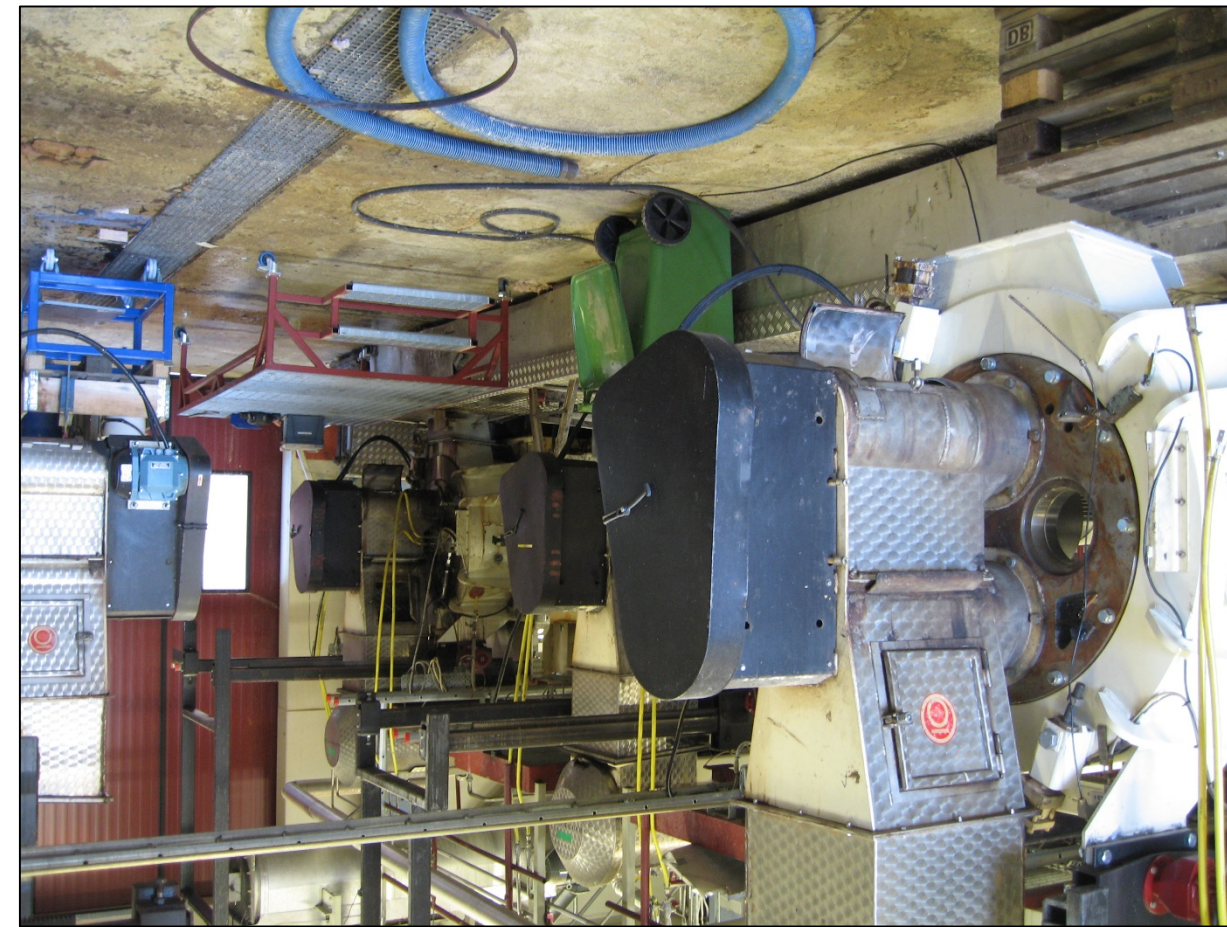
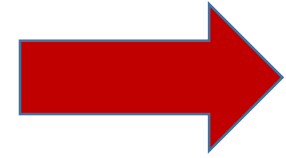


# Fully-automated Residential Wood Heating Systems



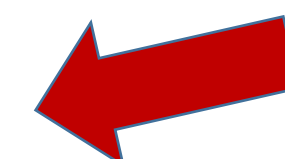
Dry wood shavings or sawdust ...



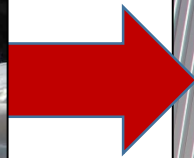
...is compressed by big machines into pellets.



Pellets must be uniform in size and quality to ensure trouble-free automation of household heating systems.



Pellets can be stored in bags ...



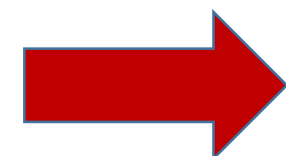
... or just stored in bulk.



Bulk pellets can be transported like oil or propane...



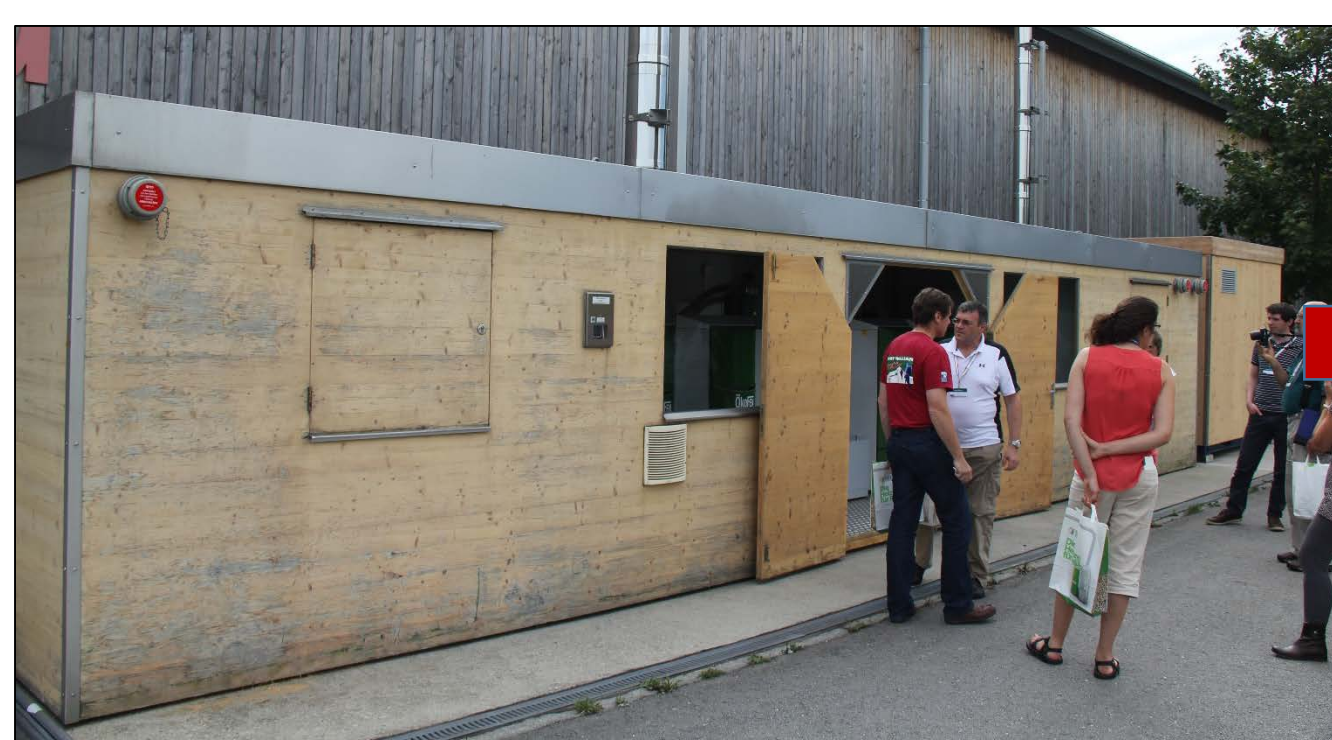
...and blown into residential storage rooms once each year.



A house will have a dust-free storage room and a boiler to make heat and hot water. Rooftop solar panels might be integrated as well.



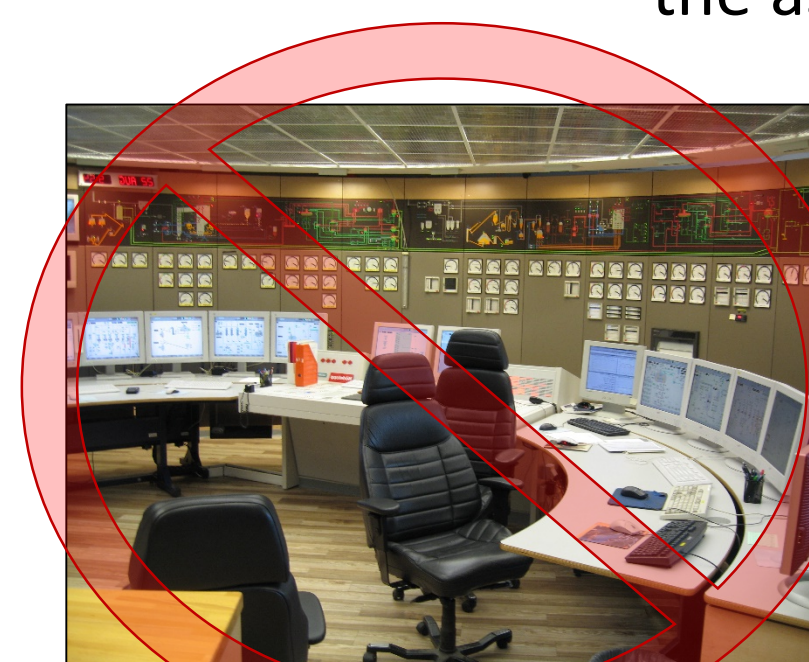
Modern boilers are clean and efficient. They can even produce electricity. And, you only take out the ash twice a year. Nice!



Big or small systems can be containerized and placed outside.



Controls are automated and internet enabled.



No rocket science here!



# District Heating Micro-grids Using Wood Chips



**District Heating** can be scaled to service whole cities, schools, factories, or even small clusters of houses. Heat is distributed through hot water pipes. Systems sometimes combine heat with electric power production (CHP). Others add cooling (CCHP).



Fuel chips can come from logging residuals...



...from short rotation energy plantations...



...or from poor quality trees that nobody else wants.



Air heated by the sun is forced up through grates under the chips to dry them. This extends storage and improves combustion efficiency. Small operators can supply enough biomass in this way to heat villages, like Sattledt, Austria.



Lady Luck!



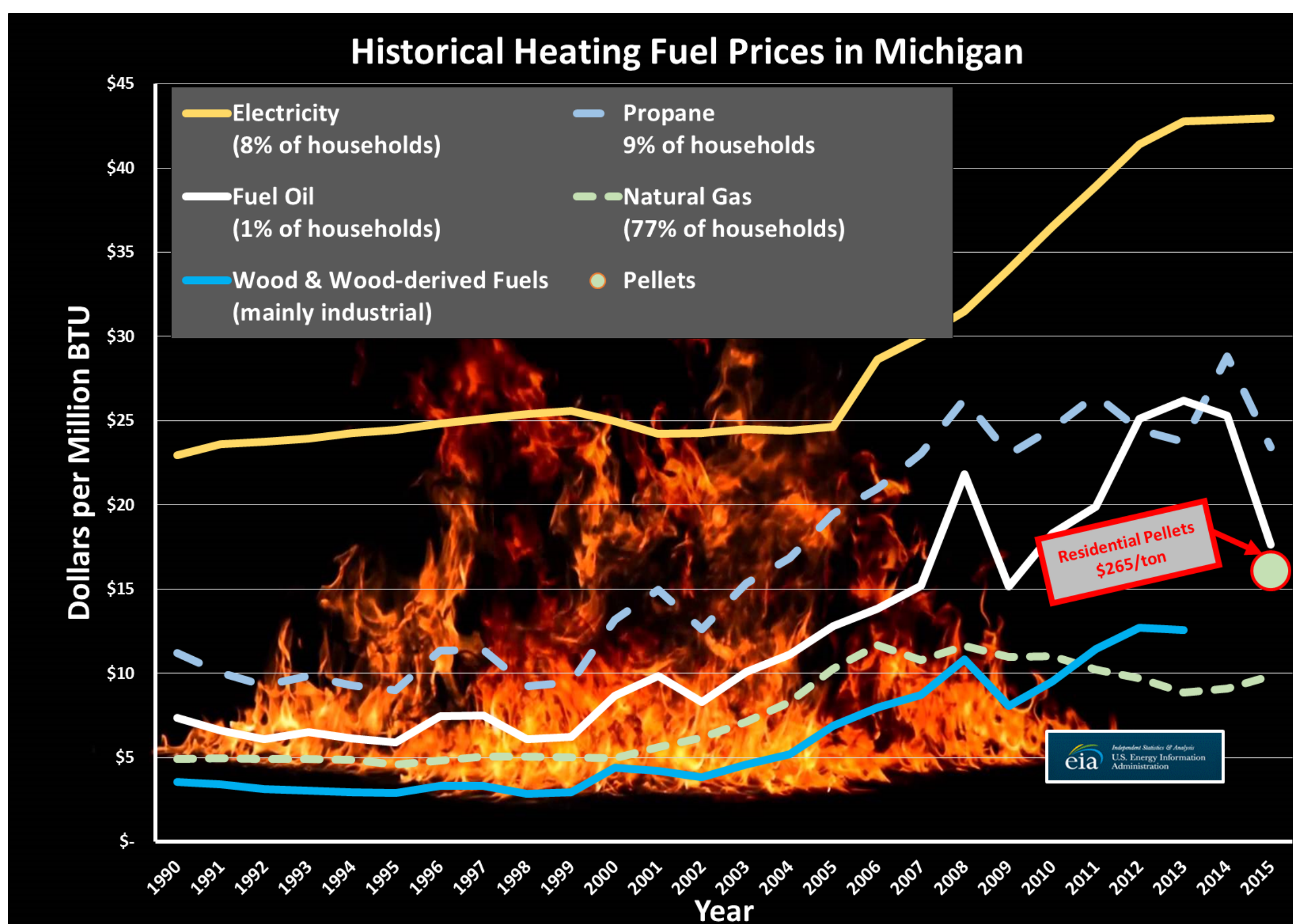
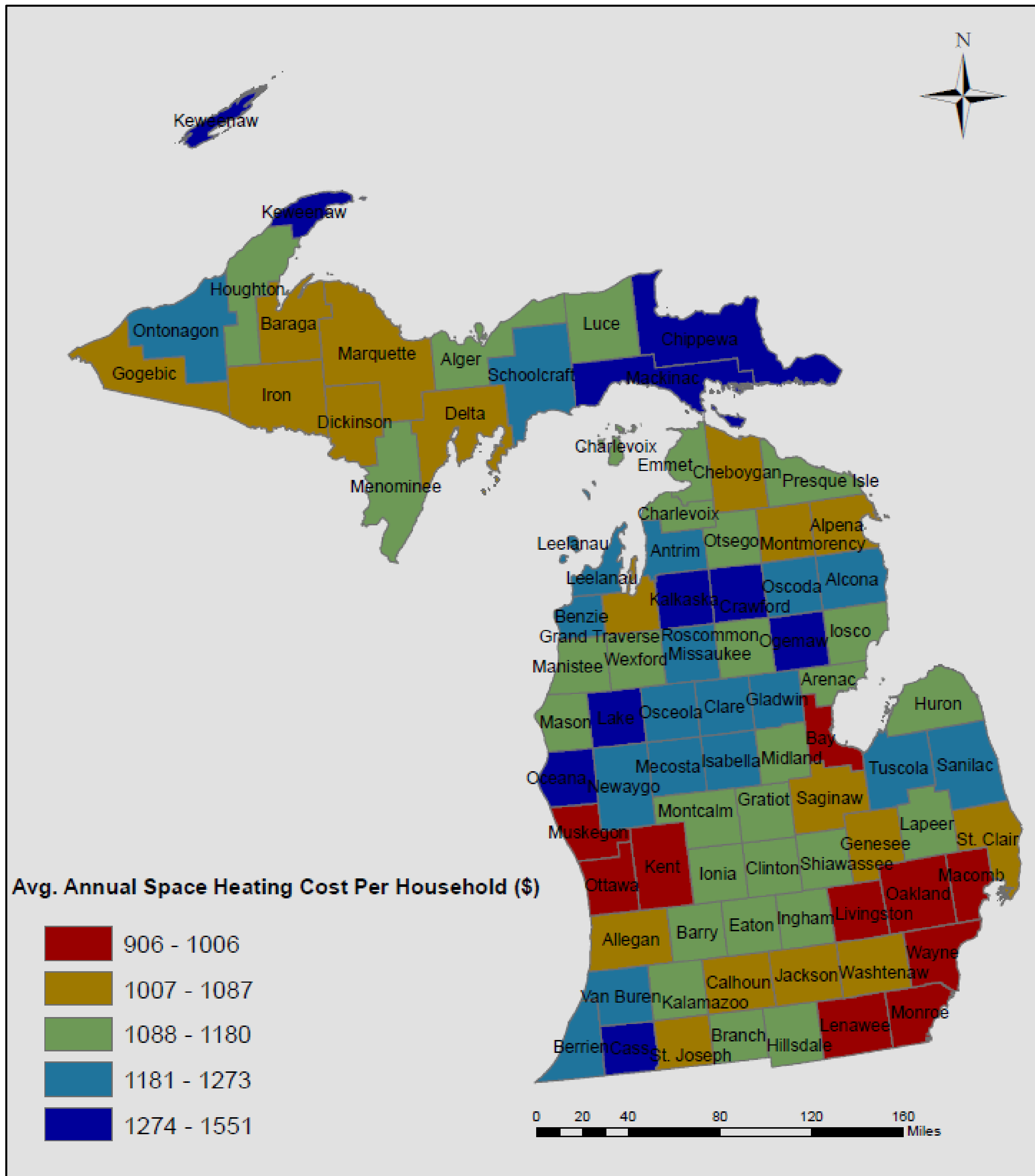
Dry chips can be stored and transported in various ways. Chip systems tend to be larger than pellet systems so they don't have problems with this less uniform fuel.



This small boiler room, owned and operated by a single farmer, supplies the heat to a **micro-grid** of nine houses.



# What do Michigan Households Pay For Space Heating Each Year?



Source: US Energy Information Administration (EIA)-<http://www.eia.gov/>

**Occupied Housing Units Using Different Fuel Types for Space Heating in Michigan**

Fuel type	No. of occupied housing units	Percentage of occupied housing units
Utility gas	2,952,438	77.1 %
Bottled, tank, or LP gas	324,449	8.5%
Electricity	317,669	8.3%
Fuel oil, kerosene etc.	53,688	1.4%
Coal or coke	1,142	0.03%
Wood	129,776	3.4%
Solar energy	646	0.02%
Other fuel	32,969	0.9%
No fuel used	15,103	0.4%
Total	3,827,880	100%

Source: US Census Bureau, 2010-2014 American Community Survey 5-year estimates

