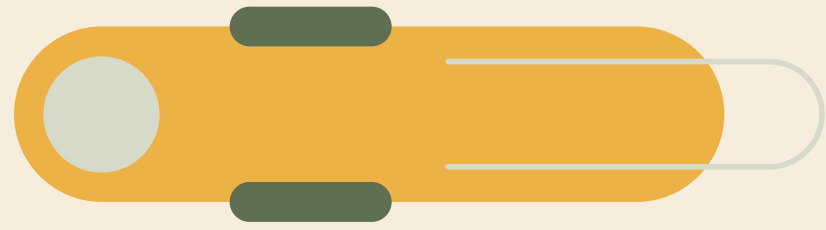




# Research Presentation

**Utilizing Absorbed Heat from Concrete to  
Generate Clean Electricity**

**Kate Caulfield, Yenthy Luong, Haroon Ehsan**



# Abstract /Research Summary

01

## Background of the Study

Urban Heat Island Effect

02

## Problem Statement

Heating in cities + Clean Energy

03

## Methodology

Sample Creation and Apparatus

04

## Data Collected

Trials

05

## Analysis and Reflection

Results

# Intro

The urban heat island (UHI) effect describes the tendency of urban areas to be significantly hotter than nearby rural areas.



# Intro

One of the leading causes of this effect is due to the thermal properties of concrete, which absorbs lots of thermal energy and slowly radiates it into the environment,



# Intro

Through utilizing the Seebeck effect- a phenomenon in which a temperature difference between conductors creates voltage- concrete can be modified into modules for harnessing thermoelectric energy.



# Research Question

How do different materials incorporated into concrete samples affect their ability to generate electricity?

# Problem Statement



Our study focused on the efficiency of generating electricity from concrete for 3 main reasons.

## City Life


The Urban Heat Island Effect shows that excessive heat may be detrimental to the environment of a city

## Sustainable Energy

The excessive heat in cities may be harnessed into sustainable energy

## Materials

Our research specifically wanted to grasp a better understanding of how different materials added to concrete would affect their efficiency, particularly in the case of “hybrid samples”



# Hypothesis



## Control Samples

This was just regular concrete to act as a control to compare samples to. We expect it to perform below average, compared to other samples



## Enhanced Samples

Enhanced samples have one add-in, and we expect the majority of these samples to perform around average when compared to other samples

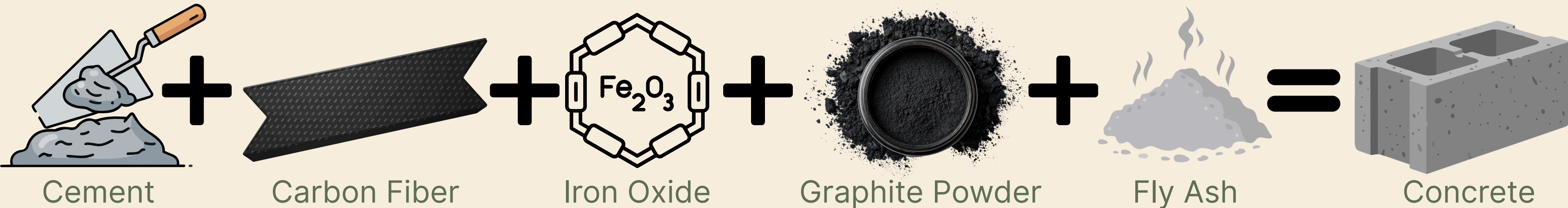


## Hybrid Samples

Hybrid samples are concrete samples with multiple add-ins, and we predict that these will produce the highest voltages when tested



# The Study



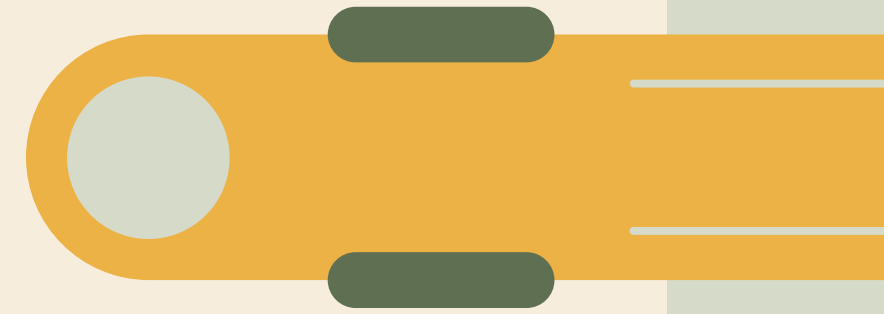
This study specifically focused on the addition of carbon fiber, iron oxide ( $\text{Fe}_2\text{O}_3$ ), graphite powder, and fly ash. We held a strong focus on the “hybrid” or “mixed” samples as well as the economic feasibility of each sample.

Total of 19 samples (including controls)





# Methodology



## Samples

Samples of the concrete were made in silicone molds and were allowed to wet cure for a minimum of 2 weeks.

19 samples in total were made.



## Data Trials

All trials were done in a temperature-controlled environment. We measured 10 data points for each sample over the course of 4 trials, totaling 760 data points.

# Trials

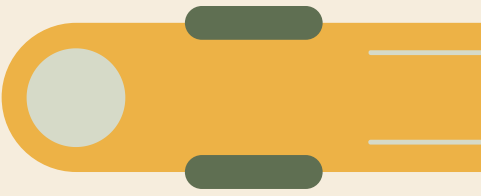
Our data collection consisted of 4 trials. One with copper end caps at 72°F (C72), one without copper end caps at 72°F (N72), one with copper end caps at 32°F (C32), and one without copper end caps at 32°F (N32).



Photo taken April 19<sup>th</sup>, 2026



# Quantitative Data



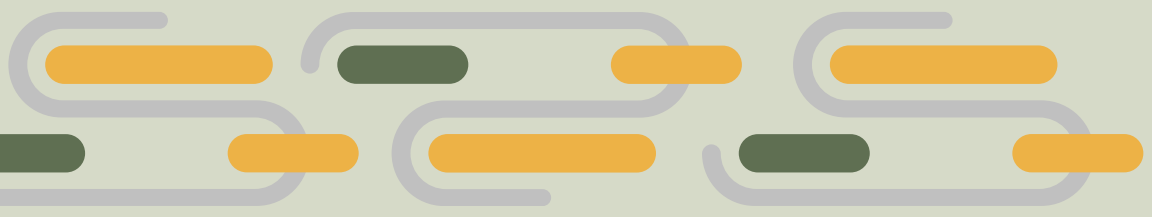
All data in this experiment was charted in tables in excel and may be observed to the right.

Heat Lamp Trials with copper ends and cooled side of 32 * (mV produced)											
SAMPLE	1	1.5	2	2.5	3	3.5	4	4.5	5	MAX	
control	0	0	0	0	0	0.1	0.1	0.1	0.1	0	0.1
less water	0.2	0.1	0.1	0.1	0	0	0	0	0	0	0.2
iron	0.1	0.2	0	0	0	0	0	0	0	0	0.2
cf	0	0	0	0	0.1	0.1	0.1	0.1	0	0	0.1
gp	0	0	0	0	0	0.1	0.1	0.1	0.2	0.3	0.2
fa	0	0	0	0	0	0	0	0	0	0.1	0.1
iron + cf	0	0.1	0.02	0	0	0	0	0	0	0	0.2
iron + gp	0.2	0.1	0.1	0.1	0.1	0	0.1	0.1	0	0	0.2
iron + fa	0	0	0	0	0	0	0	0	0	0	0
cf + gp	0	0	0	0.1	0.1	0.1	0	0	0	0	0.1
cf + fa	0	0	0	0	0	0	0	0	0	0	0
gp + fa	0	0	0	0	0	0	0	0	0.1	0	0
iron + cf + gp	0.2	0.4	0	0	0	0.1	0.1	0.1	0	0	0.4
iron+cf+fa	0.1	0.1	0.1	0.2	0.2	0.3	0.1	0.1	0	0	0
iron + gp + fa	0.1	0.1	0.1	0.2	0.4	0	0	0	0	0	0
cf + gp + fa	0	0	0	0	0	0	0.1	0.1	0.2	0	0
everything	0	0	0	0	0	0	0.1	0	0	0	0.1
iron+cf+fa X2	0.2	0.2	0.3	0.5	0.1	0.1	0	0	0	0	0
less water all	0.1	0.1	0.2	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2

Heat Lamp Trials without copper ends and cool side of 72											
SAMPLE	1	1.5	2	2.5	3	3.5	4	4.5	5	MAX	
control	0.2	0.3	0.5	0.6	0.7	0.7	0.5	0.5	0.3	0.7	0.7
less water	0.5	0.7	0.9	0.7	0.7	0.6	0.3	0.2	0.2	0.2	0.9
iron	0.3	0.4	0.3	0.2	0.3	0.3	0.2	0.3	0.3	0.4	0.4
cf	0.2	0.4	0.5	0.5	0.5	0.5	0.4	0.5	0.5	0.5	0.5
gp	0.1	0.1	0.2	0.3	0.4	0.4	0.4	0.3	0.4	0.4	0.4
fa	0.2	0.1	0.1	0	0.1	0.1	0.1	0.2	0.2	0.2	0.2
iron + cf	0.3	0.2	0.3	0.2	0.2	0.1	0.2	0.4	0.4	0.4	0.4
iron + gp	0.4	0.6	0.5	0.4	0.2	0.5	0.3	0.2	0.3	0.6	0.6
iron + fa	0.3	0.2	0.3	0.4	0.4	0.5	0.6	0.4	0.6	0.6	0.6
cf + gp	0.5	0.5	0.7	0.5	0.6	0.7	0.7	0.8	0.8	0.8	0.8
cf + fa	0.5	0.4	0.5	0.6	0.5	0.4	0.4	0.3	0.3	0.6	0.6
gp + fa	0.4	0.6	0.7	0.7	0.8	0.7	0.8	0.9	0.9	0.9	0.9
iron + cf + gp	0.4	0.3	0.2	0.3	0.4	0.5	0.4	0.3	0.3	0.5	0.5
iron+cf+fa	0.2	0.3	0.5	0.5	0.6	0.4	0.6	0.4	0.6	0.6	0.6
iron + gp + fa	0.2	0.3	0.4	0.7	0.6	0.8	0.9	1	1	1	1
cf + gp + fa	0.5	0.4	0.5	0.5	0.5	0.4	0.4	0.5	0.4	0.4	0.4
everything	0.3	0.5	0.5	0.6	0.7	0.7	0.4	0.3	0.2	0.7	0.7
iron+cf+fa X2	0.3	0.3	0.2	0.2	0.3	0.4	0.5	0.2	0.2	0.4	0.4
less water all	0.5	0.7	0.4	0.2	0	0.1	0.1	0	0	0.7	0.7

ACTUAL DATA (Heat Lamp Trials with copper ends + cool side of 32)											
SAMPLE	1	1.5	2	2.5	3	3.5	4	4.5	5	MAX	
control	0.1	0.1	0	0	0	0.1	0.1	0.1	0	0.1	0.1
less water	0.4	0.3	0.1	0.1	0	0	0	0	0	0	0.4
iron	0.1	0.2	0	0.1	0.1	0.1	0.2	0.3	0.2	0.1	0.3
cf	0	0.1	0	0	0	0	0	0	0	0	0.1
gp	0.1	0.2	0.1	0.1	0	0.1	0	0.1	0	0.1	0.2
fa	0	0	0	0.1	0.1	0.1	0.1	0.1	0	0	0.1
iron + cf	0	0.1	0	0	0	0.1	0.1	0	0	0	0
iron + gp	0.1	0.1	0.1	0.1	0.2	0.1	0.1	0.2	0.2	0.2	0.2
iron + fa	0	0	0	0	0	0	0	0	0	0	0
cf + gp	0	0	0	0.1	0.1	0.2	0	0.1	0.1	0.1	0.1
cf + fa	0.2	0.3	0.1	0.5	0.4	0.2	0.1	0.1	0.1	0.1	0.5
gp + fa	0.1	0.1	0	0	0.1	0.1	0	0	0	0	0.1
iron + cf + gp	0	0	0	0	0	0	0	0	0	0	0
iron+cf+fa	0.4	0.2	0.1	0.2	0.5	0.2	0.1	0	0	0	0.4
iron + gp + fa	0.1	0	0	0	0	0	0	0	0	0	0.1
cf + gp + fa	0.1	0.1	0.1	0.2	0.4	0.1	0.1	0.2	0.1	0.4	0.4
everything	0	0.2	0.1	0.1	0	0.2	0	0	0	0	0.2
iron+cf+fa X2	0.1	0.1	0	0.1	0	0.2	0	0	0	0	0.1
less water all	0.1	0.1	0	0	0	0	0	0	0	0	0

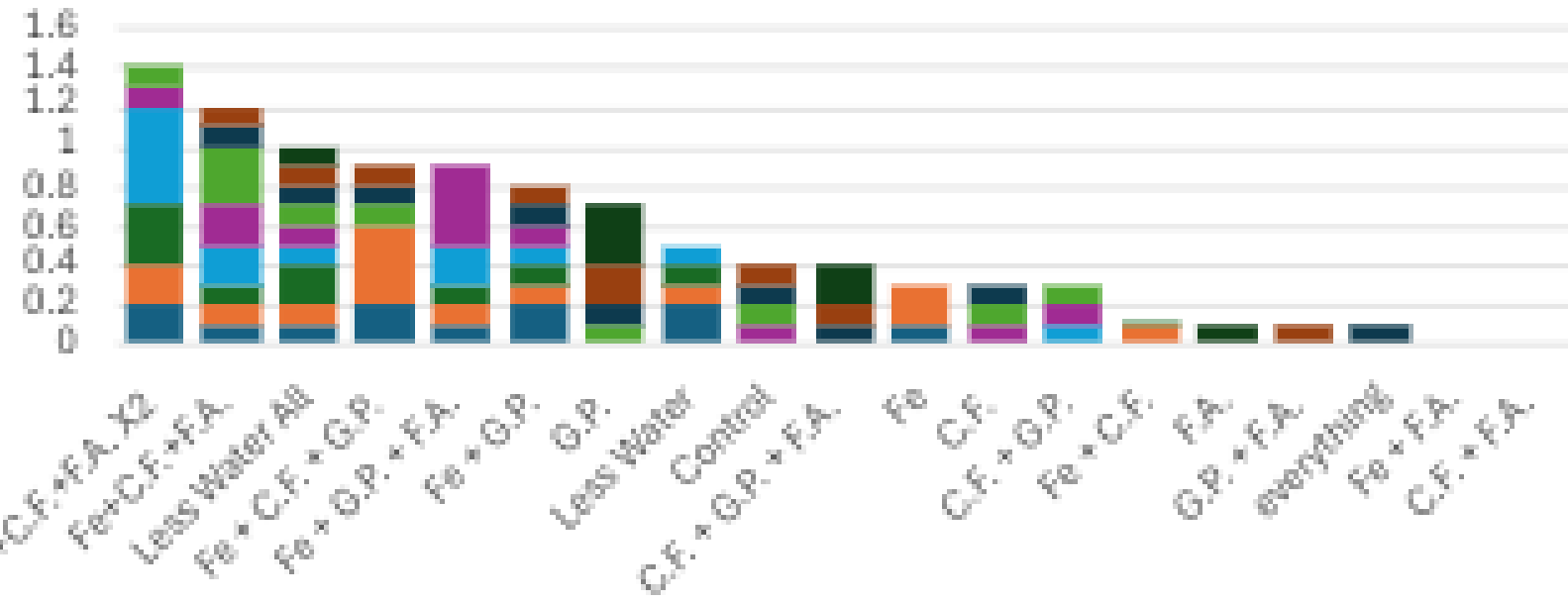
Heat Lamp Trials without copper ends + cool side of 32											
SAMPLE	1	1.5	2	2.5	3	3.5	4	4.5	5	MAX	
control	0.1	0.1	0	0	0	0	0	0	0	0	0.1
less water	0.3	0.2	0.4	0.2	0.1	0.6	0.4	0.4	0.4	0.4	0.6
iron	0	0	0.2	0.2	0.4	0.2	0.4	0.2	0.2	0.2	0.4
cf	0.1	0	0	0	0.1	0	0.1	0	0	0	0.1
gp	0	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.1	0.2
fa	0.3	0.2	0.3	0.3	0.2	0.3	0.4	0.3	0.5	0.5	0.5
iron + cf	0.2	0.1	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.3	0.3
iron + gp	0	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.4	0.4
iron + fa	0.1	0.2	0.2	0.2	0	0	0	0	0	0	0
cf + gp	0.3	0.2	0.2	0.1	0.1	0.7	1.1	0.3	0	1.1	1.1
cf + fa	0.5	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.8	0.7
gp + fa	0.1	0.1	0.2	0.4	0.5	0.6	0.3	0.4	0.5	0.6	0.6
iron + cf + gp	0.1	0.2	0.3	0.5	0.4	0.4	0.3	0.3	0.2	0.5	0.5
iron+cf+fa	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.3	0.2	0.3	0.3
iron + gp + fa	0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.2
cf + gp + fa	0	0	0.1	0.2	0.5	0.2	0.2	0.1	0.1	0.5	0.5
everything	0.6	0.7	0.6	0.6	0.7	0.7	0.6	0.6	0.5	0.7	0.7
iron+cf+fa X2	0.1	0.1	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.3	0.3
less water all	0.3	0.3	0.2	0.4	0.4	0.4	0.4	0.5	0.7	0.6	0.7



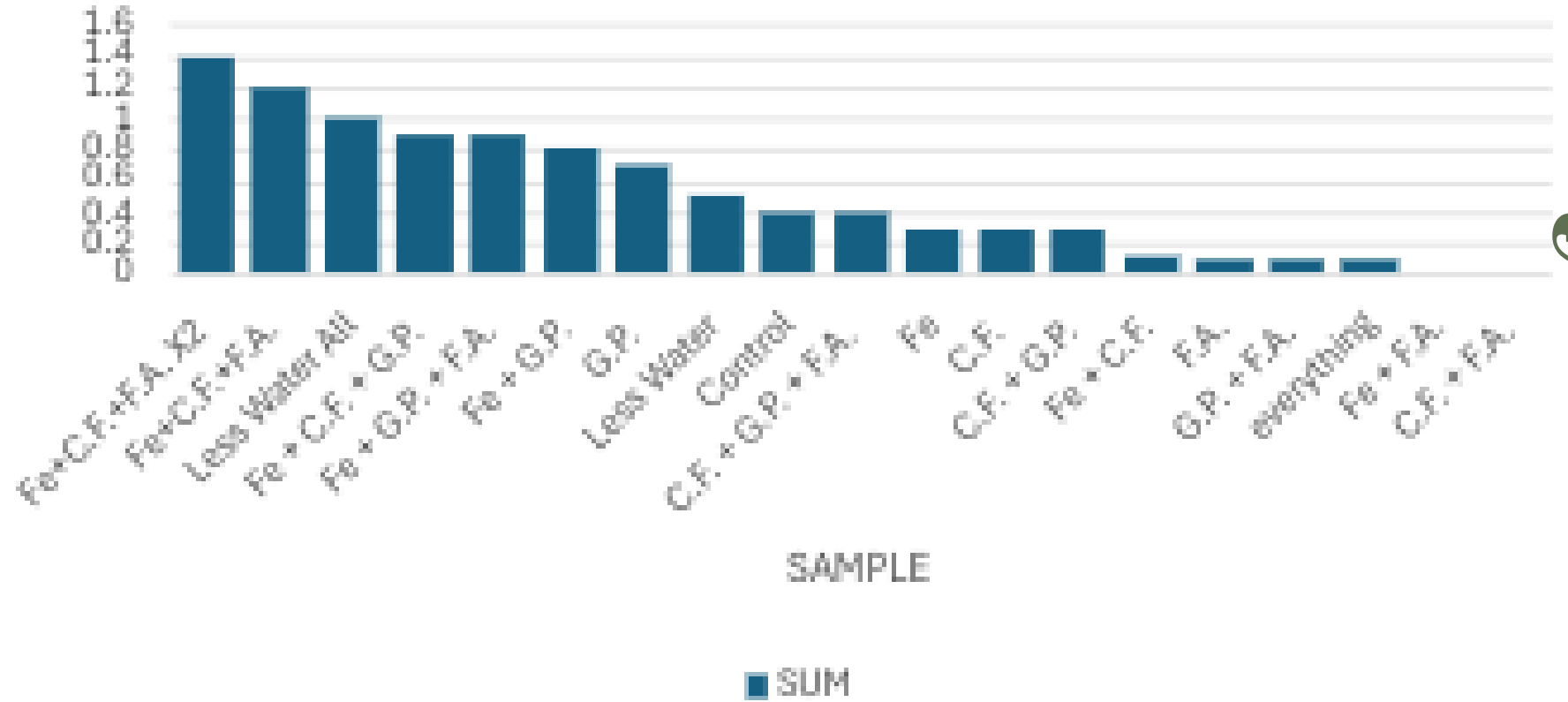
### Heat Lamp Trials without copper ends + cool side of 32

SAMPLE	1	1.5	2	2.5	3	3.5	4	4.5	5	MAX	
control		0.1	0.1	0	0	0	0	0	0	0	0.1
less water		0.3	0.2	0.4	0.2	0.1	0.6	0.4	0.4	0.4	0.6
iron		0	0	0.2	0.2	0.4	0.2	0.4	0.2	0.2	0.4
cf		0.1	0	0	0	0.1	0	0.1	0	0	0.1
gp		0	0.1	0.2	0.1	0.2	0.1	0.2	0.1	0.1	0.2
fa		0.3	0.2	0.3	0.3	0.2	0.3	0.4	0.3	0.5	0.5
iron + cf		0.2	0.1	0.2	0.2	0.3	0.3	0.3	0.2	0.2	0.3
iron + gp		0	0.2	0.1	0.1	0.1	0.1	0.2	0.3	0.4	0.4
iron + fa		0.1	0.2	0.2	0.2	0	0	0	0	0	0
cf + gp		0.3	0.2	0.2	0.1	0.1	0.7	1.1	0.3	0	1.1
cf + fa		0.5	0.7	0.7	0.6	0.6	0.6	0.6	0.6	0.6	0.7
gp + fa		0.1	0.1	0.2	0.4	0.5	0.6	0.3	0.4	0.5	0.6
iron + cf + gp		0.1	0.2	0.3	0.5	0.4	0.4	0.3	0.3	0.2	0.5
iron+cf+fa		0.1	0.1	0.2	0.1	0.1	0.1	0.2	0.3	0.2	0.3
iron + gp + fa		0.1	0.1	0.2	0.1	0.1	0.2	0.1	0.1	0.1	0.2
cf + gp + fa		0	0	0.1	0.2	0.5	0.2	0.2	0.1	0.1	0.5
everything		0.6	0.7	0.6	0.6	0.7	0.7	0.6	0.6	0.5	0.7
iron+cf+fa X2		0.1	0.1	0.2	0.3	0.3	0.2	0.2	0.2	0.3	0.3
less water all		0.3	0.3	0.2	0.4	0.4	0.4	0.5	0.7	0.6	0.7

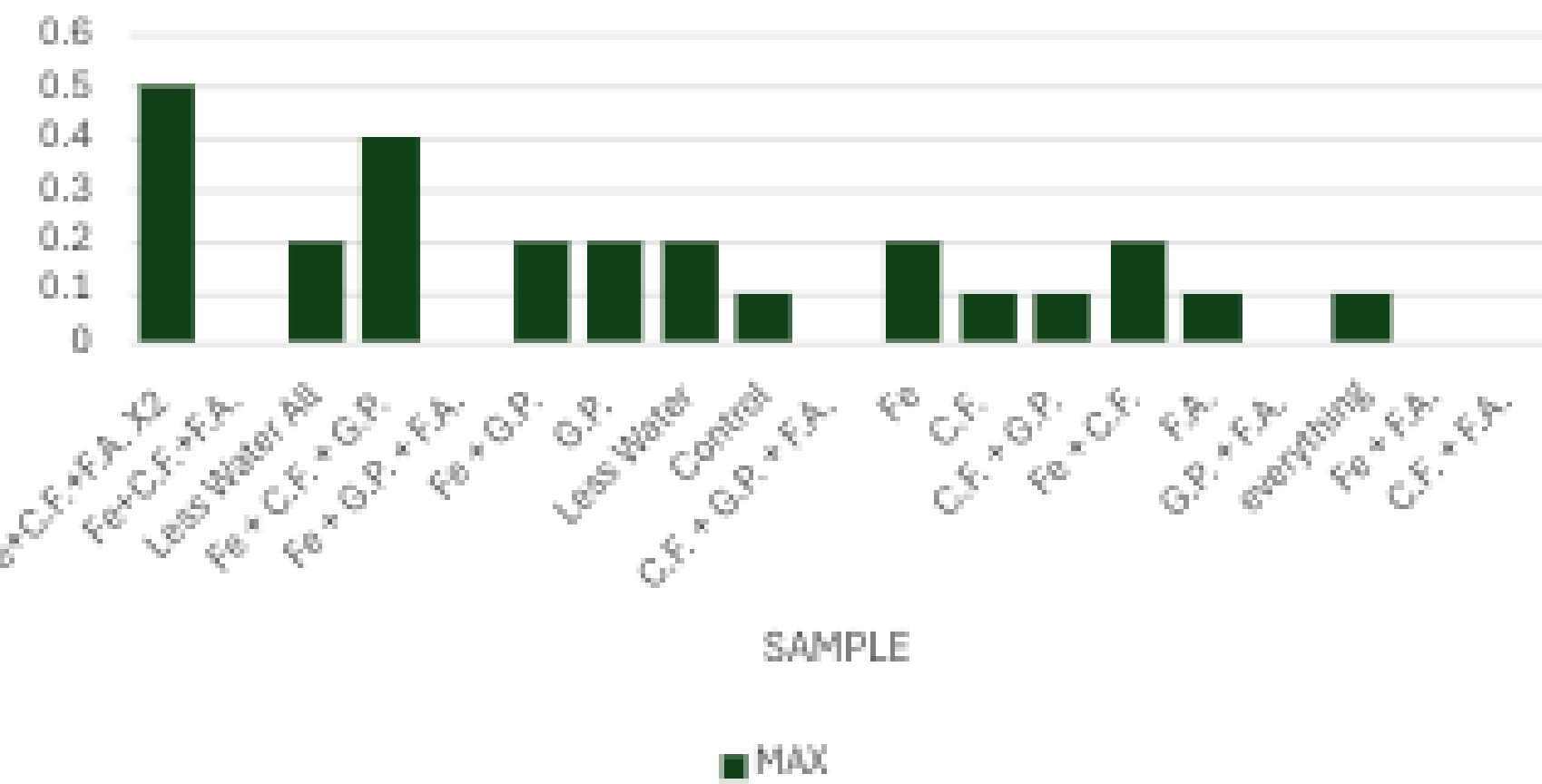
mV Produced by Each Sample at Various Time Points in the C72 Trials



Total mV Produced by Each Sample in the C72 Trials



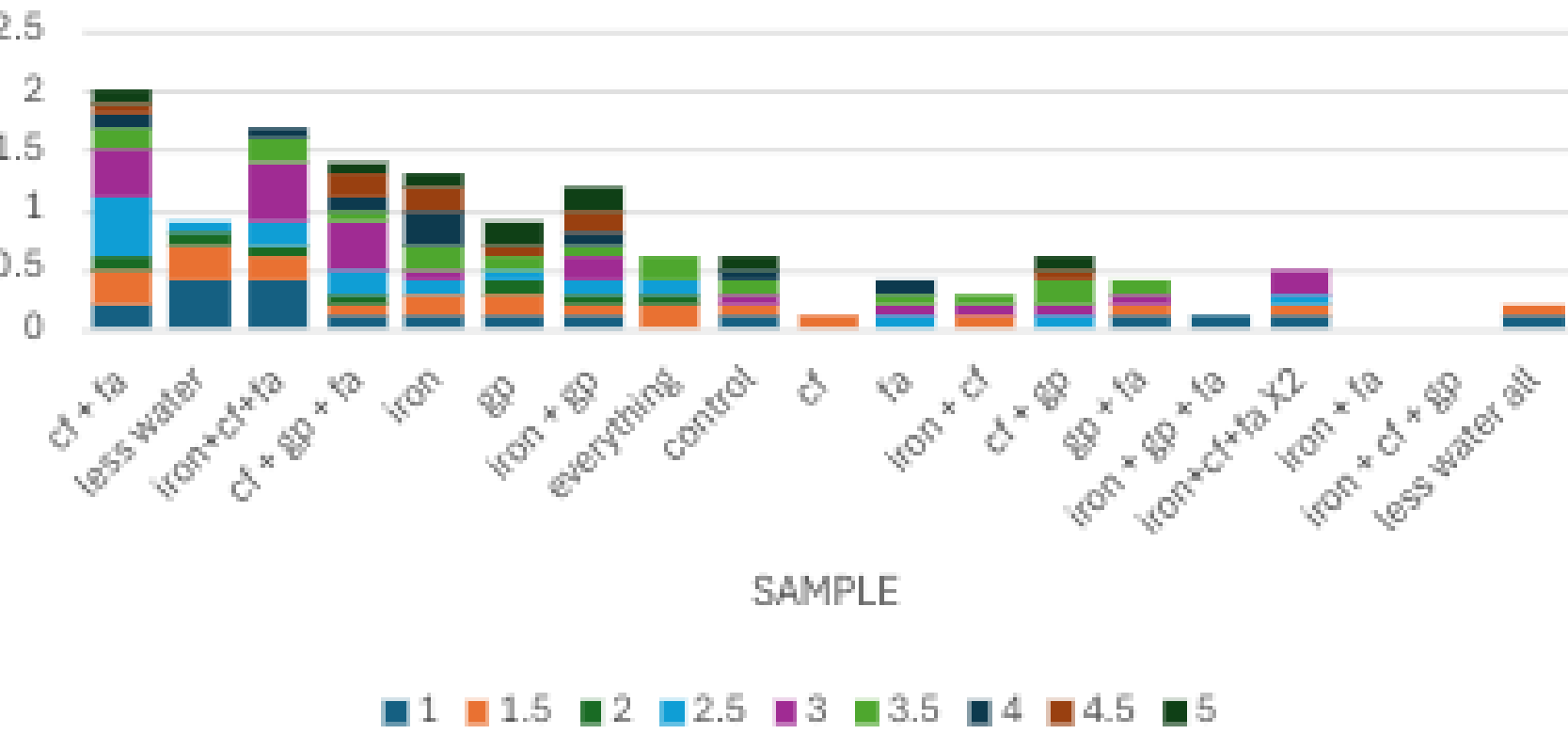
Maximum mV Produced by Each Sample in the C72 Trials



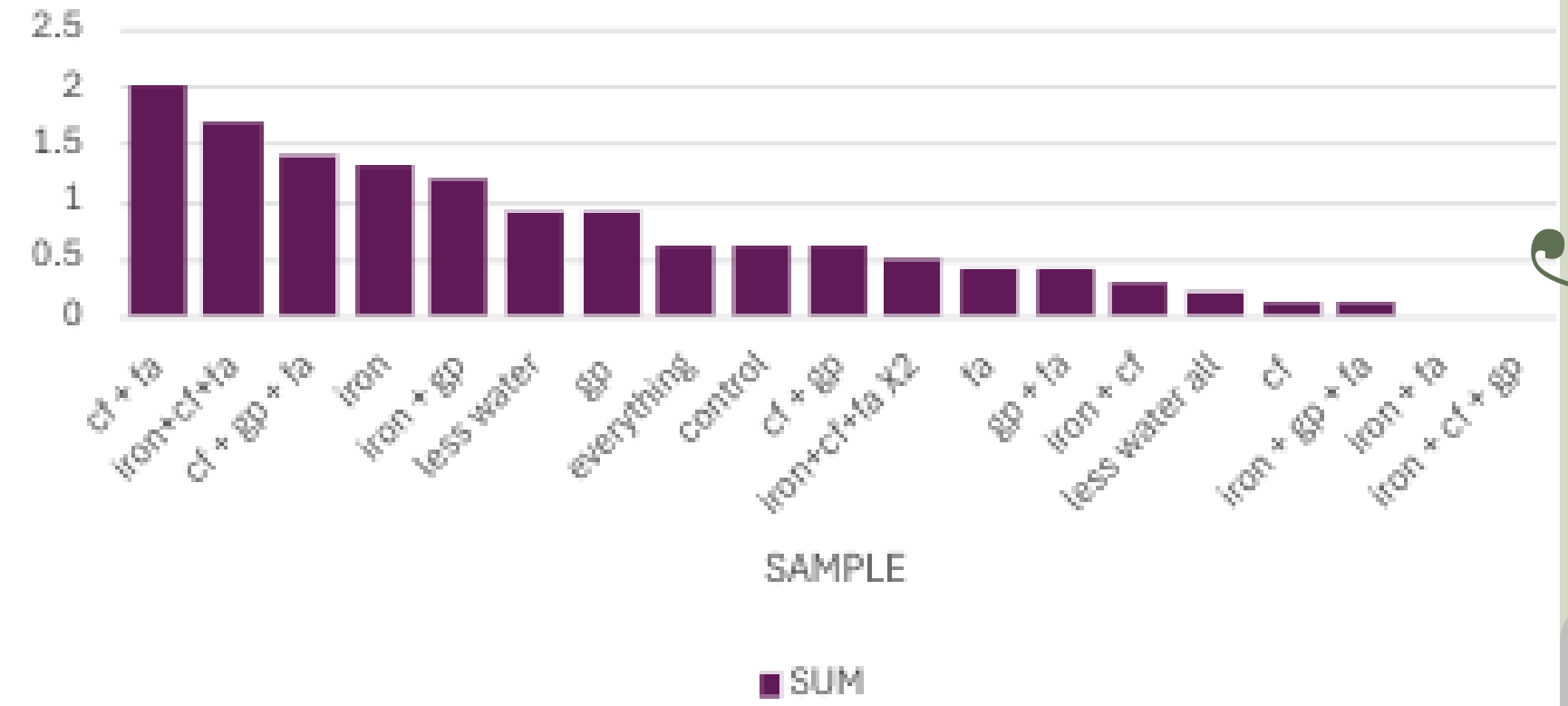
## Fe+C.F.+F.A. x2 in C72

- Highest Maximum mV
- Highest Total mV produced

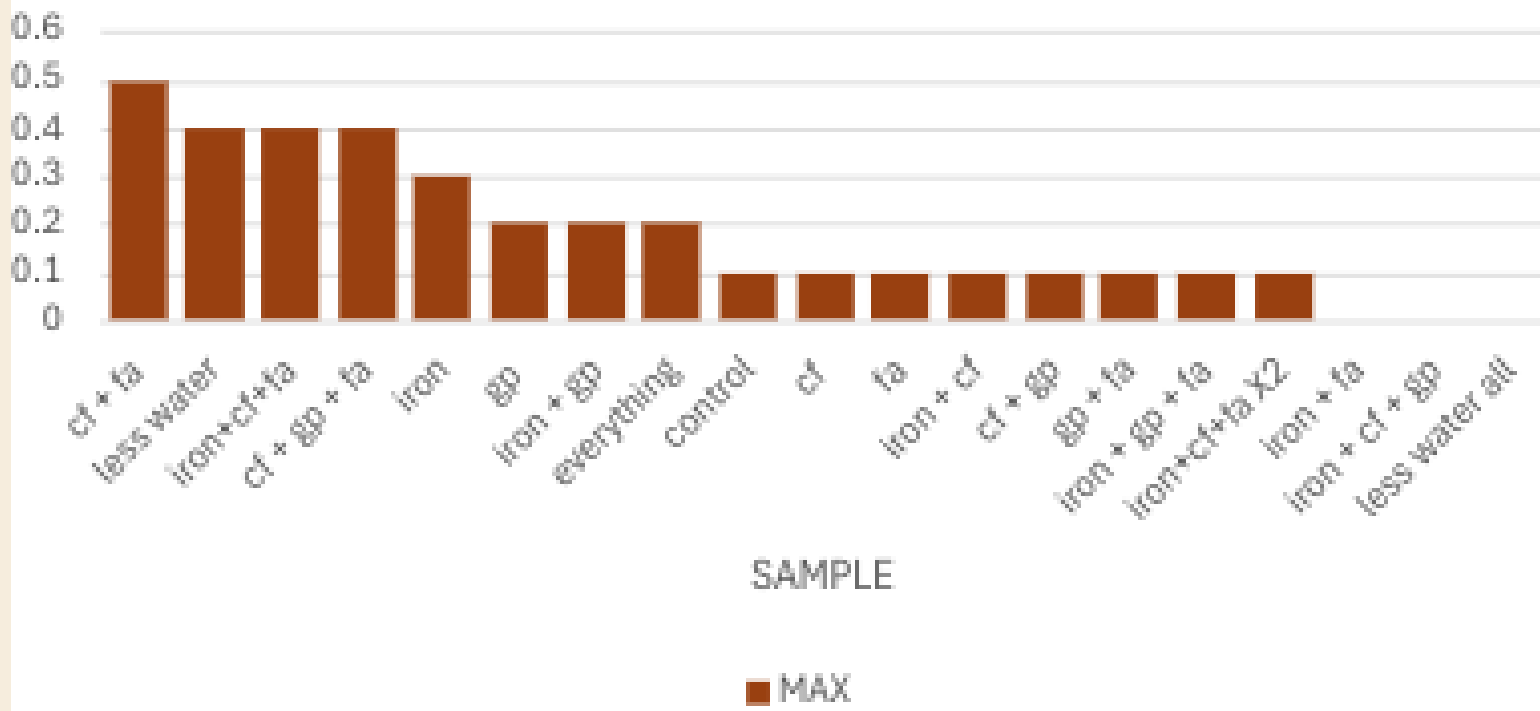
mV Produced by Each Sample at Various Time Points in the C32 Trials



Total mV Produced by Each Sample in the C32 Trials



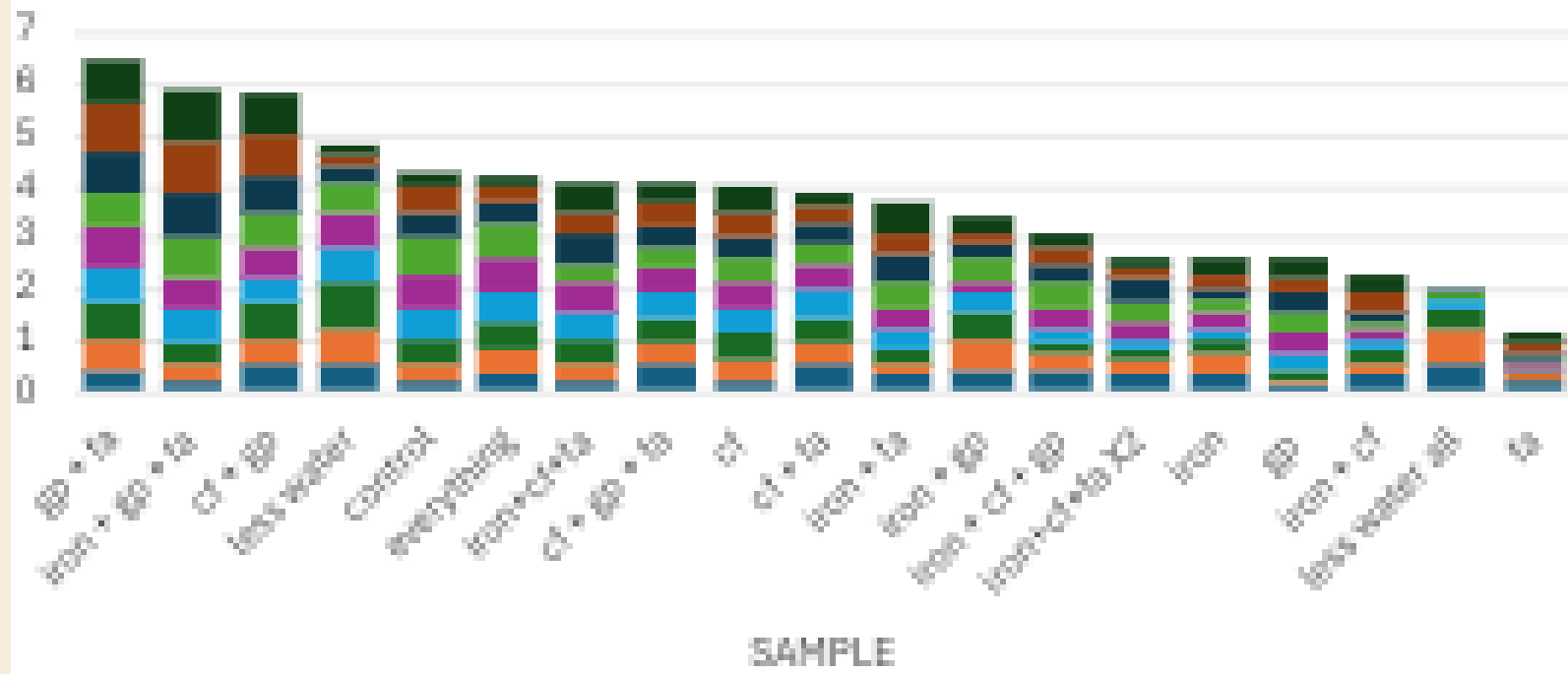
Maximum mV Produced by Each Sample in the C32 Trials



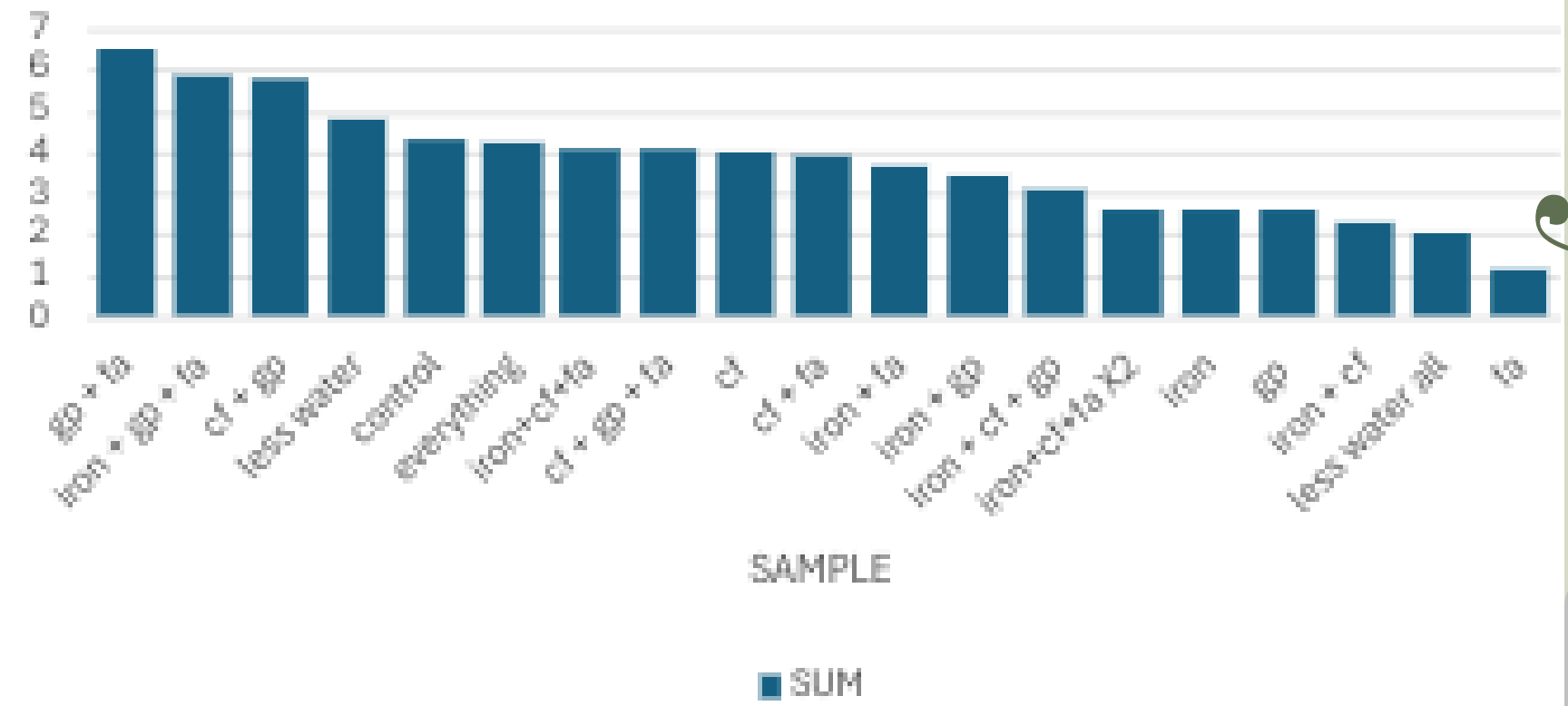
## C.F.+E.A. in C32

- Highest Maximum mV
- Highest Total mV produced

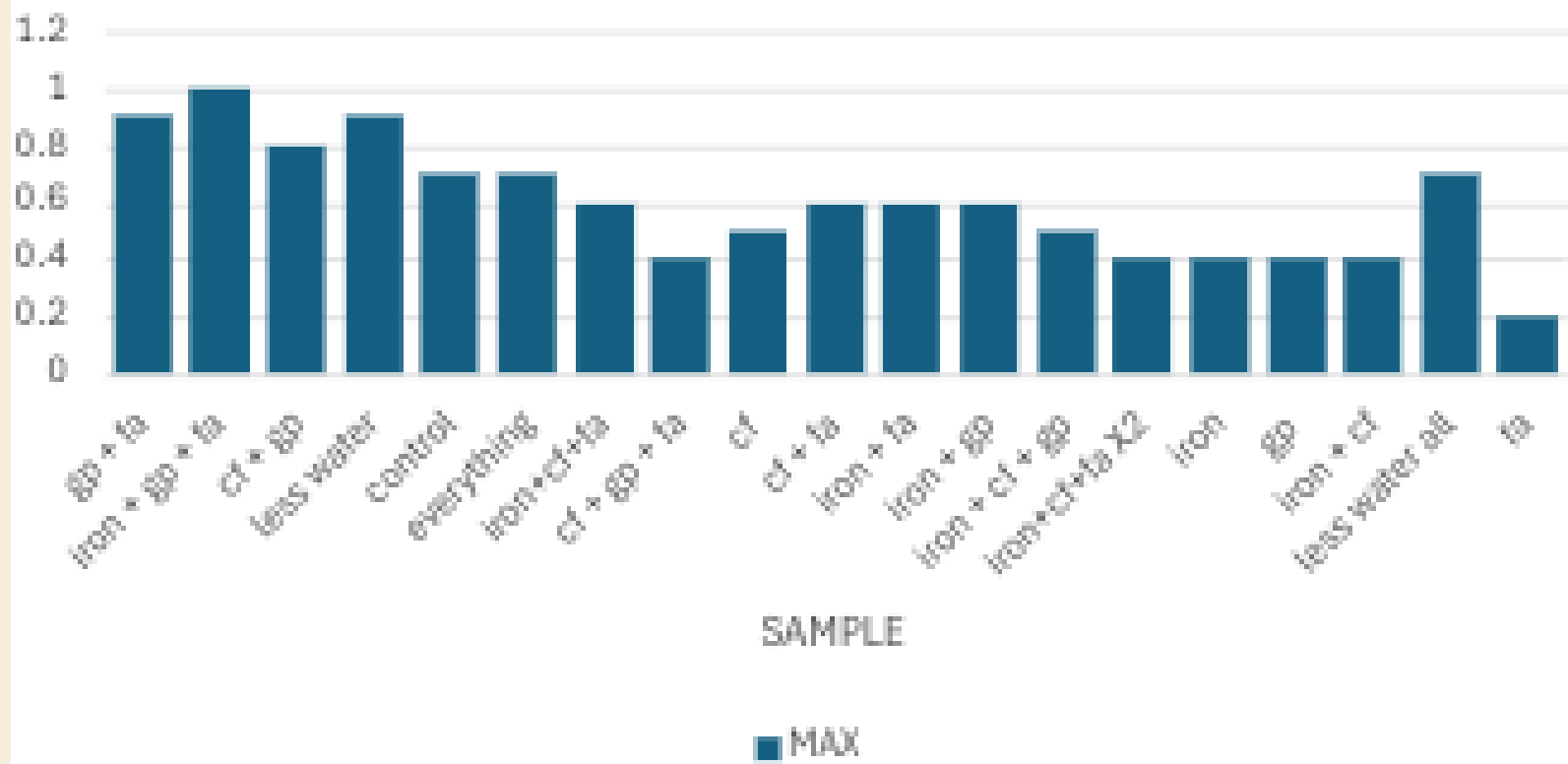
mV Produced by Each Sample at Various Time Points in the N72 Trials



Total mV Produced by Each Sample in the N72 Trials



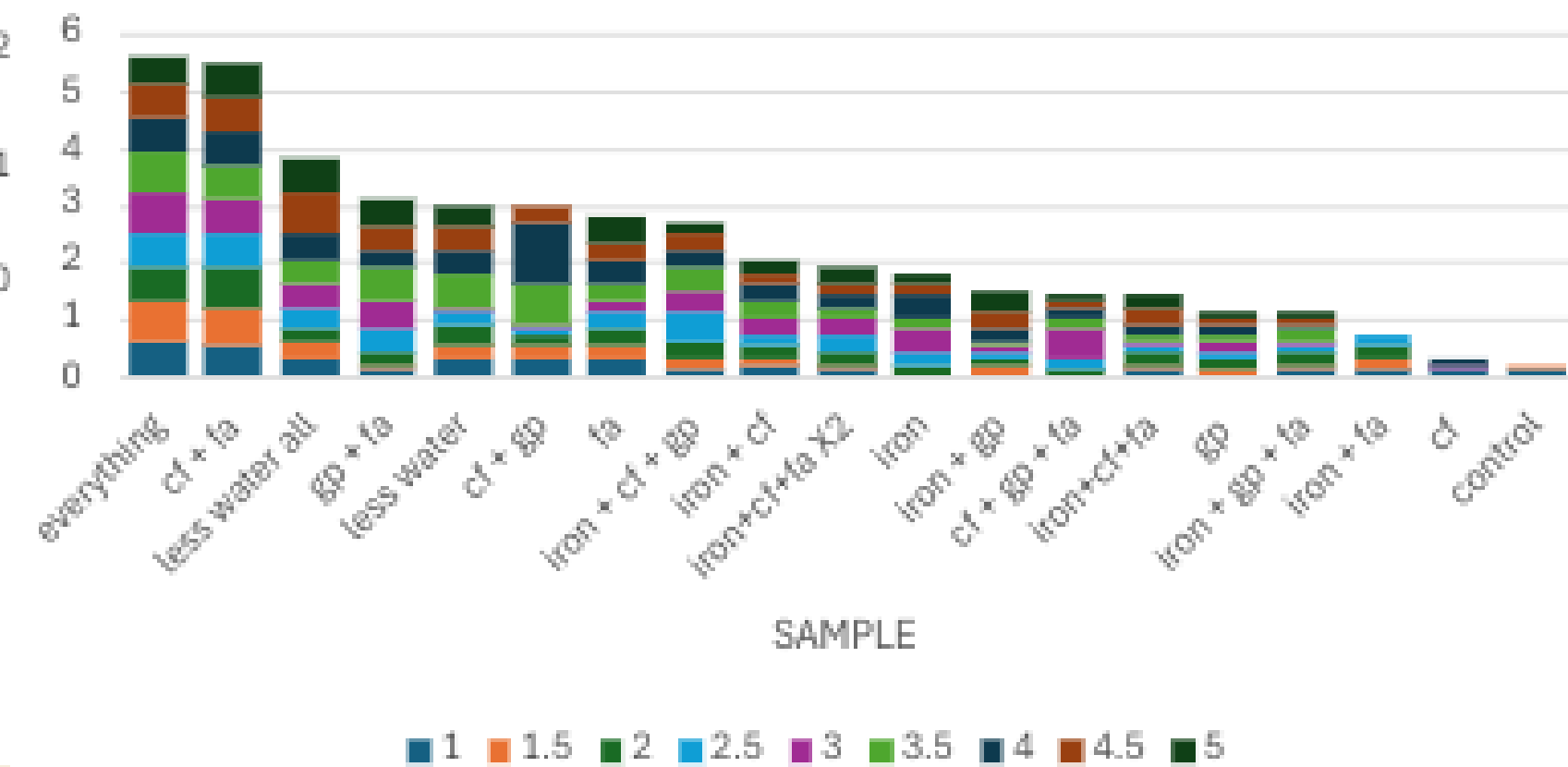
Maximum mV Produced by Each Sample in the N72 Trials



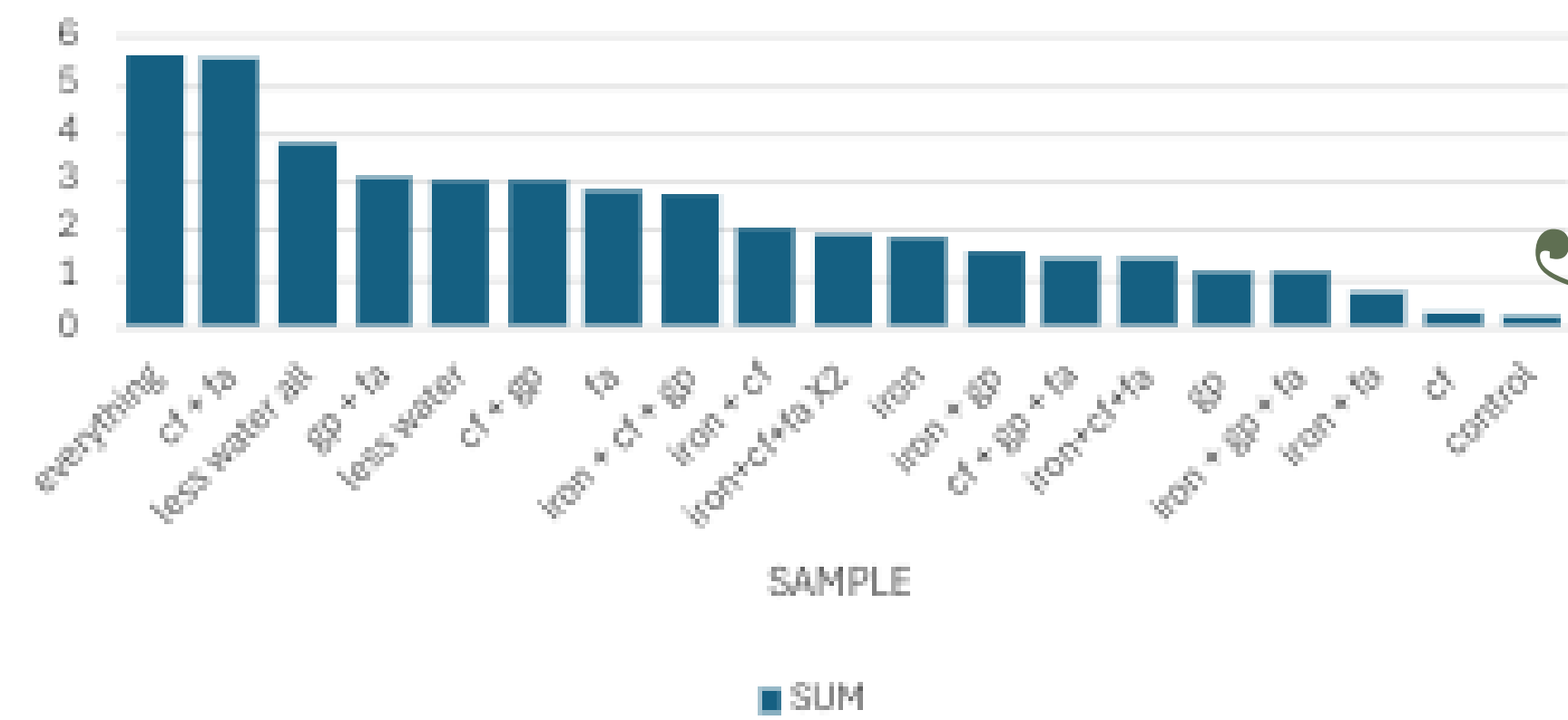
## G.P+F.A. in N72

- Highest Total mV produced
- Fe+G.P.+F.A. had the highest Maximum mV

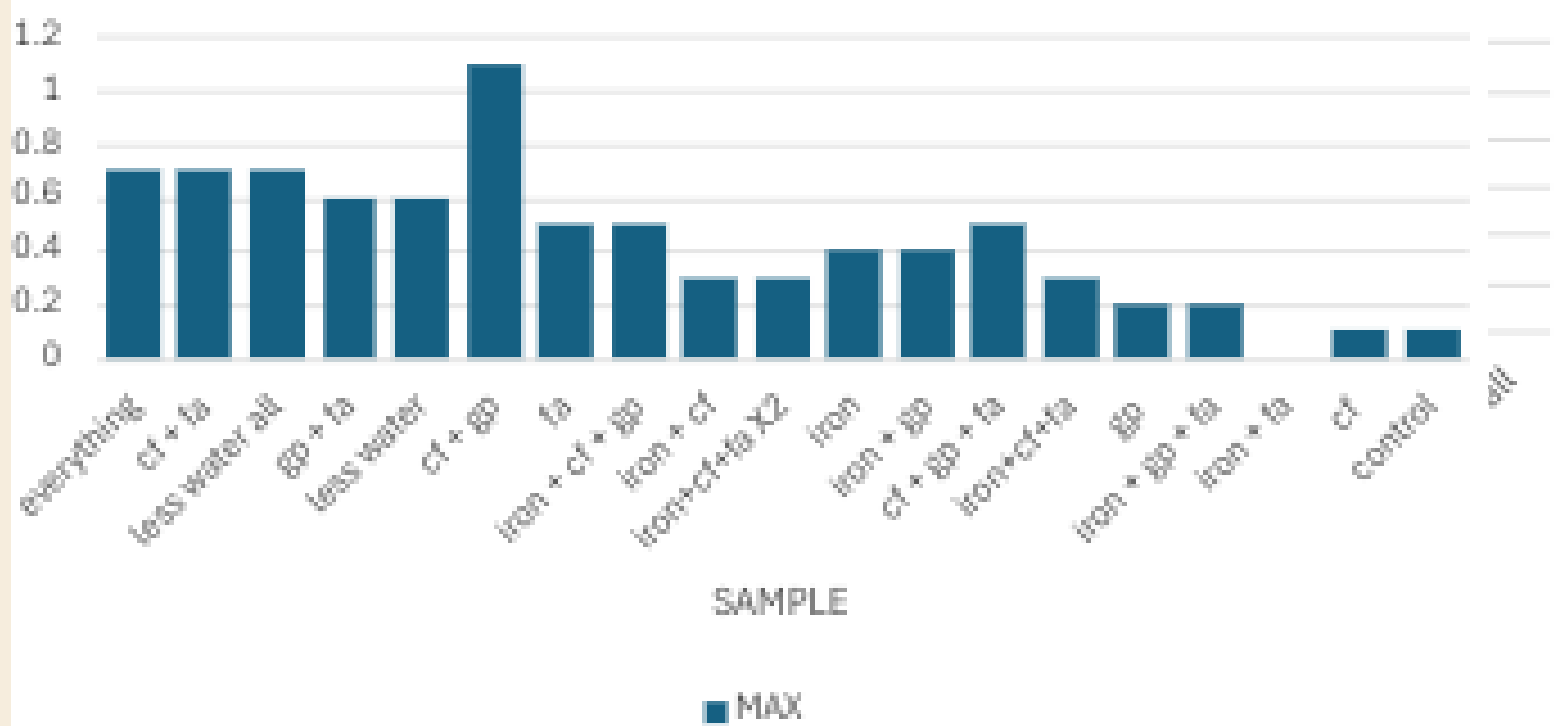
mV Produced by Each Sample at Various Time Points in the N32 Trials



Total mV Produced by Each Sample in the N32 Trials



Maximum mV Produced by Each Sample in the N32 Trials

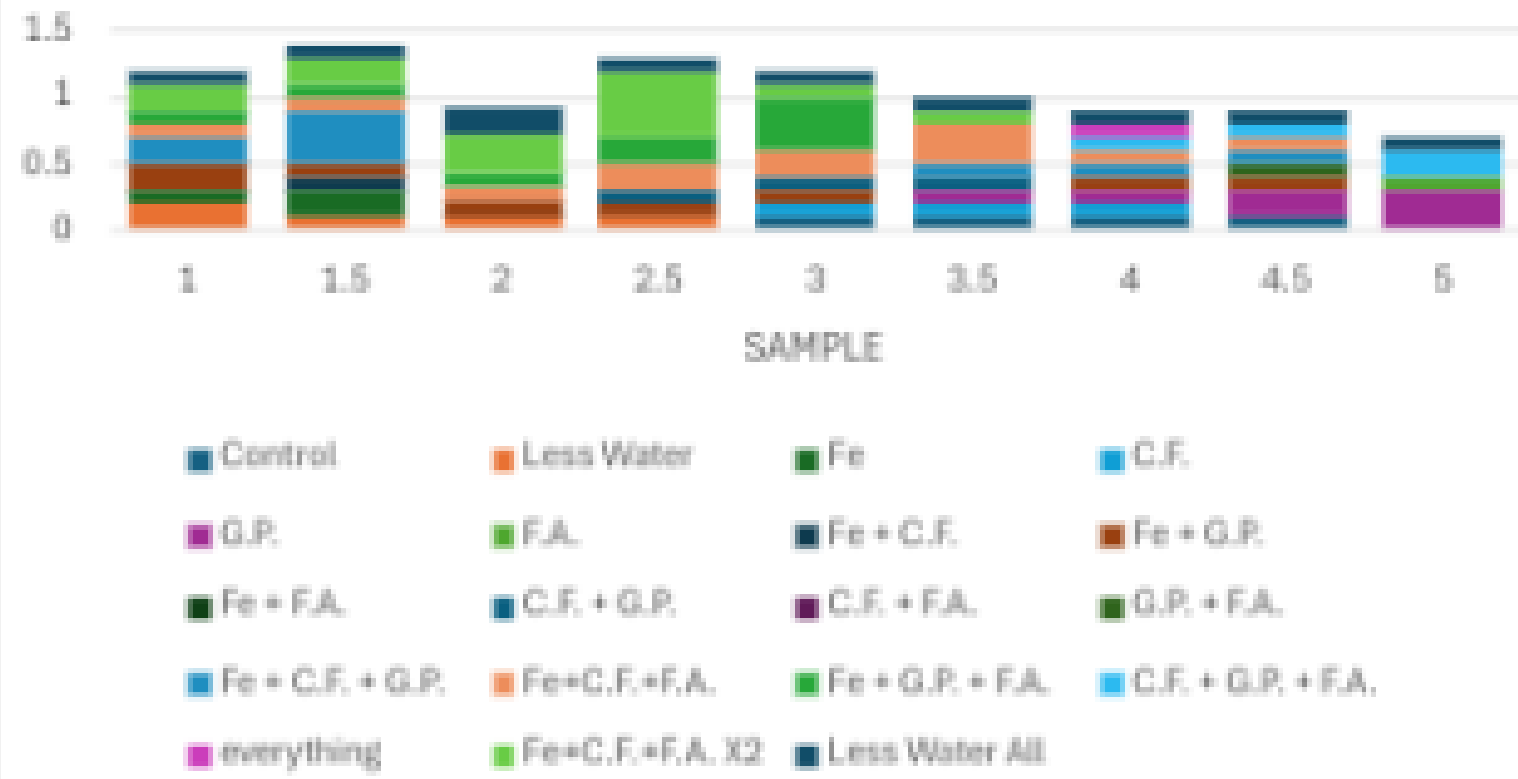


**everything in N32**

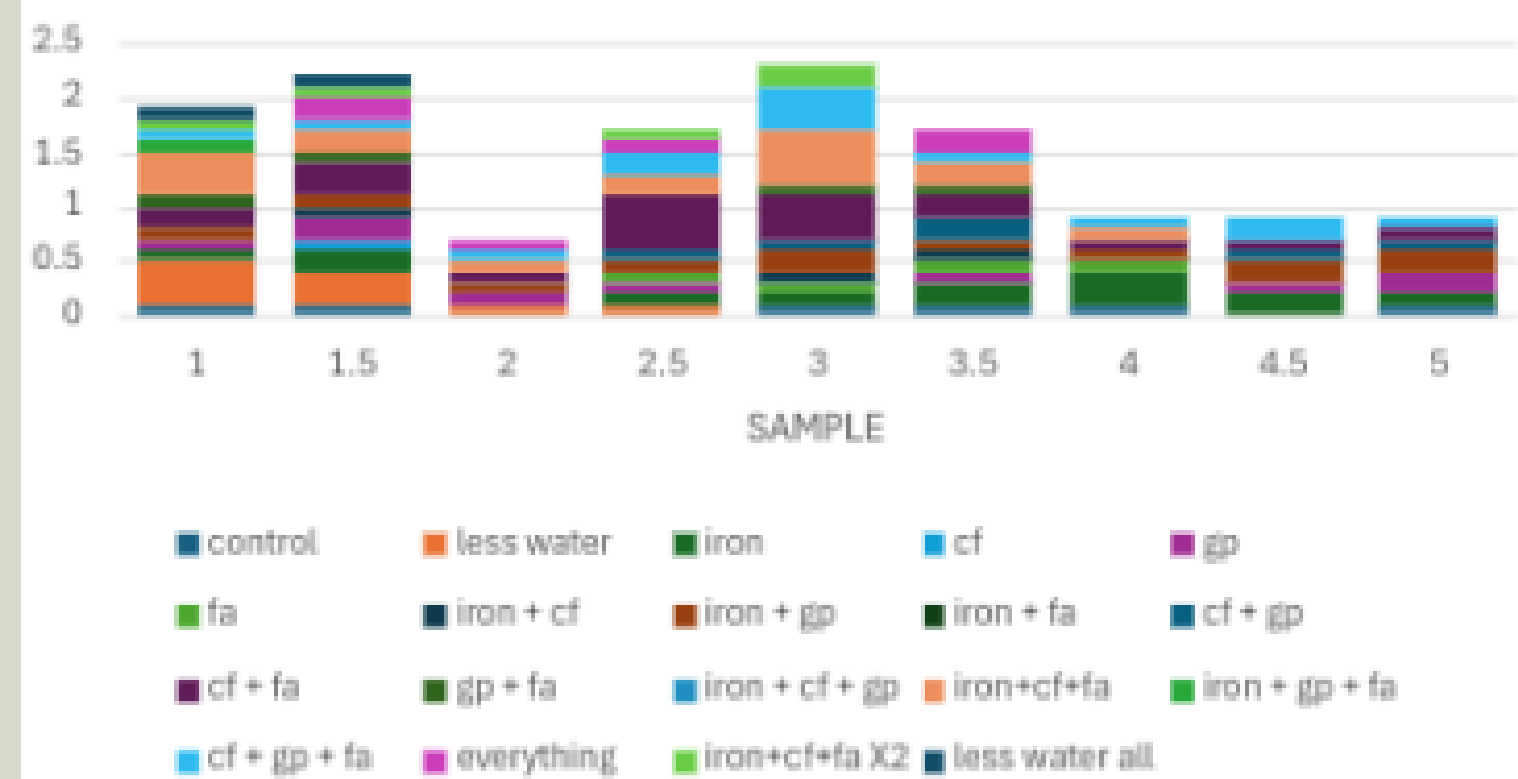
- Highest Total mV produced
- C.F. + G.P. has the maximum mV



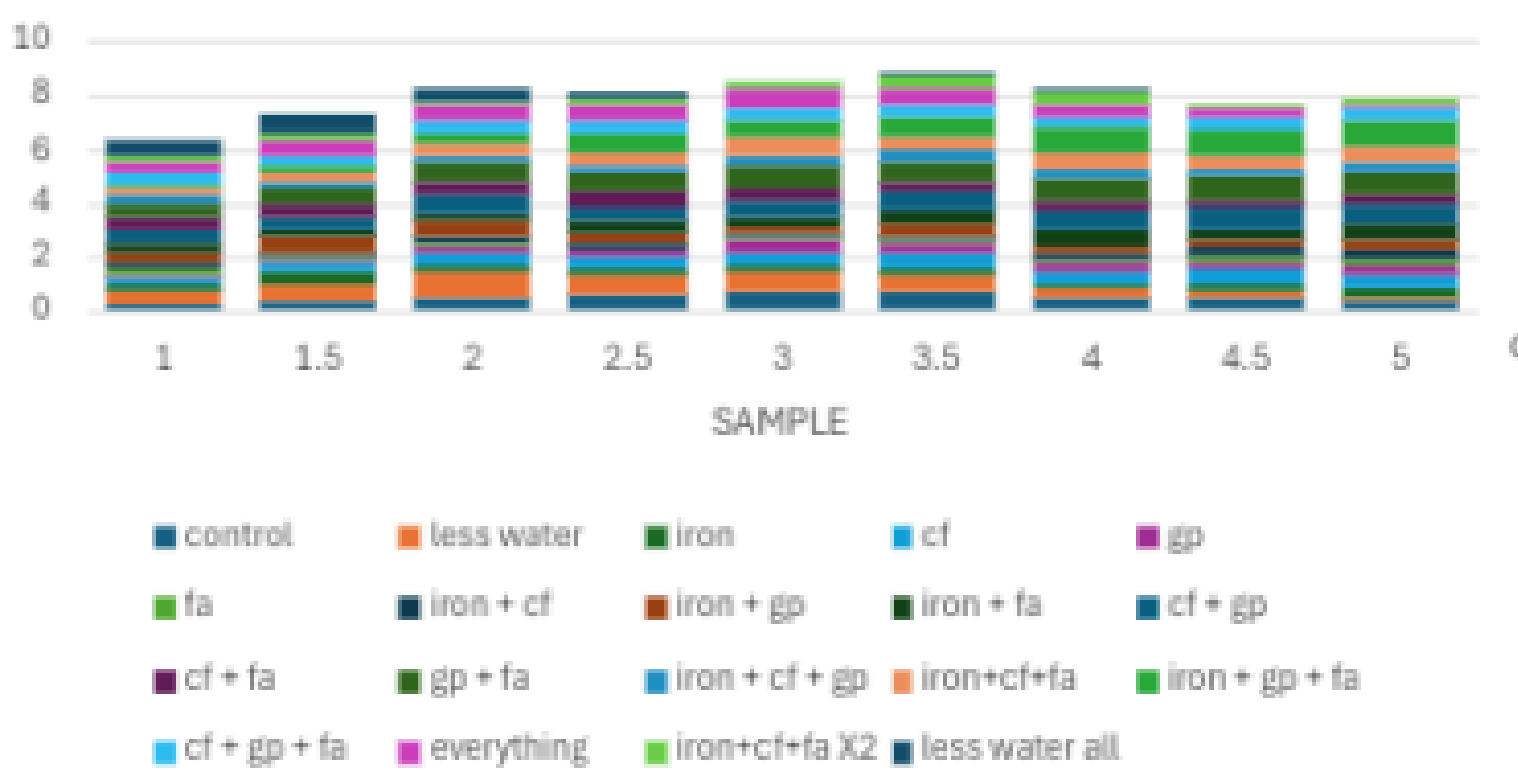
### C72 mV Produced Over Time



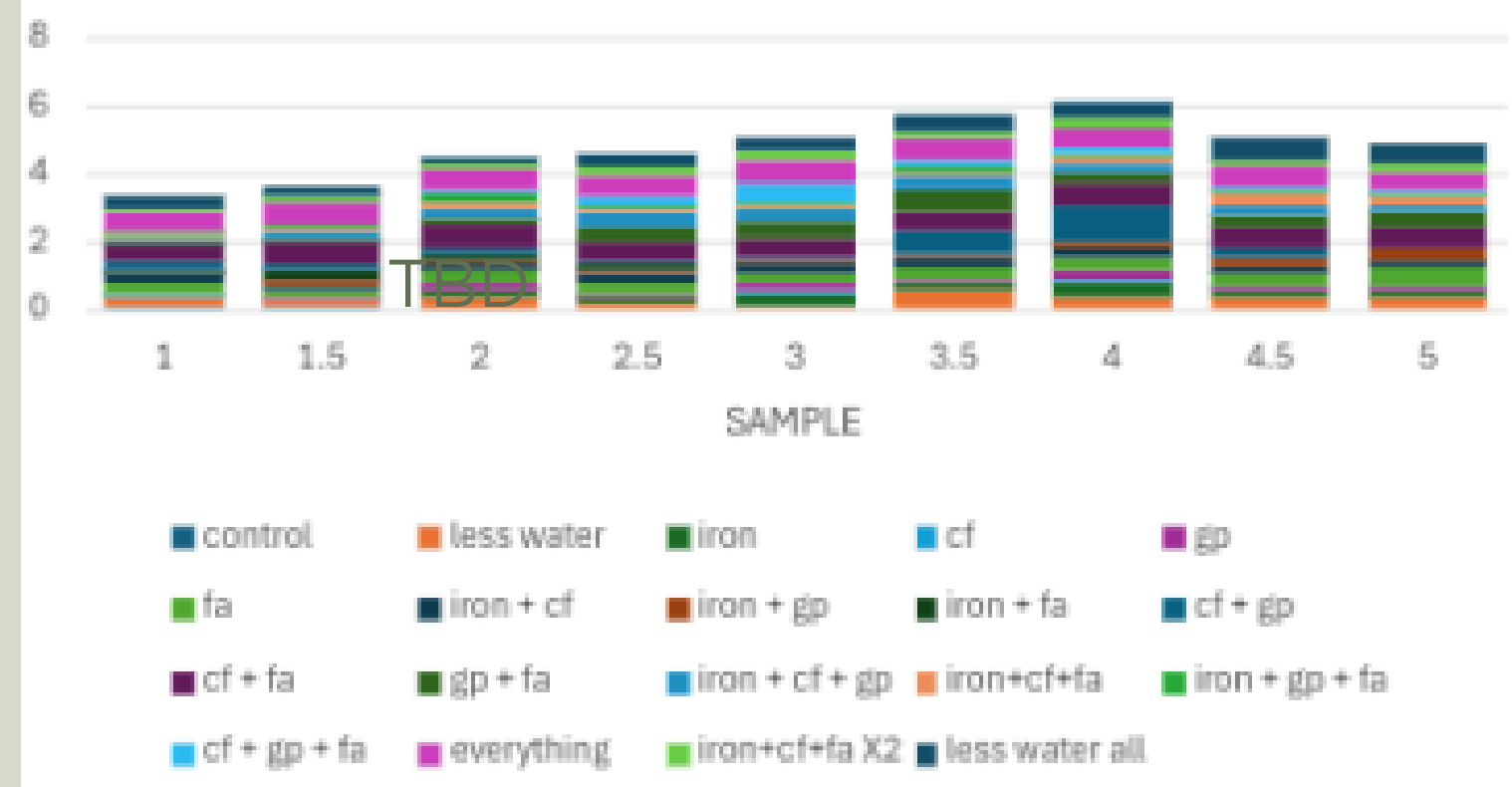
### C32 mV Produced Over Time



### N72 mV Produced Over Time



### N32 mV Produced Over Time



# Data Analysis

C72

C32

N72

N32

Ultimately, throughout all four trial sets, fly ash seemed most effective for generating voltage when paired with another conductor. Carbon fiber was found to be the most helpful, although graphite powder + fly ash was also optimal in the C32 trial.

# Cost Effectiveness for each sample

Item	Total Cost	Amount/sample	\$\$\$/sample
Cement	80lb for \$5.96	60g	\$0.01
Water	1000gal for \$2	6.5tsp	\$0.00
Iron Oxide (iron)	10oz for \$11.99	1tsp	\$0.20
Carbon Fiber (cf)	1lb for \$40.48	1tsp	\$0.88
Graphite Powder (gp)	4oz for \$9.99	1tsp	\$0.42
Fly Ash (fa)	1/4gal for \$24.09	1tsp	\$0.13
Superplastisizer	8oz for \$12.59	1tsp	\$0.26

Sample	Cost
control	\$0.27
less water	\$0.27
iron	\$0.47
cf	\$1.15
gp	\$0.69
fa	\$0.40
iron + cf	\$1.35
iron + gp	\$0.89
iron + fa	\$0.60
cf + gp	\$1.57
cf + fa	\$1.28
gp + fa	\$0.82
iron + cf + gp	\$1.77
iron+cf+fa	\$1.48
iron + gp + fa	\$1.02
cf + gp + fa	\$1.70
everything	\$1.90
iron+cf+fa (v2)	\$1.48
less water all	\$1.90

^^Determining cost per sample ->

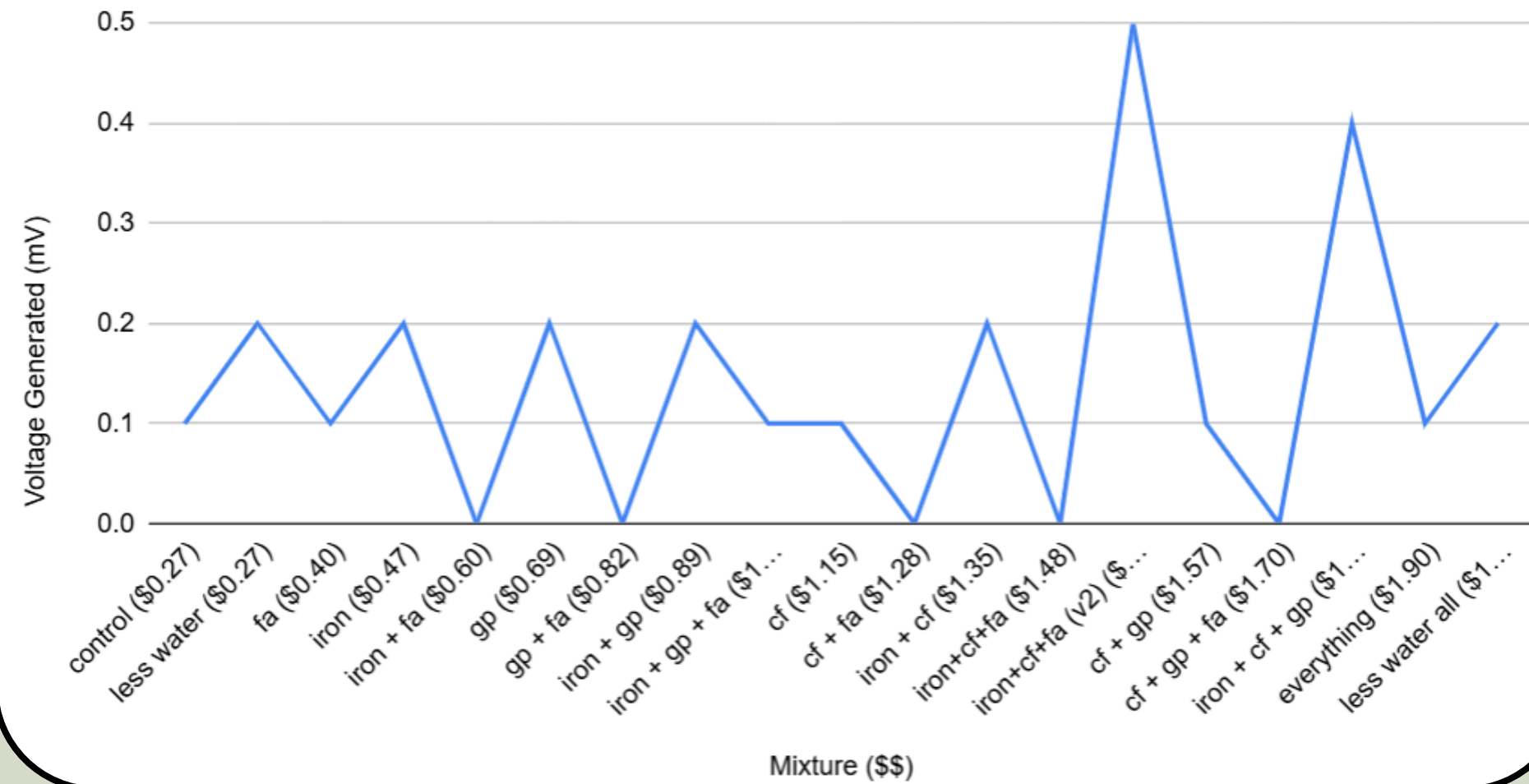
# Cost vs Efficiency

C32 and C72



Voltage Generated (mV) vs. Mixture (\$\$)

With Copper Caps at 72F Trials



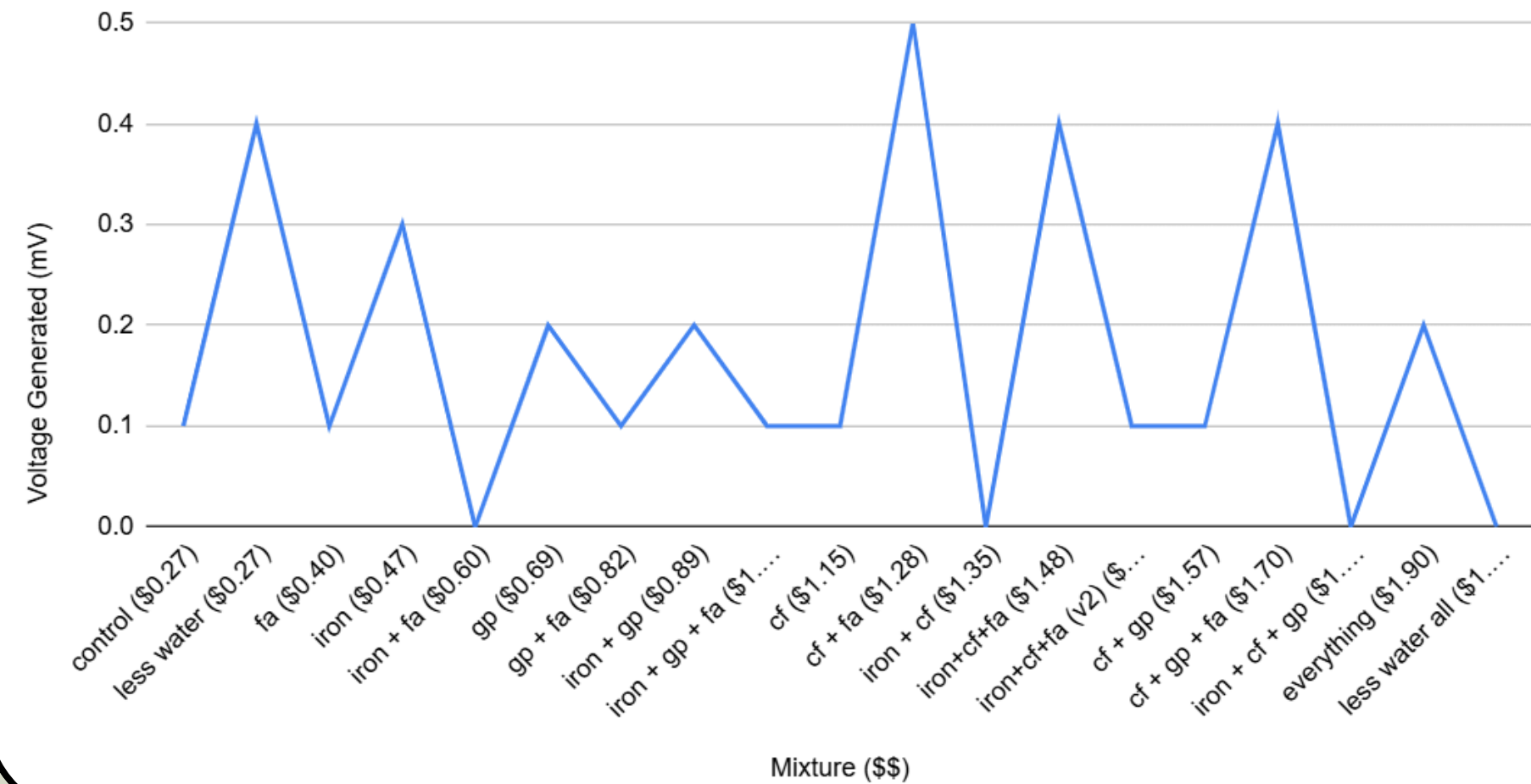
C72 trials

Maximum Voltage Generated vs Mixture and cost

C32 trials

Voltage Generated (mV) vs. Mixture (\$\$)

With Copper Caps at 32F Trials



# Cost vs Efficiency

N32 and N72

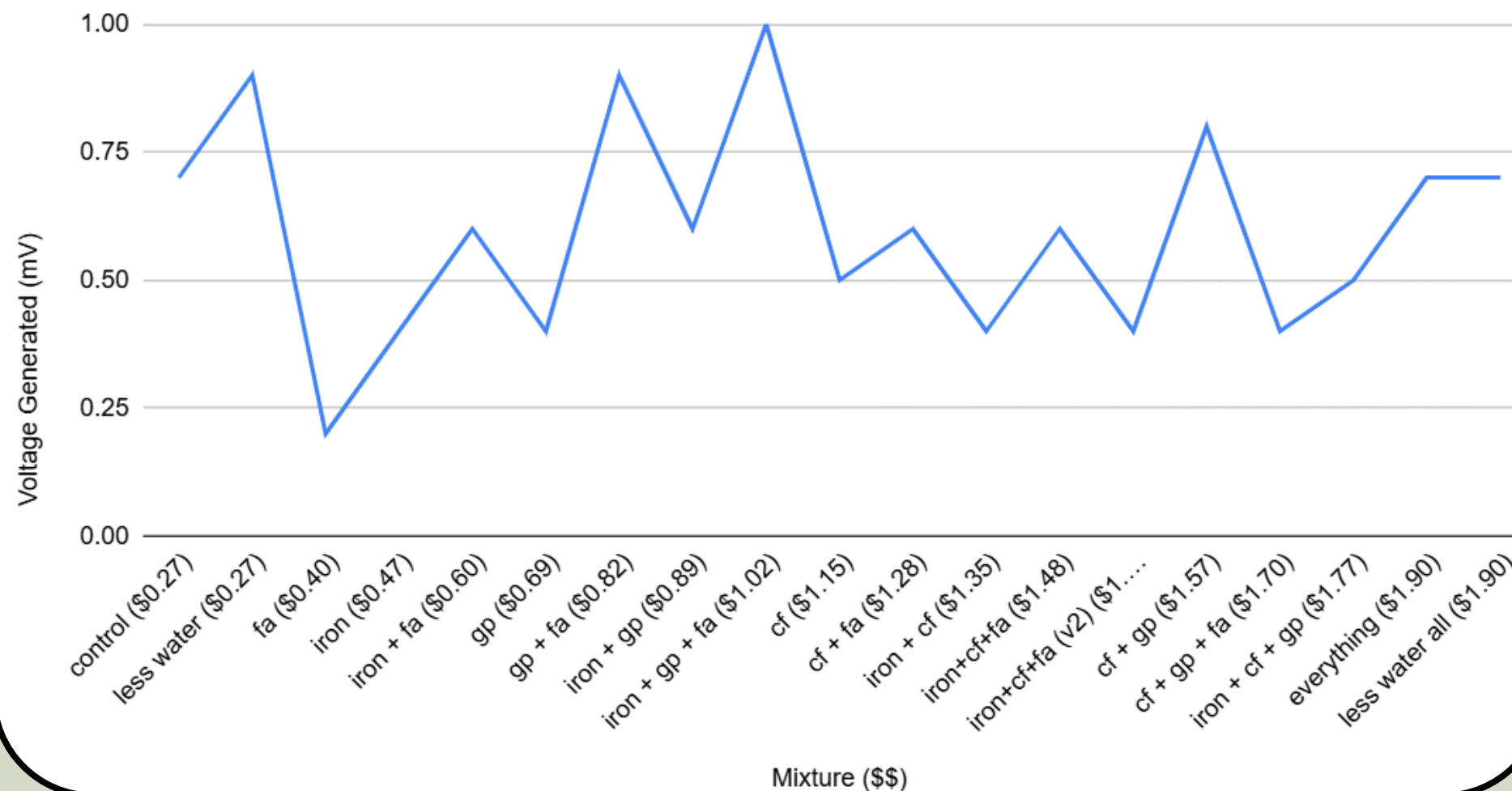


## Maximum Voltage Generated vs Mixture and cost

N72 trials

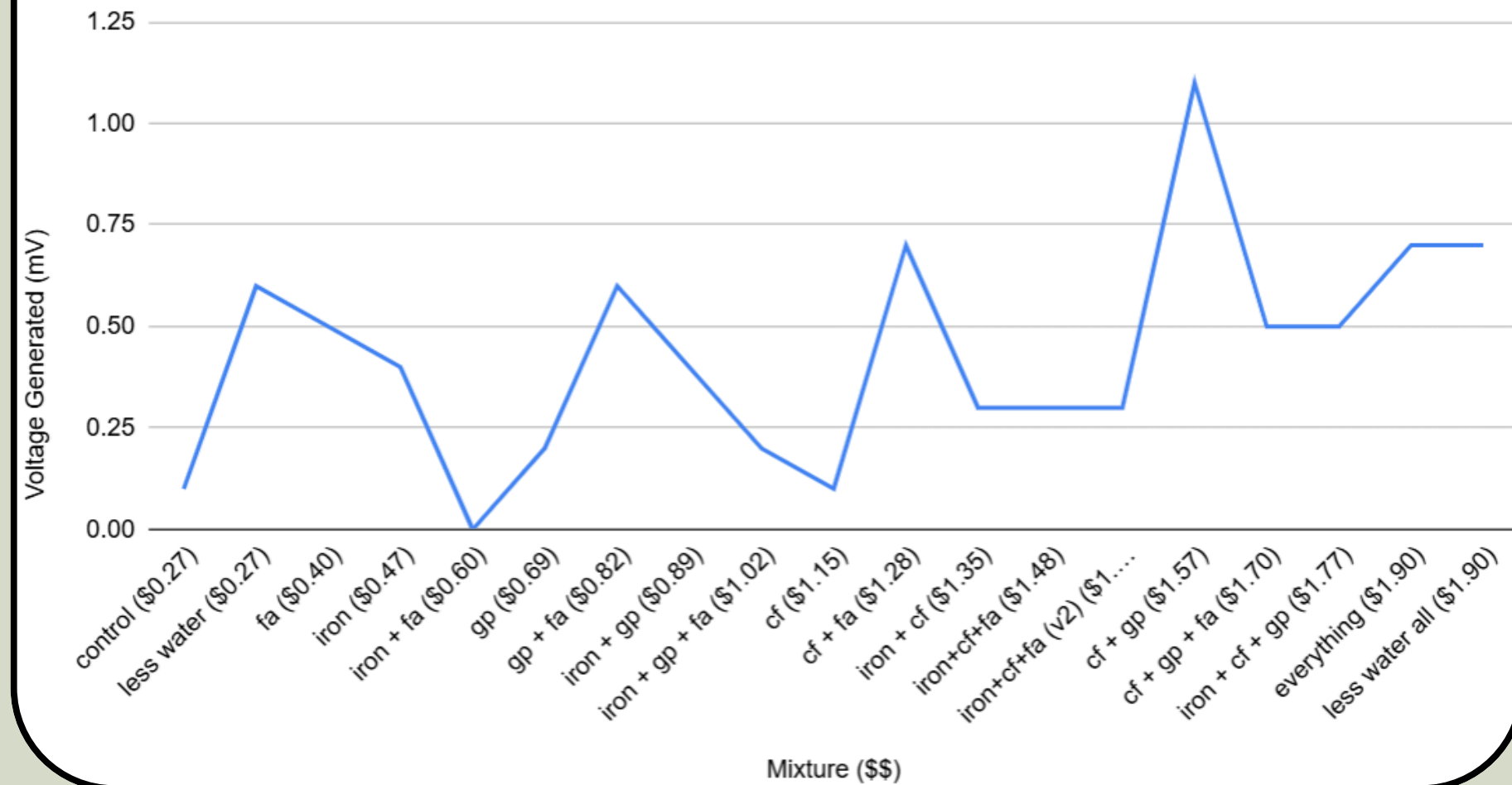
Voltage Generated (mV) vs. Mixture (\$\$)

Without Copper Caps at 72F Trials



Voltage Generated (mV) vs. Mixture (\$\$)

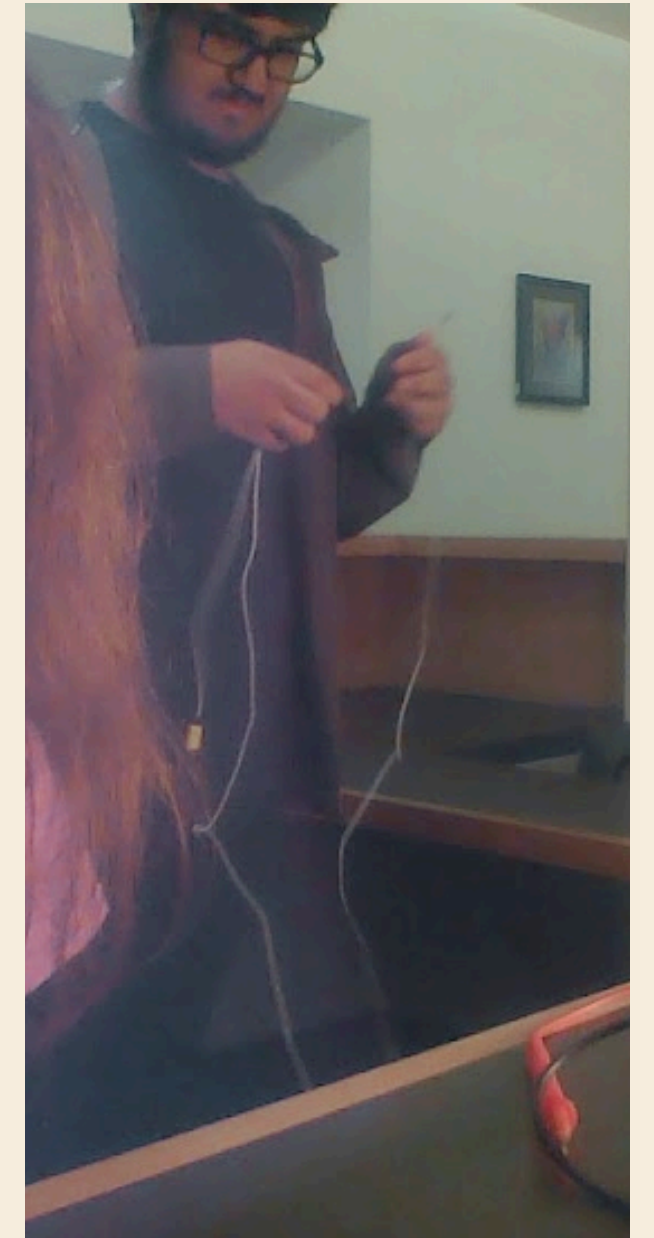
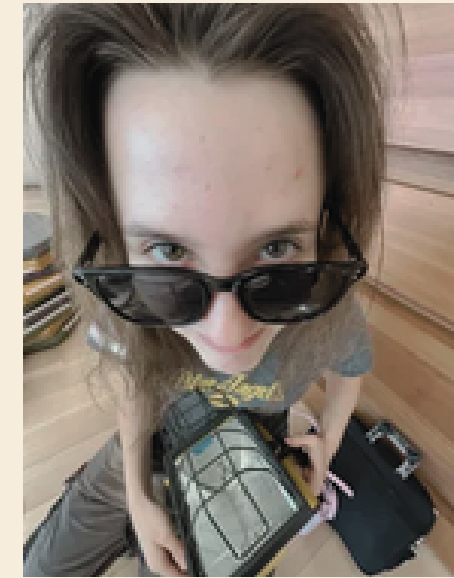
Without Copper Caps at 32F Trials



N32 trials



# Research Photos



# Research...

...fucking shit the multimeter melted from 24 V and sent sparks flying tf

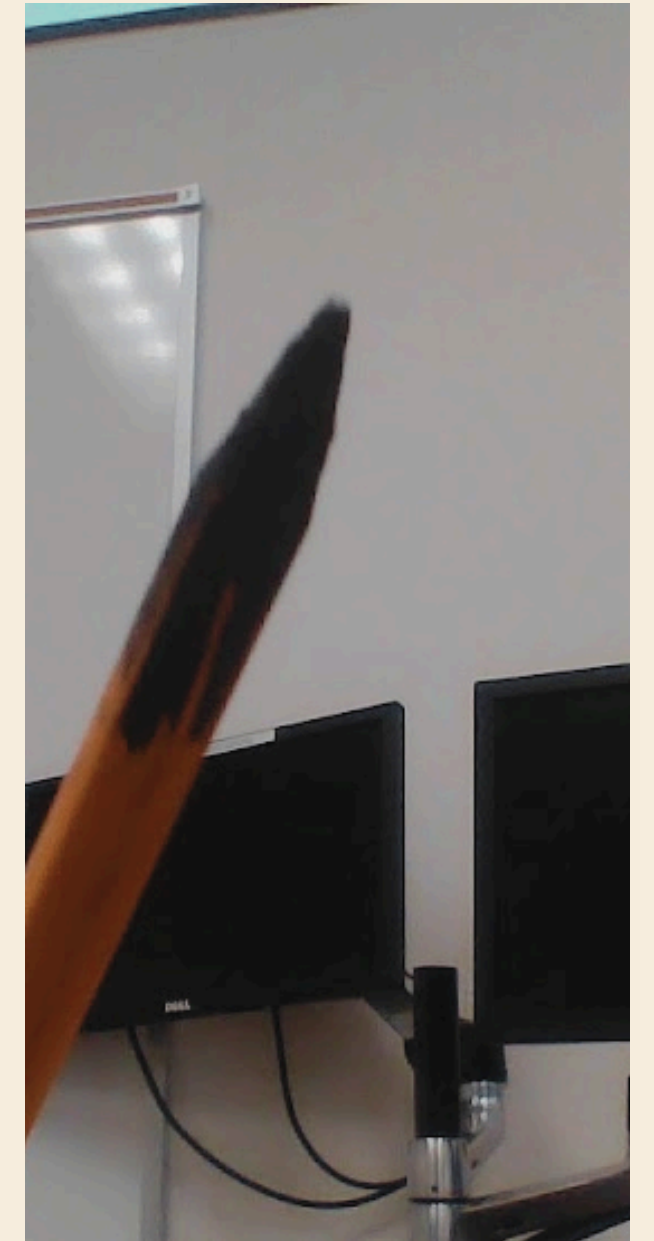


...g's very wrong"-Troy

...ieve you almost tried to kill me"- Maddy

..."-Ian

...meter was definitely not working before"-Troy





**Thank You**