# A Time of Energy Transition
# At Princeton University …And In Your Life!

Sierra Club
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## The Problem

**Reduce $CO_2$ footprint & other negative environmental impact with:**

- Good financial stewardship
- Existing buildings & campus aesthetics
- Space limitations
- Existing technologies
- Existing codes, tariffs
- No interruption of education and research
- Additionality
- Replicability
- No discomfort
- Reliability

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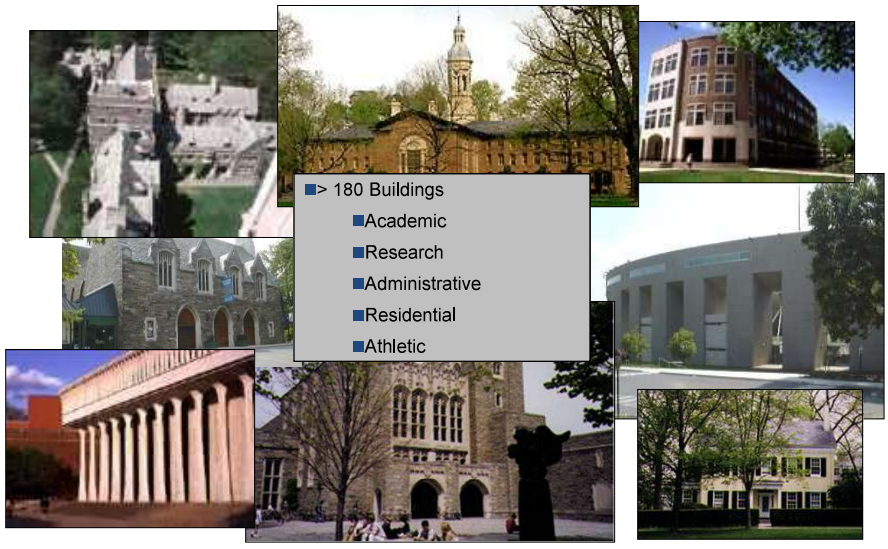
# Energy Demands at Princeton

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# Today's Energy Equipment and Peak Demands

| | Capacity | Peak Demand |
|---|---|---|
| • **Electricity** | | |
| – (1) Gas Turbine Generator | 15.0 MW | 27 MW |
| – Solar Photovoltaic System | 16.5 MW | |
| • **Steam Generation** | | |
| – (1) Heat Recovery Boiler | 180,000 #/hr | |
| – (2) Auxiliary Boilers @ 150 ea. | 300,000 #/hr | 240,000 #/hr (70.3 MW heating) |
| • **Chilled Water Production** | | |
| – (3) Steam-Driven Chillers | 10,100 Tons | |
| – (5) Electric Chillers | 10,700 Tons | 15,000 Tons (52.7 MW cooling) |
| – (1) Thermal Storage Tank | 40,000 Ton-hours | |
| • *peak discharge | 10,000 tons (peak) | |

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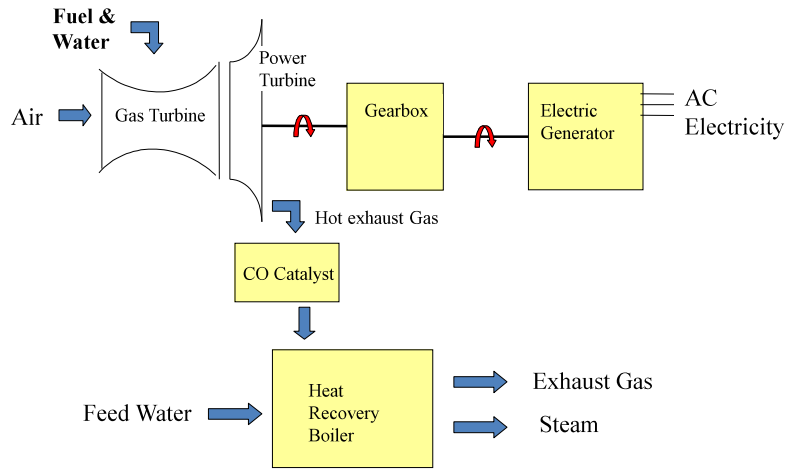
## Combined Heat & Power, "Cogeneration"

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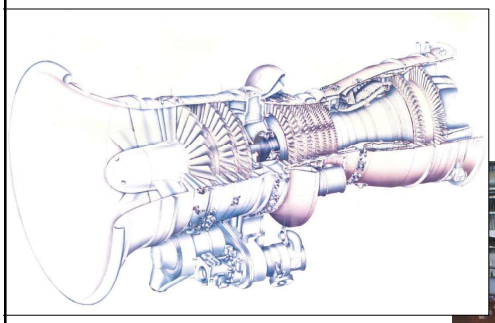
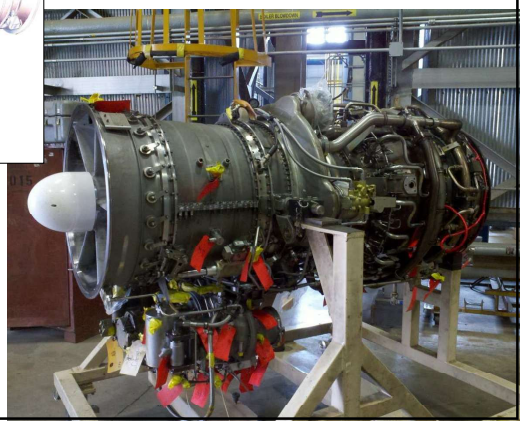
## The GE LM-1600 Gas Turbine





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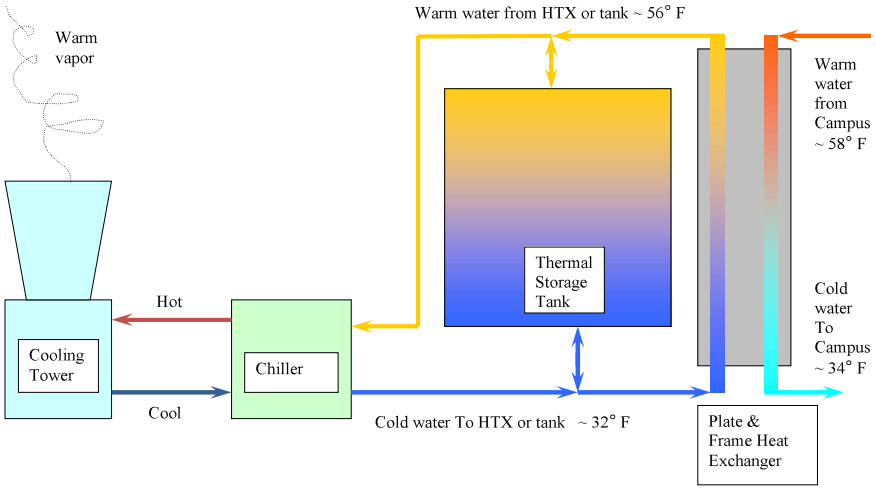
# Chilled Water & Thermal Storage

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## Princeton University Energy Plant

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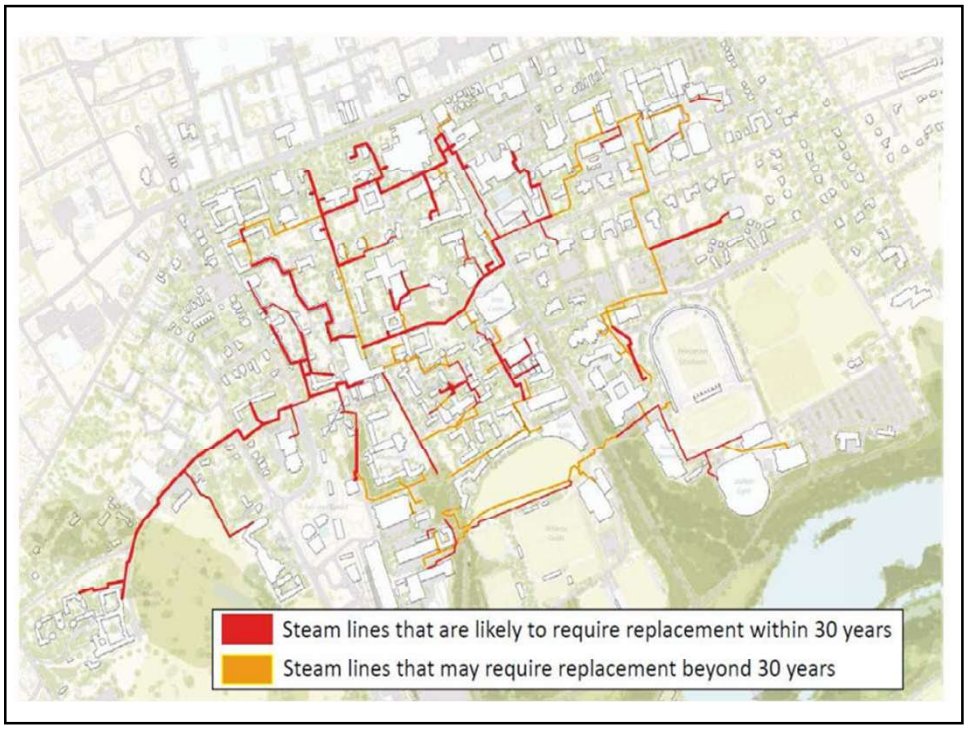
Steam lines that are likely to require replacement within 30 years
Steam lines that may require replacement beyond 30 years

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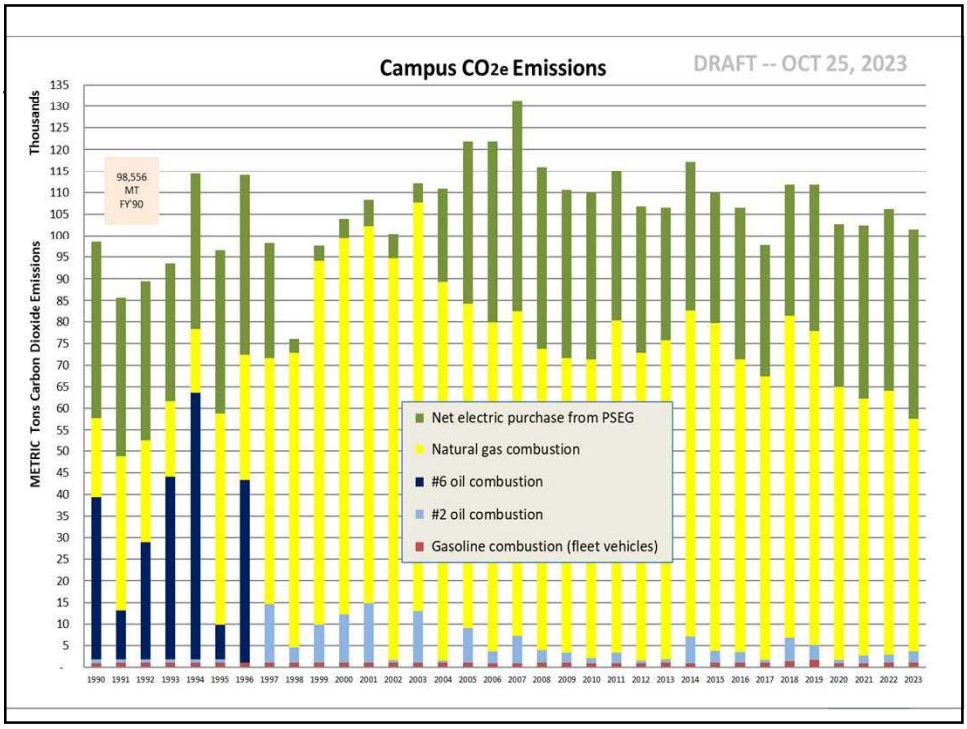
Campus CO2e Emissions
DRAFT -- OCT 25, 2023
Thousands
METRIC Tons Carbon Dioxide Emissions
98,556 MT FY'90
Net electric purchase from PSEG
Natural gas combustion
#6 oil combustion
#2 oil combustion
Gasoline combustion (fleet vehicles)

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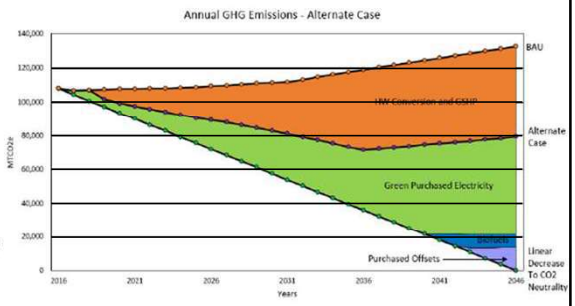
# Goal: Carbon Neutrality

- Carbon Neutrality by 2046
- Continuous downward slope from present

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# Major Areas of Work to Minimize Carbon Footprint:

- High performance envelope, passive design, use of hot water for heating
- Replace district steam system with district hot water system
- Create electric-powered Heat Pump facility
- Create daily thermal storage – tanks
- Create seasonal thermal storage – geoexchange
- Install on-site renewable energy production – solar PV
- Supplement with off-site renewable energy

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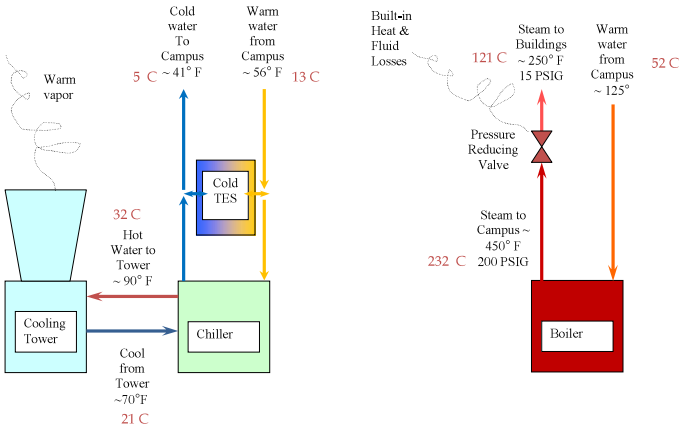
## Separate Heat Removal (CHW) & Addition (Steam)

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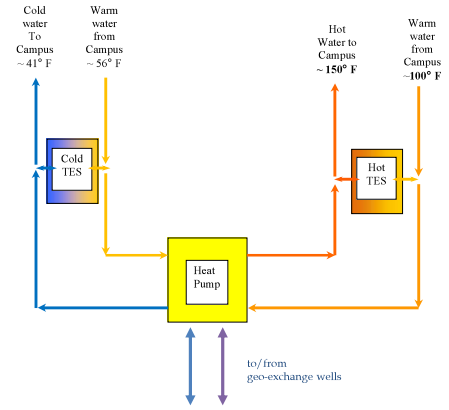
## Combined Heat Removal (CHW) & Addition (HTW)

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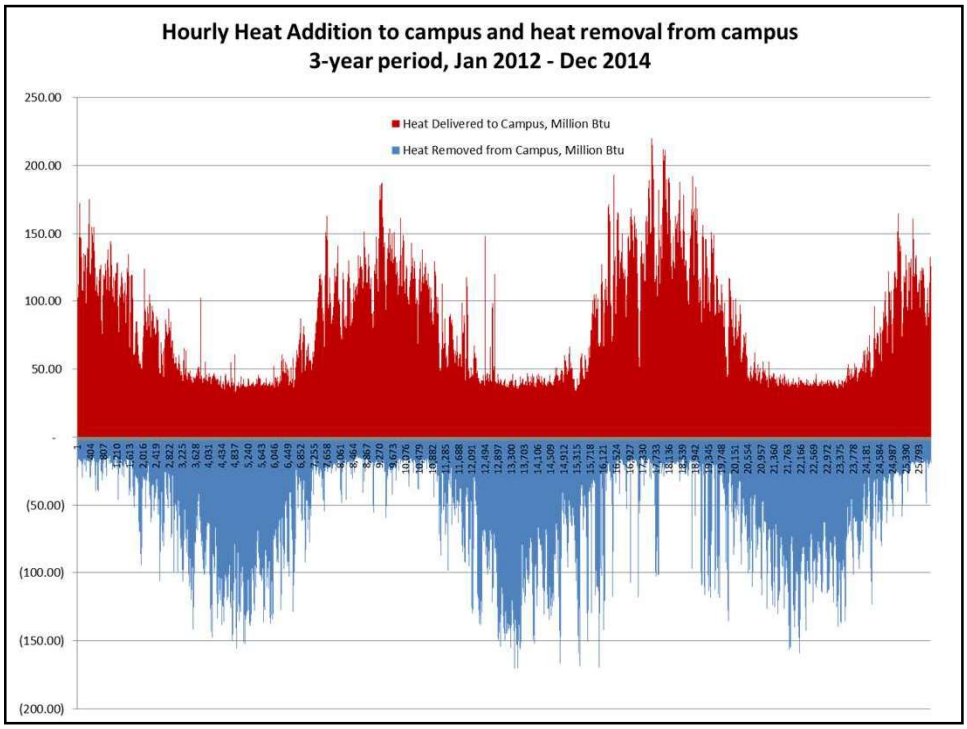


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Drilling Rig and Heat Pump

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1.5” HDPE Geoexchange Pipe

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## TIGER Plant Rendering

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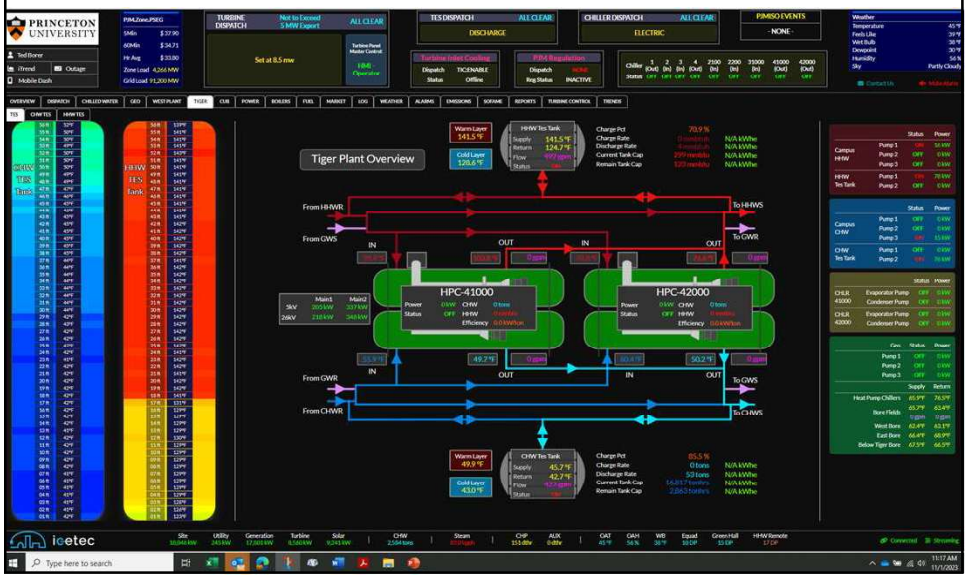
# TIGER Economic Dispatch Screen

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# Geoexchange Monitoring


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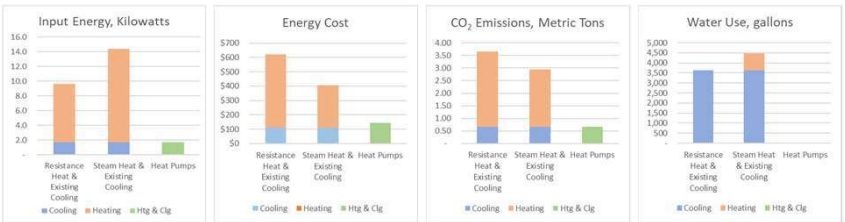
# Summary of Change to Heat Pumps




Natural Gas fuel input for steam production is shown as energy-equivalent Kilowatts.

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# What YOU Can Do

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# Personal Actions To Reduce Carbon Footprint

- **Calculate Your Carbon Footprint --** Carbon Footprint Calculator | Climate Change | US EPA
- **Create Less Food Waste** – Buy local, organic, whole foods, and in bulk. Make just what you'll eat. Label leftovers. Compost.
- **Cut (back on) your lawn** – Mulch. Grow fruits, herbs, and veggies
- **Buy less** – Buy durable things, repair, downcycle, share, give away. Don't over-build your house.
- **Walk, Bicycle, or take Public Transit** whenever possible. Don't fly unless you must.
- **When your old car is no longer serviceable**, trade-in for a hybrid or EV.
- **Get a home energy audit,** air sealing, and insulation. When your house heater, water heater, or air conditioner are no longer serviceable, upgrade to a heat pump. Use only LED light bulbs. Home Performance with ENERGY STAR® | PSE&G (pseg.com)
- **Learn about climate change and social justice**
- **Reduce your consumption of animal products**, especially beef.
- **Educate others**.

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HOME ENERGY

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# Install Solar Electricity or purchase renewable electricity

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## Install Geoexchange Energy Storage

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## Use Solar Hot Water and/or Heat Pump Hot Water Heaters


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## Replace boilers, furnaces, hot water heaters, and air conditioners with heat pumps

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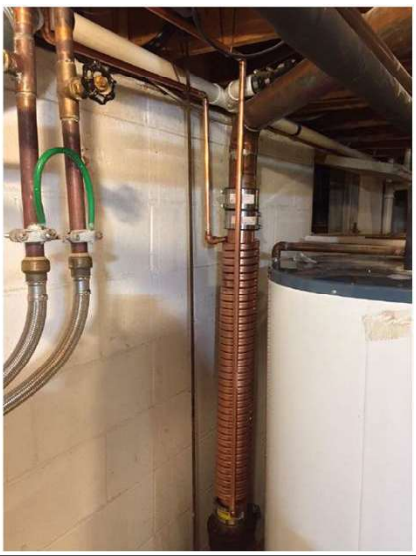
## Install Shower Drain Heat Recovery



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## Heat with renewable, local fuels

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## TRANSPORTATION

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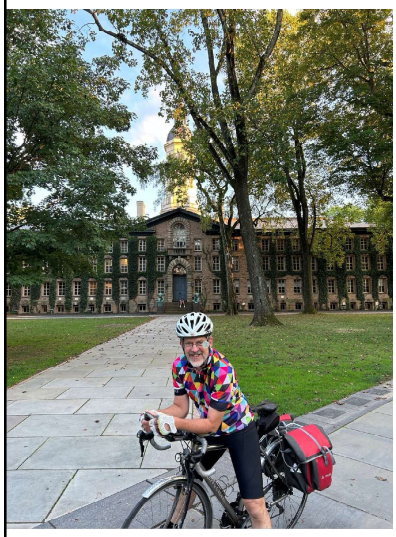
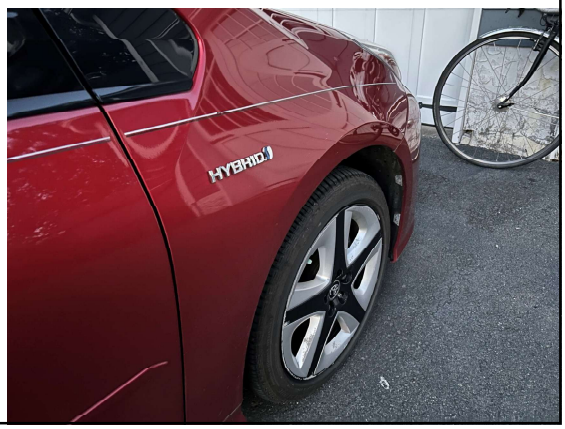
## Walk, Bike, or Take Public Transit. Make your next car a hybrid or EV



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## FOOD

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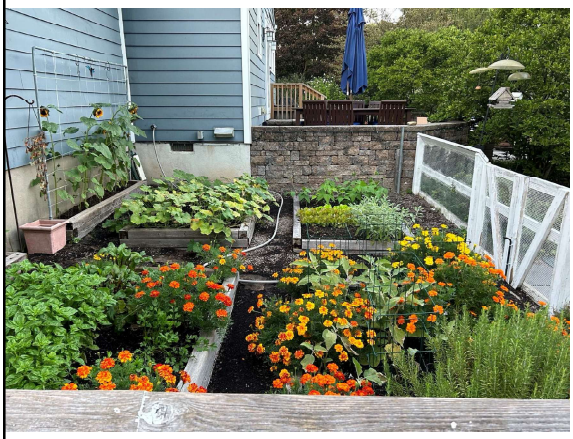
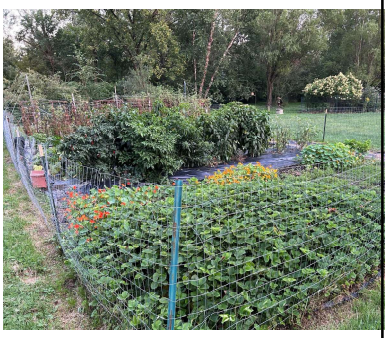
## Grow Fruits, Herbs, and Vegetables





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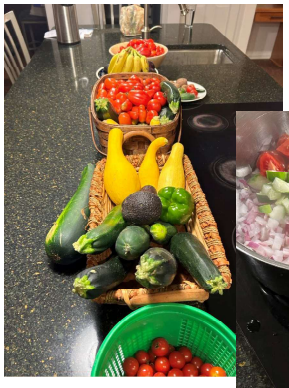
## Follow a whole-food, plant-based diet as much as possible.

- Grow your own or purchase locally.
- Avoid packaged food.
- Read ingredient labels
- Avoid “processed food”



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## Preserve the harvest

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## Raise hens for eggs and manure for the compost pile


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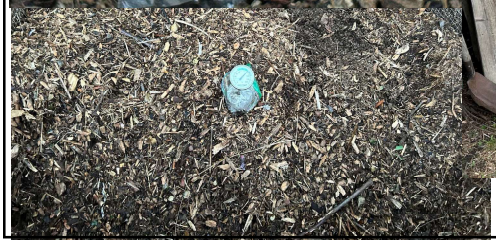
## Compost yard waste and food scraps

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## WATER

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## Capture and re-use rainwater

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## Avoid buying bottled water and canned drinks. Drink tap water, filter if needed.


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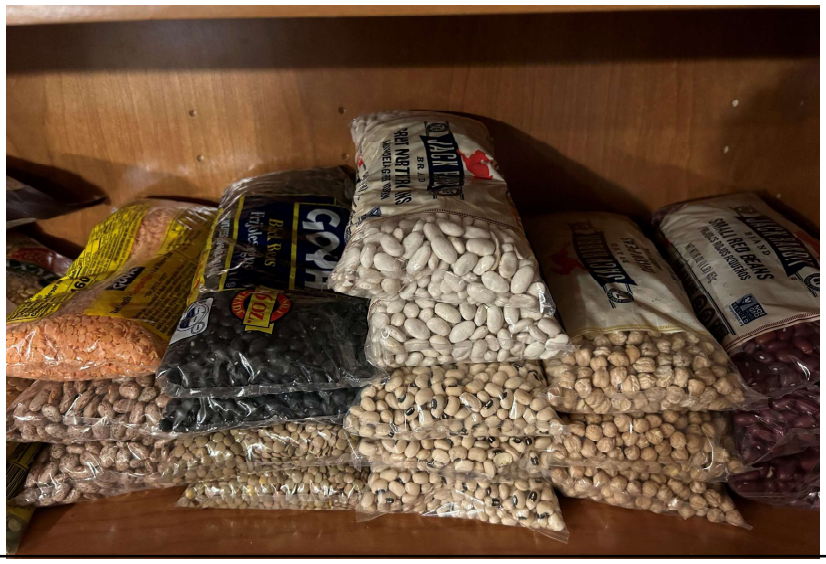
## Purchase dried beans instead of canned. Rehydrate and cook at home.



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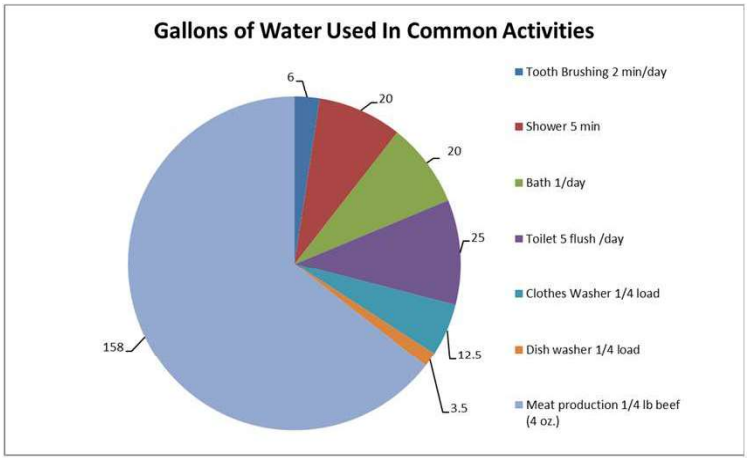
## Effect of Reduced Meat Consumption

| | Tooth Brushing | Shower | Bath | Toilet | Clothes Washer | Dish washer | Meat production |
|---|---|---|---|---|---|---|---|
| | 2 min/day | 5 min | 1/day | 5 flush /day | 1/4 load | 1/4 load | 1/4 lb beef (4 oz.) |
| Gallons | 6 | 20 | 20 | 25 | 12.5 | 3.5 | 158 |

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Thank you

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