HOME HEATING AND VENTILATION 11 April 2023

Flueless Gas Fire

Closed Combustion Wood Stove

1) BEFORE INSTALLING A FIRE / HEATER DECIDE HOW MUCH HEAT YOU WILL NEED

1a) How many m³ will 1 kw of continuous energy heat

(Note; continuous means that the heater will supply this amount of heat continuously over a long period)

Location of the home in which the heater is to be installed.

We live in a large country with a diverse climate.

In July 2022 average temperatures were

Area	Min (C)	Max (c))
Johannesburg	2	19
Bloemfontein	-3	18
Cape Town	8	16
Durban	11	24

An industry rule of thumb, in colder winter climates such as Johannesburg or Bloemfontein would be that 1 Kw of continuous heat output will heat 40m³ of volume , in a home with some insulation in the roof, reasonably well fitting doors & windows and some of the house carpeted or wooden floors.

Where you are in the country climatically, will affect the volume that can be heated by 1 Kw.
I.e.,
Near the coast in Natal where the climate is milder, 1 Kw will probably heat 60 to 80 m³
If you are in the Drakensberg 1 Kw will probably only heat 25-30 m³ on a cold winters' night.

Decide where the heater installation is be done in the country and work out how many m³ you can heat on average on a cold winter night per 1Kw of heat produced.

1b) How the house is constructed will also influence how much of the house can be heated by 1 Kw of output.

Decrease in Heating Ability	**Increase in Heating Ability**
No insulation in roof	100 mm plus of insulation in roof (FYI many European homes have 500 mm) Polystyrene Ceiling 40 mm thick or thicker
Lots of single skin Glass windows	Small area of windows Double/Triple Glazing
Ill-fitting Windows/Louver windows Steel Window frames	Well-fitting windows Wooden/Aluminium window frames
Badly fitted cornices with air gaps	
Single Skin Glass Skylights	
Tiled Floors	Carpets/Wooden floors/thick curtains
Open Fireplace Chimneys **Ø**	
High Ceilings **Ω** Double Volume Spaces **Ω**	Room above the room being heated
	Insulated floors (starting to happen in some new builds)
	Insulated walls, Europe has a double skin wall brick; brick externally and internally /insulation in the middle. Very clever.

Ø Open Fireplace chimneys. Hot air rises. Generally speaking in winter, the air outside a house is colder than in the house for a large part of the day. So for 80% + of the 24 hour day, warm air in a room with an open chimney will go up that chimney. Losing valuable heat from the home in big quantities.

In the Cape area there is a tendency for some braais to be built inside the house, so that you can braai in winter/rain/ windy conditions. Often these braais have no doors to seal them off when not in use. People spend fortunes heating their home in winter, without thinking about how much of that heat goes straight up the braai chimney. The addition of a simple set of doors to seal or seriously restrict air flow up the chimney will do wonders for a warmer home, a lower heating bill, and the environment.

Ω High Ceilings & Double Volume Spaces Hot air rises. Where there is a ceiling at say 2.7m high the hot air can only rise that far. The heat is contained and the air below the ceiling can warm up with any circulation of the air and heat input from the heating source. Where there is a ceiling at say 6m high, most of the heat will sit in the 3 to 6 m height above floor level and will be no use to the occupants of that room.

Two Solutions can improve this high ceiling scenario.

1) A ceiling mounted fan that can blow the heat down.

2) Use an Infra-red-light source such as that provided by a Closed Combustion Stove with an insulating inner jacket and large glass door. Or use a Flue-less Gas Heater with an infra-red heat source. (Glowing panels)

To sum up, depending on where the house is located geographically and the construction of the house as detailed above, 1 Kw of energy output is likely to heat anywhere between 10 to 80m³

2) UNDERSTAND THE FUEL COST PER YEAR TO HEAT A HOME OVER THE WINTER SEASON

(this may be more important that the combined purchase and installation cost of your chosen heater)

2a) Energy required to heat a 250-300m³ house located in a Johannesburg type climate over a 4-month winter.

A reasonably well insulated 250-300m³ house will require about **10 000 KwHrs** of energy to heat it to temperatures in the order of 19-22 degrees over a 4-month winter period.
Assumed hotter near the heater and a drop off in temperature with distance from the heater.
Most people do not want bedrooms at the same temperature as the living room.

In warmer climates or better insulated houses this energy requirement will decrease.
Conversely colder climates/badly insulated houses this energy requirement will increase.

2b) Efficiency of Heating Appliances

Heat Source	Approx. Efficiency	Comment
Electrical heaters	100%	Assumes free-standing or wall mounted electrical heater in a room.
Electrical under floor heating	70 - 90%	Time delays/heat losses in older systems buried deeper in the floor.
Air Conditioners	200-300%	Takes heat from the external air. Most efficient when the external air is warm but requires electricity to operate.
Open Wood Fires	5 – 20%	Brick fire 5%, Damper unit 10% Open steel firebox c/w convection system 20%
Closed Combustion Wood stove	60 - 80%	Cast Iron Box 60% Steel or Cast-Iron Box c/w internal insulation 70-80%
Open Flued Gas fire	30%	30% when operating 70% + heat loss up the chimney. No adjustable damper allowed in chimney. Vents a lot of warm air up the chimney, 24 hours a day.
Flue-less Gas Fire/Heater	100%	All heat from gas consumed remains in room.

2c) Energy Costs incl. VAT

1 Kwhr Electricity (JHB ESKOM)	R3.30	
48 Kg LP Gas Refill	R1 857	equivalent to about 13KwHrs energy/kg = R2.97/kwhr
1 Ton firewood	R1 000	1 Kg of good dry wood has about 4 Kwhrs energy

ENERGY COST FOR 10 000 KWHRS OVER A WINTER SEASON

TYPE OF HEATER	APROX FUEL COST OF HEATING 250-300 m³ HOUSE OVER 1 WINTER	
Open Flued Gas Fire	R 100 000	This is why sales of these fires are pretty much extinct in SA
Under floor heating	R 40 000	
Electrical Heaters	R 33 000	
Flue-less Gas Fire/heater	R 30 000	
Open wood fire	R 28 000	See comment on open chimneys
Air conditioners	R 15 000	
Closed Combustion Wood Stove	R 4 000	

3) AIR POLLUTION AND WATER USE AT POWER STATIONS

Interesting facts

Most Coal Fired Power Stations are water cooled. The photo on the right shows water evaporating from the cooling towers

If Eskom runs the precipitators to clean exhaust fumes from these units. this also consumes water and takes electricity.
Note the dirty smoke from the 1 smokestack and cleaner smoke on the other.
1 Precipitator working and 1 not?

Power stations are generally a long way from consumers. The power lines have quite large power losses in this transmission process.

For Eskom to provide 10 000Kwhrs of useable energy in your home, they have to burn 4+ tons of coal and consume 200 000+ litres of water. These figures assume the Eskom plant is running efficiently. If not these consumption figures will be higher.

In terms of reducing Carbon Emissions into the atmosphere and retaining water for other purposes in a country with water supply issues, reducing the demand for Eskom coal generated power would be hugely beneficial.

Open Fire

Flued Gas Fire

Flueless Gas Fire

Flueless Gas Heater

<u>4) HOME HEATING TRENDS OVER THE LAST DECADE</u>.

Anthracite Fires have died a death as they are heavily air polluting, take a lot of effort to get going well, and need re-fuelling several times a day. Often with a fair amount of dust and fumes being brought into the home when lit/refuelling. These have been replaced with easier to light, better visual flame effect and more environmentally friendly Closed Combustion Wood Stoves.

Open wood fires have plummeted in demand, except where they are used primarily as a focal point, not a heating source. i.e., on patios, in pubs. Open Steel fireboxes and grates have likewise plummeted in sales.

There has been a huge growth in Closed Combustion Wood Stoves installations. Homeowners are installing these as a primary heating source, capable of running up to 24 hours per day and keeping a large portion of their homes warm. The initial Capital Expenditure is recovered in the first 2 years of use, versus paying fuel costs of other forms of heating. Thereafter they have cheap heat that works even if there is load shedding.

There is a little work in lighting and refuelling these Wood Stoves fires that may put a few people off these units.

Open Flued gas fire sales are now pretty much extinct. There will no doubt be some on manufacturer/shop shelves but whether these are still legal to sell, if they do not have a valid Safe Appliance Permit, is very arguable.

Flue-less Gas Fires/heater sales have surged as homeowners reap the benefit of heat at the flick of a switch. Generally these are capable of heating about 300 m^3 of home, great if you have one large room you want to heat. These units are also in demand by people without the time/ wish to make and look after a fire.

Some of these gas heaters do require an electrical power source to function.

Most flue-less gas fires operate without power and are immune to Load Shedding.

5) CLIENT PREFERENCES

We make little comment on electrical heating methods.
As seen above they are expensive heating sources, unless used as an air conditioner in Heating Mode.
With Load Shedding now a daily occurrence of many hours, I suspect with the exception of Air Conditioners, that are used mostly for cooling but can heat, or maybe Underfloor Heating in some bathrooms, these sales are virtually non- existent.

If you have the time, or a maid, that can light and operate the fire, Closed Combustion Wood Stoves are a primary choice for overall home heating, over large chunks of South Africa.

If you want to warm one room of the home and want heat at the flick of a switch/remote, then a flue-less gas fire/heater is purchased. Prime examples of rooms where you would not want to light a fire are a pyjama lounge where you can pad out of a bedroom to relax, a second lounge or study that you use occasionally, but want quick heat when you do want to use it.

In the Durban coastal area sales of flue-less gas fires dominate. Gives a great flame effect to sit around and takes the small chill off the air. Wood stove sales volumes are very small on this stretch of coast.

As mentioned earlier a lot of people want an open wood fire for heat / ambience on a covered patio or pub scenario. Generally these are used occasionally. Heat output of the fire is not a major consideration.

6) UNDERSTANDING WOOD STOVE CONSTRUCTION, HEAT OUTPUT, METHODS OF MOVING HEAT, AND EMISSIONS INTO THE ENVIRONMENT

6a) Heat Outputs

Peak heat output on a wood stove is achieved when the stove is full of wood, well alight and with the air controls fully open. It is sustainable for about 30-45 minutes, as the wood is being burnt at a rapid pace and inefficiently. To sustain this peak output longer the stove would need to be re-fuelled every 45 minutes to 1 hour, necessitating that the door would need to be opened to put more wood put in. Generally, a smoky exercise with this amount of flame in the fire.

Rated Heat output on a wood stove is when the wood stove is operating at the top end of its maximum efficiency, (max heat output per kg of wood consumed) which also correlates with minimum emissions into the atmosphere.
In many ways the efficiency curve on a wood stove is very like that of an internal combustion engine.
Maximum efficiency is typically achieved with the unit running at about 20 to 60 % of the peak heat output.

Western European Wood Stove Manufacturers encourage users of their wood stoves, to operate them at burning rates that consume wood at high efficiency (i.e., most heat per kg of wood burnt) and at levels where flue emissions are minimised. Western European Manufacturers have therefore chosen to rate the heat output of their stoves at the upper end of the maximum efficiency output.

Infiniti Fires have chosen to follow this method, when rating the heating capacity of our wood stoves.

I.e., Our 8 Kw rated heat output unit will produce at peak output $\frac{\text{8 Kw rated}}{0.6}$ = 13.3 Kw Peak Heat Output.

Our 8 Kw unit will heat in a Johannesburg type climate 8Kw x 40 m^3 = 320 m^3

Most wood stoves from the USA, Australia, South America and Eastern Europe provide the consumer with the peak heat output of their wood stove. Not the rated output. To the uninformed consumer this may suggest these manufacturers have apparently higher heat output units, than those manufacturers using the Rated Heat Output System. Wood Stove retailers should be aware of the difference between Rated and Peak outputs.

Do the maths as above to get a better comparison between rating methods.

Units using Peak Heat Output as a measure of heating ability will typically heat about 25m^3 per Kw

I.e. 13 Kw Peak Heat Output Unit x 25 m^3 = 325m^3 heating volume.

6b) Steel or Cast Iron used in Wood Stove Design

There are many variants of wood stoves on the market from basic cast iron units with no insulation material and small glass panels, to units made of steel or cast iron with insulating board and big glass panels.

Cast Iron or steel

What are the benefits of cast iron or steel when used in Wood Stoves?

Benefits	CAST IRON	STEEL
Components cast in moulds producing curves and patterns in the pieces. Cast iron units often more ornamental externally	√	NA
Components laser cut and bent	NA	√
Components bolted together	√	NA
Components welded together	NA	√
Easier to engineer good airflows for improved combustion	Tricky	√

Benefits	CAST IRON	STEEL
Movement of heat through wall of stove	No real difference between these 2 materials at these material thicknesses.	
Resistance to rust	On this thickness of cast iron or steel no real difference. Both will rust if in contact with water.	
Pieces will break if knocked hard	√	NA
Pieces may crack if liquid dropped on unit whilst hot.	√	NA

In our opinion there as many pros and cons as to whether you buy a cast iron unit or a steel unit.

There appears to be a shift by manufacturers around the world to more steel units. Easier to make, less energy consumption, better engineering possible, less labour intensive (all those cast-iron parts need to be manually bolted together!!)

6c) Efficiency of a wood stove without insulating material inside it

These tend to be units of older design that have not been upgraded.
Combustion temperature is lower than insulated units, efficiency of the unit is generally around 60% and emissions into the atmosphere are greater than with an insulated unit.
70-80% of the heat output from the unit is given out through the walls and top of the unit, with air in contact with the metal being heated. As we all know hot air rises. This heat will need a ceiling to contain it, and with time and an insulated ceiling the heat will roll down to where the occupants of the room are sitting.
20 to 30 % will come out through the glass door as Infra Red Heat. This will move as a light wave across the room.

These units best installed in rooms c/w a standard height ceiling.

6d) Insulating material used inside a stove/ and the benefit of a bigger glass

Insulating material is used to line the inside of many Wood Stoves manufactured today.

This insulating material raises the peak combustion temperature inside the stove to just below 1000 C.

At these higher temperatures the wood burns incredibly cleanly, sending very little in the way of emissions into the atmosphere.

If this stove, with decent insulating material is fitted with a large piece of glass, 70% of the heat produced by this stove will travel through the glass as an Infra red light wave. Just like the sun's rays this heat will travel fast across the length of the room and will be absorbed by walls, furniture, people or whatever this Infra red light is absorbed by.

Only 30% of the heat from this stove will be brought into the room as hot air.

These units with good insulating material and a large glass are generally about 75 to 80 % efficient. Great at heating large open plan spaces, and certainly not so essential to have a ceiling at standard height to roll the hot air back down.

6e) How much wood do you need to burn?

1 kg of decent dry firewood has about 4 Kwhrs of energy inside it.

Assuming you have a high efficiency unit with efficiency at 80%

1 Kg of wood burnt in 1 hour with produce 4 Kwhrs x 80% = 3.2 Kw hrs of useful energy in your room.

So if you want 10 Kw heat output (to heat 400 m^3) you will need to burn $\frac{10kw}{3.2}$ = 3.2 Kg/hour of wood

6f) Movement of heat around a house

Each home is different in its layout and thermal efficiency.

A heat source, typically put in the lounge or family room, will heat that area first.

Once that room is warm, if the heat source is capable of heating a volume bigger than that room, and this room is open through a door or similar to other parts of the house, then heat will start to flow into other rooms of the house.

Double story houses are really good at moving heat from a heat source on the ground floor to upstairs rooms.

Closed Combustion Stoves are designed to be run for many hours a day, enabling good heat dispersion around the home.

6g) Emissions into the atmosphere.

Flue emissions from wood being burnt in a good quality Wood Stove are less than if the wood had rotted naturally in the forest. If you are growing trees that you are burning or if you are purchasing wood from a sustainable source your contribution to Global Warming from heating your home is Nil.

Flue emissions of Co2 for typical home heating fuels are;

FUEL TYPE	EMISSIONS Kg CO2/KwHr
Wood logs	Less than 0.00612
Natural Gas	0.216
LPGas	0.234
Electricity	0.460

Source Biomass Energy Centre, UK

7a) VENTILATION FOR HOME HEATING APPLIANCES

GENERAL

Definition of **Permanent Ventilation:** opening to the outside atmosphere that is fixed in the open position.

Gas and Wood fires / heaters consume oxygen when alight and produce carbon monoxide and dioxide amongst other gases in the combustion process. Air needs to be brought into the room to replace the air consumed and the fumes from the fire / heater need to be dealt with.

Failure to do this properly could hurt or in extreme cases kill people/animals.

Generally speaking, in SA, most older houses have good numbers of air bricks and gaps around doors and windows that can bring fresh air into the room to replace air being consumed by Closed Combustion Wood Stoves/ Flueless Gas Fires/Heaters and the occupants of those rooms.

In houses that are more airtight, additional louvers or airbricks may need to be installed to bring in adequate fresh air or remove products of combustion for the safe operation of the heating product installed.

7b) FLUED WOOD OR GAS FIRES

The manufacturer of the product will provide a flue outlet on the product. The installer of this product needs to use a flue of the same size to vent the combustion fumes to outside the house. Most times the flue needs to extend to above the roof line but on some gas products through an external wall could suffice. With any appliance the Instruction book will detail the correct flueing process that must be used.

Measure the flue area in mm^2. This is the amount of air gaps that should be available to feed fresh air into that room for the safe operation of this appliance. You can measure gaps around doors and windows as well as any existing air bricks or any other form of installed permanent ventilation(to the outside of the house), to see if this total area adds up to that of the flue. If needed install additional air bricks or louvers to the outside of the house.

7c) FLUELESS GAS FIRES & HEATERS

These fires / heaters burn gas very cleanly with very low emissions of Carbon Monoxide and Dioxide.

All of these appliances sold in SA should by law have been tested to ensure their emissions are below the legal maximum.

By law these heaters must also have a **Flame Failure Device** fitted to them, that will switch off the gas supply to the heater in the event that the Oxygen content of the room falls below 18% **or** the Carbon Monoxide content exceeds 0.2%. I.e., the unit turns itself off if either of these events occurs.

The combination of these low tested emissions and this Flame Failure Device makes these appliances very safe heaters to install without a chimney, provided they are installed in a room of adequate size.

It is a legal requirement that manufacturers detail in their instruction manual;
•The minimum size room volume the product can be installed in, without needing any additional Permanent Ventilation
and
•The amount of Permanent Ventilation required, in the event this product is installed in a room that is smaller than the defined minimum.

Example
Model Infiniti Fires Slimline 1000

Room Heating Capacity	400 m^3
Legal minimum Room Size	148m^3
Permanent Ventilation if required	2 x 240cm^2

This model can be installed in a room of 148 m^3 or bigger without the need for any Permanent Ventilation to be installed. If the room is smaller than 148m^3 then airbricks or similar with a total open airflow of 240 cm^2 must be installed at high level in the room in **an external wall** and a similar size installed at low level in **an external wall**. In theory the low level will bring in fresh air to the room. The higher will remove the products of combustion.

Air bricks vary a lot on the amount of Permanent Ventilation they give a room. But most would give about 40 or 50 cm^2 per brick. So, an installation of this product in a room of say $140m^3$ would require 5 airbricks of 50 cm^2 installed high up and 5 low down on an external wall. An awful lot of airbricks to put in. A lot of building work to an existing structure and probably a cold room with that much airflow. In reality most people would not do this option.

You will note the room heating capacity is a much bigger volume than the legal minimum room size, some 2.7 x bigger.

The right answer on safely installing a flue-less gas product, without needing to put in permanent ventilation, is to better size the room heating capacity of the gas fire/heater to the room volume. Ie put in a smaller heater that has a heating capacity better matched to the room volume.

It will make the installation safer, easier and more efficient as a heater, and remove the expense and heat losses associated with building in airbricks.

Note in the event the room in which a flue-less Gas Fire/heater is to be installed, has a common opening of reasonable size with an adjoining room, the volume of both rooms can be added together in determining the room volume.

FLUESS GAS FIRES & HEATERS BANNED IN BEDROOMS AND BATHROOMS

Bedrooms and bathrooms tend to be smaller rooms than living rooms. There has been some misunderstanding/sloppiness by gas fitters who have installed Flue-less gas Fires and Heaters in bedrooms and bathrooms, with no consideration of room size or that the fire could be left operating throughout the night whilst the occupant sleeps. As a result, the installation of Flue-less Gas Fires or Heaters has been banned in both bedrooms and bathrooms.

The installation of gas operated water geysers that vent the fumes into the room in which they are installed has also been banned. Quite a few people have died in Southern Africa from geysers incorrectly installed in bathrooms.

NOTE ON VENTILATION

The draft update to SANS 1537 has increased the requirement for ventilation, to encourage consumers to better size the appliance purchased to the size of the room volume, as this will improve safety.

It also includes ventilation requirements on kitchen hobs and stoves that have historically been ignored in this code. Bearing in mind the huge move by consumers towards gas stoves/hobs to be able to cook in Load Shedding this was a safety issue that needed to be addressed.