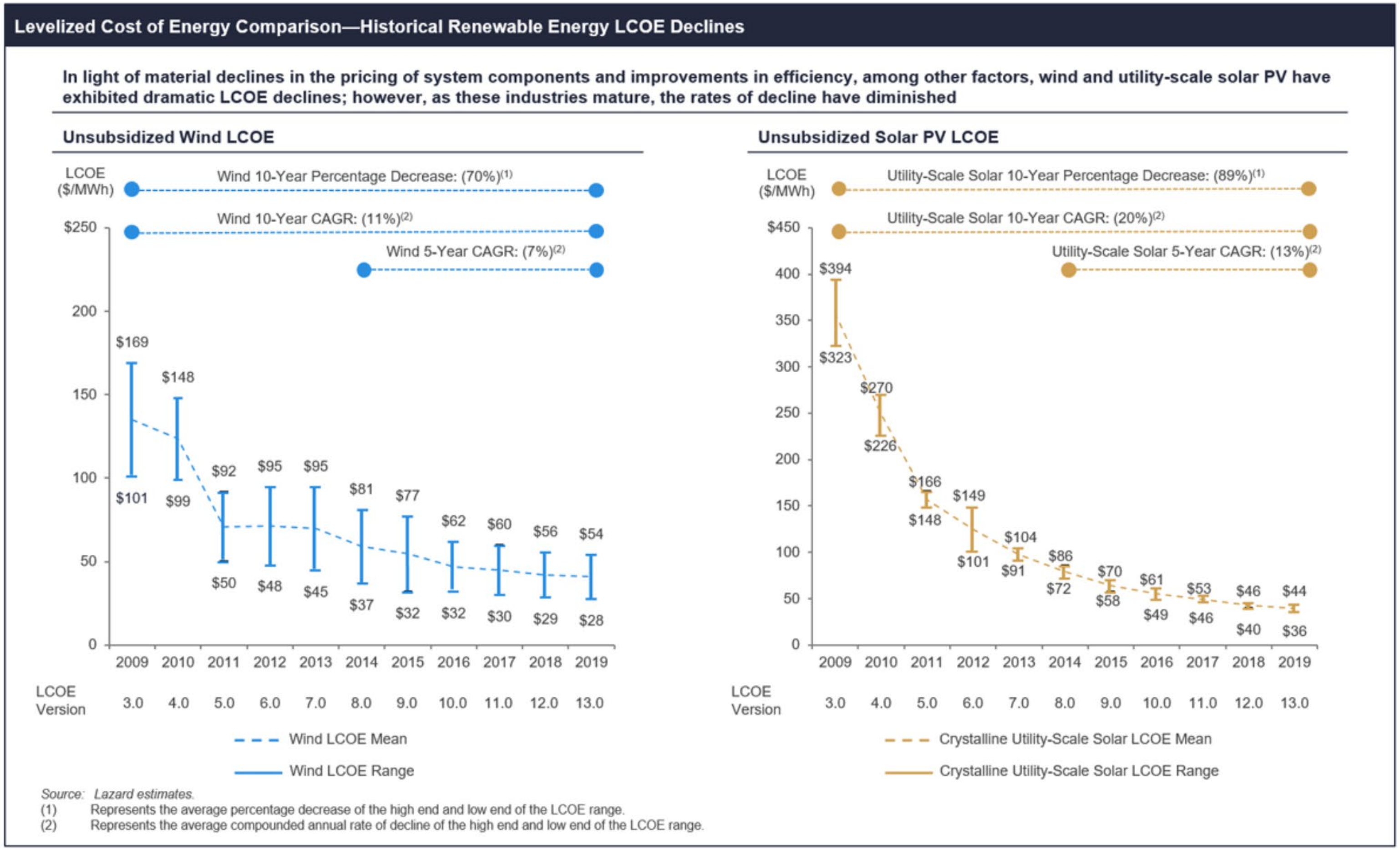
(4) Unless otherwise indicated, the analysis herein does not reflect decommissioning costs, ongoing maintenance-related capital expenditures or the potential economic impacts of federal loan guarantees or other subsidies.

(5) Represents the midpoint of the marginal cost of operating coal and nuclear facilities, inclusive of decommissioning costs for nuclear facilities. Analysis assumes that the salvage value for a decommissioned coal plant is equivalent to its decommissioning and site restoration costs. Inputs are derived from a benchmark of operating coal and nuclear assets across the U.S. Capacity factors, fuel and variable and fixed operating expenses are based on upper and lower quartile estimates derived from Lazard's research. Please see page titled "Levelized Cost of Energy Comparison—Renewable Energy versus Marginal Cost of Selected Existing Conventional Generation" for additional details.

(6) High end incorporates 90% carbon capture and compression. Does not include cost of transportation and storage.

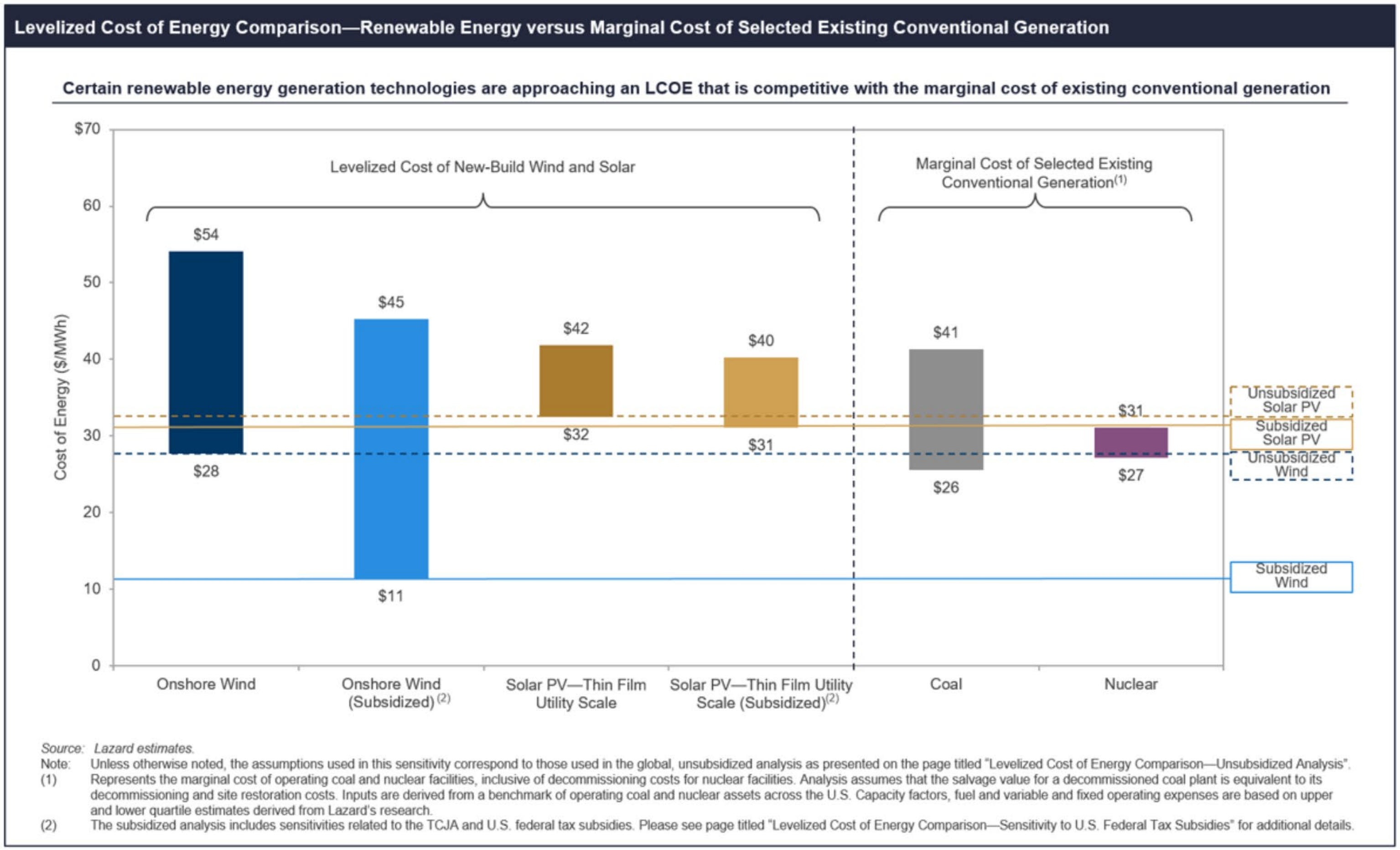
Source: https://www.lazard.com/perspective/lcoe2019/

LCOE Comparison: Historical RE Declines



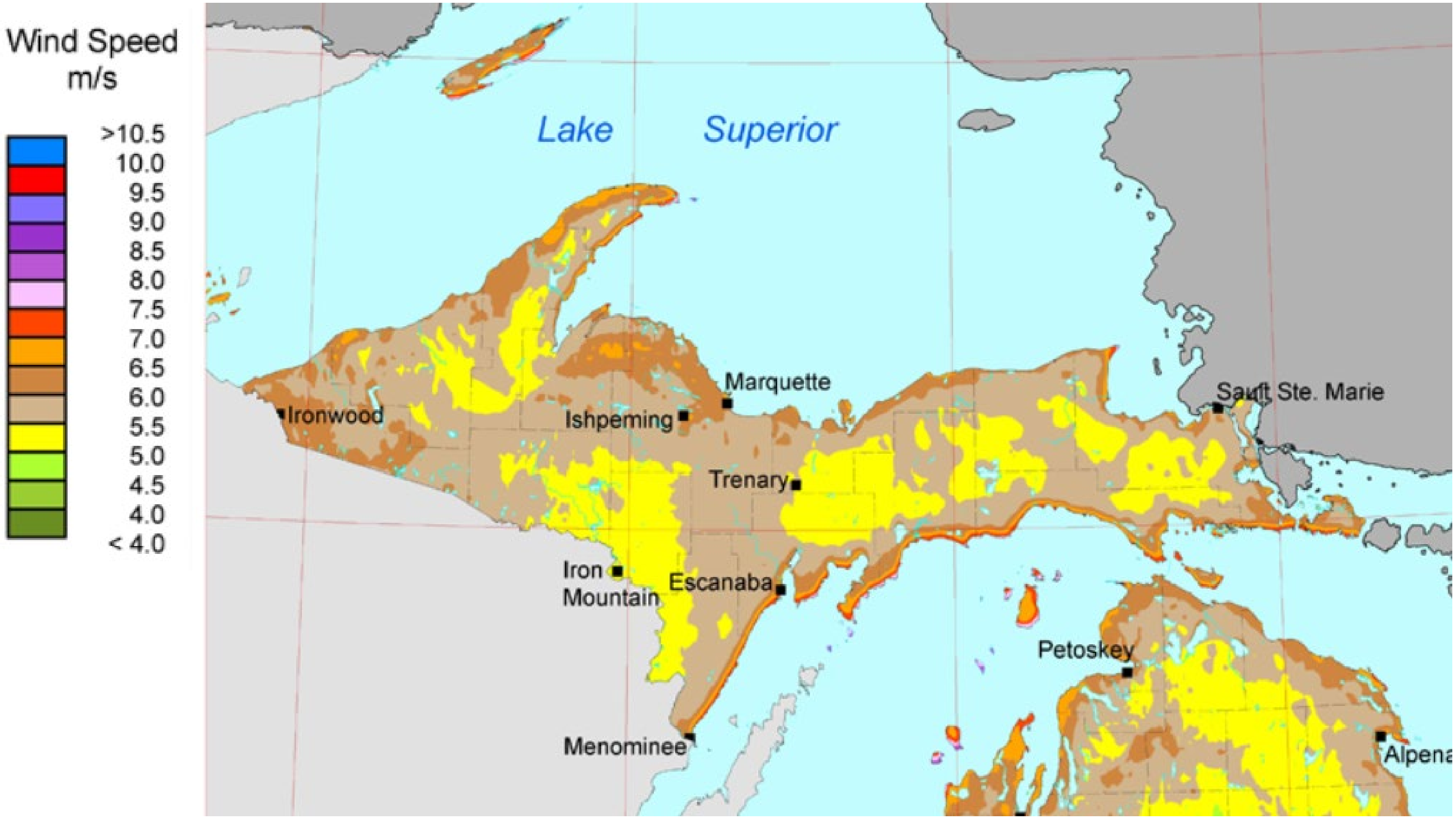
Source: https://www.lazard.com/perspective/lcoe2019/

LCOE Comparison: New RE vs. Existing Conventional



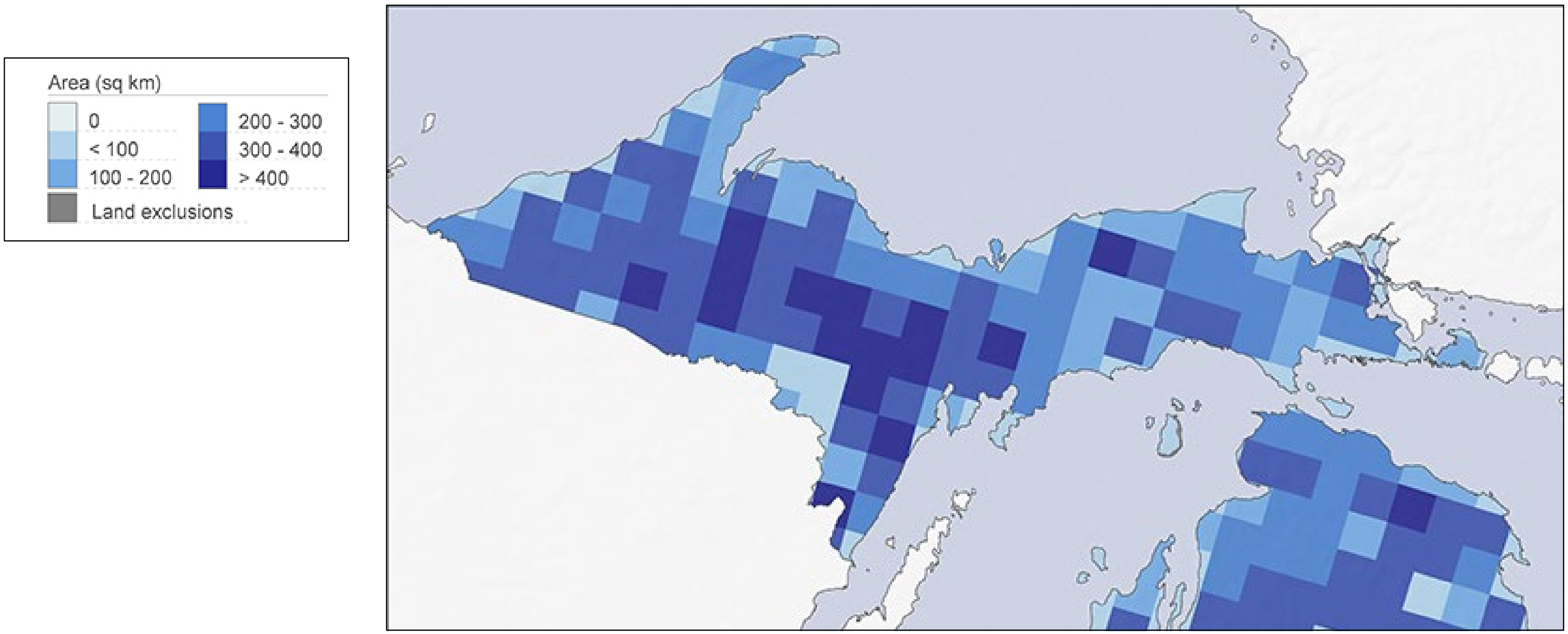
Source: https://www.lazard.com/perspective/lcoe2019/

Annual Average Wind Speed at 80m



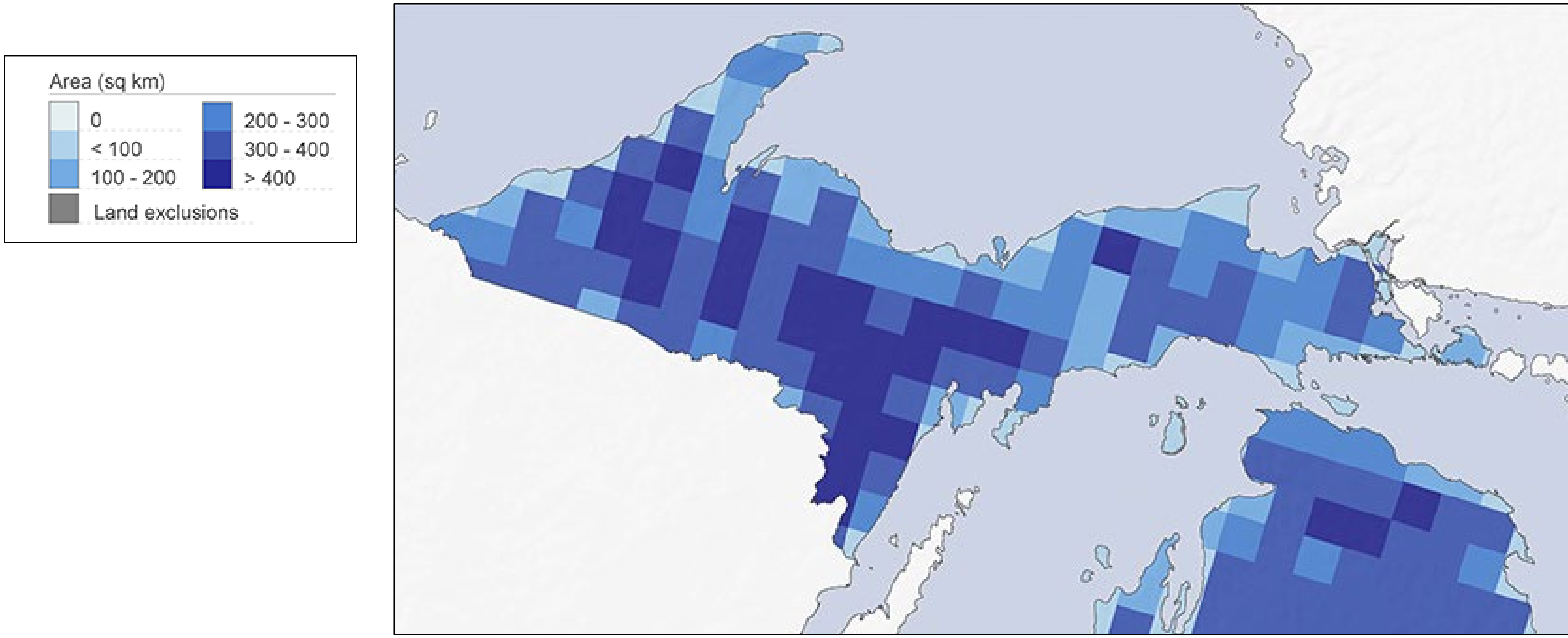
Source: NREL

Potential Wind Capacity at 110m



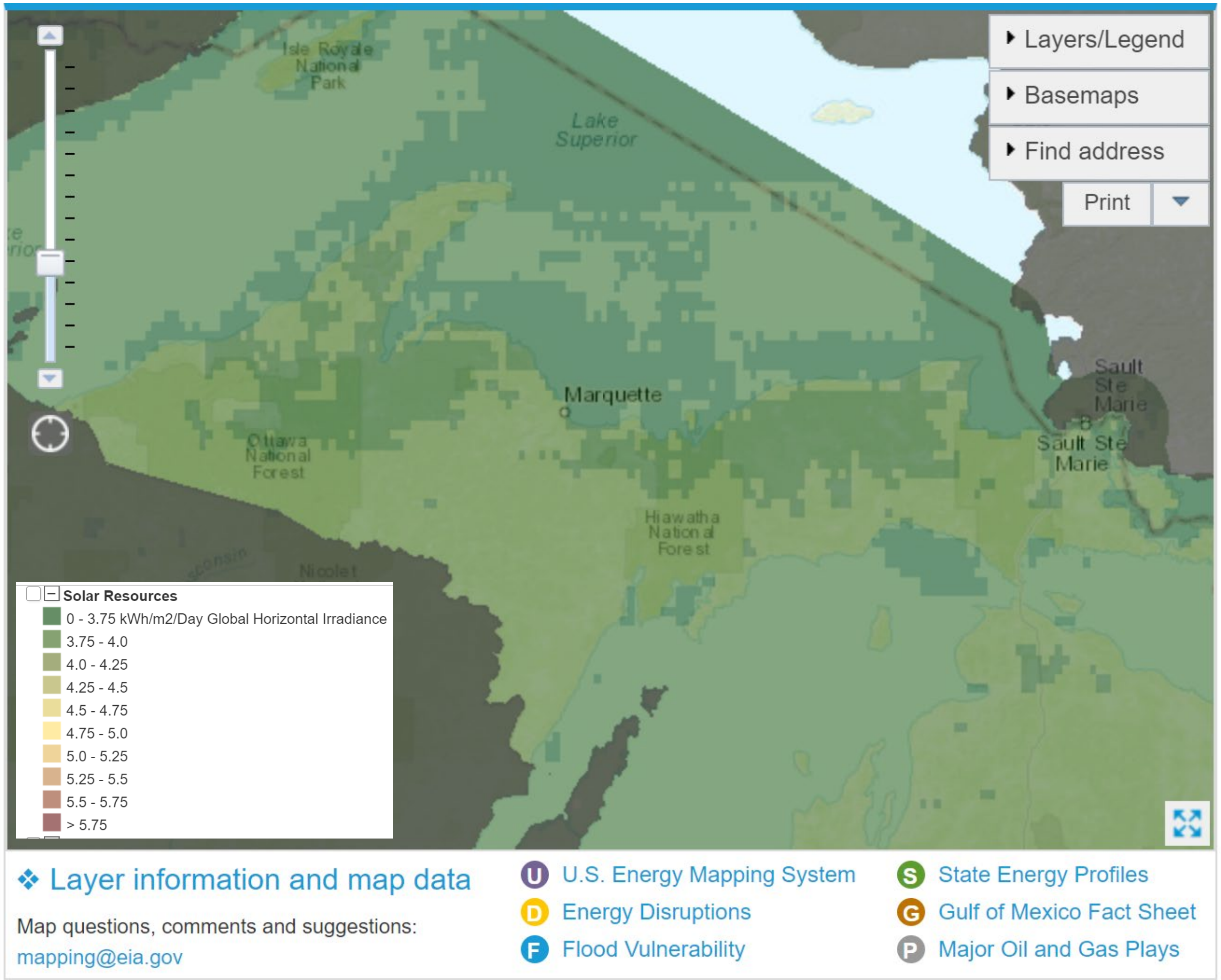
Source: NREL

Potential Wind Capacity at 140m

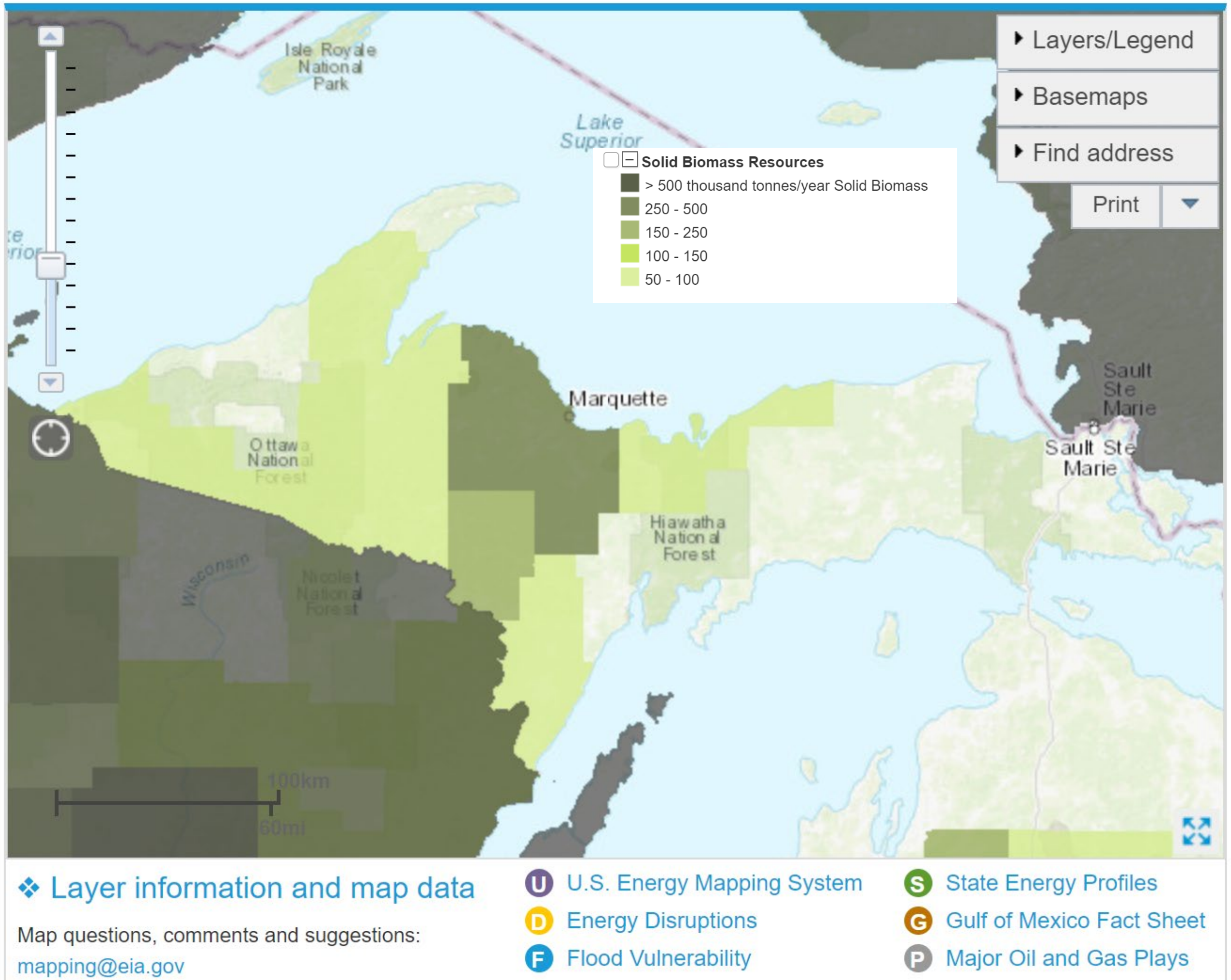


Source: NREL

Solar Resources



Solid Biomass Resources



Renewable Energy Footprint

How much land area would be needed to replace all U.P. electricity net imports with equal parts wind and solar?

U.P. Annual Electricity Net Imports	1,118,102	MWh

Land Area for Wind		
Energy from Wind	559,051	MWh
Capacity Factor (Wind)	0.348	
Installed Wind Capacity	183	MW
Land Use for Wind 1-10 MW	85.0	acres/MW
Conversion Factor	0.0016	square miles/acre
Wind Footprint (Total Project Area)	24.4	square miles
Wind Footprint (Direct Impact)	0.2	square miles

Land Area for Solar PV		
Energy from Solar PV	559,051	MWh
Capacity Factor (Solar)	0.245	
Installed Solar Capacity	260	MW
Land Use for Solar 1-10 MW	6.1	acres/MW
Solar Footprint	2.5	square miles

Migrating Electricity Generation to Renewables

Renewables are already cost-effective for new generation:

- UPPCO Integrated Resource Plan
- Consumers Energy Integrated Resource Plan
- DTE Integrated Resource Plan

Siting in the UP is the Challenge:

- Siting elsewhere and importing increases supply risk
- Siting elsewhere and importing reduces economic benefits
- Siting elsewhere may not be any easier
- Larger scale is cheaper and more disruptive
- In whose back yard?

Electric Transport at Scale

What if all U.P. consumption of motor gasoline was replaced with electric vehicles?

U.P. Current State:		
Annual spending on motor gasoline	$ 368,567,930	
Average unit cost (motor gasoline)	0.12	$/Mile
Annual electricity sales	3,212,245	MWh
U.P. Future State:		
Typical EV unit average	0.30	kWh/Mile
Average electricity rate (residential)	16.1	cents/kWh
Average unit cost (EV)	0.05	$/Mile
Average unit cost of electriciy G&T	4.16	cents/kWh
Annual spending on electricity to operate EVs	$ 39,321,098	
Annual electricity increase to operate EVs	944,765	MWh
Increased electricity as percent of current sales	29%	

Electrifying Transportation

Vehicles must be available:

- Current models are higher cost sedans
- 2021 Models are cost-effective on a life-cycle basis
- All major manufacturers announced multiple 2022 models
- By 2025, first cost for EVs expected to be less than for

Internal Combustion Engines

Charging infrastructure is needed in the UP:

- 85% charging at home
- Fast charging needed for road trips
- Fast charging has “chicken or egg” problem
  - Not profitable until electric vehicles in use
  - Electric vehicles not viable without fast charging

Electric Buildings at Scale

What if all U.P. consumption of residential propane was replaced with electric heat pumps?

And what if residential heating demand was reduced 30% by investing in energy efficiency?

U.P. Current State:		
Annual residential spending on propane	$ 46,486,580	
Assumed average furnace efficiency	0.85	
Actual residential heating demand	2,075,587	MMBtu
Residential retail cost of propane	19.04	$/MMBtu
Annual electricity sales	3,212,245	MWh
U.P. Future State:		
Assumed heat pump COP	2.0	
Annual electricity to run heat pumps	304,160	MWh
Retail residential electricity cost per MMBtu (current)	47.23	$/MMBtu
Retail residential spending to run heat pumps (at current cost)	$ 49,014,989	
Electricity G&T cost per MMBtu (current)	12.20	$/MMBtu
Incremental electricity G&T cost to run heat pumps	$ 12,658,941	
EE scenario: Energy savings from building improvement	30%	
Annual electricity to run heat pumps (EE scenario)	212,912	MWh
Retail residential spending for heat pumps (at current cost, EE scenario)	$ 34,310,492	
Incremental electricity G&T cost to run heat pumps (EE scenario)	$ 8,861,259	
Annual residential spending on propane (EE scenario)	$ 32,545,206	
Increased electricity for heat pumps as percent of current sales	9.5%	
Increased electricity as percent of current sales (EE scenario)	6.6%	

Electrifying Buildings

Electrifying heat:

- Increases electricity sales and dilutes rates
- Significantly reduces total energy costs for the UP, but
- Electricity costs more at retail rates than the heating fuel it replaces

Co-benefits of greater investment in heat pumps:

- Leverage from existing incentives and financing
- Increased demand for skilled trades
- Supply chain activity to deliver materials and equipment

But, building electrification displaces fossil fueled economy

Deep Energy Savings in Buildings

Typical building shell improvements:

- High R-value insulation in attic, walls, foundation
- Installation of more efficient windows
- Proper air-sealing
- Cost-effective but requires significant investment

Co-benefits of greater investment in energy efficiency:

- Leverage from existing incentives and financing
- Increased demand for skilled trades
- Supply chain activity to deliver materials and equipment

Interesting potential benefits:

- Building shell improvements are forest products
- Better buildings are healthier for occupants

Key Strategic Takeaways & Suggested Task Force Priorities

- Explore Comparative Cost Structures of UP Electric Utilities
- Renewable Energy Siting
- Transport Electrification
  - Work on charging infrastructure
- Building Electrification
  - Work on electricity rate design
- Deep Energy Savings in Buildings
  - Financing and workforce/business development

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