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On Improving Natural Gas Sector Resilience

Additional submitted attachment is included below.

Cyclone Power Technologies, Inc. has designed a novel Rankin Cycle engine that can be made to run on many fuels including pelletized solids, liquids and vapor fuels such as Natural Gas. These engines have near zero NOx in the exhaust even without emissions equipment since they are external combustion engines operating at ambient pressure. These engines have a centrifugal flame front which causes most particulate to be slung out to the outside of the circle before entering the exhaust stream. The burning of the waste or fuel has a higher residence time to burn more completely and as it does it gives up much of its heat energy to the High-Side water-coil so the exhaust is not as hot and carries less of the pollutants out the exhaust.

In addition to designing engines for Power Production and Propulsion applications, these engine systems have been designed to burn waste products and convert the energy into electrical power. One example of this is the 1 megawatt Biomass Unit which chips, dries and feeds solids into the combustion feed conveyor to be burned to produce power in excess of what is needed to operate the system. These units were designed for client(s) in the pulp wood industry and this company seeks to also market them to the Department of Defense for Expeditionary Waste to Power purposes.

This Response for **Comments on Draft Solicitation Improving Natural Gas Sector Resilience** will show that the Cyclone Engine exhibits Combustion Efficiency, Energy Balance and Flue Gas Emissions reductions (specifically NOX). As indicated above, since our burn process is at lower temperature and pressure conventional liquid fuels do not produce any nitrous oxide molecules (except for some at initial start up of the flame and then very little). Also, it is assumed that our units will compare very favorably in the areas of Life-Cycle Assessments (LCAs) by producing exportable energy, reduced objectionable emissions and cost impacts.

These 1 megawatt Waste-Burner-Engine Generator units can be highway transportable in their ISO type container(s) with one having the engine-generator, chipper, hopper, drying mechanisms and source from residual heat from the combustion process along with some of the controls in the one container. Another container will be advocated for a climate controlled operations control room and either integral with it or separate is maintenance and additional fuel media storage depending on the rate of intended process.

These engines could improve Natural Gas Resilience by burning clean on Natural Gas and also burning clean on other heat sources as may be available. For instance, these Cyclone Engine Generator units could be banked together in such a way as to allow a combination of energy and renewable energy resources to be utilized as needed for divers changing load requirements. These engines use no oil for lubrication.

The Cyclone engines can also run on a Concentrated Solar heated substance to make electricity, or to have the heated substance stored for use when demand requires. Furthermore if there is excess wind power or solar PV energy available, then the excess can be used to supplement the heating of the thermal storage substance in the hot side for use at a later time. Natural gas can efficiently run these engines.

The following was written by the Cyclone Power Technologies company president:

FIRST OF SERIES

GLOBAL WARMING/CLIMATE CHANGE/PREMATURE DEATHS TO BE REDUCTED BY MORE THAN 20% BY TECHNOLOGY AVAILABLE NOW

By Frankie Fruge, President, Cyclone Power Technologies Inc.

NO_x AND HEAT IN ENGINE EXHAUST NEGATIVE IMPACTS - GLOBAL WARMING/CLIMATE CHANGE, PLANTS, ANIMALS, AND HUMANS - THE ANSWER IS HERE NOW!! CYCLONE POWER ENGINES NEAR-ZERO NO_x - 66% DECREASE OF HEAT & PARTICULATES

Nitrogen and oxygen are present in the ambient air, which means they're present in the air-fuel mixture combusted in all gasoline and diesel engines. During high temperature/high pressure combustion, these elements combine to form NO_x. It's not possible to design an internal combustion engine that does not produce NO_x when it burns fuel. BUT CYCLONE HAS DESIGNED A LOW TEMPERATURE EXTERNAL COMBUSTION ENGINE THAT BRINGS THIS TO NEAR-ZERO OR ZERO NO_x.

NO_x production in diesel engines runs from 850mg/m³ to 1250mg/m³ based on peak temperature combustion:

NO_x reacts with atmospheric chemicals to form secondary fine particulate matter (PM_{2.5}), or soot. Exposure to PM_{2.5} can cause stroke, ischemic heart disease, chronic obstructive pulmonary disease, lung cancer, and lower respiratory infections.⁵ PM_{2.5} caused [4.2 million premature deaths](#) worldwide in 2015.

When combined with volatile organic compounds and sunlight, NO_x helps form ground-level ozone, a major component of smog. Ozone can cause or exacerbate chronic lung diseases like asthma, chronic obstructive pulmonary disease, or emphysema, especially among vulnerable populations like children and the elderly, for whom it may prove deadly. Researchers attribute [254,000 premature deaths](#) to ozone pollution in 2015.⁵

NO_x emissions also affect ecosystems and agricultural crops. Ozone pollution is toxic to plants and contributes to loss of biomass, crop yields, and forest productivity. PM_{2.5} pollution reduces solar irradiation, decreasing photosynthesis in plants and reducing their biomass. The loss in biomass means less carbon is sequestered in plants, leaving more CO₂ in the atmosphere. Both ozone and PM_{2.5} pollution can directly change the way ecosystems work by affecting the exchange of CO₂ and water vapor across the surface of leaves, which can have significant effects on hydrology—even changing stream flows.

Particulate matter or soot is created during the incomplete combustion of diesel fuel. Its composition often includes hundreds of chemical elements, including sulfates, ammonium, nitrates, elemental carbon, condensed organic compounds, and even carcinogenic compounds and heavy metals such as arsenic, selenium, cadmium and zinc.¹ Though just a fraction of the width of a human hair, particulate matter varies in size from coarse particulates (less than 10 microns in diameter) to fine particulates (less than 2.5 microns) to ultrafine particulates (less than 0.1 microns). Ultrafine particulates, which are small enough to penetrate the cells of the lungs, make up 80-95% of diesel soot pollution.

Diesel exhaust has been classified a potential human carcinogen by the U.S. Environmental Protection Agency (EPA) and the International Agency for Research on Cancer. Exposure to high levels of diesel exhaust has been shown to cause lung tumors in rats, and studies of humans routinely exposed to diesel fumes indicate a greater risk of lung cancer. For example, occupational health studies of railroad, dock, trucking, and bus garage workers exposed to high levels of diesel exhaust over many years consistently demonstrate a 20 to 50 percent increase in the risk of lung cancer or mortality.²

Of course, soot levels in many cities of China, India and poorer countries are much worse than in the US and Europe, with horrible health impact. Dirty diesel trucks, backup generators, dirty motorbikes and cars with little to no pollution control devices (as well as coal plants) are to blame.

NOx in Gasoline powered engines:

In the US, Europe and Japan, modern gasoline-engine vehicles are equipped with an effective three-way catalytic converter as part of the exhaust system. It's called a three-way catalytic converter because it controls three pollutants: carbon monoxide (CO), which combines with oxygen in the converter to become carbon dioxide (CO₂); unburned hydrocarbons, which combine with oxygen to produce CO₂ and water vapor (H₂O); and NO_x, which is reduced over the catalyst to nitrogen and water and/or CO₂. The three-way catalyst, invented in the 1970s, is inexpensive and poses little or no penalty to fuel economy, performance, drivability, or maintenance. And it is effective. A new 2017 gasoline-engine passenger car properly tuned and with a well-maintained catalyst operating in normal conditions, reduces by 90% the NO_x that would otherwise exit the tailpipe. (This does not mean that the NO_x problem is fully solved for gasoline engines; a hundred thousand cars stuck in traffic still add up to a health hazard and a pollution problem.)

NOW AN ANSWER FOR BOTH GASOLINE AND DIESEL ENGINES THERE IS STILL SIGNIFICANT NO_x AND ALSO HEAT WHICH EXITS THE ENGINE AT 1200° F in gasoline and 700 to 1090° F in diesel engines.

Fact: There are 276 million registered motor vehicles in the US in 2019 and over 1.2 Billion worldwide, inclusive of gas and diesel, and if the average exhaust temperature is say 1000° F that means we are putting into the air 276 million times 1000° F of additional exhaust heat into the atmosphere every second we run these engines. And this is just on road vehicles in the US, not even considering the more than one billion registered vehicles outside the US, or the heat and NO_x coming from off road, generators, pumps, train, ships, etc. that are all putting NO_x and excessive heat into our world.⁸

NOW FOR THE SOLUTION TO EXCESSIVE HEAT AND NO_x:

External combustion engines are here NOW with NEAR-ZERO to ZERO NO_x; exhaust heat to the atmosphere of only 190° F to 350° F; no catalytic converter needed; and able to use Gasoline or Diesel or Bio-Fuel or any combustion with the same results. Efficiencies of energy used to energy out is between 32% and 37% depending on working fluid temperature. ZERO oil changes and manufacturing friendly.¹

HEAT TO ATMOSPHERE IS NOW REDUCED BY 276 MILLION(USA)/1.2 BILLION (WORLD) TIMES 275° F (CYCLONE AVERAGE EXHAUST TEMPERATURE) A REDUCTION OF 66%.

CYCLONE POWER ENGINES, HEAT REGENERATIVE EXTERNAL COMBUSTION, RANKINE CYCLE IN SIZES FROM LAWN MOWERS TO 1 MW POWER PLANTS.

NEAR-ZERO TO ZERO NO_x - A REDUCTION OF 97% to 100%

Greenhouse gases and waste heat contribute to global warming:

A **greenhouse gas** (sometimes abbreviated **GHG**) is a **gas** that absorbs and emits radiant energy within the thermal infrared range. **Greenhouse gases** cause the **greenhouse effect**. The primary **greenhouse gases** in Earth's atmosphere are water vapor, **carbon** dioxide, methane, nitrous oxide and ozone.⁴

Elon Musk has dubbed the internal combustion engine, powered as it is by thousands of small explosions inside its cylinders, a “*remarkable kludge*.” Automotive engineers have indeed made modern gasoline and diesel engines perform remarkably — but now the limits are being reached.⁶ And while there are specific uses for electric cars, it has to be noted that they use twice the amount of fuel to create the electricity for them.⁷

Now **technology trends**, public insistence, industry investment, and government policy are all signaling that Beilenson's dream — an end to the burden of a transportation system powered by exploding gasoline or diesel combustion engines — is coming within grasp.³

THE ANSWER:

By employing the use of Cyclone's external combustion engine, we have:

- Reduced the heat to the atmosphere by 66%.
- Eliminated NO_x by 97% to potentially 100%, *the greatest health risk component of Greenhouse gases.*
- Reduced carbon dioxide by 30% or more.
- Reduced particulate matter by 80% by Cyclone's centrifuge burning.
- Reduced significantly the 4.2 million premature deaths caused by ICE's.

An **external combustion engine** is a heat **engine** where an (**internal**) working fluid is compressed and heated by **combustion** of an **external** fuel through the **engine** wall or a heat exchanger. The fluid then, by expanding and acting on the mechanism of the **engine** (piston or turbine), produces a shaft power.³

“We have One Planet and Now One Engine to preserve it!”

Sources: If you have questions please email them to: info@cyclonepower.com

1. <https://www.greencarcongress.com/2009/03/dieselfueled-cyclone-external-combustion-engine-shows-nearzero-nox.html>

2. <https://www.scholarsmine.mst.edu>

3. <https://www.theicct.org>

4. <https://www.yaleclimateconnections.org>

5. <https://www.ucsusa.org>

6. <https://www.Huffpost.com>

7. <https://www.cyclonepower.com>

8. <https://www.statista.com/statistics/859950/vehicles-in-operation-by-quarter-united-states/>

TOPIC FOR Series Number 2: Why the Clean/Efficient Small External Combustion Engine Was Just Invented and Its Attributes over Diesel and Internal Combustion Engines

This Small Business is in the negotiation stage of building these and similar but smaller units for the clean-up of the storm damaged Bahamas (located about a 100 miles from their company headquarters) but seriously needs some “working capital” up front to start producing these units in significant numbers. There is hope that after further review of the advantages to the environment and to disaster recovery this RFI Response will result in the up-front awarding of funds to get these into demonstration and full scale production as a major achievement for the use of DOE funding at such a critical time as this.

A consultant/Product Integrator for Cyclone Power, Don White, has discussed the potential opportunities for providing these or variations of these clean, Natural Gas Compatible engine-generators for the local area of the consultant who works out of Russellville, AR. Some applications are: clean back-up power for a new casino (in or adjacent to this municipality); power and cost saving clean heat and electrical energy for the local rendering plant (undisclosed name pending the funding) which is close enough to also serve as an additional back-up power to the city's sewer plant(s) in fairly close proximity; and to provide cleaner power to the city water company's pumps at the wells.

There is consideration toward putting a facility in the Arkansas River Valley with possible support from the SBA via a grant assistance program. This was discussed in vague details with the local SBA Center Director and a local SBA focused lending institution in regard to working with toward common goals of local jobs and future sales, cleaner power for the environment and advancing out "Technology to the Marketplace" plans. There is already an aluminum extrusion plant locally that could make the engine blocks with much potential cost savings to our companies (especially with the wood mill 2 blocks away that has piles of shavings suitable for burning in a bio-mass version of the system). Also, there is a preferred third generation-owned machine shop less than a mile away that has done machining and fabrications for prototypes for my company for decades.

Likewise, we could establish a business presence in California for specific aspects of manufacturing and distribution of clean burning Natural Gas engine generators. Also note that the issues with converting conventional engines to Natural Gas are eliminated or dwarfed with the External Combustion Cyclone Engine which is made to withstand corrosion from water.

In California is a person, John Nijssen,
strokerengine@hotmail.com

John has built well pump engines and racing engines. Some are used to provide power for pumps to water orchards with Natural Gas engines where power for electric motors is not readily available. John is looking for the opportunity to Sell/Distribute/ Install Natural Gas Cyclone Engines in California commercially for power related purposes and plans to use the name: Pacific Cyclone Power Technologies as his business identifier when the California funding is available and when these Cyclone Engines are available.

Discussion Questions:

The focus of this company's efforts will not duplicate the efforts of others because of the technologies involved in the design of these engine systems. These engines will run not only on Natural Gas but also on other vapor, liquid and pulverized solid fuels. These engines are environmentally friendly with features to make them meet and exceed exhaust emissions requirements. For instance, the centrifugal flame front causes a rotation that spins much of the particulates out to be caught before entering the exhaust stream. The near ambient pressure

combustion prevents the nitrous oxide molecules from forming. These engines don't use oil for lubrication of the cylinders and rotating crankshaft components. A patented Rotary Valve allows only the right amount of steam to enter the cylinders for correct torque and rpm by regulating the per cent cut-off of the valve opening for each cylinder requirement. The super-critical hot water is maintained at temperature by burn rate and at pressure by pumps. So the super-critical water doesn't flash to steam until the Rotary Valve opens to admit it into the cylinders. These are Rankin Cycle external combustion engines but unlike fossil fuel turbines with a broader power range and these can be shut down or stopped when power is not needed whereas turbine engines are very inefficient and use significant amounts of fuel when idling or partially loaded and have advantages not obtained by Sterling engine types.

The proposal could be refined by separating into multiple topics, i.e. The Cyclone Engines could run on Natural gas and be used for Propulsion Engines with their high torque, wide operating range and for the ability to run forward or backwards. Therefore coupling and power transmission requirements are simplified. The Cyclone Engines could run on Natural Gas and be used for quarries, construction and sea port material handling applications. The Cyclone Engines could run on Natural Gas and supplement electrical power demand regional loading requirements. Ideally, a common generator could be designed to be selectively coupled to other forms of renewable energy such as Concentrated Solar thermal to run the engine (with zero emissions) when available in quantities to power the generator and these are vertical shaft engines that could also be buck-boost coupled to smaller size vertical Axis Wind Turbines (VAWTs) to provide transient loads or to use off-peak power to heat the thermal substance for use after the sun sets over the horizon. (VAWTs) have not been in widespread use since many designs are not self starting at low wind speeds but these Cyclone Engines, having a high torque at low rpm >50rpm could kick on to initiate VAWT rotation then be automatically uncoupled and stop. If the VAWTs are coupled and banked with a selective choice of renewable power sources could make off-shore systems more feasible in smaller outputs for regional savings and in specific and less objectionable waterfronts with the use of Cyclone Engines for supplemental and auxiliary purposes.