BE-SATED: Building Energy Storage At The Edges of Demand

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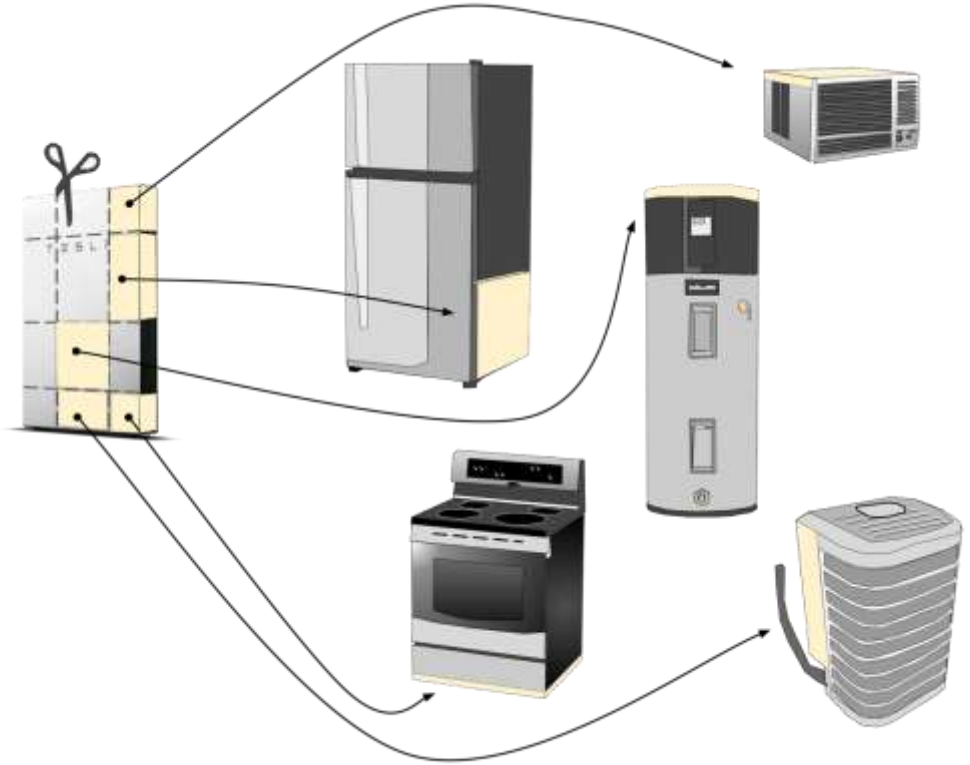
Project Summary

Objective and outcome

Develop and validate battery-integrated appliances, enabling residential battery storage at significantly lower costs per kilowatt-hour than other options, and provide the potential to utilize a 120V electrical outlet without requiring home electrical service upgrades. This effort will also increase electrical appliance cost by no more than 25%.



Team and Partners

Otherlab

CHANNING STREET 29 COPPER COMPANY

Stats

Performance Period: October 2020- April 2024

DOE budget: $2,210,992 Cost Share: $552,748

Milestone 1: Appliance based demand response at TOU

Milestone 2: Acceptance testing in line with cert standards

Milestone 3: Iteration, Deployment, and Certification testing

Problem

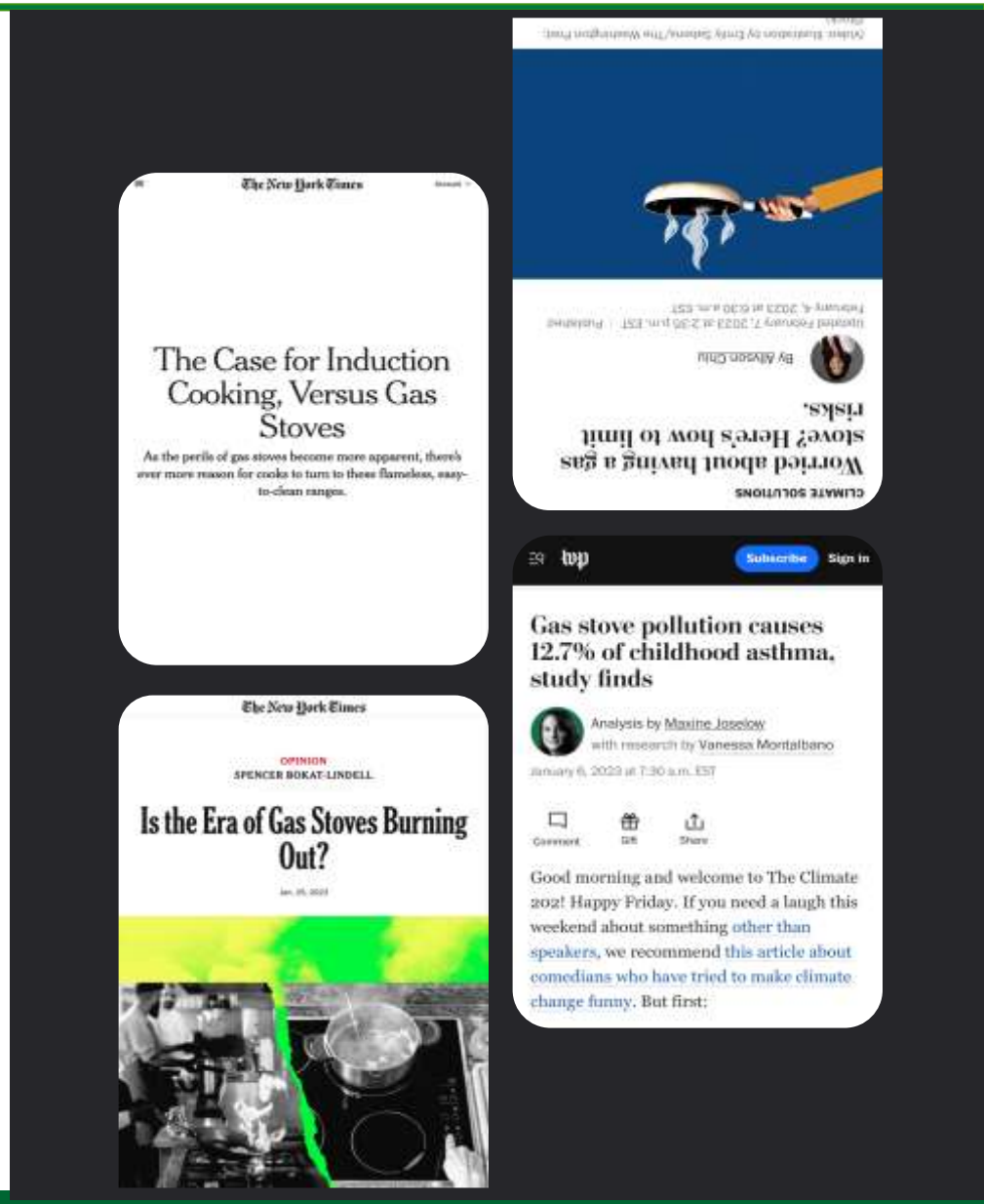

There are half a billion fossil fuel burning machines in homes in the US. They all need to be retired in the next 25 years.

Problem Solving

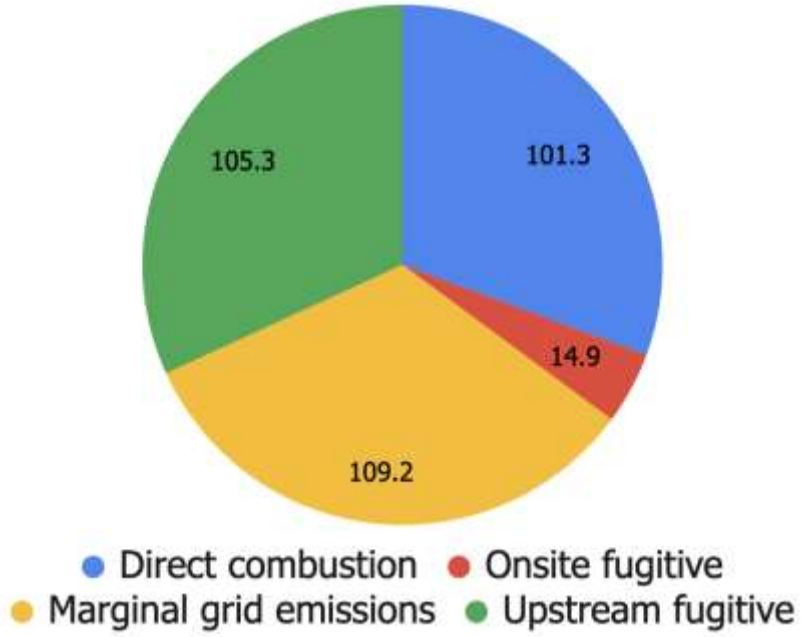
We start by focusing on the most pressing needs of families: a healthy way to cook inside their homes.

Gas Stoves are:

- ✕ **Bad for our health**
  42% increase in childhood asthma for children living in home with a gas stove.
- ✕ **Clunky, outdated performance**
  Longer to heat food, less precise, dangerous, and hot.
- ✕ **Bad for the planet**
  The gas appliances in the Bay Area contribute more NOx pollution than all of the passenger vehicles.



Alignment and Impact



Appliance	Direct	Fugitive on-site	Fugitive upstream	Marginal grid	Total
Stove	7.02	2.41	6.81	25.73	41.96
Water heater	61.16	7.05	61.98	34.89	165.08
Clothes dryer	2.09	0.25	2.20	34.97	39.51
Total	**70.27**	**9.71**	**70.99**	**95.58**	**246.55**

Table 1: Residential sector emissions estimates, in millions of metric tons of CO_2e per year.

Appliance	Direct	Fugitive on-site	Fugitive upstream	Marginal grid	Total
Stove	6.96	2.39	7.70	6.91	23.96
Water heater	22.47	2.59	24.86	4.71	54.63
Clothes dryer	1.61	0.19	1.78	2.04	5.61
Total	**31.04**	**5.17**	**34.34**	**13.65**	**84.20**

Table 2: Commercial sector emissions estimates, in millions of metric tons of CO_2e per year.

The annual emissions reduction potential of Copper's Energy Storage Enabled appliance technology is roughly 330 million metric tons (MMTs). Of this, roughly 30% comes from direct combustion, 5% from on-site fugitive emissions, 33% from upstream fugitive emissions, and 32% from marginal grid emissions.

These emission reductions are play a significant part in BTO's 2035 and 2050 emissions reduction goals.

Alignment and Impact

45 million gas ranges are still firing today in American homes. These homes are our beachhead market.

Switching gas ranges to electric is conservatively a **$100 billion** market.
Once established in the ESE range category, we'll build a suite of plug and play, ESE appliances to expand further into the home and electrification market.

Approach

Why is the ESE approach novel and more exciting than others?

- Ease of installation. Eliminates soft costs of residential storage by retaining use of 120v instead of 240v installation. “Plug and play”.
- Resiliency. The Copper range will have sufficient energy to cook 6 meals after power goes out.
- Makes storage more granular, thereby modular per appliance, not “wasting” or oversizing battery.

Approach

Why stoves?

- New research has uncovered the health hazards of cooking with gas.
- Wiring for 240V 50A is a major hurdle to electrification, especially with 100A service.
- A modestly-sized battery enables high performance induction cooktop and oven on an existing circuit.
- This solution is especially well suited to multifamily housing units, which have been historically difficult to electrify.

Approach

Task and Milestone Delivery

Energy Modeling

- White Paper written: *Emissions reduction potential of battery-enabled appliances in the U.S.*

Hardware Prototyping and Testing

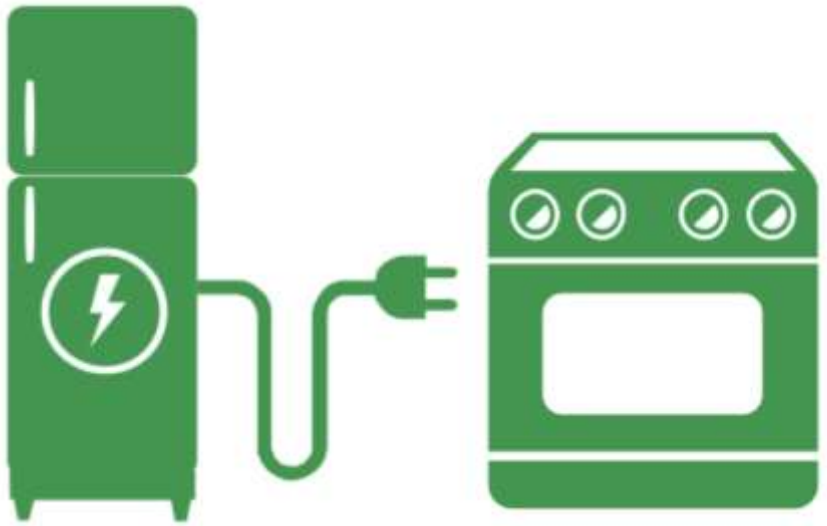
- A series of full sized battery integrated induction ranges, in-the-field stove tests complete, currently implementing “backdoor” methodologies to apply DC current to AC hardware, enabling inverterless power methods.

Software Development

- Full time monitoring of stove energy usage. Implemented TOU rate storage/usage based on energy sources and storage capabilities based on various seasonal rates and times.

Business Development

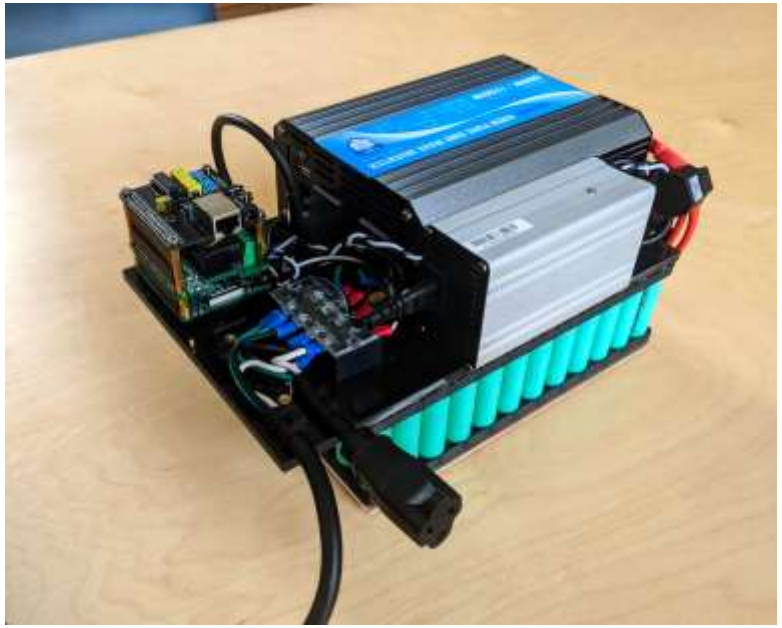
- Channing St Copper Formation, fundraising, utility partnership development, exploration and mapping of subsidies, partnering with local chefs and retailers. Farmers markets and local events. Showrooms and sales.



Approach

Step 1

Build an energy storage system.



Step 2

Integrate it into an appliance.

Approach

Step 3

Make it better.

Approach

State-of-the art performance, timeless design and the right price make choosing our product a no-brainer.

COMPETITIVE LANDSCAPE

MAKES GAS APPLIANCES

We have counter-power positioning over incumbents that make gas appliances.

LG · GE · VIKING · Electrolux · SAMSUNG · BOSCH · WOLF

JUST A BATTERY

Can't be used to cook a meal.

GENERAC · ENPHASE · ECOFLOW

COOKTOP ONLY

Impulse's product has no oven and targets new construction or major renovation.

impulse

We are the *only* brand that offers a full range with induction cooktop that plugs into a standard outlet.

Progress and Future Work

Progress and Future Work

We've demonstrated product market fit, and the margins are looking good.

- We demonstrated market demand at $5999.
- We are now building our OEM Range with 50% Margins.

26
DTC pre-orders

>1000
person waitlist

LOI for a pilot of
300+ units
from sunrun

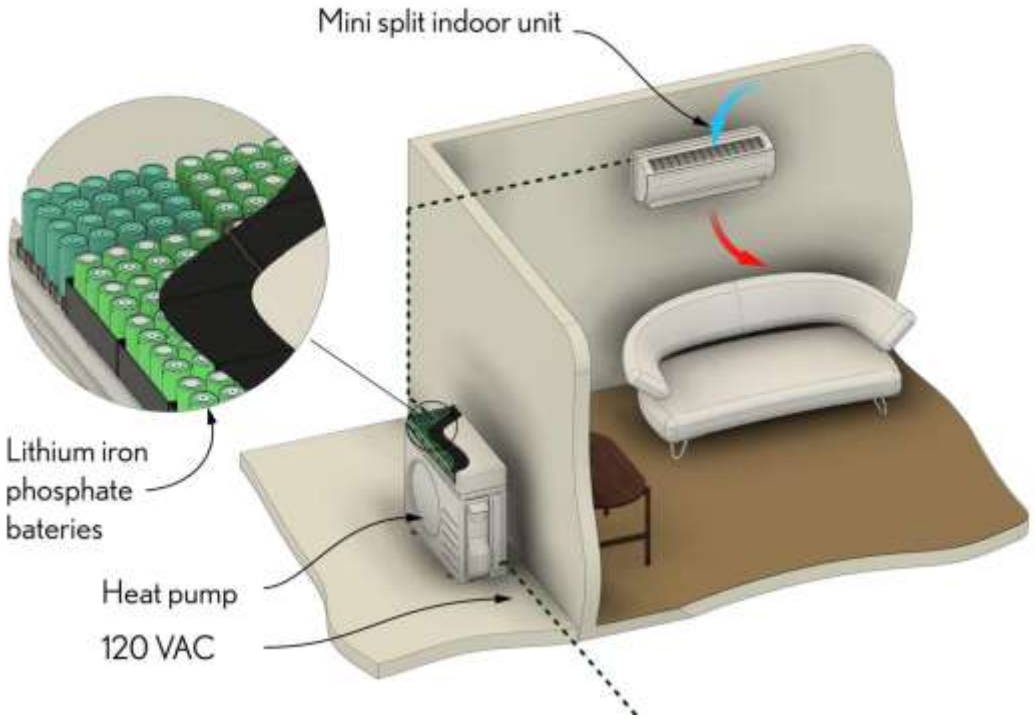
MULTI-FAMILY RESIDENCES

36 units
ordered on CalNext grant in partnership with Redwood Energy

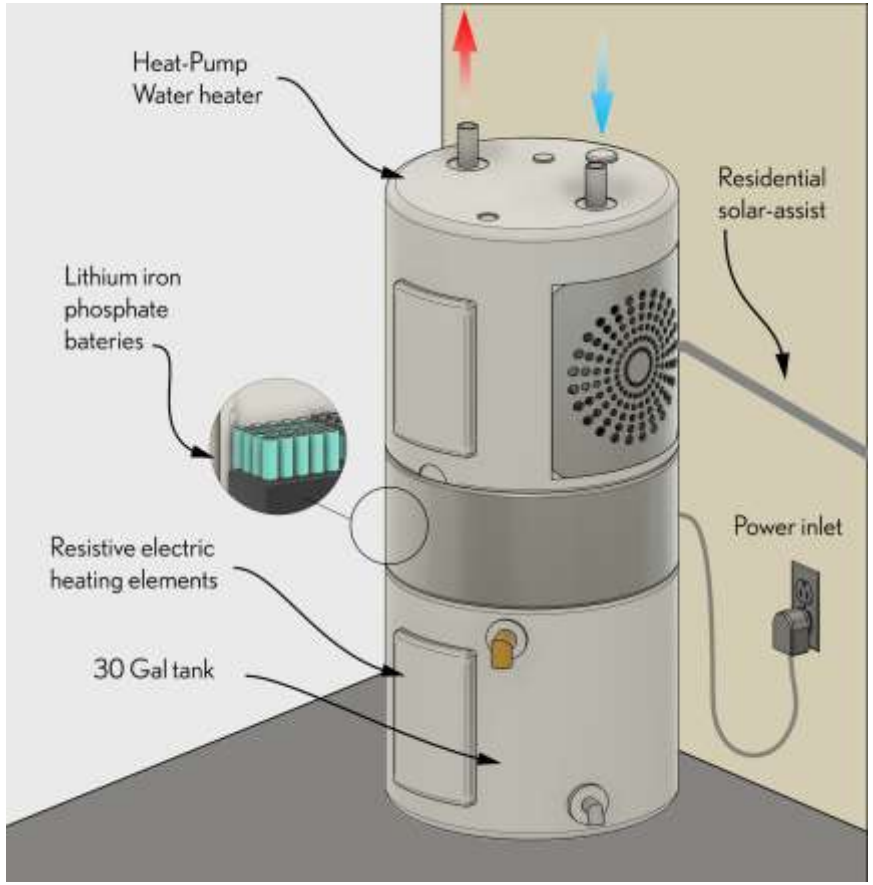
LOI from Amalgamated Housing Co-Op in New York for
500 units

First home installation of our induction range

Progress and Future Work



Copper's ESE mini-split heat pump, which uses a battery to limit needed amperage. Both appliances have optional inputs for non-interconnection solar installations.



Copper's ESE 120v heat pump water heater, which utilizes a battery to eliminate the need for 240v input without sacrificing performance.

Progress and Future Work

A high level look at the next 18 months at Copper.

April
In-house Manufacturing;
Charlie Range Preorders

December
UL Cert. Lab Testing

April
End of BENEFIT Contract

October
Supply Chain Producing
1000-5000u Delta Range

2023 | 2024

July
V1 ESE Hot Water Heater

October
Installation of 5x Charlie
Ranges in Pilot Homes

January
Initial Production Round
Delta Range Rolled Out

July
V2 Hot Water Heater UL Cert.

Team

We have the right people to build a category defining company

FOUNDING TEAM

Eric Wilhelm, PhD
CEO

Tucker Gilman
COO

Saul Griffith, PhD
Advisor

Sam Calisch, PhD
Chief Scientist

Weldon Kennedy
CMO

Josh Land
VP of Partnerships

FIRST HIRES

David Kosecoff
Electrical Engineer
Apple

Helen Yamamoto
Technical Program Manager
Lockheed Martin & Amazon

SOME OF WHAT WE'VE DONE

18 Companies founded (acquisitions by Autodesk, Google, Linamar)

3 MIT PhDs

2 Consumer brands built

8 Years gourmet restaurant and bakery experience

Millions of products shipped to customers from supply chains we have created.

Wrote *Electrify*, the book on the electrification opportunity

Led big teams: VP at Autodesk & MD at Change.org

Thank You!

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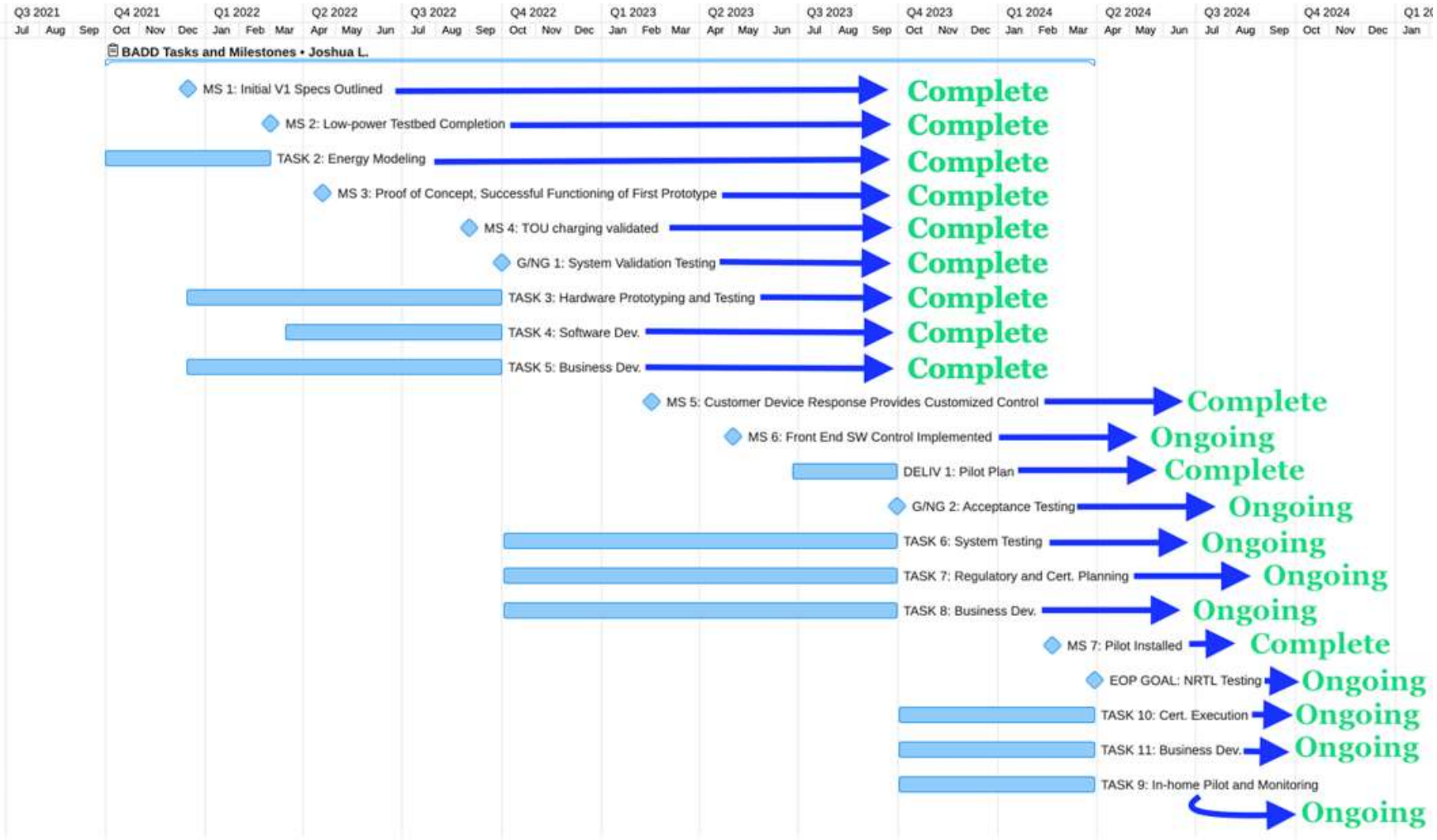
REFERENCE SLIDES

Project Execution

	Title	Start date	Due date
1	**BADD Tasks and Milestones**		
2	MS 1: Initial V1 Specs Outlined		12/15/2021
3	MS 2: Low-power Testbed Completion		03/01/2022
4	TASK 2: Energy Modeling	10/01/2021	03/01/2022
5	MS 3: Proof of Concept, Successful Functio		04/18/2022
6	MS 4: TOU charging validated		08/31/2022
7	G/NG 1: System Validation Testing		09/30/2022
8	TASK 3: Hardware Prototyping and Testing	12/15/2021	09/30/2022
9	TASK 4: Software Dev.	03/16/2022	09/30/2022
10	TASK 5: Business Dev.	12/15/2021	09/30/2022
11	MS 5: Customer Device Response Provides		02/15/2023
12	MS 6: Front End SW Control Implemented		05/01/2023
13	DELIV 1: Pilot Plan	06/26/2023	09/29/2023
14	G/NG 2: Acceptance Testing		09/29/2023
15	TASK 6: System Testing	10/03/2022	09/29/2023
16	TASK 7: Regulatory and Cert. Planning	10/03/2022	09/29/2023
17	TASK 8: Business Dev.	10/03/2022	09/29/2023
18	MS 7: Pilot Installed		02/19/2024
19	EOP GOAL: NRTL Testing		03/29/2024
20	TASK 10: Cert. Execution	10/02/2023	03/29/2024
21	TASK 11: Business Dev.	10/02/2023	03/29/2024
22	TASK 9: In-home Pilot and Monitoring	10/02/2023	03/29/2024
+	Add task		



EERE/BTO goals

The nation's ambitious climate mitigation goals

Greenhouse gas emissions reductions

50-52% reduction by 2030 vs. 2005 levels

Net-zero emissions economy by 2050

Power system decarbonization

100% carbon pollution-free electricity by 2035

Energy justice

40% of benefits from federal climate and clean energy investments flow to disadvantaged communities

EERE/BTO's vision for a net-zero U.S. building sector by 2050