Renewable Energy at UNH

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Goals:

- Our main goal is to use renewable energy sources to power UNH's campus and decrease the amount of CO2 emitted by nonrenewable energy sources.

Why UNH?

- UNH has signed the American College & University President's Climate Commitment (ACUPCC) and has pledged to reduce campus greenhouse gas emissions by 80% by 2050 and ultimately achieve carbon neutrality.
- Several million dollars have been invested in retrofit projects including high efficiency lighting systems, motors, and control systems. On capital construction projects, UNH has committed to energy efficiency measures to garner the equivalent of AT LEAST a LEED Silver rating

- UNH ranks in the top 5% for energy efficiency
- UNH generates and distributes its own power and heat from our combined heat and power plant, which uses processed landfill gas as its primary fuel source through a 12 mile pipeline known as Ecoline.
- EcoLine meets up to 85% of the university's energy needs

Kingsbury Hall

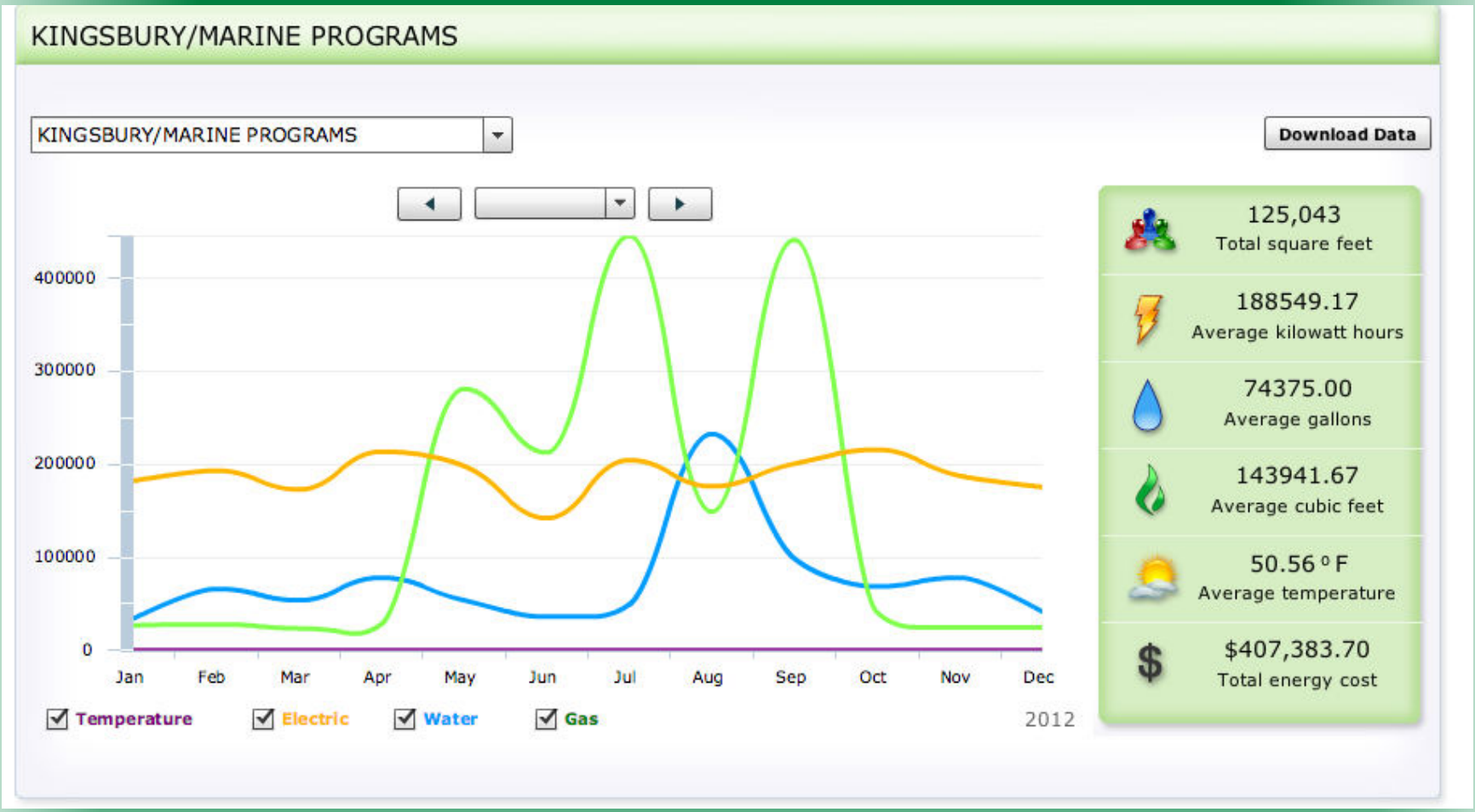
Why Kingsbury?

- Engineering building at UNH
- Requires a lot of energy
- Flat roof
- Good location (on campus) – minimal trees surrounding it

Kingsbury Hall

- Energy Costs: FY ‘12
- $586,059
- Co2 Emission
- 1,510 MT Co2

Kingsbury 2012



Compared to James Hall

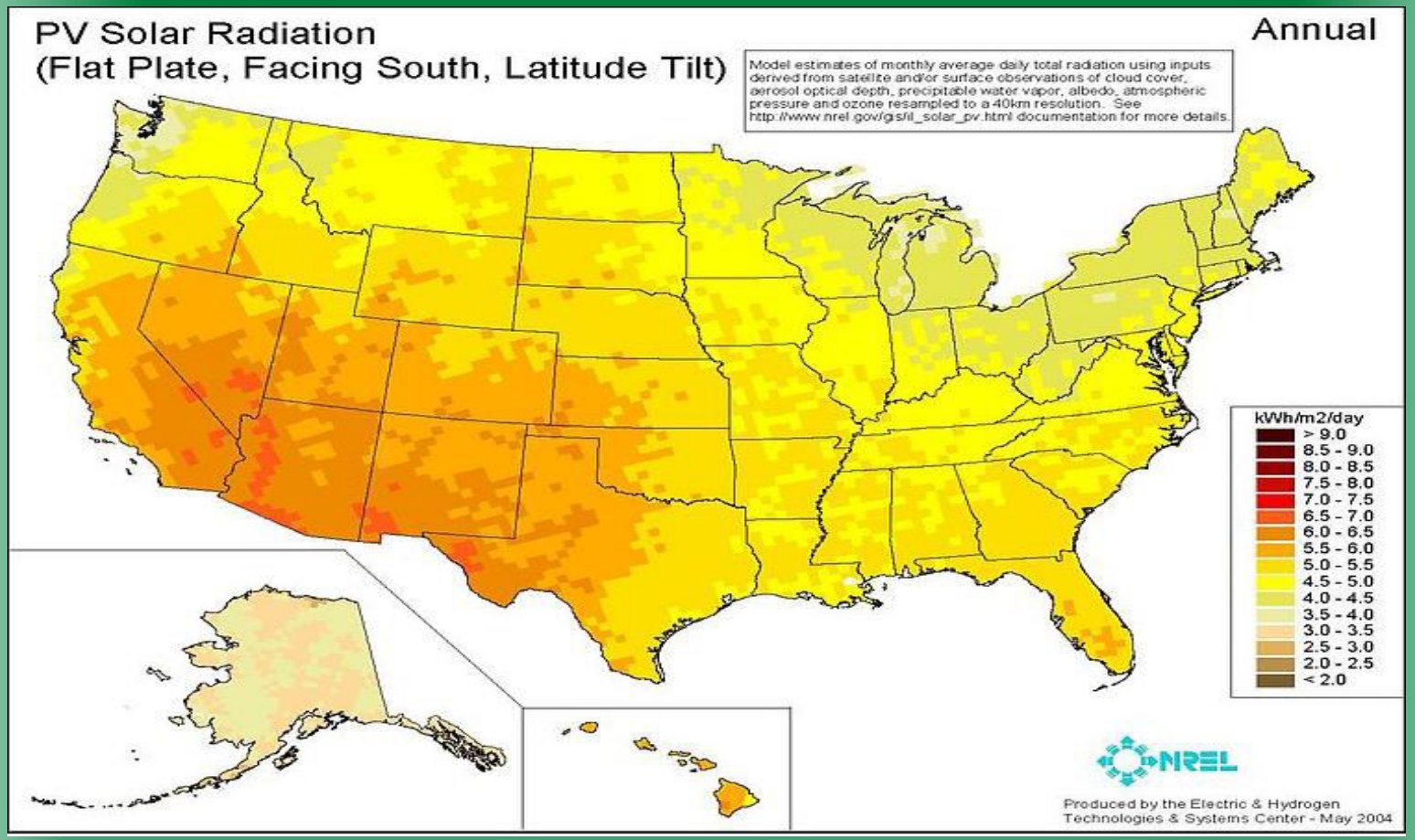
- James is LEED Gold certified

Why Solar?

- UNH currently does not have solar panels on campus
- Easy implementation
- Relatively inexpensive

How It Works

- PV cells are semi conductors, light causes electrons to flow
- PV array mounted on roof of Kingsbury
- Direct current to the inverter
- Transforms current to alternating current
- Power then connects directly to building for use
- Excess power flow back to grid, stored in a battery, or connected to nearby buildings.


PV Solar Radiation
(Flat Plate, Facing South, Latitude Tilt)
Annual
Model estimates of monthly average daily total radiation using inputs derived from satellite and/or surface observations of cloud cover, aerosol optical depth, precipitable water vapor, albedo, atmospheric pressure and ozone resampled to a 40km resolution. See http://www.nrel.gov/gis/il_solar_pv.html documentation for more details.
kWh/m2/day
> 9.0
8.5 - 9.0
8.0 - 8.5
7.5 - 8.0
7.0 - 7.5
6.5 - 7.0
6.0 - 6.5
5.5 - 6.0
5.0 - 5.5
4.5 - 5.0
4.0 - 4.5
3.5 - 4.0
3.0 - 3.5
2.5 - 3.0
2.0 - 2.5
< 2.0
NREL
Produced by the Electric & Hydrogen Technologies & Systems Center - May 2004

Sunmodule SW255

- At year 10, the Sunmodule's capacity is guaranteed to be at least 90% of the nameplate as opposed to the industry standard guarantee of 80%.
- SolarWorld Plus-Sorting
- 255 watts-peak power rating
- 25 Year performance warranty
- 10-year extended product workmanship warranty
- Extended cable lengths for easier installation
- Originally $765, sale price $323

Component Materials	
Cells per module	60
Cell type	Mono Crystalline
Cell dimensions	6.14x6.14in / 156x156 mm
Front	tempered glass (EN12150)
Frame	Clear anodized aluminum
Weight	46.7 lbs. (21.2 kg)

SolarWorld Sunmodule+ Specifications	
Model SW255	
Performance under standard test conditions (STC)*	
Maximum power - P max	255 Wp
Open circuit voltage - V oc	37.8 V
Maximum power point voltage - V mpp	31.4 V
Short circuit current - I sc	8.66 A
Maximum power point current - I mpp	8.15 A
*STC: 1000W/m², 25°C, AM 1.5	

Inverter

- Endurance tested to 20 year operating life
- Lowest part counts and fewest interconnects eliminate common failure points
- Field-proven technology with thousands of units installed nationwide
- price: $**1,901.81**

15 modules per person per hour installation time
25 year warranty, 100% recycled content

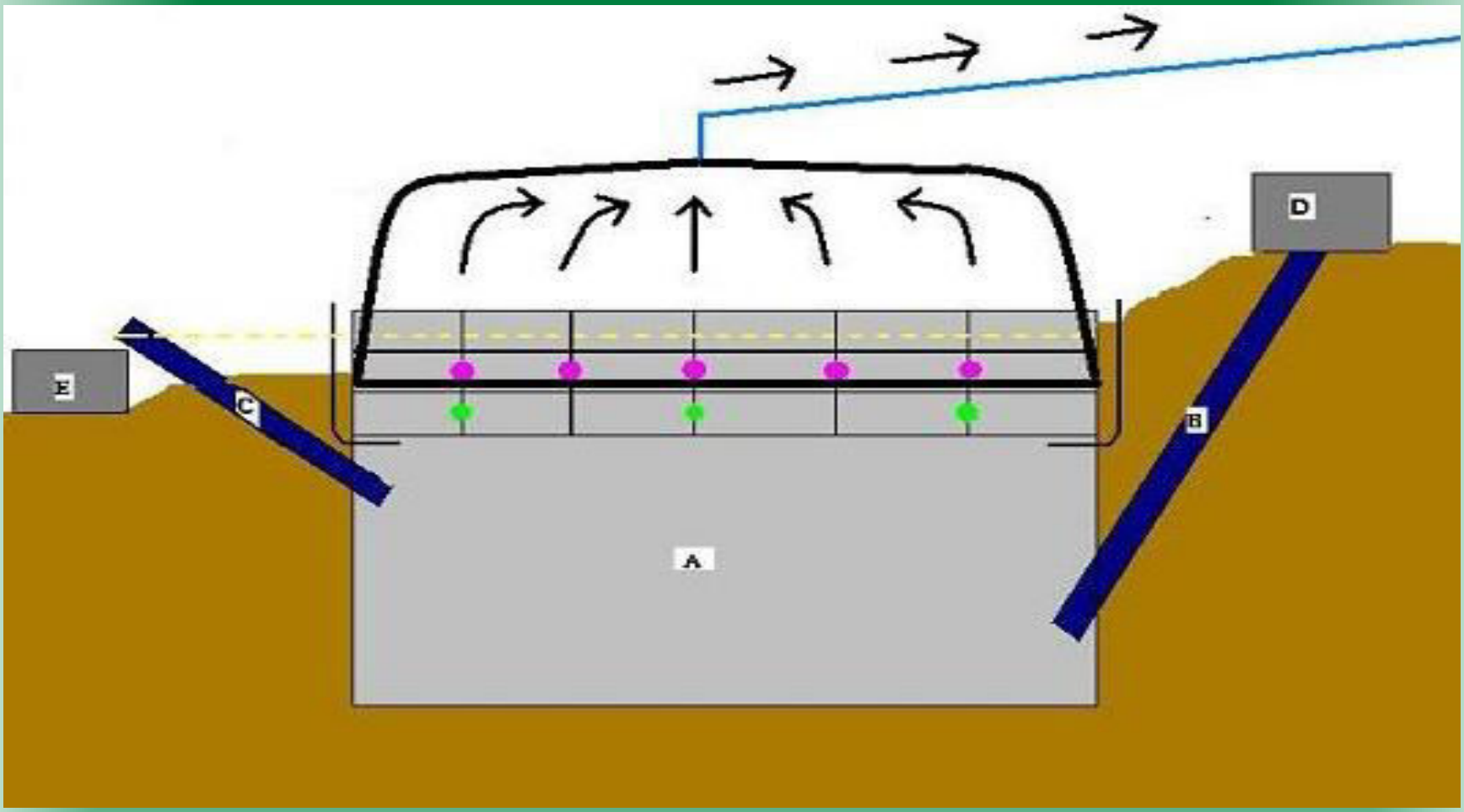
Biodigester

- The University of New Hampshire's Fairchild Dairy and Research Center houses 124 Holsteins. 25 of these cows are managed by undergraduate students.
- The average Holstein produces about 14 lb of organic waste every day of about 12 gallons of total waste.
- Based off of these numbers the average cow can account for 0.17kWh

Manure Production

	Heat requirement (Btu per hour)	Swine (150 pounds)	Dairy (1,200 pounds)	Poultry (4 pound bird)	Beef (1,000 pounds)
Kitchen range[1]	65,000	77	14	1,547	11
Water heater[2]	45,000	107	20	2,143	15
Refrigerator[3]	3,000	22	4	429	3
Heat 1,500 square foot home[4]	37,500	535	99	10,714	72
In-bin grain drying heater[5]	2 million	14,285	2,631	285,714	1,923
50 hp tractor operating at full load[6]	637,000	4,550	838	91,000	612

Biodigester Design



Biodigester

- Using the already constructed natural gas power plant network, methane gas can be collected from a biodigester and fed into the power plant for energy production.
- Each $10m^3$ biodigester can handle 5 cows and costs around $600-750
- Assuming an energy cost of around $0.04 per kWh, the ROI for each biodigester is estimated to be just under 3 years.

Further Uses

- The effluent from the biodigester can be used to fertilize crops and plants grown by the university.
- It seems most feasible to use the smaller group of 25 cows managed by undergraduates and 5 biodigesters to start the project.
- 25 cows could produce 37230 kwh/yr

Conclusion

- One of the best things about this project is that it can be implemented at other universities across the nation
- It is also a great way to get students like us involved in hands on projects on campus