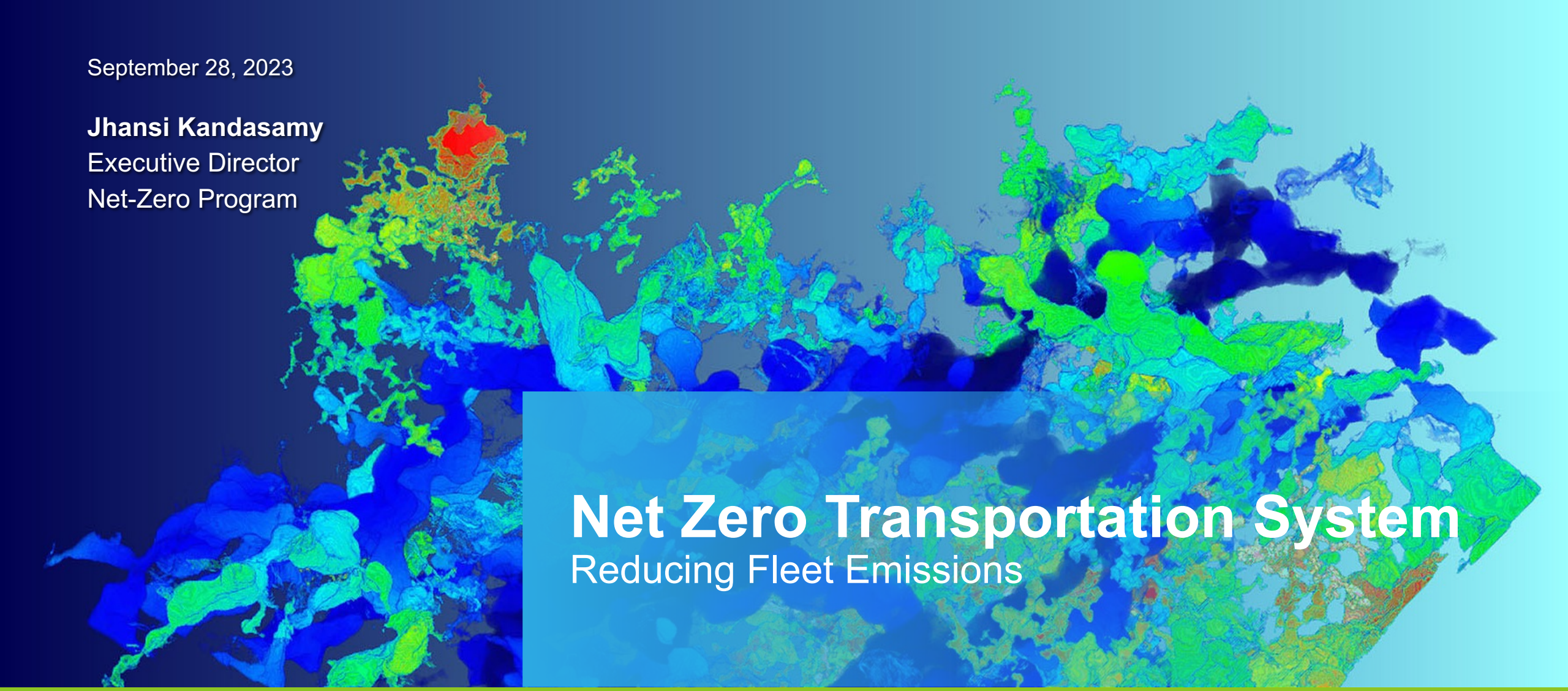
September 28, 2023

Jhansi Kandasamy
Executive Director
Net-Zero Program



Net Zero Transportation System

Reducing Fleet Emissions

Battelle Energy Alliance manages INL for the
U.S. Department of Energy's Office of Nuclear Energy

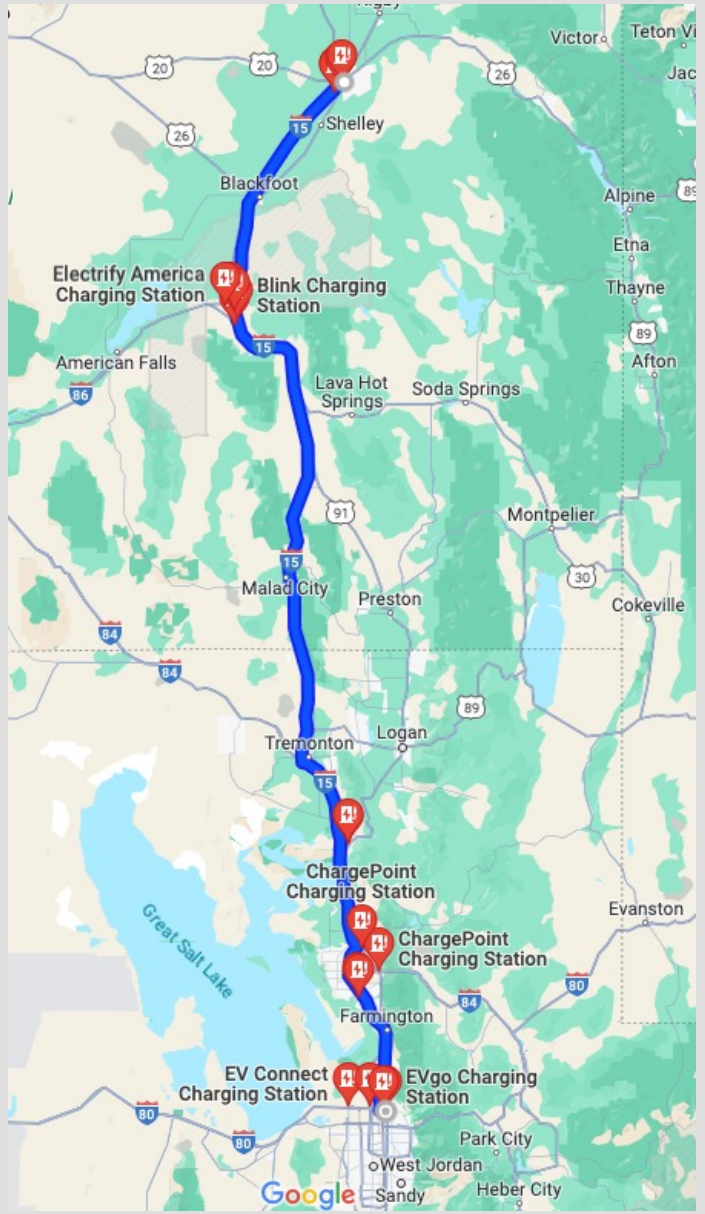
Idaho National Laboratory

Decarbonizing Transportation in the U.S.

- Passenger vehicles AND public transit systems need to decarbonize
- By 2030: A projected 26.4 million more EVs on the road
  - Idaho: Between 2020 and 2023 hybrid ownership up 269%
  - Utah in 2026: 1,000 EVs → Utah in 2023: 30,000 EVs
- Between 2022 – 2029: Predicted 45% growth rate for Hydrogen Fuel Cell Vehicle Market
- NEVI funding:
  - Utah: $36 million
  - Idaho $30 million

Tourism & Interstate Corridors

- Transportation solutions need to work for out of state visitors as well
- 2022 visitor numbers:
  - Zion – 4.5 million
  - Yellowstone – 3.3 million
  - Arches – 1.6 million
- 2021 Economic impacts of tourism:
  - Utah: $10.56 billion
  - Idaho: $3.7 billion



Net-Zero Fleet at INL

- National focus: EVs
- INL: Committed to diverse solutions to meet our challenges and requirements
- 890 square mile site
- ~700 vehicles
- 3 fire departments
- Security vehicle fleet
- Heavy equipment
- Public transit system

Fleet emissions in comparison with other emissions sources

FISCAL YEAR 2022

GHG emissions from sources owned or controlled by DOE

Mobile combustion	9,038 | 11.38%
Stationary combustion	5,931 | 7.47%
On-site landfill	5,729 | 7.21%
On-site wastewater treatment	134 | .17%
Fugitives & refrigerants	44 | .06%
20,876 $MTCO_2e$ | 26.28%	

GHG emissions from electricity, heat or steam purchased by DOE

Purchased electricity	42,871 | 53.97%
Transmission & distribution loss *(owned)*	380 | .48%
43,252 $MTCO_2e$ | 54.45%	

GHG emissions from sources not owned or controlled by DOE

Employee commuting	8,763 | 11.03%
Business travel *(air & ground)*	3,848 | 4.84%
Transmissions & distribution *(shared)*	2,399 | 3.02%
Contracted wastewater & MSW	300 | .38%
15,311 $MTCO_2e$ | 19.27%	

23-50147_02

INL's FY22 greenhouse gas (GHG) emissions in metric tons of carbon dioxide equivalent ($MTCO_2e$)

TRANSFORM INL TO NET-ZERO

Align mission activities with operations to achieve net-zero carbon emissions on the site by 2031

Our plan to reach Net-Zero at INL

Implementation Plan

Purchased Electricity

Secure carbon-free electricity from power providers, including nuclear, when available.

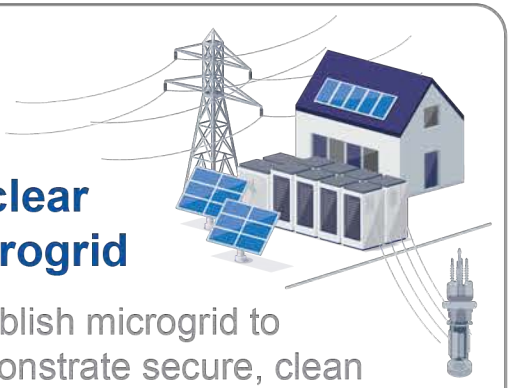
Mobile Combustion

Convert to non-carbon emitting vehicles and develop fueling alternatives.

Stationary Combustion

Increase building efficiencies, electrify equipment, and identify carbon-free alternatives.

Nuclear Microgrid



Establish microgrid to demonstrate secure, clean integrated energy systems with the potential to support discrete site operations.

Wastewater

Monitor and mitigate emissions from wastewater facilities.

Other Fugitive Emissions

Monitor and mitigate emissions from fugitive sources.

Landfill

Monitor and mitigate landfill emissions.

Public Engagement: Communication, Outreach and Education

23-50457_R4

Identifying challenges & demonstrating solutions

- Public transit system = >80 motor coaches
  - ~2,500 people/day
  - 365 days/year
  - 2.7 million miles annually
- LDVs = >300 sedans and light-duty pickup trucks
- Weather
  - Temperature variations b/w -30 and 100+ degrees
- Distance
  - Rural site connected to the city of Idaho Falls
- Siting infrastructure in rural locations that lack access to CFE
- Leasing requirements

TRANSFORM INL TO NET-ZERO

Align mission activities with operations to achieve net-zero carbon emissions on the site by 2031

Mobile Combustion Accountability Chart

Objective: Transition INL Motor Coaches to alternative sourced fuel for achievement of Net-Zero goals

Scope: Purchase and/or Lease three electric Motor Coaches; Procurement of Electric Motor Coaches, installation of charging stations, eMC use and data sharing on range

Owner: Ira Pray

Approach/Key Actions/Owners

Action	Owner	Comments	Perf
IPL Electric Coach Purchase	Ira Pray	Will need milestone payment exception from GSA	
MC Leasing	Ira Pray w/ DOE/GSAI	Will not occur	
Charging station purchase and install	Need new POC	EROB Station complete and MFC next	
ABB Level 3 Use Authorization	Maryl Fisher/Howard Pugmire	Charge Point Developing OTA Authorization	
Correct charging issue	Jeff Brown	Currently working with MCI to correct issue	

Risks and Opportunities

- Market price and availability ($1.5M per MC)
- Lease process and timeline controlled by GSA
- EO 14057 Plan for 100% eLDV by 2027
- INL believes H2/electric is the better long-term solution for operations
- Charging issue currently has eMC disabled

Results

- Proposed fund paper to joint office (in revision)
- GSA awaiting Quote for Second BEV MC
- EROB charging station install completed 5/31, Currently in use
- Enhancement to ABB Level 3 at EROB to capture Asset charging information
- Motor Coach acquisitions to date: 1
-

KPIs

- -

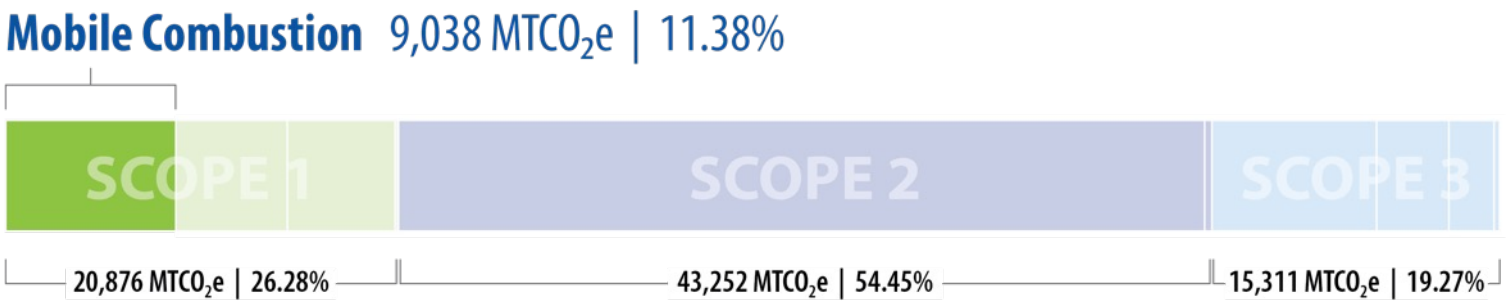
Schedule

- Click or tap here to enter text.

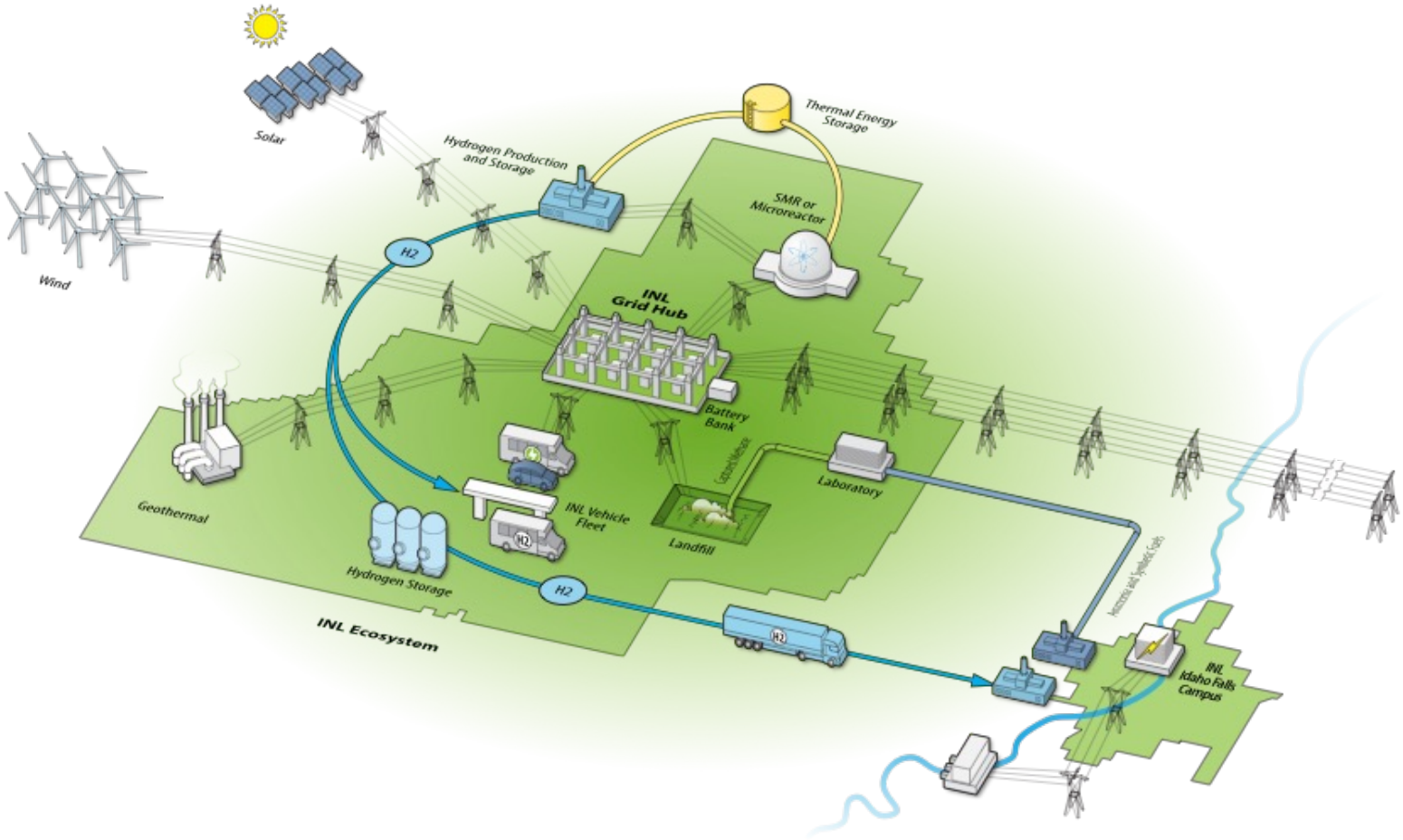
Mobile Combustion: *9,038 $MTCO_2e$ (FY22)*

Developing diverse decarbonization strategies

- Fleet transition initiated
  - 20 of 207 LDVs → electric
  - 1 of 8 motorcoaches → electric
    - **$16,814/year** reduction in fuel costs | **36.8 $MTCO_2e$**
  - 10 eClimacoach systems
- H_2 bus options
- 23 charging stations
- 200,000 gallons of R99 → anticipated 2,041.30 $MTCO_2e$ reduction
- *R&D solutions: R99 winter blend, solar charging bays*

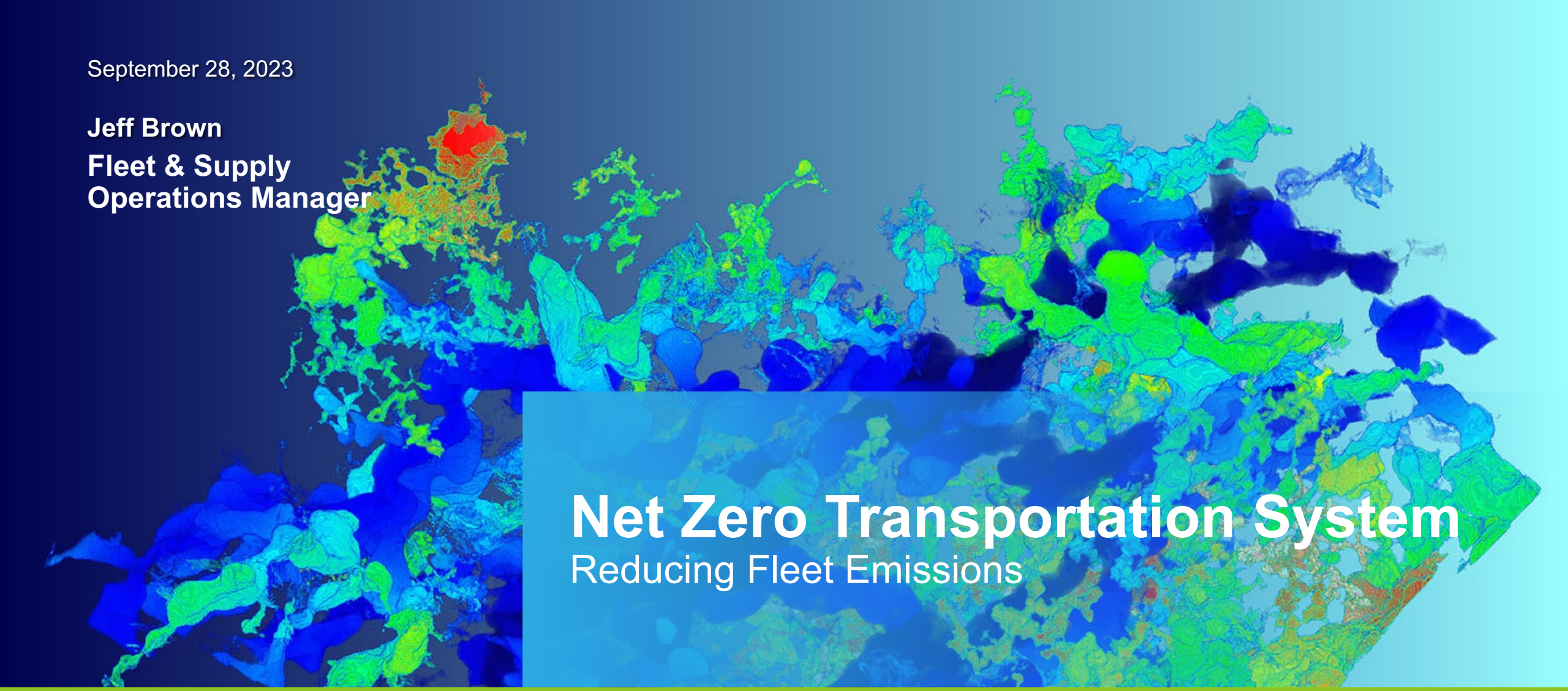


Part of a larger decarbonization commitment



Idaho National Laboratory

Battelle Energy Alliance manages INL for the U.S. Department of Energy's Office of Nuclear Energy. INL is the nation's center for nuclear energy research and development, and also performs research in each of DOE's strategic goal areas: energy, national security, science and the environment.



September 28, 2023

Jeff Brown
Fleet & Supply Operations Manager

Net Zero Transportation System

Reducing Fleet Emissions

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INL Idaho National Laboratory

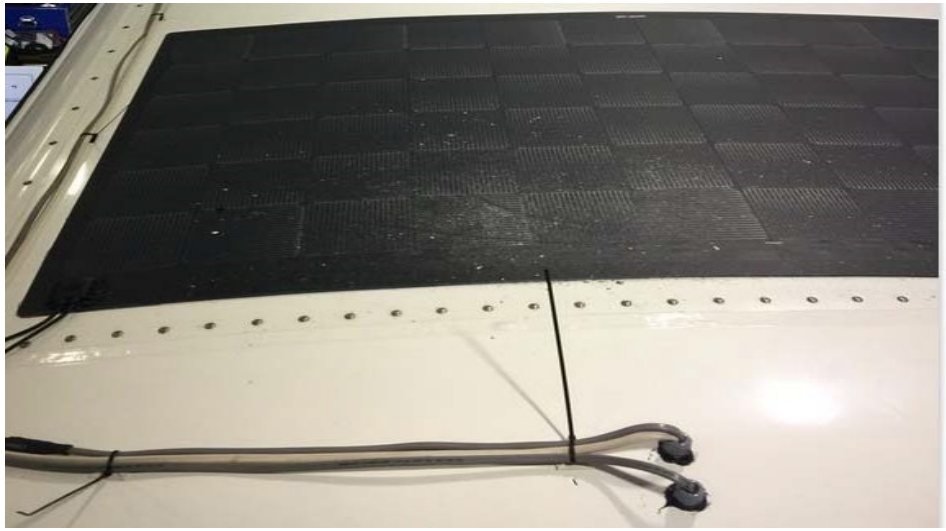
Getting to net-zero emissions with new technologies

Three 330-watt, 24 V flexible solar panels provide power

SUN POWER

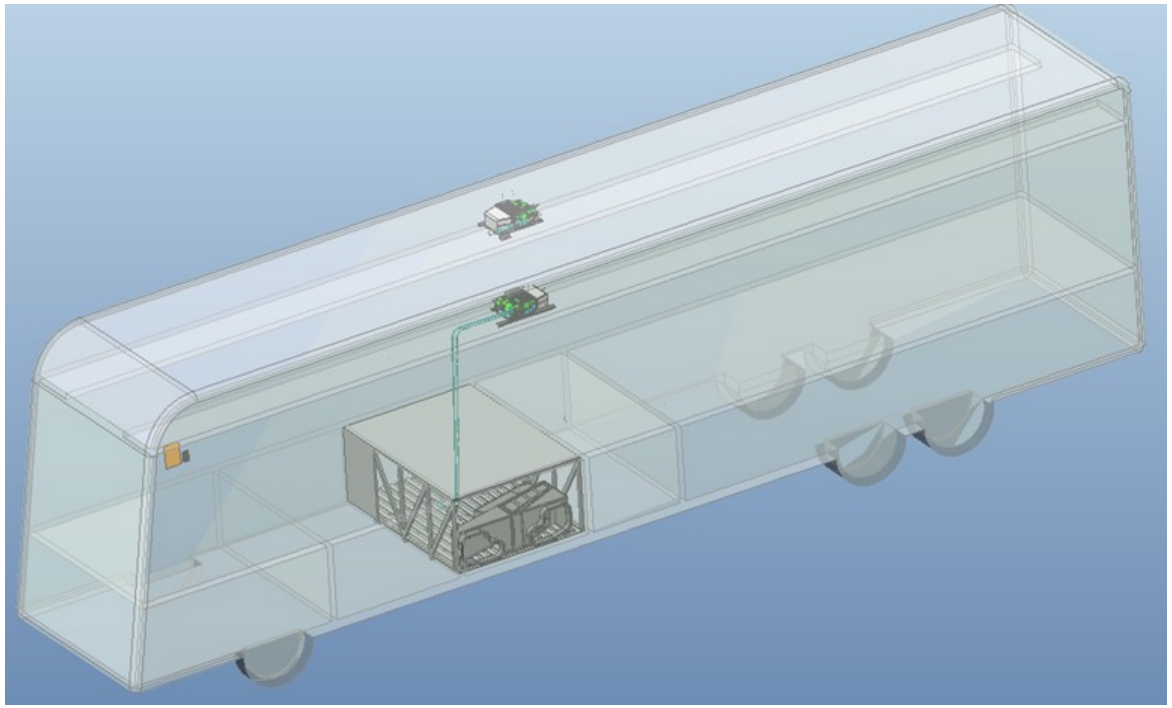
The solar-powered system allows drivers to maintain temperatures in the coach by both heating and cooling without running the engines. A complete no-idle system includes three roof-mounted solar panels, a battery pack and a blower, motor and compressor to run bus air conditioning separately from the bus engine.

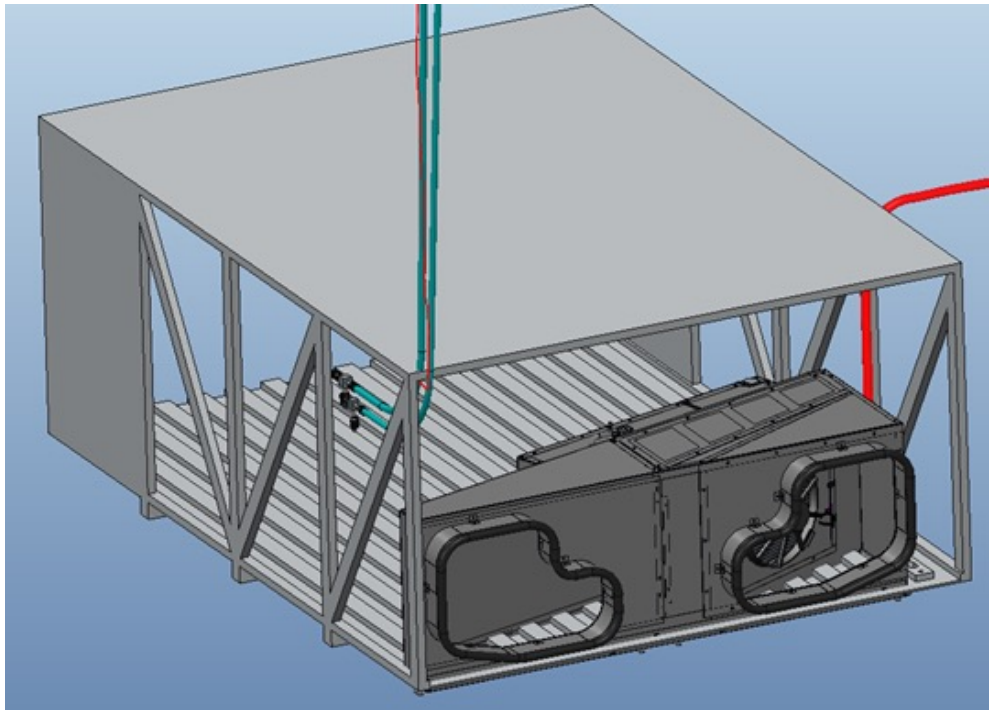
Solar Panels



No-idle control unit

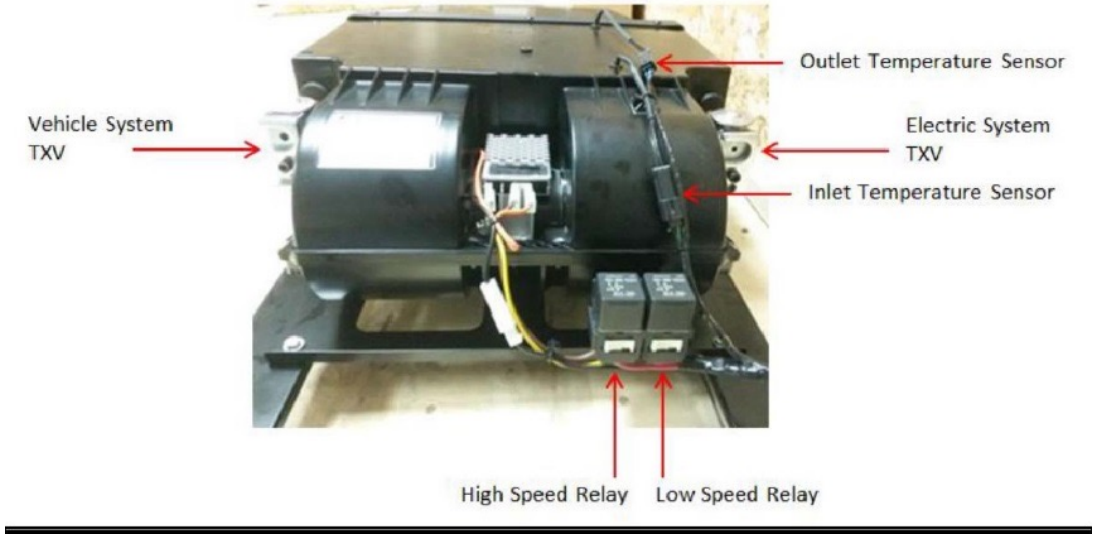
eClimacoach No-Idle System Layout





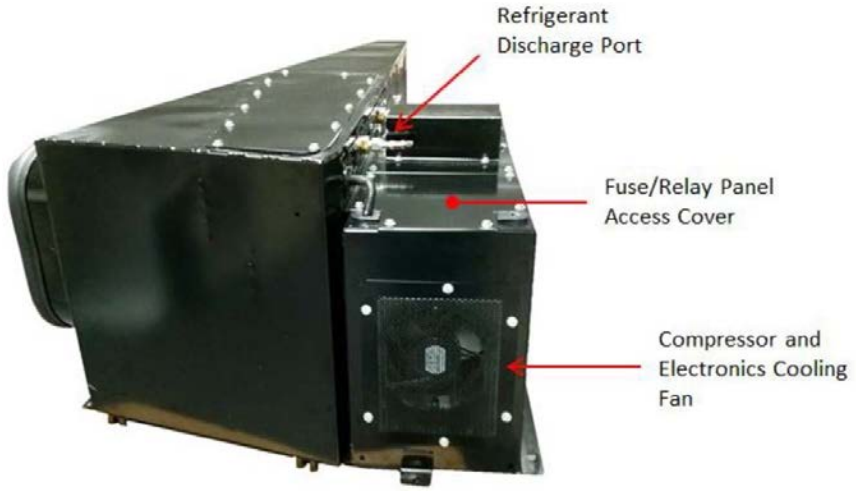
Development

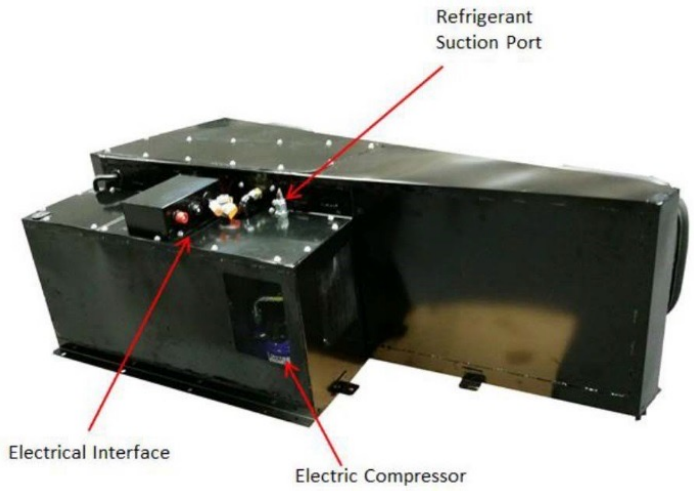
- Maintain the original equipment look and feel using existing ductwork and mounting location.



HVAC

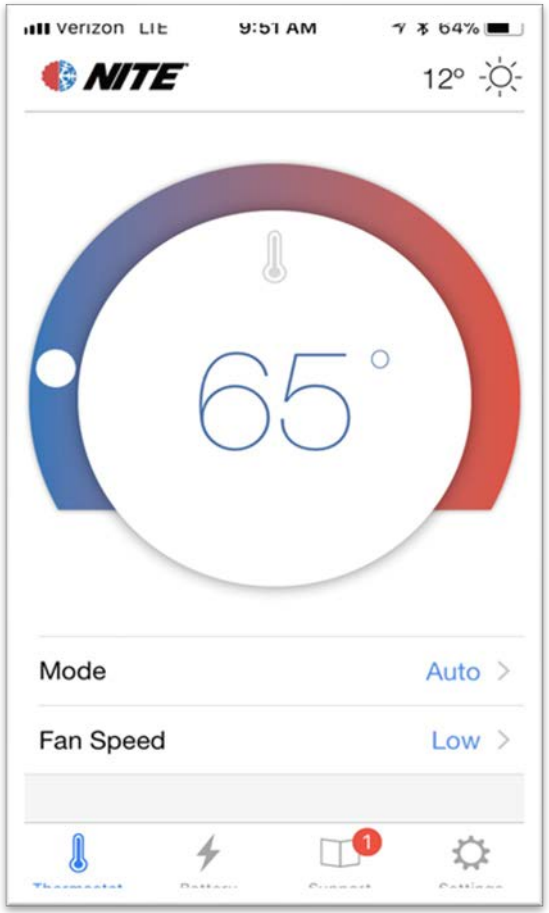
- Compressor system installed in the luggage bay of the coach
- Size of next generation of this system reduced by almost half





Controls

- Bergstrom App
- *Able to control the system wirelessly from inside or outside of the coach.*



Performance Test Summary

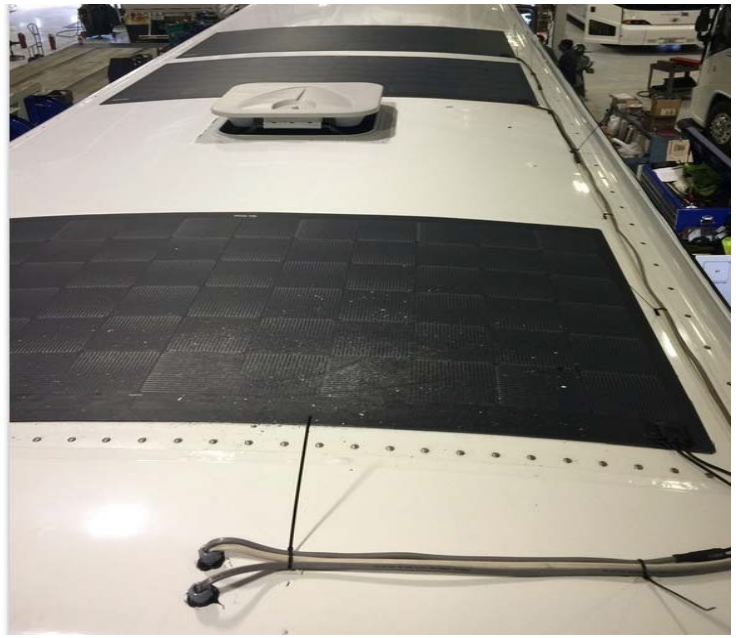
Ambient	Solar Irradiance Avg.	Set Point	Bus Starting Temp	Bus Avg. Temp End of Run	Solar Power Avg.	HVAC Power Avg.	Run Time	Battery Recharge Time	Time of day
°F	W/m2	°F	°F	°F	Watts	Watts	Minutes	Minutes	Hour/Min
86-93	830	70	71	73	0	1808	48	116-NS	1:42-4:36 pm
93-103	875	70	72	75	580	2100	63	73-WS	3:10-5:39 pm

eClimacoach No-Idle System fuel savings reducing carbon footprint

Bus	Week	FUEL (GAL)	IDLE FUEL	MILES	MPG	ENGINE HOUR	Weekly <MPG	Weekly MPG>	Beginning <MPG>	CO2 lbs per Gal diesel burned	CO2 lbs per Gal diesel eliminated		
	Week prior to program												
514	10-Feb	117.42	2.91	746.16	6.35	21.25				2628			
528	10-Feb	112.67	2.11	632.35	5.61	24.85				2522			
552	10-Feb	104.61	2.25	662.79	6.34	22.35				2341			
554	10-Feb	104.88	2.64	675.27	6.44	22.4				2347			
	Week 1 of program												
514	17-Feb	126.01	3.17	828.69	6.58	18.45		0.23	0.23				
528	17-Feb	124.16	2.91	667.45	5.38	27.5	0.23		0.23				
552	17-Feb	99.99	1.59	649.89	6.5	19.8		0.16	0.16				
554	17-Feb	152.43	2.64	946.38	6.21	35.45	0.23		0.23				
	Week 2 of program												
514	23-Feb	36.59	0.79	248.73	6.8	5.35		0.22	0.45				
528	23-Feb	81.5	3.04	496.9	6.1	19		0.8	0.49				
552	23-Feb	56.14	1.45	368.6	6.57	10.4		0.07	0.23				
554	23-Feb	53.23	1.59	375.16	7.05	8.65		0.84	0.61				
	Week prior to program miles utilizing week 2 MPG for CO2 comparisions												
514	10-Feb	109.72	0.79	746.16	6.8	5.35		0.22	0.45	2445	**-183**		
528	10-Feb	103.66	3.04	632.35	6.1	19		0.8	0.49	2320	**-202**		
552	10-Feb	100.88	1.45	662.79	6.57	10.4		0.07	0.23	2258	**-83**		
554	10-Feb	95.78	1.59	675.27	7.05	8.65		0.84	0.61	2144	**-203**		
									Change of driver behaviors		mean 168		
									Increase all fuel MPG		168 x 50 wks = 8400 lbs		
											8400 x 75 cchs = 630,000 lbs		

Realized Maintenance Benefit

- Battery replacements
- Expensive service calls
- Alternator replacements
- Amounting to a $91,246.00 savings in first year



BENEFITS

Reduced wear:

Your engine deserves a break.

- Reduce engine idle time.
- Avoid cold starts: pre-heat the engine block when engine is off.
- Reduce frequency of scheduled engine maintenance.
- Reduce frequency of emissions system cleaning and maintenance.
- Reduce wear on electrical system components.

Increased comfort:

Cool down or heat up, on your terms.

- Pre-heat or pre-cool the coach interior before you even enter with wireless connectivity and auto start capability.
- Enhance A/C performance of existing system.
- Maintain interior temperature for up to four hours with engine off.

Green:

Easy on the environment.

- Decrease idle time resulting in significant fuel savings.
- Reduce emissions with no-idle operation resulting in greenhouse gas reductions.

Payback

- Maintain 70-75 degrees for up to 4 hours on warm sunny days without starting the coach engine.
- System is capable of climatizing coach (cool/heat)
- Bluetooth enabled system allows for activation without entry into the coach.
- Decreases idle time resulting in fuel savings and reduced maintenance.
- Reduced emissions due to engine off option versus idling to maintain a comfortable environment.

Best Driver Practices

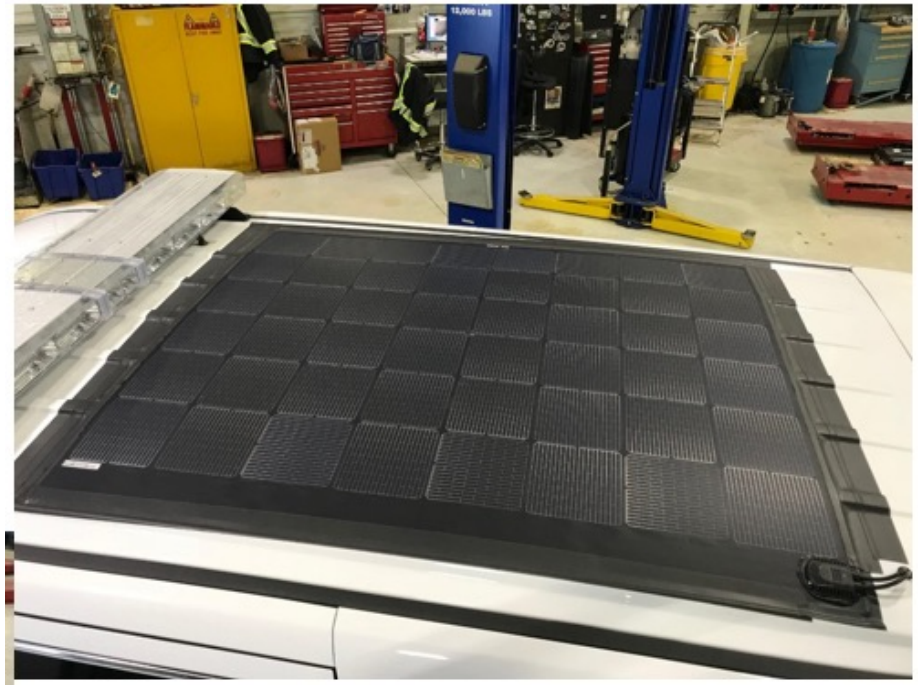
The Human Side of Heavy Vehicle Research (HVS)

- **The human factor.** It's possibly the most important factor to consider when researching heavy vehicle technologies and alternative fuels.
- **HVS researchers** jumped into action when they discovered that motor-coach drivers for the INL fleet could drive the same bus over the same route yet have differing fuel efficiencies of up to 30%.
- **Using knowledge** of INL road topography, combined with engine data, HVS researchers developed a prototype simulator that predicted – in advance – what steps the driver needed to take to maximize fuel efficiency

INL Collaboration

- Collaboration with INL means CAES researchers have access to data covering:
  - **86 bus drivers**, driving
  - **87 motor coaches**, carrying
  - **2,500 passengers** per day, totaling
  - **2.7 million miles**/year
- This collaboration led to an unexpected discovery:
  - *How much fuel efficiency can differ between drivers of the same INL bus, following the same route.*
- The answer: **30%**
  - Equated to a 1.7 increase in MPG.
  - Savings of 112,000 diesel gallons annually.
  - Goal savings of 1,137 MTC annually

Scalability



GREATER IDAHO FALLS TRANSIT

Public Transit EV Planning

AL LABORATORY

Greater Idaho Falls Transit

GIFT is a pilot project in Idaho Falls

- Light duty fleet with EV elements
- App powered
- Door to door ride share

EV Chargers

Fleet Facts

- Full charge in 2 hours.
- 40k miles a year in EV mode.
- Charge is done in off peak hours to assure clean hydro power is being sourced from the local power provider.

Lessons Learned

- Programmable chargers are essential.
- Significant economic advantages compared to a traditional fleet in fuel and maintenance.
- EV’s are preferred when the option is given.

GIFT
GREATER IDAHO FALLS TRANSIT