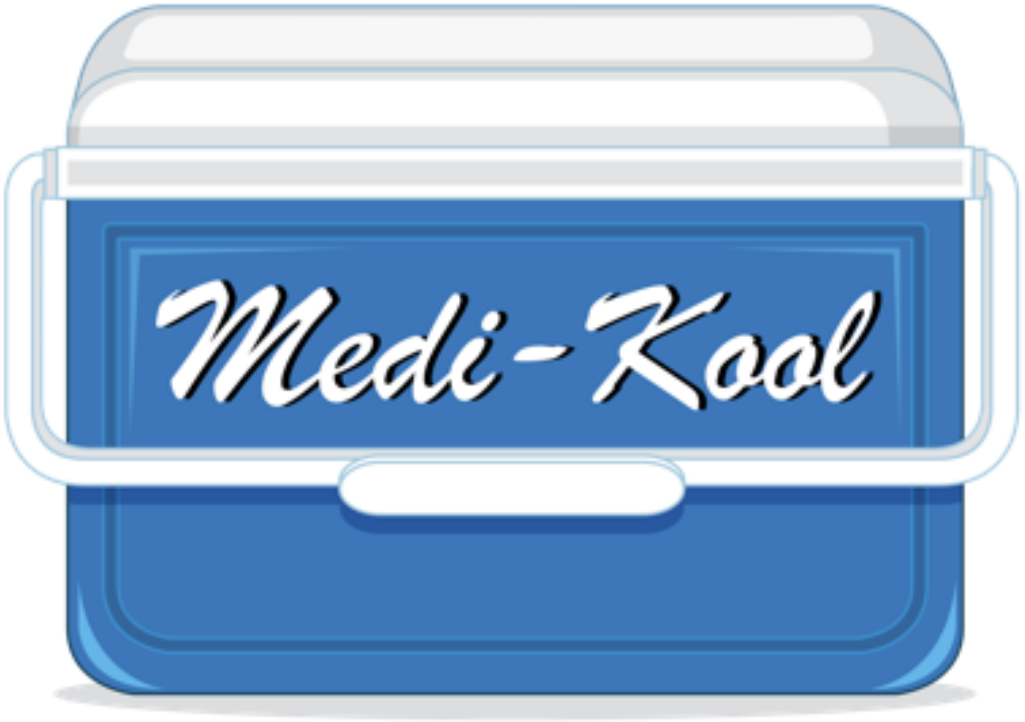

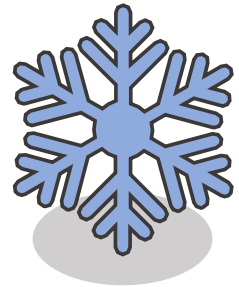

Temperature Sensitive Medication Storage During Natural Disaster

Team Introductions

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Systems Integration Engineer

Travis Amaral
Project Manager & Research Engineer

Nick Georgevich
Design Engineer

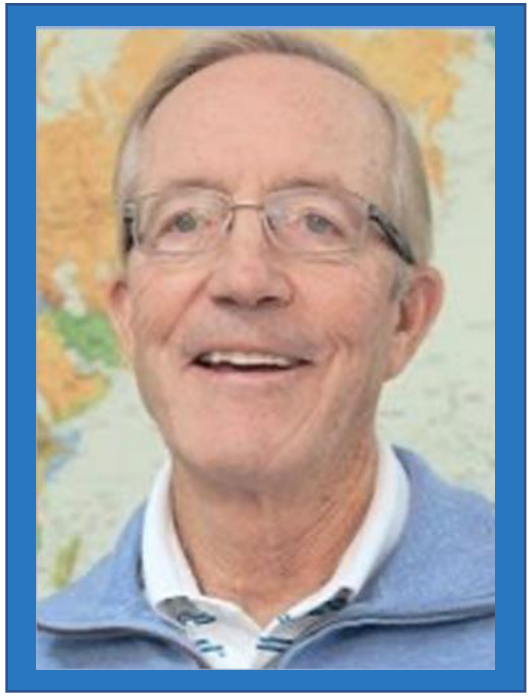
Keon Glass
Entrepreneurial Leader & Research Engineer

Diego Mendoza
Electrical Engineer

Andrew Sayers
Quality Control Engineer

Advisors & Sponsor

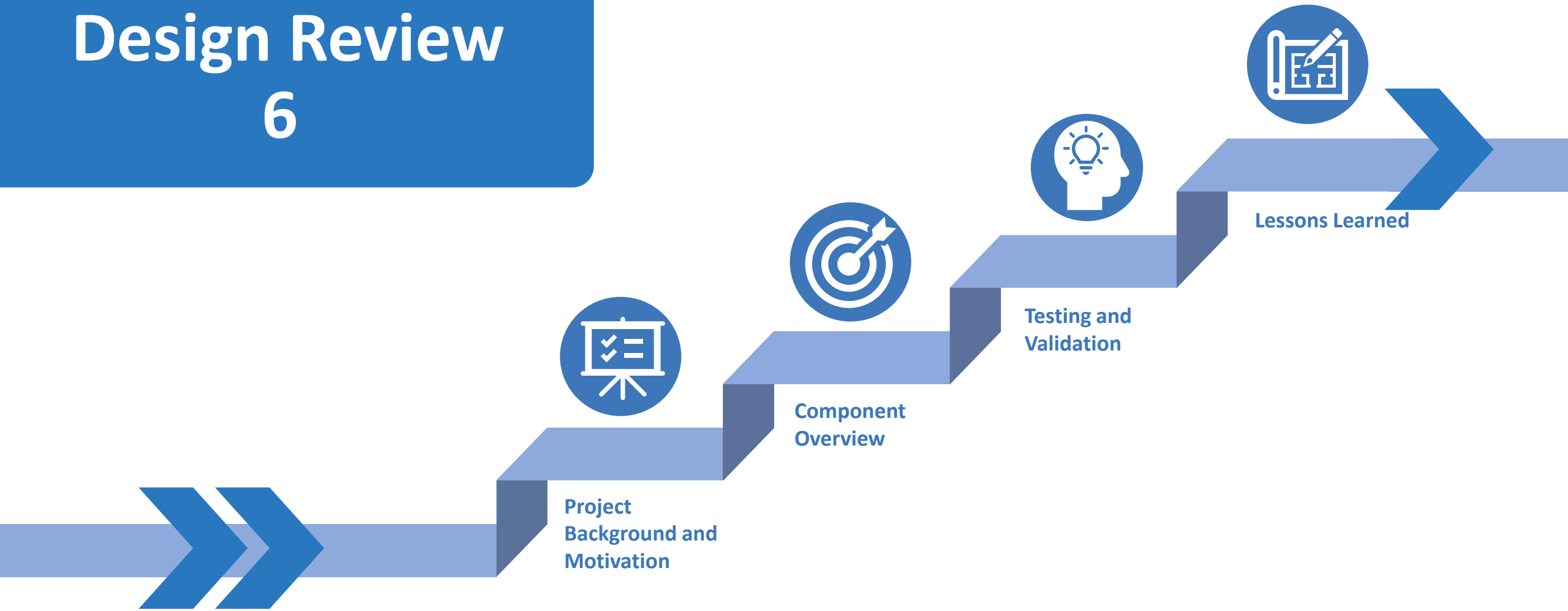
Dr. Shayne McConomy



Dr. Michael Devine

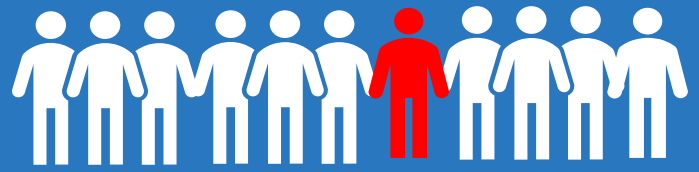
FAMU-FSU College of Engineering

Design Review 6



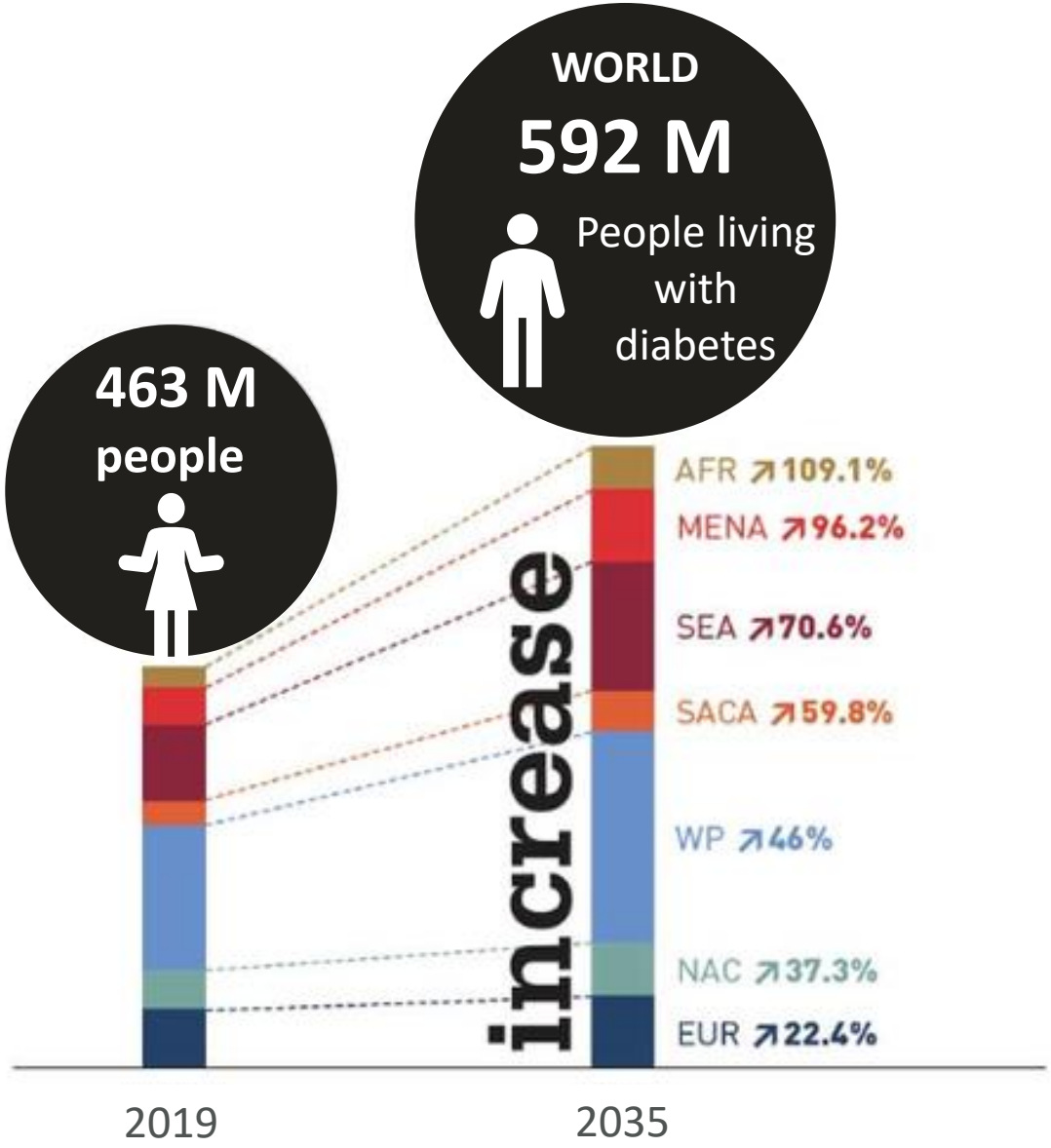

Before

Motivation



1 in 11 adults require insulin

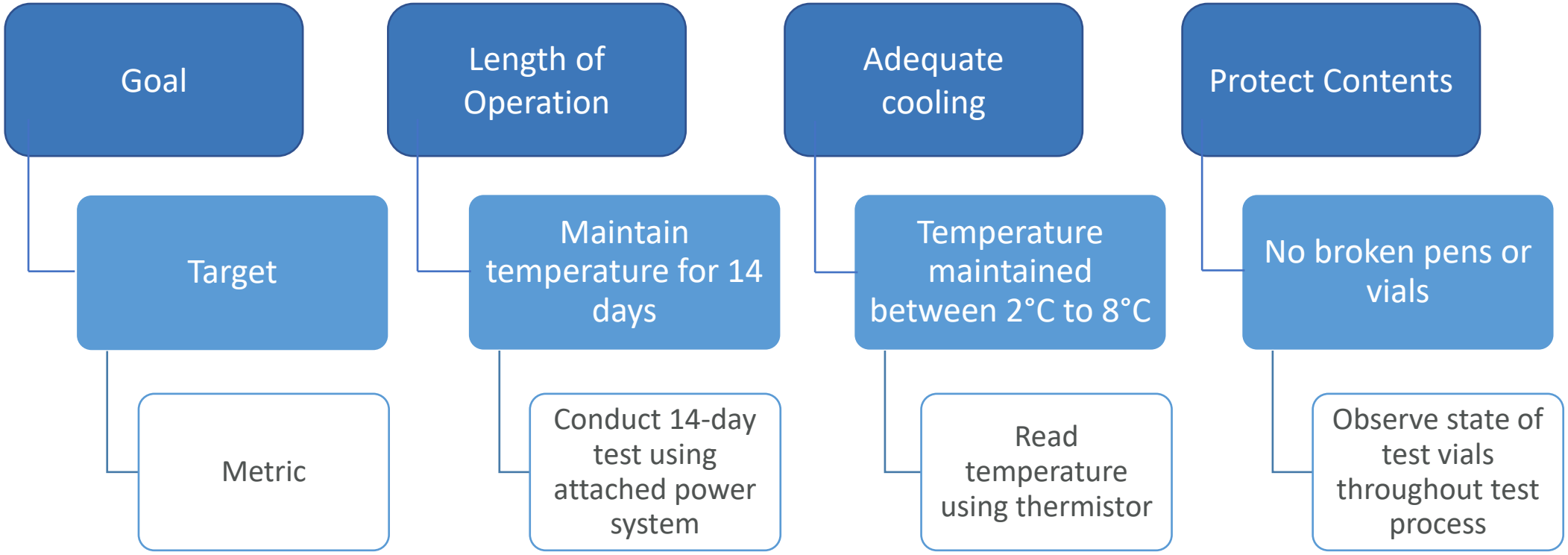
One study found that hurricanes increase diabetes related deaths by **40%**



Objective

Our objective is to develop a device that stores and maintains the quality of temperature sensitive medication in the event of a long-term power outage

Targets & Metrics



Concept Generation

Housing

- Soft Bodied Cooler
- Hard Bodied Cooler

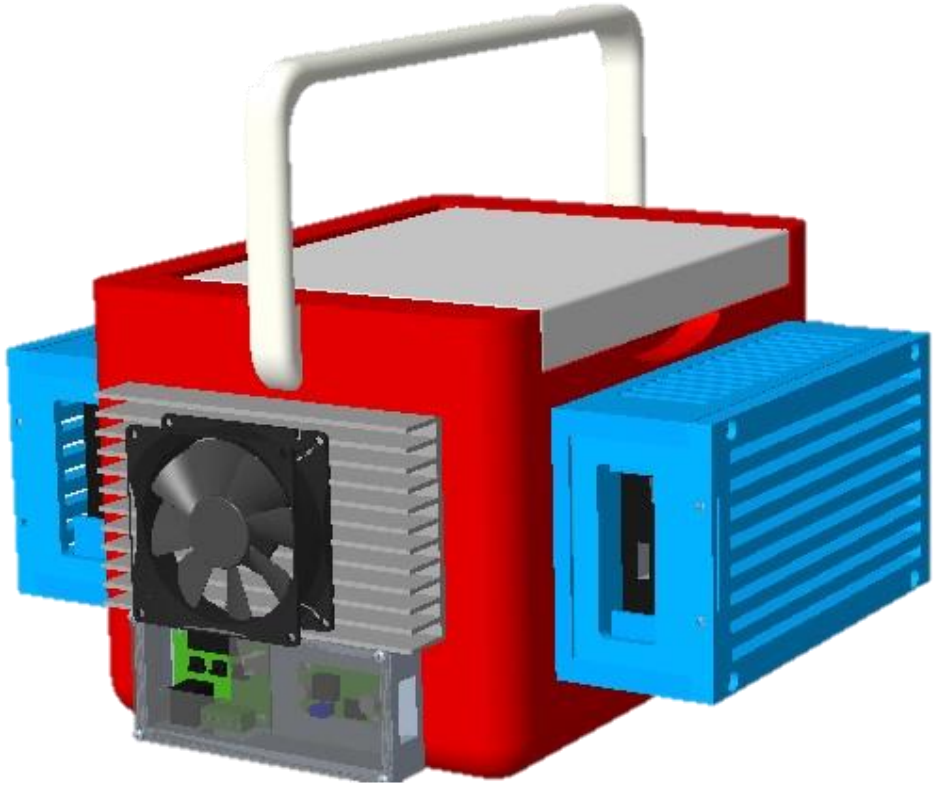
Thermal System

- Thermoelectric Peltier Plate
- Convective Peltier System
- Liquid Heat Exchanger

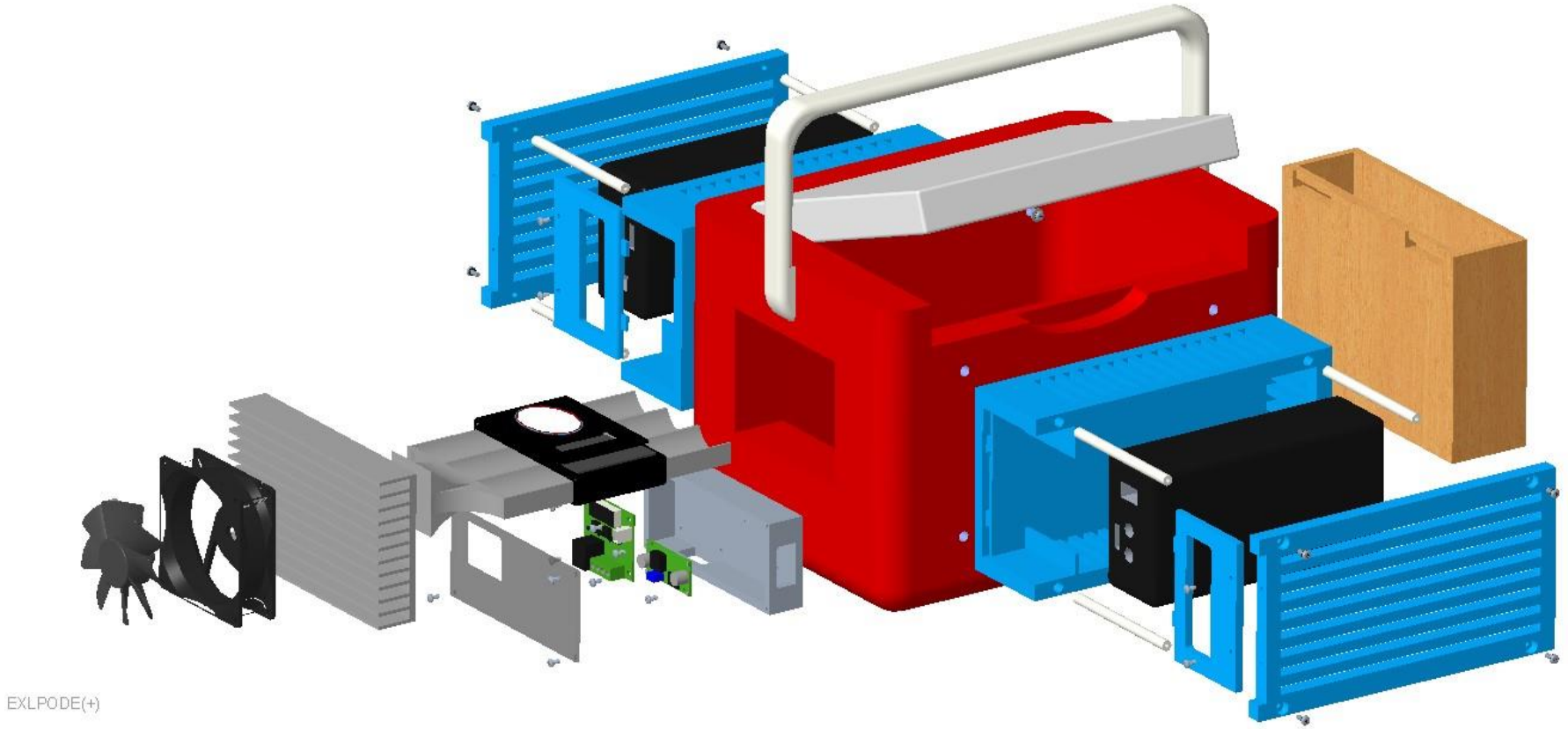
Power System

- Solar Panel Battery Combo
- Portable Power Station

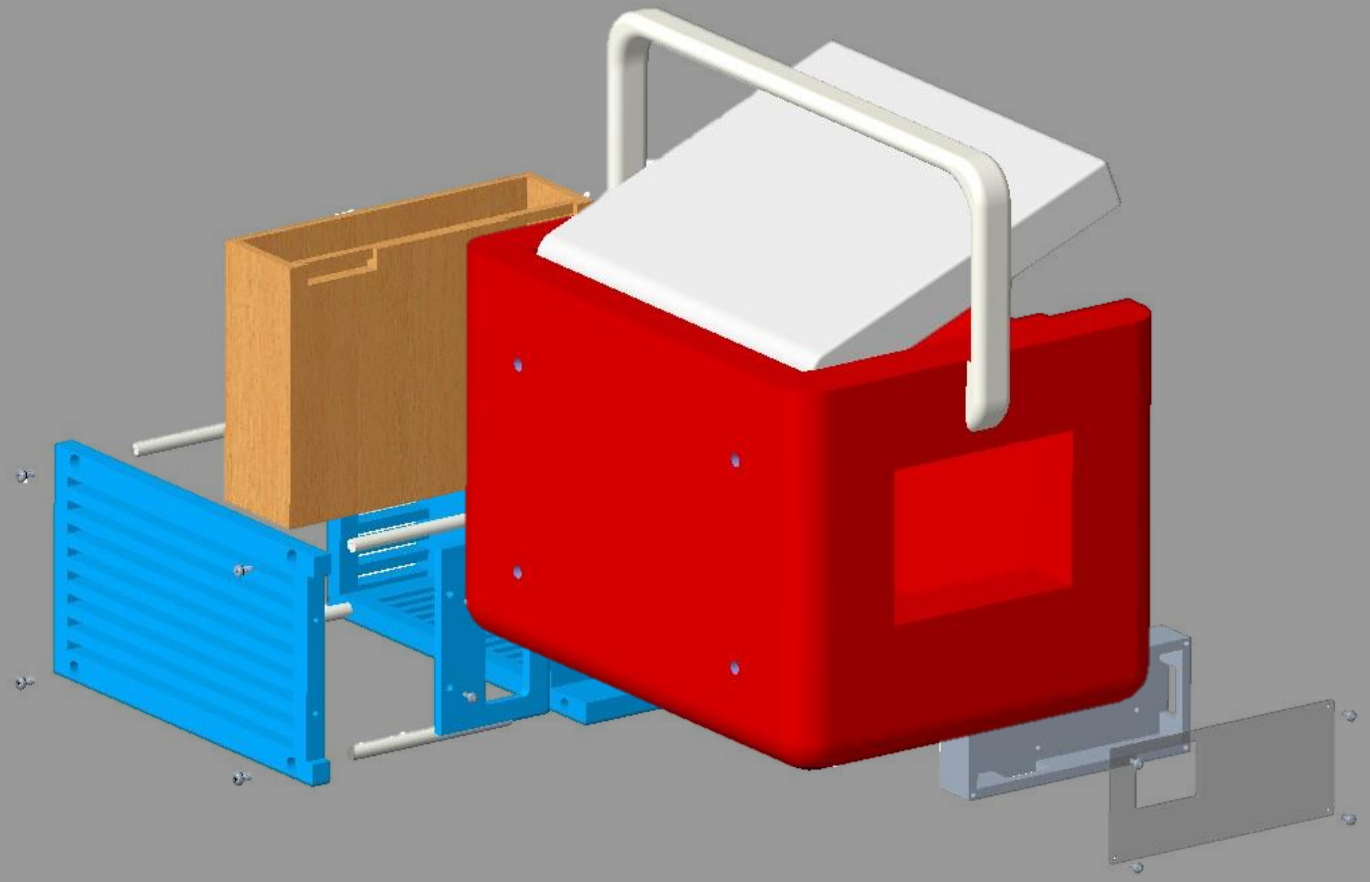
Final Concept Selected



Final Concept Selected

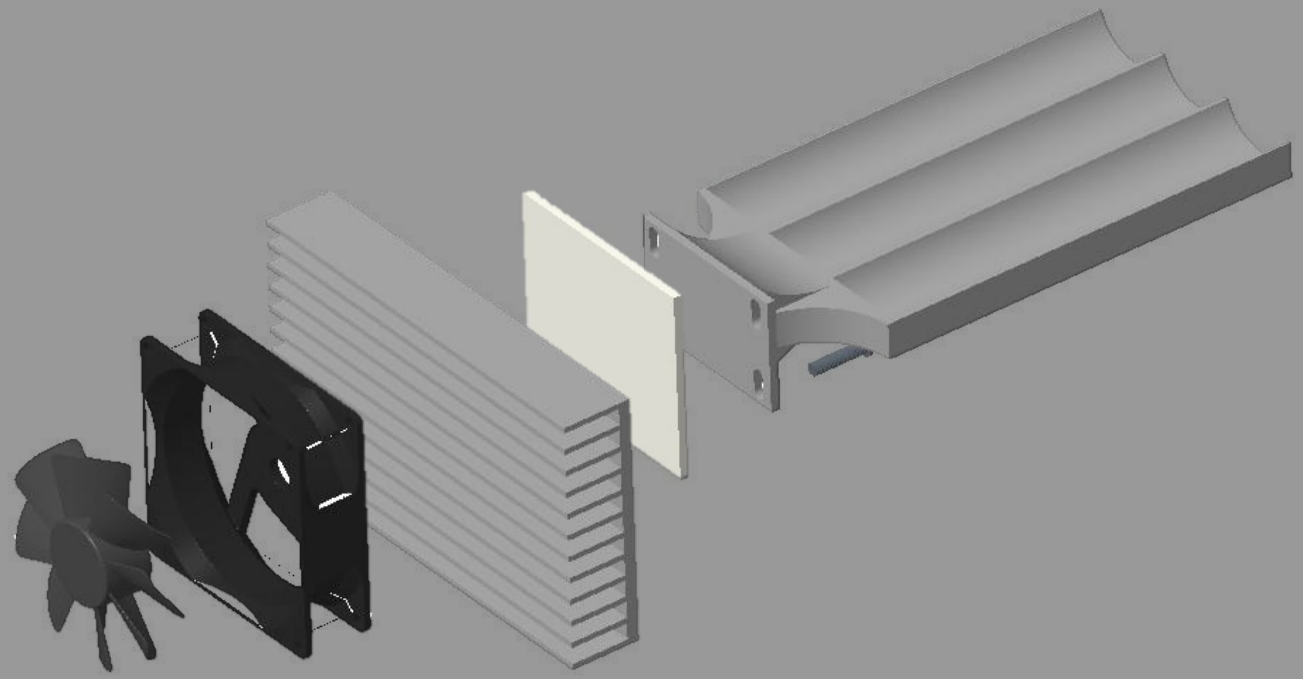


Cooler Housing



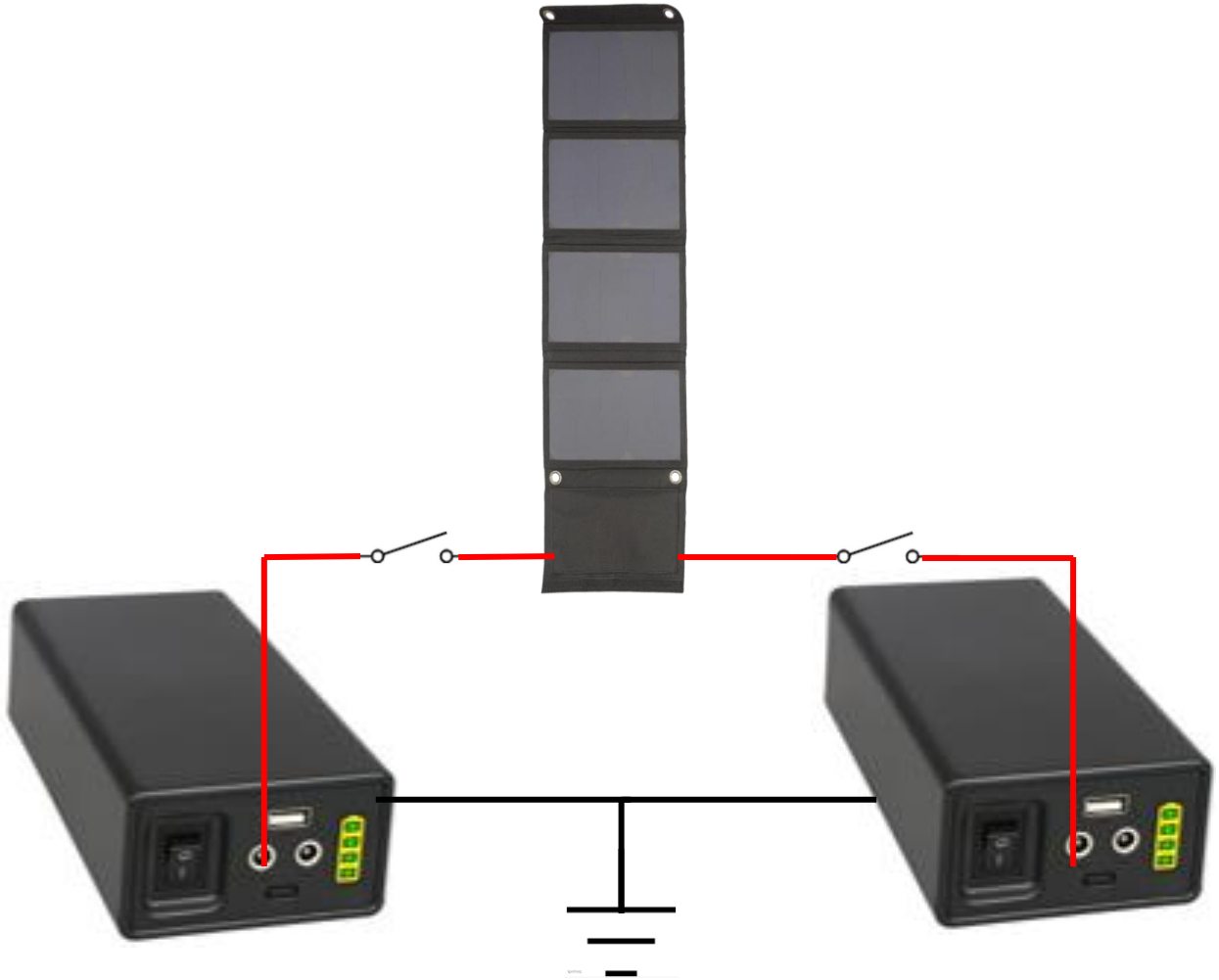
- 5 Quart Hard Body Cooler
- 1” Wool Insulation on all sides
- Battery Housing Along Front and Back
- Electric Component Housing Adjacent to TEC Module
- Solar Panel Housing Opposite TEC Module

Cooling System



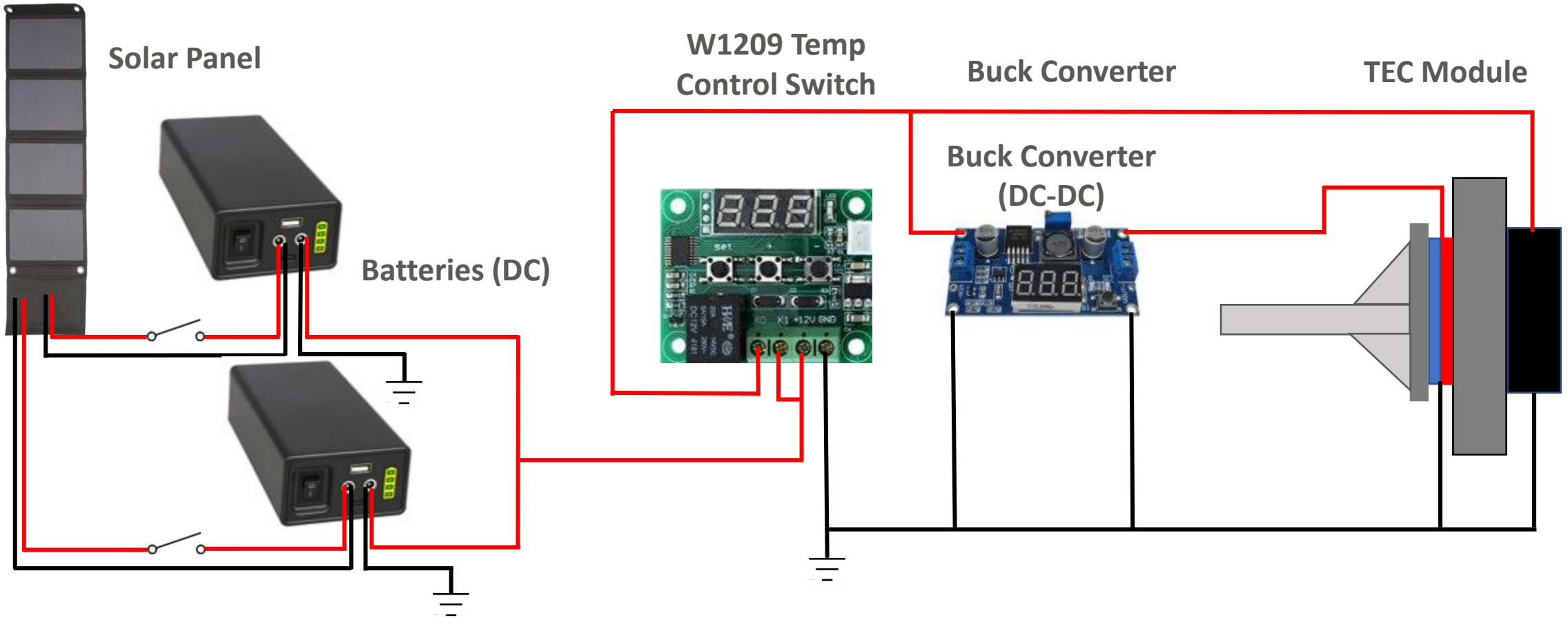
- Custom Aluminum Cold Plate
- Peltier Plate
- Heat Sink
- Axial Fan

Power System

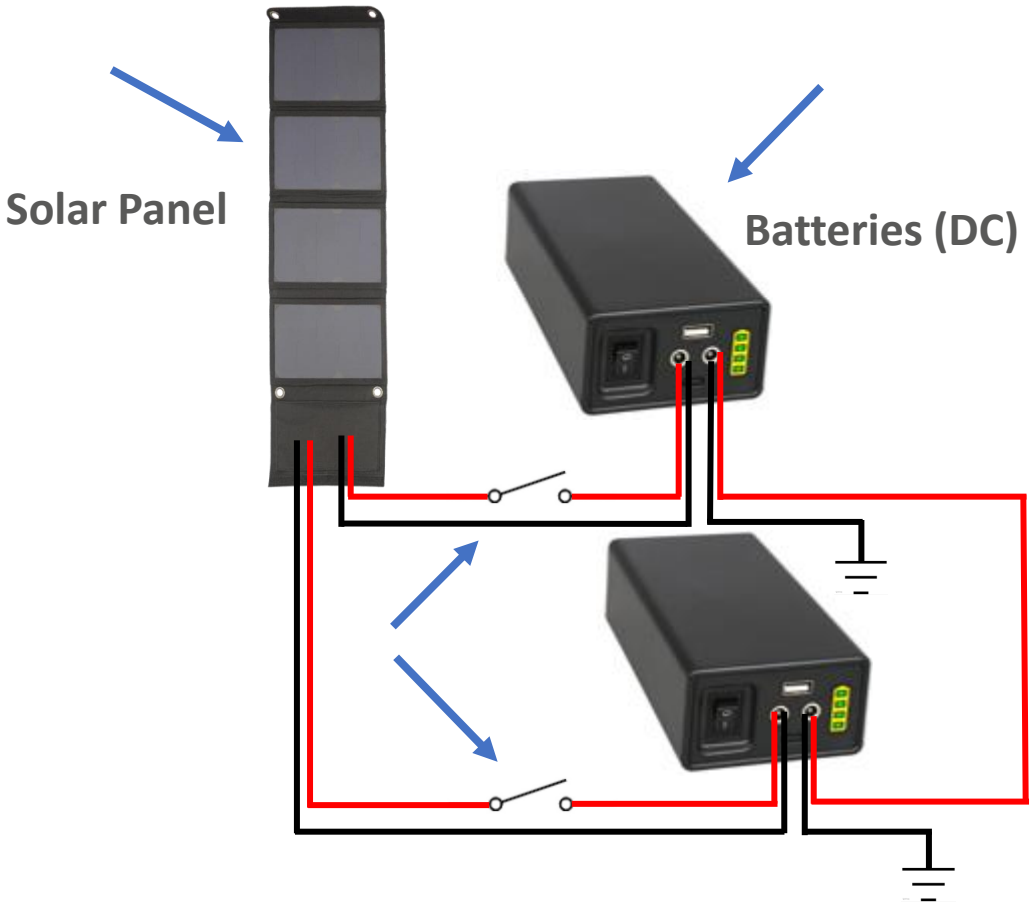


- Two TalentCell Lithium Batteries (12 V)
  - Single battery houses 38,400 mAh
- Solar Panel (22 Watt)
  - Around 20% efficiency
- Switches to turn off and on solar charging

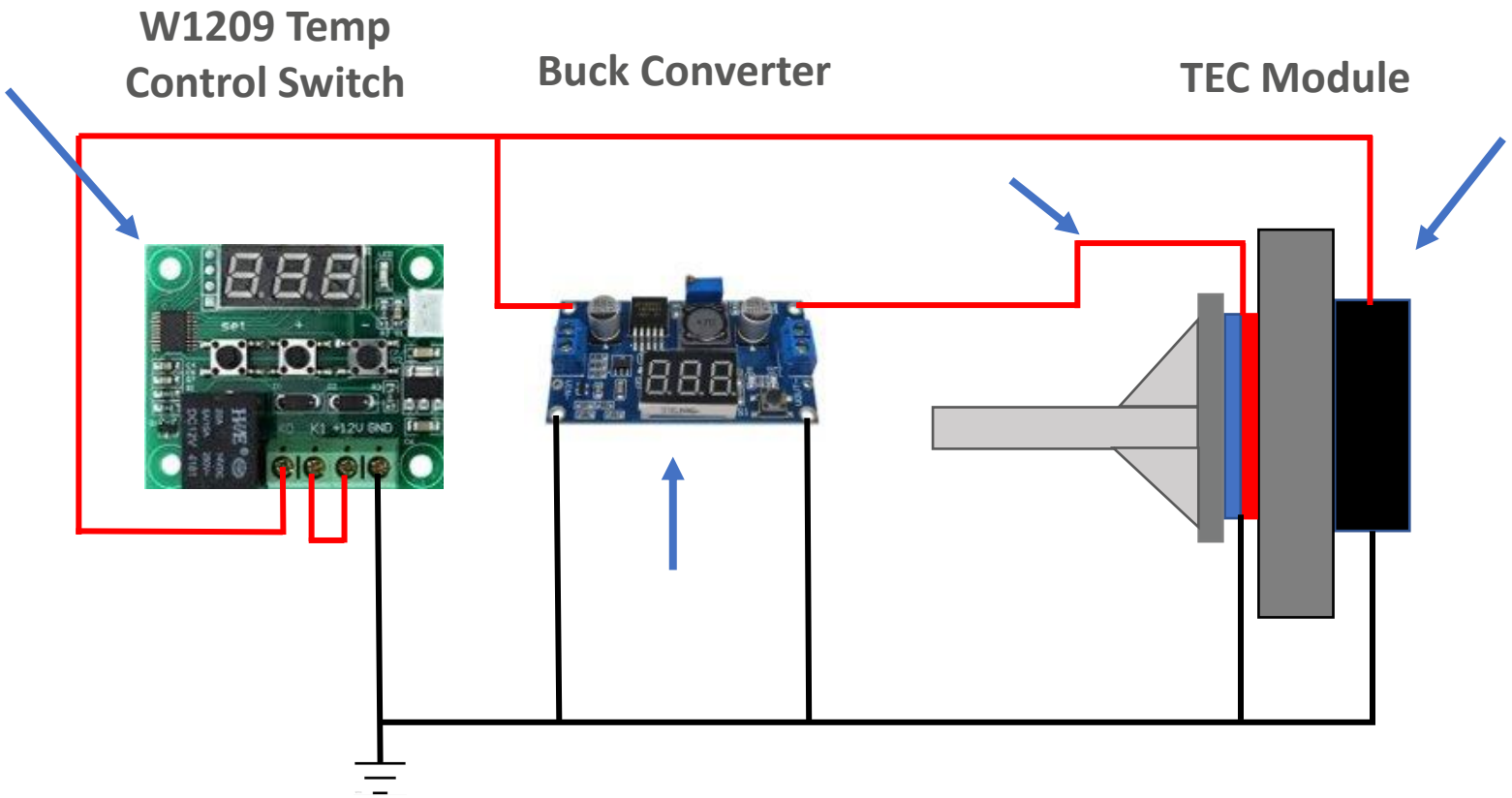
Electrical System Schematic



Power System Schematic



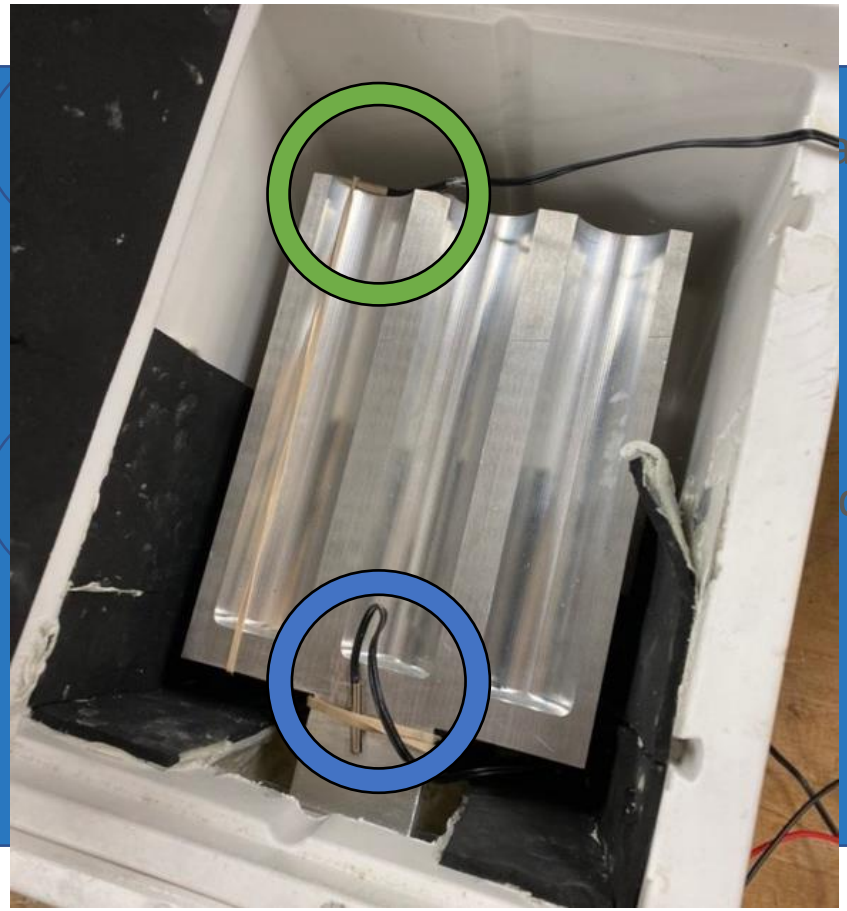
Control System Schematic



Steps to Concept Validation

1. Reaching our temperature target
2. Ensuring the entire cold plate is within range
3. Observe long term power requirements
4. Keeping temperature within range for 14 days

Steps to Concept Validation



Test Setup

Two thermistors

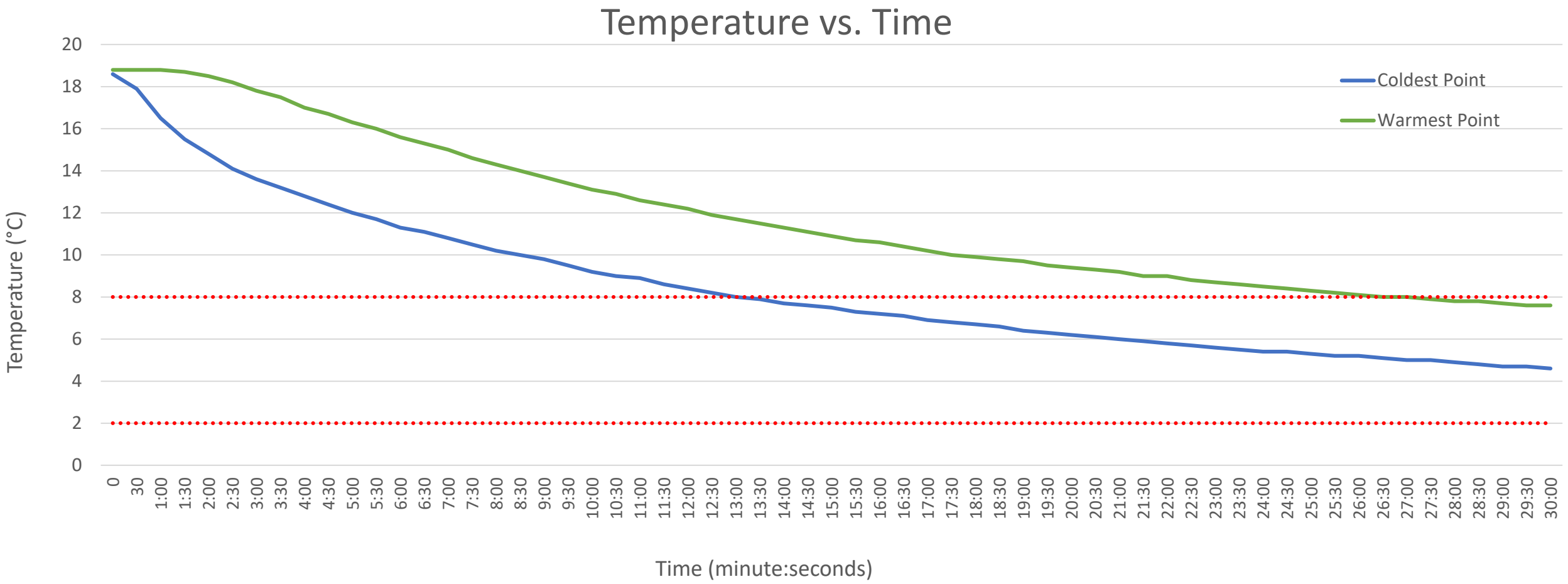
- 1 Furthest from TEC
- 1 Closest to TEC

30-minute run time

Test Objectives

- Observe temperature gradient
- Observe cool down rate

Test Results

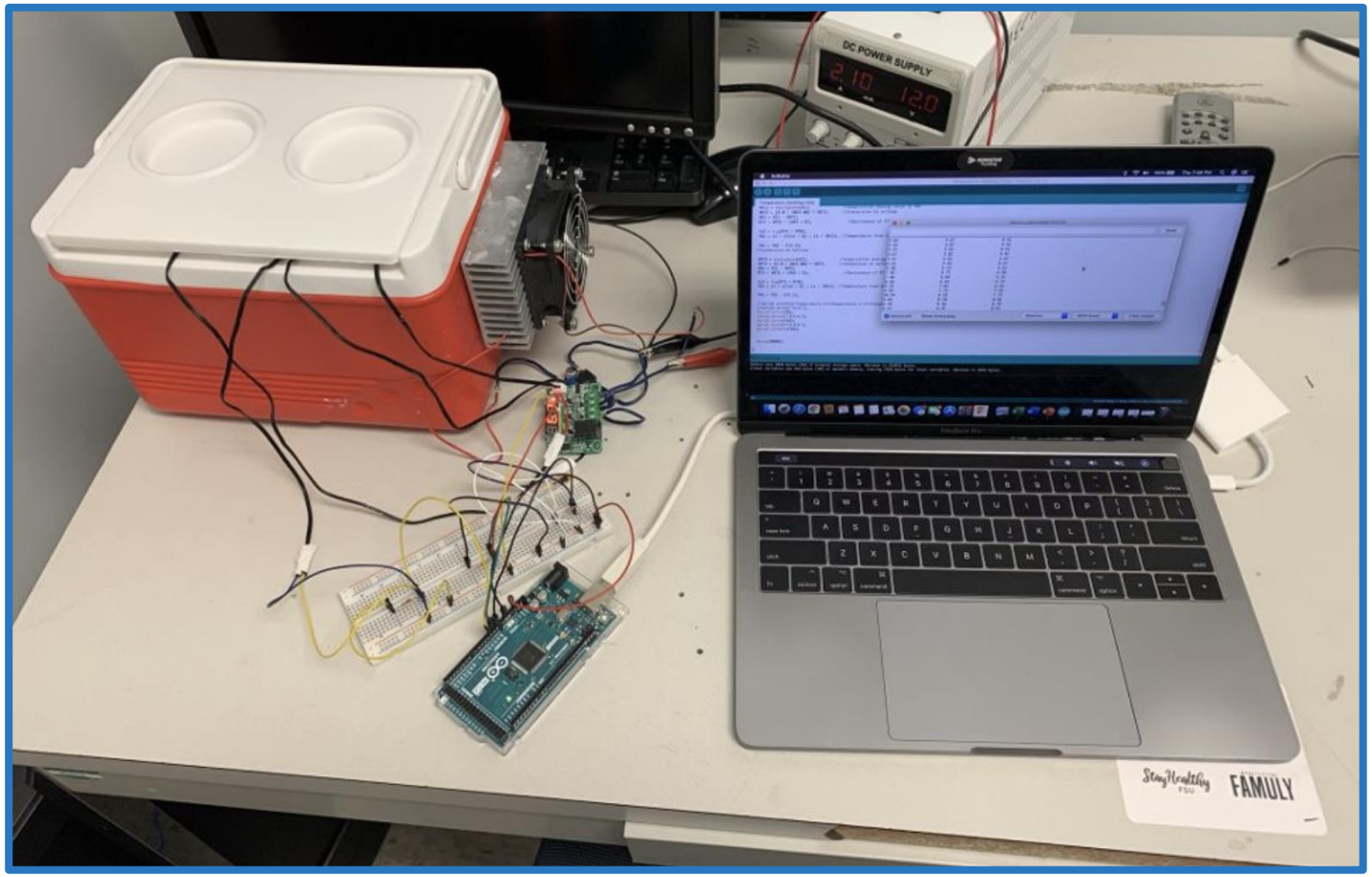


Test Conclusions

- Temperature difference was 4°C at its worst and 3°C at its best without insulation
- Temperature difference is acceptable to keep medicine within 2°C and 8°C
- Additional TEC will not be needed
- Cold plate was fully in range after about 27 minutes

3

Observe long term power requirements

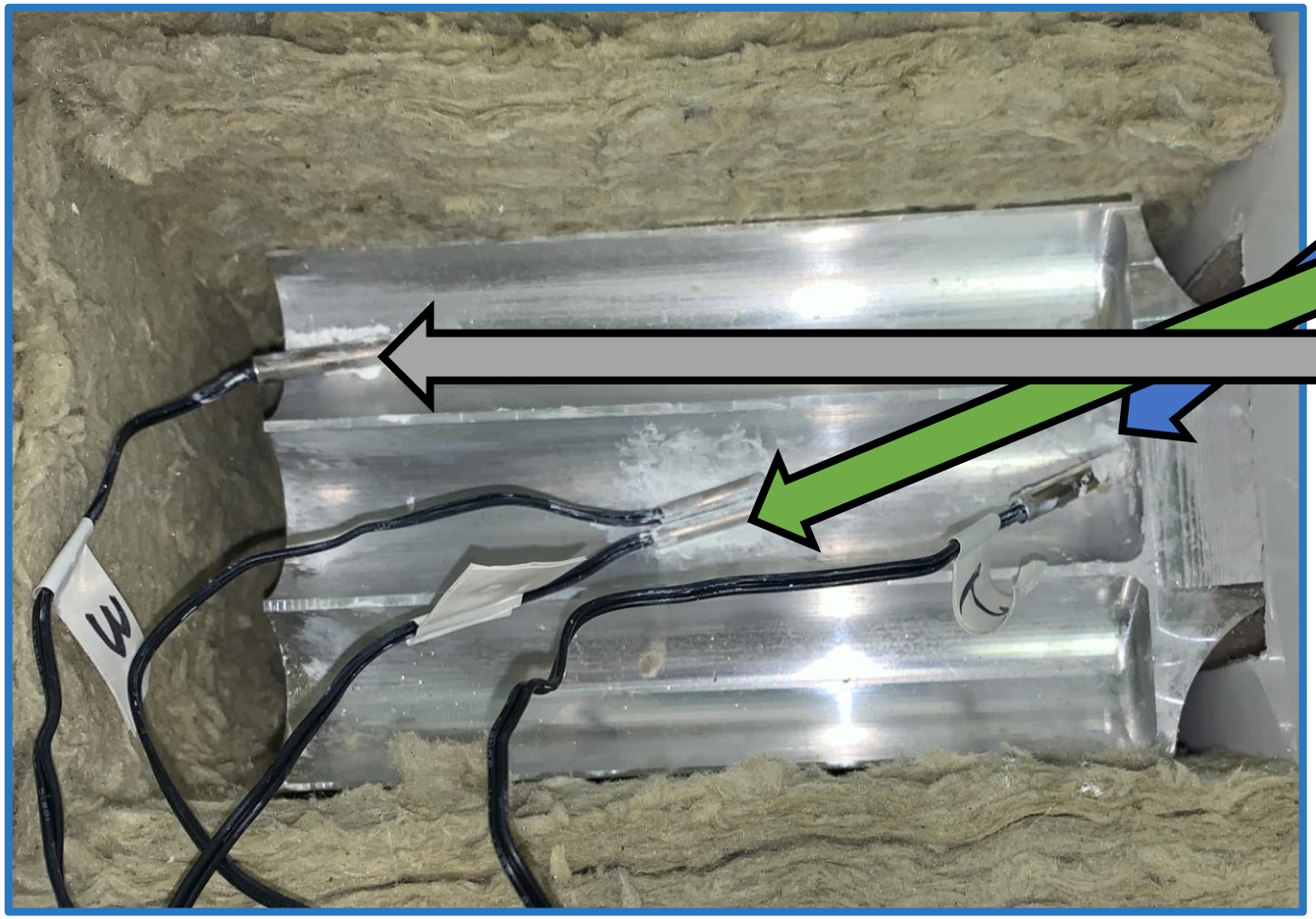


Test Objectives

- Observe long-term temperature fluctuations
- Take temperature from 3 spots every 30 seconds
- Extrapolate long term power requirements
- Confirm cold plate gradient is acceptable

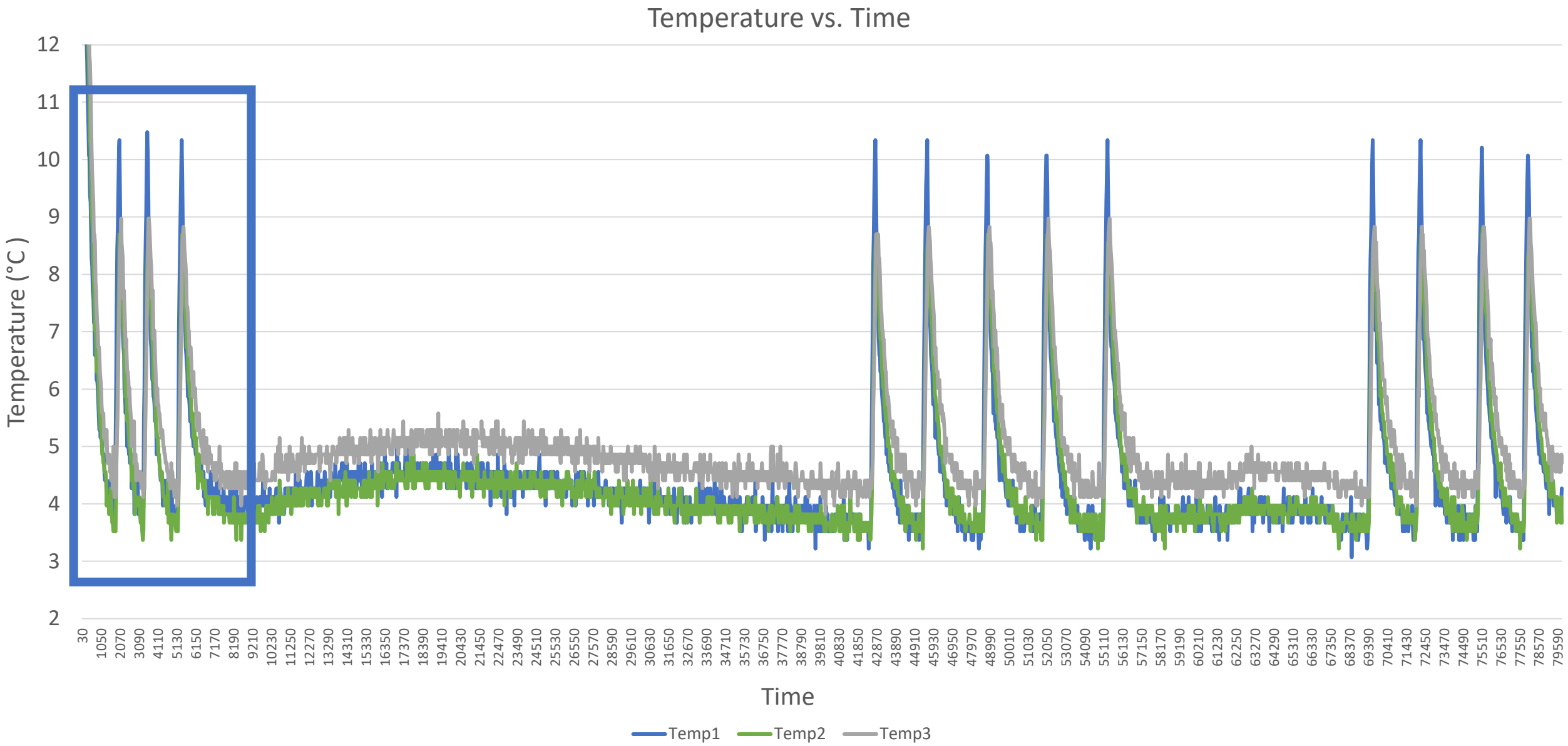
3

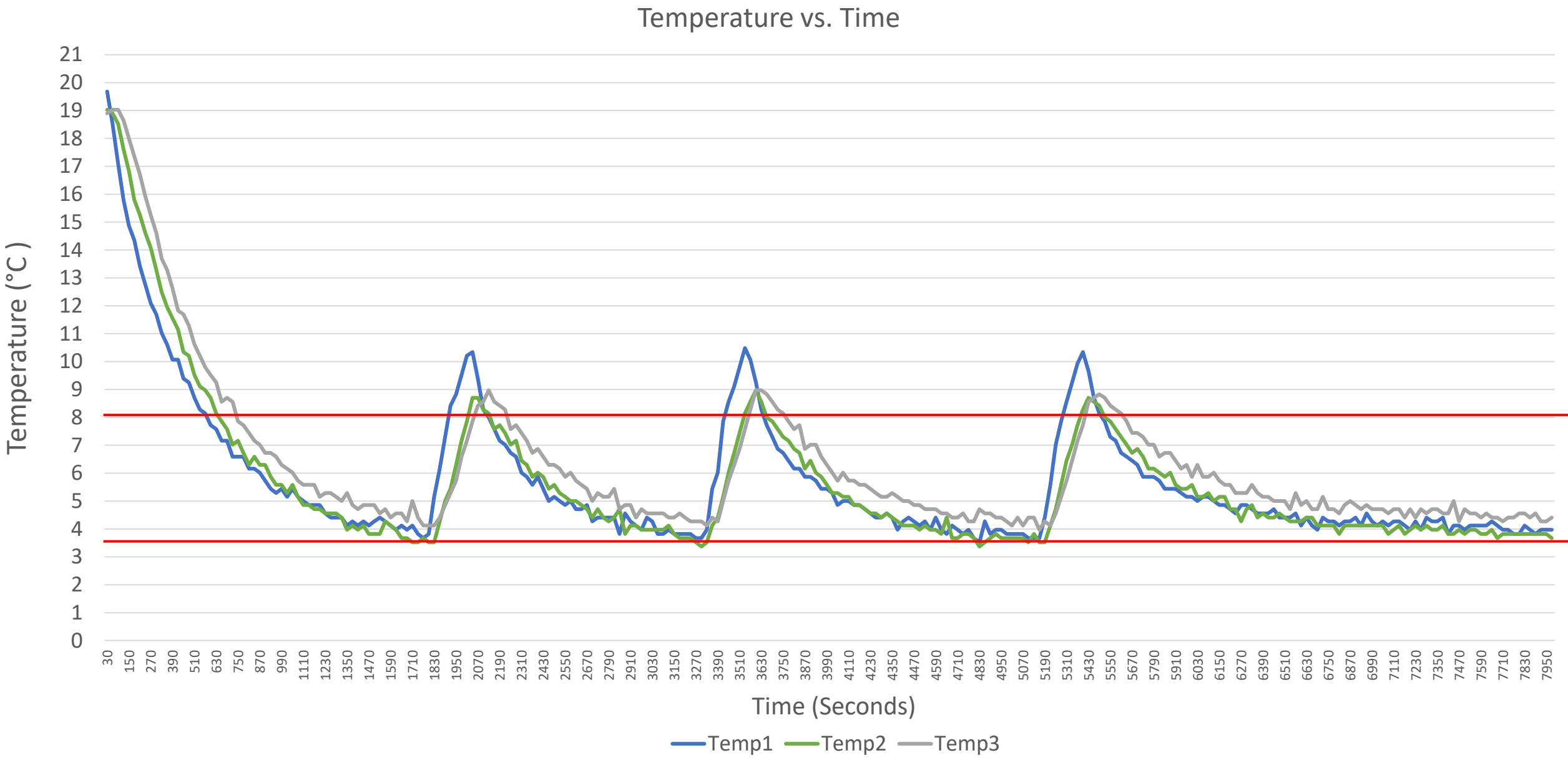
Observe long term power requirements



Test Setup

- Temp1: Closest to TEC
- Temp2: Middle
- Thermistor for Temp Control Switch
- Temp3: Furthest from TEC
- Hooked up to Arduino to record temperatures
- Added buck converter
- Turn OFF at 3.5°C
- Turn back ON at 8°C


Temperature vs. Time
Temperature (°C)
12
11
10
9
8
7
6
5
4
3
2
30
1050
2070
3090
4110
5130
6150
7170
8190
9210
10230
11250
12270
13290
14310
15330
16350
17370
18390
19410
20430
21450
22470
23490
24510
25530
26550
27570
28590
29610
30630
31650
32670
33690
34710
35730
36750
37770
38790
39810
40830
41850
42870
43890
44910
45930
46950
47970
48990
50010
51030
52050
53070
54090
55110
56130
57150
58170
59190
60210
61230
62250
63270
64290
65310
66330
67350
68370
69390
70410
71430
72450
73470
74490
75510
76530
77550
78570
79590
Time
Temp1
Temp2
Temp3


Temperature vs. Time
Temperature (°C)
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
0
30
150
270
390
510
630
750
870
990
1110
1230
1350
1470
1590
1710
1830
1950
2070
2190
2310
2430
2550
2670
2790
2910
3030
3150
3270
3390
3510
3630
3750
3870
3990
4110
4230
4350
4470
4590
4710
4830
4950
5070
5190
5310
5430
5550
5670
5790
5910
6030
6150
6270
6390
6510
6630
6750
6870
6990
7110
7230
7350
7470
7590
7710
7830
7950
Time (Seconds)
Temp1
Temp2
Temp3

Test Conclusions

- New cold plate with buck converter got to range in 7 min compared to 27 min
- Cold plate out of range for 3.5 min at a time
- TEC off for 7.5 minutes at a time
- Temp1 (closest to TEC) heated up quickly after TEC shuts off

4

Keeping temperature within range for 14 days

Battery Supply 76.8 Ah

Power Consumed 43.4 Ah

× **Test Length** 22 h

= **39** Hours

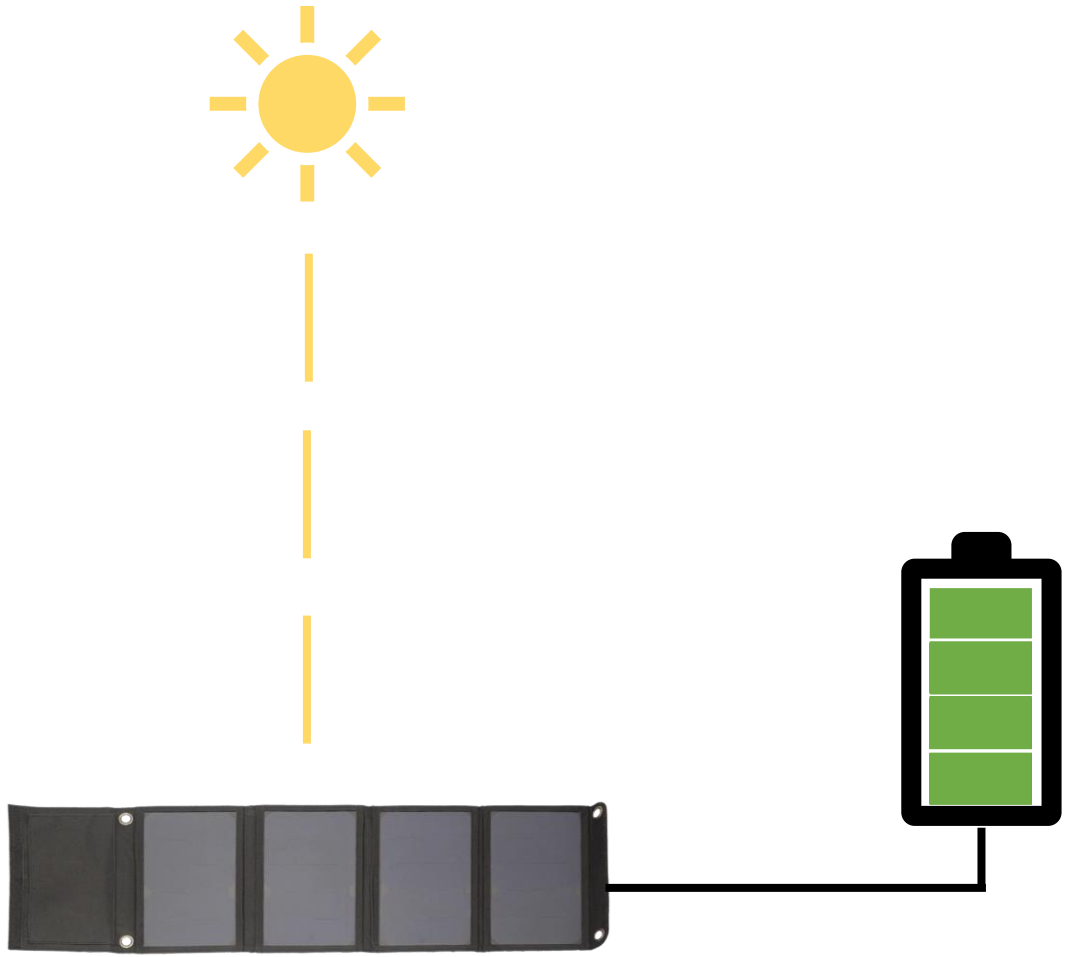
4

Keeping temperature within range for 14 days

Assuming Ideal Conditions

8 Hours of Sunlight Provides 1 Battery Full Charge

1 Battery Supplies 18 Hours of Power



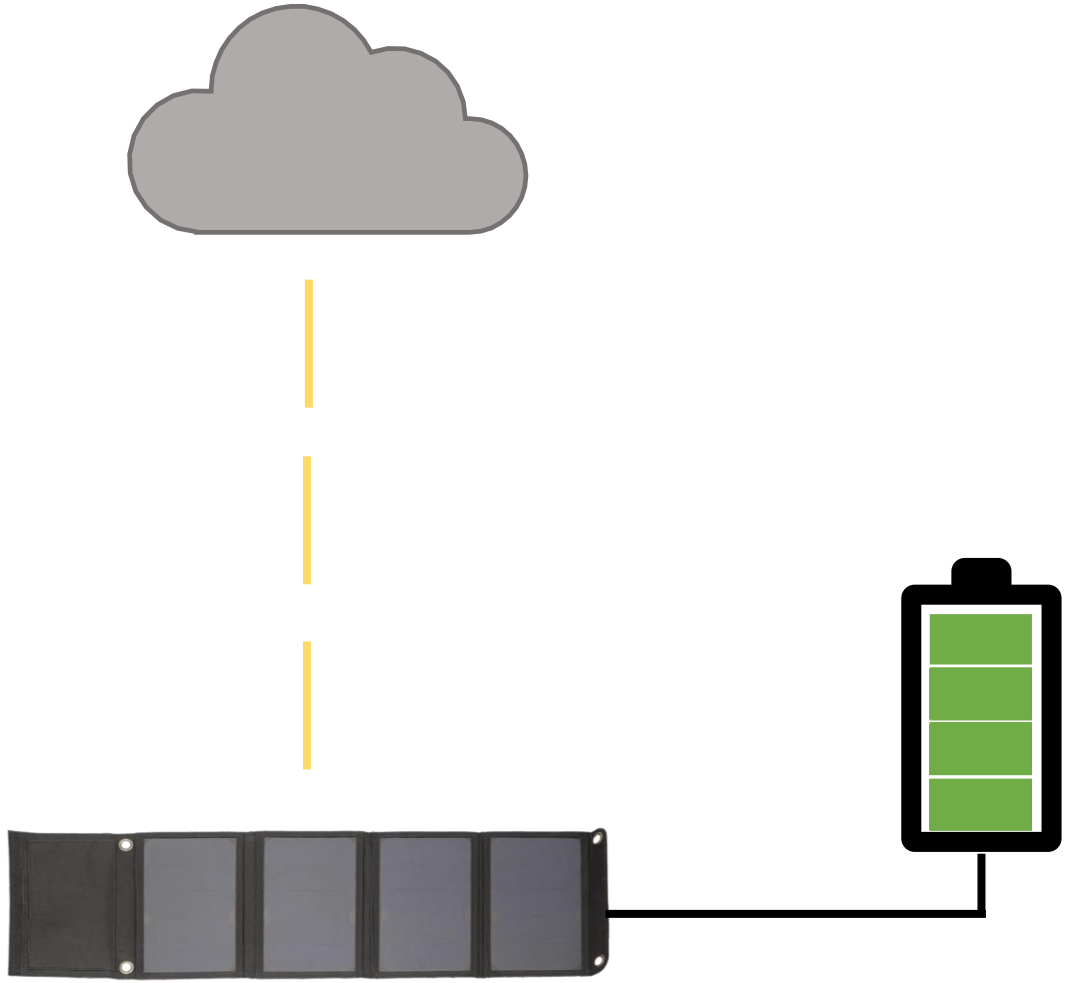
4

Keeping temperature within range for 14 days

Additional Factors

Lack of Direct Sunlight

Outdoor Climate



4

Keeping temperature within range for 14 days

Field Test For Design Validation

Test Setup

- Only solar panel and batteries
- Outdoor area with direct sunlight available
- Fully charged batteries

Test Objectives

- Observe total operational time
- Compare experimental data to previous testing and calculations

Additional Testing

Insulation

- Evaluate/test different types and methods
- Evaluate effect on holes/sealing

Fan Optimization

- Test cost-benefit of increased fan size
- Analyze ideal fan usage

Additional Testing

TEC Placement

- Compare cooling of TEC configuration
- Test difference in power requirements

Component Heat

- Test components for heat dissipation
- Test heat shielding methods

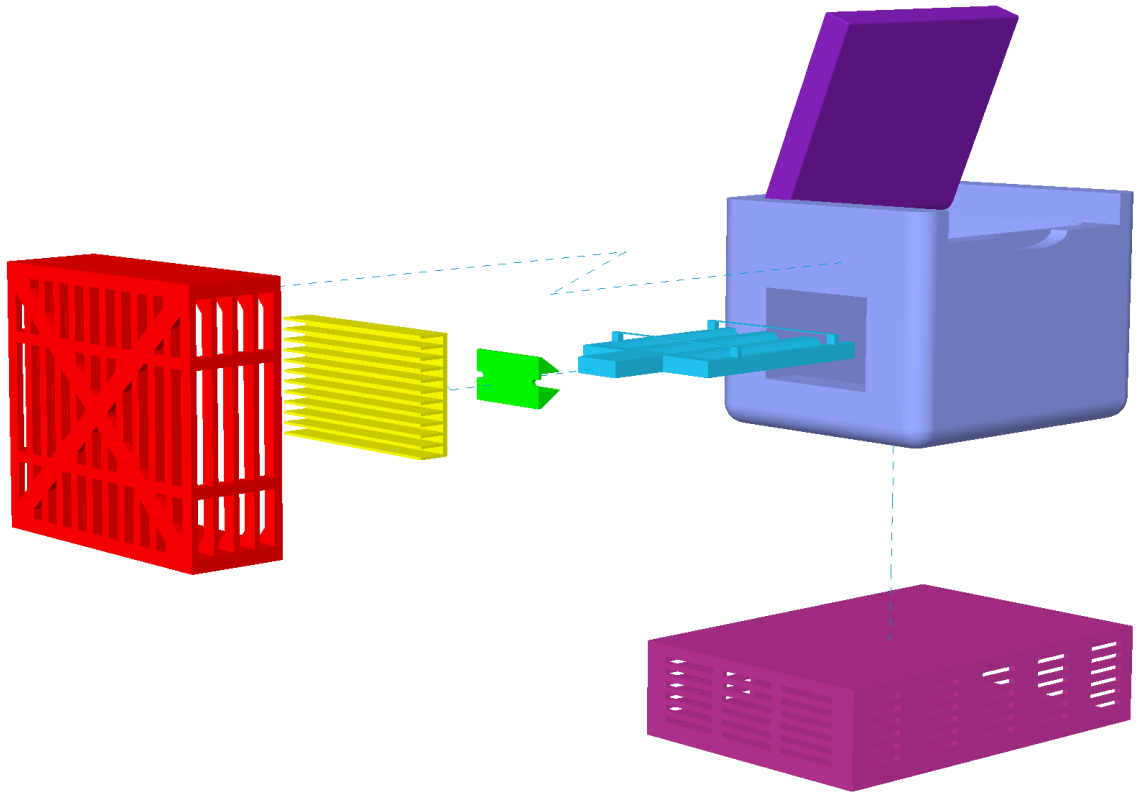
Lessons Learned

- Lots of condensation after long-term test
- Need better sealing from outside air
- Could still be fixed

Lessons Learned

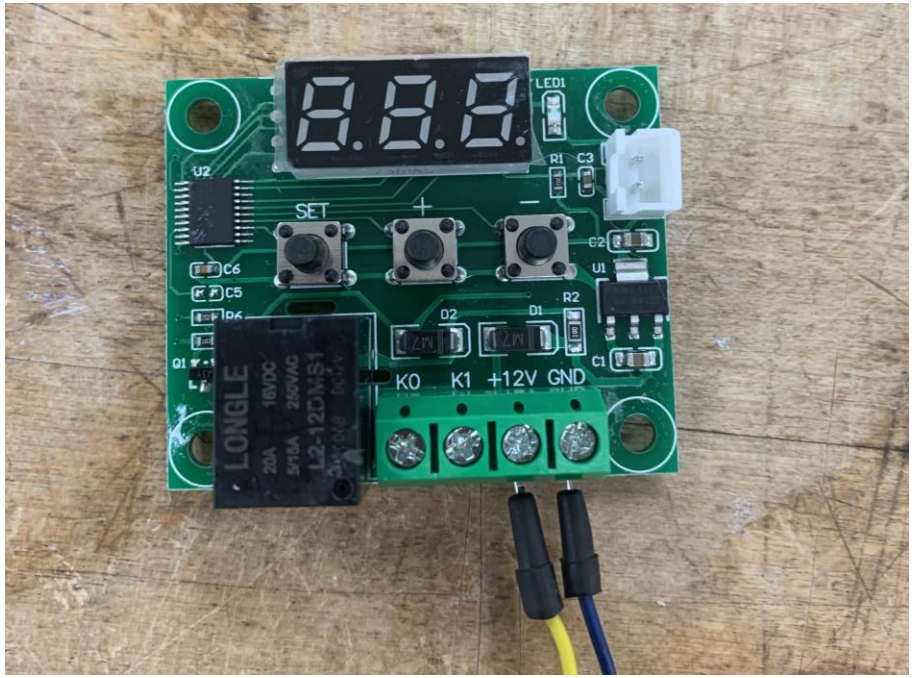
- Wool insulation easily fell apart
- Crumbly and makes a mess
- Not sterile or appropriate for medicine storage
- Holds moisture

Lessons Learned



- Prototyping should have begun a lot earlier
- Original CAD needed more detail
- Didn’t originally CAD extra components and wiring

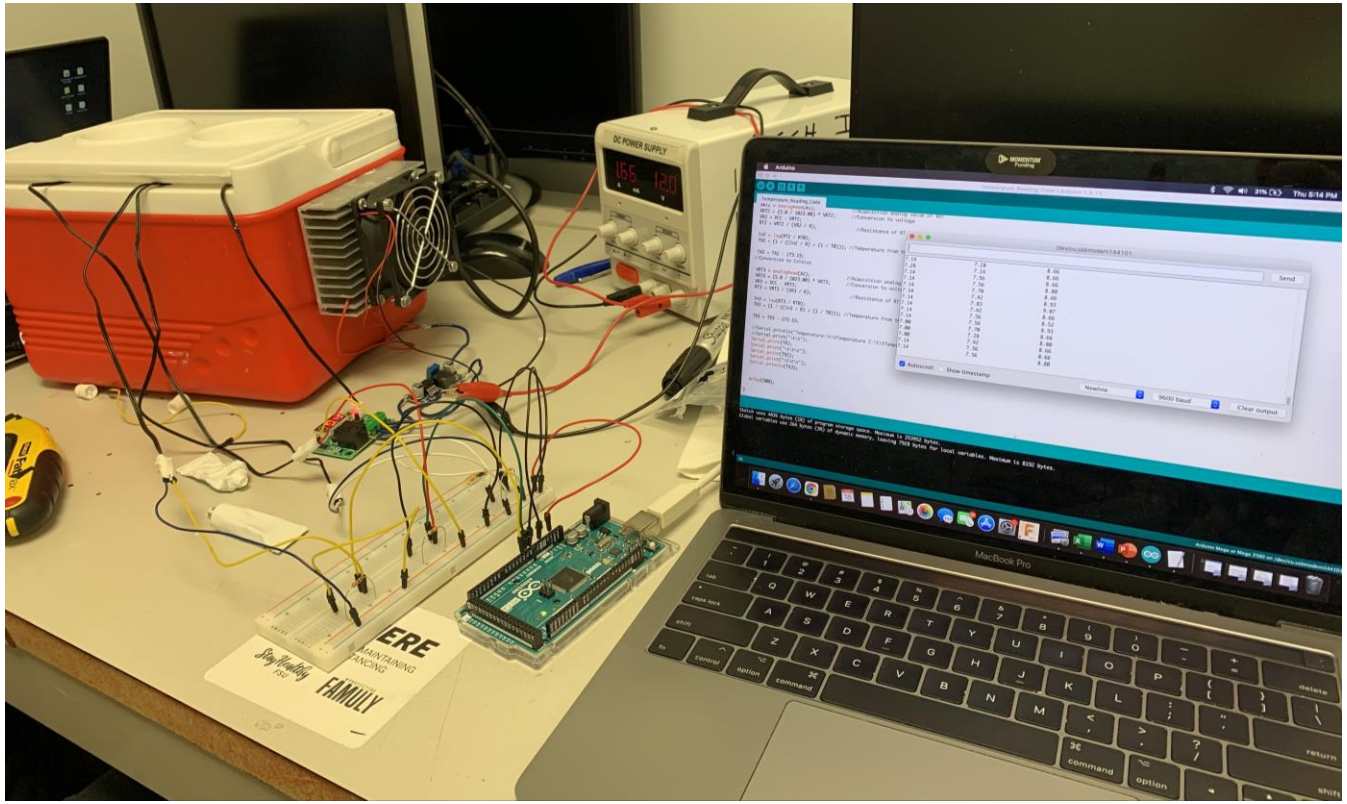
Lessons Learned



W1209 Temperature Control Switch

- Would break easily and often
- Sometimes temperature readings differed by 1°C - 2 °C

Lessons Learned



- Needed a better method to collect data
- Data was lost multiple times during long term test

Project Summary

Completed Work

- Getting device to be in the temperature range
- Packaging the device

Continued Work

- Complete a 14-day test
- Electrical equipment
- Power Consumption vs. Generation

Entrepreneurship

Medi-Kool

MEDI-KOOL
FLORIDA STATE UNIVERSITY

ACC INVENTURE PRIZE

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