ME

Minutemen Engineers

Project Presentation

Multifunctional Building Proposal

The Minutemen Engineers:

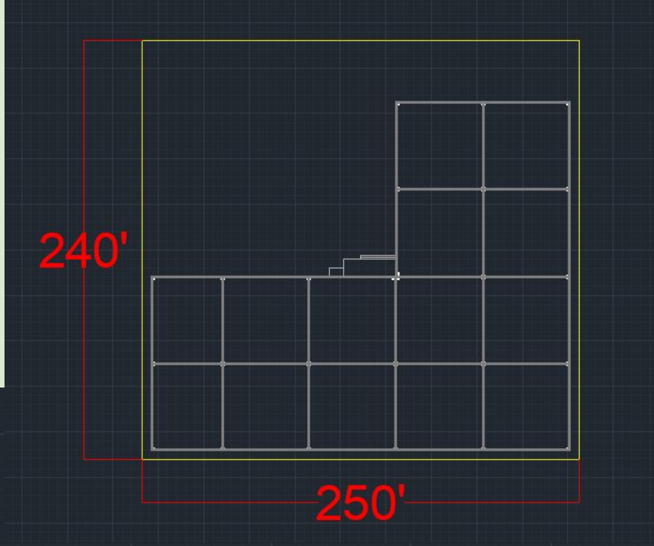
Justin Marcotte: Structural Engineer

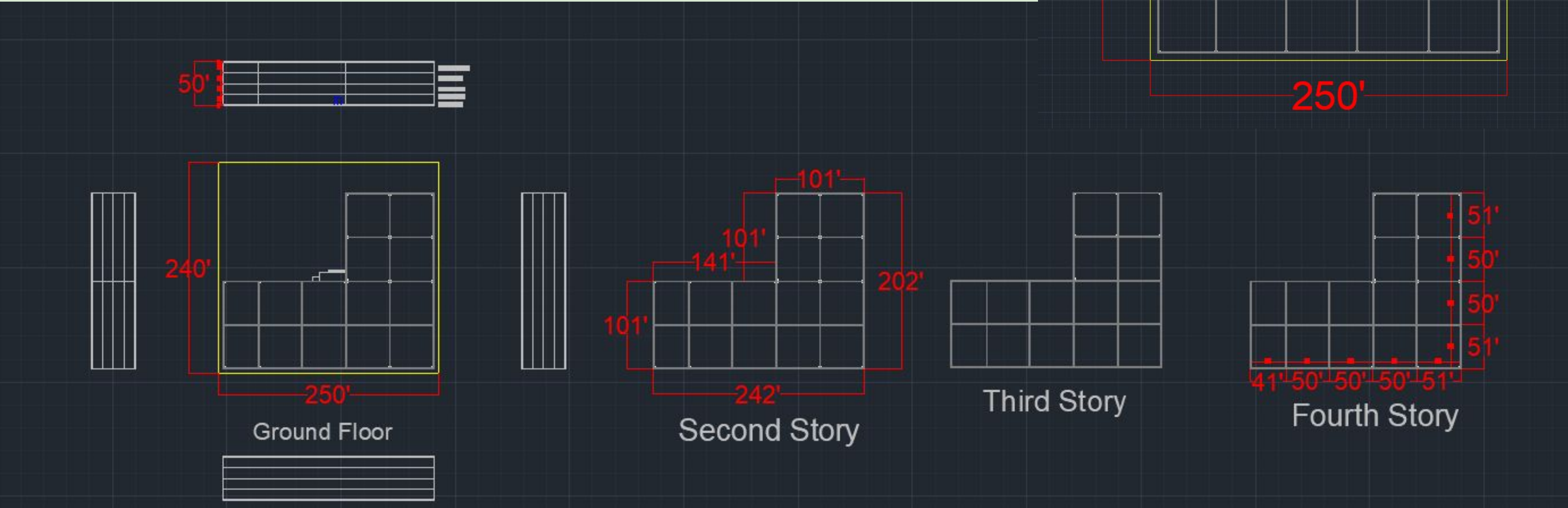
Julia Leventis: Electrical Engineer/Project Manager

Josh Davis: Architectural Engineer (AutoCAD specialist)

Nicholas Valianti: EWRE/Geotechnical Engineer

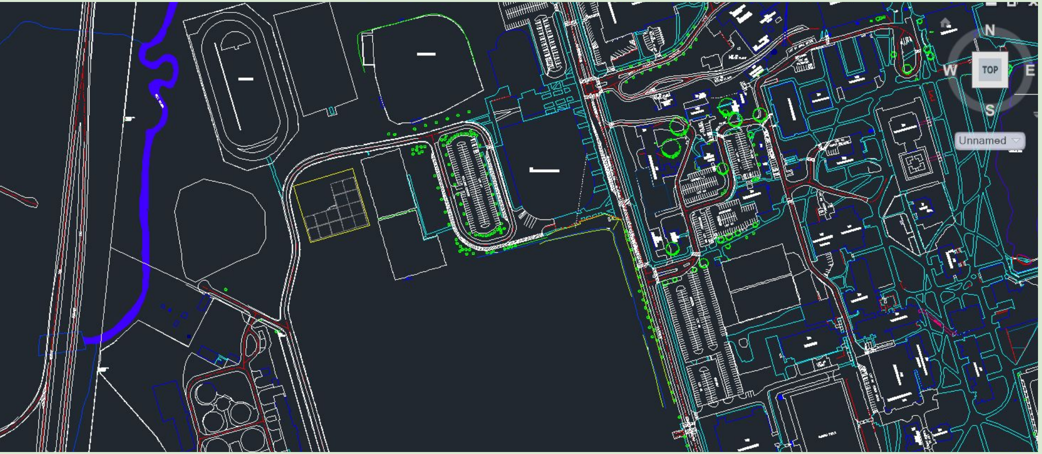
CAD Drawings And Specifications

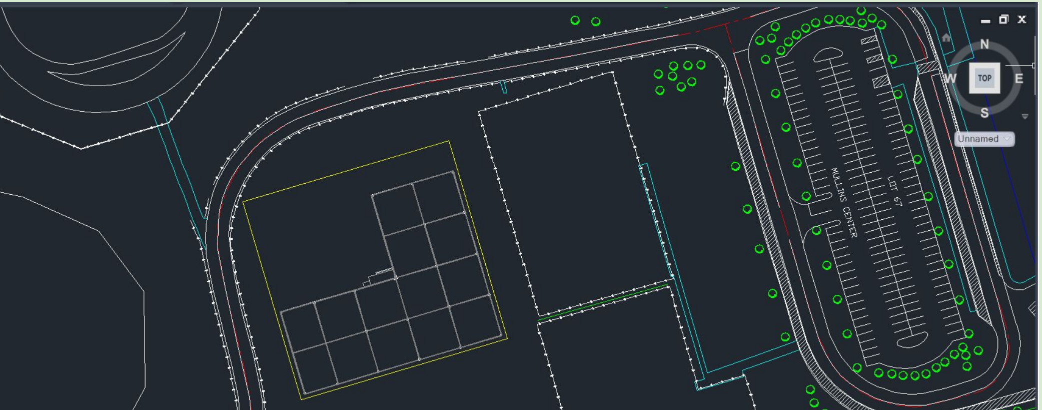


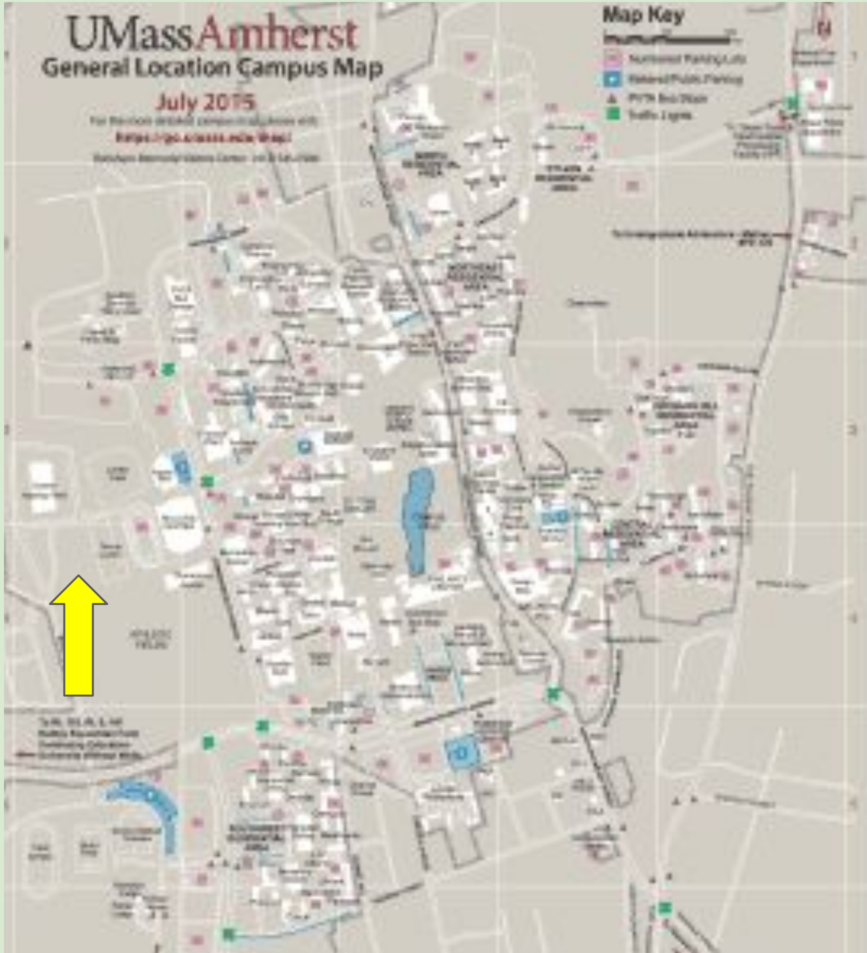


Autocad

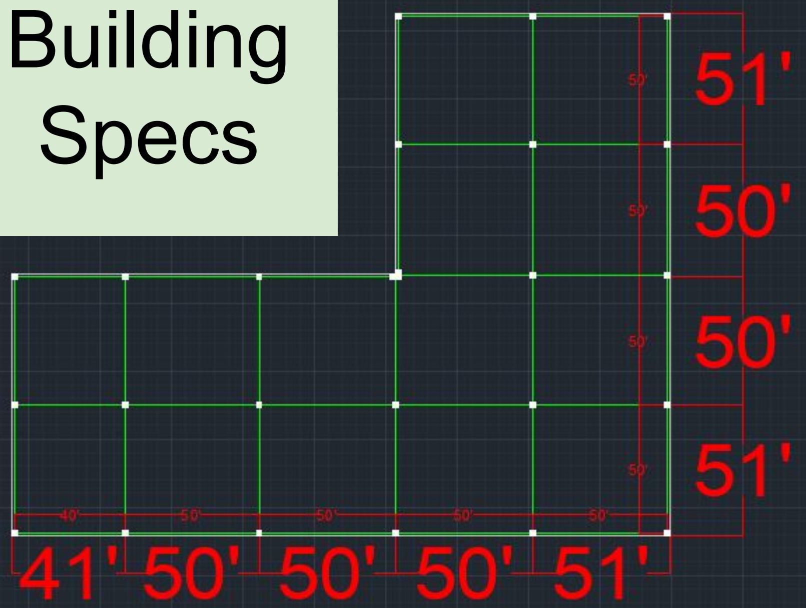
Building Location

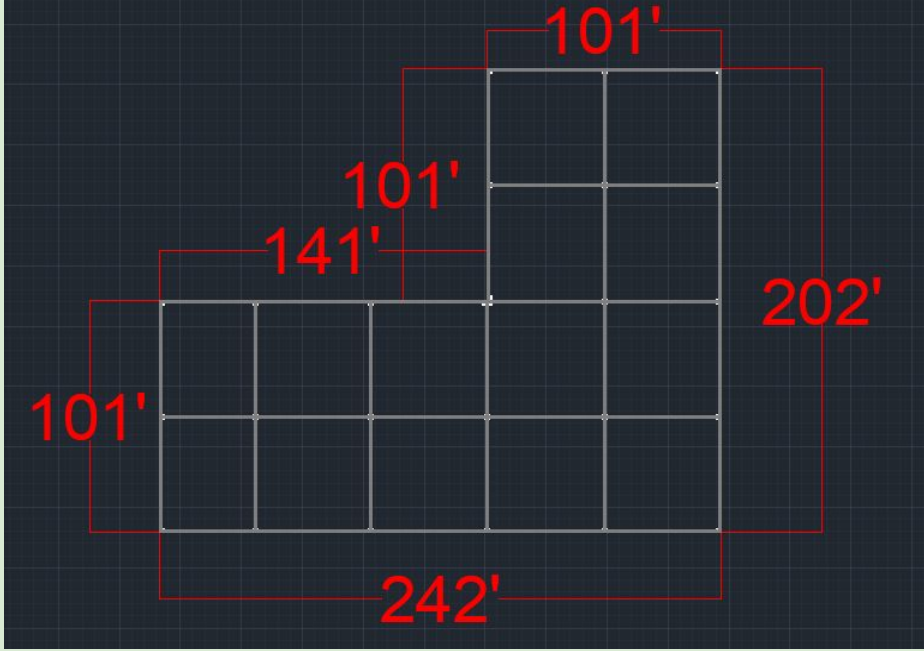


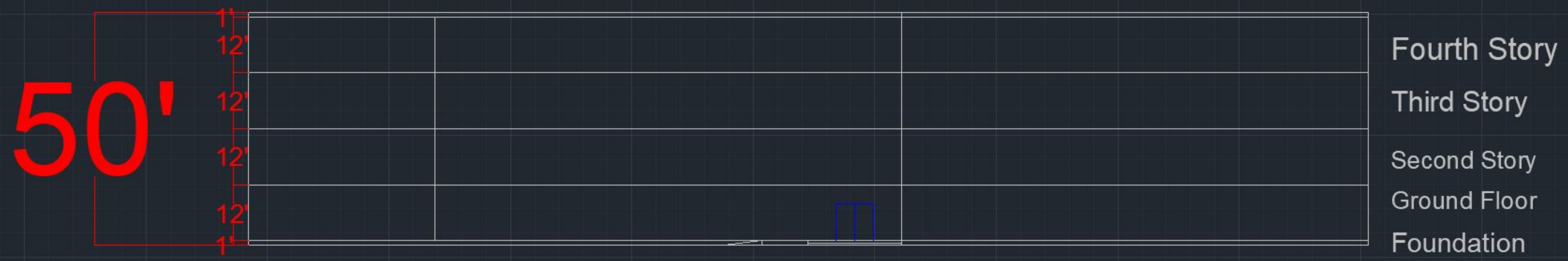




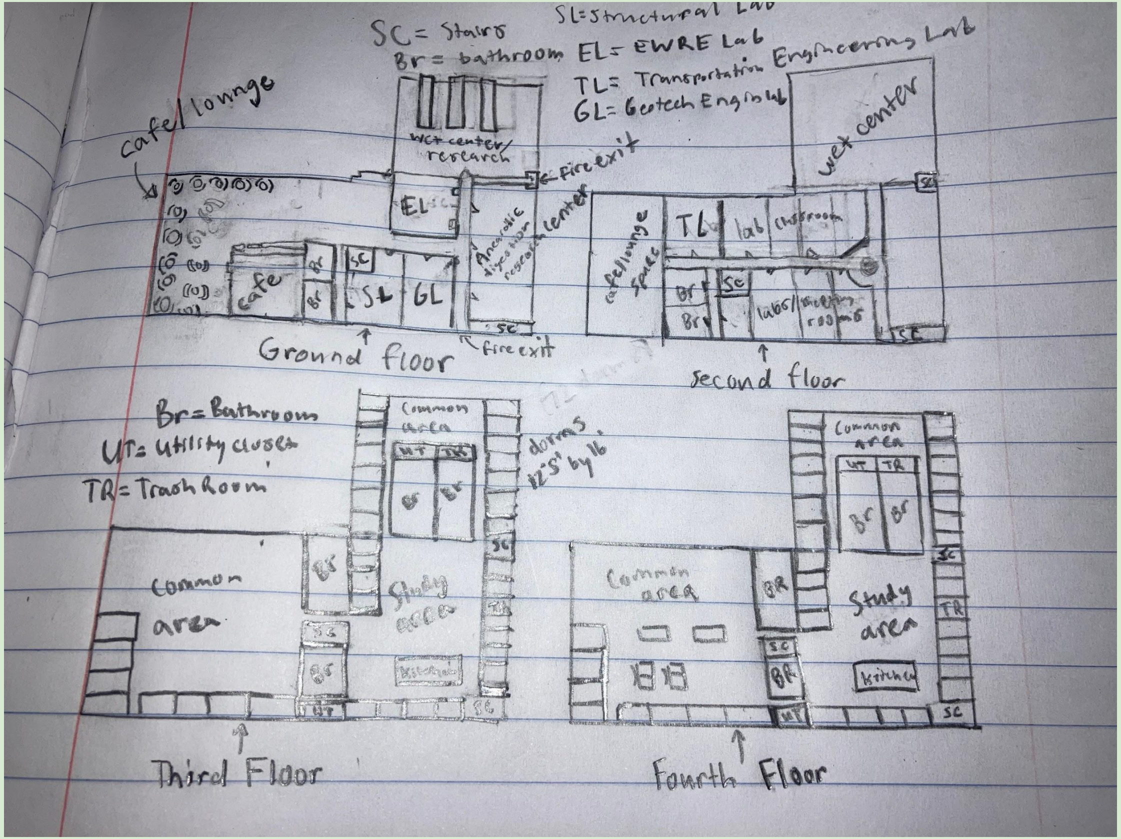
Building Specs



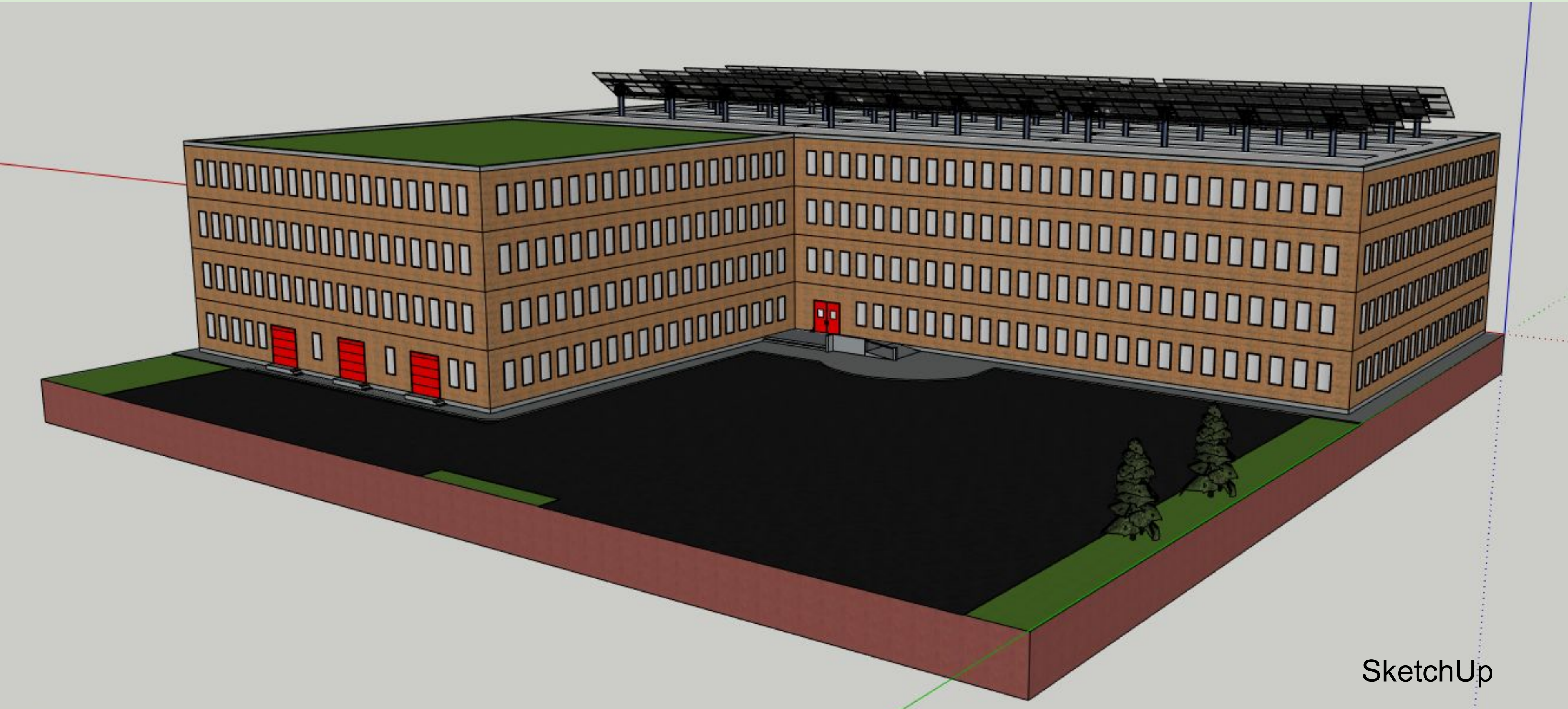




Multifunctional Floor Plans

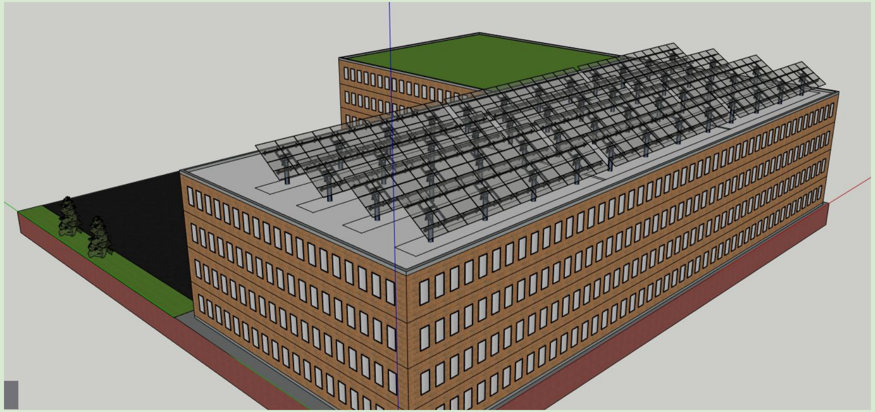


Model

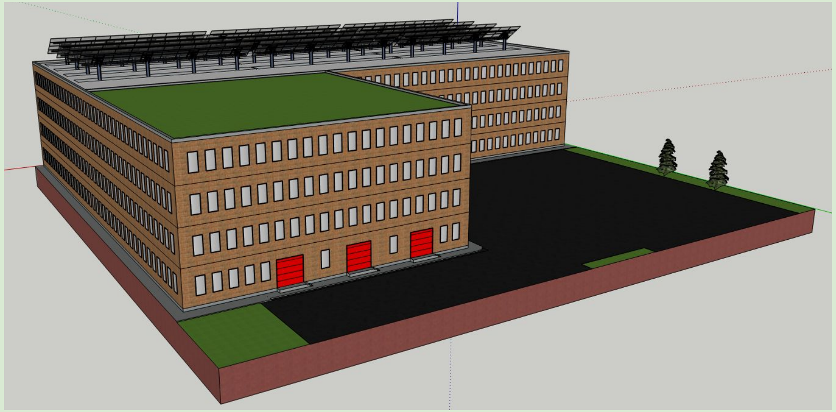


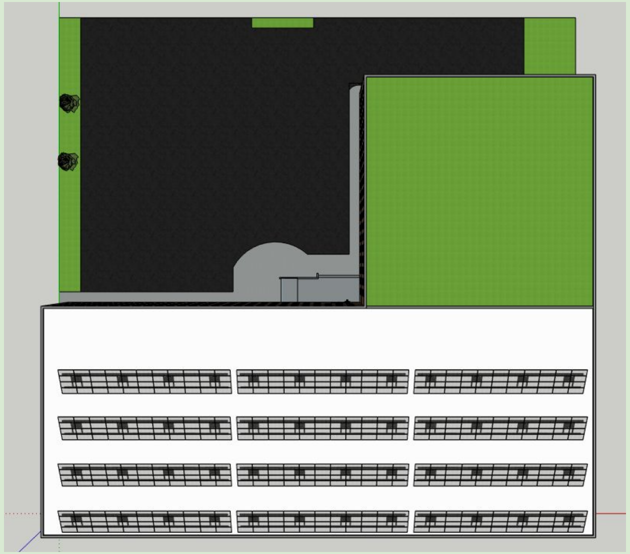
SketchUp

Solar And Roof Garden View



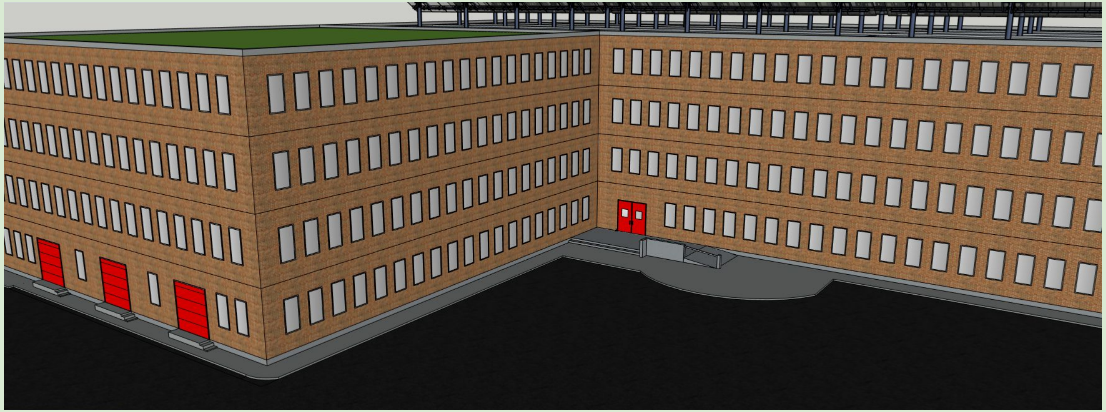
North East View





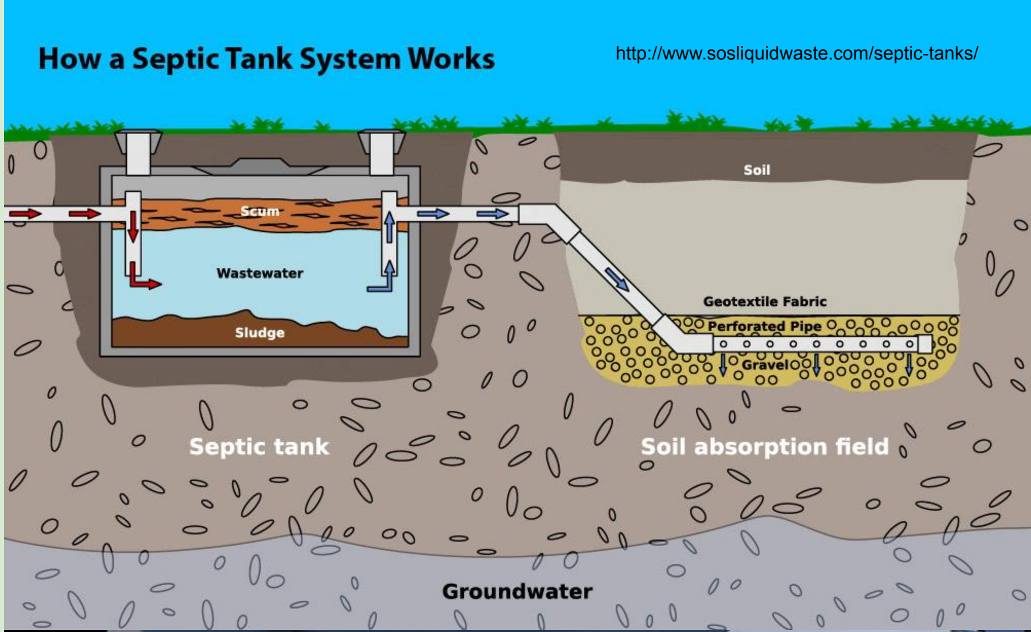
Birds Eye View

North West View



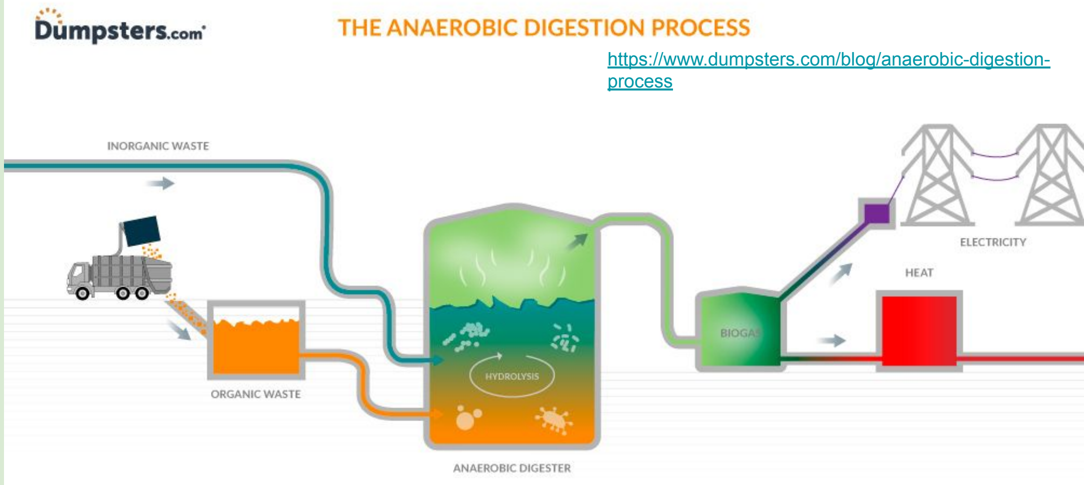
Water Sustainability

- Toilets, showers, sinks, etc. will be hooked up to city water
- Lab component of the building will use groundwater after research is conducted
- Some wastewater will go to our anaerobic digester. The rest will be sent to the the Amherst WWRF.
- The semi-permeable pavement will make the rain that hits the parking lot be transferred to the ground instead of storm drains.
- We will add a gutter system to our solar panels to harness water and use it as grey water for our geothermal heating/cooling system.



Anaerobic Digester

- Researching this form of energy generation
- Proposing to fund a Digester at Amherst WRRF
- helps clean wastewater
- Helps prevent certain wastes from going to landfills.
- We will use our buildings organic waste and wastewater to create biogas or methane and use this as an energy source.



https://www.dumpsters.com/blog/anaerobic-digestion-process

https://www.biocycle.net/anaerobic-digestion-in-the-northwest/

Solar Energy

- Solar energy will be placed on the roof of the building
- The solar panels will convert sunlight into electricity that our building can use for power without emitting greenhouse gas into the atmosphere.
- By implementing natural light, using little to no automatic doors, and using other sustainable power sources, less panels are needed to provide electricity/ power throughout our building, making solar energy for our building a wise investment.

https://gosun.co/blogs/news/how-solar-panels-are-made

Offshore wind farm

- We will fund an offshore wind farm somewhere off of the coast of New England.
- Facility will double as a research facility for more developments on offshore wind.
- Selling the amount of offshore wind we use

https://nawindpower.com/construction-begins-on-japans-first-large-scale-offshore-wind-farm

http://1.bp.blogspot.com/-h1lenyXLfxk/Uqre_h5v_3I/AAAAAAAADu8/_c9KhrBgMAo/s1600/new-england-states-map.jpg

Energy Calculations: how the building’s energy is allocated

- Assumptions/ Givens/ Work:
- 24442 ft^2 solar panels on roof
- About 24 kWH for 1 square foot of panels per year = 24kWh x 24,442 ft^2 = 586,608 kwh x 7kW/ 8.8kW = **466,620 kWh per year** (7kW/ 8.8kW is a ratio for production in california, which produces 24 kWh per sf and Massachusetts)
- How Many Solar Panels Do I Need? System Size Guide | EnergySage
- How Much Electricity Does a Solar Panel Produce? (solarreviews.com)
- Funding at least 3MW turbines on offshore wind farm
- 365 days x 24 hrs x 3000 kW x .4 efficiency factor = **10,512,000 kWh per year**
- How Much Power Does a Wind Turbine Generate? (sciencing.com)
- .19 cents per kWh back to National Grid = $1,997,280 per year (if we sell all energy produced)
- https://www.ecori.org/renewable-energy/2019/10/17/8shag5cooei2jb7tkfyy3dggdnhnj4
- 150 kW is not used due to natural lighting and minimal use of heating and cooling energy
- Our digester is small, 600 kWh per dry ton of food and 450 kWh per dry ton of wastewater solid
- (600 kWh x 5 tons) + (450 kWh x 5 tons) = 3000 + 2250 = **5,250 kWh per year**
- 14,241 sf for cafe, 50,096 sf for lab space, 69,286 sf for dorms
- Lab space and cafe are comparable in energy usage to a food service facility (56 kWh per ft^2), dorms are comparable to public assembly building (15 kWh per ft^2).
- (14,241 sf x 56 kWh/ sf) + (50,096 sf x 56 kWh/ sf) + (69,286 sf x 15 kWh)/ sf) = 4,700,000 kWh per year
- Benchmarking Commercial Building Energy Use Per Square Foot | Iota (iotacommunications.com)

- Assumptions/ Givens:
  - 24442 ft^2 solar panels on roof
  - About 15 kWH for 1 square foot of panels = 15kWh x 24,442 = 366630 kwh /8760 hours = **41.85kW a year** (https://www.solarreviews.com/blog/how-much-electricity-does-a-solar-panel-produce)
  - 31,536,000 seconds per year
  - Funding at least 3 turbines on offshore wind farm
  - .25 kW / turbine a day x 365 days = 91.25 kW a year from one Wind turbine x 3 = **273.75 Kw a year**
  - 0.016 kW/ ft^2 <- average kilowatts per square footage (https://homeprofessionals.org/solar/average-kwh-usage-for-a-2000-sq-ft-home/)
  - 150 kW is not used due to natural lighting and minimal use of heating and cooling energy
- ❖ Max power of anaerobic digester: can power more than 800 homes = ours is small so **100 kW a year** (https://www.eesi.org/papers/view/fact-sheet-biogasconverting-waste-to-energy#:~:text=The%20energy%20potential%20is%20significant,digester%20to%20increase%20biogas%20production)

Power per square footage of building - 34,643 ft^2 x 0.016 kW/ ft^2 = 554.288 kW - 150 kW = 404.288 kW<- amount of power needed for building (https://homeprofessionals.org/solar/average-kwh-usage-for-a-2000-sq-ft-home/)

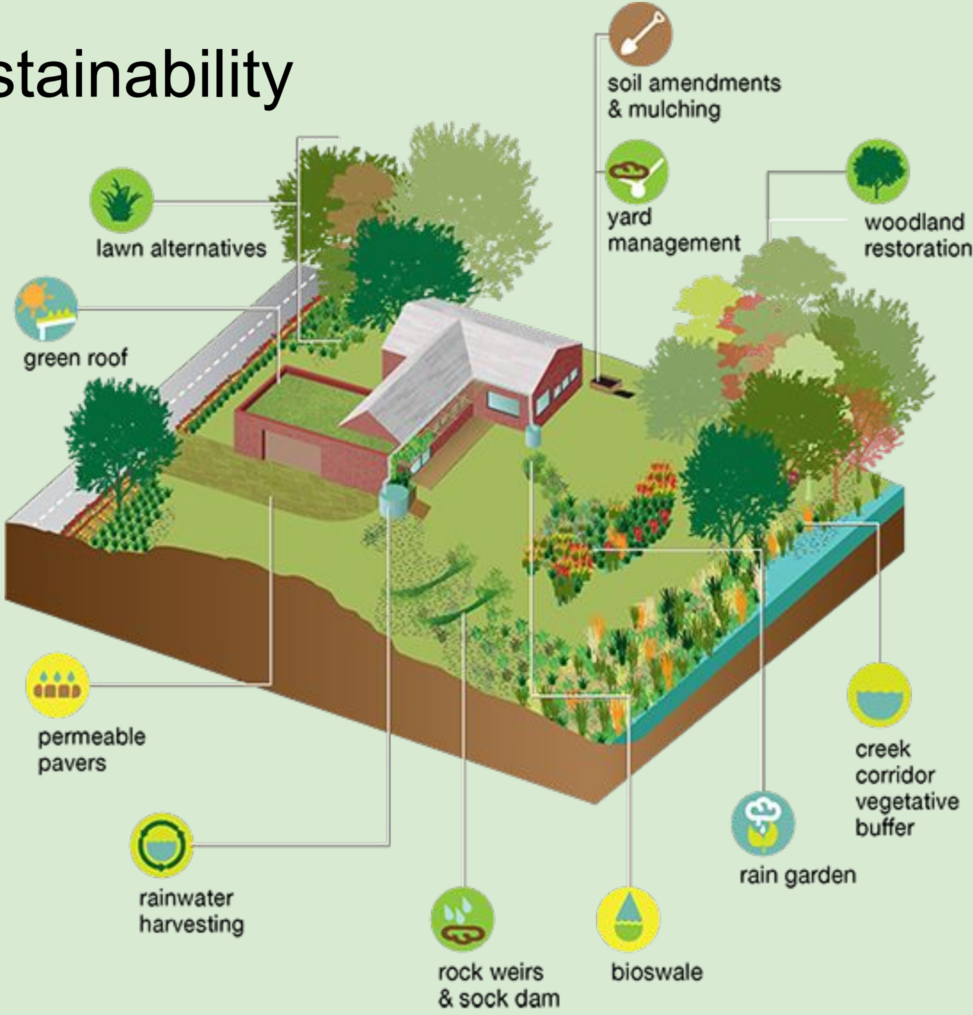
- Work:
- ❖ Equation: Energy = total power * time
  - Power from solar panels: 41.85 kW a year
  - Power from offshore wind farm used to offset nonrenewable energy: 3 turbines * .25 kilowatts a day x 365 a year = 91.25kW a year/turbine = 273.75 kW
  - Power from anaerobic digester = 100 kW <- because an anaerobic digester can power more than 800 homes, we can *assume* it can power 100kW

=> Total Power = 41.85kW + 100 kW + 273.75 kW = 415.6 kW <- meets requirement for building

- ★ Energy = total power * time = 415.6kW * 31,536,000 seconds per year = **1.31 x 10^10 Joules per year**

Building landscape aims for sustainability

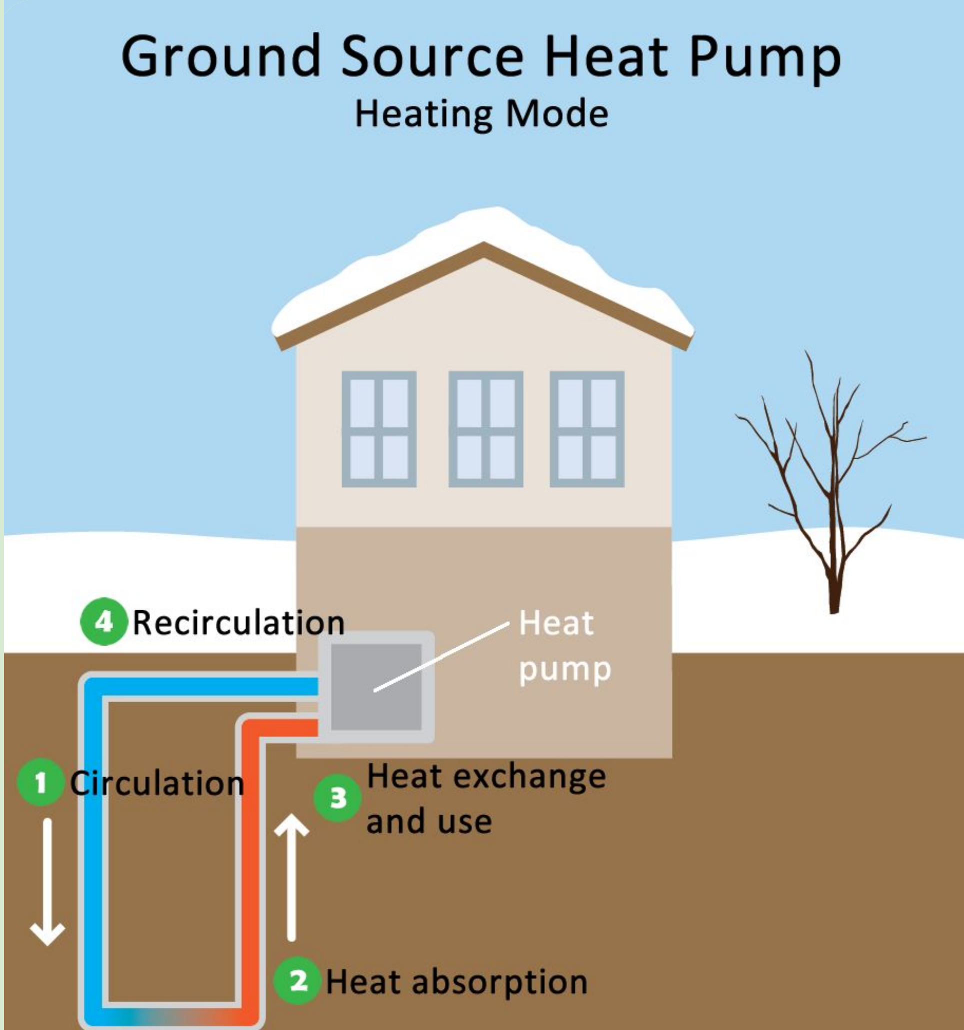
- As can be seen on the image to the right for reference, our building's landscape will incorporate trees and a garden. In addition, we will implement compost to provide nutrients to plants: the organic material helps soil hold onto water and reduces the amount of waste that gets put into landfills. This allows for environmental sustainability and cost efficiency when it comes to maintaining plants.
- The vibrant and lush landscape surrounding our building will be aesthetically pleasing to pedestrians and visitors.
- The three P's of sustainability are accounted for: **people, planet, profits.**



https://www.pinterest.com/pin/159526011773819289/

Heating and Cooling Sustainability

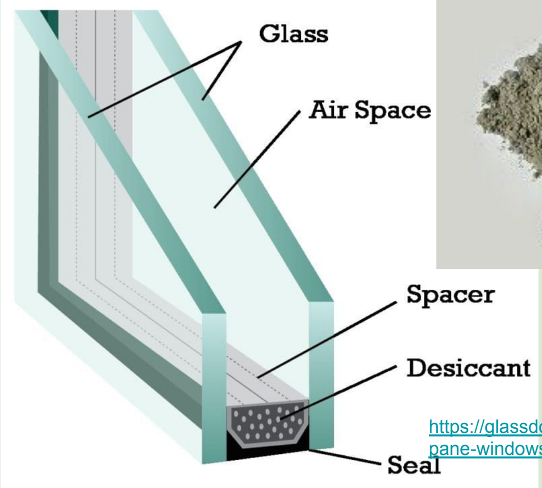
- **Geothermal heating only really has an upfront installation cost**
- Water is pumped from the building down into the ground, either hot or cold depending on what time of year it is, and comes back the opposite.
- As the water is below ground, it will expel heat or absorb it and then be pumped back into the building for release. **Sustainable Heating! No need for natural gas!**



https://www.epa.gov/rhc/geothermal-heating-and-cooling-technologies

Resilient materials used for building

- Dual-paned windows: insulation, energy-efficiency, and cost benefits
- Steel bracing for building: can withstand many natural disasters, is durable, and has elasticity
- Fly-Ash Concrete: higher strength and workability than regular concrete. Reduced energy in its production reduces CO_2 emissions!



https://glassdoctor.com/expert-tips/all-about-window-glass/double-pane-windows

https://paddyengineering.blogspot.com/2015/01/fly-ash-is-residue-that-is-left-from.html

https://www.pinterest.com/pin/3166662214914305/

Sustainability in Transportation

- Bike spaces with electric bike charging and and normal bike racks
- Bus stop for Umass PVTA transit along the side of our parking lot
- Electric vehicle charging stations
- All to promote sustainable transportation and decrease emissions!

https://www.umass.edu/transportation/premium-bus

- The EV charging station will have a solar canopy to generate some of its electricity

https://www.turbosquid.com/3d-models/ev-charging-station-3d-1211023

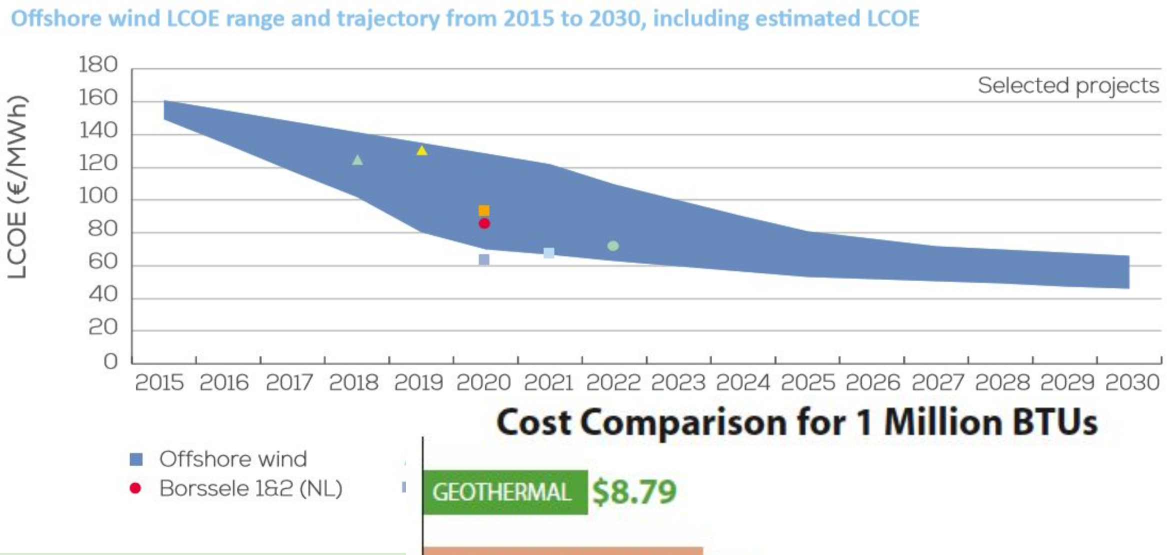
LEED Certification

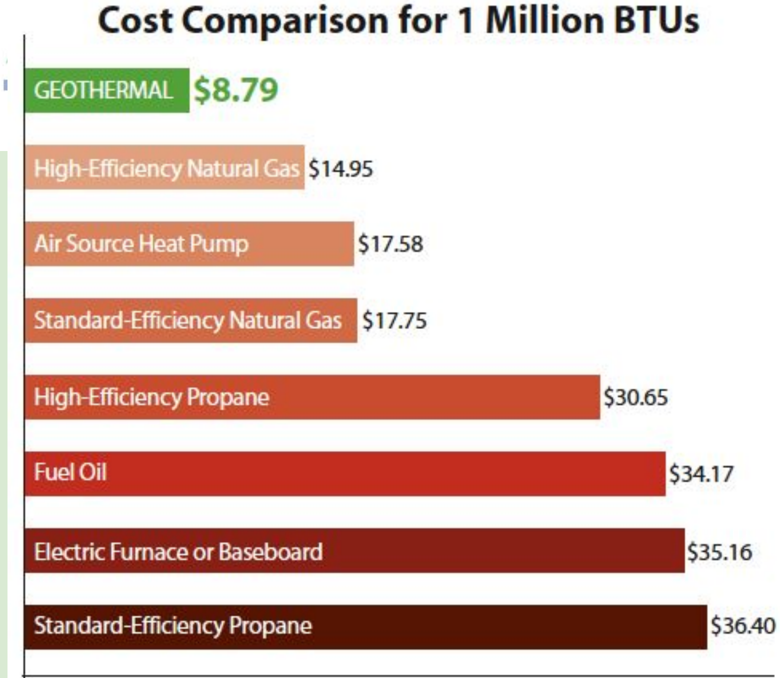
- Our building has the potential for LEED Certification
- “LEED certification means healthier, more productive places, reduced stress on the environment by encouraging energy and resource-efficient buildings, and savings from increased building value, higher lease rates and decreased utility costs,” Leadership in Energy and Environmental Design

<http://leed.usgbc.org/leed.html#:~:text=LEED%20certification%20provides%20independent%20verification,healthy%2C%20cost%2Deffective%20buildings>

Cost Benefit$

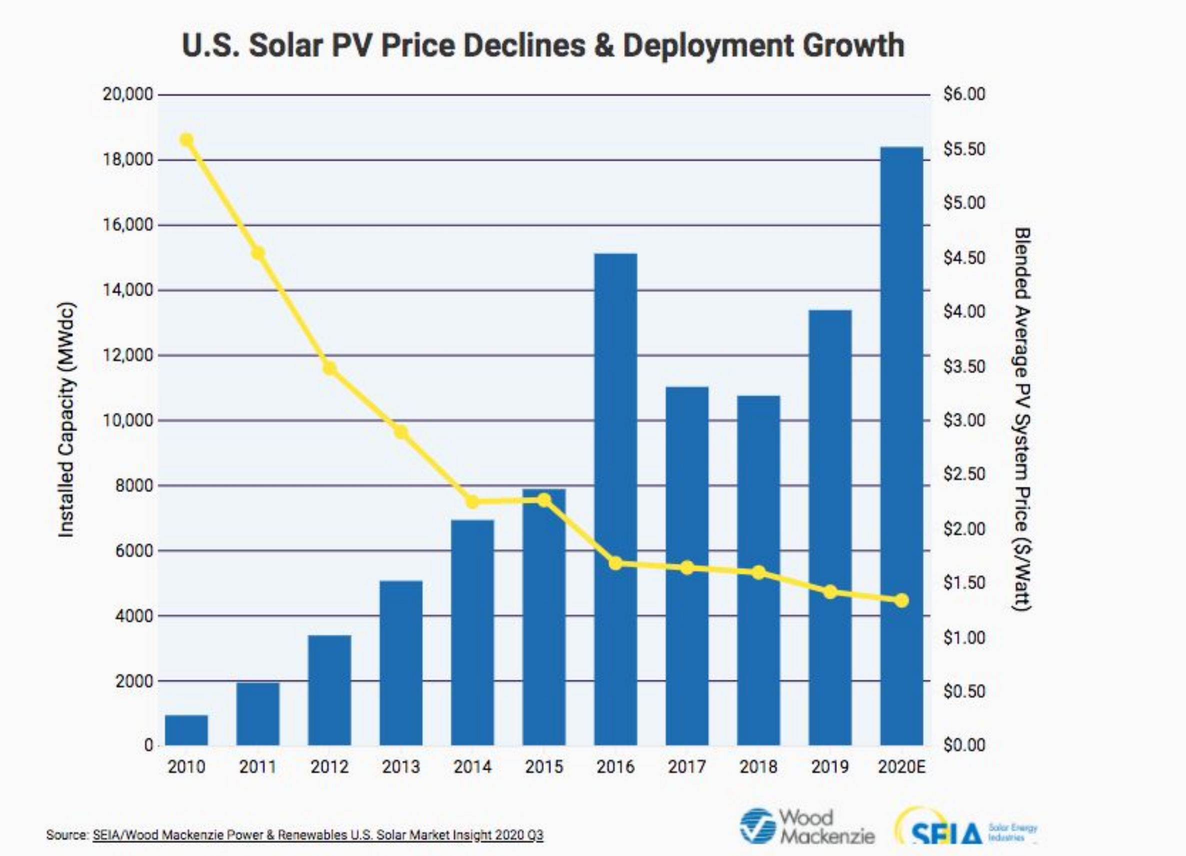
- Offshore wind is projected to **drop in price in the coming years**
    - **Installing Geothermal heating/cooling saves tons of $$ in the long run** because there is less energy needed (natural gas heating was used prior to this) **no longer paying for it!**





Cost Benefit$ Continued

- Solar Energy prices have been dropping for the past 10 years and is therefore expected to continue to drop in price
- Solar has an upfront cost, but its energy is continuous and sustainable for years!



Wise investment

- Sustainable: for people and the planet. 100% renewable energy building with aesthetically pleasing landscape
- Resilient: building materials able to withstand various natural disasters
- Sustainable + Resilient = wise investment: benefits exceed the cost