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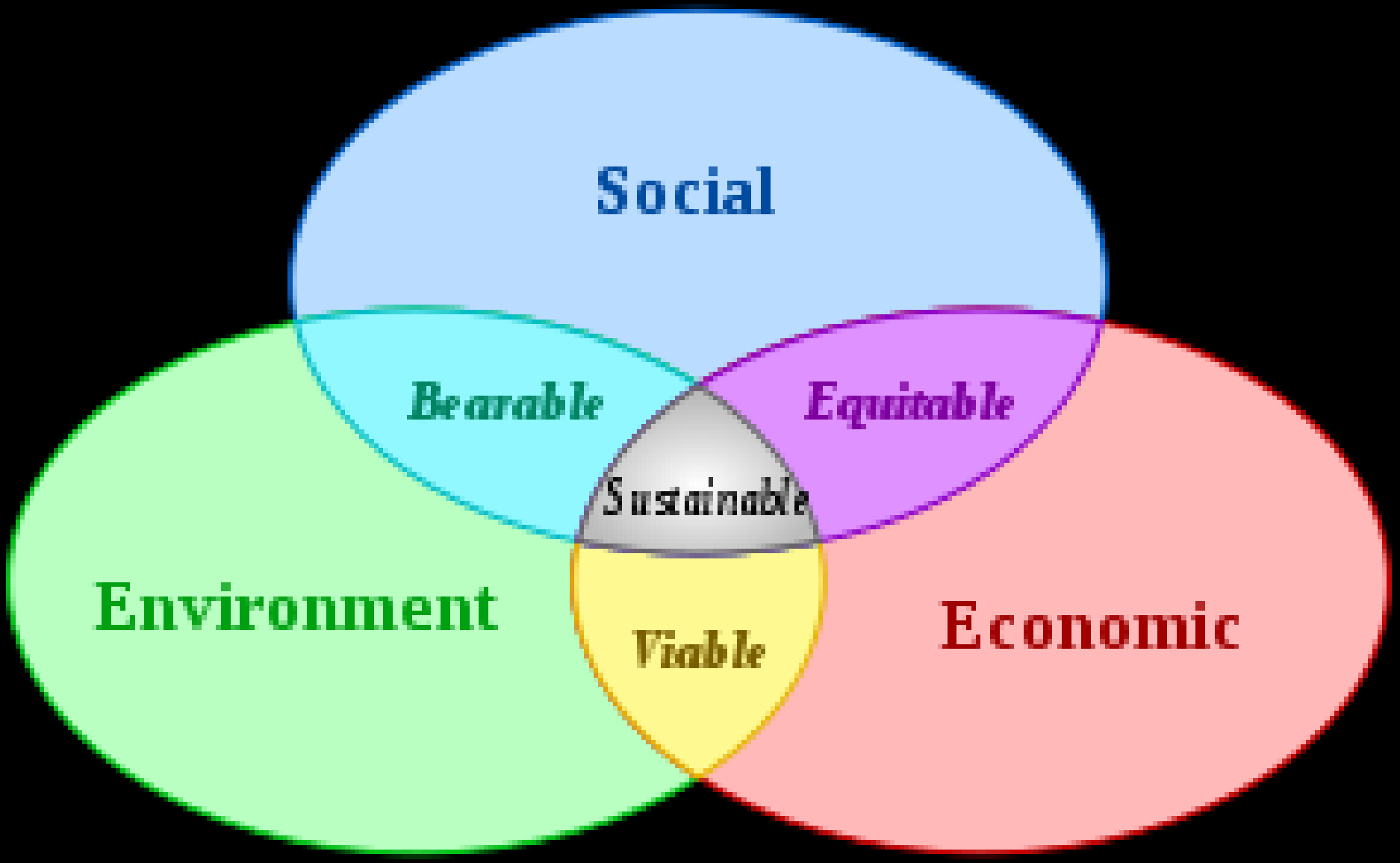
Social
Bearable
Equitable
Sustainable
Environment
Viable
Economic

St. Olaf Sustainability

- St. Olaf College is like a small city
- People live and work there
- They need what people need in a city:
  - Water
  - Electricity
  - Heat
  - Roads and sidewalks
  - Food
  - Garbage service
  - Sewer and storm water

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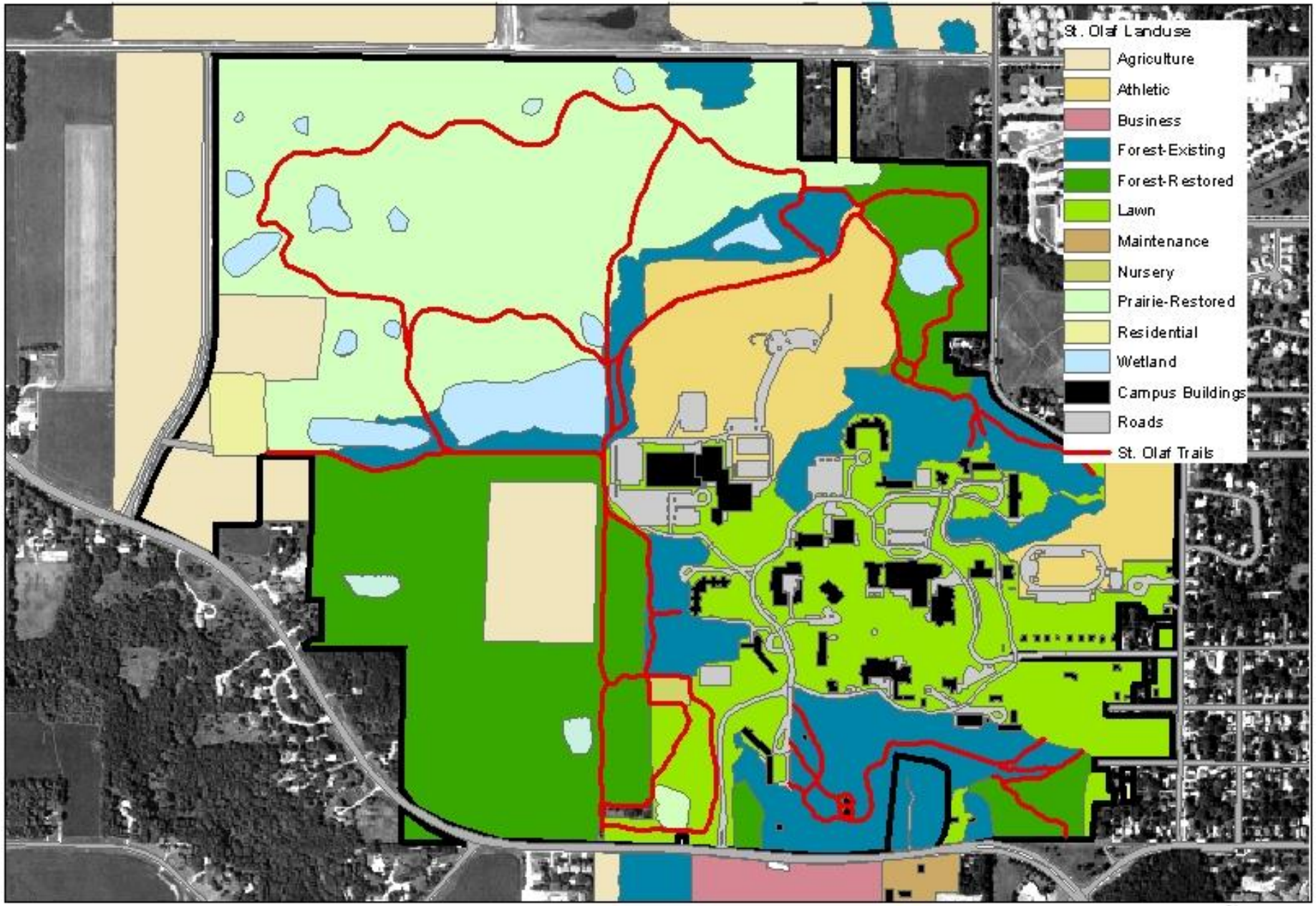
St. Olaf Landuse
Agriculture
Athletic
Business
Forest-Existing
Forest-Restored
Lawn
Maintenance
Nursery
Prairie-Restored
Residential
Wetland
Campus Buildings
Roads
St. Olaf Trails
0
0.1
0.2
0.4 Miles
N
W
E
S

- Things flow in, and outcomes flow out of the city:
  - Water - Sewer
  - Electricity - Carbon
  - Heat – Carbon
  - Roads and sidewalks – Salt, exhaust
  - Food - Garbage

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St. Olaf Sustainability

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St. Olaf Sustainability

- Electricity
  - We purchase about 14,500,000 KWHs per year
  - This yields 7,000 metric tons of CO2
- Our Wind turbine generates another 3,500,000 kwh
  - This yields NO CO2

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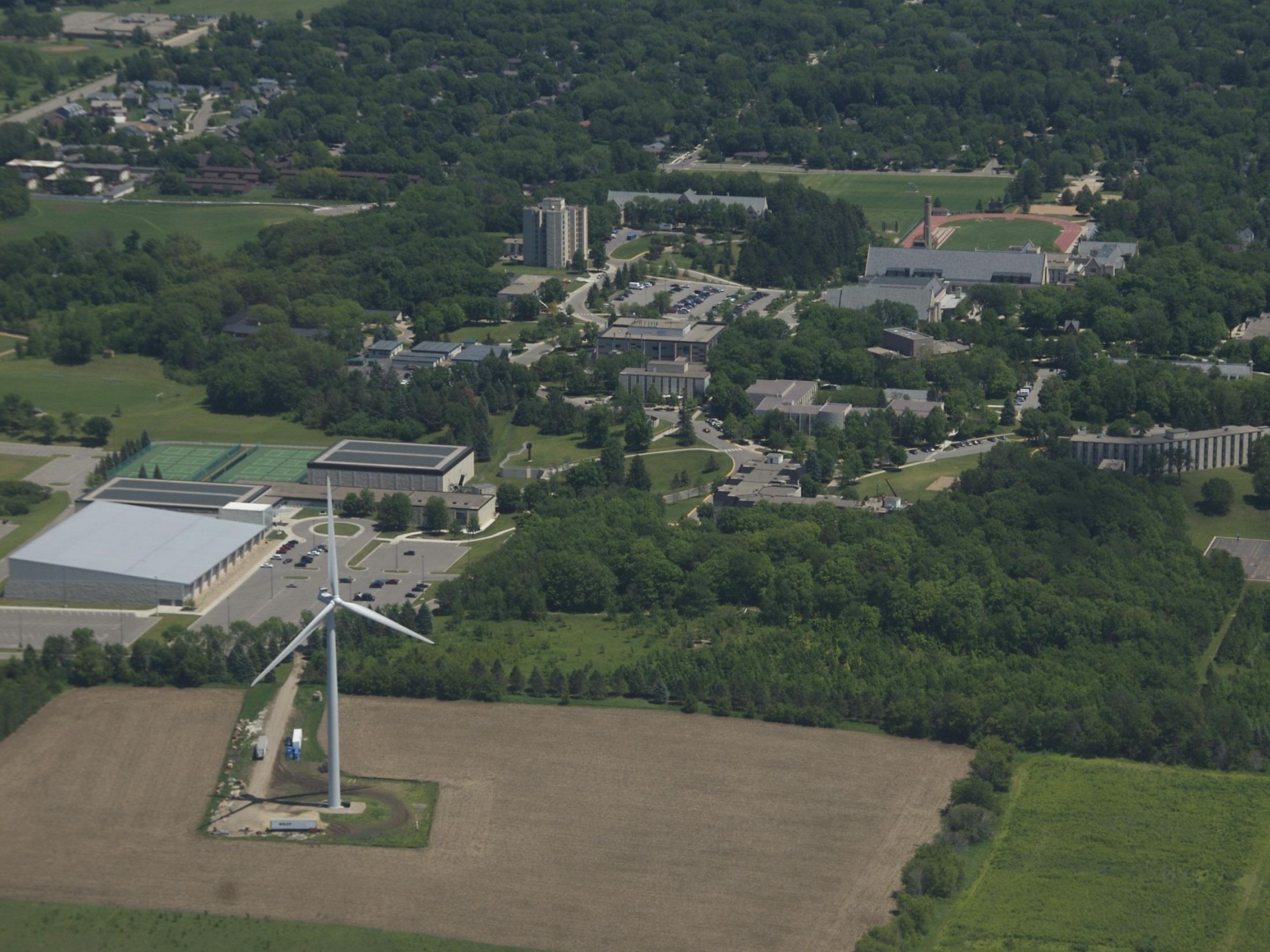

St. Olaf Sustainability

- All of our energy comes from the Sun
- Natural gas, oil, and coal are all made of early life, mostly plants, compressed by the Earth
- These life forms were all fed by the Sun
- Even the energy in wind comes from the Sun

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- The energy from the Sun warms the air
- When the air warms unevenly, ***wind*** happens
- ***Wind Power*** is a direct affect of the energy from the Sun warming the air

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- As the sun warms the Earth and the air big changes happen

- Air pressure changes come from unequal heating of the atmosphere by the sun

- Air pressure is important in making wind

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- Warm air rises because it expands and its pressure drops; it flows to places where the air is cooler

- When the warm air gets there and is cooled, it drops down, and then flows back to where it had been warmed - ***Wind***

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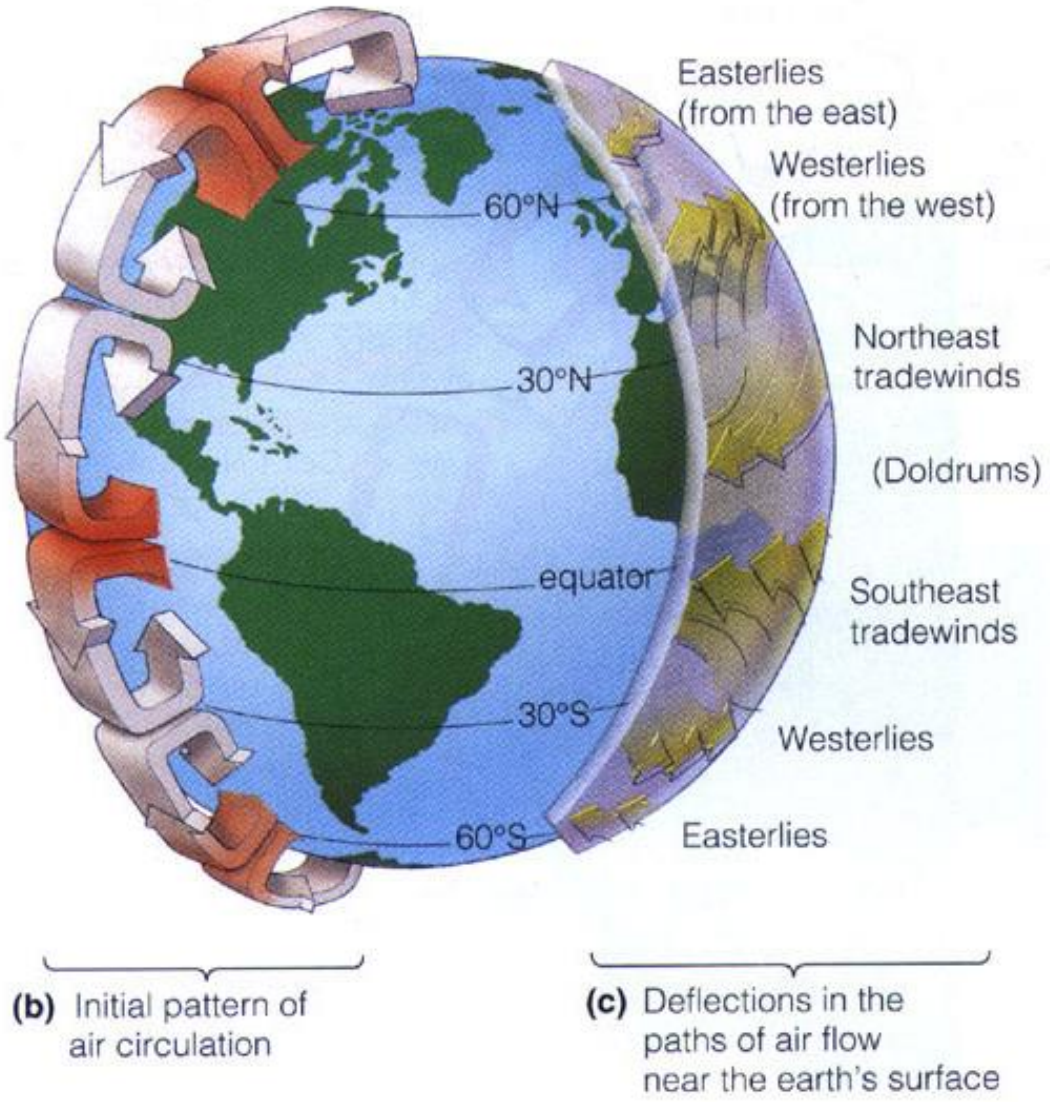

The Sun's energy is strongest at the equator because that is the closest the Earth comes to the Sun.

As air is heated, its pressure goes down and it rises.

Cooler air rushes in behind it causing WIND

The spin of the Earth influences this air flow

At the Equator the Earth's spin to the East causes the wind to flow to the West

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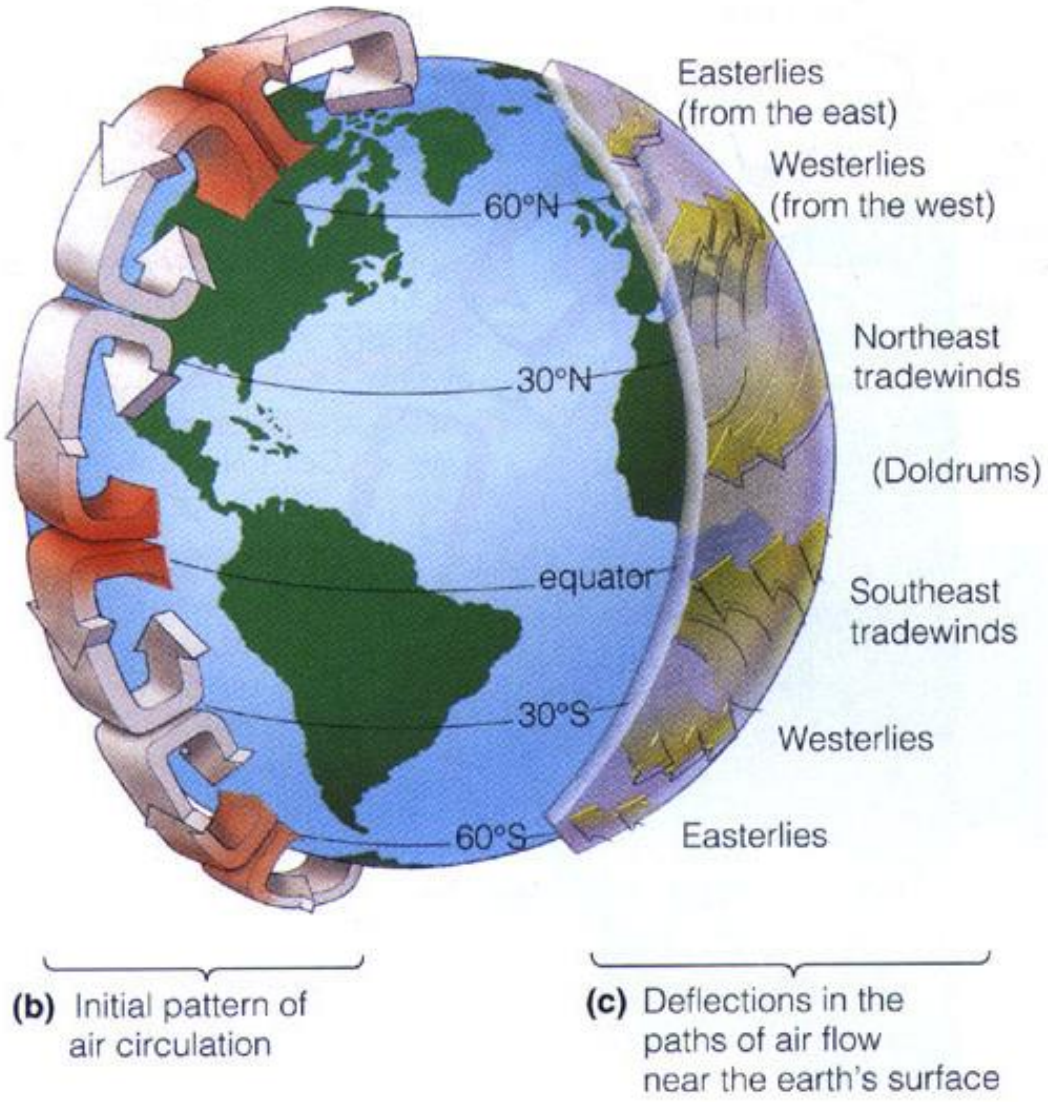

At the poles, air is falling because of the relatively low sun energy

It flows into the void caused by the air rising at the Equator, causing still more wind

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- Air pressure is important in other ways too
  - The atmosphere is huge, and weighs a lot even though we cannot “feel” the weight
  - It is pushing against us from all directions at 15 pounds on every square inch of our bodies
  - This pressure keeps us together, without the pressure we would blow up

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This space suit helps the astronaut by keeping air pressure, 15 pounds per square inch, on the body.

There is no pressure in space, and without it, the gases in our body would expand until –

Poof!

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- Wind turbine blades are really wings
  - Wings work because they can change the air pressure on each part of the surface
  - Our turbine can move the blades around to catch the most possible wind energy
  - The turbine's computers tell the wings what to do in order to control the rotation of the rotor precisely

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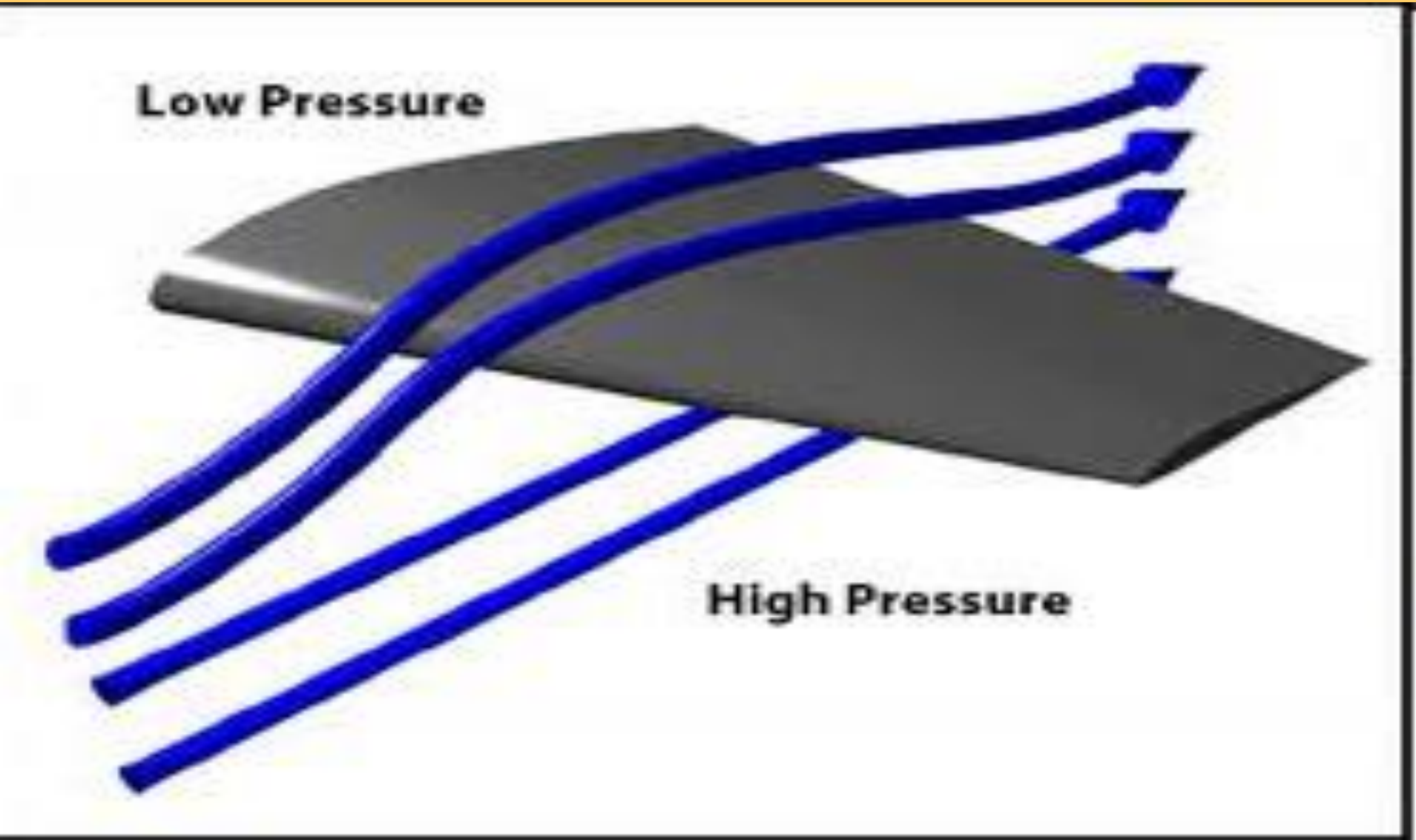
St. Olaf Sustainability



Blowing across the top of a piece of paper makes the air pressure less than below the paper.

The higher air pressure below pushes the paper up. This is how a wing works

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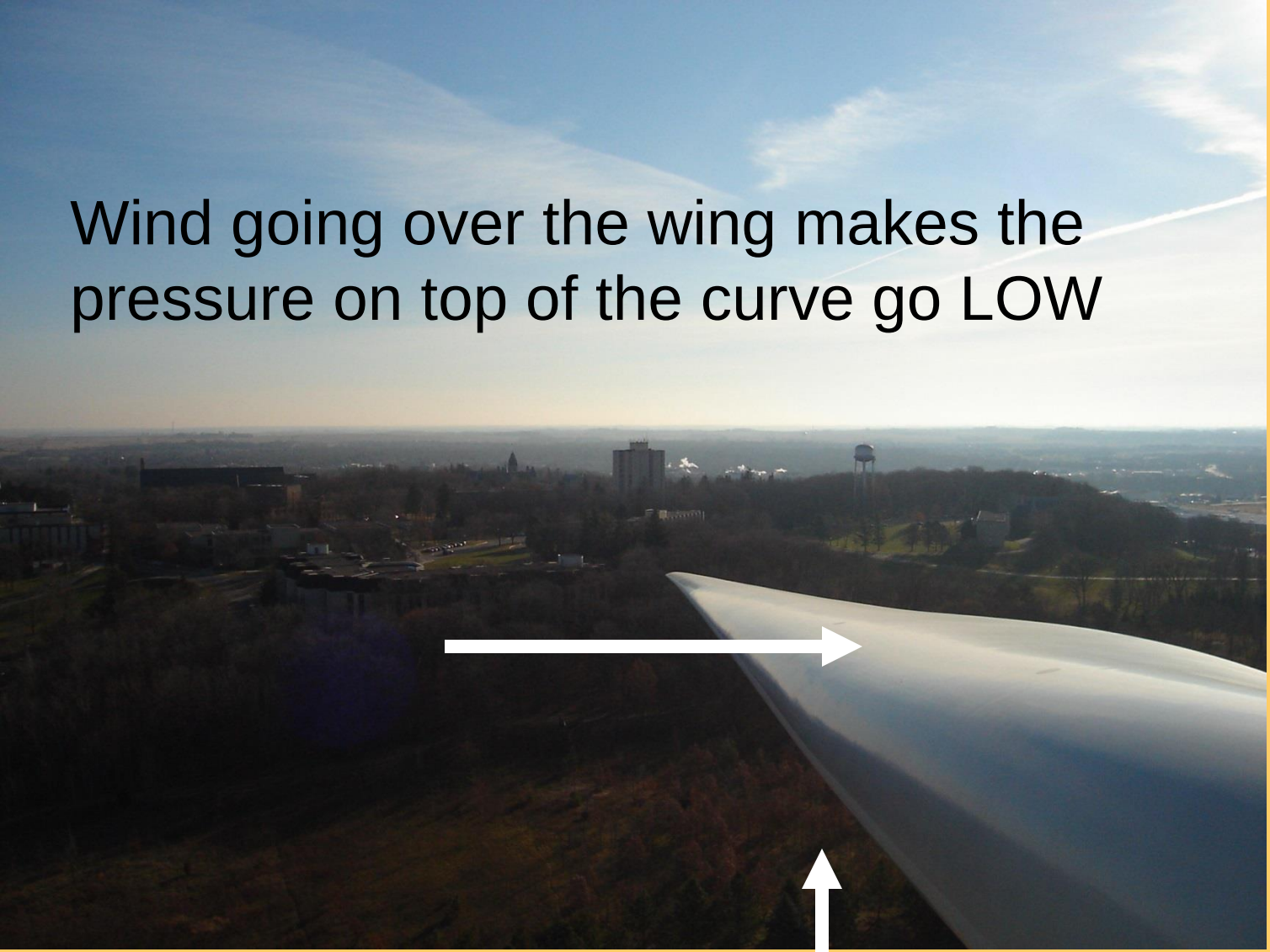

Higher pressure air under the wing pushes the wing up

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St. Olaf Sustainability

- The electricity we use in America is called 60 hertz
  - We use alternating current – AC – electricity
  - It alternates 60 times per second, 60 hertz

- The turbine must spin 14.4 times per minute in order to make 60 hz electricity
  - If it goes too fast or slow, the electricity will be bad and it will cause big problems

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St. Olaf Sustainability

- The only control of this 14.4 rpm is the ability to vary the angle of the wings by computer and hydraulics
  - If the wind is too slow, we catch more
  - If the wind is too fast, we catch less wind
  - If it is way too fast we change the wings so they do not catch any wind

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- So, **WIND** power is **SOLAR** power
- Wind power ***potential*** is measured in terms of watts per square meter of the turbine's "swept" area
- The swept area is the number of square meters that the rotor "sweeps", when spinning

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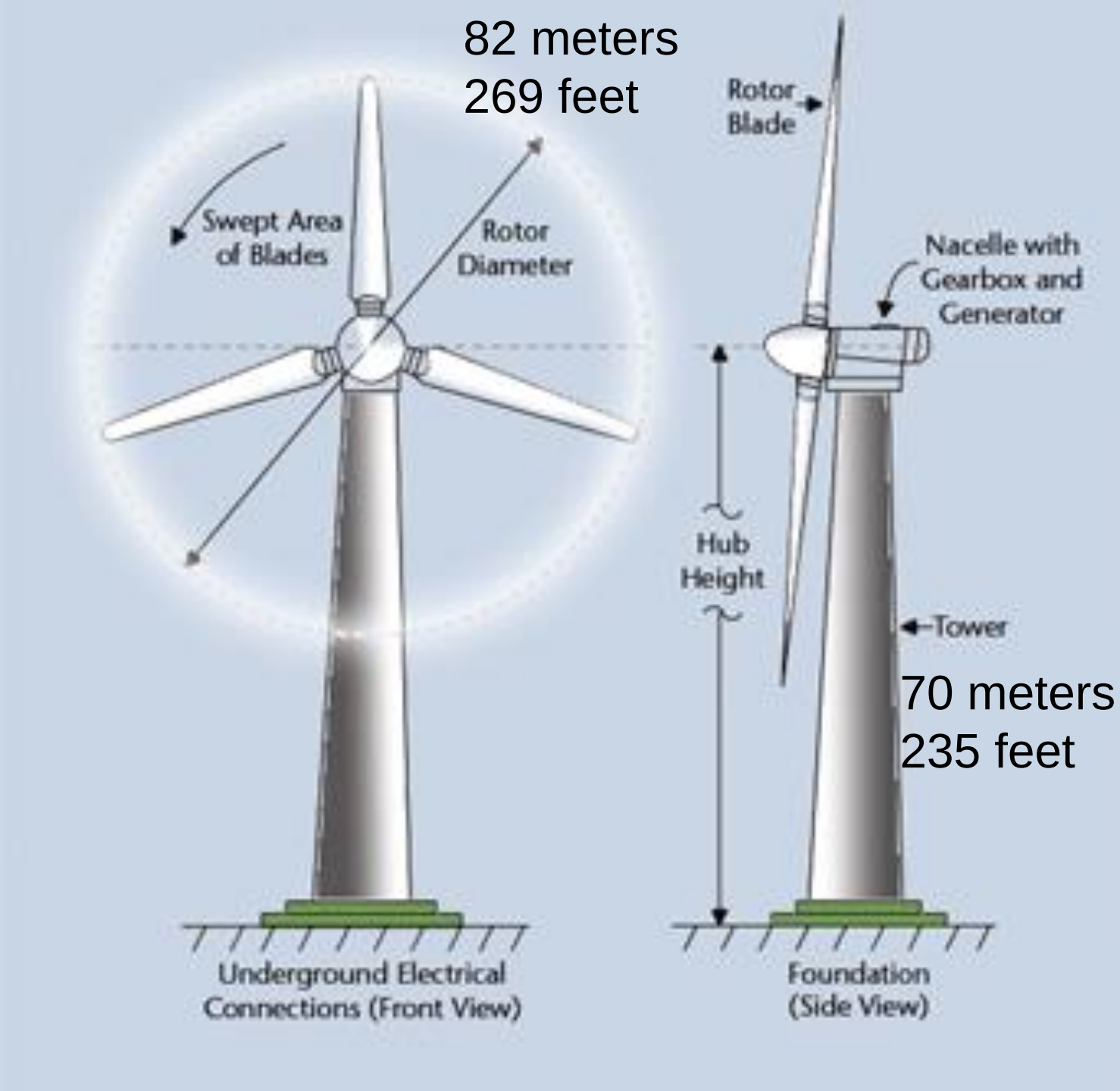

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St. Olaf Sustainability

- St. Olaf's wind turbine rotor has a swept area of 5,280 square meters
- It's maximum output is 1,650,000 watts per hour (1.65 megawatts)
- It produces 312.5 watts per square meter of rotor swept area

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St. Olaf Sustainability

- Wind turbines like ours cannot store electricity in batteries
- St. Olaf uses the electricity directly – this is called “self-generating”
- Carleton College has a wind turbine also, and they sell the watts to the electric company

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Standby Generation, 4.2 mw
Utility Feed
1.65 mw Wind Turbine
Internal Distribution Loop
N
W
E
S
© 2007 Europa Technologies
Image © 2007 DigitalGlobe
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http://www.youtube.com/watch?v=PyehD1j0kUU

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St. Olaf composts all campus food waste, reusing the product on campus, and prolonging the life of our county land fill

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Sustainability at St. Olaf - Food

- Student food service uses:
  - Local dairy
  - Local, grass fed beef
  - No antibiotic poultry
  - Vegan meals
  - No bad oils and fats
  - As much local produce as can be handled seasonally – STOGROW and other growers
  - Full circle food handling

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Sustainability at St. Olaf - Composting

- All campus food waste is gathered for composting
- All compost must be used on campus land
- Tree waste is chipped to add to the compost
- Finished compost is used all over the campus

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Rice County requires that we use a “proven technology”, and that it be contained in a building

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A look into the composting machine

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Elevator for hoisting the full containers

Sensors for the mixing zones

Auger and conveyor for emptying

This is the composter. We provided plenty of extra room around it for service and storing of cleaned waste containers.

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The vessel is well insulated.

The compost generates heat so that it could even be outside, but it works better inside.

Liquid from the food waste is collected in a sump at the bottom, and used if moisture must be added.

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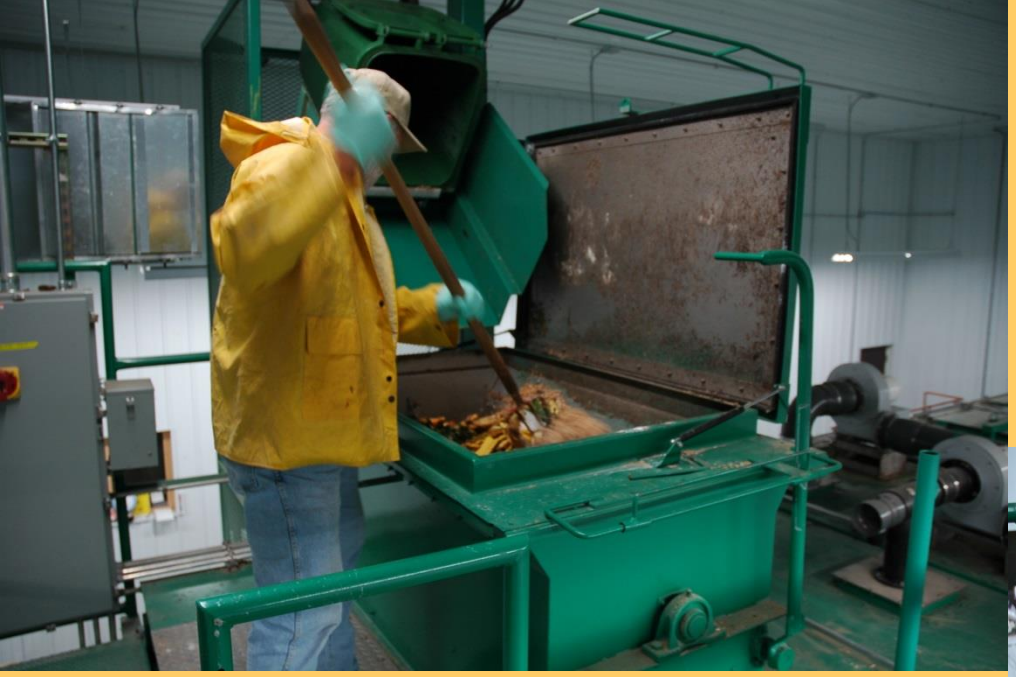
First food waste, then wood chips to add carbon



The mixer rotor will chop almost anything.

It mixes until the operator can form a “snowball”. A smelly one!

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After 21-28 days, compost is moved to a shed before screening for use on campus

We store compost under these covers to keep rain from washing it away

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