# Castor Solutions Inc.

*“The Power of Air Energizing & Hydrating Your Entire World”*

# Executive Summary

Company: Castor Air 2 Electricity & Water Solutions, Inc.
Chelsea, MA 02150
www.castorair2electricity.org
617-216-5714

- DUNS #: 080976565;
- Minority-owned and Operated (EST. 12/2008)

Who we are:

- Castor Air 2 Electricity & Water Solutions, Inc researches and develops next-gen, cleantech-focused Onsite Energy Harvesting Technologies that double as Onsite Water Harvesting Technologies to individualize personal onsite access to not only electrical generation and storage process but also access to stored drinking water.

- Our patent-pending metered, cogenerated, Air-to-Electricity & Water Multiplier Microgrid Technology can feature 2 modes:

1) Air- to-Electricity mode (As an Onsite Energy Harvesting Microgrid Technology), where the setting generates, transfers and stores electricity and resources to provide next-gen, renewable-based utility services; and

2) Air-to-Water mode (As an Onsite Water Harvesting Technology), stored electricity is directed to run an onboard motor that will collect and store moisture or water molecules in the air within the storage tank for water harvesting purposes.

- In Air-to-Electricity mode, our Microgrid utilizes renewable and can convert a 24/7-accessible onsite resource, which is storable ambient gas, for isothermal-based portable thermal energy storage (Referred to as Air-to-Electricity Mode) to trigger a series of high-energy-density-promoting novel generators using environmentally-safe pressure as pneumatic force instead of limited, costly fossil fuels or natural gas.

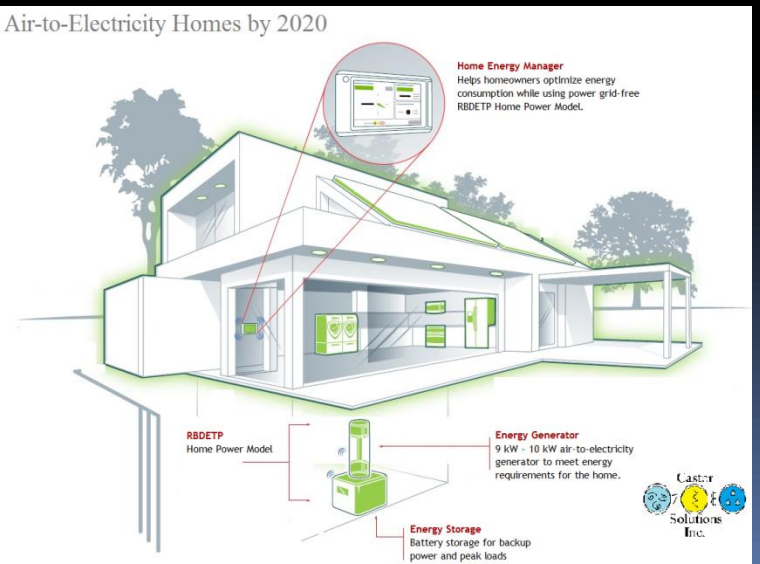
- Besides utilizing a 24/7-accessible resource in the form of storable ambient gas to produce and store electricity, another unique value proposition of Air-to-Electricity mode is that the system's exhaust pressure or waste heat can then be autonomously recycled back into the storage tank (Thereby increasing both energy efficiency and cost efficiency) to refill and raise the volume of pressure in the tank using coupled single-direction and adjustable release valves for prolonged systemic access to high-density-based pneumatic pressure, instead of relying on an onboard motor that drains power to convert ambient gas to stored thermal energy.

# Technology Concept

Solution: Autonomous, Cogeneration-Based Air to Energy and Water Harvesting Microgrid System for Disaster Relief Applications

Manipulating the power of air, Castor Air 2 Electricity & Water Solutions Inc. developed a multifunctional, onsite Energy Harvesting Technology that doubles as an onsite Water Harvesting Technology. As an Energy Harvesting Technology, our patent-pending Air-to-Electricity Microgrid utilizes, collects and stores surrounding resources to promote high density energies onsite that is 24/7-accessible when you need it so there is no more worrying about unreliable or intermittent power, blackouts, attacks on fuel supply runs, harmful emissions, and high utility costs. The power of air can hydrate and energize your entire world. Utilizing storable cheap clean air to generate and storage electricity 24/7 onsite, we are here to provide consumers better, affordable, decentralized energy options while simultaneously generating a significant profit mechanism in the energy sector. In summation, through the conversion of air-to-storable electricity, there will be no more worrying about unreliable and intermittent power, blackouts, attacks on fuel supply runs, harmful emissions, high utility costs, or having to pay for both supply and electrical generation costs.

Besides producing high-density energy onsite when you need it, our patent-pending microgrid enables the harvesting of water from air, even in arid and semi-arid conditions, thereby significantly reducing or eliminating the need to transport water and reduce the fuel demands required to establish, support and operate contingency operating base camp. As an onsite water harvesting technology, it could greatly reduce the footprint of water resupply.




# Problems in Energy Sector

**INNOVATION AND IMPACT**

There are many problems that continue to plague the energy sector. Access to consistent power is vital for U.S. national security and developing countries. Problems that we are tackling include 1) outdated and overstretched power grid, 2) high feed line costs, 3) lack in reliable onsite access to power, even in developing countries, and 4) high utility costs, and 5) lack in efficient CHP systems. For example, the feed resources - natural gas, methane, hydrogen and water for steam (thermal cost) to operate - that operate micro-CHP energy systems are expensive, intermittent, emission-prone and very limited resources. Within a 40-year period, the average consumer pays $53,000 or more, mainly due to increased resource or supply costs from using limited resources that are passed down to the consumer to pay.

Globally, lack of access to reliable energy solutions continue in 2018. In developing countries, only 75% of citizens have access to power. Even for the wealthy, the limited supply makes it availability unreliable and frequent power outages are a reality for residents. Of the 1.2 billion world citizens who live in the dark, around 550 million live in Africa.

As for existing renewable, although abundant, solar and wind are also limited resources regulated by regional discrepancies, consistent changes in weather conditions or time of day. Intermittency plague standalone renewables like solar and wind, making standalone solar inefficient at night and in certain weather conditions, and standalone wind inefficient in areas where it is not windy. Farms of costly renewables are needed to produce high density energy.
Finally, as for oil, in 2010, the investment bank HSBC published a white paper that speculated that even under the rosiest scenarios, the world only has 50-year supply of oil left, which is why oil companies are drilling offshore and in the Arctic - the easily accessible oil is already used up. The U.S. Department of Defense is the largest single consumer of energy in the world, gobbling up 3.8 billion kW hours of electricity and 120 million barrels of oil per year. Reliance on combustibles is an expensive habit, costing the agency some $20 billion a year. These combustible systems are not a long-term solutions for energy independence.

Ever since it was discovered that the Earth was suffering from global warming due to combustibles, renewable energy has been a much-discussed topic. The ability to harvest high density energy from natural sources (like solar and air) while reducing the use of combustion fuel to reduce the effects of pollution is so crucial that world leaders have continued to work together since the 2016 Paris Climate Change Summit [1]. The main obstacles with current standalone renewable energy sources is that it is expensive (because the relative energy-conversion efficiency is still very low and its expensive start-up cost) and unreliable (due to unpredictable weather conditions and/or expensive energy storage cost).

Air, as a viable convertible natural resource, is regionally accessible 24/7, particularly for electrical production and storage. Extensive research and development in thermal energy storage-based multiplier microgrid technology at Castor Air 2 Electricity & Water Solutions Inc showed that 1) pressurized gas houses energy, 2) ambient gas houses moisture that can be collected, 3) ambient gas can be stored as pressurized gas or energy to trigger generators and 4) ambient gas can be continuously recycled as energy back into storage tank to increase energy efficiency, and 5) renewables can be adopted to supplement excess energies, and 6) batteries can be adopted to store cogeneration and multiplier energies for later usage.

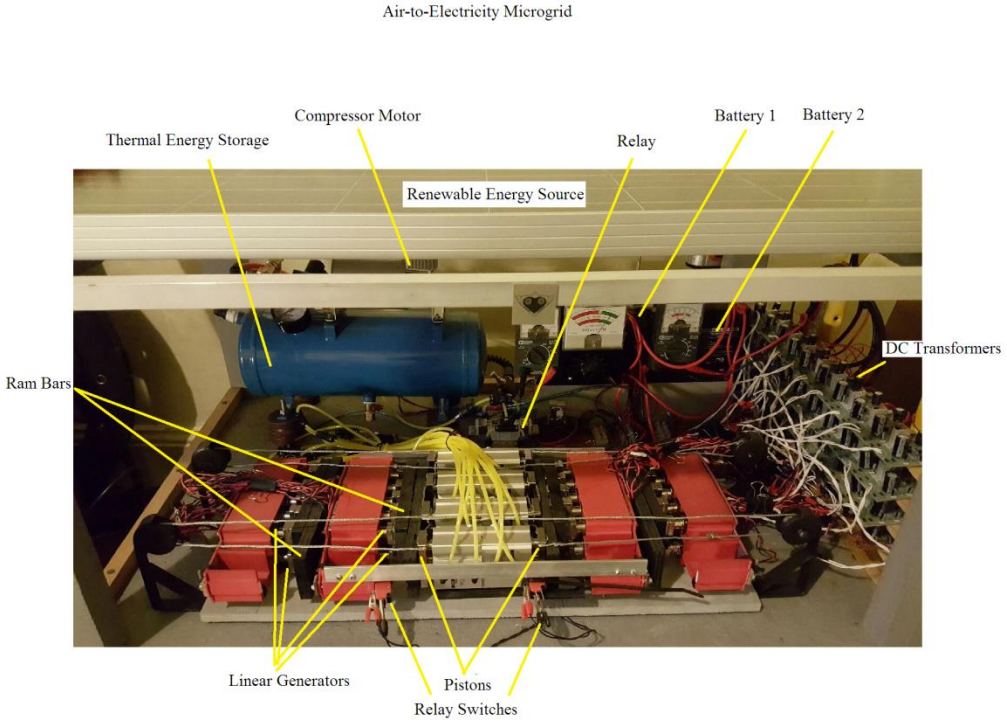
The meter-based Air-to-Electricity Mobile Microgrid offers a more mobile and cost-efficient and completely environment friendly all-in- one electrical generator and storage for both electrical and water collecting as well as storage for onsite electrical and ambient gas resources. This low cost microgrid design will prevent blackouts while allowing onsite, hurricane-proof water & energy harvesting capabilities while using onsite resources like air as pressurized gas so utilities can provide uninterruptable power. Global regions facing unreliable access to power and regions reliant on harmful costly resources will benefit from a pressure conversion multiplier microgrid that can convert 24/7-accessible air into pressure to generate and collect onsite reliable high-density energy and water.

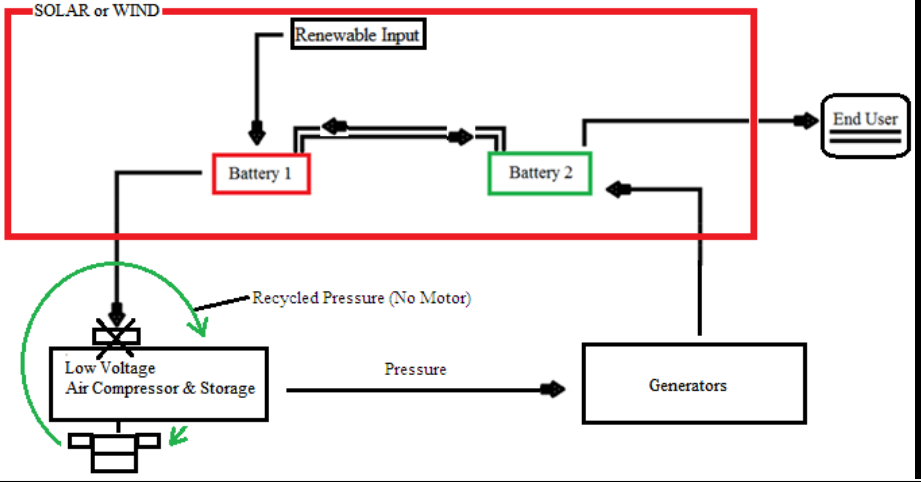
Expected Conclusions Reached (5KW 10KWH Model)

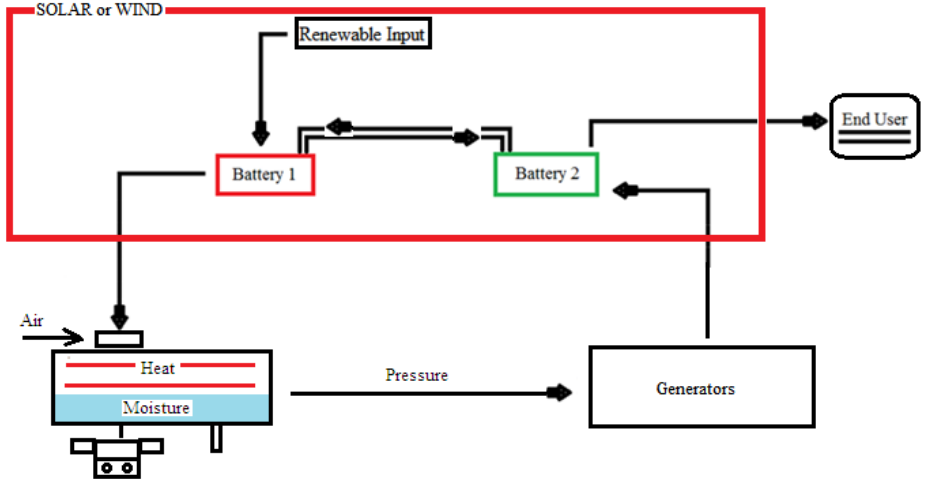
-Energy Output: 5KW Total (2KW Renewable + 3KW CHP)
-Electrical Battery Storage: 10kWh
-Kwh usage: $.05
-Static Conversion: > 90%
-Dynamic Conversion: > 90% in Air-to-Electricity Mode,
66% in Air-to-Water Mode
-System: Combined Renewable + CHP, Isothermal-Based
-Gallon: > 10
-Pressure: >150-300 psi
-Horsepower: > 3 3/4 HP
-Estimated Cost: < $15,000-$25,000

## Prototype Videos

- Promo Video – 2018 – URL - https://youtu.be/mjsZPoC6y-E
- Prototype Video - Air-to-Electricity Mobile Microgrid – 2016 – URL - https://youtu.be/x3FLJN5uUgw
- Prototype Video - Novel Generator – 2014 - URL- https://youtu.be/33QIvPIR6sQ






**Onsite Energy Harvesting Process**
**(Air-to-Electricity Mode)**

Process:

1) Renewables energize operational battery (Battery 1)

2) Batteries energize low voltage motor (Compressor) once, thereby collecting and converting ambient gas as storable thermal energy. Pressure is then recycled manually (Motor not activated in order to conserve energy)

3) Stored thermal energy pneumatically triggers multiplied generators for excess energy

4) Multiplied generators energize supplemental battery (Battery 2)

5) Battery 1 and 2 can remain separated or can be interconnected for balancing bidirectional energy flow for the end user.

6) Exhaust pressure exiting the system can be continuously recycled in a single direction back into gas storage tank, which will prevent the pressure conversion motor from needing to operate after its initial conversion, which will prevent battery drainage and increase energy efficiency from 66% (motor usage) to 90% due to recycling pressure.

7) Repeat Steps 1 and 3.

**Onsite Water Harvesting Process**
**(Air-to-Water Mode)**

Process:

1) Renewables energize operational battery (Battery 1)

2) Directs stored power (Batteries) to energize low voltage motor (Compressor) continuously, thereby collecting and converting moisture-rich ambient gas as storable thermal energy and water.

3) Stored thermal energy pneumatically triggers multiplied generators for excess energy

4) Multiplied generators energize supplemental battery (Battery 2)

5) Battery 1 and Battery 2 are interconnected for bidirectional energy flow balancing for end user

## Scalable Models

1. handheld power (70W 140WH)
2. low residential power (1KW 2KWH)
3. electric vehicle power (2.5KW 5KWH)
4. high residential power (5KW 10KWH)
5. residential power (100MW+)

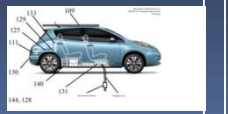
## Applications

**Military & Defense Applications**
- Base power
- Handheld power for Warfighter equipment
- Electric vehicle power
- Space (Pressurized gas energy converter)

**Aerospace Applications**
- Battery-Powered aircraft
- Drones
- The International Space Station

**Green Building Applications**
- Disaster Relief
- Residential power
- Commercial/Industrial power
- Utility-Scaled Power
- Backup for Existing Solar or Wind
- Standalone power for campaigns

**Transportation Applications**
- EV-to-Grid applications
- Battery-Operated transportations
- Mars explorer vehicles



## PROJECTED MANUFACTURING COST – MODELS VS. COST (RETAIL AND ONE-PIECE PARTS):

Since we have the desktop model (360W, 576Wh) ready, this model would be sold since it is presently ready. We would need adequate time to manufacture, test and scale the other model sizes for pre-orders as we formulate a business relationship with the right manufacturer and continue to build our team. Since all that is necessary to do is scale the model to appropriate sizes, the following outlines the models:

| Model | Estimated Manufacturing Cost | Sale Price |
|---|---|---|
| *70W 140WH - Handheld | $100-170.86 | $350 |
| 340W 576 WH - Desktop | $500-838.75 | $1,200 |
| *1KW 2KWH Low Residential Power | $1,505.57 | $3,511.15 |
| 2.5KW 5KWH - Medium Residential Power - Electric Vehicle | $3,011.15 | $8,500.00 |
| *5KW 10KWH – High Residential | $7,527.85 | $20,000.00 |

****Manufacturing Options:

Building the following parts in-house would result in considerable savings on generators, springs, magnets and transformers. Formulated strategic partnerships with both renewable and battery manufacturers to incorporate their products into marketed project in exchange for time-limited Power Purchasing Agreement share ownership can be pursued.

## Scalable Models

1. handheld power (70W 140WH)
2. low residential power (1KW 2KWH)
3. electric vehicle power (2.5KW 5KWH)
4. high residential power (5KW 10KWH)
5. residential power (100MW+)

## Applications

**Military & Defense Applications**
- Base power
- Handheld power for Warfighter equipment
- Electric vehicle power
- Space (Pressurized gas energy converter)

**Aerospace Applications**
- Battery-Powered aircraft
- Drones
- The International Space Station

**Green Building Applications**
- Disaster Relief
- Residential power
- Commercial/Industrial power
- Utility-Scaled Power
- Backup for Existing Solar or Wind
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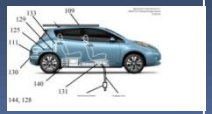

| MODELS | Handheld | Desktop (1/8HP) -Higher energy conversion -Draws less power | Small Residential | Medium Residential |
|---|---|---|---|---|
| Total Energy: | 100W | 340W | 980W | 5kW |
| Input Renewable Energy: | 50W | 100W | 500W | 2.5kW |
| CHP-based Generators: | 50W | 240W | 480W | 2,496Kw |
| Air Compressor Power: | -46.60W | -93.75W | -372.85 W | -2,330.31 |
| Use, KW of Renewable electricity | | $0.04 | | |
| Use, KW of Renewable electricity | | $0.05 | | |
| Static Conversion: | .06/50W =.99.9% | .06/240W = .99.9% | .06/500W = .99.9% | .06/2.5KW=.99.9% |
| Battery Dynamic Conversion: | 46.60/200W = 76.7% | 93.75/576W = 98.62% | 372.85/2kw = 81.36% | 2330.31/5,000 = 53.4% |
| CHP Dynamic Conversion: | 46.60/50W= 6.79% | 93.75/240W = 61% | 372.85/480W = 22.33% | 2330.31/2496 = 6.64% |
| Total Dynamic Energy Conversion: | 46.60/100 = 53.4% | 93.75/440W = 79% | 372.85/980W = 61.96% | 2330.31/5000 = 53.4% |
| Gallon: | .3975 Gal. | 1.59 Gal. | 3.975 Gal. | 19.875 Gal. |
| Pressure Volume: | 47.7 PSI | 120 PSI | 300 PSI | 1,500 PSI |
| Relay Type | Timed Release | Timed Release | Timed Release | Timed Release |
| Horsepower: | 1/16 | 1/8 | 1/2 | 3 1/8 |
| 0-120 PSI Rate | 24.5 s | 3 min 15 s | 50 s | 20 min 41 s |
| Cfm @ 90 PSI | .5 | 1.0 | 4.1 | 25.8 |
| Cfm @ 120 PSI | .3 | .7 | 3.1 | 19.4 |
| Palm-size Generators: | 2 | 40 | 80 | 1,248 |
| # of Batteries: | 1 | 4 | 8 | 20 |
| Total Battery Storage: | 200Wh | 576Wh | 2,000Wh | 5,000Wh |
| Inverter: | 12V, 100W | 12V, 500W | 24V, 2,000W | 24V, 5,000W |

# Competition

Traditional CHP (Combined Heat and Power) microgrids use turbine generators and allows for maximum extraction of the renewable power by coordinating control between renewable and the fossil fuel-based generators which runs off combustion [10].Traditional CAES (Compressed Air Energy Storage) models utilize diabatic storage (designed with heat expansion or combustion components) to recycle combustible-based heated gas to trigger turbine motion to generate electricity. Energy efficiency is reduced due to energy lost in wasted heat and mechanical energy to manipulate a turbine cycle.

The Air-to-Electricity Mobile Microgrid is an adiabatic-based system that stores and synchronizes multiple power sources. The generator and storage system works in conjunction with renewable energy auxiliary, a motorized pump, heat recycling and a series of interconnected generators to produce electricity that is stored in a series of batteries. The generators are push-down magnetic induction generators which are lighter, less bulky and require less energy to trigger movement than their turbine counterparts. By utilizing a battery in the mix, energy will be available instantaneously when it is required. The Air-to-Electricity Mobile Microgrid increases energy conversion, minimizes heat losses, requires no combustion, and is much more mobile due to its smaller size and mass for societal needs.

## CHP Systems – Combustibles vs. Isothermal

We live in a combustible world, where our society runs off combustion, from our cars to generating electricity. Unfortunately, these combustible systems run on costly, toxic, limited resources like fossil fuels and natural gas.

## Existing Combustibles (Chemical reaction-based)

In the East, National Grid (Eversource) →

- charges between $250-$300 per month for both electrical delivery and electrical generation
- fluctuating rates ($.07 from July to December and $.11 from January to June, with fixed being $.097.
- Within a 40-year period, the consumer pays $53,000 or more due to increased supply costs for feed lines that are passed down to the consumer to pay.

In the West, The average delivered minimum bill for PG&E is $.32, with the average total rate being $.22 per kwh.

## Isothermal (Storable heat energy-based)

Our CHP Air-to-Electricity microgrid →

- Charges $153 per month all year round for only electrical generation (Half the rate)
- Fixed rate per scaled model (Rate is $.05 per kwh all year round for residential power)
- Runs on and stores 24/7-accessible, environmentally safe, cheap stored air
- Dynamic Conversion: 90% efficient
- Leasing and maintenance fees will apply.

# CHP Competition

(Combustible vs Isothermal)

Traditional CHP (Combined Heat & Power):

- is combustible-based
- recycles heated air to trigger turbine motion to generate electricity
- utilizes diabatic storage (designed with heat expansion or burning fuel for combustion components)
- is designed with bulky turbines (not energy efficient since excess energy is wasted to rotate turbine)
- require heat to be generated continuously, which means energy escapes or is used up more.
- utilizes renewables
- burns fuel that adds to the cost of the recovered electrical energy and compromises the ecological benefits associated with most renewable energy sources
- is thus far the only system which has been implemented commercially.

VS

Air-to-Electricity & Water Microgrid :

- is isothermal-based
- recycles stored compressed air to trigger magnetic induction linear motion to generate electricity
- utilizes adiabatic storage
- is designed with a series of linear generators that are primary power source for batteries
- allows for the onsite conversion, storage and later usage of ambient gas as storable thermal energy
- utilizes renewables as secondary power source for batteries
- utilizes two bidirectional flow batteries that stores excess electricity and continues motor operations ,when needed
- can harvest moisture in the air as water byproduct for drinking purposes
- is a storable thermal energy system that is capable of being implemented commercially.

## Proposed Work

Currently, Castor Air 2 Electricity & Water Solutions Inc. has already produced a desktop-scaled 340W 576Wh prototype which proves that the product of the innovation is valid and functional. Therefore, at this stage (which is scheduled to be 9 months), funds are requested to, 1) develop analytic models and simulation of desktop prototype using Matlab, 2) data analysis of desktop prototype, 3) finalized testing of refined desktop model and 4) research and development on a 5kW 10kWh residential model. To achieve this, Castor Air 2Electricity & Water Solutions Inc. will finalize collaboration with New York University.

Renewable energy is a very popular topic at the moment and thus the competition will be fierce as there will be many companies selling their own version of renewable technology. However, so far, the product that is most similar to the adiabatic-based Air-to-Electric Mobile Microgrid that is commercially implemented is the diabatic CAES, and as stated before, the Air-to-Electric Mobile Microgrid has many advantages over it. The solution would be an affordable generator and storage system with low operational costs that works with renewable and operates on accessibly cheap resources. Air is the only cost-efficient resource that is constantly available or accessible 24/7. Converting air, the most abundant resource that we have, into storable applicable force is very cheap ($.05 per kWh), accessible 24/7 and supplies high energy densities when converted to compressed air, even with a low volume motor. For efficient force application, the energy market needs an innovative CHP system that can not only use air as fuel but can also work with existing renewables and storage to promote higher energy densities when consumers need it.  The main challenge will be discovering a method to scale up the total energy storage and power transfer without jeopardizing the energy conversion efficiency (and thus cost) and its mobility too much (or to an acceptable degree).

**Budget**

Funding:
Federal funding requested: $493,750

Item/Name
Cost/Compensation
Principle Investigator (Jaimin Jha)
$80,000
Principle Investigator (Kwok Ben)
$80,000
Inventor/Co-Principle Investigator (Varnell Castor)
$100,000
Material Costs
$50,000
Travel
$10,000
Sub-award (New York University)
$150,000
Cost Sharing
$23,750
**Total**
**$493,750**

**4. TEAM ORGANIZATION AND CAPABILITIES**
The project team comprises of Castor Air 2 Electricity& Water Solutions Inc. and New York University.

**Castor Air 2 Electricity& Water Solutions Inc.**
Varnell Castor (Founder,Inventor)(Co-P.I.)
Varnell has the leadership experience, management skillset, and hands-on electrical and mechanical engineering background to lead product development and oversee its tech-to-market transition.

Jaimin Jha (M.S.E.E.) (P.I.)
Jaimin has completed his Masters of Science from New York University and is working as a Principle Investigator at Castor Air 2 Electricity & Water Solutions Inc. He will be supervising the development and testing of model.

Kwok Ben (M.S.E.E) (P.I.)
Ben has got his Masters of Science from New York University and is working as a Principle Investigator. He will be working with NYU on validating the developed model.

**New York University**
Prof. Francisco De Leon (Ph.D.)
Prof. De Leon is working as an associate professor at NYU. During his tenure he has guided many Masters and Ph.D. students and has authored in over a 100 papers. He has great experience working in power systems, heating systems and storage systems. He will be guiding the principle investigators as well as a Masters student who will be developing and testing the model.

# Company Viability

## Market Strategy

Customers appealed to reliable onsite energy and water harvester

- telecommunication companies
- Military branches that require buildings or Forts
- homeowners (Energy is the lifeblood of tech-driven society, powering 130 million homes in the US and 57.2 billion homes worldwide)
- developing countries
- electric vehicle manufacturers
- existing utilities seeking to save on supply costs
- outdoor enthusiasts can utilize our independent energy system to transition their fossil

6 significant impacts on society

- the device will allow more users to use energy at reduced costs ($.05 kWh)
- device will access high-density air as fuel to power equipment
- adopted facilities would not need to be tied to the grid
- portability of the microgrid would all for access to power anywhere air is accessible
- microgrid can be scaled to size for multiple applications to fit end user needs
- water as a thermal energy byproduct can be collected onsite for drinking purposes

Business Perks

- job creation (local assembly while parts purchased from China to save costs)
- fuel the America economy
- protects the environment
- product sourcing would include local assembly of our cleantech IP system

## Summary
## Business Plan for Growth

1.We secure startup funding through:

- Donations
- Federal Grants

2.Utilize funding to manufacture 4 scalable models:

- 70W 140Wh handheld model,
- 1Kw 2kwh low energy model,
- 2.5kw 5kwh medium energy model (average homes and electric vehicles)
- 5kw 10kwh residential high energy model

3.We will market and promote to the Department of Urban and Housing Authority as well as other low income development agencies at the local level

4.Revenue is generated monthly through:

1) unit leasing agreements,
2) customer electrical generation and usage,
3) power purchasing agreements with utility companies to combat overstretched power grid, and
4) maintenance fees

5.In 2 years, we utilize series A, B and C funding as well as a portion of allocated revenue to target Military and key global energy markets, including 9 global energy leaders - France, Russia, Germany, Spain, U.K., China, Japan, Africa, Canada

6.Other 185 global market allies that signed the Paris Climate Change Treaty will be entered

7.Exit Strategy - After allocating global investors and continued revenue, in 5 to 7 years, we will position ourselves for a merger and acquisition strategy by a Military or global utility company.

## Revenue Strategy

**Revenue Streams:**

1. Donations

2. Sales
   - Desktop model (Drones, Robotics)
   - Medium power model (2.5KW, 5KWH) (Homes, Electric Vehicles)

2. Leasing agreements
   - Low power model (1KW 2KWH) (Drones, Robotics)
   - Medium power model (2.5KW, 5KWH) (Homes, Electric Vehicles)
   - High power model (5KW 10KWH) (Large Homes)
     - -All customers charged a leasing fee when financed or leased in 12, 24, or 48 month lease terms
     - Mandated leasing agreements on regional models
     - Regional models and Industrial models are charged higher interest rates

3. Power Purchasing Agreements
   - Low power model
   - Medium power model
   - High power model
     - Regional models
     - Sell power back to utilities

4. Monthly Utility Charge (@ $.05 per KWH)
   - Low power model
   - Medium power model
   - High power model
     - Low, Medium and High Power Building Owners
     - $153 per month at average $1,836 annual income per customer
     - Regional models and Industrial models are charged higher KWH rates

5. Maintenance Fees
   - Optional monthly insurance or maintenance fee on all models
   - Covers damages and/or breakdowns
   - Scalable package fees – Silver, Gold, and Platinum -, with separate package offers for each scaled model size