

"it's just air<sup>TM</sup>"

CryomatIKs Inc.

Accelerating the World's Adoption of Zero  
Emission Technologies

[www.itsjustair.info](http://www.itsjustair.info)

[www.CryoEnergy.Tech](http://www.CryoEnergy.Tech)



# *Cryomatiks' Patented Zero Emission Range Extender*

Our proprietary Cryo Turbo design enables a compact, powerful, modular solution that functions as a Range Extender for Zero Emission Vehicles (ZEVs) including Battery Electric Vehicles plus serve as a Portable Generator for Emergency Power

Cryo Turbo Solutions take advantage of the following:

**Low Cost Electricity  
(Wind, Solar, or off-peak)**

**Existing Global Supply Chain  
for Liquid Air/Nitrogen**

**Latest Wireless Communications  
(this enables Real Time optimization  
of our Zero Emission Range Extender)**



# Why use the air to power a *Zero Emission Range Extender*?

Uses Unlimited Free Abundant Air



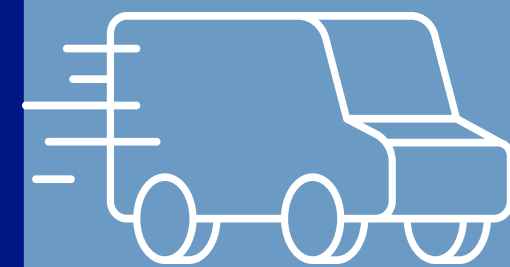
Existing Supply Chain for Liquid Air/Nitrogen

100% Non-Toxic Zero Emissions



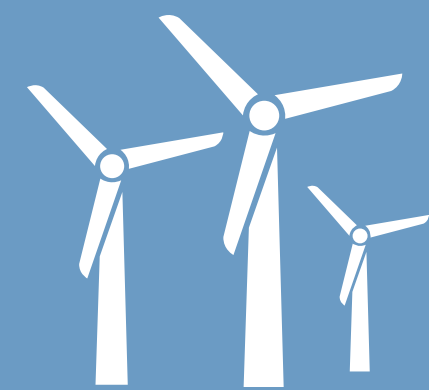
Powers Vehicles & Portable Generators

Available Everywhere (it's just air!!)



Enables Zero Emission Energy Delivery Services

Condensing Air removes impurities in Real Time plus optional Carbon Capture



Provides method for "Wind/Sun to Wheels"



# Economics of *Wind To Wheels* & *Sun To Wheels* Process

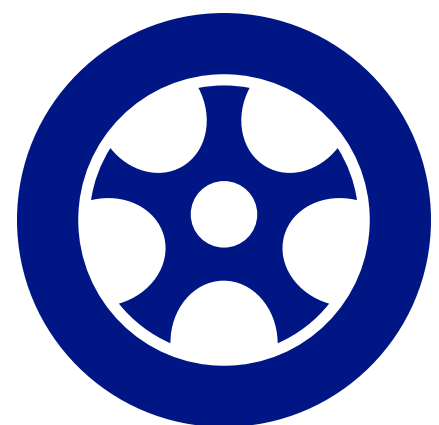
**Bulk Production of Liquid Air/Nitrogen requires 375-525 Wh/kg**



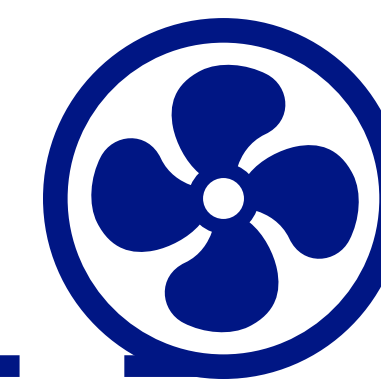
  
**\$25-\$50/MWh Electricity Cost**

**\$0.0094-\$0.026 /kg**

**Production Cost to provide 1kWh at the wheels with 100% end to end Zero Emissions**



**\$0.075-\$0.21**



**Range Extender converts Liquid Air/Nitrogen into Power**  
**~125 Wh/kg\*\***

\*\*Reference for EVs: 2021 Audi e-tron's battery pack is ~125 Wh/kg (86.5kWh usable energy/700kgs)

**Miles/1kWh @ the Wheels**

- 3-4 Miles Light Duty Vehicle
- ~2 Miles Medium Duty Vehicle
- ~1 Mile Heavy Duty Vehicle

# Energy Capacity Cost for Liquid Air/Nitrogen in transportation 20X Less than Lithium Ion Batteries

Cost of onboard storage tank(s) for Commercial Vehicle  
with 100kWh of Liquid Air/Nitrogen - <\$500

## Primary Energy Storage Cost



Cost of Atmospheric Air =

**\$0**

Cost of Storage Tanks =

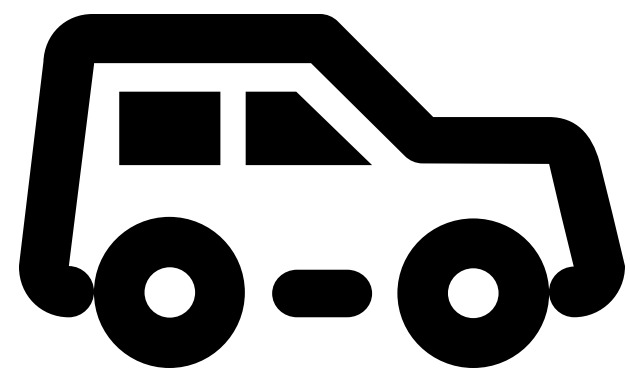
**<\$5/kWh**

Peak Power is handled by onboard energy pack with similar  
\$/kW as conventional battery packs

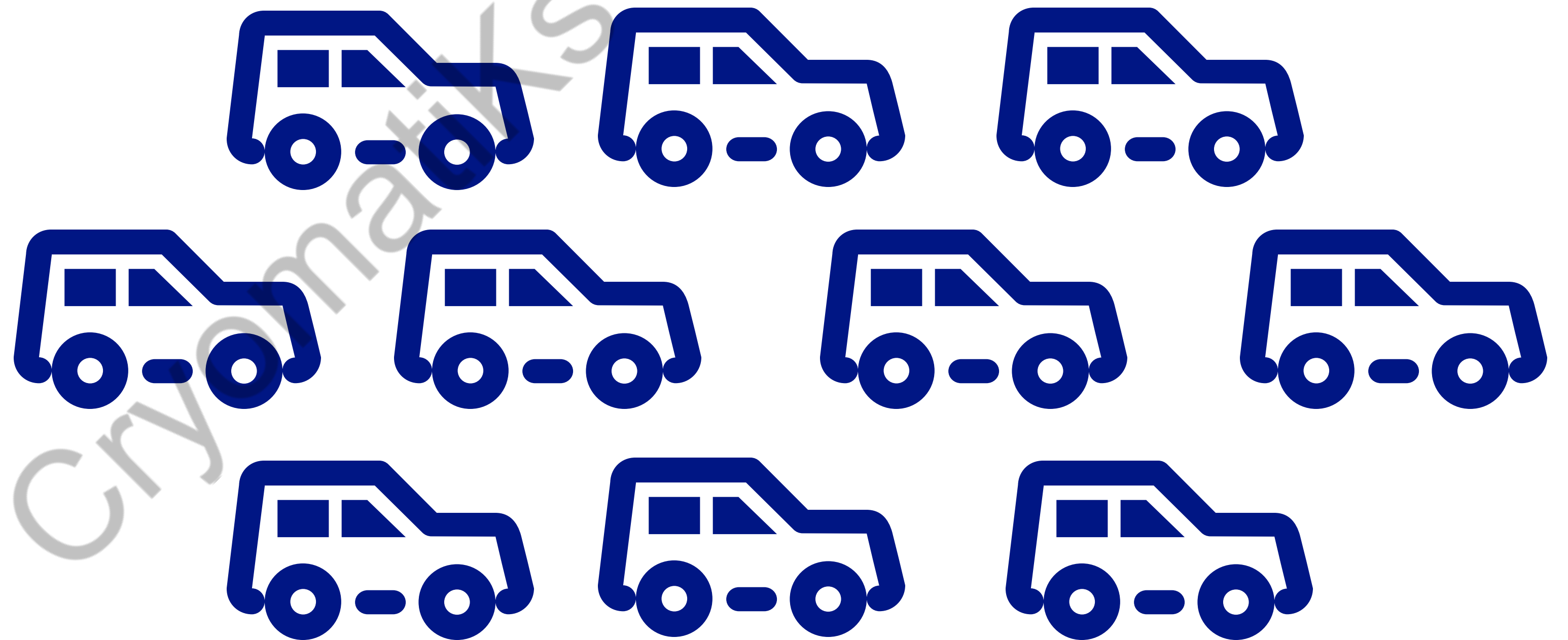


EVs with Liquid Air/Nitrogen Range Extender scale **10x** better than **Pure BEVs** for the same battery capacity

1 BEV



=



10 EVs with Liquid Air/Nitrogen Zero Emission Range Extender

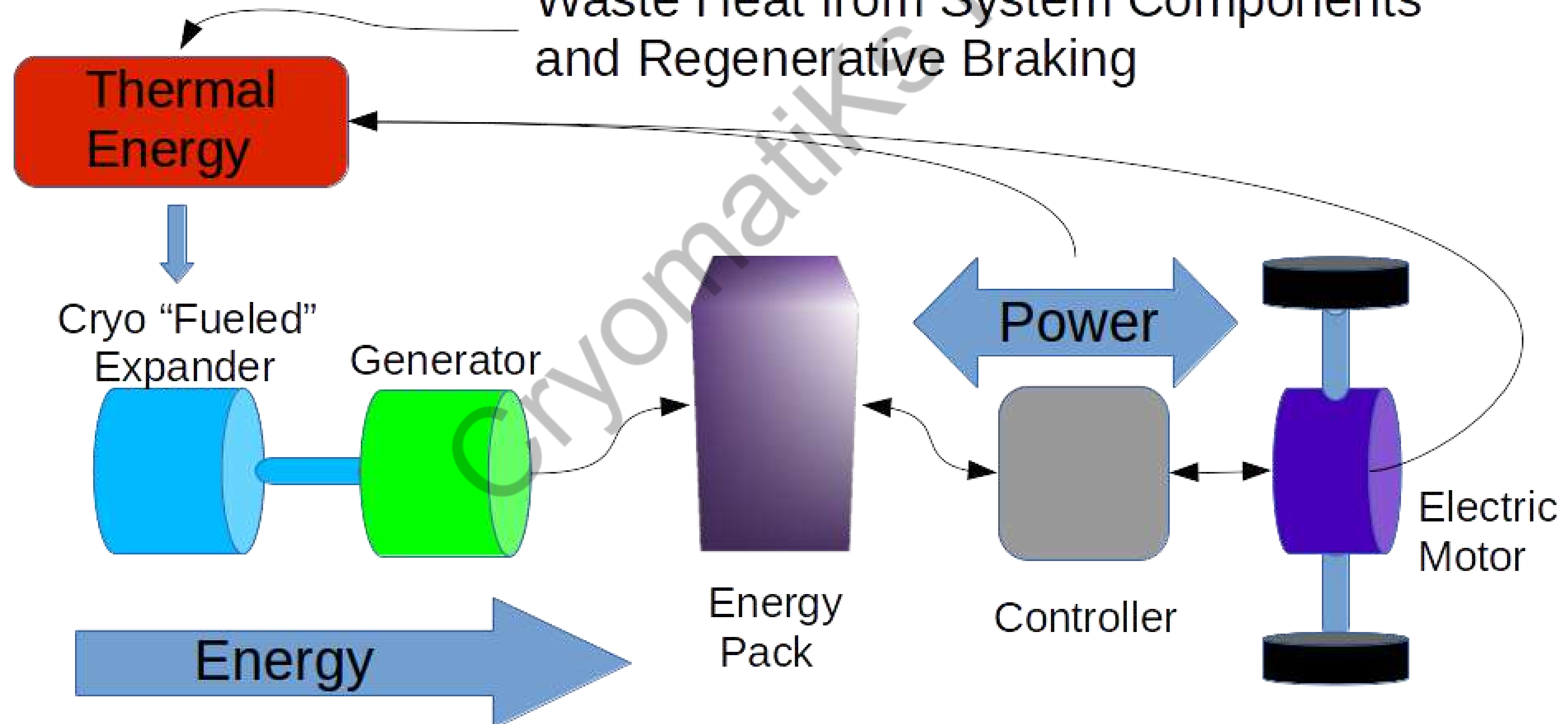
Single BEV with 100kWh pack = 10 Vehicles with Range Extender + 10kWh onboard energy pack

# Drivetrain same as EV

Serial Layout Separates Power Capacity from Energy Capacity

## Flexible Modular Design

Waste Heat from System Components and Regenerative Braking



High Speed Expander + Generator provides Power capacity above 1kW/kg

Modular "Energy Pack" consist of various chemistries of battery cells and/or capacitors.

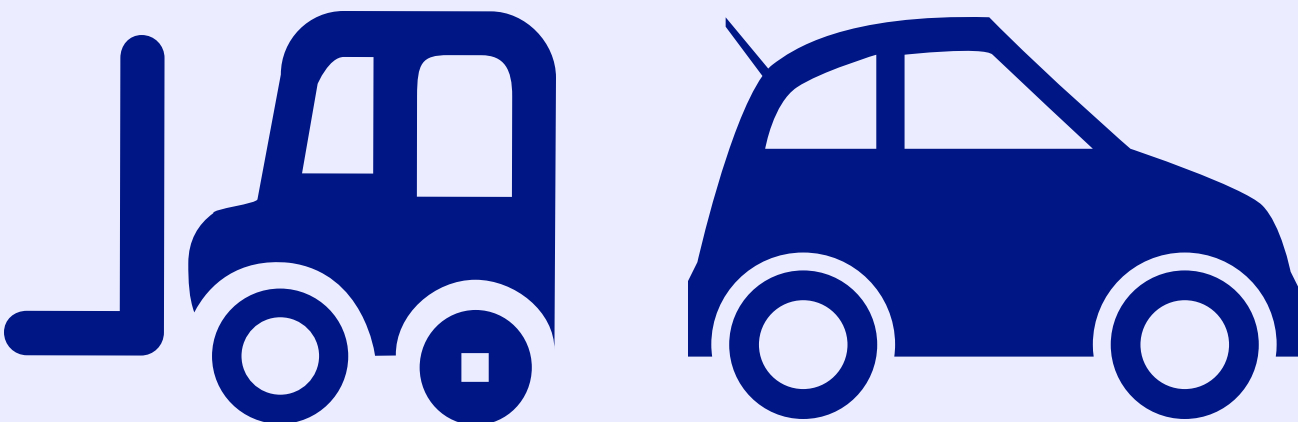


# Modular Cryo Range Extender Design

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*Sharing Common Components Creates a Family of Scalable Zero Emission Solutions*

## 10kW - 30kW Range Extender



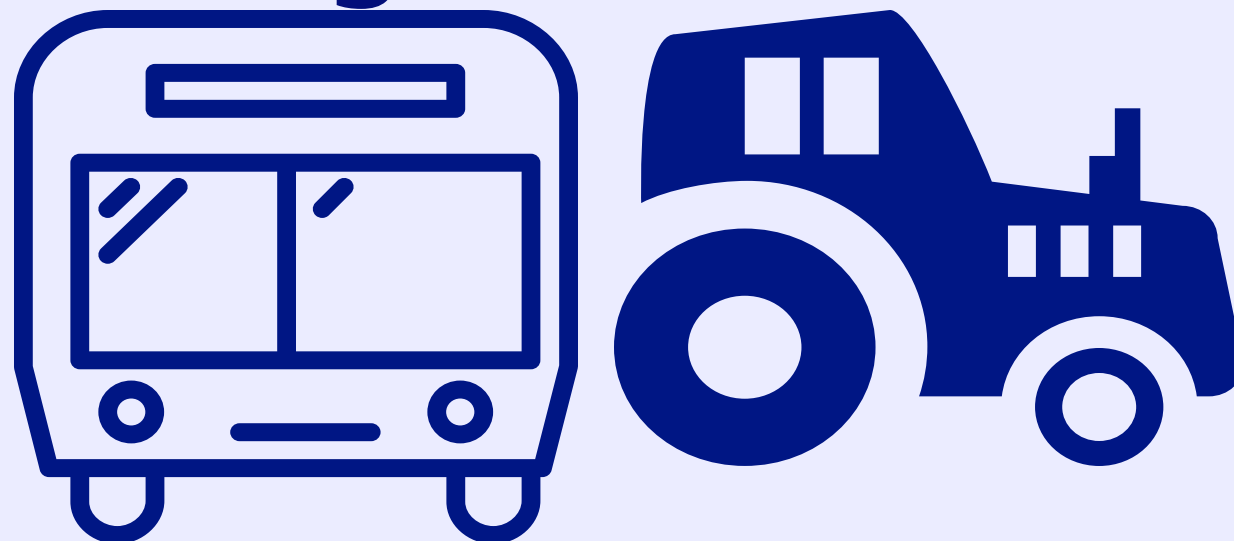
Portable Generator  
Forklifts  
Golf carts/UTVs  
City Vehicles

## 50kW - 80kW Range Extender



Delivery Vehicles  
Hybrid Vehicles (SUVs)  
Medium-Duty  
Commercial Vehicles

## 120+kW\* Range Extender



City Buses  
Construction Equipment  
Farming Equipment  
Marine Equipment  
Drayage (Port) Vehicles  
Heavy-Duty Vehicles

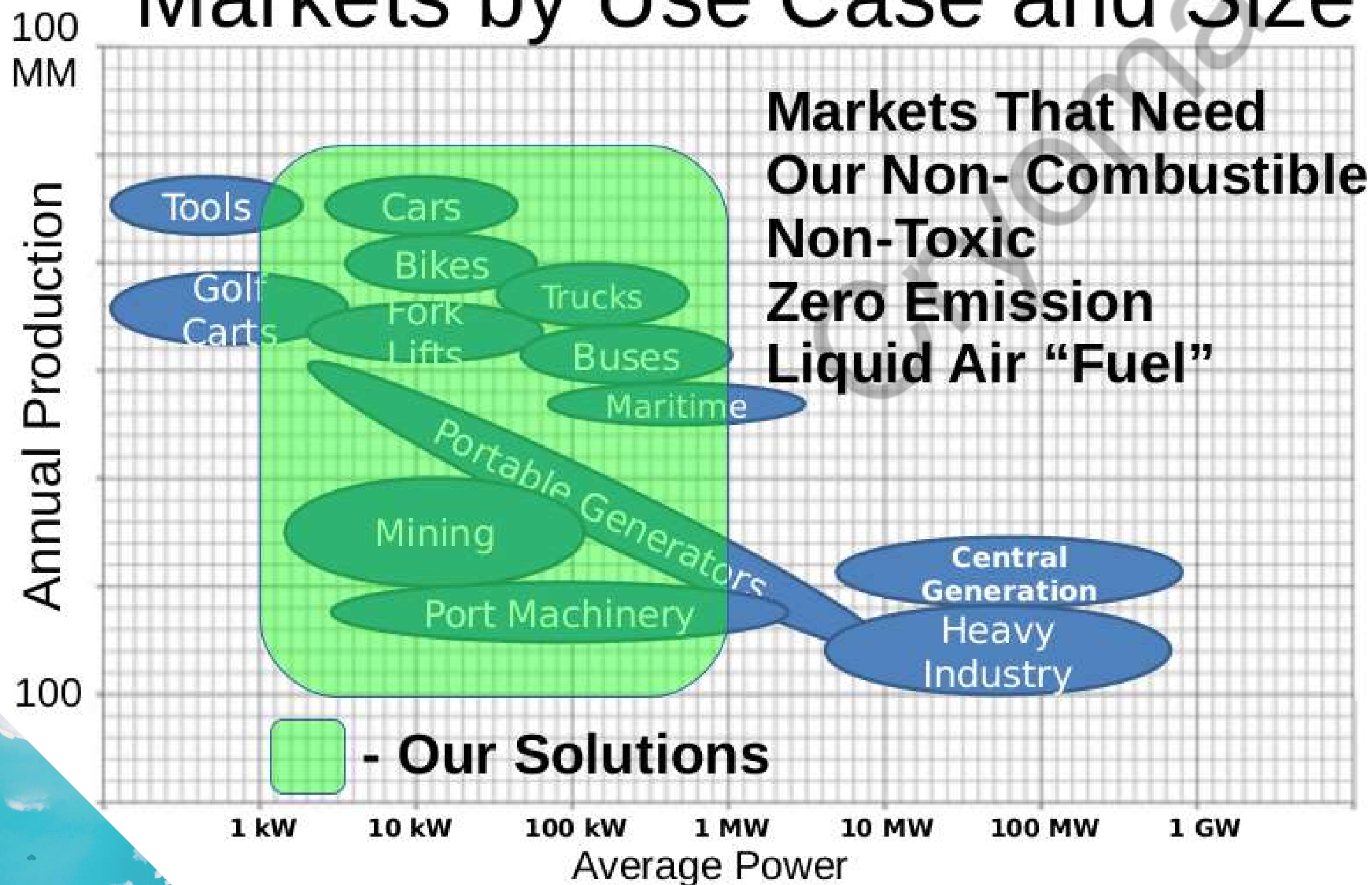
*\*Multiple 120kW modules can be combined to meet requirements of nearly all transportation related use cases*



# Single Design that scales up/down to meet specific use cases



## Markets by Use Case and Size

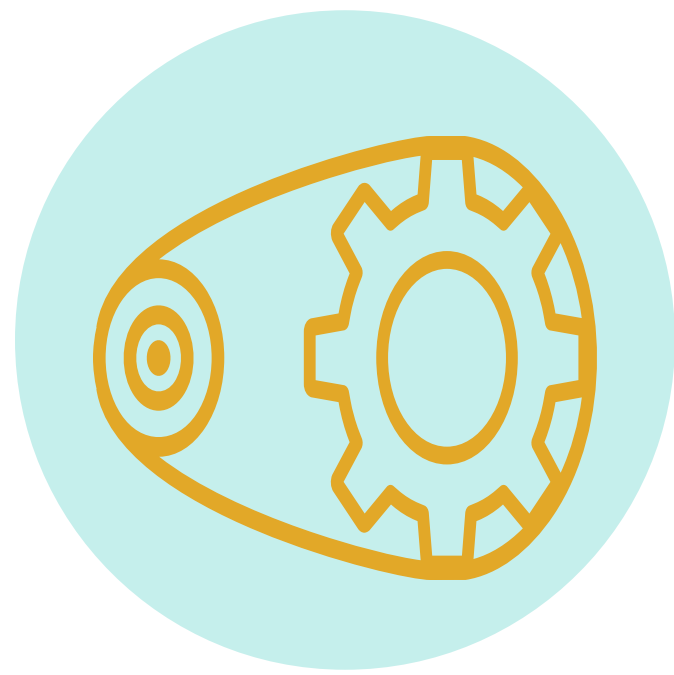


"LEGO Block" system design covers markets with highest demand and highest annual production



# OUR PATENTED DESIGNS AND PROCESSES

(our secret sauce) 😊



## Previous Designs

Previous designs using Liquid Air/Nitrogen for portable power based on low speed designs

**Baseline**  
75Wh/kg



**+20%**  
90Wh/kg



**+30%**  
117Wh/kg



**+20%**  
140Wh/kg



## High Speed Expander

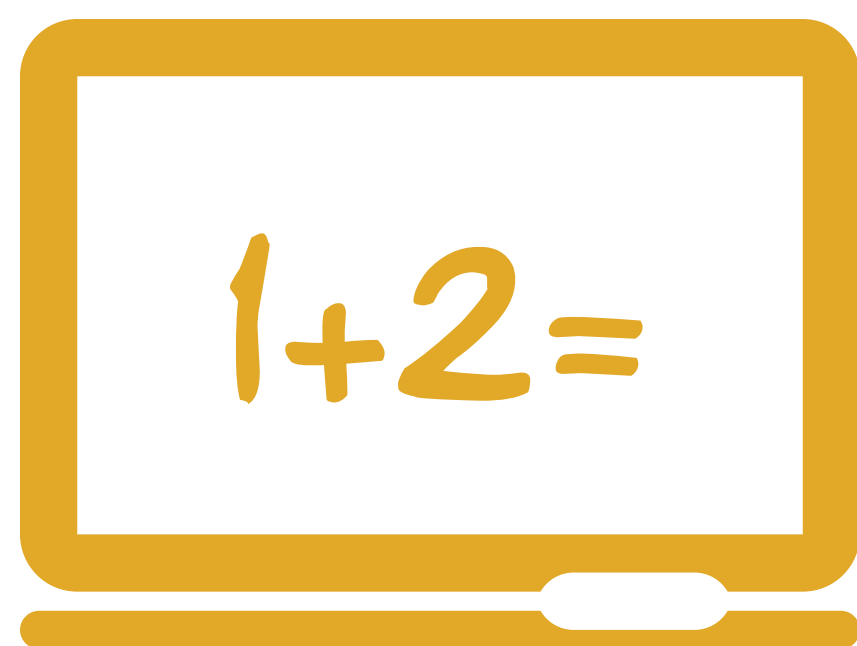
High Speed Expanders are able to convert more potential energy

## Add Waste Heat

Waste Heat from system components and regenerative braking

## Optimization

Optimizing the flow rate to match thermal energy input that is available



The figures above represent the sequential increase of potential energy output from our patented designs and processes, starting from previous conventional baseline designs.



# Carnot EFFICIENCY

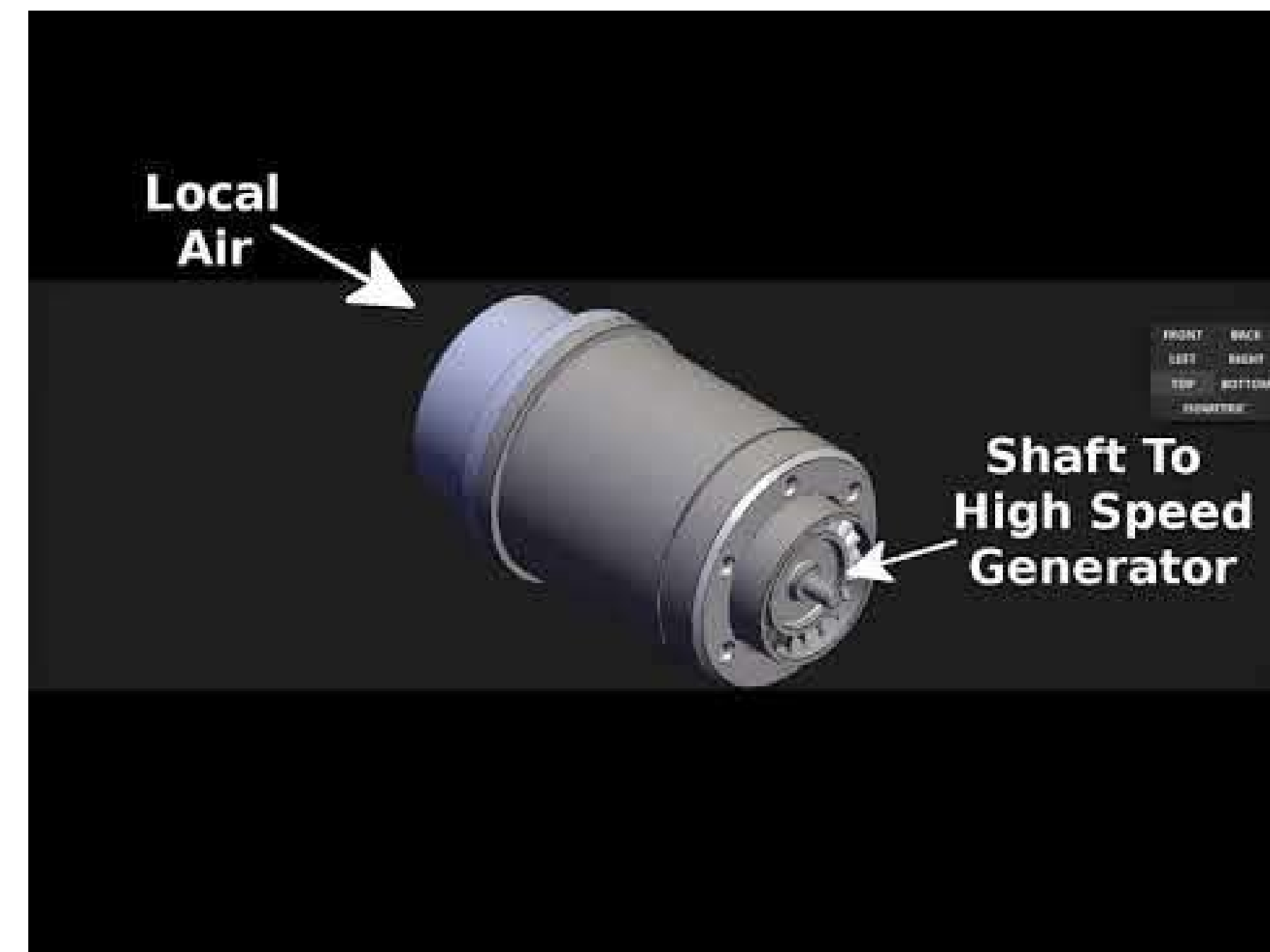
Our Range Extender is a Reverse Heat Engine that utilizes the ambient as the primary heat source

Liquid Air/Nitrogen = 77K  
Ambient = 300K  
 $1 - (77/300) =$   
Carnot Efficiency of:

74%

Potential Energy of Liquid Air/Nitrogen - 205Wh/kg X 74%  
(Carnot Efficiency) =  
~150Wh/kg

[Click Here for Introduction Video of Range Extender + High Speed Generator](#)



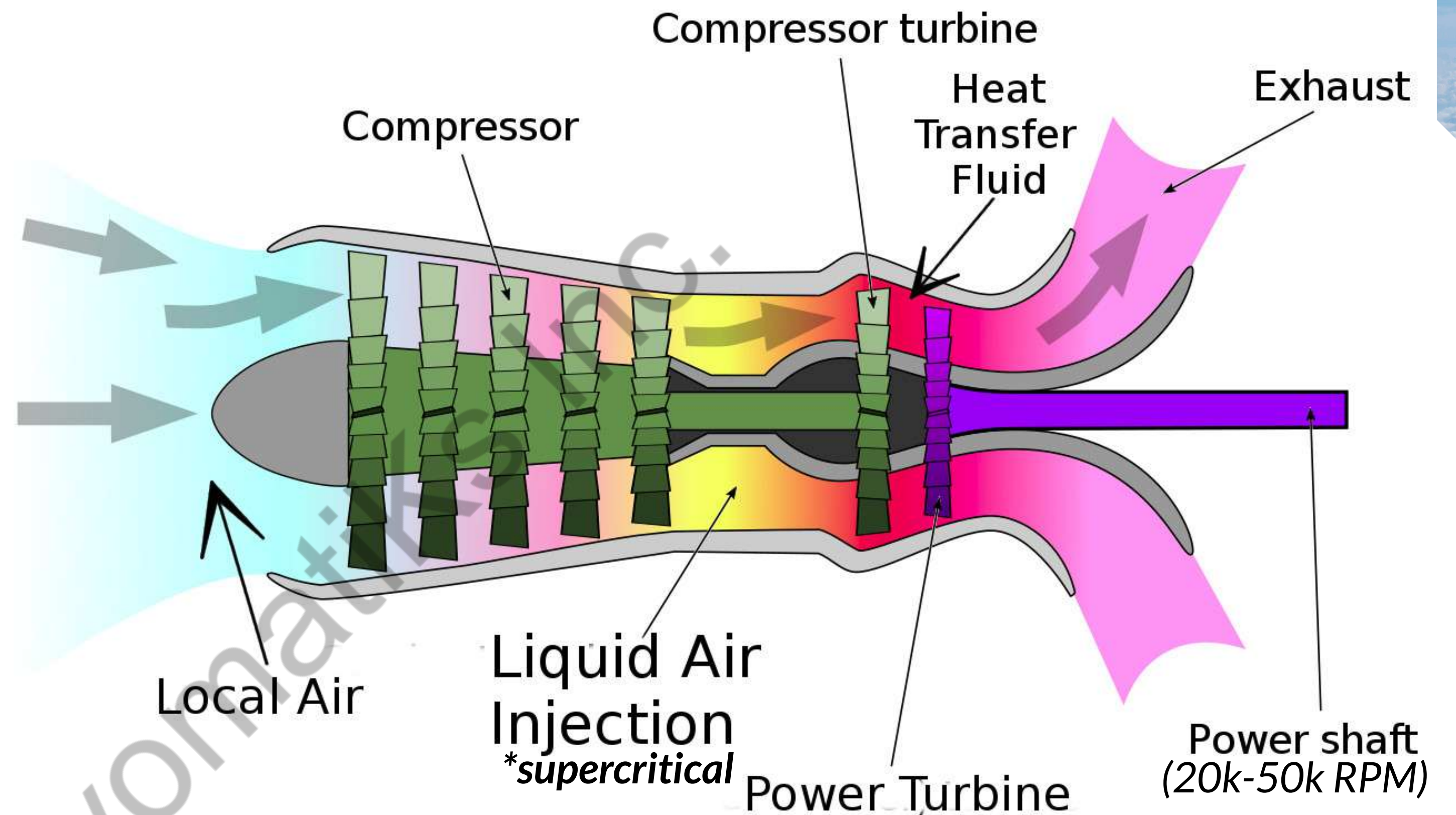


# QUASI ISOTHERMAL *EXPANSION*

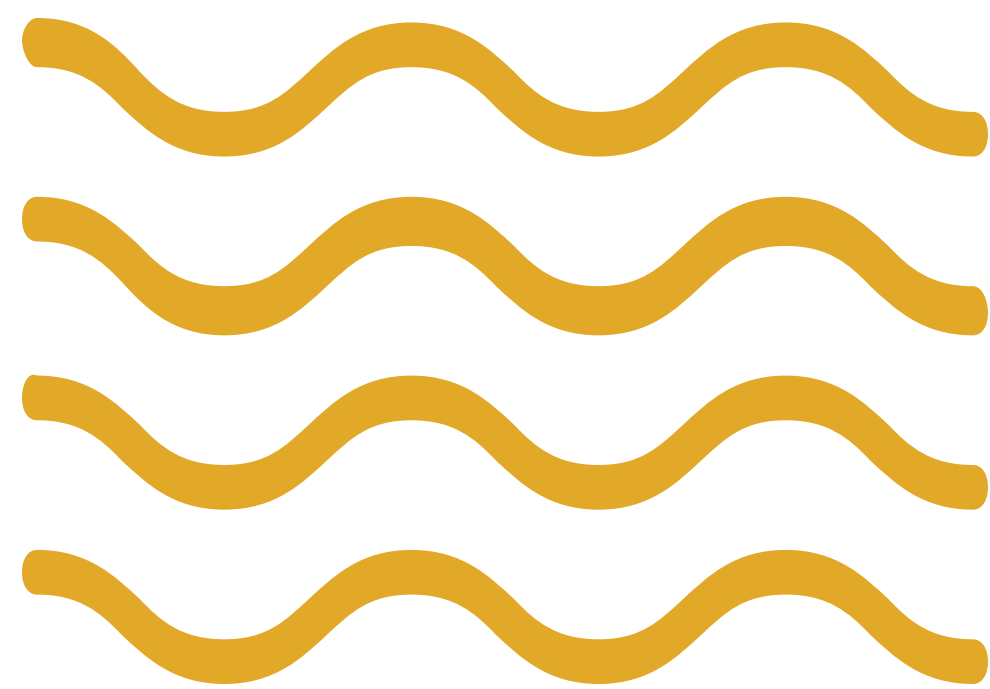
Increases Conversion Rate Closer to Carnot %

## Thermal Inputs

- Ambient
- Waste Heat from System Components (Generator, motor controller)
- Regenerative Braking



Increasing shaft RPM 2x increases power output 2x with the same size and mass of generator



Thermal levels above average ambient (~300K) increases potential energy capacity and peak Carnot efficiency



# HAS THIS BEEN DONE BEFORE?

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## Previous Designs that utilize Liquid Air/Nitrogen

**1900s** - Converted Steam Engine Directly Driving Wheels

**1970s** - Heat Exchanger + Air Engine Directly Driving Wheels

**1990s** - Improved Heat Exchanger + Air Engine Directly Driving Wheels

**2010s** - Grid Scale High Speed Turbines + Cold/Hot Storage. Design is not applicable for transportation or portable power (250MWh Stationary System under construction in the UK now)



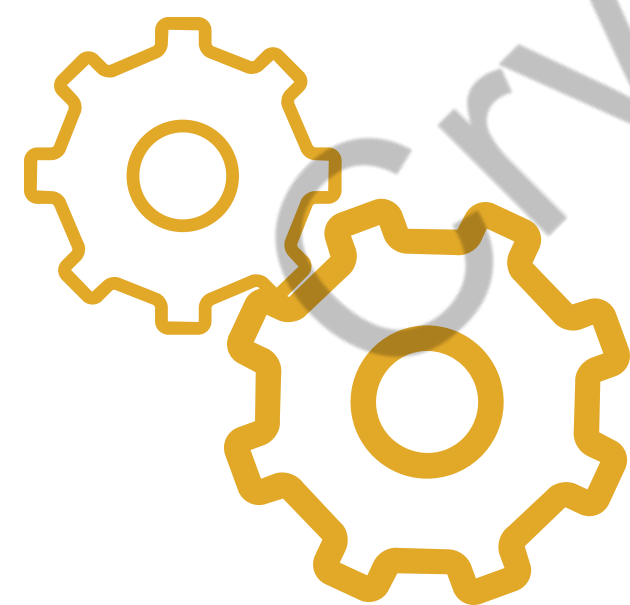
# ISSUES WITH PREVIOUS DESIGNS/*OUR SOLUTIONS*

Every design has trade offs and issues that must be resolved. Here's a few of the main issues with previous designs and how we address those issues.



**Frost:** The buildup of frost limited the conversion rate of previous designs. We address this issue by having the Liquid Air/Nitrogen change phase within the turbine

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**Direct Drive:** Mechanically coupling the air motor or turbine to the drive wheels limits the performance and design options. We address this issue by utilizing a serial layout combined with existing off the shelf EV components

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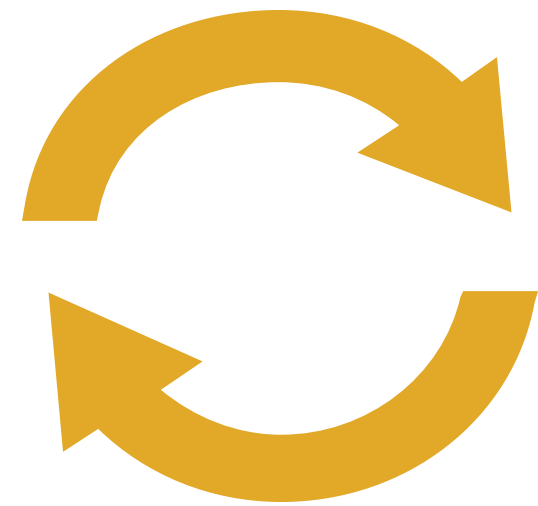


**Energy Capacity:** Solutions for transportation and portable power need to be compact while providing 100+ Wh/kg. We address this issue with a Quasi Isothermal expansion process that utilizes the ambient plus available waste heat from system components

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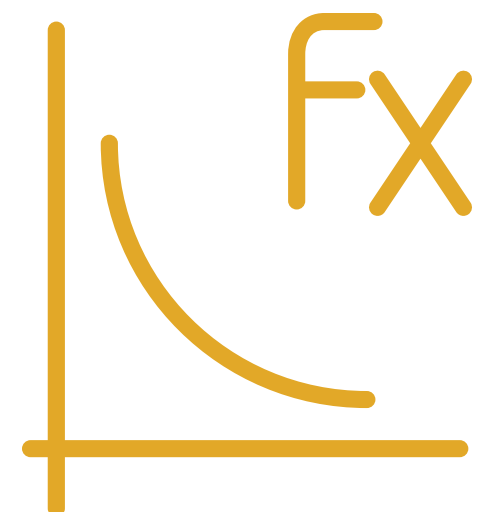


# Key Benefits Relative to other *Zero Emission Technologies*



**Unlimited Cycles & Infinite Scalability**  
**No Rare Earth Metals (it's just air!!!)**

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**Our Range Extender can be optimized in Real Time for specific vehicle, route, and weather**

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**Modular design - As individual components become cheaper, system cost is reduced**

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**5 minute quick refueling, Just-In-Time energy services, and mobile quick charging**



# **VALUE PROPOSITION of USING** **CRYO TURBO SOLUTIONS** **POWERED BY LIQUID** **AIR/NITROGEN**

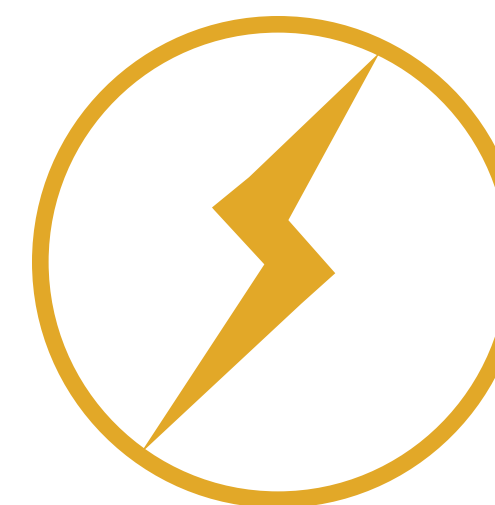
## **Value Created for Cities**

Accelerate the adoption of zero emission commercial vehicles that operate within busy city streets



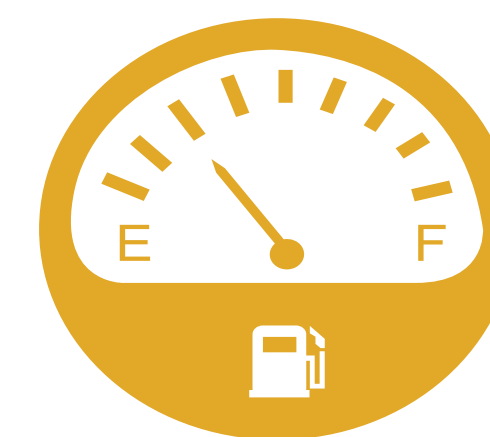
## **Value Created for Utilities**

The use of Liquid Air/Nitrogen creates new loads and new use cases. Helps to minimize curtailment of wind/solar and provides an additional use for off-peak electricity



## **Value Created for Fleets**

Reduces per mile operating cost, helps to meet emissions regulations, single design for multiple vehicle types



## **Value Created for Everybody**

Converting air into a liquid purifies the air we all breathe. Cryo turbo solutions are both sustainable and help prevent future pollution





Thank You

[Click Here for motivation  
of Cryo Energy Technology](#)



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