

RENEWABLE ENERGY IN OHIO

Reducing our carbon footprint

Frederick C. Michel

President, Wayne County Sustainable Energy Network



“The American Way of Life is NON-NEGOTIABLE!”

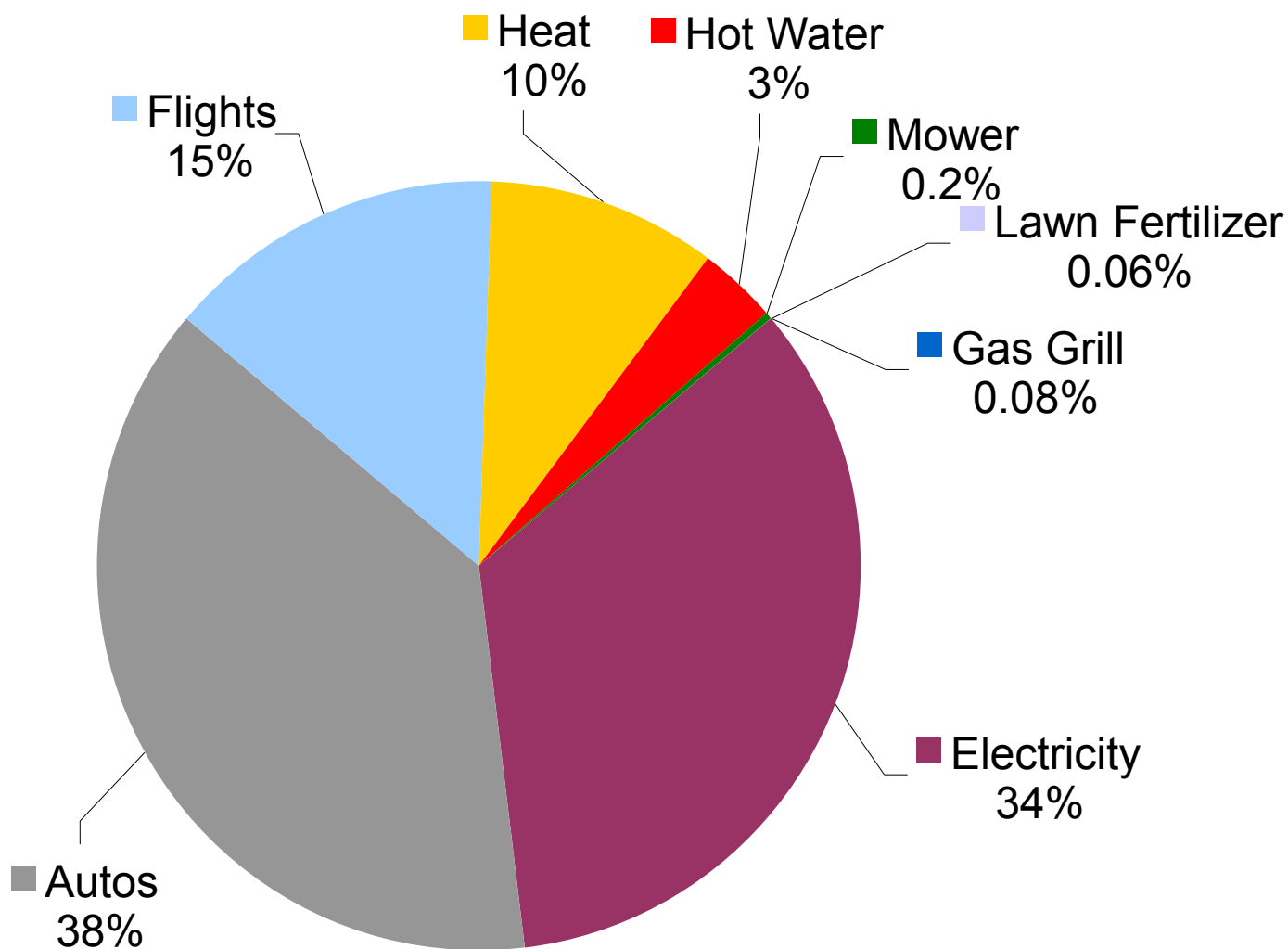


Dick Cheney

“The American Way of Life”

Home energy use for our family in 2005

29,805 kg CO₂/yr



Muir Glacier, SE Alaska

August, 1941 (photo by William Field)



August, 2004 (photo by Bruce Molnia)



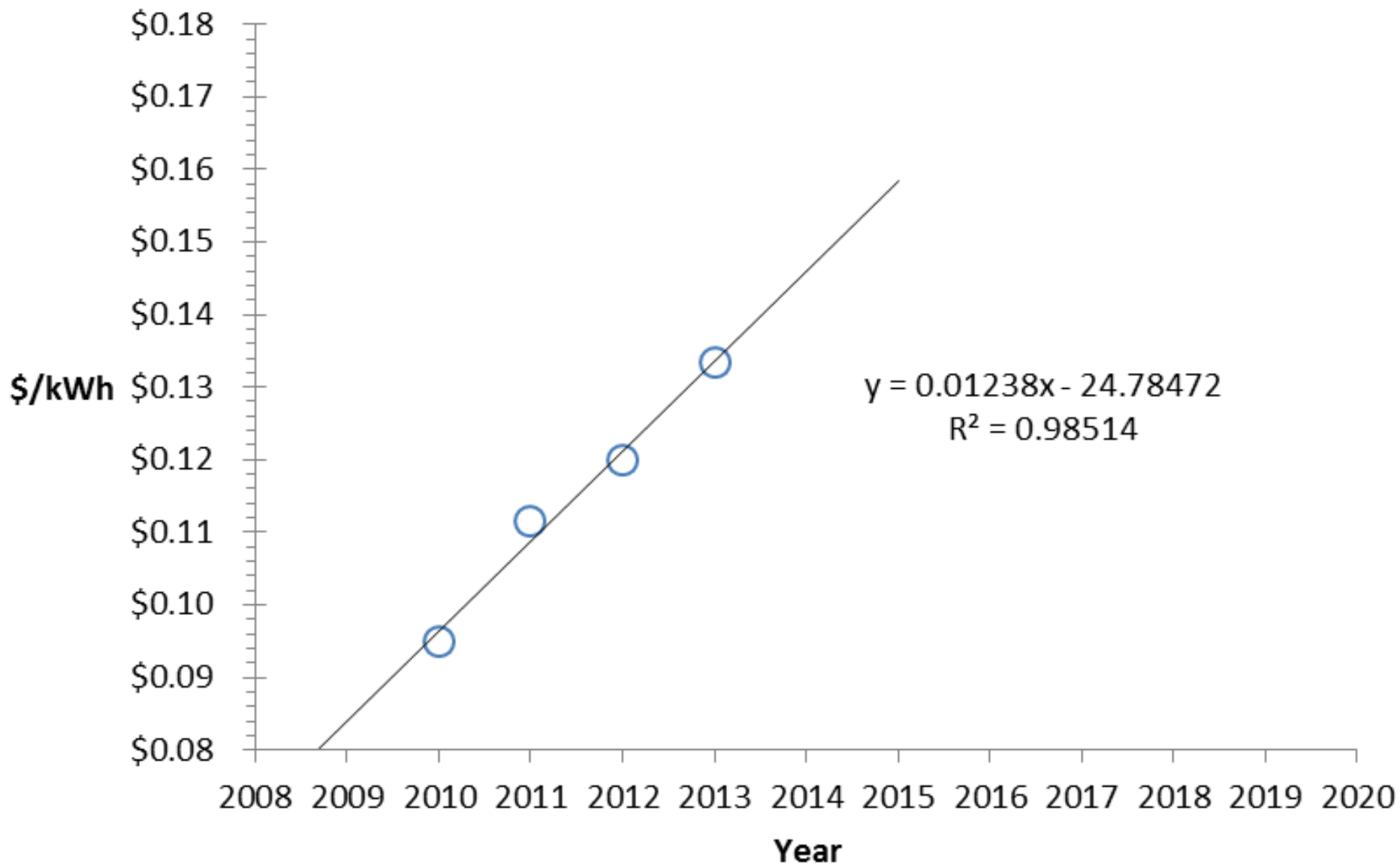
Extreme weather events, like the OARDC tornado, are occurring more frequently and causing greater destruction



Question:

Can the “American Way of Life” be fueled by renewable energy sources that are Carbon neutral and potentially sustainable?

Electricity Prices in our community have climbed 40% in 3 years



What can be done?

1. Work locally to promote and develop renewable energy solutions.
2. Personally adopt energy efficiency measures to reduce fossil energy use.
3. Generate clean energy at home using photovoltaics and other sources.
4. Drive EV or PHEV vehicles that receive electricity from renewable energy.

Wayne County Sustainable Energy Network

Our Mission

- *“To promote energy sustainability through education and action”*
- *501c3 not-for-profit charitable organization dedicated to the promotion and support of sustainable energy practices and policies in Wayne County.*



WCSEN Projects

Habitat for Humanity

Solar Power Station



Armstrong Building



DATE: July 2010

LOCATION:

Armstrong Building
Wayne County Fairgrounds
199 Vanover Street
Wooster, Ohio

FEATURES:

- 32 Uni-Solar PVL-68 Photovoltaic Panels
- 2.2 kW grid tie system provides power to the fairgrounds
- Xantrex GT 2.8 Converter

Has returned ~ \$1000 of SREC income to WCSEN

Norwayne Elementary



DATE: November 2010

LOCATION:

Norwayne Elementary School
Outdoor Classroom Pavilion
350 S. Main Street
Creston, Ohio

FEATURES:

- 16 Uni-Solar PVL-136 Photovoltaic Panels
- 2.1 kW grid tie system
- Monitoring equipment for student interaction
- Centerpiece to an environmental learning and discovery garden

Romich Residence



DATE: August 2010

LOCATION:

1517 Beall Avenue
Wooster, Ohio

FEATURES:

- 26 Uni-Solar PVL-68 Photovoltaic Panels
- 1.75 kW grid tie system
- 225 W 12-volt battery backup solar PV system
- Energy efficient, insulated and air-sealed, 2" x 6" stud construction on 24" centers

Clement L. Ault Education Center



DATE: September 2010

LOCATION:

Clement L. Ault Education Center
312 S. Main Street
Creston, Ohio

FEATURES:

- 15 Uni-Solar PVL-68 Photovoltaic Panels
- 1 kW grid tie system
- Energy efficient, insulated and air-sealed, 2" x 6" stud construction on 24" centers
- Raised heel roof trusses and insulated headers



Unitarian Universalist Fellowship, Wayne County



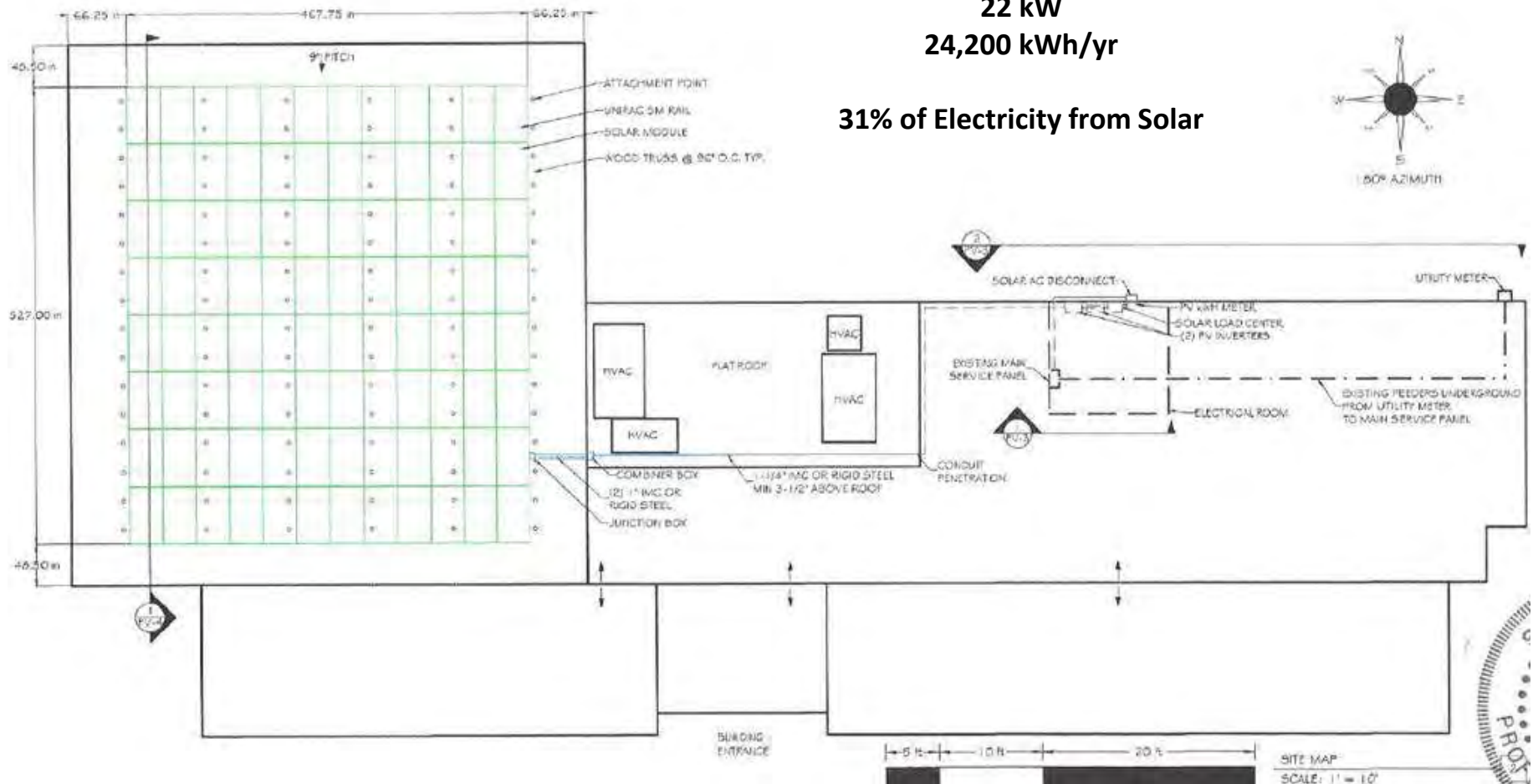
UU Roof PV Array

96 panels

22 kW

24,200 kWh/yr

31% of Electricity from Solar







Sustainable Energy Installations in Wayne County

G&S Titanium, Wooster
68 kW solar PV

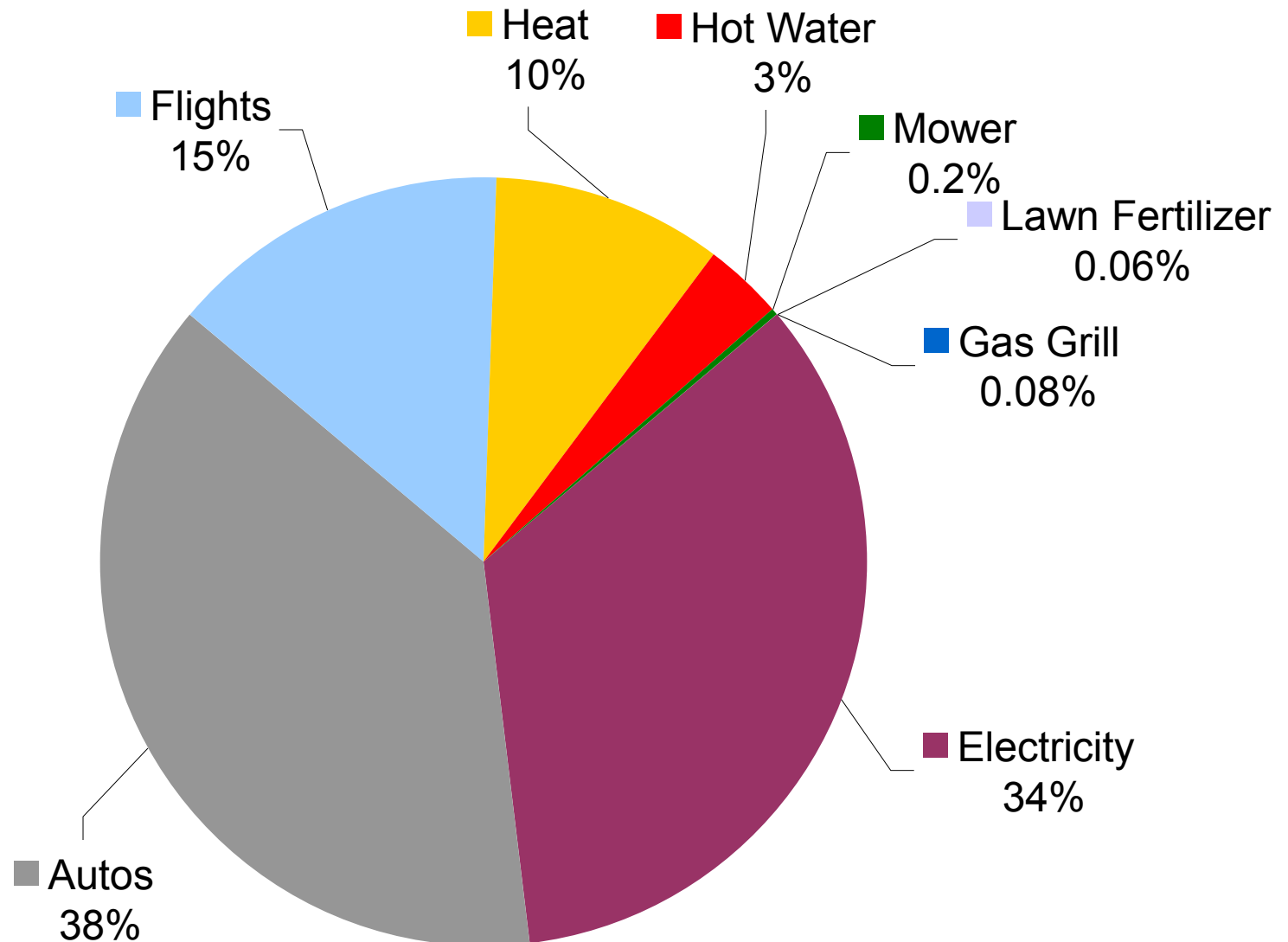


WCSEN Educational Programs



Yesterday

29,805 kg CO₂/yr



ENERGY TYPES

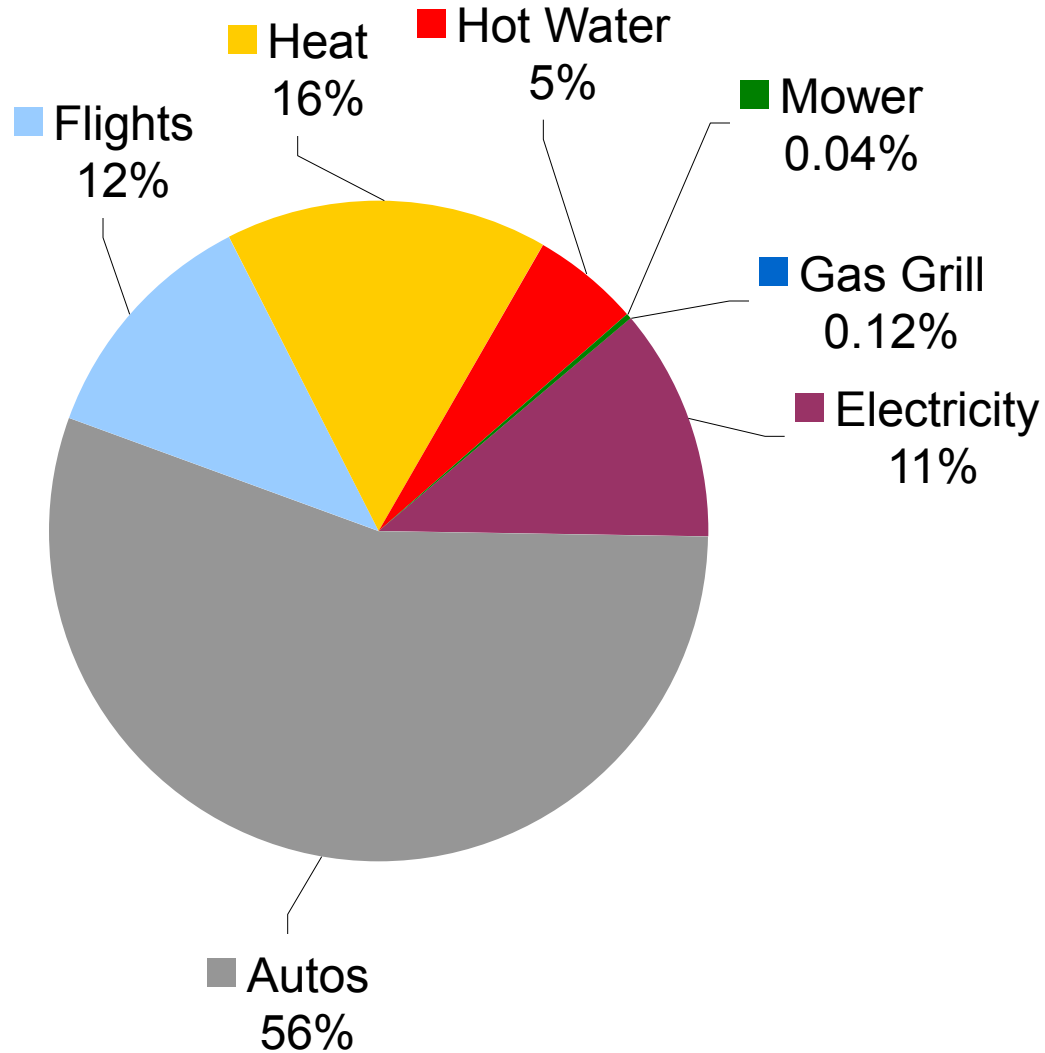
ENERGY	YESTERDAY	TODAY
Lighting	Incandescent	CFL/LED
Electric	Grid	PV/Grid
Auto	Gasoline	Gas/EtOH/Electric
Air	Jet Fuel	Jet Fuel/Less
Heat	Nat Gas	Nat Gas
Hot water	Nat Gas	Nat Gas
Mower	Gasoline	Electric
Gas Grill	Propane	Propane/Biogas
Lawn Fertilizer	Chemical	Chemical/Organic

Our 100% solar electric home in Wooster, Ohio



Today

18,708 kg CO₂/yr



Ford Escape Hybrid

- 4 cylinder Atkinson Cycle engine
- Continuously variable automatic transmission (CVT)
- Regenerative braking system
- 300 Volt AC electric motor
- 1 kWh NiMh battery
- EPA mileage 31 mpg city, 29 mpg highway.
- Touch screen hybrid system monitoring display.



Enginer PHEV conversion

- 48 volt Li-Phos battery
- 4 kWh capacity
- 10 mile full electric driving range
- Charged using 110 V AC
- Cost \$3,000.

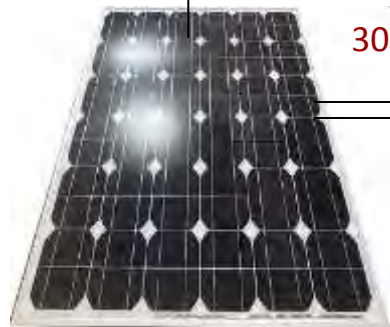


Solar Charger for Escape PHEV

- A roof mounted 175 Watt, 24 volt PV solar panel directly charges the Li-Phos battery
- Mounted to allow tipping to provide optimum solar gain.
- Voltage converter increases the solar panel voltage to a constant 56 volts DC.
- This energy flows into the LiPhos battery using a Battery Management System
- that facilitates even charging of the batteries and prevents overcharging.
- In full sun, the charging system provides 1/4 mile of all electric driving each hour.
- A full day of sun can provide 2-3 miles of EV driving distance.
- Total cost for the solar charger approximately \$300.



Sunlight



30-50 V DC



Charge
Converter
CV 24/48 - 6PV

56.4 V DC



DC meter
Watts up?
Wh

24 V Solar Panel
175 Watt

110V AC



Charger

55.5 V DC



Battery
Management
System

50-60 V DC

Enginer
Battery
4 kWh



48 V DC



Escape Electric Motor

300V DC



Voltage
Converter

SOLAR ESCAPE PHEV ENERGY USE FOR 100 MILES OF MOSTLY CITY DRIVING

Solar Energy from 170 watt roof rack panel (10 days)	5.2 kWh
Grid Electricity (measured using Kill-a-watt meter)	15.7 kWh
Gasoline used	2.0 gallons

Constants-

Energy in gas	36.6 kWh/gal
Efficiency of Internal Combustion gasoline engine	0.20
Efficiency of Escape electric motor	0.95
Efficiency of AC to DC inversion	0.95

Calculations-

Energy from gas	$2.0 \text{ gal} * 36.6 \text{ kWh/gal} * 0.30 =$	16.1 kWh
Energy from grid	$15.7 \text{ kWh} * 0.95 * 0.95 =$	15.3 kWh
Solar Energy	$5.2 \text{ kWh} * 0.95 =$	5.4 kWh

Percent contributions of the three energy sources -

Gasoline	44%
Grid Electricity	42%
Solar Electricity	15%

Life Cycle Carbon emissions

Based on a Well to Wheels analysis using EPA City mpg estimates for comparisons. The grid electricity mix used is for Ohio, 90% coal, 10% nuclear.

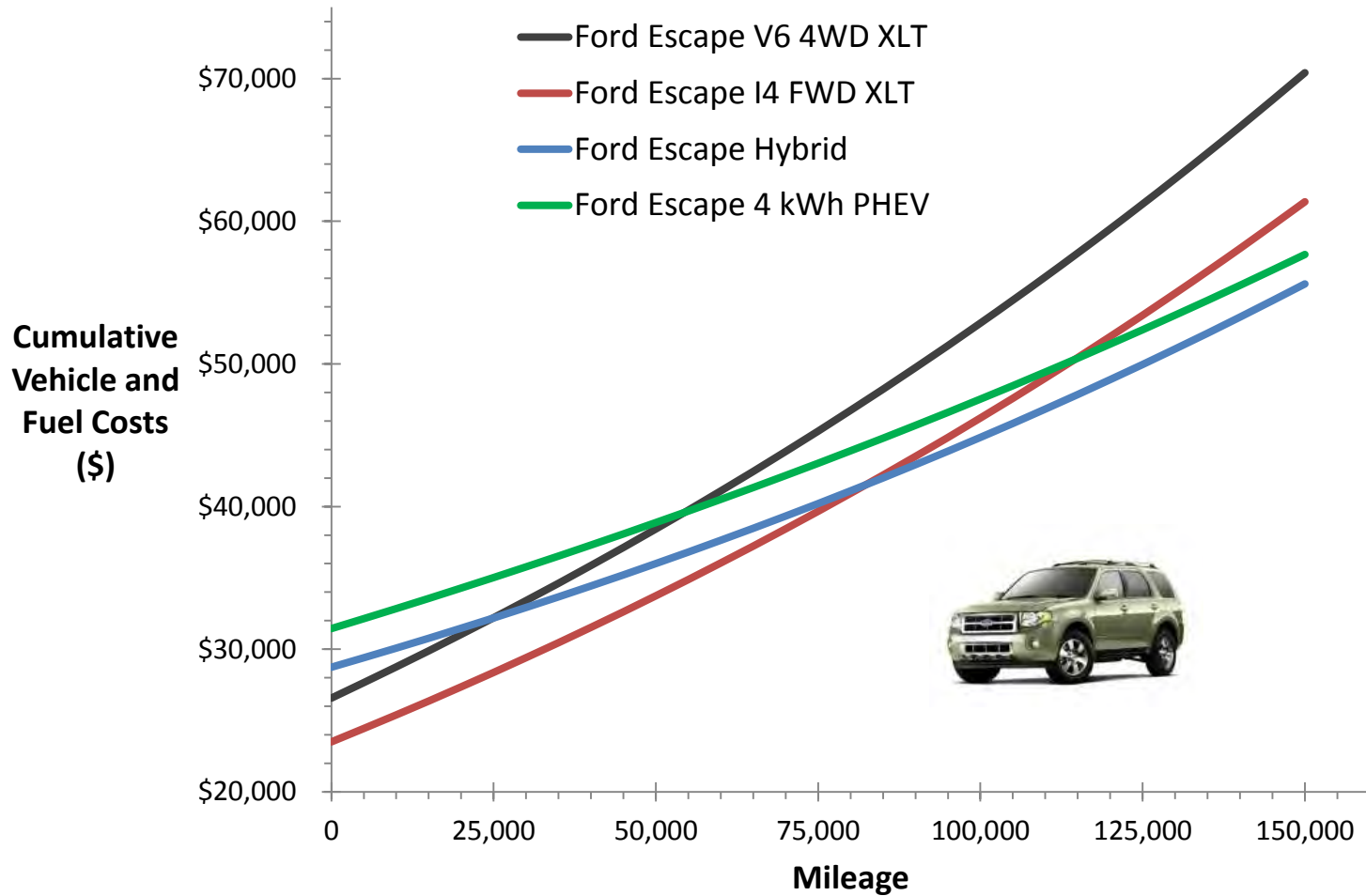
Escape Enginer Solar PHEV with home PV charging	190 g CO ₂ /mi
Escape Enginer Solar PHEV	322 g CO ₂ /mi
Escape Enginer PHEV	364 g CO ₂ /mi
Escape Hybrid (34 mpg)	341 g CO ₂ /mi
Escape I4 (23 mpg)	504 g CO ₂ /mi
Escape V6 4WD (18 mpg)	644 g CO ₂ /mi
Prius HEV	229 g CO ₂ /mi

The Solar Escape reduces CO₂ emissions compared to an I4 Escape by 36% and by 50% compared to a 4WD V6 Escape. But the Ohio electricity mix means that a PHEV actually has worse CO₂ emissions than a regular hybrid. The solar charger reverses that. The Solar Escape PHEV produces 41% more CO₂ than a Prius HEV that gets 43 mpg. But if the battery is charged at home from a PV system, the Life Cycle CO₂ emission drops to 190 g CO₂/mi.

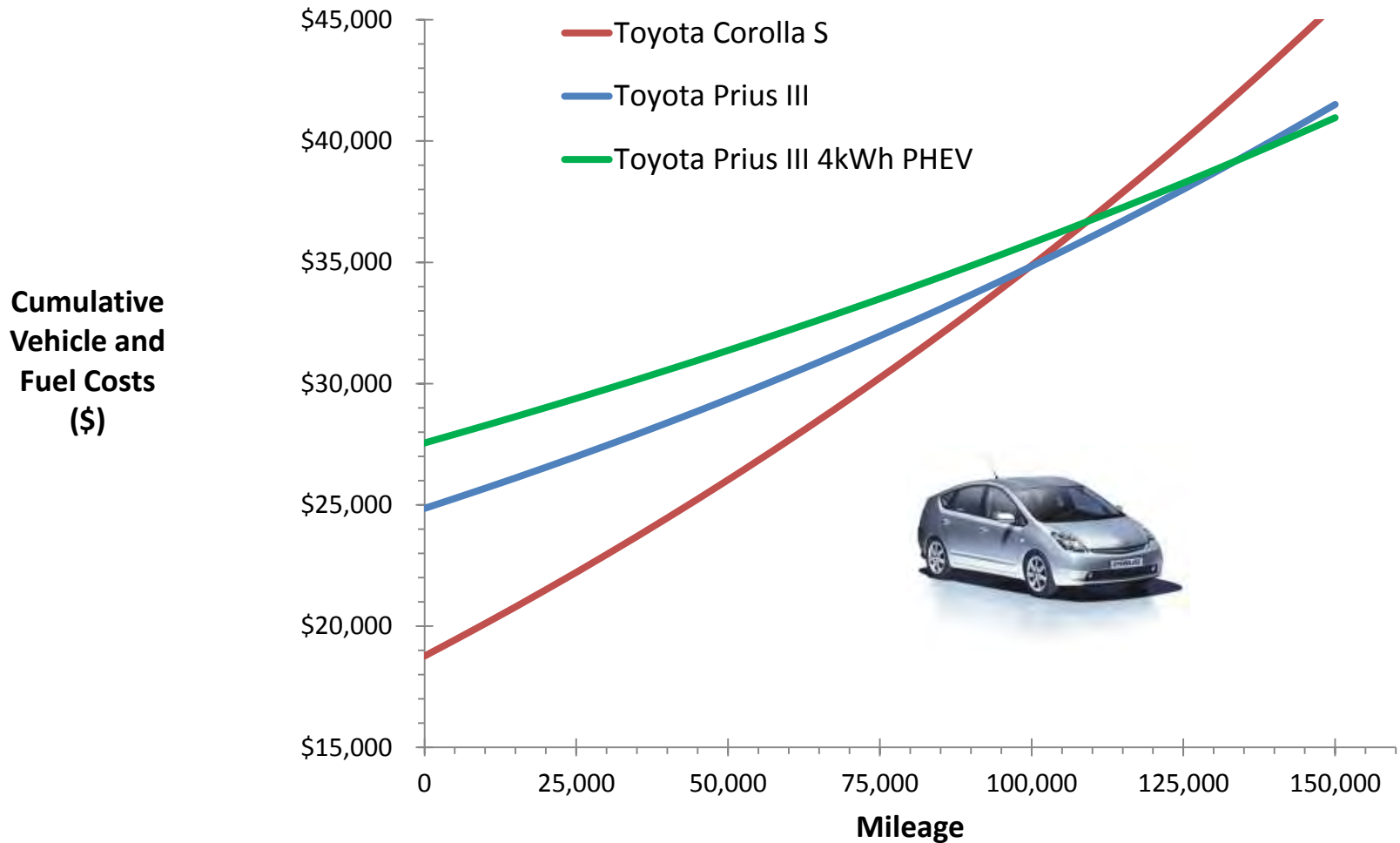
Costs and MPG of hybrids, PHEV and conventional vehicles

Assumptions	Ford Escape V6 4WD XLT	Ford Escape I4 FWD XLT	Ford Escape Hybrid	Ford Escape 4 kWh PHEV	Toyota Prius III	Toyota Corolla S	Toyota Prius III 4kWh PHEV
Vehicle Cost (\$ MSRP new)	\$24,465	\$21,685	\$27,445	\$30,445	\$24,050	\$17,470	\$27,050
MPG (EPA est. combined)	19	22	31	40	50	31	70
Gas use (gal/10,000 mi)	526	455	323	250	200	323	143
Electricity Use (kWh/mile)				0.3			0.2
Electricity Price (\$/kWh)				0.12			0.12

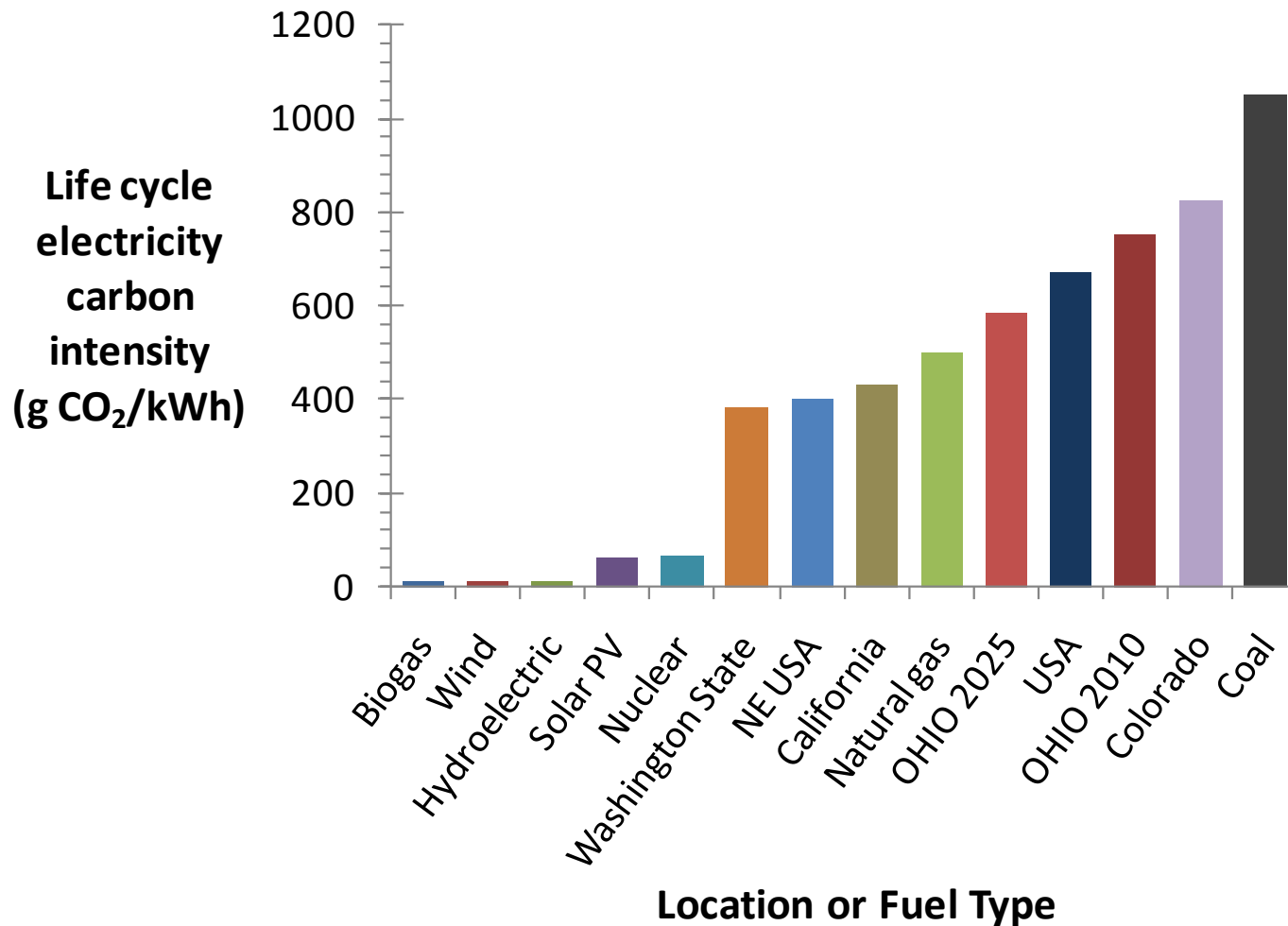
Costs to Own V6, I4, Hybrid or PHEV Ford Escape



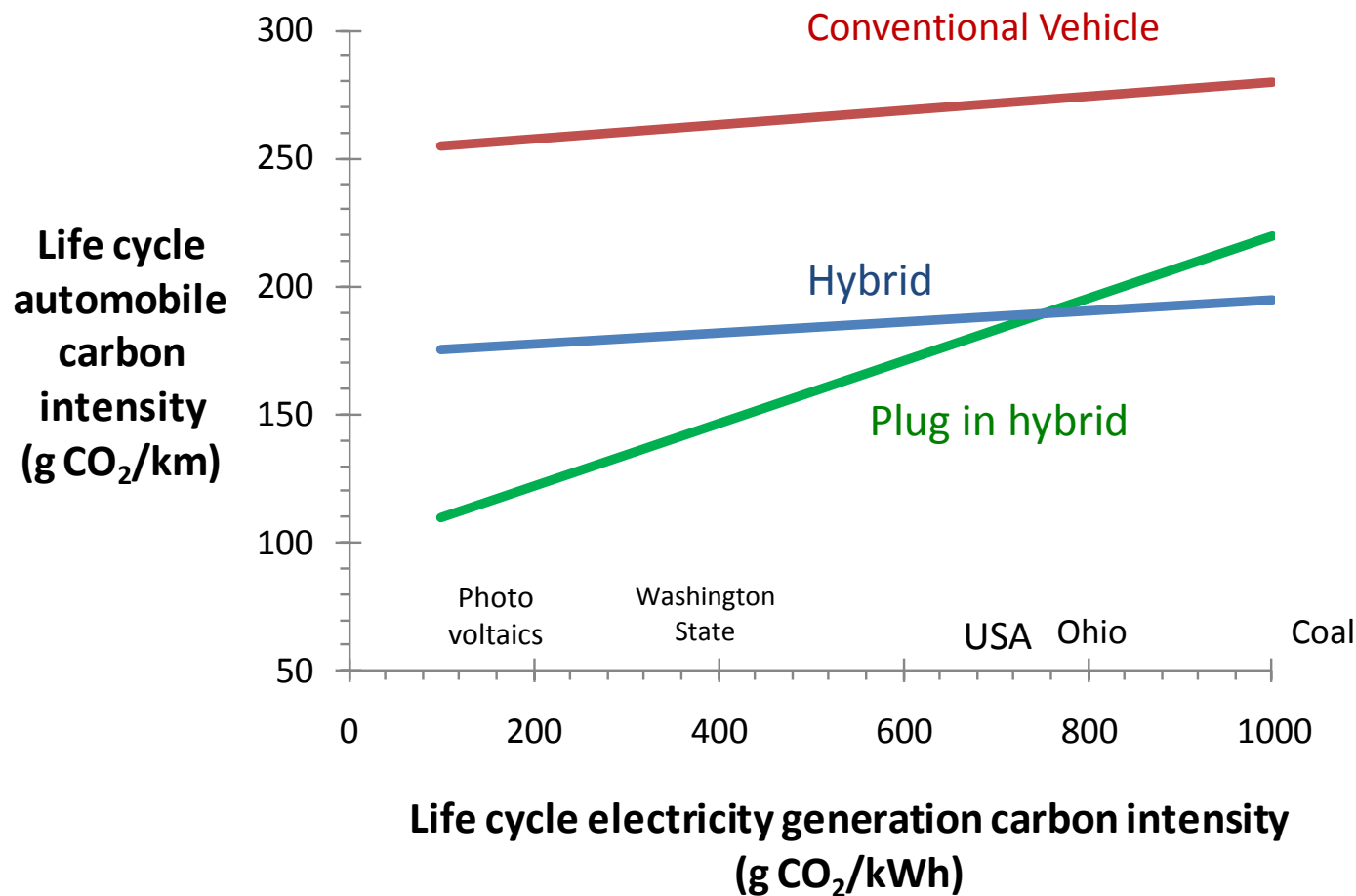
Costs to Own a Toyota Corolla, Prius or Plug in Hybrid Prius



Carbon intensity of electricity

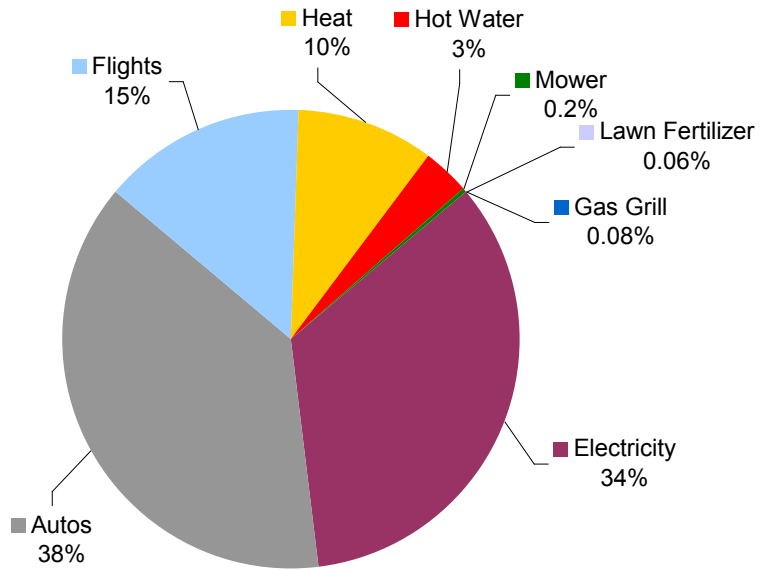


Life cycle carbon intensity of conventional, hybrid and PHE vehicles as a function of the electricity fuel mix

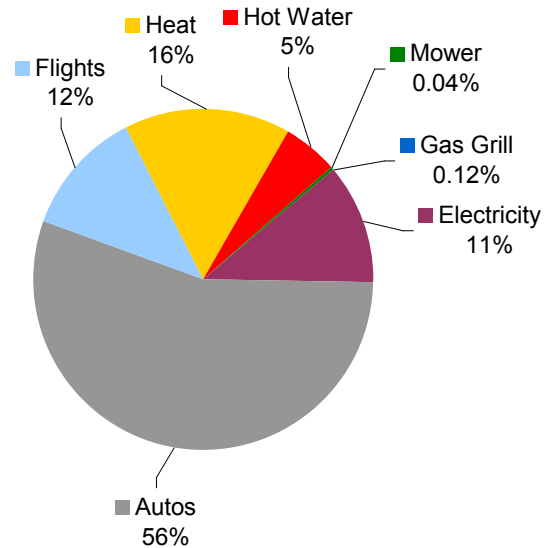


OHIO FAMILY CARBON FOOTPRINT

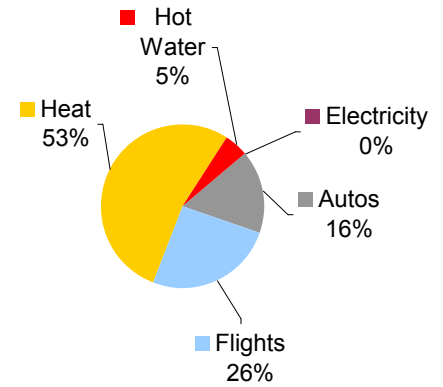
Yesterday



Today



Tomorrow



References

1. Samaras, C. and K. Meisterling. 2008. Life Cycle Assessment of Greenhouse Gas Emissions from Plug-in Hybrid Vehicles: Implications for Policy. *Environ. Sci. Technol.*, 2008, 42 (9), 3170-3176.
2. Sovacool, B.K. 2008. Valuing the greenhouse gas emissions from nuclear power: A critical survey. *Energy Policy*. 36:2950.
3. Weber, C.L., P. Jaramillo, J. Marriott and C. Samaras. 2010. Life Cycle Assessment and Grid Electricity: What Do We Know and What Can We Know? *Environ. Sci. Technol.*, 2010, 44 (6), pp 1895–1901

Educational programs and workshops

- Workshops
 - Solar photovoltaics and renewable energy credits (RECs)
 - Energy efficient home construction
 - Fuel cell technology developments
 - Lighting upgrades to reduce energy use
 - State, Federal and other incentives for renewable energy
 - Wind energy
 - Recycling and Composting
- Site tours (Quasar, Medina MRF, etc)
- ASES/GEO Green Energy tour
- Scarlet, Gray and Green Fair
- Hybrid/Plug In Hybrid/Electric Car Cruise-In
- Wayne County Fair
- Transition Towns Workshop



SUSTAINABLE ENERGY NETWORK
WAYNE COUNTY

WCSEN Home Grant

To Encourage Energy Efficient Building

- Grants of 1% of project cost, up to \$1000, are being made available to individual homeowners for new construction using energy efficient methods. This may cover the majority of extra construction costs. Reduced HVAC equipment costs can contribute as well.
- Only one grant will be provided per contractor and the home must be the first built by the contractor in Wayne County using modern methods.
- The grant application can be downloaded from the WCSEN web site: www.wcsen.org