F°CAL:

Smart Solar Cooking

FOCAL

The Team

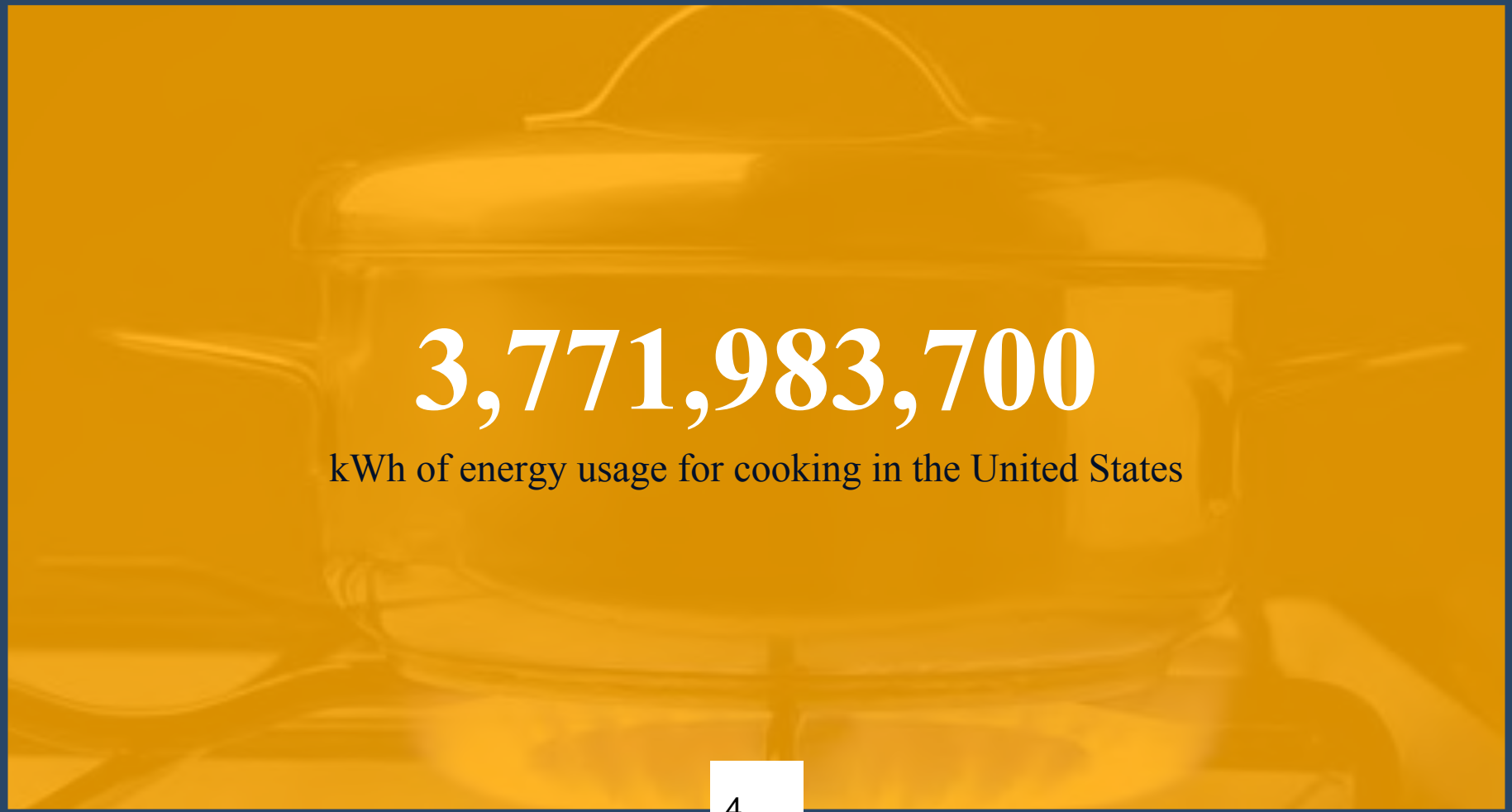
Alyssa Yu
Hardware/Construction

Adrian Diaz de Rivera
Construction/Sensors and Actuation

Elizabeth Chu
Solar and Temperature Algorithm

Max Jung
Connectivity and Visualization

Motivation

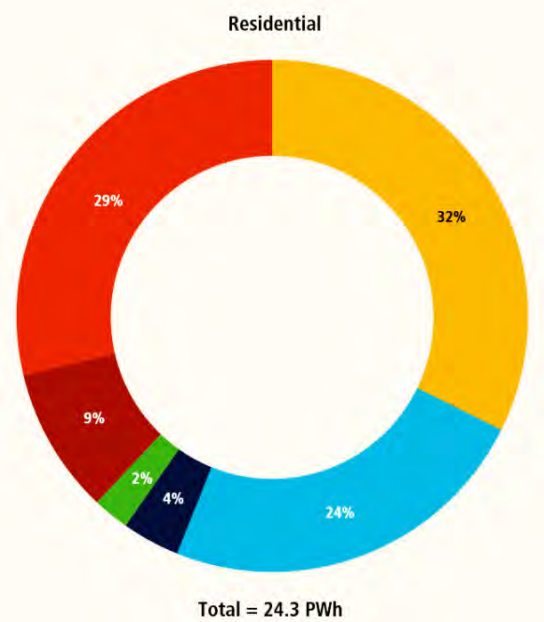


3,771,983,700

kWh of energy usage for cooking in the United States

Globally...

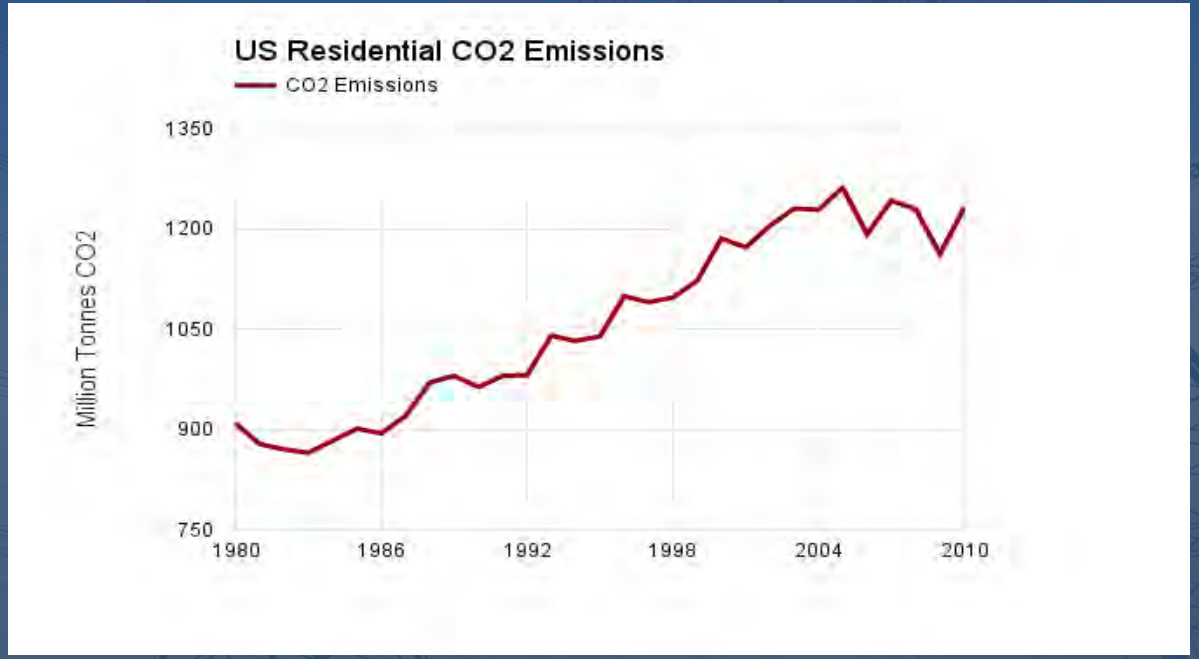
7.05 PWh =
7,050,000,000,000 kWh



Source: International Energy Agency (2013)

Figure 9.4 | World building final energy consumption by end-use in 2010.

The Broader Issue



Source: United Nations

The Broader Issue

2016 Likely to Top 2015 as Hottest Year on Record, Scientists Say

By SEWELL CHAN NOV. 14, 2016

The previous hottest year on record was 2015, according to the World Meteorological Organization. By NEETI UPADHYE on November 14, 2016. Photo by Roberto Schmidt/Agence France-Presse — Getty Images. Watch in Times Video »

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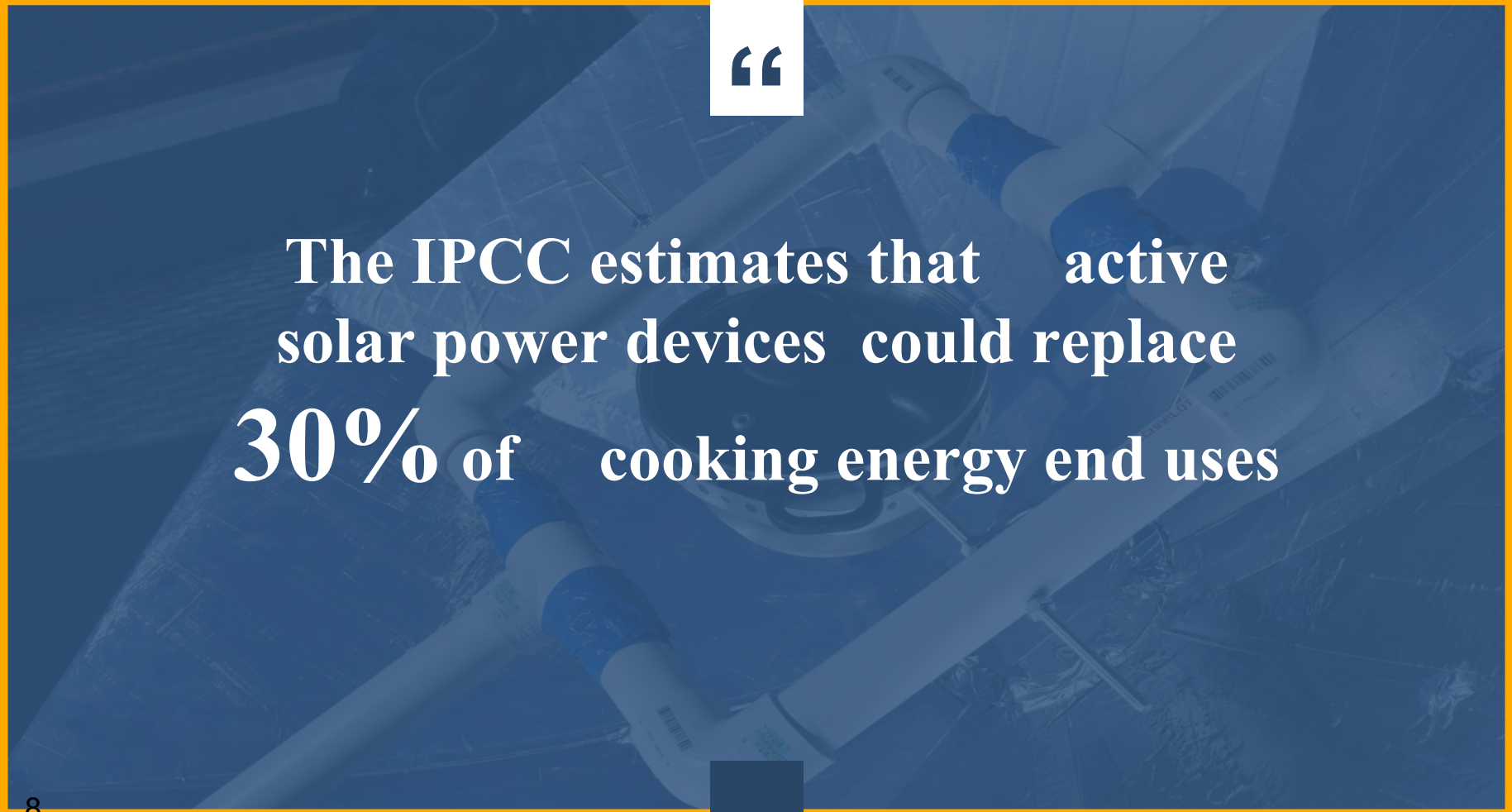
Global Temp
Another Rec


2016 Alread
Temperature


2015 Was H
Scientists Sa

This year will be “very likely” the hottest on record, with global temperatures breaking the previous record, set in 2015, scientists with the World Meteorological Organization

Source: United Nations



“

The IPCC estimates that active solar power devices could replace 30% of cooking energy end uses

Our Solution

Smart Solar Cooking

Reduce grid energy usage

Reduce emissions, particularly in areas currently burning dirty fuels

Increase useful time and total productivity

Our Mission

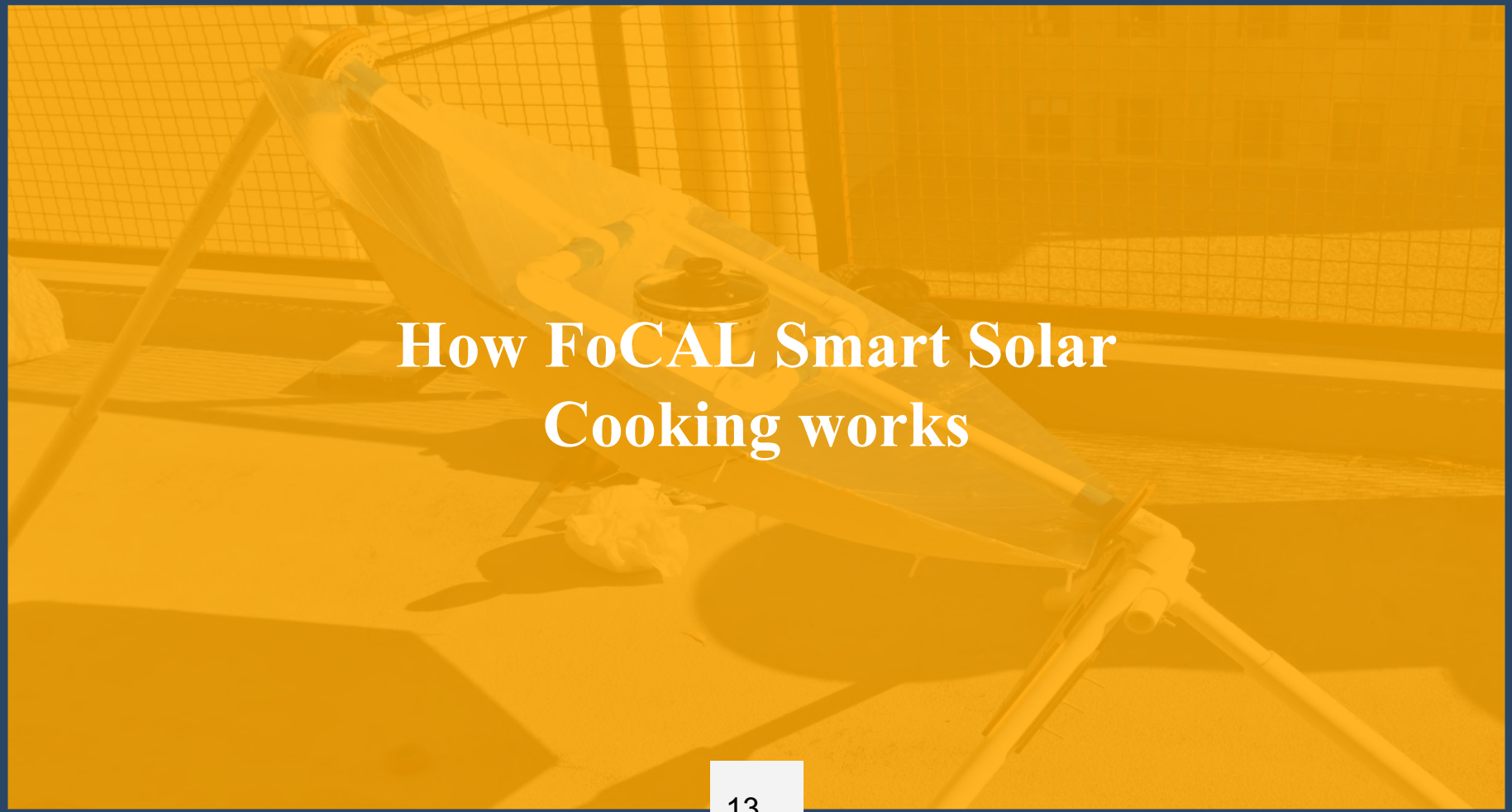
To create a solar cooking experience that is as convenient as a traditional oven

Existing Solar Cooker Designs

What makes FoCAL unique?

FoCAL combines the principles of existing solar cookers with the easily controlled settings of conventional ovens.

	Conventional Oven	Existing Solar Cookers	FoCAL Solar Cooker
Temperature Control	✔	✘	✔
Adjustable Cook Time	✔	✘	✔
Clean Energy	✘	✔	✔
Autonomy	✘	✔	✔
Sunlight Tracking	—	✔	✔
Real-time Status	✘	✘	✔



How FoCAL Smart Solar Cooking works

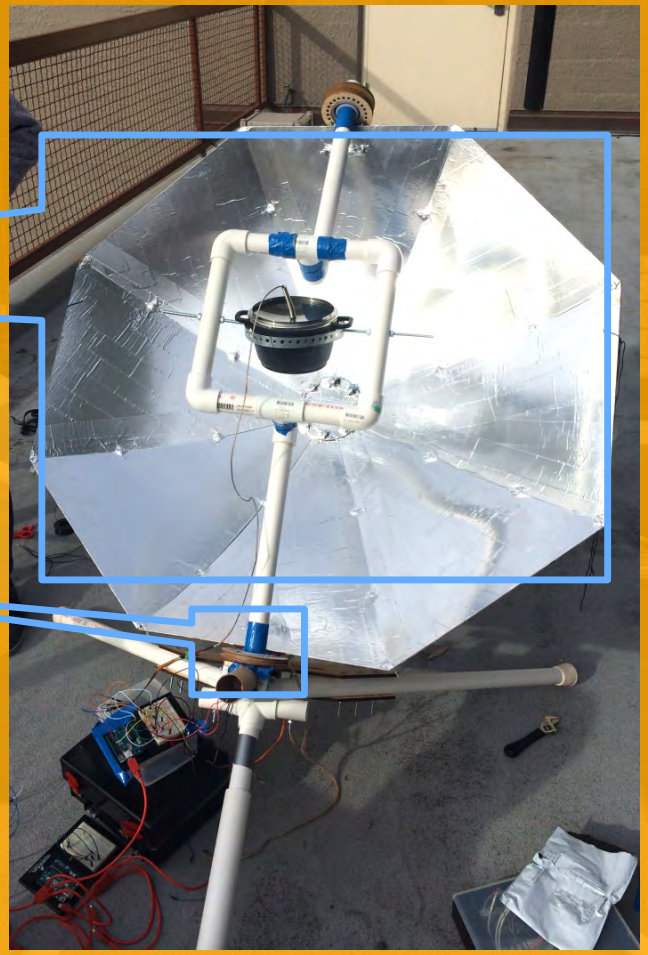
From Light to Heat

The **parabolic** shape reflects all sunlight into its focal point, where the cooking pot is located.

The pot is mounted on a **gimbal**, which allows free N-S rotation for leveling.

The frame always faces south, while the reflector **independently rotates** west with the sun.

[Rotation enabled by pulley and Servo motor]

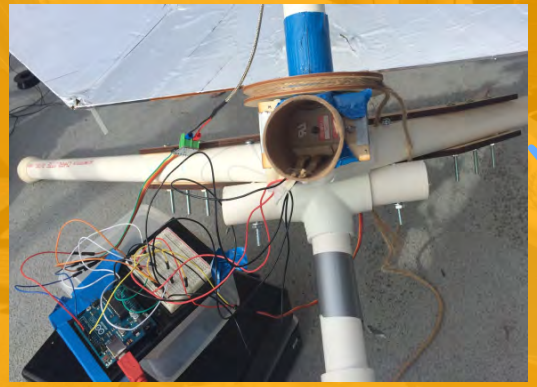


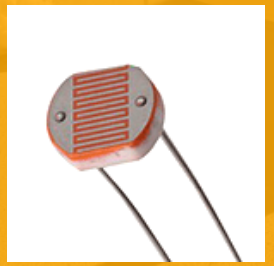
Light Sensing/Tracking

Three photoresistors are configured in a line, separated by a cardboard roll.

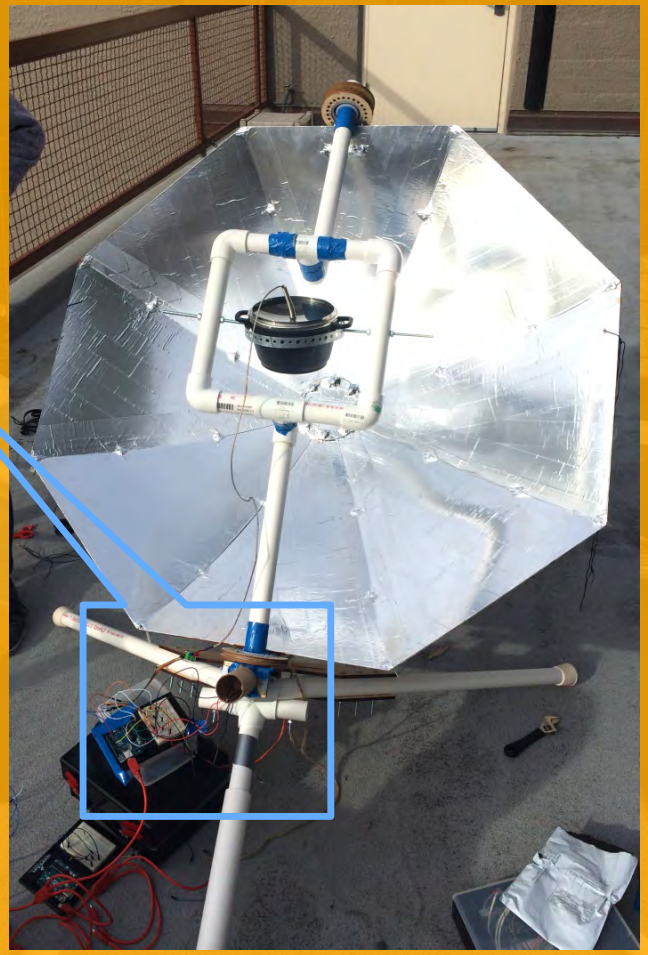
The Arduino reads the light sensor values and controls the servo motor to rotate the system E/W

When the center sensor has the most light, the motor stops





[Light intensity measured by photoresistor]



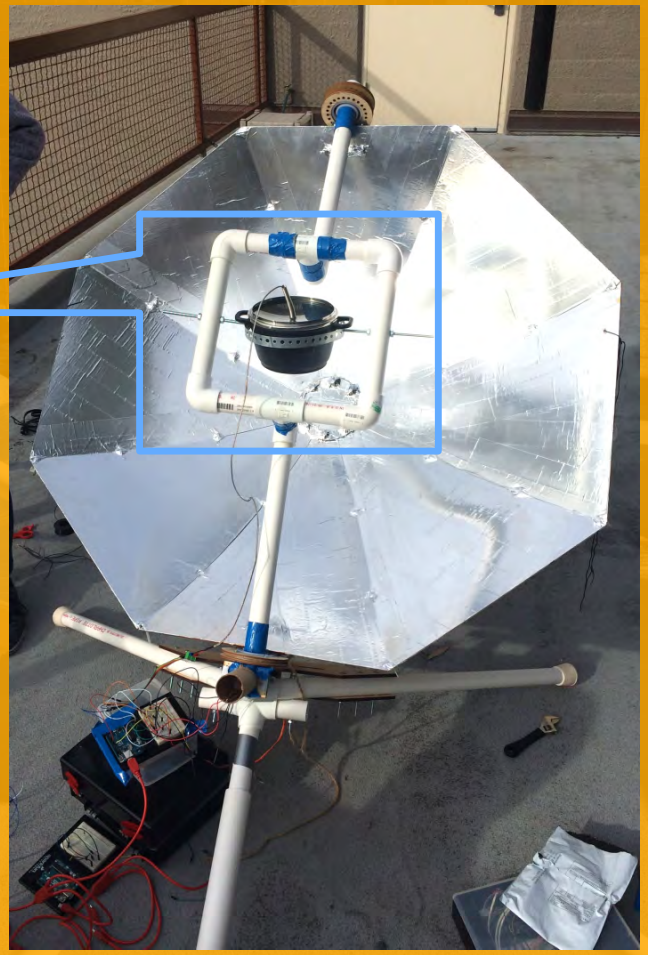
Temperature Regulation

Temperature of food is constantly monitored to ensure it is at the desired value.

--If **too cold**, the reflector will continue to orient itself towards the sun, according to photoresistors.

-- If **too hot**, the reflector will turn away from the sun.

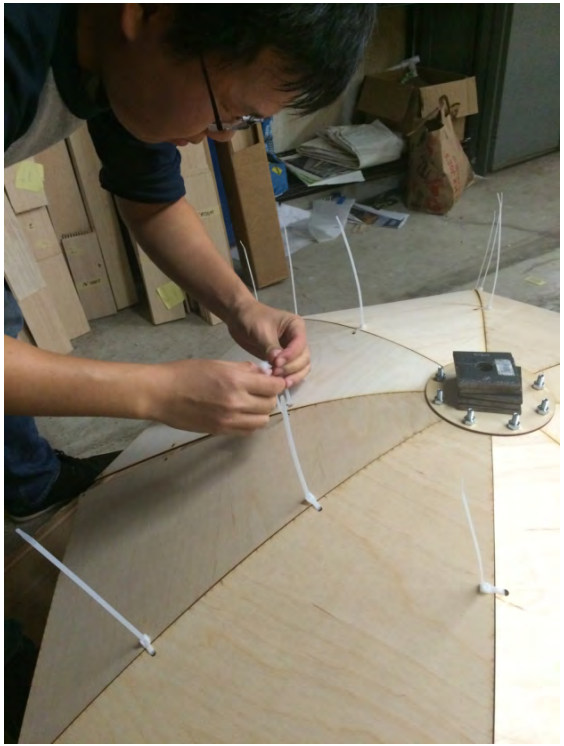
[Temperature values measured by Type-K Submergible Thermocouple]

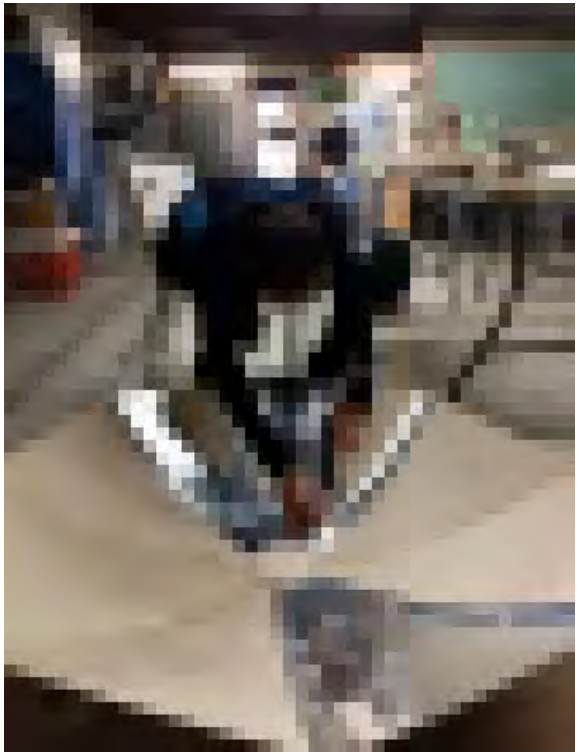


The FoCAL System

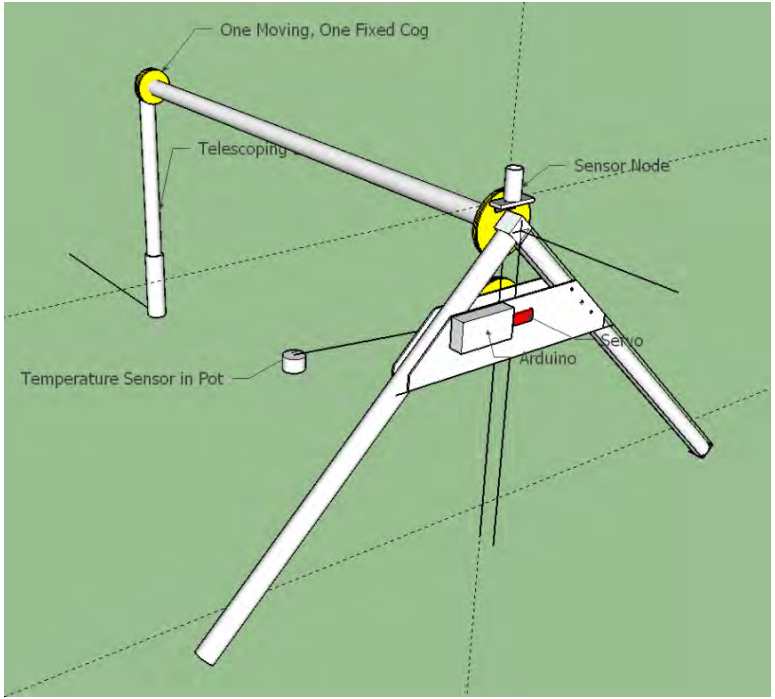
Hardware

Hardware: Reflector

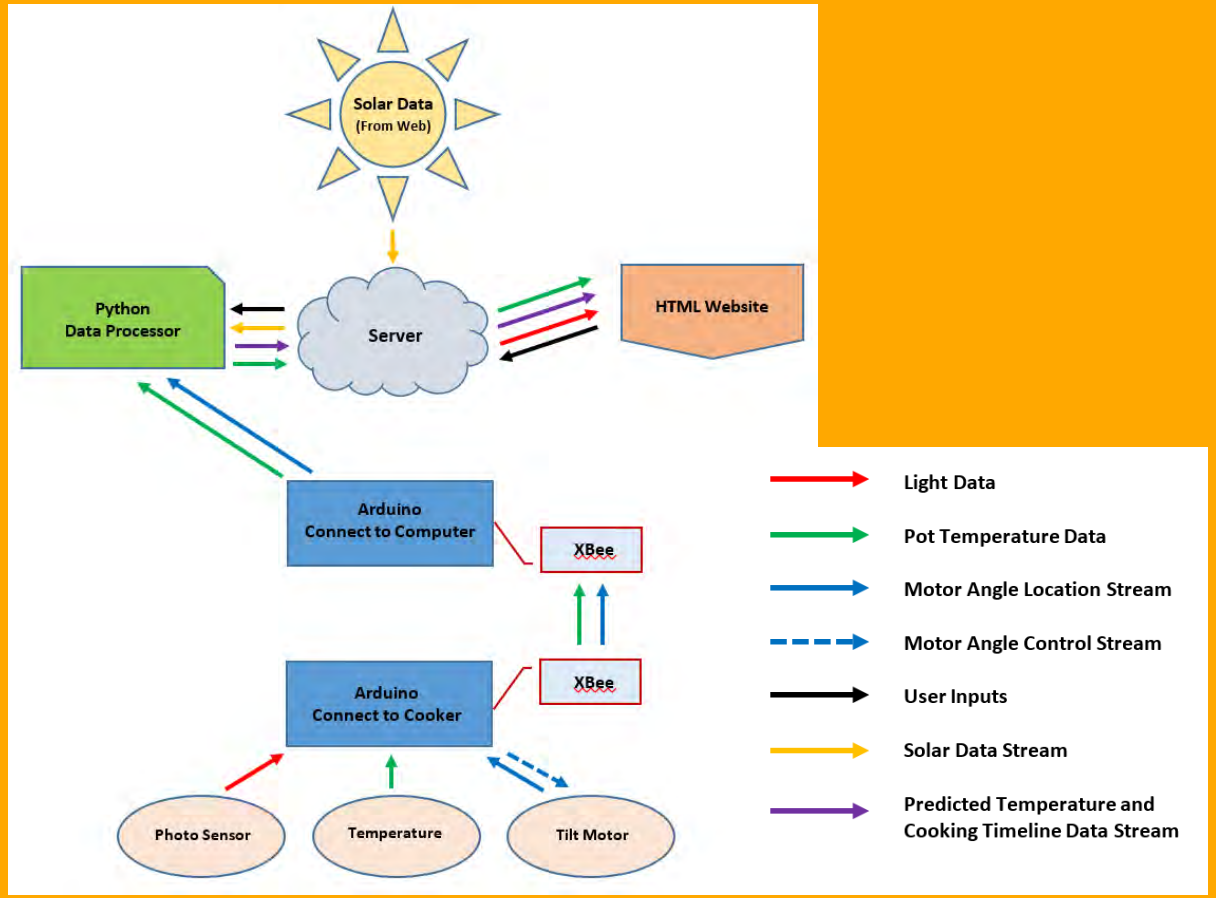




Hardware: Frame and Actuation

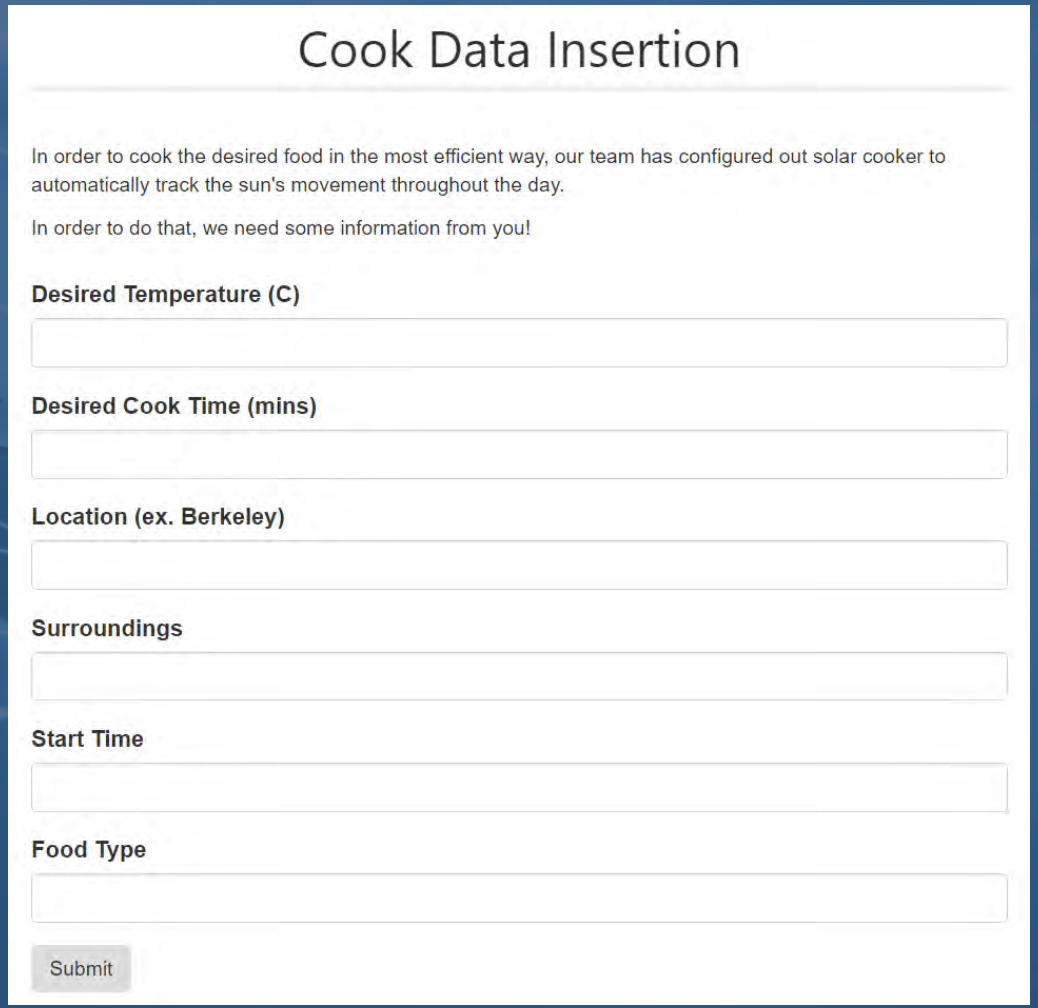


Cyber System



The physical system is backed up with a weather data-based thermal model and informative web visualizations to enhance the cooking process for the user

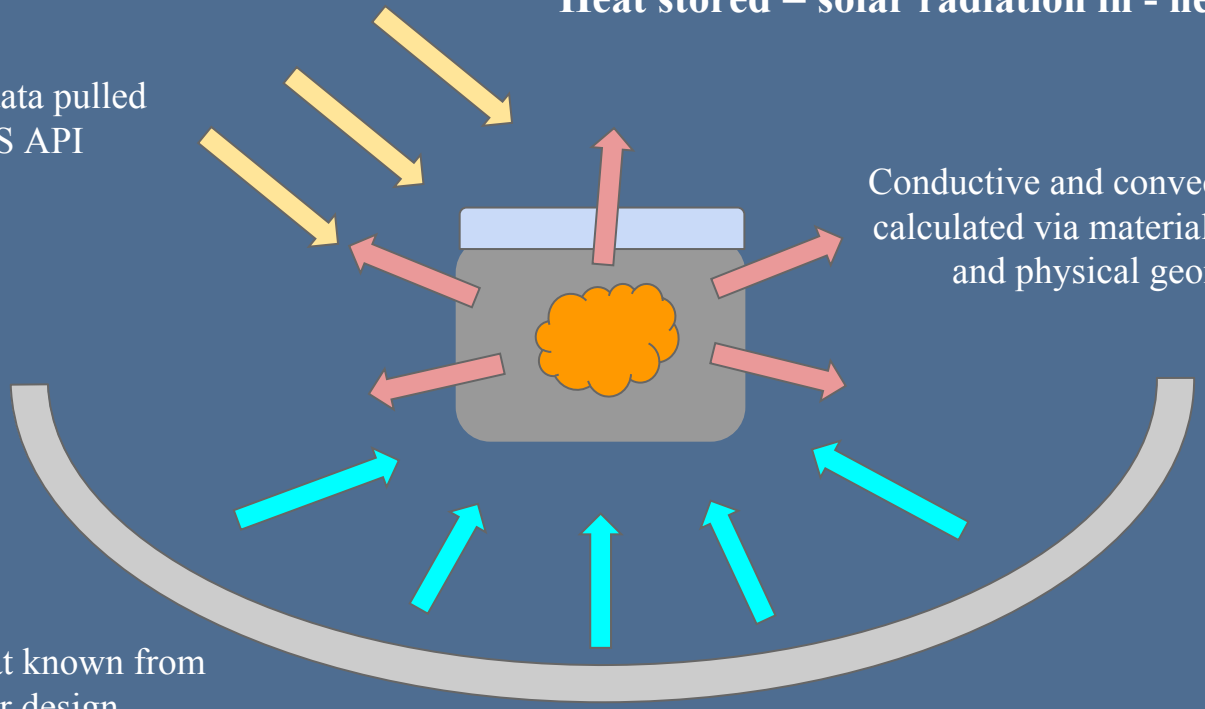
User Inputs


Cook Data Insertion
In order to cook the desired food in the most efficient way, our team has configured out solar cooker to automatically track the sun's movement throughout the day.
In order to do that, we need some information from you!
Desired Temperature (C)
Desired Cook Time (mins)
Location (ex. Berkeley)
Surroundings
Start Time
Food Type
Submit

Thermal model

Heat stored = solar radiation in - heat lost

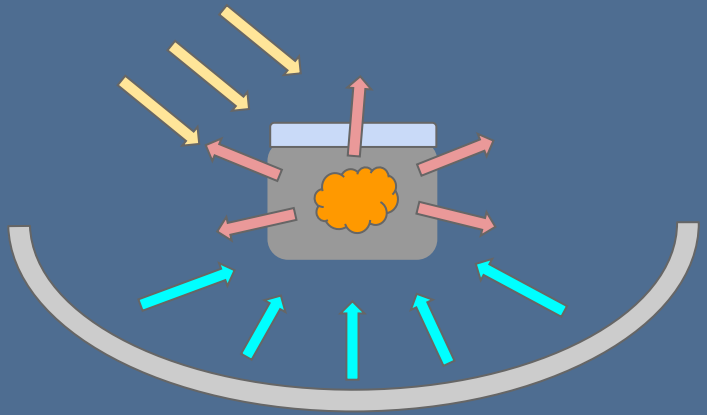
Solar radiation data pulled from RENES API

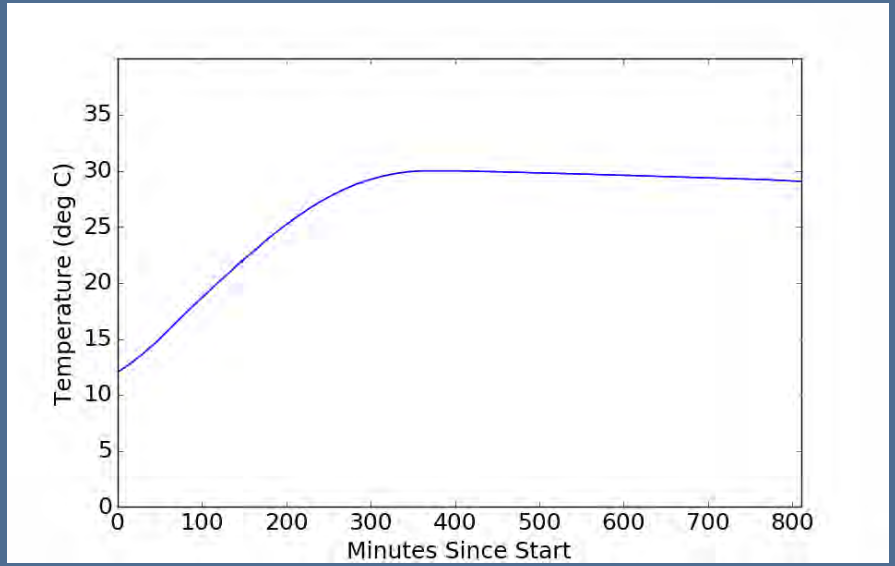


Conductive and convective losses calculated via material properties and physical geometry

Reflected heat known from reflector design

Thermal model

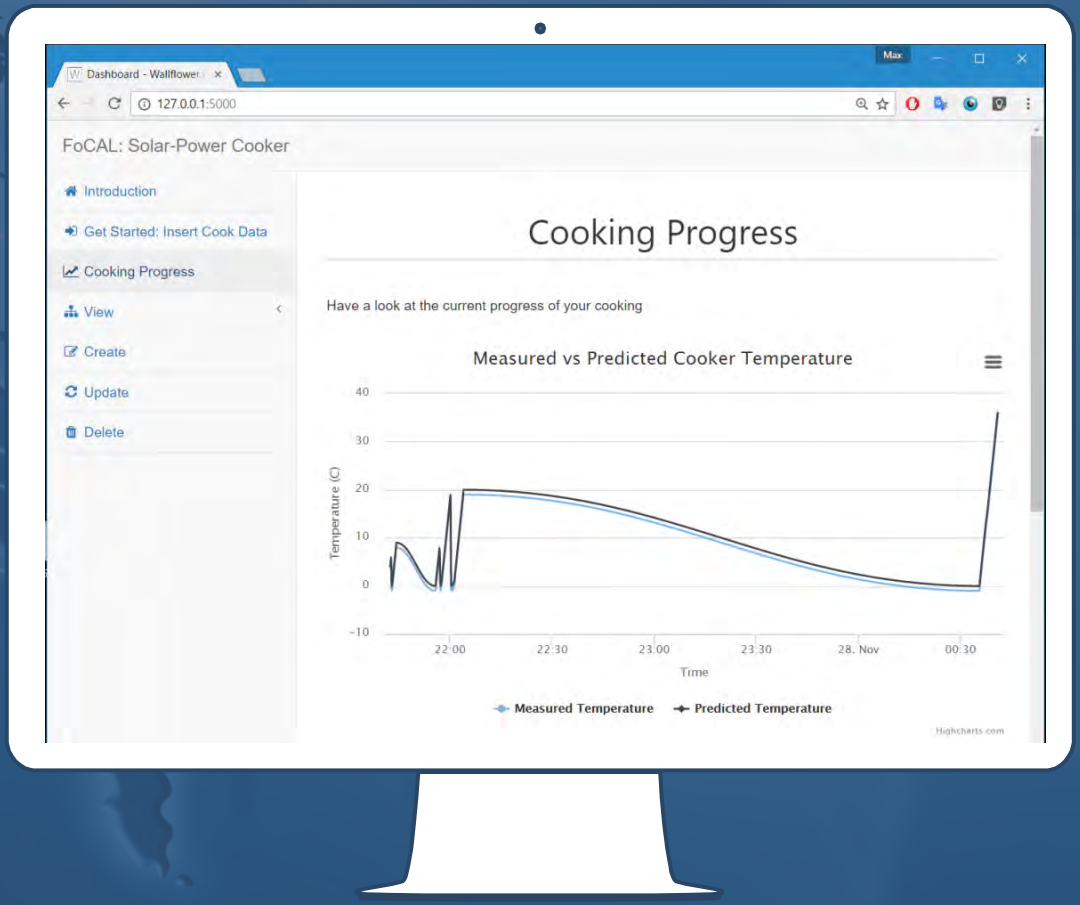




Visualizing Data

Easy-to-read plots and diagrams inform the user of their cooking progress

Real time report of food temperature and angle of the sun



Demonstration

If every household in the US used the FoCAL cooker to replace their slow cooker, it would save:

- **1,380,000,000 kWh**
- **$165,600,000**

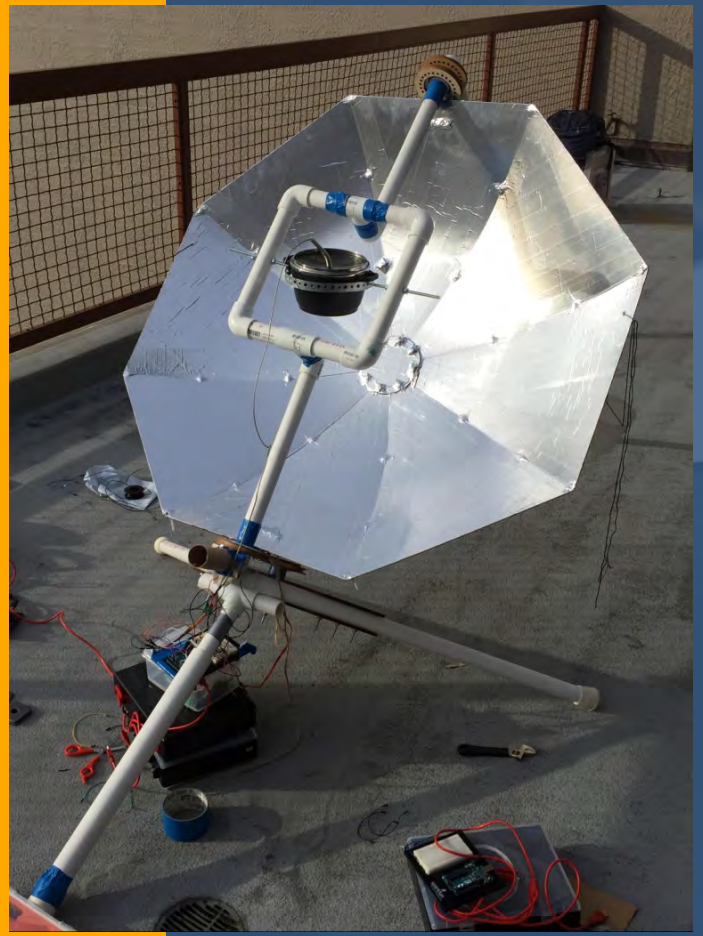
assuming the average American family uses their slow cooker 15 times per year for 4 hours per meal

Future Considerations

- Design a self-balancing system to enable easy rotation across the spectrum of angles
- Enable cooking prediction further into the future
- Think about alternative materials and a method of insulation to reduce heat loss
- Simplify system for use without a personal computer

FoCAL Points

- Clean Energy
- Temperature Control
- Sunlight Tracking
- Real-Time Status
- Easy-to-read graphics



Thanks for listening!

Any questions?