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Тел/факс: (495) 7774788, 5007154,55, 65, 7489626, 7489127, 28, 29

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*general PRESENTATION*



**GREENS**

# Introduction to GREENS Combustion

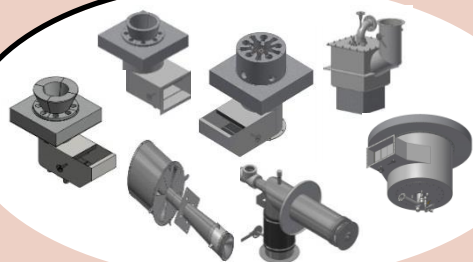
*Michael Booth – Sales & Marketing Director*



**GREENS  
COMBUSTION**

# GREENS Combustion

*what we DO*



## Equipment Supplier

Full range of low NOx & ultra low NOx burners

New build / revamp

Thermal oxidisers, control systems & valve trains

5,000 m<sup>2</sup> R&D and test centre

## Site Services

Site surveys with operator partnerships

Combustion advice and consultancy

Refurbishment and upgrade specialists

Spares & replacement parts

Upgrade kits

## Group Products

New build boilers

Turnkey revamps

Boiler components

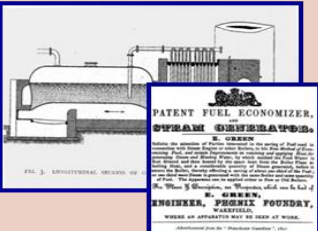
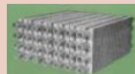













**GREENS  
COMBUSTION**

# GREENS Group

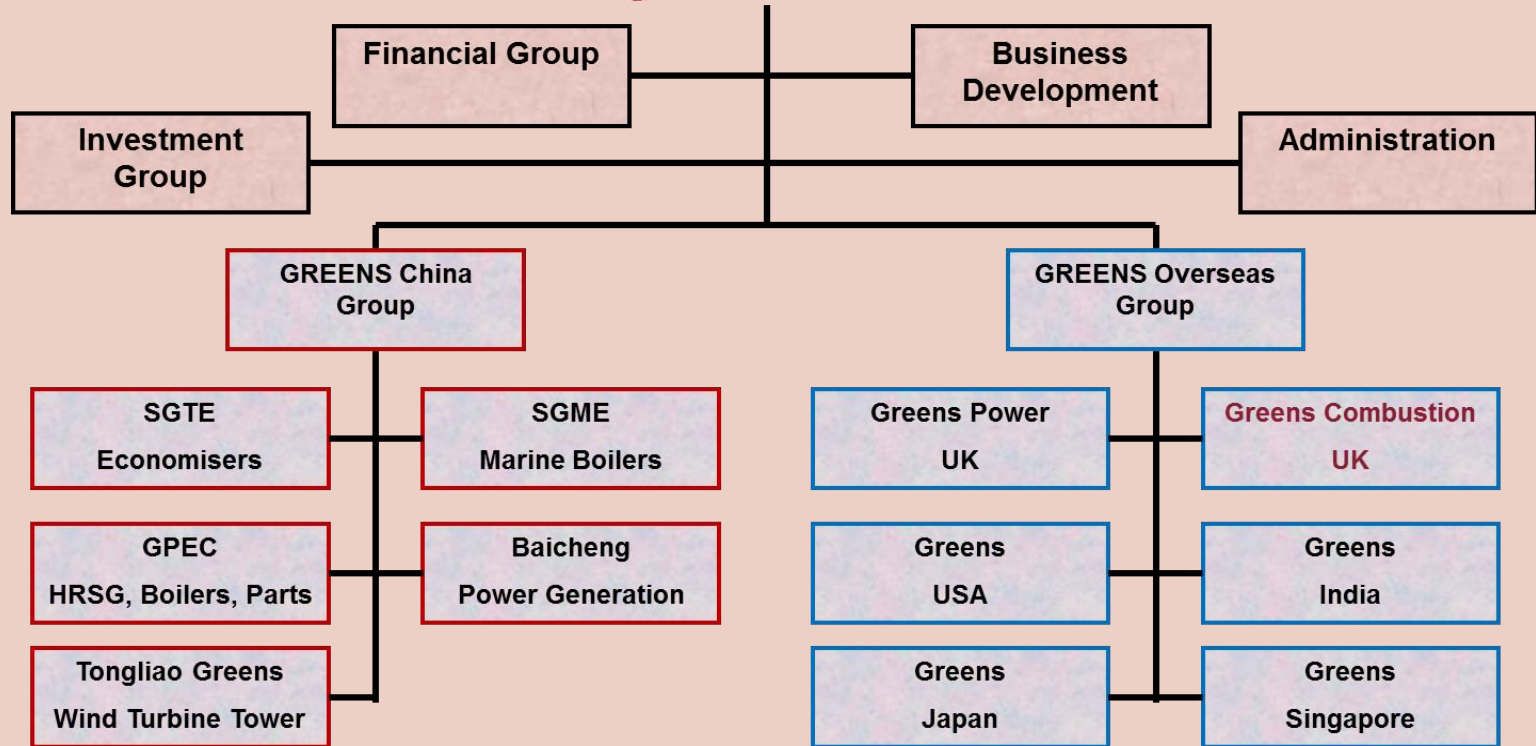
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## strength in HISTORY

 <p><b>PATENT FUEL ECONOMIZER, and STEAM GENERATOR.</b>          E. GREEN          ENGINEER, SENIORS FOUNDRY, WAKEFIELD.</p>		 <p><b>SPANNER SUPREME</b></p>				
<p>Green patents first economiser <b>1845</b></p>	<p>First Steel welded economiser <b>1960</b></p>	<p>Spanner Supreme Burner <b>1960</b></p>	<p>First HRSG produced at Wakefield <b>1993</b></p>	<p>Fabrication starts in China <b>2002</b></p>	<p>Public Listing on HKSE Becomes Greens Holdings <b>2010</b></p>	
<p><b>1833</b> Edward Green &amp; Company</p> 	<p><b>1933</b> E Green &amp; Son trade in Wakefield and London as 'Green' and 'Senior'</p> 	<p><b>1983</b> Companies combine to form Senior Green</p> 	<p><b>1988</b> Becomes Foster Wheeler Power Products</p> 	<p><b>1997</b> Becomes Thermal Engineering Int'l</p> 	<p><b>2008</b> Becomes Greens Power Ltd</p> 	<p><b>2012</b> TEI Greens Ltd renamed Greens Combustion</p> 

# GREENS Group

## GROUP structure



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COMBUSTION**

# GREENS Group

## global RESOURCES

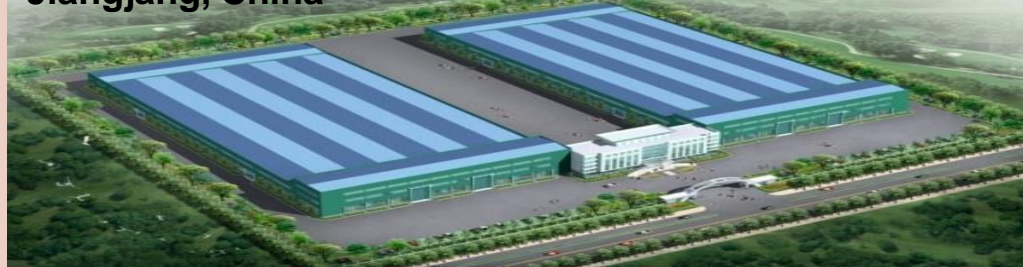
~1,200 people employed

~170,000 m<sup>2</sup> factories in 6 locations

~100,000 m<sup>2</sup> offices in 6 countries

特力动力设备中国有限公司厂区鸟瞰图

## Jiangjang, China



## Wakefield, UK



## Shanghai, China



## Tongliao, Mongolia



## Jiangjang, China



## Poole, UK



## FengXian, China

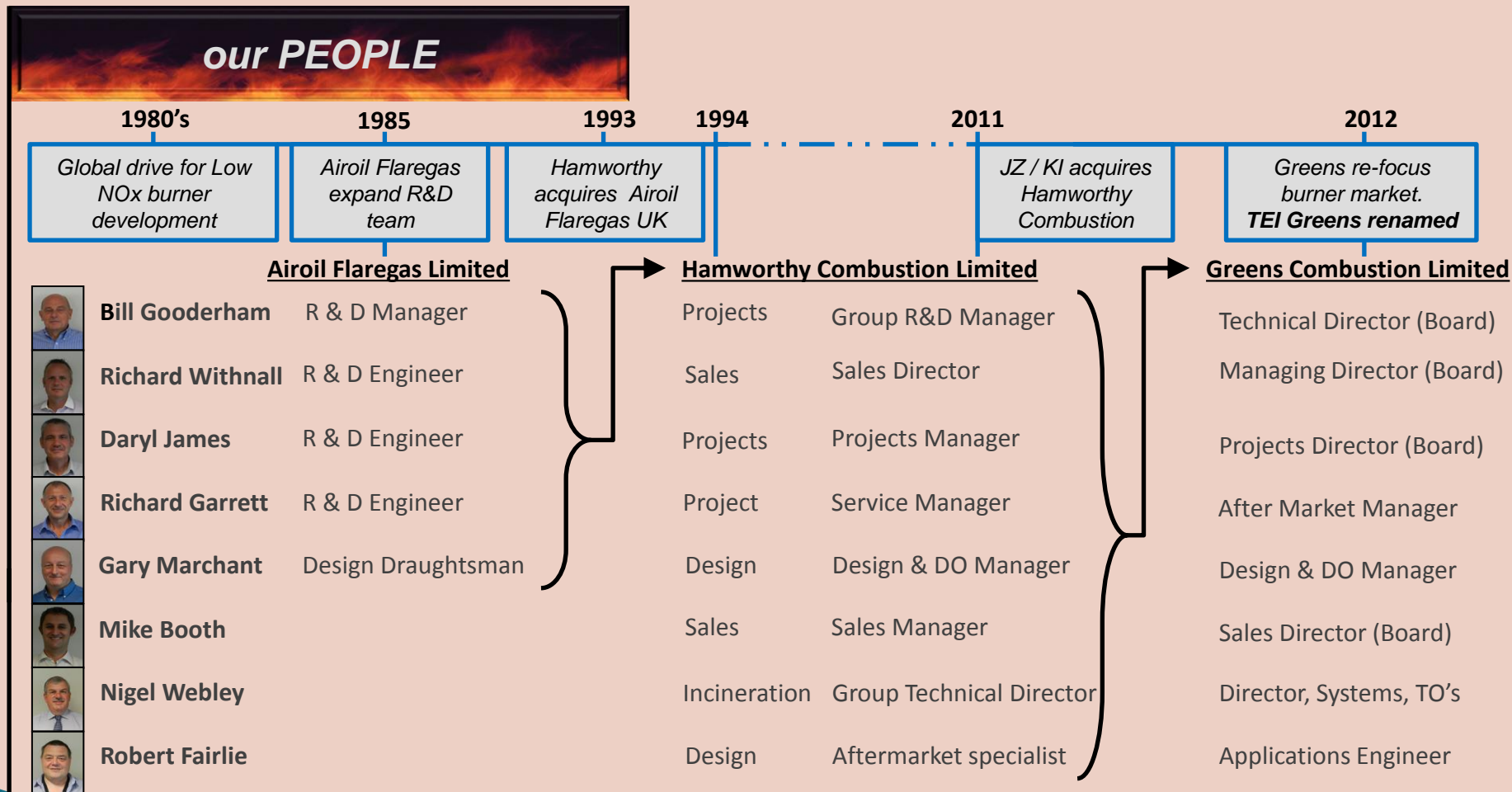


## Wakefield, UK



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**COMBUSTION**

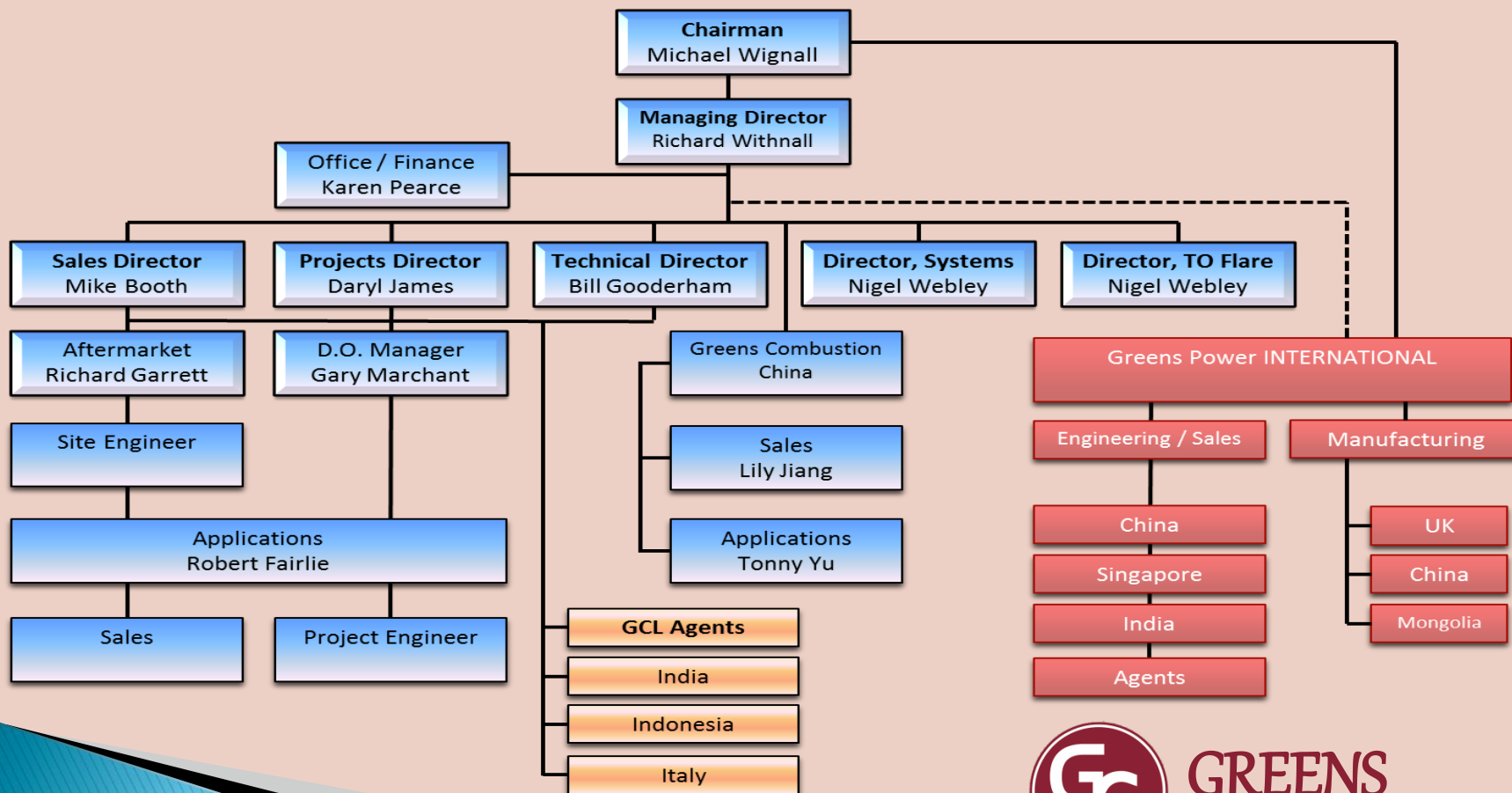
# A Combustion Story



**GREENS  
COMBUSTION**

# Greens Combustion Limited

## current STRUCTURE



# Greens Combustion Limited

## **MILESTONES achieved**

### **Company**

- registered as Greens Combustion Limited 28<sup>th</sup> May 2012
- 1<sup>st</sup> person employed 28<sup>th</sup> May 2012, now have 12 people

### **Product range**

- Design of 1<sup>st</sup> burner released 7<sup>th</sup> August 2012 - trademark *GreenBurn* registered 23<sup>rd</sup> August – now 8 burner ranges
- Expanded into Incineration and Systems March 2013

### **Orders**

- 1<sup>st</sup> Order 31<sup>st</sup> August 2012, 14 orders to date - £350 to \$1,500,000
- 1<sup>st</sup> *GreenBurn* (RWND) ordered 12<sup>th</sup> November 2012, installed and operating well

### **Approvals**

- Saipem first formal approval - over 20 key contractors, licensors and end users have approved or working with us

### **Quality**

- ISO 9001:2008 obtained independently as GCL 3<sup>rd</sup> June 2013

### **Finances**

- 1<sup>st</sup> set of audited accounts (31<sup>st</sup> December 2012) small profit



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# Greens Combustion Products

## *personal REFERENCES*

### *Refinery*

*Over 500 low NOx, Ultra low NOx heaters*

Hot Oil Heaters  
Atmospheric Distillation Unit  
Vacuum Distillation Unit  
Visbreaker  
Hydrotreaters  
Hydrocrackers  
Coking units  
Isomerisation Unit  
Hydrogen reformers

### *Reformers*

*Over 200 reforming & 50 cracking furnaces*

Steam reformers  
Steam crackers  
EDC  
Ethylene  
Hydrogen  
SynGas  
Methanol  
Ammonia

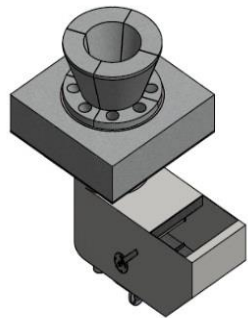


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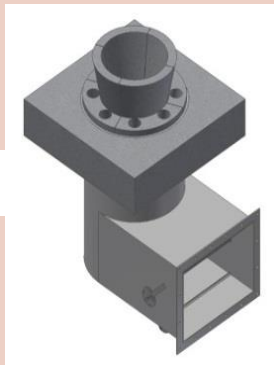
# Greens Combustion Products

## burners for FIRED HEATERS

*Dimensions and capacity curves on data sheet*



*GreenBurn ND*



*GreenBurn FD*



*GreenBurn Ultra*

- **Designed in accordance to API560 & 535**
- **Low NOx and Ultra Low NOx**
- **Natural draught,**
- **Forced draught (conventional and low pressure)**
- **Single or dual fuel**
- **Single inlet damper**
- **Up or side fired orientation**
- **Round or flat flame**

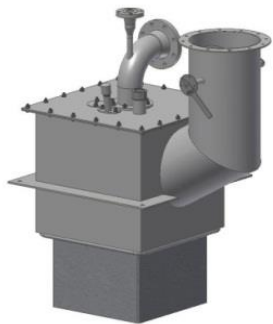


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# Greens Combustion Products

## burners for REFOMERS

*Dimensions and capacity curves on data sheet*



*GreenBurn DF*

- **Top fired round flame**
  - gas & gas /oil
  - forced and natural draught
  - minimum on site setup and adjustments
  - high efficiency internal thermal insulation
  - improved air flow design

*GreenBurn RWND*



*GreenBurn RWFD*

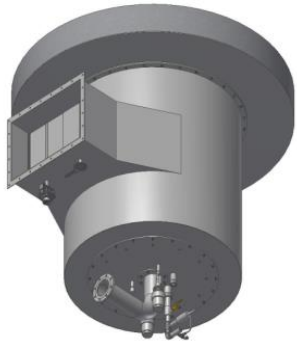
- **Side fired radiant wall**
  - single and dual gas
  - self inspirating & forced draught
  - robust air damper control
  - high hydrogen capability
  - low noise silencer integral to RWND



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# Greens Combustion Products

## *OTHER applications*



*Thermal  
Oxidisers*

- **Thermal Oxidisers**

- burners or complete systems
- gaseous and liquid
- ASME design if required

*Boiler Conversions*



*Components & Spares*

- **Boiler Conversions**

- burner upgrades or new install
- control system revamp or replace
- turnkey boiler services within Group

- **Site services, components & Spares**

- virtually all makes and models
- recondition through to component supply
- trouble shooting & technical services



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# Greens Combustion Products

## *TESTING, R&D facilities*

*Planned for start-up Q3 / 2013*

- **Internationally recognised facility**
- **Located in Shanghai**
- **Unique in Asia region**
- **7 furnaces planned**
- **Area ~ 5,000 m<sup>2</sup>**
- **Gases - NG, H<sub>2</sub>, N<sub>2</sub>, CO<sub>2</sub>, LPG,**
- **Liquids - Heavy fuel and diesel**
- **Fuel and combustion air preheaters**
- **Latest emission and flow control monitoring & data logging**

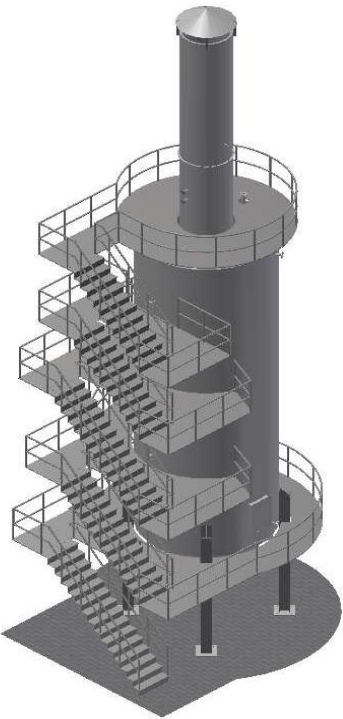


**GREENS  
COMBUSTION**

# Testing & R&D Facilities

## UP-FIRED test furnace

F-101



### Key Features

- Single burner unit
- Dimensions
  - Overall height 18.8 m (61')
  - Radiant section 9.0 m (29'3")
  - Inside Diameter 3.0 m (9'9")
- Water jacketed
- Rated duty 5 MW (17 MM Btu/hr)
  - *Planning for 3 MW(10 MM Btu/hr) & 10 MW (34 MM Btu/hr)*
- Measuring / site ports every 1 m (3'3")
- Air preheat
  - 350°C / 7,500 kg/h / 200 mmwc (660°F / 16,500 lbs/hr / 8" wg)



**GREENS  
COMBUSTION**

# Testing & R&D Facilities

## *DOWN FIRED test furnace*

F-201



### Key Features

- Single burner unit
- Dimensions
  - Overall height 18.8 m (61')
  - Radiant section 9.0 m (29'3")
  - Inside Diameter 3.0 m (9'9")
- Water jacketed
- Rated duty 3 MW (10 MM Btu/hr)
- Measuring / site ports every 1 m (3'3").
- Combustion air preheat
  - 350°C / 7,500 kg/h / 200 mmwc (660°F / 16,500 lbs/hr / 8" wg)
  - Future planning TEG
    - 14% O<sub>2</sub> 500°C (932°F)
- Fuel preheat 200°C (392°F)

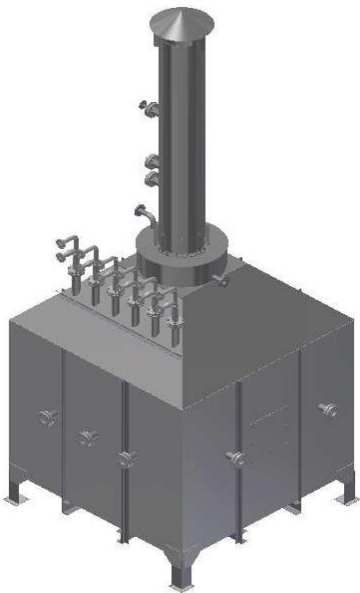


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# Testing & R&D Facilities

## *SIDE FIRED test furnace*

F-102



### Key Features

- Single burner unit
  - *Planning for dual burner unit*
- Dimensions
  - Radiant section 2 x 2 x 3 m  
(6'6" x 6'6" x 9'9")
  - Stack 1.7 m (5'6")
- 6 x cooling tubes opposite firing wall
- Rated duty 0.93 MW (3.2 MM Btu/hr)
  - *Dual unit 1.86 MW (6.4 MM Btu/hr)*
- Measuring / site ports every 0.6 m (2')
- Combustion air preheat
  - 540°C / 1,400 kg/h / 450 mmwc  
(1,000°F / 3,080 lbs/hr / 18" wg)

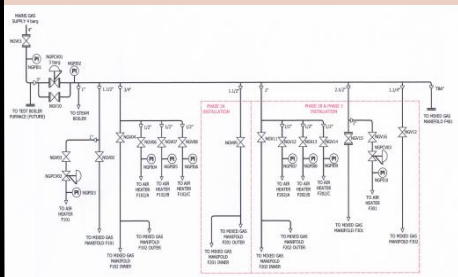


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# Testing & R&D Facilities

## MONITORING fuel & emissions



## Key Features

- Gases
  - Natural Gas 1,550 Nm<sup>3</sup>/h
  - LPG 200 Nm<sup>3</sup>/h
  - Hydrogen 1,000 Nm<sup>3</sup>/h
  - Nitrogen 100 Nm<sup>3</sup>/h
  - Carbon Dioxide 130 & 700 Nm<sup>3</sup>/h
- Oil
  - HFO 1,000 l/h
  - Naphtha 360 l/h
  - Steam 350 kg/h
- Flue gas monitoring- NO<sub>x</sub>, SO<sub>2</sub>, CO, CO<sub>2</sub>, O<sub>2</sub>
  - Horiba, Japan
- Flow measurement
  - Coulton, UK
- Data logging, CO Probe, HMI, Heat Flux



**GREENS**  
**COMBUSTION**

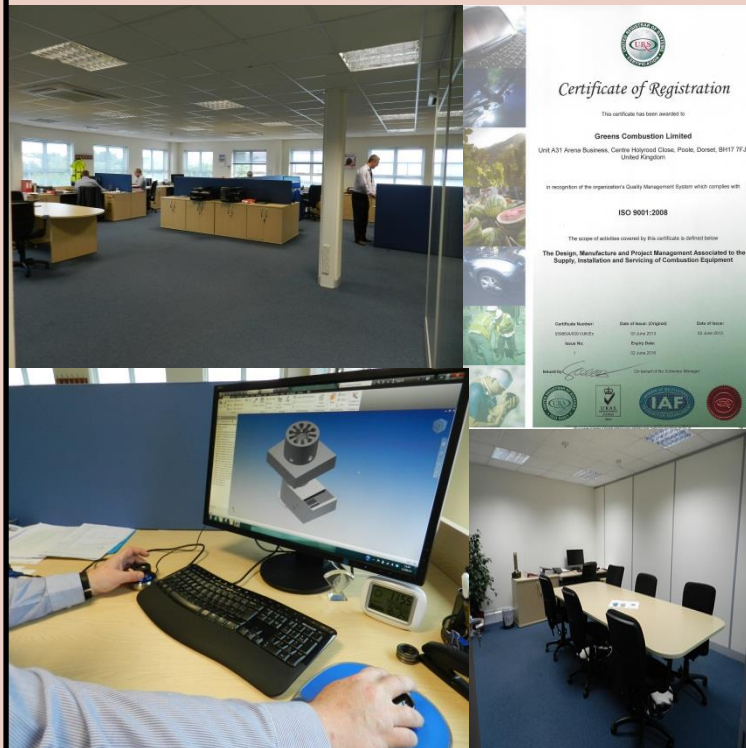
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# Design & Project Execution

## Poole, UK Facilities



- Centre for design and project execution
- 185 m<sup>2</sup> (2,000 ft<sup>2</sup>) fixed
  - *Additional space for expansion*
- ISO 9001:2008
- 3D CAD used for ALL drawings
  - *Autodesk Inventor*
- In house conference facilities
- Video conferencing
- CFD used for design evaluation



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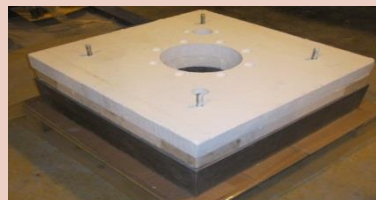
# Design & Project Execution

## *selection projects AWARDED*

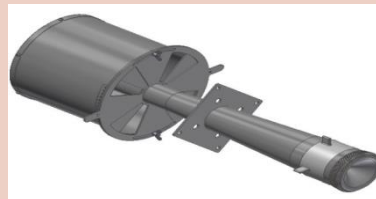
burner modernisation.  
replacement casing.  
add. gas line / re-use oil.  
reduced TAR time.



HTAS Reformer.  
modular tiles.  
upgraded material.  
DDP Supply contract.



HTAS Reformer.  
GreenBurn RW ND.  
improved operability  
improved efficiency.

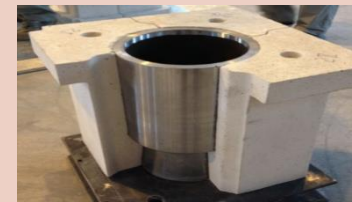
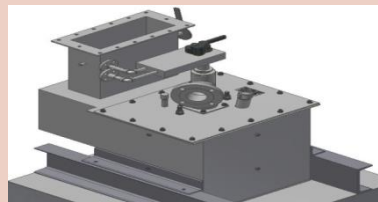


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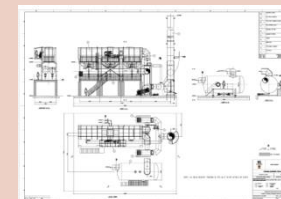
# Design & Project Execution

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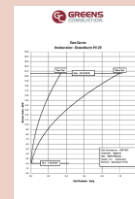
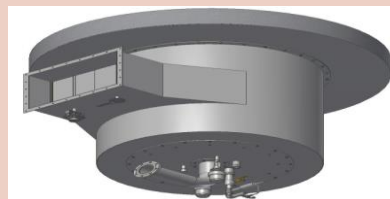
GreenBurn DF  
replacement internals &  
replacement bricks  
30% saving in TAR time



Regenerative Thermal  
Oxidiser.  
Turnkey supply.  
Phenol / Cumene Plant.



Incinerator GreenBurn HI  
Pilot & Scanners.  
20MW per burner.  
10 : 1 turndown



Parameter	Value
Rated Power	20 MW
Rated Temperature	1000°C
Rated Turndown Ratio	10:1
Rated Fuel	Gas
Rated Air Flow	1000 m³/h
Rated Fuel Flow	1000 kg/h
Rated Air Pressure	1.0 bar
Rated Fuel Pressure	1.0 bar
Rated Air Temperature	20°C
Rated Fuel Temperature	20°C
Rated Air Humidity	50%
Rated Fuel Humidity	50%
Rated Air Composition	21% O₂, 79% N₂
Rated Fuel Composition	CH₄, C₂H₆, C₃H₈
Rated Air Velocity	10 m/s
Rated Fuel Velocity	10 m/s
Rated Air Density	1.2 kg/m³
Rated Fuel Density	0.7 kg/m³
Rated Air Viscosity	1.8e-5 Pa·s
Rated Fuel Viscosity	1.5e-5 Pa·s
Rated Air Thermal Conductivity	0.026 W/m·K
Rated Fuel Thermal Conductivity	0.025 W/m·K
Rated Air Specific Heat	1.0 kJ/kg·K
Rated Fuel Specific Heat	1.7 kJ/kg·K
Rated Air Prandtl Number	0.7
Rated Fuel Prandtl Number	0.7
Rated Air Reynolds Number	1000
Rated Fuel Reynolds Number	1000
Rated Air Nusselt Number	10
Rated Fuel Nusselt Number	10
Rated Air Schmidt Number	1.0
Rated Fuel Schmidt Number	1.0
Rated Air Lewis Number	1.0
Rated Fuel Lewis Number	1.0
Rated Air Peclet Number	1000
Rated Fuel Peclet Number	1000
Rated Air Damkohler Number	1000
Rated Fuel Damkohler Number	1000
Rated Air Thiele Modulus	1000
Rated Fuel Thiele Modulus	1000
Rated Air Biot Number	1000
Rated Fuel Biot Number	1000
Rated Air Fourier Number	1000
Rated Fuel Fourier Number	1000
Rated Air Peclet Number	1000
Rated Fuel Peclet Number	1000
Rated Air Damkohler Number	1000
Rated Fuel Damkohler Number	1000
Rated Air Thiele Modulus	1000
Rated Fuel Thiele Modulus	1000
Rated Air Biot Number	1000
Rated Fuel Biot Number	1000
Rated Air Fourier Number	1000
Rated Fuel Fourier Number	1000



**GREENS  
COMBUSTION**

# Upgrade Opportunities

Typical Reformer



100's side wall burners



old & worn out ?



- Reduced maintenance
- Improved efficiency
- Longer life
- Lower noise
- Reduced furnace fouling
- Increased resilience to flashback
- Lower front face temperature
- Easier air control
- Lighter burners
- Resized for actual operating conditions

***Enhanced burner components can mainly be replaced with furnace on-line***



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# Upgrade Opportunity

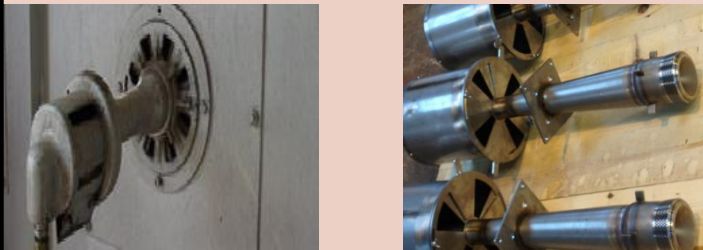
## *replace burned out NOZZLES*



### Enhanced nozzle

- High alloy material used for longer life
- Enhance drilling patterns and profile
  - Cooler nozzle
  - Longer life
  - Resilient to flashback - flame arrester principles applied
- Resized for new operating conditions

## *replace old heavy BURNERS*



### Lightweight burner body

- Lightweight stainless steel used
  - Enhanced corrosion properties
    - Longer life
  - Significant weight reduction
    - ~ 50kg to ~5kg
    - Single operator maintenance



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# Upgrade Opportunity

## *replace damaged REFRACTORY*



### Improved refractory module

- Single piece module used for easy installation
- Enhanced material used
  - Increased thermal shock – reduce cracking
  - Reduced spalling of hot front face
  - Wear resistance – reduce furnace fouling
- Reduce front face temperatures & hot spots

## *Upgrade crude AIR CONTROL*



### Enhanced air damper and silencer

- More robust damper controls ensure closer control of excess air improving efficiency
- Air inlets horizontal for lower noise and to avoid debris falling into burner (reduced maintenance)
- Additional silencing for further noise reduction.



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# Greens Power Limited

## *GROUP products*

- **Boilers**
- **Boiler Components**
  - Finned Tubes
  - Super-heaters
  - Re-heaters
  - Steam Drums
  - Membrane Wall
- **Economisers**
- **H.R.S.G's**
- **Waste Heat Boilers**
- **Bespoke Heat Exchangers**
- **Steam Air heaters**
- **Condensers**
- **Wind Tower Manufacturing (PRC only)**
- **Waste Heat Power Generation (PRC only)**



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# Greens Power Limited

## fired BOILERS



Spanner "VSF"	Spanner "VDF"	Spanner "HF"	Spanner "LSK"	Spanner "TD"	Spanner "ZYC"	Spanner "LYF"	D "ESD"	Diesecon Finned Tube Economiser	Spanner "VEG"
Oil fired Vertical Side Fired	Oil fired Vertical Down Fired	Oil fired Horizontal Fired	Oil fired Vertical Side Fired	Oil fired Vertical Top Drum	Oil fired & Exhaust Gas Composite	Oil fired & Exhaust Gas Composite	Oil or Dual Fired D Type	Exhaust Gas Economiser	Exhaust Gas Boiler
0.5 - 5.5 t/h	5.5 - 15 t/h	0.5 - 15 t/h	6.5 - 35 t/h	6 - 50 t/h	To suit engine	To suit engine	20-220 t/h Saturated or Superheated	To suit engine	To suit engine
Cylindrical Plain Smoke Tubes	Cylindrical Plain Smoke Tubes	Cylindrical Plain Smoke Tubes	Cylindrical Pinned Tubes	Cylindrical Plain Water Tubes	Cylindrical Plain Water Tubes	Cylindrical Plain Smoke Tubes	Two Drum Plain Water Tubes	Steel H Flat Finned Water Tubes	Cylindrical Plain Smoke Tubes
9 bar g	9 bar g	9 bar g	11 - 18 bar g	20 bar g	9 bar g	9 bar g	upto 80 bar g	20 bar g	9 bar g
Pressure Jet Rotary Cup	Pressure Jet Steam Atomised	Pressure Jet Rotary Cup	Pressure Jet Rotary Cup	Steam Atomised	Pressure Jet Rotary Cup	Pressure Jet Steam Atomised	Steam Atomised / Rotary Cup	Not applicable	Not applicable



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## ECONOMISERS



- **World's first patent for fuel economiser**
- **Over 700 utility size economisers – largest reference list**
- **Over 70% of Operational UK Coal Fired Power Stations use Greens Steel H Economisers**
- **Extended surface steel H design**
- **New build economisers**
- **Retrofit & replacement economisers**



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## HRSG



- **Bespoke turnkey design and supply or “Build to Print”**
- **Single or dual pressure**
- **Horizontal or Vertical Gas Flow design**
- **HRSG downstream of gas turbines, gas engines and diesel engines**
- **Supplementary and Auxiliary firing**
- **Boiler and burner control system and instrumentation**



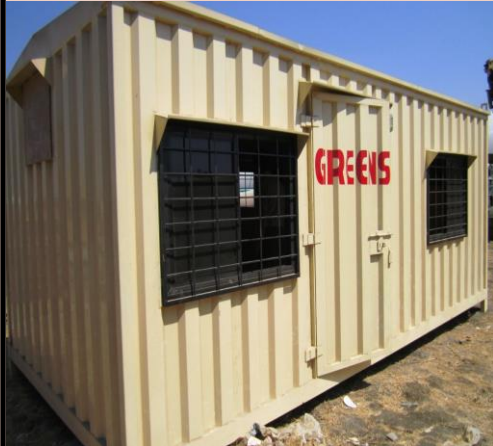
**GREENS  
COMBUSTION**



# Greens Power Limited

По всем вопросам обращайтесь в наш офис ООО "ТИ-Системс":  
Тел/факс: (495) 7774788, 5007154, 55, 65, 7489626, 7489127, 28, 29  
Эл. почта: info@tisis.ru Интернет: www.tisis.ru www.tisis.kz www.tisis.by www.tisissec.ru

## TURNKEY installations



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## boiler COMPONENTS



**Headers & manifolds**



**Steam air heaters**



**Tube bundles**



**Steam drum**



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## boiler COMPONENTS

Fin tubes



Membrane panels



Steam drum



Structural fabrication

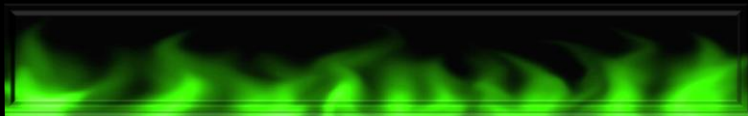


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# Why go GREEN



**GREENS**



## **Reputation & Experience**

- 180 years of the GREENS brand
- Extensive Group product range and capability
- Financial security as part of a P.L.C.

## **Engineering Excellence**

- 200 years of experience dedicated to combustion systems and burner design
- The name may be new but the team is well recognised and approved

## **Global presence**

- Well respected partners and / or local offices

## **Vision & Ambition**

- 5,000 m<sup>2</sup> grass roots test facility



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# Thank you



## GREENS



[www.greensholdings.com](http://www.greensholdings.com)

[www.greenscombustion.com](http://www.greenscombustion.com)



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