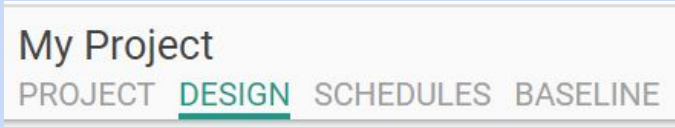
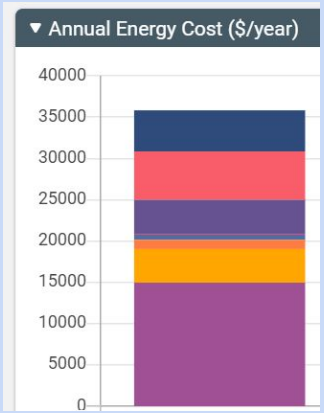
# Sketchbox™ by Slipstream

Thursday, August 15, 2024



## Teaching Presenters

**Joe Phillips -** phillipsj@esschools.k12.wi.us
HS and MS Science Teacher, Eleva-Strum

**James Reichling -** jpreichling@madison.k12.wi.us
Physics & math teacher, Madison Metro School District
Instructor, CREATE center

**Samara Hamzé -** samara.hamze@uwsp.edu
Program Manager at KEEP (Wisconsin's K-12 Energy Education Program)

# Slipstream Staff

**Dave Vigliotta**
Senior Director of Partnership Development

**Drew Morrison**
Senior Energy Engineer

**Emily Golen**
Energy Engineer II

**Peggy Heisch**
Project Manager

# Participant Introductions

Your name

What level and classes you teach or other industry connection

How do you expect you will use sketchbox?

**Recording in Progress!**

For later training purposes today’s sessions are being recorded

# Thank you

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**PARTNERS**

Wisconsin K-12 Energy Education Program (KEEP)
College of Natural Resources
University of Wisconsin-Stevens Point

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CREATE Energy Center
Working to Advance Energy Technology
Educational Programs

slipstream

**Accelerating climate solutions. For everyone.**

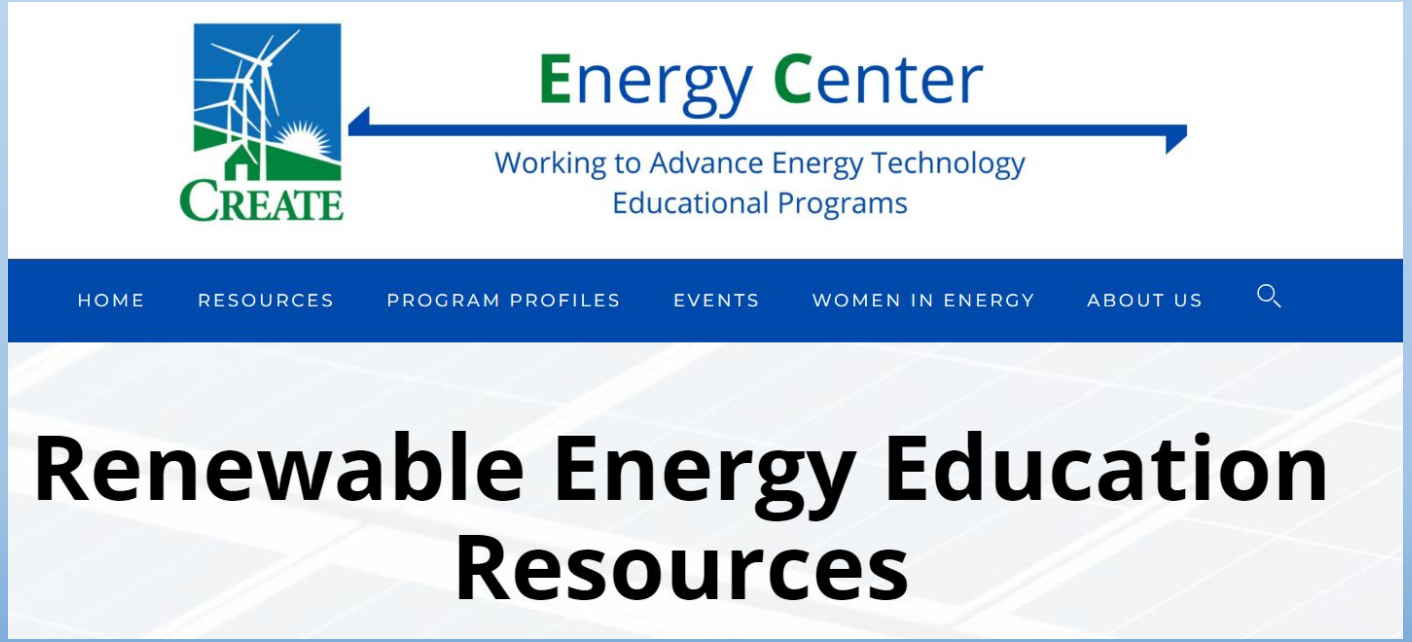
We deliver research, technical assistance, financing, education and training, and programs for stakeholders.

www.slipstreaminc.org

# CREATE

Center for Renewable Energy Advanced Technological Education

https://createenergy.org/resources/



# Agenda (part 1)

| | |
|---|---|
| 9:00 - 9:15 | Introductions and objectives |
| 9:15 – 9:30 | Overview of Sketchbox |
| 9:30 – 9:40 | Curriculum Connections |
| 9:40 – 10:00 | Sample Building Model |
| 10:00 - 10:10 | Overview of Lessons and Resources |

BREAK - Resume at 10:25 CDT

# Agenda (part 2)

10:25 – 10:35 Integration of External Resources
(e.g. PV Watts, Future Urban Climates, Career Roadmaps)

10:35 - 10:50 Breakout Groups with Sketchbox

10:50 - 11:05 Technical Q & A with Slipstream

11:05 – 11:15 Review of Resources, Brief Evaluation

Conclusion of Workshop

# Objectives

Introduce Sketchbox Building Energy Modeling Interface

Motivate the use of energy modeling in the classroom, including career connections

Describe available lesson materials and resources

Demonstrate creation of several building models

# Overview: Energy use in buildings

US EIA reports buildings account for 39% in 2021

Example strategies to save energy, reduce cost
- upgrade lighting
- scheduling and set points
- update mechanical systems
- building envelope improvements

Energy modeling helps make decisions about which strategies provide the greatest return on investment

US Dept of Energy (DOE) provides DOE2 Building Energy Use and Cost Analysis Software

DOE provides E-Quest as a user interface

Download and install required, can be hard to learn

# Sketchbox by Slipstream as a teaching tool

Online user interface to DOE2

Free to use, no download required

Runs on a student chromebook

Students can change parameters to explore impact on energy utilization and cost. Examples:

Building type (school, commercial, library, fitness center)

Location (City and State)

Window Fraction and Spatial Orientation

Energy Code

# Sketchbox navigation through tool tabs

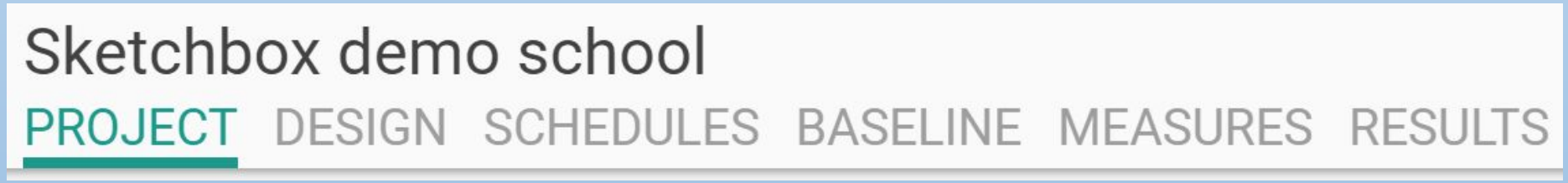


Pre-loaded sample data for quick-start including: Building types, building size, mechanical systems, weather data and utility rates by location

# Sketchbox Example

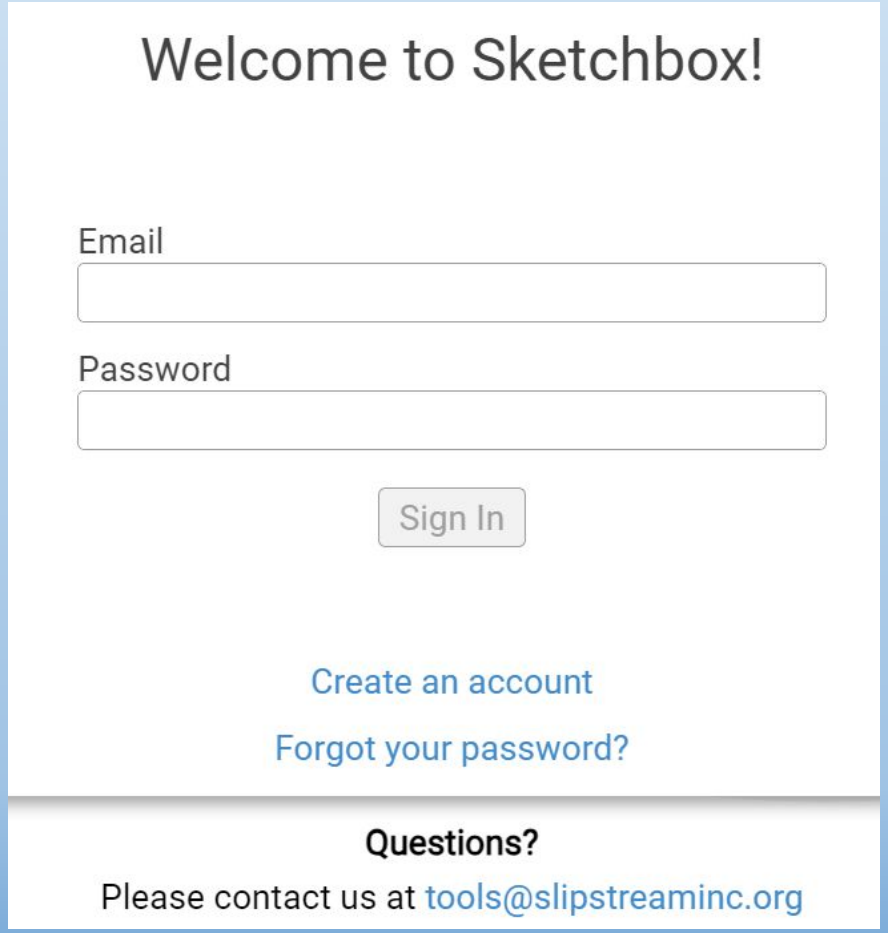
150,000 square foot school building in Chicago

Demonstrate in sketchbox

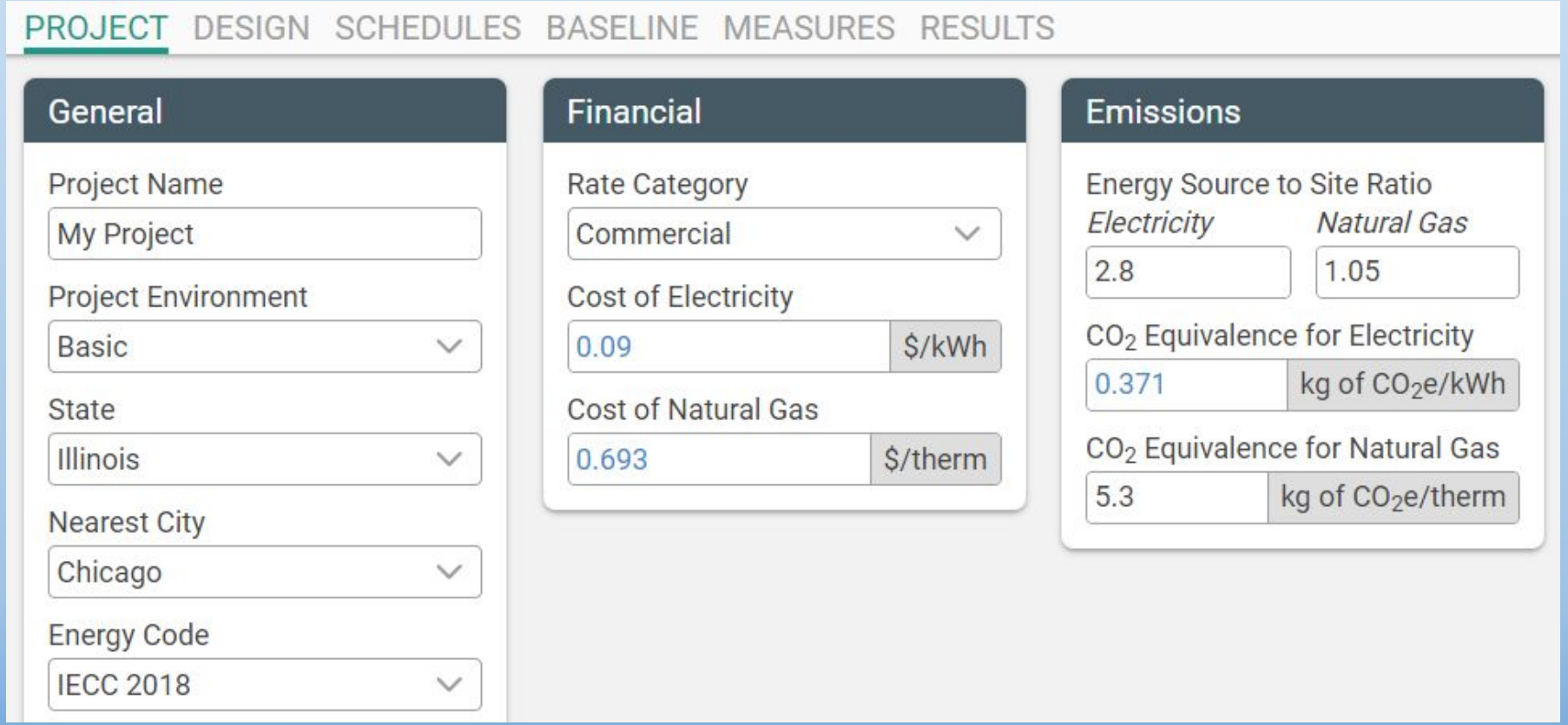


https://slipstreaminc.org/sketchbox

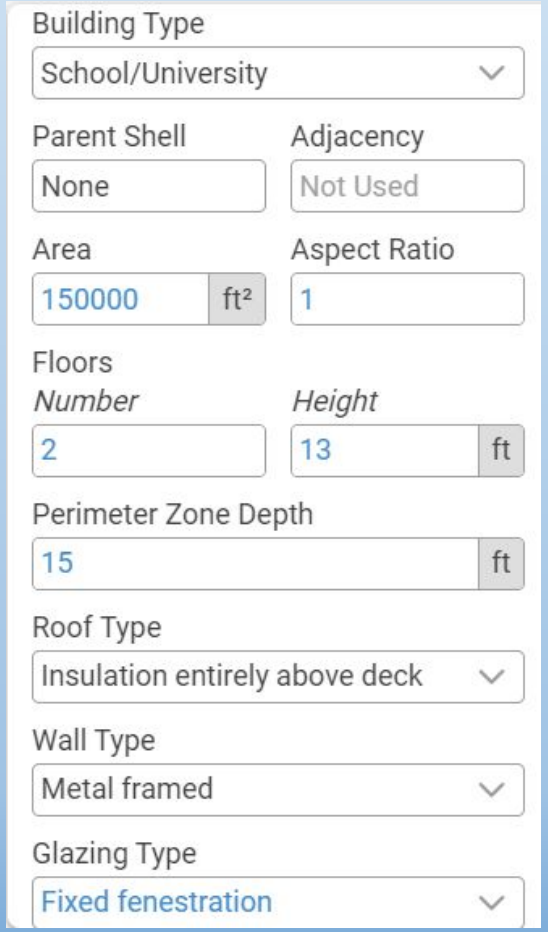
START USING SKETCHBOX TODAY

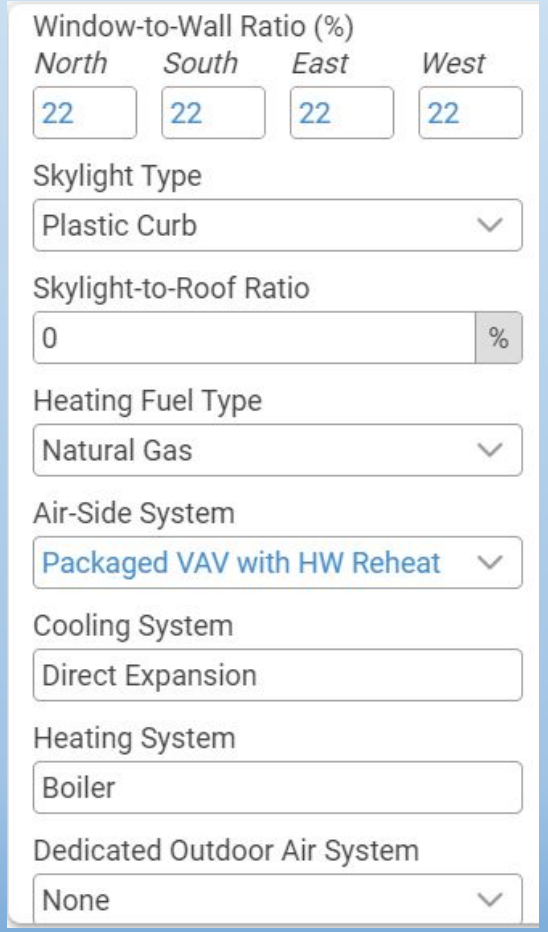


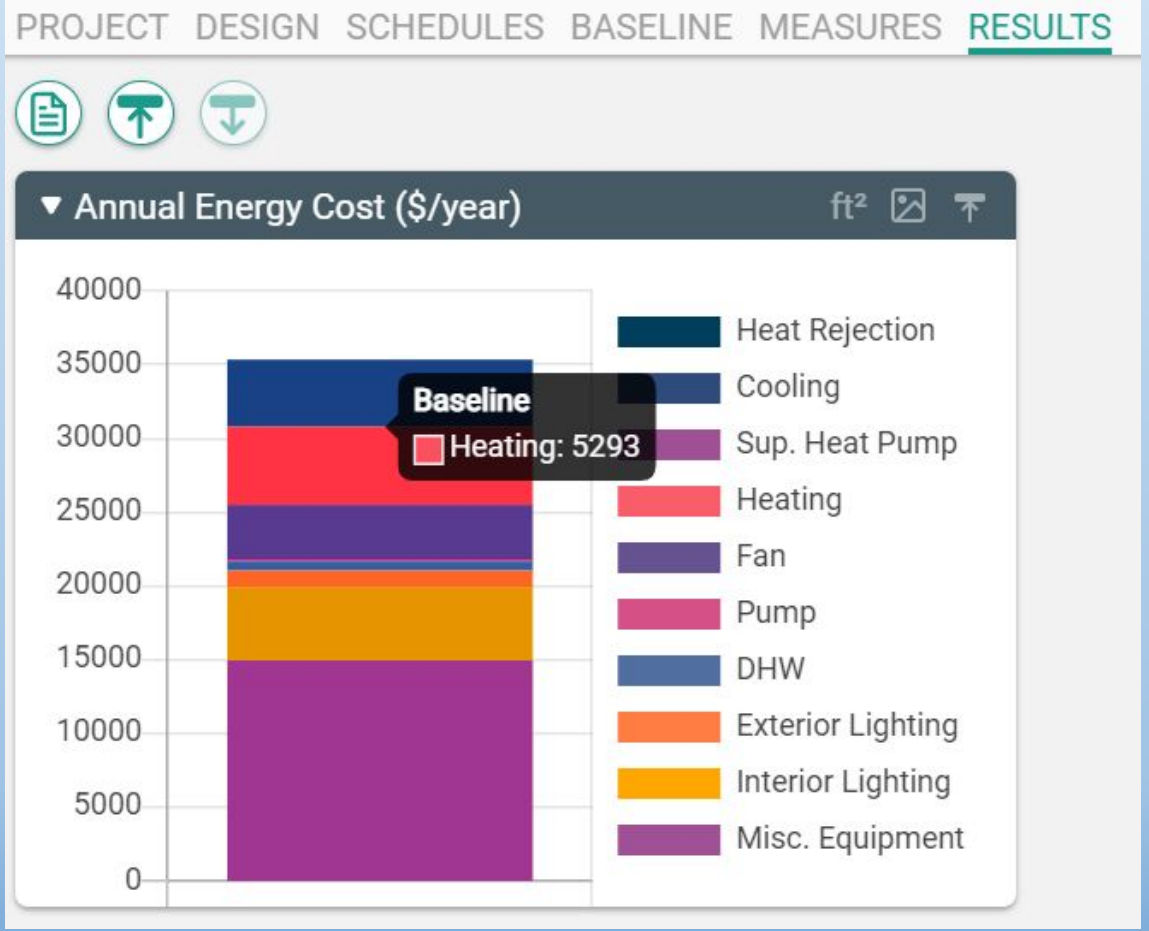
# Default Project Settings



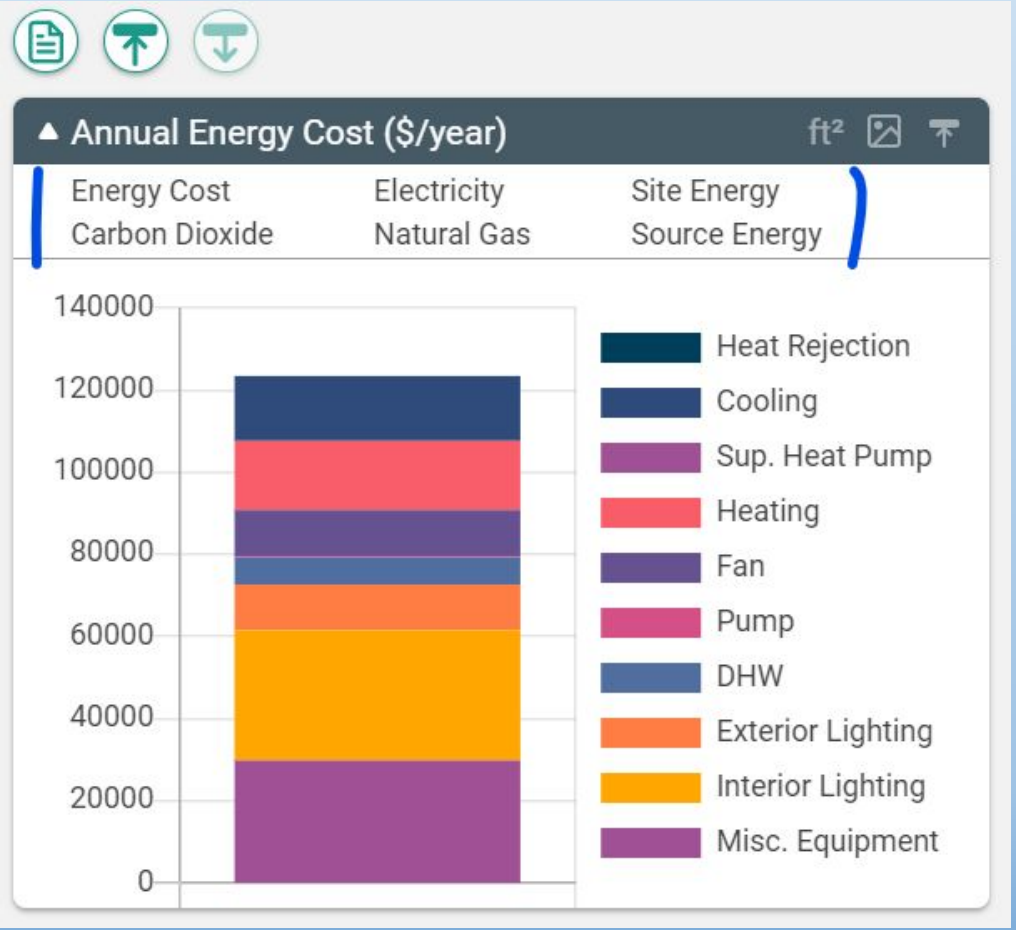
# Design Tab Options



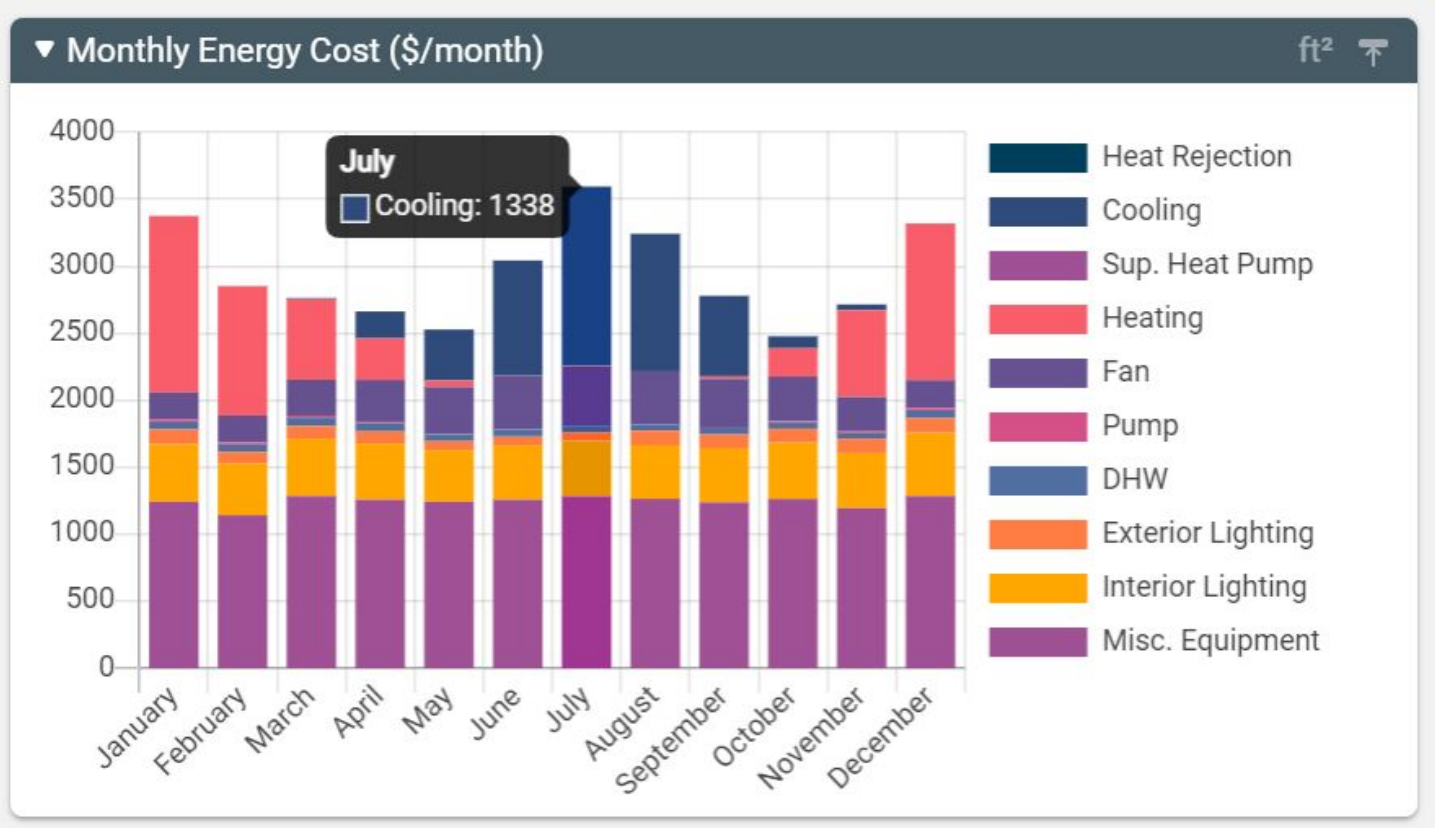



# Energy Cost by Utilization




# Other display options

# Monthly breakdown



# Annual Summary

**Results Table**

| | Peak Cooling (kBTU/hr) | Peak Heating (kBTU/hr) | Peak Electric Demand (kW) | Annual Electric Consumption (kWh) |
|---|---|---|---|---|
| Baseline | 3244.8 | 2404.7 | 413.1 | 1027457 |

| Annual Natural Gas Consumption (therm) | Annual Energy Cost ($) | Annual Water Consumption (gal/yr) |
|---|---|---|
| 34975 | 116709 | 1950000 |

Sketchbox Example - What if… ?

Building size reduced by half

Original building had more windows

Original building moved to LA

https://forms.office.com/r/XWvFWevVF0

# Lesson 1 - Introduction to Sketchbox - RESULTS

| Scenario | Electricity (MWh) | Natural Gas Therms | Total Cost Dollars ($) |
|---|---|---|---|
| Baseline | 1027 | 34,975 | 116,709 |
| Half area (75,000 $ft^2$) | 513 | 18,672 | 59,074 |
| Double window area | 1064 | 35,163 | 120,122 |
| Move to LA | 1051 | 10,064 | 166,944 |

# Lesson 1 - Introduction to Sketchbox - RESULTS

| Scenario | Electricity (MWh) | Natural Gas Therms | Total Cost Dollars ($) |
|---|---|---|---|
| Baseline in Chicago | 1027 | 34,975 | 116,709 |
| Move to Los Angeles | 1051 | 10,064 | 166,944 |

In Chicago electricity has a carbon impact of 0.371 $kgCO_2/kWh$

In California this value is 0.191 $kgCO_2/kWh$

Natural gas is 5.3 $kgCO_2/therm$

# Lesson 1 - Introduction to Sketchbox - RESULTS

| Scenario | Electricity (MWh) | Natural Gas Therms | Total Cost Dollars ($) |
|---|---|---|---|
| Baseline in Chicago | 1027 | 34,975 | 116,709 |
| Move to Los Angeles | 1051 | 10,064 | 166,944 |

Chicago:
566,400 kg-$CO_2e$

Los Angeles:
443,30 kg-$CO_2e$

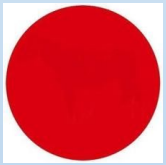
# Curriculum Connections

***Why teach this to students?***

***Classroom, Curriculum, and Common Sense Enhancement***

- Understanding Resources
- Analyzing Costs and Benefits in Life and Business
- Provide Real Examples of Climate Change and Solutions
- Demonstrate Career Opportunities, Specialization, and Advancement Possibilities
    - Building Manager, Energy Engineering, Architecture, HVAC, Energy Analysts, Construction/Contractor, Sustainability Coordinator

# Curriculum Connections



***Why teach this to students?***

***Meeting Standards in Relatable and Useful Ways***

- Mathematics: Area, Volume, Percent and Percent Change
- CTE: Insulation Values, Material Costs, Marketing and Managing
- Science:

**MS-PS1-4 Matter and its Interactions**

Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

**MS-ETS1-2 Engineering Design**

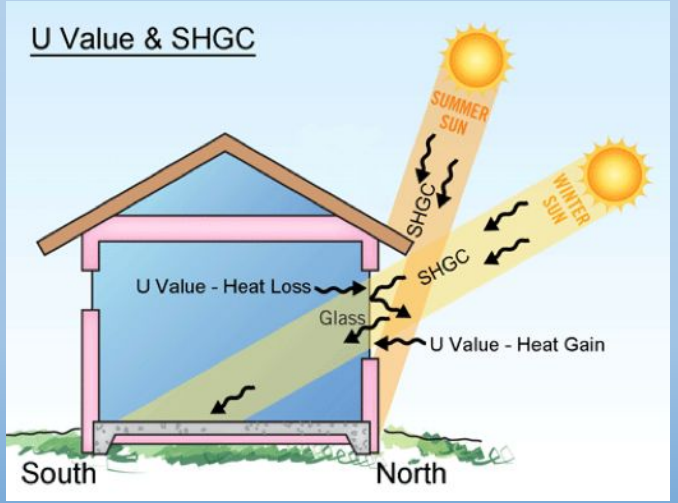
Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

# Curriculum Connections

***Why teach this to students?***

***Expand Knowledge and Possibilities***

- SHGC: What is it?
  - Solar Heat Gain Coefficient
    - Solar? Coefficient? Values?
  - Cost of materials?
  - Payback and time?
- The best “bang for the buck”?
  - As compared to LED lighting?



## Why teach this to students?

Energy DPI Pathway

Job growth in renewable energy

Green buildings career map:
https://greenbuildingscareermap.org/


## Renewable Energy Career Maps

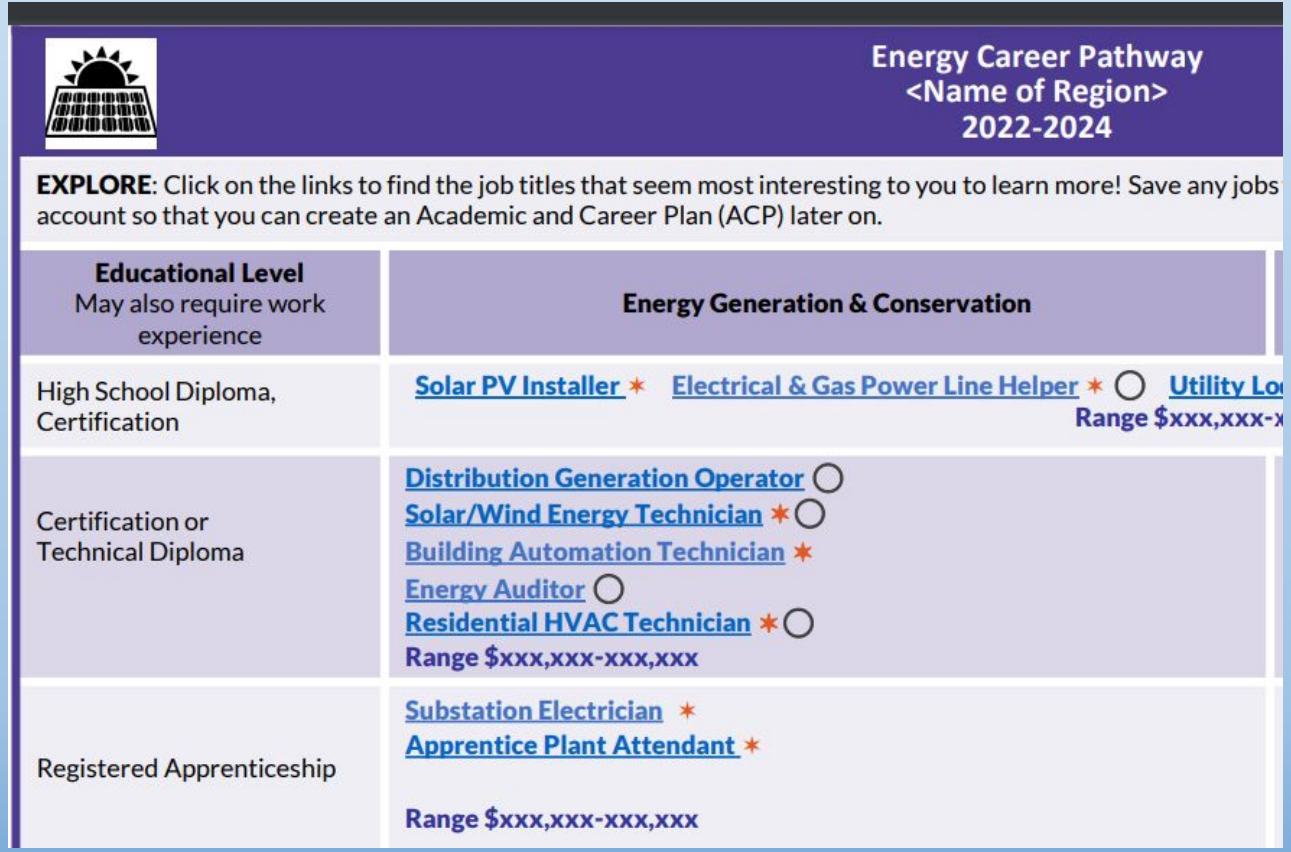
- Solar
- Climate Control
- Bioenergy
- Wind
- Green Buildings

DPI Regional Career maps
https://dpi.wi.gov/sites/default/files/imce/pathways-wisconsin/2022_11_14_Final_Energy_Career_Pathway_11.14.22.pdf

- Energy Generation & Conservation
- Energy Transmission, Distribution, & Storage

Training levels: H.S. Diploma, Certification or Technical Diploma, Registered Apprenticeship, Associates Degree, Bachelor's Degree and beyond

# DPI Regional Career maps



**Energy Career Pathway**
**<Name of Region>**
**2022-2024**

**EXPLORE**: Click on the links to find the job titles that seem most interesting to you to learn more! Save any jobs account so that you can create an Academic and Career Plan (ACP) later on.

| **Educational Level** May also require work experience | **Energy Generation & Conservation** |
|---|---|
| High School Diploma, Certification | Solar PV Installer ✶ Electrical & Gas Power Line Helper ✶ ◯ Utility Lo<br>Range $xxx,xxx-x |
| Certification or Technical Diploma | Distribution Generation Operator ◯<br>Solar/Wind Energy Technician ✶◯<br>Building Automation Technician ✶<br>Energy Auditor ◯<br>Residential HVAC Technician ✶◯<br>Range $xxx,xxx-xxx,xxx |
| Registered Apprenticeship | Substation Electrician ✶<br>Apprentice Plant Attendant ✶<br>Range $xxx,xxx-xxx,xxx |

# KEEP's Energy Lessons

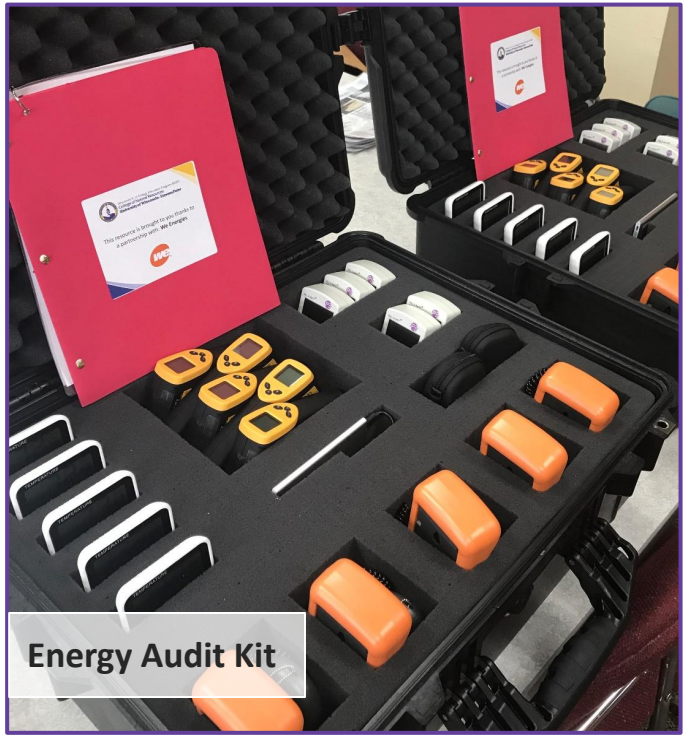
ENERGY CONCEPTS


ENERGY EFFICIENCY

RENEWABLE ENERGY

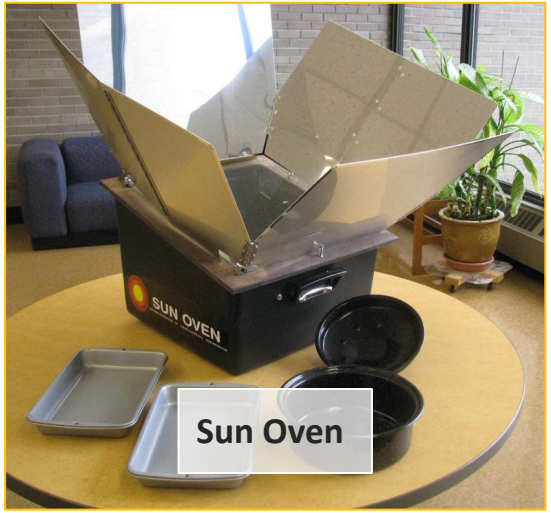
[Download FREE Resources]

# KEEP Kits


Energy Audit Kit

- **9 KEEP Energy Kits**
- > 35 total KEEP/LEAF/WCEE Kits
- Free to use throughout WI
- Most kits can be shipped

Reserve a Kit!



Sun Oven

Solar Tilt Kit

Renew Our Schools


# Renew Our Schools

## Energy Conservation Competition
## Place-Based Energy Education
## Fall 2024
## October 7- November 15

- Reduce your school's energy consumption
- Reduce your school's electricity bill
- Reduce your school's carbon footprint

**More information and Enrollment Form**

RenewOurSchools Wisconsin - Resource Central

**Learn about Participating WI Schools**

Renew Our Schools Competition (arcgis.com)

slipstream

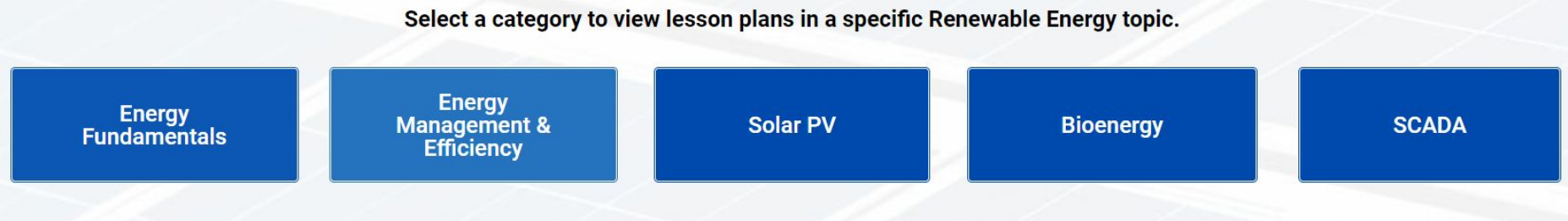

9 Clean Energy Career Video Profiles

Each video includes lesson slides and student assessment in Google format

https://slipstreaminc.org/cleanenergycareers

General building science resources and connection to Smart Start materials through CREATE

Teaching Materials, Energy Fundamentals



9:40 – 10:00 Sketchbox model of specific buildings

Start in Google Earth, make measurements from satellite image

Collect building data, select building type

Match closest geographic location, check operating schedule

9:40 – 10:00 Sketchbox model of a specific building

Design and operating characteristics:

Building area

Number of floors

Aspect ratio

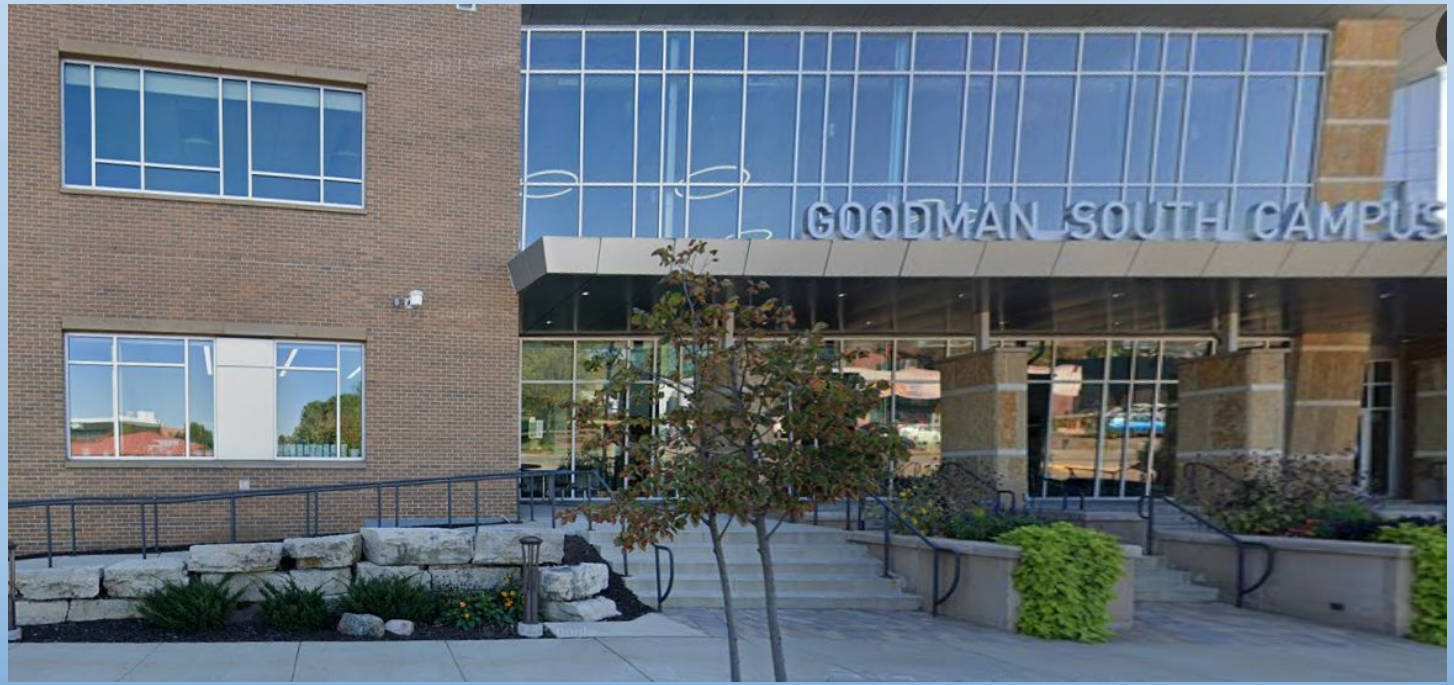
Construction

Window percent

Adjacency

Occupancy schedules

# 9:40 – 10:00 Sketchbox model of a specific building



# Goodman South Campus

School building

76,000 square feet, three floors

15 ft floor height, 55% glass

Mass walls

# *Sketchbox Example: Retail Mall*

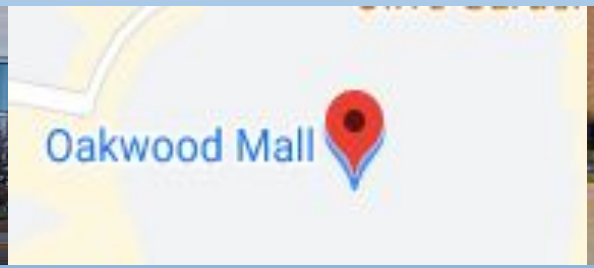
Have you ever wondered WHY the retail mall model is failing across the United States? Why are there so many online options instead?

- More options?
- Easier to ship?
- Less Employees?
- Or……

# *Sketchbox Example: Retail Mall*

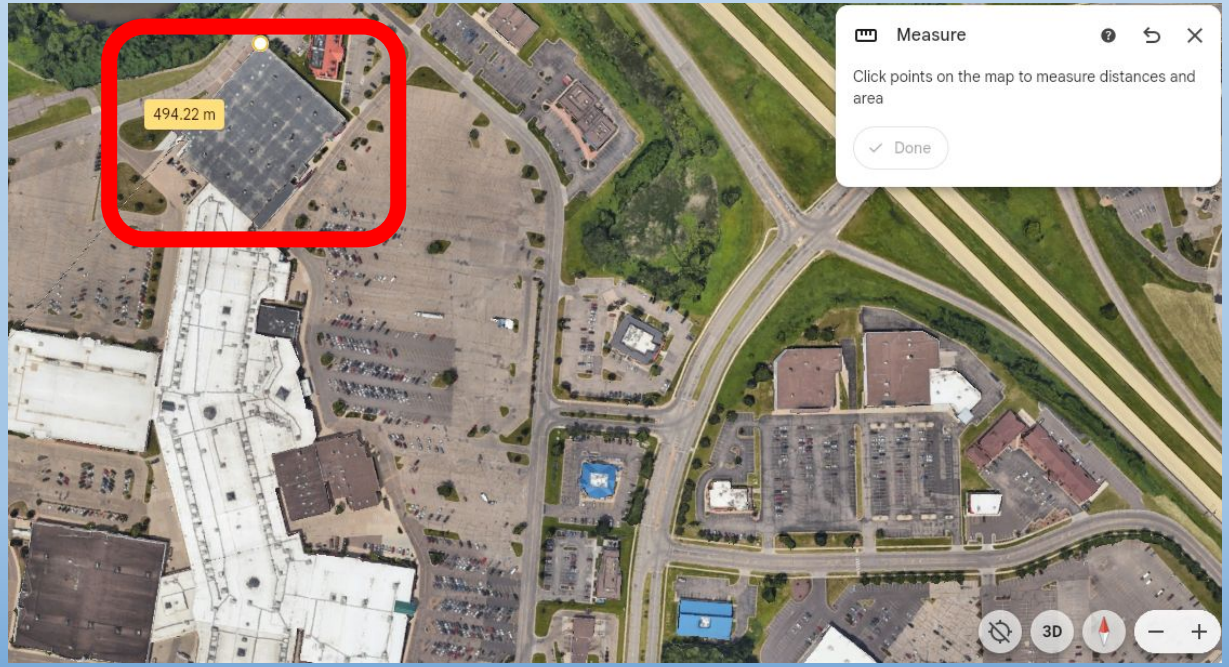
Let's discover what it costs to operate a "brick & mortar" retail space using Sketchbox!

Eau Claire, WI
Oakwood Mall, 4800 Golf Rd, Eau Claire, WI 54701


# *Sketchbox Example: Retail Mall*

Using Google Earth, I've taken dimension of one segment of the mall.




Area: 300ft x 300ft = 90,000ft$^2$

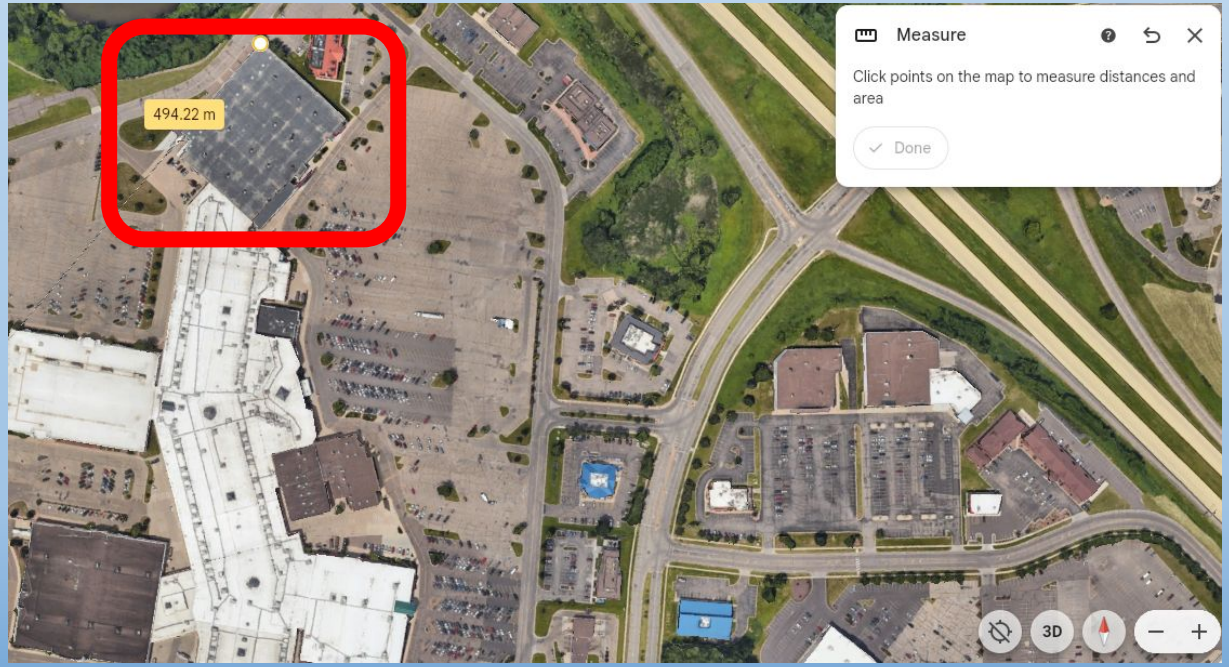
Height: 30ft

Volume: 2,700,000ft$^3$

*Area, Volume, Unit Conversion, Dimensional Analysis*

# *Sketchbox Example: Retail Mall*

## Heating & Electrical Costs?




Electrical Pre-Set: 10.8 cents/kWh

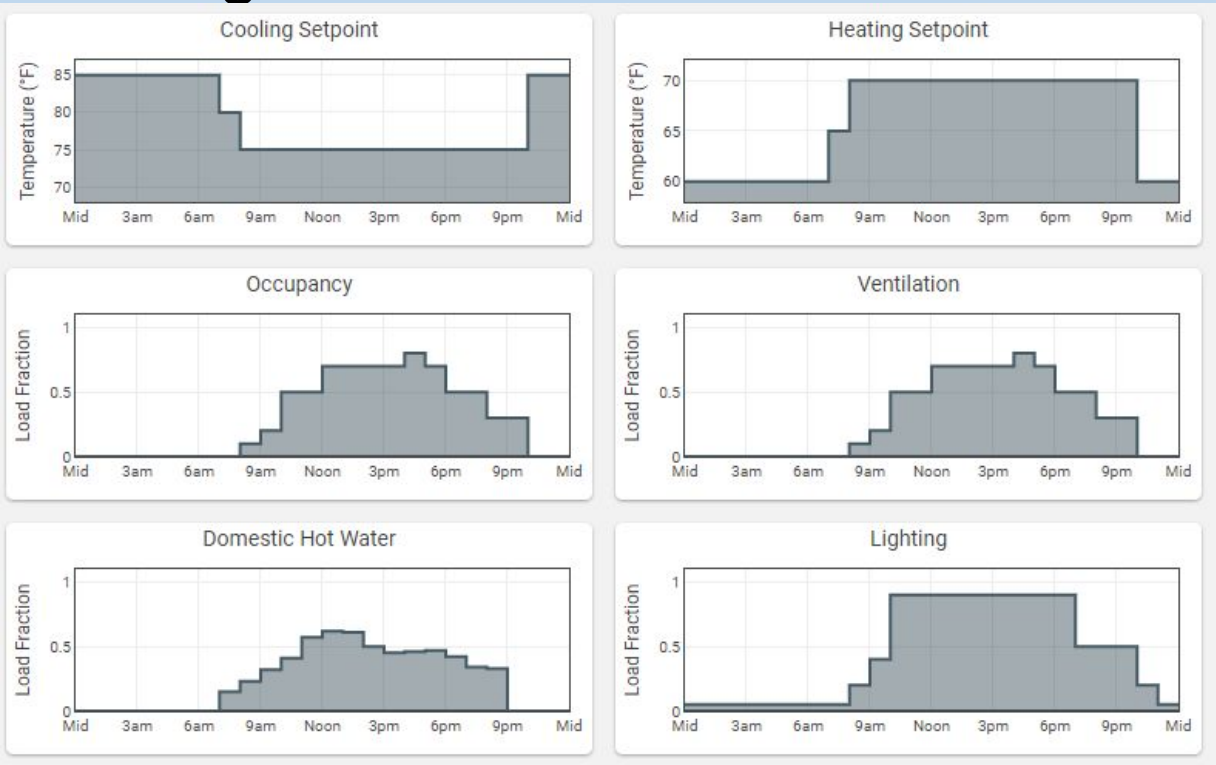
Actual: 12.9 cents/kWh
Height: 30ft

Location: Eau Claire, WI

Window Ratio

# *Sketchbox Example: Retail Mall*

## Making Sense of Schedules



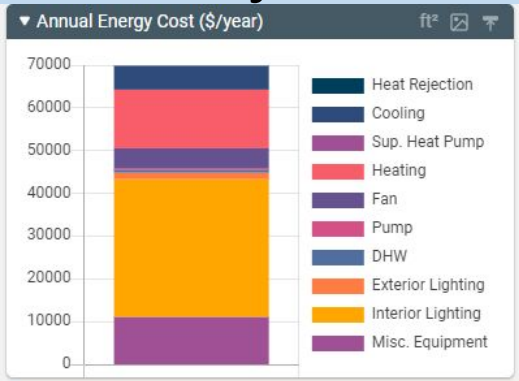

What do these schedules mean?

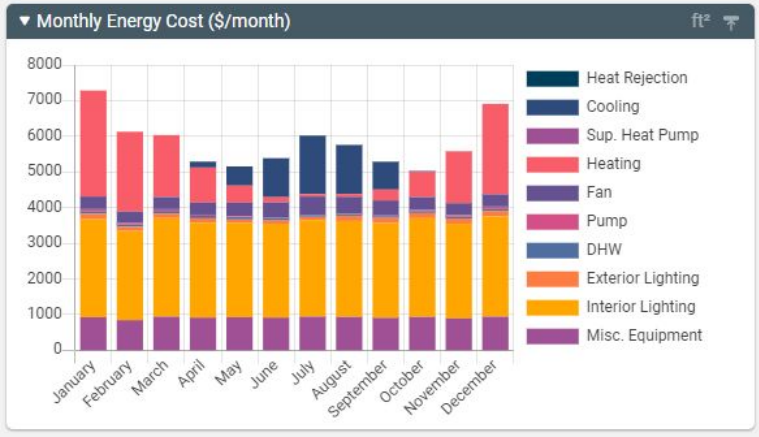
Do they relate to one another?

*Inverse vs direct relationships*

# *Sketchbox Example: Retail Mall*

## Costs and Analyzation




What is the single biggest cost?

What's the most expensive month to operate?

What <u>ONE</u> architectural adjustment could you make to save the most money?

What changes would be seen if this mall was located in Dallas, TX?

*Percentages of a Whole*

## 10:00 - 10:10 Existing lessons and Resources

Available from from Slipstream

Lesson 1 Intro to building models

Lesson 2 Energy codes and measures

Lesson 3 Building Schedules

Lesson 4 Carbon Emissions

Available from from Wiselearn

**Sketchbox Lesson Building Expansion: Energy Cost of Expansion (Dave Luety)**
This lesson examines increased energy cost for a proposed building expansion at a high school

**Energy Modeling and Climate Change (Joe Phillips)**
When added, this lesson examines changing energy use and cost due to climate change

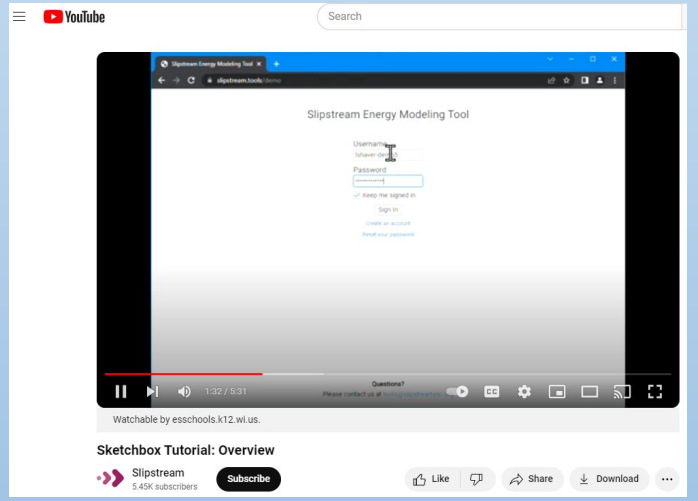
# ***Nervous? Don't Be!***

Sketchbox offers a robust YouTube channel to help get you started!

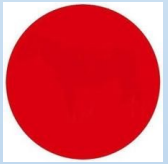
https://www.youtube.com/@SlipstreamInc/featured

NOTE DUPLICATE ~ slide 31

Slipstream Sketchbox Playlist



## Slipstream Sketchbox Youtube Playlist Includes:



Short tutorials on each Sketchbox function tab

3 part case study of a community library

53 minute Sketchbox Webinar from 2022

Time to take a break!

Create Account and Login to Sketchbox
https://www.sketchbox.io/login

Compile technical questions for Q & A

Return in 10 min

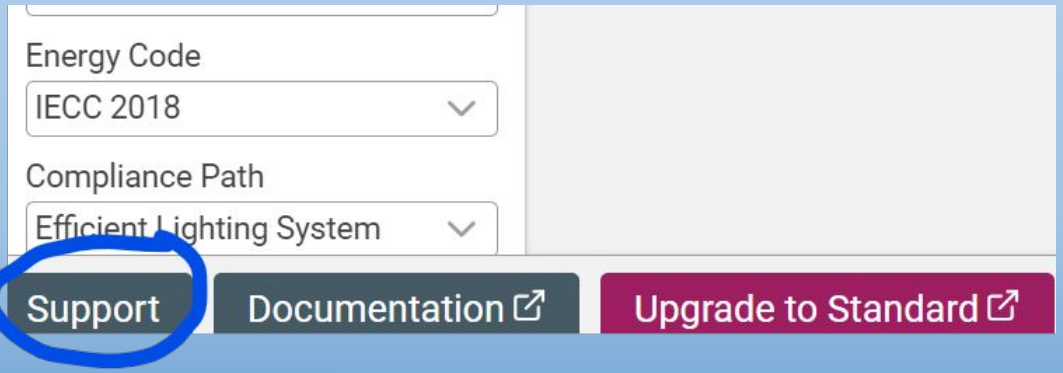
**Recording in Progress!**

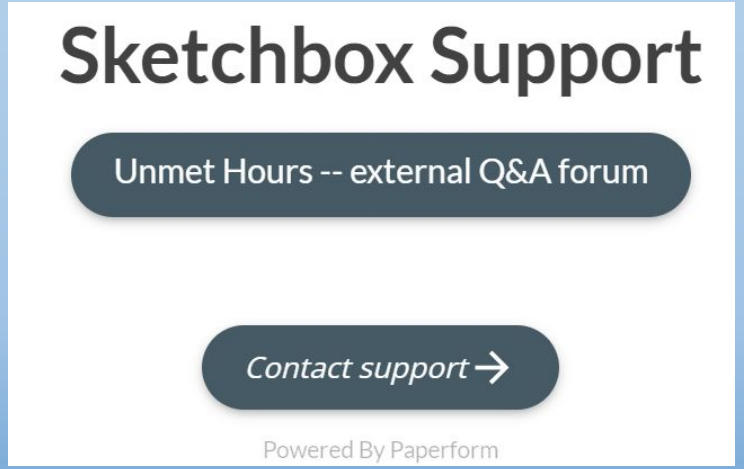
For later training purposes today's large group sessions are being recorded

# Support Features in Sketchbox

Unmet Hours for technical questions

“Contact Support → “ for account issues or software errors



# In Development

Lesson 5 Energy Use Intensity

Lesson 6 Integrating Sketchbox with solar PV

# Lesson two sample results

Table 1

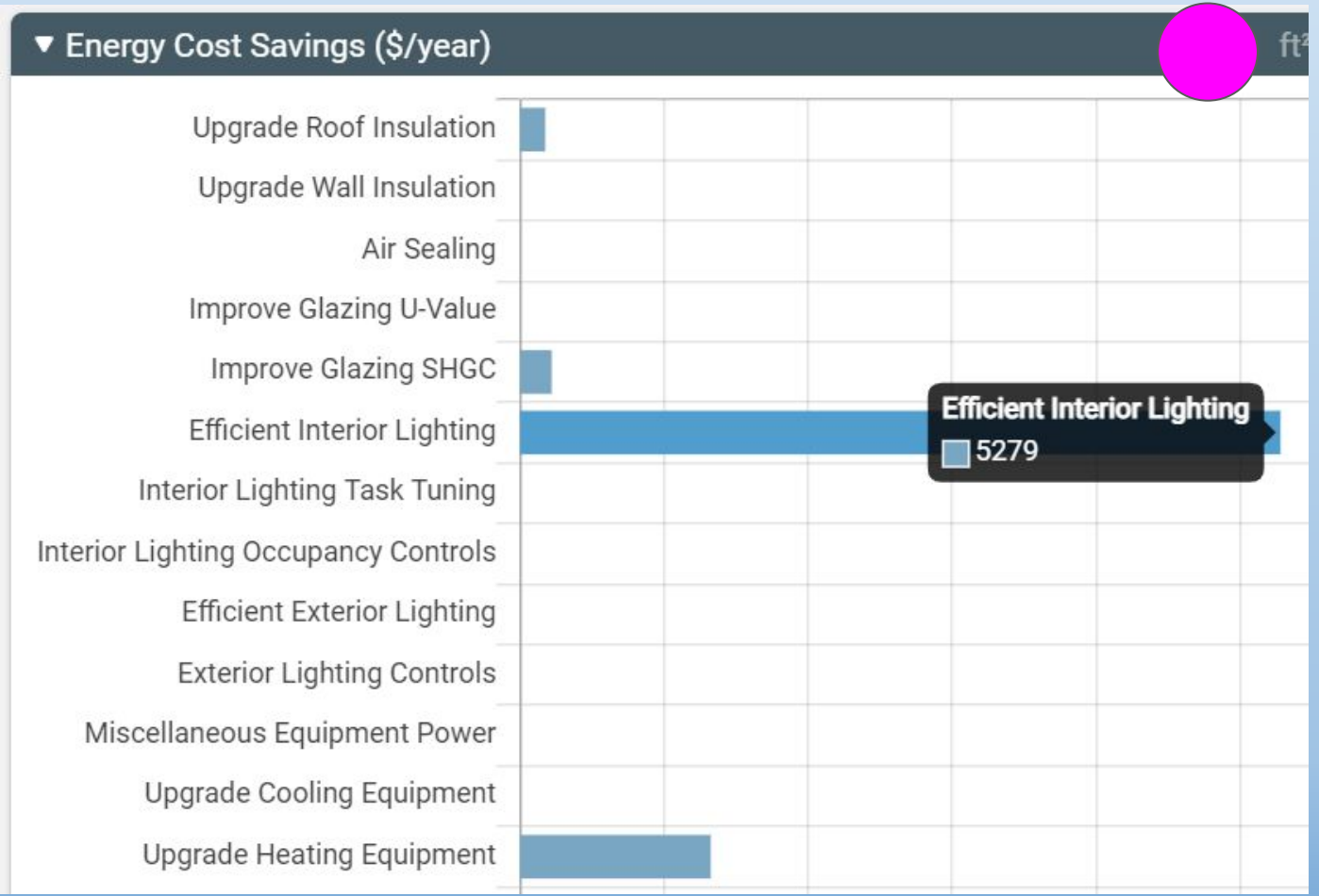
| Building model | Annual electric use (kWh) | Annual natural gas use (therm) | Annual energy cost (USD, $) |
|---|---|---|---|
| Baseline (IECC 2018) | 1,030,906 | 34,336 | 116,577 |
| IECC 2015 | 1,111,081 | 33,763 | 123,395 |
| ASHRAE 2016 | 1,066,255 | 33,384 | 119,099 |

# Lesson two sample results

Table 2

| Building model | Annual electric use (kWh) | Annual natural gas use (therm) | Annual energy cost (USD, $) |
|---|---|---|---|
| IECC 2018 “no change” (baseline- from table 1) | 1,030,906 | 34,336 | 116,577 |
| IECC 2018 Four selected improvements | 947,063 | 33,981 | 108,784 |
| IECC 2018 “best” measures set | 686,592 | 14,533 | 44,498 |

# Sample results



# Sketchbox™ by Slipstream

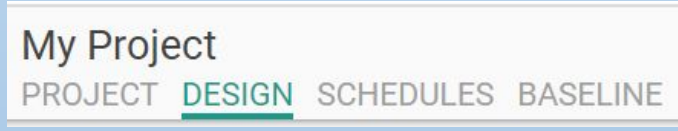
Thursday, August 15, 2024: Part 2

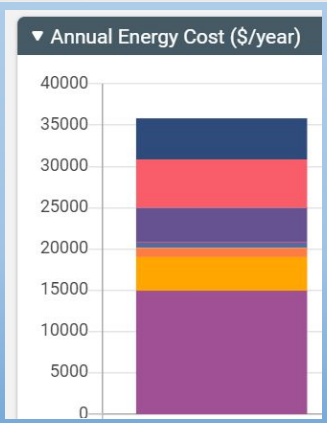
Joe Phillips, science educator

James Reichling, MMSD and CREATE

Samara Hamze, KEEP

Dave Vigliotta, Slipstream



# Agenda (part 2)

10:25 - 10:35 Integration of external resources
(e.g. PV Watts, Future Urban Climates Interactive)

10:35 – 10:50 Sketchbox in breakout groups

10:50 – 11:05 Q & A with Slipstream Staff

11:05 – 11:15 Participant reactions, Conclusion

# Integrating Solar Energy with Sketchbox

https://pvwatts.nrel.gov/

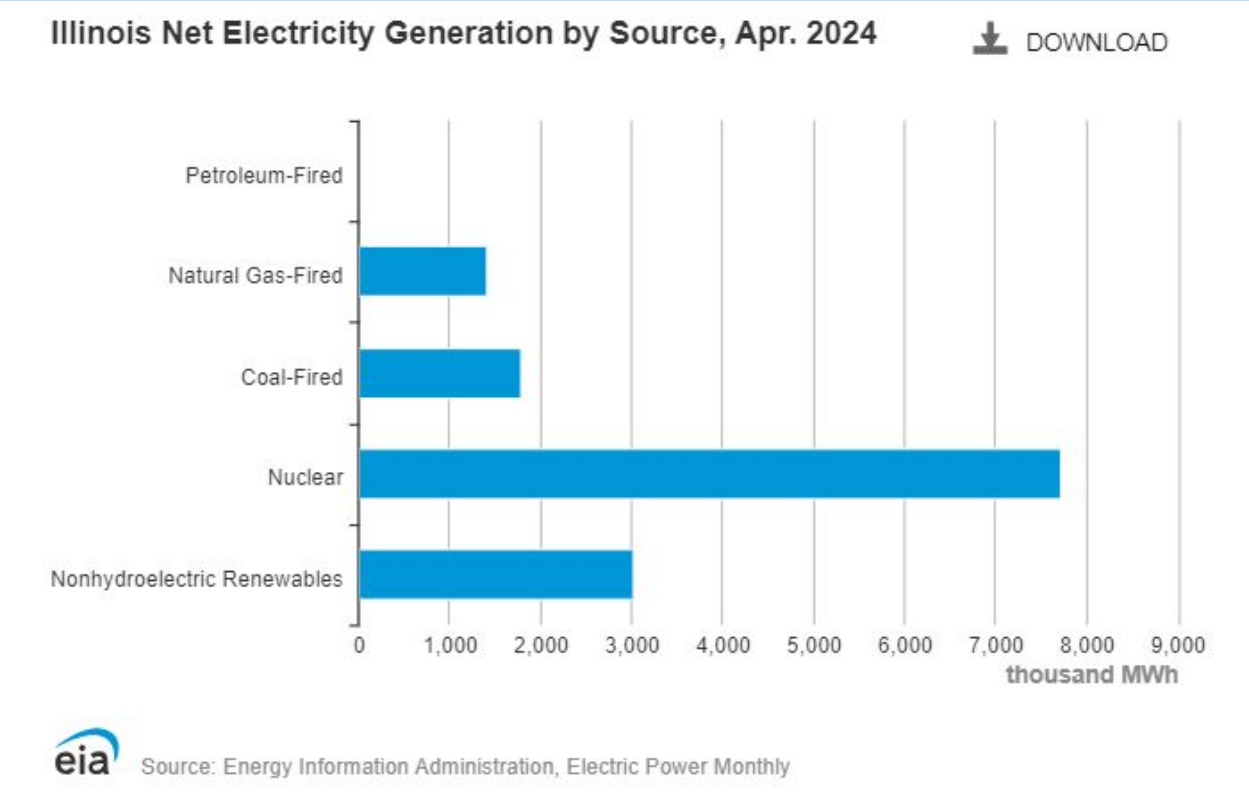
Electrification using heat pumps for HVAC and hot water

https://slipstreaminc.org/education/air-source-heat-pumps-and-electrification

# Sketchbox and Climate Change

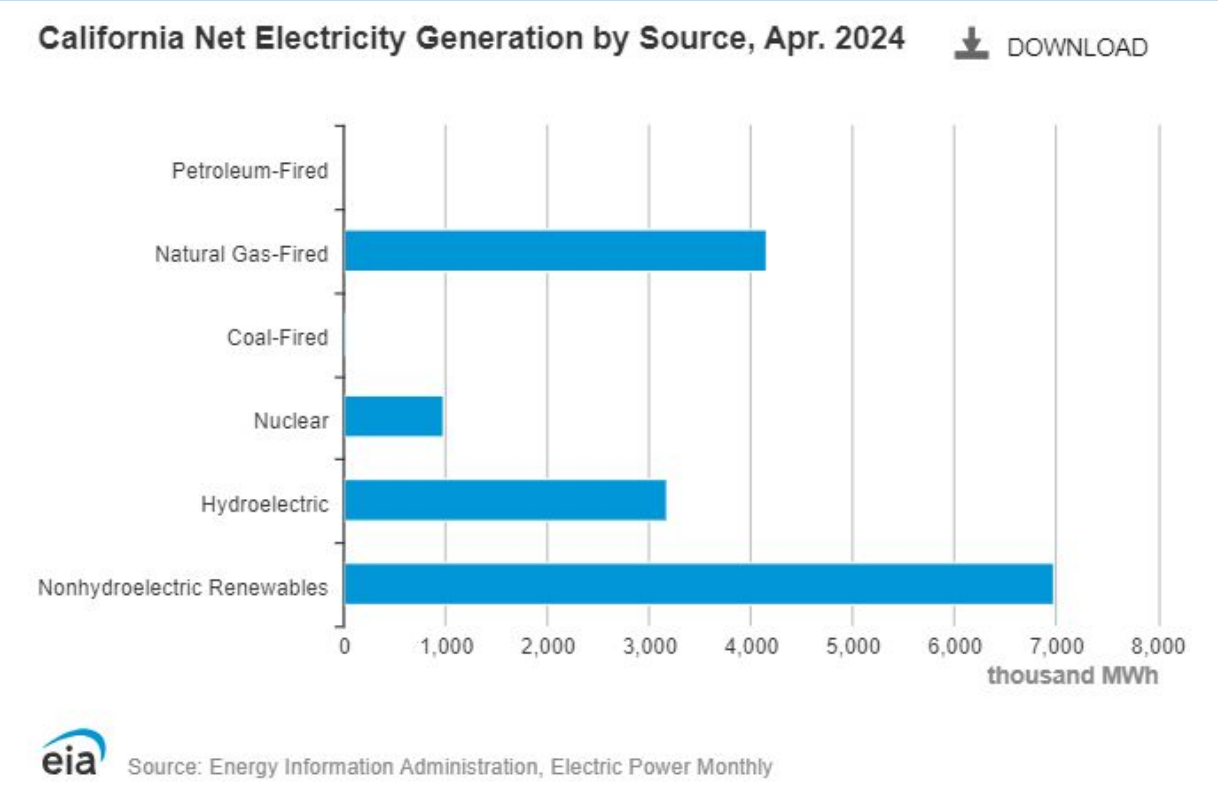
Future Urban Climates (University of Maryland)
https://www.umces.edu/futureurbanclimates

# EIA state energy profiles: https://www.eia.gov/state/




Illinois

# EIA state energy profiles: https://www.eia.gov/state/




California

LEED: https://www.usgbc.org/leed

Leadership in Energy and Environmental Design

U.S. Green Building Council

# Working Groups

Model a 30,000 sq ft health care clinic

Report annual electricity consumption, peak electric demand, and annual energy cost for different locations in microsoft form:
https://forms.office.com/r/ykkm1k8fKN
Explore additional features as a team by interest
https://forms.office.com/r/ykkm1k8fKN

# 10:50 - 11:05 Technical Questions with Slipstream Staff

What are the major variables to consider when students are just starting out?

- Learn by doing, try out some of the lessons
- Window/Wall ratio (glazing)
- Lighting
- Types of HVAC systems;  heating & cooling efficiencies

How to decide which building type to use when using Sketchbox when that building category is not in Sketchbox:

- Choose one that you think is similar (consider general building usage, the building's operation & occupant usage)
- Alternatively possible to create 2 shells in Sketchbox and use those

What differentiates an Office from a School? Helpful to have reference material.

- Drew conducted an on-screen demonstration

Where does Slipstream see the Sketchbox tool going?  It seems like it's pretty new.

- Genesis out of Slipstream staff need to streamline some of their workflow

Any plans for a specific residential version of Sketchbox?  Getting further into the details of wall or roof assemblies?

- Currently good for modeling multi-family buildings (have in templates now)
- Modeling a house or duplex; no because this is so different from a commercial building

11:05 - 11:15

Closing remarks, workshop evaluation, participant lessons

Workshop evaluation: https://bit.ly/3YLgb9r

Lesson development / Model Exploration

WI educators may contribute a lesson and receive a stipend

Submit lessons in Word or Google Doc format to Jim: jpreichling@madisoncollege.edu and CC Samara: samara.hamze@uwsp.edu

Deadline: Monday, Sept. 16

# Lesson development template: Objectives

1) Demonstrate energy, financial, or $CO_2$ savings from updating a building schedule

2) Show how the $CO_2$ impacts of a building are different in different areas of the United States

3) Compare estimated building energy savings from improved building schedules to the savings from adding energy efficient lights

4) Estimate the added annual energy costs for a building expansion

# Lesson development template: NGSS standards

HS-LS2-7 Ecosystems: Interactions, Energy, and Dynamics
Design, evaluate, and refine a solution for reducing the impacts of human activities on the environment and biodiversity.*

HS-ETS1-4 Engineering Design
Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

# NGSS Science and Engineering Practices

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

# Lesson development template: Metatags

Budget, building code, building design, building envelope, building science, carbon emissions, carbon footprint, computer model, data analysis, efficiency, electricity, energy, energy career, energy conservation, energy economics, energy efficiency, energy management, green building, heating and cooling, HVAC, kwh, natural gas, NG, simulation, sustainability, utilities, utility rates

# End of presentation

# Career Connections to Sketchbox

Example careers: building manager, energy engineer, architect, HVAC, energy analyst, construction/contractor, sustainability

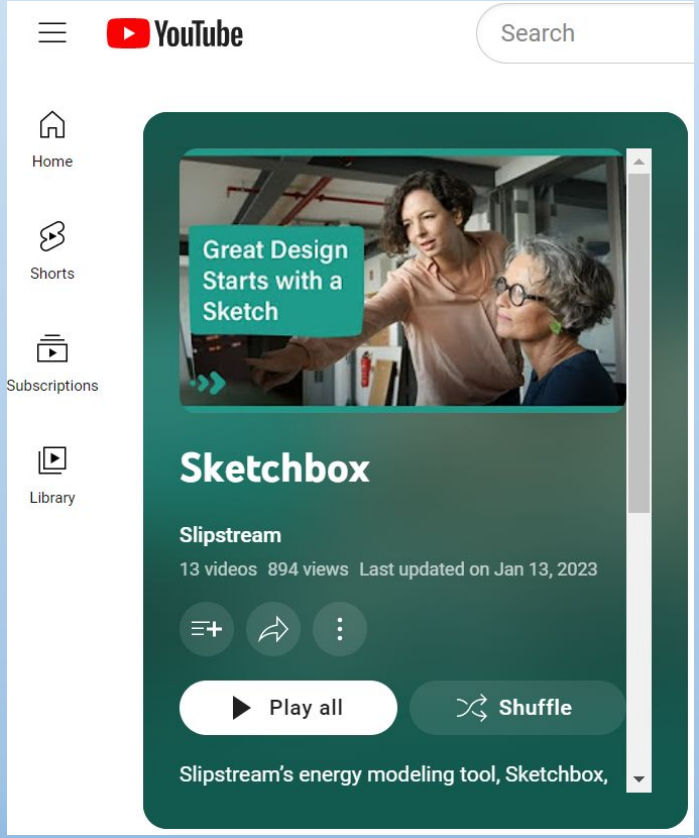
https://greenbuildingscareermap.org/

createenergy.org
Resources → teaching materials → energy fundamentals → exploring a job in the energy industry

# Sketchbox Support

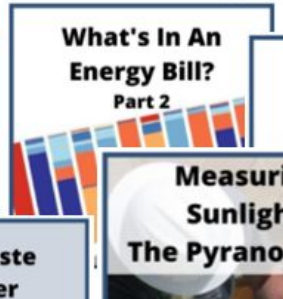
Youtube tutorials at the sketchbox youtube channel

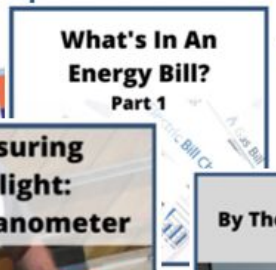
Support: tools@slipstreaminc.org

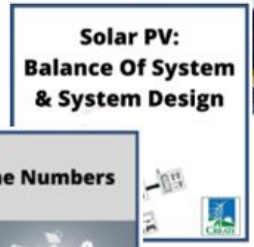


# Createenergy.org



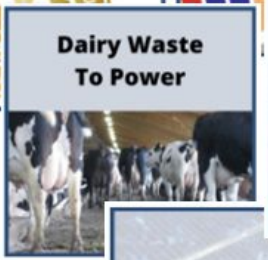



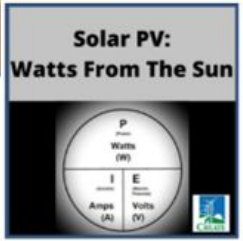


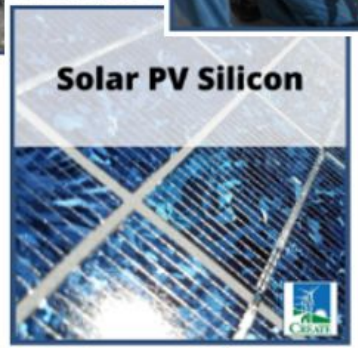


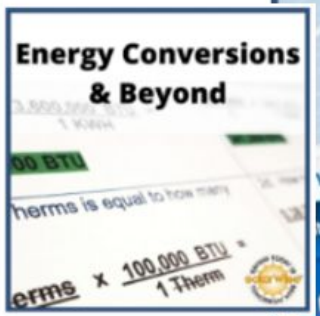



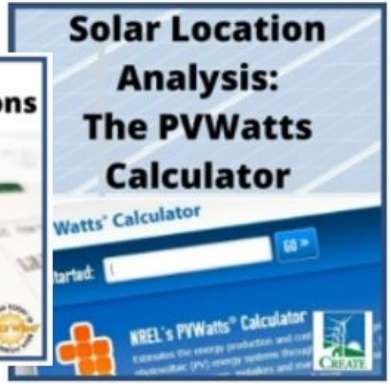




UPDATE: General building science resources and connection to Smart Start materials through CREATE

# Energy Career Maps through CREATE

https://createenergy.org/resources/

Student reactions from class trials

High level of engagement

Easy access to results

Desire to independently explore

Students in pilot asking to participate in another round

What did students find most interesting about sketchbox?

“... how small factors can change so many things. I also found predicting them fun.”

“How this ties into architecture and buildings”

“How [the building in] California uses less energy but costs more”

“How small changes in building design can greatly influence energy cost”

Additional presentation notes follow on the next slides

# Links to Sketchbox lessons 1 - 4 in google doc form

https://docs.google.com/document/d/1fj2sXF77KSPGMQqkucsKC4C8kxyMpLXMhAJ0U3wJfrA/edit?usp=sharing

https://docs.google.com/document/d/12ksKAdrqxvzbYqLVu1RnP-KTPbrxNwLtUlO3El8p2Rk/edit?usp=sharing

https://docs.google.com/document/d/16c0ITKcOpXZkV5R925S7FArZy7w752yUsV4o0qTTCZk/edit?usp=sharing

https://docs.google.com/document/d/1qGTBNiFDhQyqxo5LgDvcXzc2FNZ0zOGmrjzdYribnnE/edit?usp=sharing

Links to Sketchbox lessons 1 - 4 in google doc form

Lesson 1 introduction

Lesson 2 energy code

Lesson 3 schedules and measures

Lesson 4 carbon emissions

# Annual Summary

**Results Table**

| | Peak Cooling (kBTU/hr) | Peak Heating (kBTU/hr) | Peak Electric Demand (kW) | Annual Electric Consumption (kWh) |
|---|---|---|---|---|
| Baseline | 972.1 | 785.3 | 134 | 325849 |

| Annual Natural Gas Consumption (therm) | Annual Energy Cost ($) | Annual Water Consumption (gal/yr) |
|---|---|---|
| 9365 | 35816 | 700000 |

# Agenda (part 2)

10:00 – 10:15 Technical Q & A with Slipstream

10:15 - 10:25 Integration of external resources
(e.g. PV Watts, Future Urban Climates Interactive)

10:25 – 10:35 Intro to Participant Lesson Development

10:35 – 10:45 Resources: KEEP, DPI, CREATE, Slipstream

10:45 – 11:00 Participant reactions, Conclusion

# Sample Lesson three results

Table 1

| Building model | Annual electric consumption (kWh) | Annual natural gas consumption (therm) | Annual energy cost ($) |
|---|---|---|---|
| Baseline (simple thermostats) | 1,027,748 | 33,651 | 115,817 |
| Simple thermostats Weekday 8am – 8 pm | 1,030,906 | 34,336 | 116,577 |
| Simple thermostats Weekday 8am – 4 pm | 1,026,151 | 33,382 | 115,488 |
| 68 degree heating setpoint 77 degree cooling setpoint | 998,770 | 32,249 | 112,238 |

# Exceeding code - Lesson 2 overview

Roughly 40 building parameters on the “baseline” tab

Pre-set upgrades on the “measures” tab

Three values for each (no change, better, best)

# Lesson 3 and 4 objectives

Investigate scheduling and its impact on building energy

Calculate carbon equivalent emissions avoided due to energy savings

Explore electrification of heating and its impact on emissions

# Sample Lesson four results

Table 1

| Building model | Annual electric consumption (kWh) | Annual natural gas consumption (therm) | Annual Kg-$CO_2$e |
|---|---|---|---|
| Baseline | 326,919 | 8539 | 166,544 |
| Energy efficient lights | 301,874 | 8829 | 158,789 |
| Demand control ventilation | 325,514 | 7568 | 160,876 |
| Move to Madison, WI | 322834 | 10109 | 257,932 |