

# INTRODUCTION TO FREEPOWER ORC SYSTEMS



## Zero Fuel - Zero Emissions Low Grade Wasted Heat Power Generators

The Freepower team has been involved in the design, development, prototyping, testing and manufacture of Organic Rankine Cycle (ORC) Turbine Electrical Generating Equipment since 1996. ORC technology is not new, however, the technology used by existing players is somewhat dated, and has been produced over many years for “bespoke” ie project built applications; this approach has resulted in very large, heavy and relatively expensive equipment.

Freepower’s approach to the ORC technology is to apply the very latest turbine technology combined with compact heat exchanger designs and the latest PWM (Pulse Width Modulated) switch mode power inverter advances to produce a very compact, high efficiency, cost effective system.

Freepower has developed software programmes for the turbine geometry design appropriate for a range of potential working fluids; they have also optimised the design of high effectivity, compact heat exchangers. Freepower designs the complete system in house; it sub-contracts out the manufacture at sub-assembly level and then completes the final assembly and production acceptance testing in house prior to shipping. Freepower’s products are planned to cover the power range from 2kWe to 500kWe, relating the size of each product to a particular market requirement and building products in volume to achieve an acceptable sale price level.

The technology involved is as follows: -

1. Turbine: Compact medium speed (20-50000 rpm.) 3 stage radial inflow turbine.
2. Heat Exchangers: Compact finned plate and bar systems.
3. Pumps: Leak free long life piston pumps.
4. Alternators: High speed, rare earth, permanent magnet machines.
5. Power Conditioning: State of the art purpose designed IGBT technology PCU Systems.

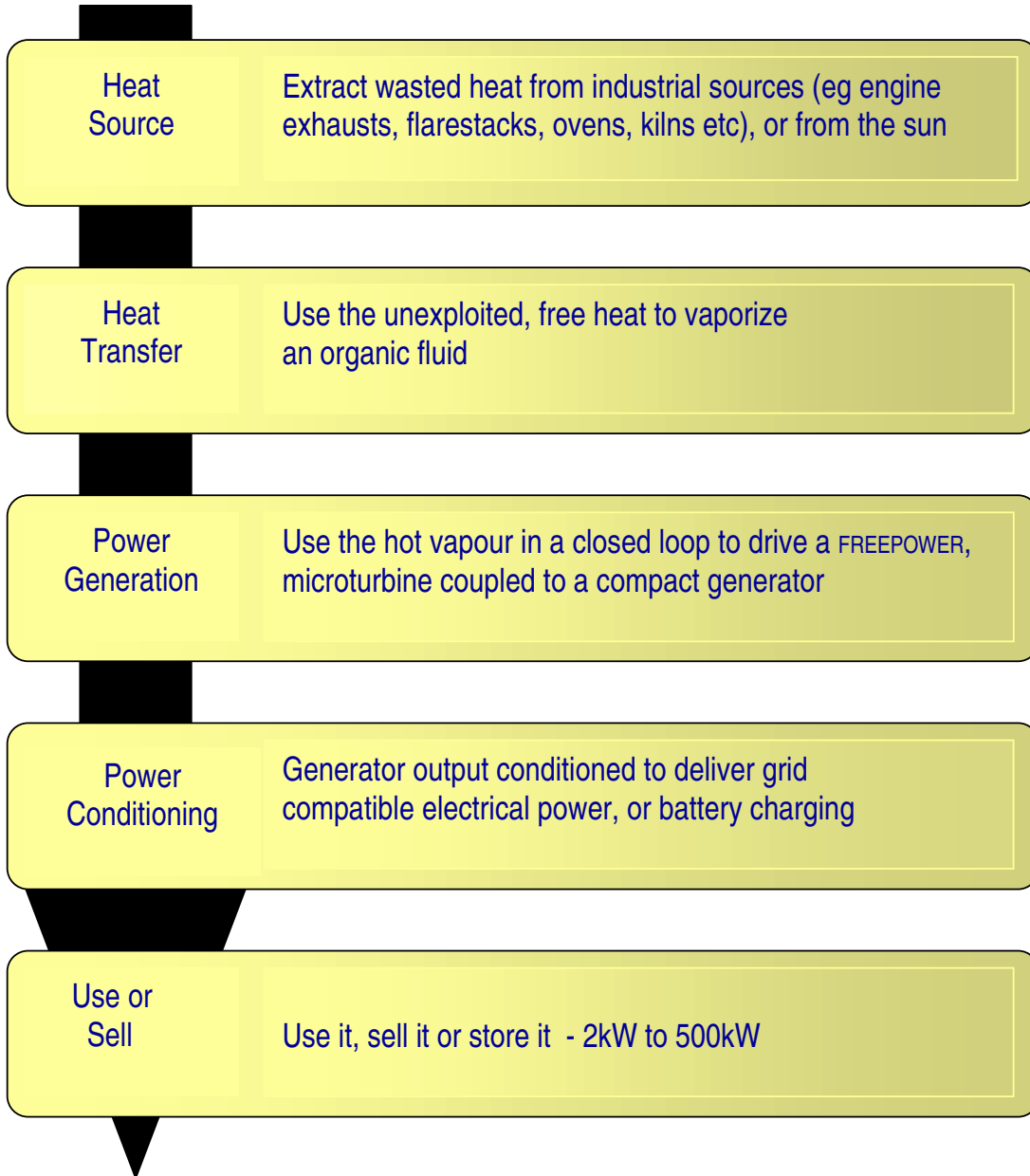
The typical size for a 200kW system from existing ORC manufacturers is 12m x 3m x 3m and weighs around 25 tons. The planned FP250kWe system is 3.5m x 1.5m x 2m and weighs less than 3 tons. It is forklift transportable and requires no special infra structure or interference with the operation of the host heat source, and is designed for an 80,000 hour life. With only 2 moving assemblies maintenance cost are minimal – circa US\$ 0.00028/kW/h

The unique combination of these proven technologies, has resulted in Freepower being granted 6 patents with a further 2 more awaiting approval and has resulted in the Freepower product range offering the advances in ORC technology for the 21<sup>st</sup> century.

FREEPOWER reserve the right to alter any specification without warning.

[www.freepower.co.uk](http://www.freepower.co.uk)

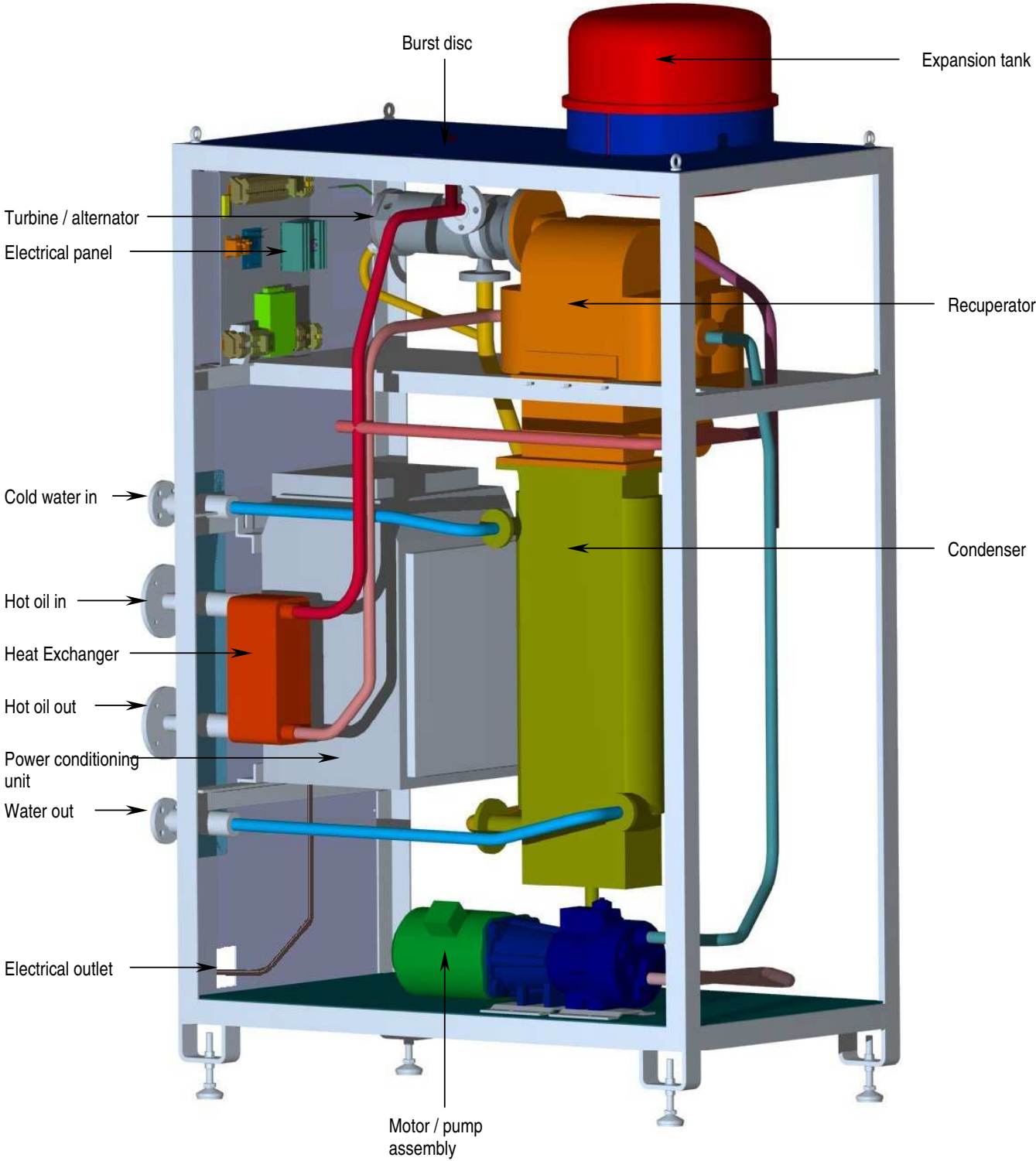
# HOW FREEPOWER TURNS WASTED HEAT INTO CLEAN ELECTRICITY



Comprehensive range: Planned Outputs of 2, 6, 10, 25, 60, 120, 250 & 500 kW

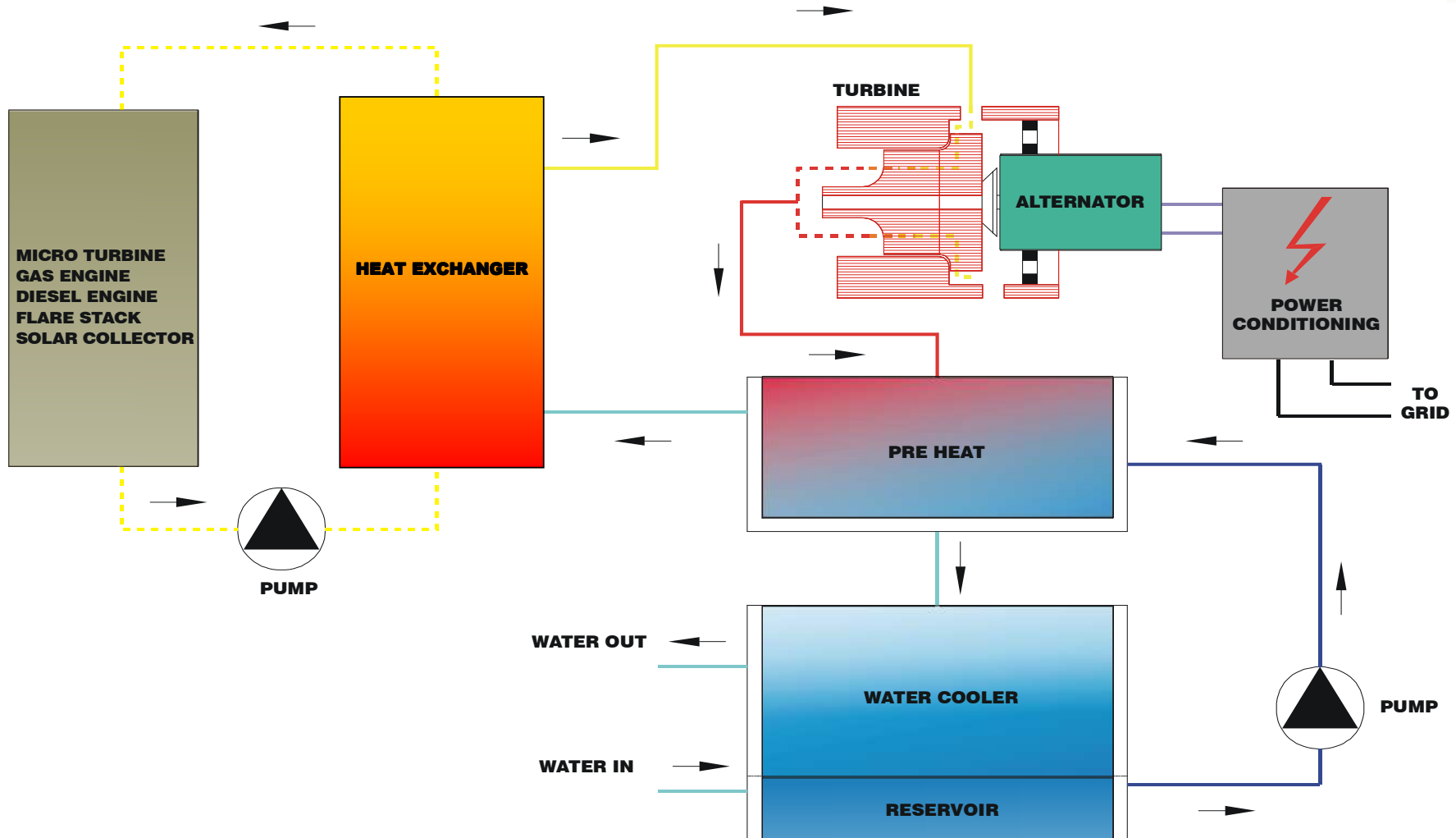
[www.freepower.co.uk](http://www.freepower.co.uk)

# Generic Component Layout



FREEMPOWER reserve the right to alter any specification without warning.

# INSTALLATION SCHEMATIC

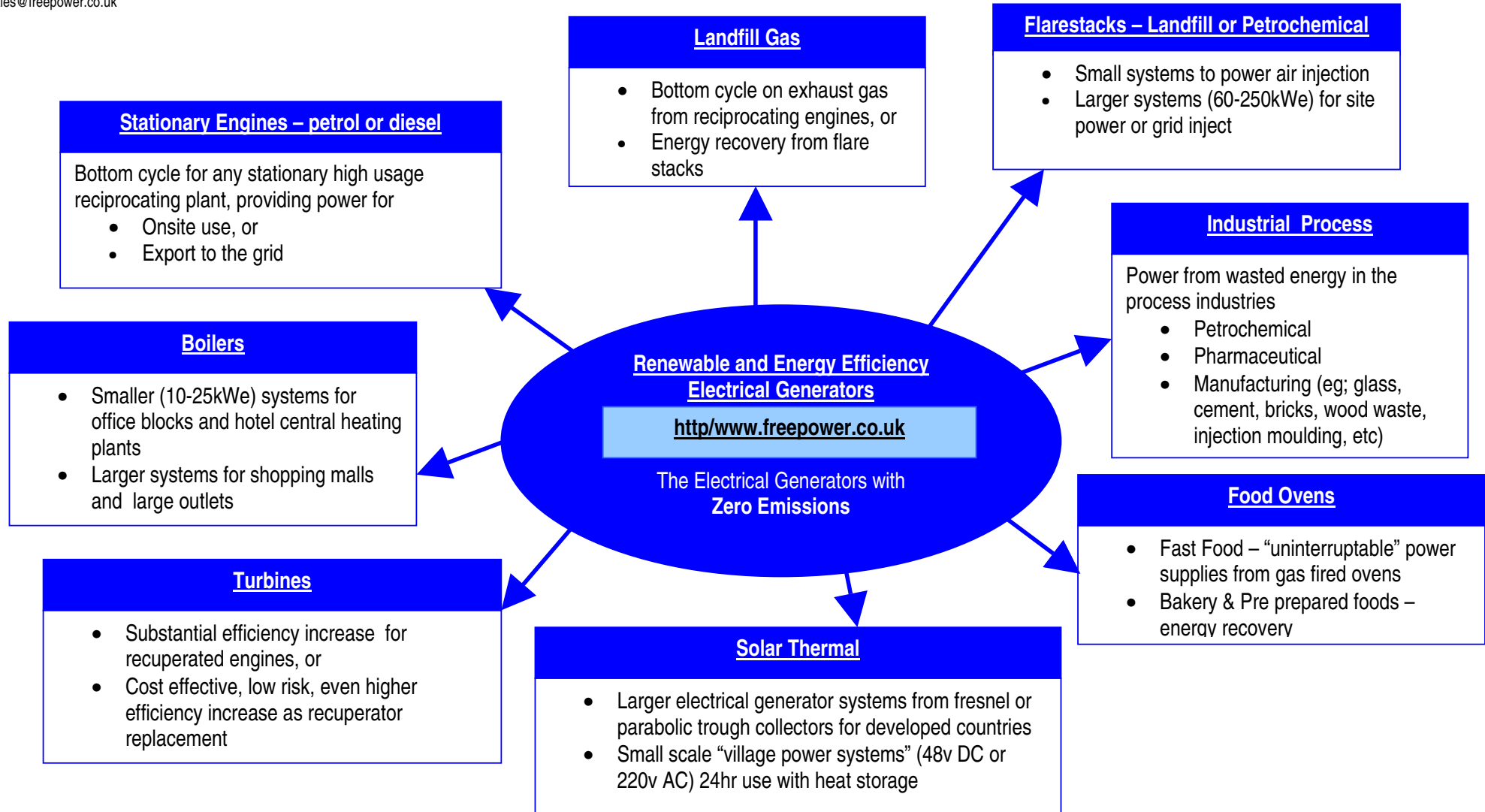


[www.freepower.co.uk](http://www.freepower.co.uk)

# REDUCE NOx EMISSIONS - INCREASE SYSTEM EFFICIENCY - GENERATE ELECTRICITY



Copyright © 2000-2005 Freepower Ltd. All rights reserved June 2005  
sales@freepower.co.uk



[www.freepower.co.uk](http://www.freepower.co.uk)

# SPECIFICATION SHEET



## FREEMPOWER FP6

Specification & Dimensions for  
6kWe Electricity Generating  
Equipment

**Power Output :** 6kW Min

**Type :** Single phase AC

**Voltage :** 240v 50hz or 110v 60hz

FP6 low temperature waste heat ORC generator system converts low grade wasted heat and/or solar heat into a reliable, cost effective source of usable electrical energy.

FP6 is a hand built limited production system designed for you to become familiar with the technology and come up the learning curve at low cost. It will be followed in the near future by the first full production machine – the FP120.

### Turbine

Two stage radial inflow..  
Operating Speed 45000 rpm  
Turbine entry temp 165°C.

### Power Conditioning

240V 50/60 Hz 6kWe output  
Harmonic distortion to comply to IEEE 519  
Grid inject standard  
G83 compatible

### Alternator

High speed 2 pole rare earth (SmCo<sub>5</sub>) permanent  
alternator  
Journal bearings  
Working fluid cooled  
6kWe output.

### Heat Supply

Secondary (external) oil circuit  
e.g. BP Transcal N 0.426 kg/sec  
Inlet Temperature 180°C  
Return Temperature 123°C  
Thermal Input 70kW  
(Note : Duty calculations from 125°C upwards from  
any viable low grade wasted heat source.)

### Working Fluid

Hydrofluroether.  
Non flammable  
Non toxic  
Non ozone depleting

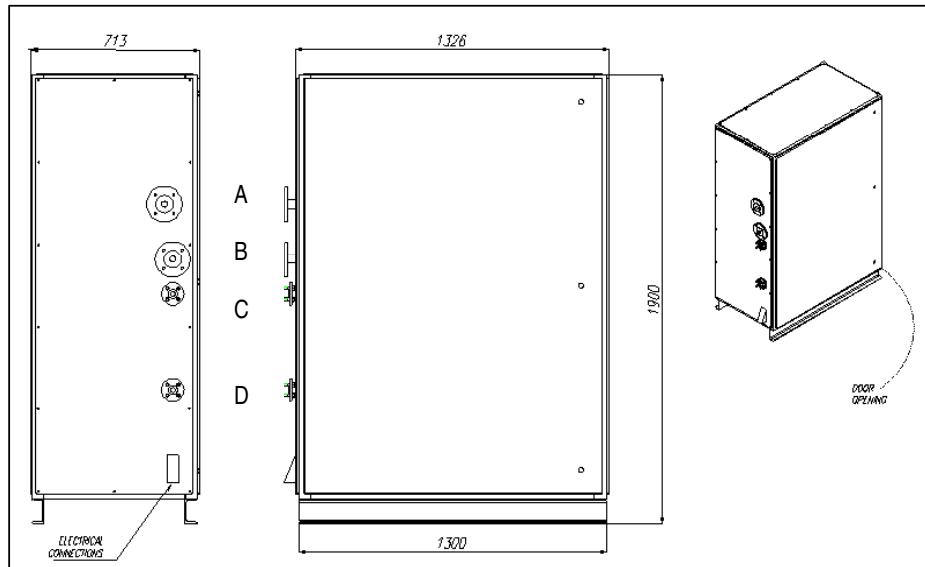
### Cooling

Must provide:-  
Flow rate 0.794 kg/sec  
Inlet (Max) 35°C  
Outlet Max 55°C  
Thermal Output 60 kW

# FP6 Cabinet



## Outline Dimensions & Connections



Dry Weight : 370kg.

Dimensions in mm's

**A : Heat Transfer Medium IN**  
**B : Heat Transfer Medium OUT**  
**C : Cooling Water IN**  
**D : Cooling Water OUT**

FREEPOWER reserve the right to alter any specification without warning

[www.freepower.co.uk](http://www.freepower.co.uk)

# SPECIFICATION SHEET



## FREEMPOWER FP120

### Specification & Dimensions for 120kWe Electricity Generating Equipment

**Power Output :** 120kW Min.

**Type :** 3 phase AC

**Voltage :** 380/480v line to line RMS  
50/60Hz

The Freepower FP120 unit has been specifically designed to operate off the exhaust gas heat of a 1MW reciprocating engine or from any appropriate wasted heat source, be it engine, turbine, oven, flarestack, process heat, geothermal or solar energy.

**NOTE:** The operating inlet temperature is managed by the secondary oil circuit, the actual source of wasted heat may be very much higher.

### Turbine

Three stage radial inflow.  
Operating Speed 30,000 rpm.  
Turbine entry temperature 210°C.  
Plain bearings.

### Power Conditioning

PWM (Pulse Width Modulated) solid state programmable to customer requirements.  
Output 380-480v line to line rms; 3phase; 4 wire;  
50/60Hz; 120kWe.  
Grid inject standard.  
G59/1 compatible

### Alternator

High speed 4 pole rare earth permanent magnet  
Alternator  
Journal bearings  
water cooled  
134kWe output.

### Heat Supply

Secondary (external) oil circuit  
e.g. BP Transcal N 2.679kg/s  
Inlet Temperature 225°C  
Return Temperature 140°C  
Thermal Input 716kW  
(Note : Duty calculations from 150°C upwards from any viable wasted heat source).

### Working Fluid

Hydrocarbon.

### Cooling

Must provide:-

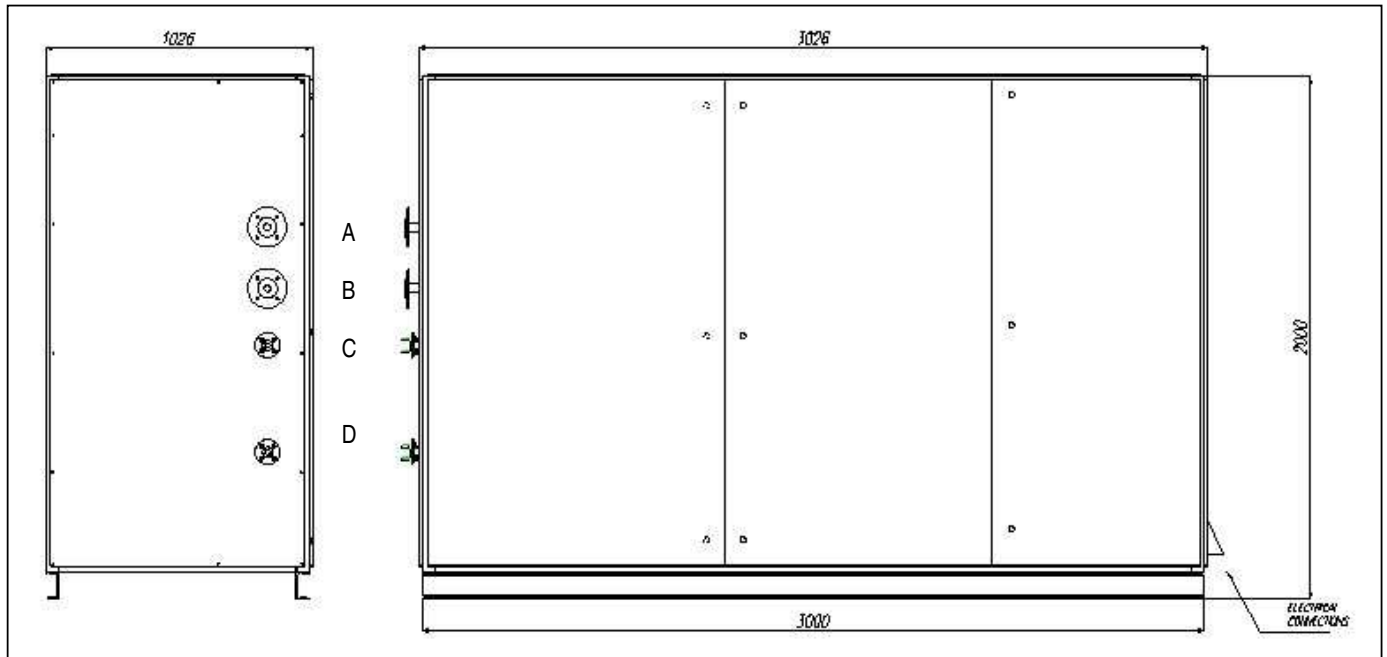
Flow rate 7.683kg/s.  
Inlet (Max) 44°C  
Outlet Max 64°C  
Thermal Output 578 kW

[www.freepower.co.uk](http://www.freepower.co.uk)

# FP120 Cabinet



## Outline Dimensions & Connections



Dry Weight TBA

Dimensions in mm

<b>A : Heat Transfer Medium</b>	<b>IN</b>
<b>B : Heat Transfer Medium</b>	<b>OUT</b>
<b>C : Cooling Water</b>	<b>IN</b>
<b>D : Cooling Water</b>	<b>OUT</b>

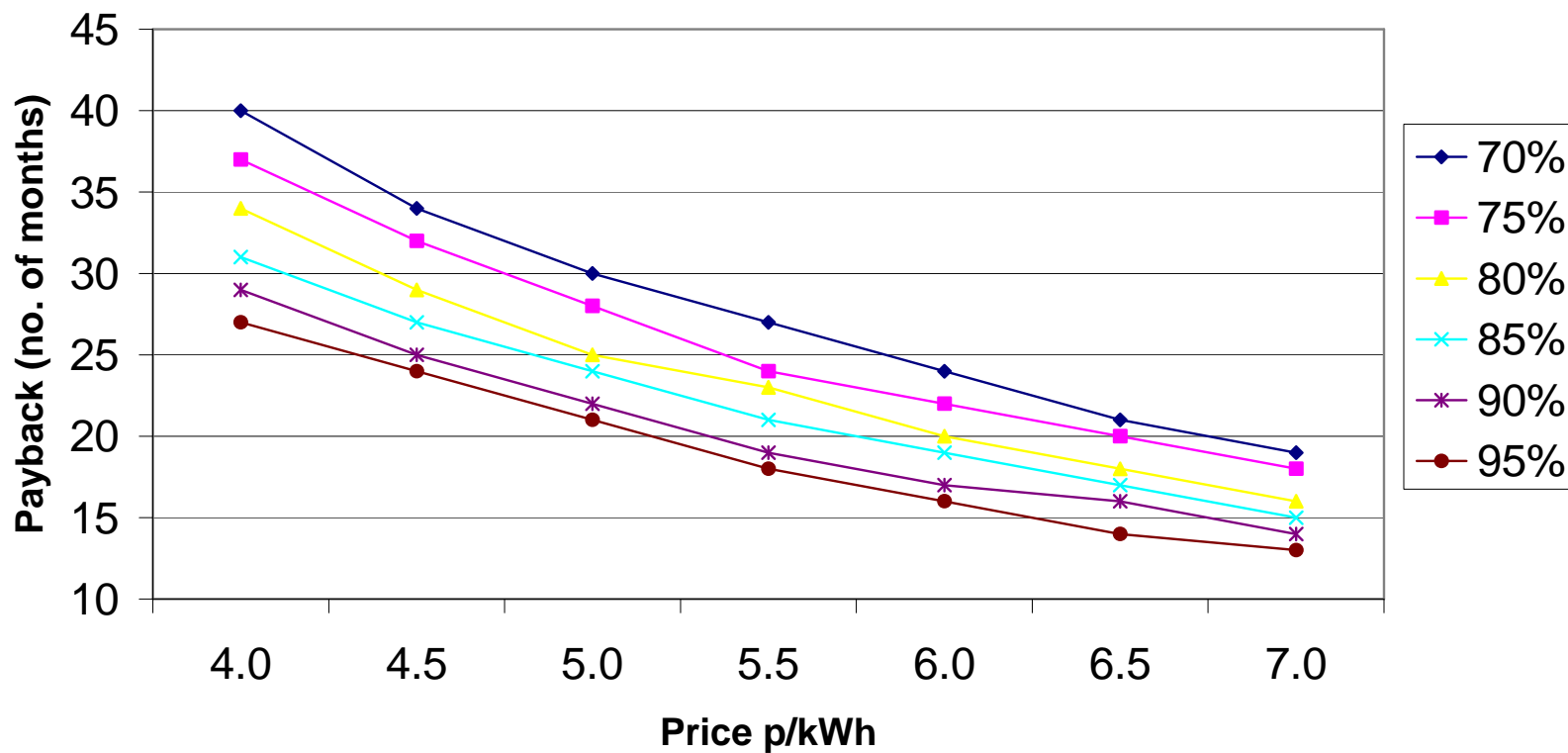
FREEPOWER reserve the right to alter any specification without warning.

[www.freepower.co.uk](http://www.freepower.co.uk)



## ILLUSTRATIVE REVENUE FOR PAYBACK GRAPH

**Illustrative Revenue Payback in Months for FP Units  
@ 25kW+ to Include Budget for Installation Costs**



[www.freepower.co.uk](http://www.freepower.co.uk)