Time 2 Clear the Air

A new clean solid eco-fuel to help reduce CO2 and deforestation; FireDragon

Executive summary

In conjunction with Cardiff university, BCB have perfected and scaled up for mass production a method of solidifying ethanol, helping to transform the potential users for this fantastic eco fuel. By solidifying ethanol it makes ethanol a lot safer and more practical to use. Especially in the third world, where almost a third of households still use wood as their primary cooking and heating source.

By making FireDragon readily available and low cost to these wood burning households, will potentially save;

- Over **2,400 million tons of Carbon Dioxide** per year,
- Plus other significant quantities of greenhouse gases,
- And could **save 24 million hectares of trees per year; which is about the size of the UK.**

The eco properties of ethanol are well known, but it has been limited in its use, because in its liquid form, it is dangerous to transport, store and difficult to use safely. Ethanol is widely available worldwide and is made from waste vegetation. Critically, it has a very short organic chemical formula,(C_2H_6O) which contains an oxygen atom. This improves its effectiveness as a fuel, releasing a considerable amount of energy per mass and delivering this energy not only quickly, but cleanly. Unlike the longer chemical chains of hydrocarbons, other fossil fuels, or the low energy density of wood or charcoal.

Burning these other fuels, is inefficient, as can be seen by the large quantity of carbon dioxide toxic fumes and smoke, all indicating incomplete burn. Ethanol`s short chemical compound, combined with its own oxygen, ensures that when ethanol burns, it does so with a very clean, complete, powerful, clear flame, so giving off very few noxious fumes, and little smoke.
It is though powerful enough, to have been used as a rocket fuel!

Using our patented method and a high 98% ethanol purity, we have successfully solidified ethanol. We call this new safer eco fuel, FireDragon. For the last 5 years we have been scaling up production of this fuel in the UK, where it has proved highly successful as a fuel mainly for outdoor cooking.

In partnership with United Purpose, an international charity primarily working in Africa, and the University of Malawi, we have conducted a study into how FireDragon would be received and used, by low income households as their primary source of fuel, in Malawi. These trials showed, **87% of households were "very happy" and 13% were "quite happy"** using FireDragon, and would prefer to use it, if it was available and affordable, instead of charcoal or wood, which was becoming more scarce to obtain.

Furthermore, the majority of low cost households liked FireDragon because it was:

- ease of use and ease to ignite,
- safe,
- waterproof, so could be used outside, and especially during the rainy season,
- speed of burning - @60% higher calorific value (J/kg) than charcoal,
- versatility and its,
- cleanliness and lack of smoke and fumes.

This project is ready to scale. To do this we require funding to build on the initial trial, to a more in-depth study, to compile a detailed business case possibly using Carbon Credits, with a view to make FireDragon sustainably and readily available and affordable, across Africa and SE Asia.

Objectives of this study.

- ✓ **To eventually make FireDragon available and affordable to the 2.9 billion people who burn wood or charcoal, as their primary domestic fuel.**
- ✓ **And so to help reduce the number of trees cutdown as fuel to burn and convert into charcoal.**
- ✓ **To save the approx. 7 million people who die from air pollution per year.**
- ✓ **To improve the health of those most affected, whose life expectancy is reduced by 9 years.**
- ✓ **To establish in country production of an improved multifuel cooker and FireDragon fuel, in an enduring sustainable low cost manner, using local waste vegetation and local resources.**

And so to help address the Sustainable Development Goals of the UN, most notably;

Goal 1
Helping tackle poverty around the World

Goal 3
Good Health and Well Being

Goal 7
Ensure access to affordable, reliable, sustainable modern energy

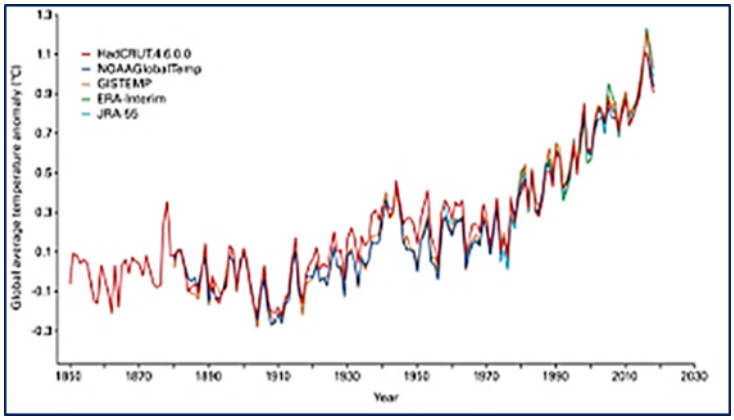
Goal 13
Climate action

Goal 15
Life on Land

FireDragon will help many of those most affected by climate change; and yet have had the least impact on it.

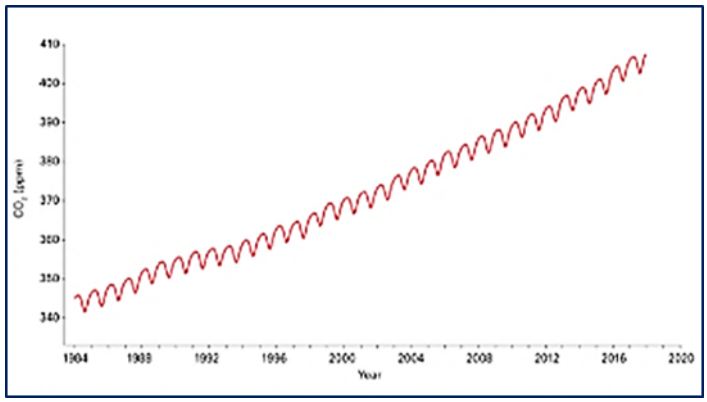
And so helping to:

- Improve the health, lifestyles and safety of the up to 2.9 billion of the poorest among us, whom daily burn wood, Charcoal or peat as their primary domestic fuel.
- Over 4.3 million people die each year due to indoor smoke inhalation **(WHO 2016).**
- Providing a better safer solid fuel to this large user base, means this small step will have an enormous impact of reducing the release of CO (and other detrimental fumes), so helping the global climate crisis.



Global mean temperature anomalies with respect to the 1850-1900 baseline, for the five global datasets **(Data source: UK Met Office Hadley Centre)**

- This in turn will substantially reduce deforestation; again, benefiting the climate.
- Reducing of other noxious and carcinogenic fume emissions considerably.
- Create many local sustainable businesses to make the cookers and fuel; so helping to reduce poverty.
- Reduce Carbon Dioxide (CO_2) substantially, carbon black, carbon monoxide (CO) by 87% and nitrogen oxides by up to 40%.



Increase in atmospheric carbon dioxide concentrations in parts per million (ppm**) World Meteorological Organization (WMO) 2018**

Tropical forest loss accounts for 8% of the World's CO_2 absorption or 4.9 billion metric tons of CO_2 p.a. **(World Resources Institute)**

Introduction

It has been long recognised that ethanol, which is produced from waste vegetation, is a clean, eco- friendly green, efficient and effective fuel. Until recently it has only been available in liquid or gel forms, which are dangerous to use, transport and store.

United Purpose Clay Stove

BCB International Ltd (BCB), working with Cardiff University, has designed and developed a low-cost effective way of solidifying ethanol and has perfected this method in large-scale production, without significant loss of heat output from the ethanol. We have called this new fuel, **FireDragon**

BCB recently helped to conduct a small user trial of **FireDragon** (FD) in impoverished households in Bangladesh, and a larger trial in Malawi, in conjunction with United Purpose (UP) a well-established,

international development charity. UP have an innovative community led approach, and have already delivered over 10,000 improved cookers to low income households in Malawi. These cook-stoves are more fuel-efficient than the traditional 3 stone fires normally used so reducing substantially the amount of wood being burnt.

Phased program introduction

BCB New Multi Fuel Stove

The main barrier to using **FireDragon**, apart from the availability, from the Malawi study was the perceived cost of **FireDragon** compared to wood or charcoal. The figures used in the study for **FireDragon** were higher than the would actually be, (as they were based on low volume UK costs). Also the study was only run in the dry season when the average cost of charcoal and wood were lower. Prices and fumes rise and cooking changes in the wet season.

It is proposed the scope of the follow on study will be undertaken in the 3 phases, and over 6 months, which should run continuously for continuity, speed of delivery and to ensure success of the objectives.

Phase 1.

A. To analysis in greater depth the local costs of FireDragon, compared to wood and charcoal in Malawi. Allowing for the greater efficiency of **FireDragon**, compared to charcoal, that only a small portion of the charcoal was usable, that the price of wood and charcoal increased in the rainy season and that these fuels are becoming more difficult to obtain.

B. To provide fuel, cookers, research and education for at a minimum, 500 low income families/households (3,000 people) during this follow-on trial.
C. Research the business case, manufacturing options locally, explore carbon offsetting arrangements, and make the business and investment case for a permanent production plant in country and possible partners for phase 2 and 3..
D. Provide extensive PR and media coverage for the project and our associated supporters.

Other considerations;

a) The households can use their existing clay and earth cookers, and modified in a similar way to the the new modifications from the recent Malawi study which can be carried out locally. Demonstrating in each village how to make these modifications and at the same time how best to use the FD. Conducted by UP and the University of Malawi.
b) A pictorial label of the above, will be added by BCB on the outside of each bucket, prior to shipping.
c) Each household comprises of on average 6 people and they cook 3 substantial meals per day.
d) That 5 liters of FireDragon is packed in a resealable bucket, which will last a household for 2 weeks.
e) Each 5 liters bucket, delivered to Malawi, in 20 foot containers for ease of handling locally.
f) Four 20 foot containers each containing @ 3,000 buckets of FD will be shipped to Malawi, including the price of the containers which will stay in country for the duration of the trial.
g) A local partner distribution company will be found to help store the fuel, distribute it and to eventually be set up to manufacture it locally.
h) The buckets can then later be used by the households for water, sanitation or storage.
i) The buckets are reusable, and could be refilled in the local market, from a central tank.
j) The more money we can raise, the more extensive and detailed this study can be.

Additional funding will speed up the delivery of phase 2 and 3 and will extend the number of countries involved in phase 1.

"One big shift (at COP 26) is that clean-energy innovation is higher on the agenda than ever.

……..and the need for new, affordable clean technology that helps people in low- and middle-income countries raise their standard of living without making climate change worse?

Six years ago, there were more people on the we-have-what-we-need side than on the innovation side. This year, though, innovation was literally on center stage.

……innovation is the only way the world can cut greenhouse gas emissions……..

At COP we need to think about how to turn lab-proven concepts into ubiquitous products that people want and can afford to buy. This will require a massive effort to fund hundreds of commercial demonstration projects of early-stage climate technologies. "

Bill Gates, November 2021.

Phase 2.

Establish local manufacture in Malawi of the finalised design of the new "multifuel" stove. This to be on an ongoing enduring trial basis; doing good as you test – test as you trial. This to be for as many users as possible, but hopefully depending on the amount of funding available, for up to 500 households over 6 months. The more funding the wider the introduction, the more beneficiaries, the sooner the project grows from trial status to really making a substantial legacy difference. And the sooner it can then progress to phase 3.

Phase 3.

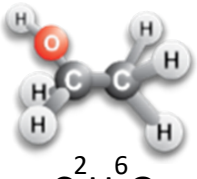
Will be to continue Phase 1 and 2 into an endearing solution, by establishing local manufacture of the solid **FireDragon** fuel. This would look to source all of the raw materials needed, or at least as many as possible, locally and certainly the primary ingredient, ethanol. Ethanol production involves a fermentation process of waste vegetation. We will look to work with local existing ethanol producers wherever possible. If there are no local producers of ethanol, then, depending on demand and funding we will look to help establish local ethanol production.

Phase 3 should try to ensure that **FireDragon** is sufficiently low cost, to make it as competitive as possible when compared to the local wood, or charcoal being used, or imported LPG gas. International carbon credits for the fuel and stove, will probably be needed to reduce the initial cost to the household so as to help ensure this program is enduring. The fuel also has to be readily available locally to ensure user acceptance and local surges in demand due to weather or population changes.

Phase 2 and 3 will not only reduce the cost of the cooker and fuel, but also to reduce the carbon footprint and create local employment, wealth and a local economy amongst the very poorest.

FireDragon Technology

Two soldiers died in their tent using hexamine solid fuel which gives off a lot of cyanide. This spurred BCB to develop FireDragon in collaboration with the chemistry boffins at Cardiff University. FireDragon solid fuel is therefore new and unique worldwide. **We believe it is THE sustainable solid fuel for the future.**



C_2H_6O

This next generation fuel is **non-toxic, high-performance and environmentally friendly.**

The secret is in the chemistry….

Ethanol has a very short chemical chain = easy to release the energy.

Ethanol contains its own oxygen = hotter more complete combustion = less fuel needed.

*FireDragon **'s bio-ethanol purity is very high at approx. 96% and is;***

✓ **Environmentally friendly**	✓ **Sustainable**
✓ **Non-toxic**	✓ **Give off little toxic fumes**
✓ **Quick & hot to cook with**	✓ **Air transportable**
✓ **Easy to light**	✓ **Will work when wet**
✓ **A hand sanitiser -** ideal when water is short or hygiene is poor	✓ **Lightweight & compact**

After it was developed it was successfully tested by the British Army over a 6-month trial both in the field and in the laboratory. In a comparative trial, set against five other solid fuels, FireDragon outperformed the other fuels in all aspects considered. It was also the most liked and easiest to use fuel tested. So much so that BCB has been awarded a second 4 year contract to supply the British Army.

We have calculated, following additional independent tests, that FireDragon has reduce the carbon dioxide emissions of the British Army since they started to use, by many tons.

Alternative solid fuels are either based on fossil fuels or wood most of which emit, higher levels of carbon dioxide, methane, carbon black, cyanide and a lot of noxious carcinogenic fumes such as formaldehyde and nitrogen oxides when burnt and a lot of carbon monoxide, due to their incomplete burn. **FireDragon** by contrast emits no formaldehyde or cyanide, and very little carbon monoxide, carbon dioxide and is more than twice as effective as wood. See the comparison test report summary below.

Please see the clean burn with little smoke and no soot being given off when **FireDragon** is burnt, compared to other solid fuels in the following video link: FireDragon Comparison Video

Bio-ethanol has been around for a long time. Till now though it has only been available in a liquid or gel form. As such it is dangerous to handle, transport, store and especially to cook with. Numerous users have been burnt when the burning liquid/gels ethanol spills or is added to the fire. FireDragon has perfected how to solidify bio-ethanol on an industrial scale. This makes it a lot safer to store, transport and more importantly to use. As the average age of refugee households is 18 years old and most of these families cooking is undertaken by the mothers or children, having

FireDragon produces the following % less than

- **26%** less Carbon Dioxide
- **87%** less carbon monoxide
- **40%** less nitrogen oxides
- **95.4%** less organic gaseous compounds
- **94.7%** less particulates @13% oxygen levels

The above information was obtained from an independent laboratory test report **BSRIA Ltd on 26th September 2019**

liquid or gel fuel around can be very dangerous.

Many people suffer burns in the UK each year, from using liquid fuels. There are no figures available for burns to impoverished families. Though LPG gas explosions (a fossil fuel also widely used for low income families) have caused numerous fatalities.

FireDragon fuel has super green eco-friendly credentials. It is made from recycled waste vegetable materials and is not a fossil fuel. Ethanol has a higher energy density than LPG, other liquid fuels and natural gases, gasoline, aviation gasoline, petrol, diesel and charcoal. It is more than twice as effective as wood.

FireDragon is also a proven very effective hand sanitizer. As we take for granted in the West, we all wash our hands prior to cooking or eating. The families we are looking to reach, especially as water and sanitation is scarce or non-existent, getting **FireDragon** onto their hands prior to cooking is a great advantage, to improve hygeine.

Over **2.2 million or 4%** of the all deaths, mainly children in the developing world, die globally each year from diarrhea. Hence, helping hygiene in these household, just before cooking and eating, will not only help to save lives, it will also help malnutrition, dehydration and the widespread suffering, associated with diarrhea.

Multi-fuel stove

Our initial new design, has been improved in the recent Malawi study and it is our intention that these would be made in the local villages, from clay and mud, using the same current method so successfully introduced by UP in Malawi, where over 10,000 UP woodburning stoves are currently in use.

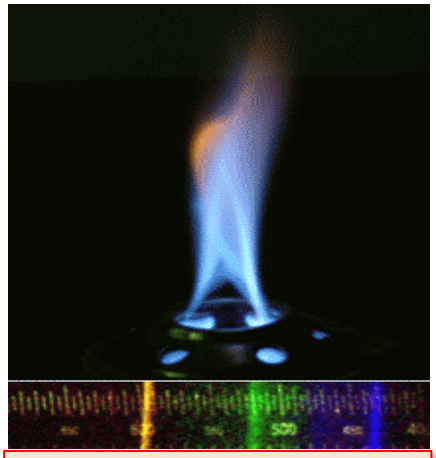
Approx. 4.3 million people die worldwide from household air pollution **WHO (2016)**

A key part of this cooker would be the foil reusable fuel pot. This will be removable from the stove and two can be fitted onto the bottom of the stove if needed for quicker cooking.

These fuel pots will be filled with **FireDragon** locally from the 5 liter sealed buckets supplied by BCB. These will have basic pictorial instructions on the outside on how to use it and safety etc., and a resealable reusable snap-on lid to save any unused fuel not burnt. The foil pot (it looks like an empty can of beans) will be approx 400 grams.

It can be removed, and more **FireDragon** fuel can be scooped out from the bucket, to be able to be repeatedly used again and again.

So hopefully the user will get some on their hands so helping to sterilise their hands automatically. One full fuel pot will be supplied with each 5 liter each bucket. In phase 3, these buckets will be able to be refilled in the local market, from a large tank of **FireDragon**.



Ethanol burning with it spectrum depicted.

UP and the University of Malawi, will train primarily the women, to make eco-friendly cookstoves from local materials. The stoves save carbon as they use 60-80% less firewood than traditional open 3-stone fires. They also reduce respiratory illness (a big killer of children in the country) and reduce deforestation (flooding also being a major risk). They will also be taught how to then sell the stoves locally, creating much needed additional incomes.

Beneficiaries for this project.

As the aid and environment differs greatly between displaced and non-displaced persons, we will consider the two groups separately. The cooking solution, instruction and supply will need to be integrated and adapted differently for the two user groups. We have discussed and studied the households in Malawi.

Refugees barter/sell up to 25% of their food in Kakuma camp Kenya in order to buy firewood & charcoal

FireDragon can also though help displaced people/refugees.

- There are over 60 million refugees worldwide.
- Refugee households spend between 15% and 20% of their income on cooking fuel.
- There are over 60 million refugees worldwide.
- Refugee households spend between 15% and 20% of their income on cooking fuel.

FireDragon is ideal for use by refugees. Either as a first response to an emergency or for people on the move as it is;

- ✓ Logistically excellent. It is, easy and safe to transport and distribute locally and can be airfreighted.
- ✓ Lightweight and a highly concentrated fuel.
- ✓ It can be stored for at least 8 years.
- ✓ Intuitive to use and takes little instruction on how to burn it.
- ✓ Can be lit when wet
- ✓ **FireDragon** is quick and easy to light with a spark or match. BCB have a small flint which is a cost effective and safer alternative to matches or a lighter.
- ✓ Non-explosive.
- ✓ As it is solid it will help to reduce burns. Liquids or gels obviously spread out quickly.
- ✓ Doesn't give off copious noxious fumes like all other fuels.
- ✓ Eco-friendly; a truly sustainable fuel for the future.

For refugees, especially if they are on the move, our new RICE (**R**efugee **I**mproved **C**ooker – **E**co) would be a more suitable cooker than the UP cooker. It is a simple, lightweight, low-cost cooker at under $0.50 and has been designed to maximise the effectiveness of the **FireDragon** . It is also designed to work with the UNHCR refugee pots and pans (Kitchen set B) and fits neatly inside the outer pan so not adding to the transport or logistical burden of distributing it to refugees. It could also easily be made locally.

ICRC & WHO in Geneva have both commented that they like **FireDragon.**

- The current fuel they use in a refugee situation is a fossil paraffin based fuel block which smells, and is part of WHO Individual Feed Kits.
- Weight of any kit/fuel is extremely important to them. **FireDragon** has a better weight to performance than paraffin.
- They like that **FireDragon** also functions as a hand cleanser.
- Both would like to test **FireDragon** and our cooker in the field.

Other agencies we will be contacting about this project will include;

- Office for the Coordination of Humanitarian Affairs (OCHA)[3]
- Inter-Agency Standing Committee, whose members are responsible for providing emergency relief.
- United Nations Development Programme (UNDP)
- United Nations Refugee Agency (UNHCR)
- United Nations Children's Fund (UNICEF) and
- World Food Programme (WFP).[4]

UN agencies have long been focusing on water, shelter, sleeping, sanitation and food, for obvious good reason, but have tended not to be too concerned with the fuel and cooking. Fuel and cooking merit (we believe) equal importance as they are all interconnected. No point for example, supplying rice if it cannot be cooked and eaten, or giving them shelter just to kill them with the fumes or burns etc.

De-forestation - 64,700 acres of forest burnt per year for refugee cooking alone

The distribution of Ethanol as a cooking fuel has always been considered as the cleanest and most successful cooking alternative in camps, but the fact that it was only available in a gel or a liquid form

- Between 50% to 90% of wood extracted in Africa is used as domestic fuel – **FAO (2010)**
- Annual deforestation is estimated at **13.7 million hectares -** the size of Greece - **Wiki (2019)**
- There are approximately 8 million hectares of plantations designated to be burnt as wood fuel – **trees we need to save.**
- **1 ton of wood burnt releases 1.8 tons of CO - Haberl et al (2012)**
- It takes **40 years for 1 tree** to sequester 1 ton of CO_2

made it unsafe and impractical to be used and distributed. Especially with a lot of children the risks of burns from liquid fuel is very high.

As well as tackling climate change through carbon capture, saving all trees will help to protect local people from the effects of soil erosion, which can cause landslides. The trees also provide local communities with medicine, fruit, shade and shelter and is an important source of income.

Over 64,700 acres of woodland are currently cut per year by refugees as fuel. Burning this wood has a double negative carbon footprint. This deforestation has a very dramatic impact on the local eco-structure and the indigenous population. For instance, in the Rohingya refugee camp in Bangladesh, most of the trees have now been cut down and burnt, which has led to soil erosion, mud slides especially aggravated by the severe monsoon rains. The local population have as a result resorted to violence especially targeting the gathers of the wood whom are normally always the women and children.

Gathering wood, mainly by women, is a security risk & a real burden on their time. 30 kilos (3 large bundles) of firewood burnt per household/week or 1.5 tons per year. Source: **Ripple Africa**

In Kenya, tree growth has been cleared up to a radius of approx. 80 km around two of the refugee camps.

Non-displaced people – so helping to address the socioeconomic longer-term factors**.**

Over 2.9 billion people cook and heat their homes with solid fuels (wood/charcoal/coal/dung/pellets, etc) as their primary fuel source. Wood, and especially charcoal, produces large quantities of toxic carcinogenic fumes, carbon dioxide (CO_2) and carbon monoxide (CO).

The American EPA estimates that a fire burning for 1 hour, will burn @ 4.5 kilos of wood & will generate 4,300 times more carcinogenic polyaromatic hydrocarbons than 30 cigarettes.

Wood gathering presents security concerns for women and children, the primary gatherers, who spend a significant amount of time doing this – almost 12 hours per week and over half of them are under 18 years old.

That is why "***the provision of clean, efficient cooking solutions should be seen as a basic humanitarian necessity***," according to the UN.

Wood has in many places been used up or is scarce. Wood is now traded and sold as a commodity. This for the world`s poorest, those least able to afford it, is a travesty. But current UN programs are funding expensive fossil fuels, which have a terrible carbon footprint, especially LPG, to try to replace wood and charcoal as their domestic fuel.

LPG has a number of drawbacks, namely;

LPG metal cylinders are explosive – 15 people died recently from an explosion in a refugee camp

- LPG is a fossil fuel and as such is a non-renewable energy.
- LPG is costly to set up. Each cylinder and cooker can cost up to $250.
- Environmentally damaging. Its carbon footprint is bad as most comes from the Middle East.

Other alternatives include kerosene, which is again a fossil fuel, is toxic and gives off a large amount of soot and nasty noxious fumes when burnt.

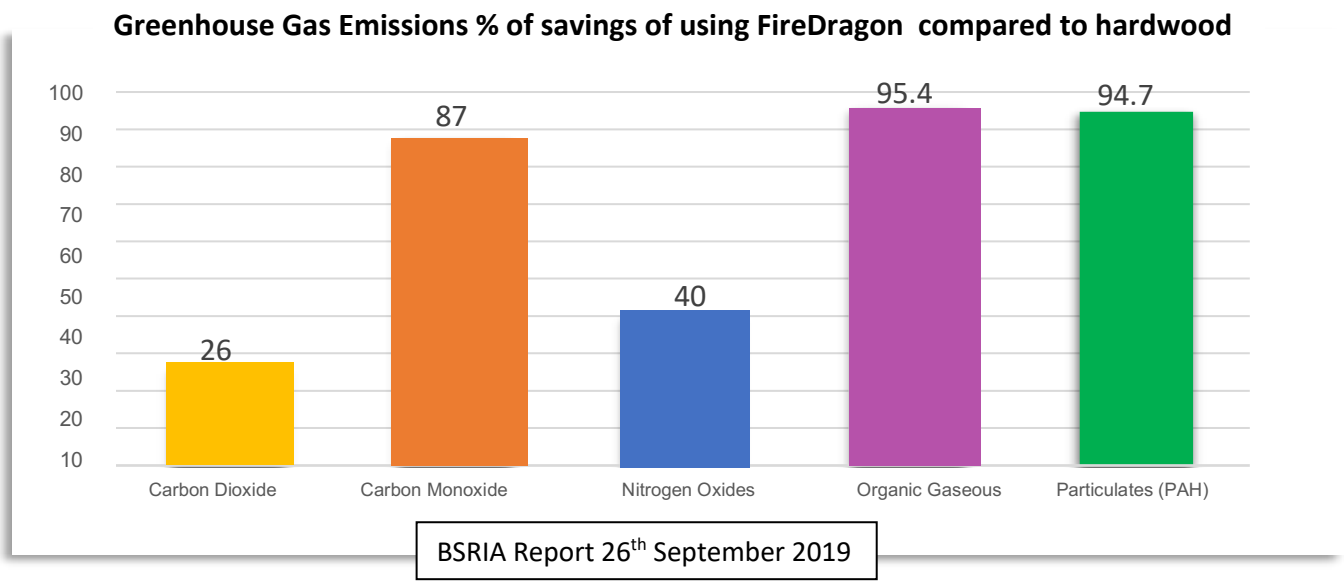
FireDragon is a clean energy solution that solves all of these issues. It is a sustainable energy fuel '***From Earth to Earth***', a bioethanol based solid cooking fuel from completely sustainable sources.

Wood smoke particulate matter generates **more DNA damage** than road traffic – generated particulate matter per unit mass in human cell lines. **P.H. Danielsen et al.**

Comparison of dry wood v FireDragon

- FireDragon gives off 87% less carbon monoxide, 26% less carbon dioxide, 40% less nitrous oxides and 95% less organic gaseous compounds compared to dried hard wood. See table below.
- FireDragon burns hotter and more intensely than most solid fuels and especially wood. It releases the energy more quickly. In laboratory trials, FD raised the temperature of the water 18 % quicker than wood. In @ 38 minutes as opposed to @45 minutes with wood. So, using less fuel and wasting less time.

500 grams of FireDragon has an equivalent calorific value – energy output - as 1100 grams of dry hard wood. Approx. 54.5% greater.



About BCB

BCB is a well and long established designer, manufacturer and supplier of innovative and life-saving equipment primarily to the outdoor, defence and marine markets. Most of the company's products are associated with lifesaving, protection, or survival. The business has operated for many decades and has an enviable reputation with its clients for the quality of its products. It is ISO 9001:2015 quality assurance approved.

BCB Factory Cardiff

Historically the Group's primary customers have been UK MoD, life raft manufacturers, Ministry of Justice and has been an occasional supplier to the UN, NGO's and Red Cross agencies for over 40 years. The company exports 45%.

FireDragon production

The company has expertise in light engineering, sewn and welded products, chemical formulation and robotics and is committed to R&D via its own staff and partnerships with local universities. The company has a well-balanced and capable management team with good financial control and proven production, quality control and distribution structures.

History	Operations
 • Business established in 1850's as Browns Cough Bottle manufacturing medicines for British troops in the Crimea • BCB Limited incorporated in 1914 • Manufacture and supply of lifeboat, medical, survival kits and other products to MOD from 1940's to 1970's • BCB International Ltd established in 1979 • Twice winner of Queen's Awards for Exports 1988 and 1993 • Commenced development of innovative new products (200's) in close collaboration with universities	• Two factories/warehouses in Cardiff approx 70,000 sq. ft. • New premises provide excellent facilities for manufacturing and is enabling the business to bring more manufacturing in-house • In House Chemist and Engineers • Over 200 product approvals • ISO, NATO & SOLAS accreditations/ approvals CERTIFIED ISO 14001 CERTIFIED ISO 9001
Business • Design, manufacture and distribution of non-lethal equipment for defence, police and marine markets • Specialising in survival, lifesaving, life preserving and protective equipment	• Approximately 350 product lines with over 45% own manufacture • Worldwide sales. Core market UK MOD but over 40% is exported

Conclusion

FireDragon has already saved many tons of CO_2 emissions since it was introduced in 2016.

This is trivial (though every little helps) compared to the many hundreds of millions of tons of carbon dioxide savings and the double benefit from the reduction in deforestation, which could be achieved if some of the 2.9 billion people used **FireDragon**, instead of burning wood or charcoal as their primary fuel.

We know the climate crisis we are all facing is alarming, impacting the health of everyone and every creature on Earth. There is no "planet B".

We estimate* if **FireDragon** replaced wood as the primary cooking source for this user group that;

- **2,370 million tons of carbon dioxide could be saved annually**
- **24 million hectares of trees would be saved per year, about the area of the UK and so saving an additional 62 million tons of Carbon Dioxide per year. In 2019 @ 23 million hectares were lost** [9]
- **Saving millions of tons of Nitrous Oxide, Methane, Carbon Black, and other noxious fumes.**
- **184,000 tons of carbon monoxide, reduction per year.**
- **Up to 6.5 million people's lives could be saved annually.**
- **That millions the worlds very poorest could be helped out of poverty.**

More information can be viewed on www.firedragonfuel.com or please email see@bcbin.com

THANK YOU !

From little acorns.. mighty oaks grow;
and should be left to grow and grow.

Small things when used by so many people will make a significant difference.
We have to help them to make this big difference in a win-win situation; less CO2 and more trees, better health. "

* **Assumptions**

1. 500 grams of FD has an equivalent calorific value and so will heat/cook the equivalent of 1100 grams of wood or 830 grams of high quality charcoal.
2. FD produces the following % less than dry wood [1] :

- ✓ **26%** less Carbon Dioxide CO_2
- ✓ **87%** less carbon monoxide CO
- ✓ **40%** less nitrogen oxides NO_x
- ✓ **100%** less methane CH_4
- ✓ **95.4%** less organic gaseous compounds OGC
- ✓ **94.7%** less particulates @13% oxygen levels

3. Low income households, in Malawi, uses approx 33 kilos of charcoal per week. With a conversion average ration of 6 kilos of wood needed for each 1 kilo of charcoal then each household would burn about 10 tons of wood per year.
4. Between 8% and 26% of households income is spent on fuel, with more lower income households buying cheaper and less efficient wood compared to charcoal. United Purpose study 2021.
5. One tree can sequester 1 ton of CO_2 by the time it is 40 years old. One tree can absorb @22 kilos of CO_2 per year [2]
6. Between 50% and 90% of all wood extracted from Africa's forests is used domestically as fuel [3]
7. 2.9 billion people rely on solid fuel (mainly wood, charcoal, dung) for their cooking/heating source [4]
8. If we can assume 6 persons per household (African average) then this is about 480 million low income households worldwide, not including displaced people.
9. 480 million households x 10 tons of wood burnt per year for fuel = 4,800 million tons of trees burnt per year for cooking/heating.
10. **Hence, using FD instead to replace wood or charcoal will reduce emissions by: 2,371 million tons of CO_2 per year**
11. **And will save 24 million hectares of woodland/forest per year which will continue to sequester carbon so increasing biomass and improving the carbon balance.** [5]
12. **These saved woodland/forests will continue to sequester carbon at a rate of 2.6 tons per acre per year, so 62.4 million tons of carbon dioxide will also be sequestered, by replacing wood/charcoal burnt with FD.** [6]

References: **1** BSRIA laboratory test report on 26th September 2019 and Cardiff University study 24th September 2021.

2 NC State University. **3** MIT. **4** WHO 2018. **5** Assuming 80 tons of wood/biomass per acre. https://www.forest2market.com/blog/how-many-tons-of-wood-are-on-an-acre-of-land **6** http://www.treesintrust.com/environmental.shtm

7 https://www.fao.org/3/y1997e/y1997e07.htm **8** https://www.fao.org/3/ae153e/AE153e04.htm

9 https://www.globalforestwatch.org/dashboards/global

All figures are approximate.