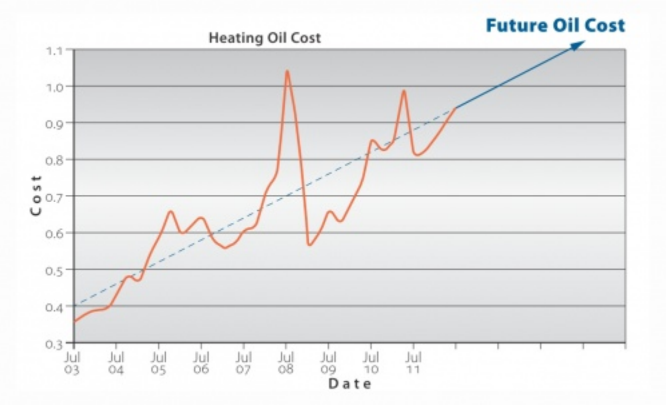
Website: RVR Hybrid Heating Explained

From RVR

RVR introduces a revolution in heating technology - Hybrid Heating

The cost of oil and gas has risen sharply over the past 10 years. The price of a litre of kerosene in July 2003 was €0.36 - today it is almost €1.00. This is an increase of over 275%. This rate of price increase is expected to continue, with no sign of slowing down.

By contrast – the rise in price of electricity has been much more moderate. It has increased by just 5% per year and cost approximately €0.175 per kW in May 2012.



It now costs almost 12c to produce one kWh of heat using a standard oil boiler.

Here is an example of the dramatic rise in fuel costs.

A home owner who spent €500 per year in 2003 would be paying:

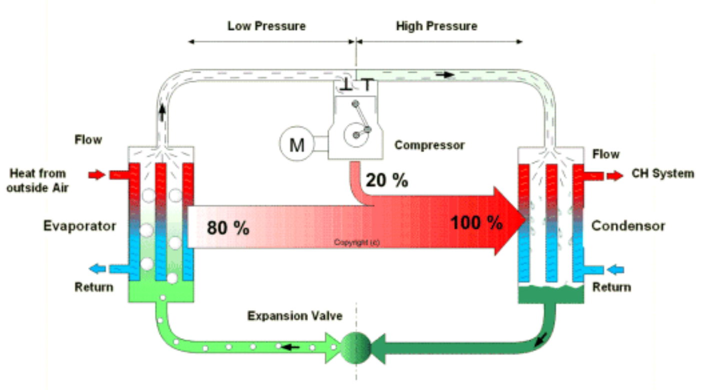
- **2003 - €500 per year**
- **2012 - €1375 per year**
- **2021 - €3780 per year**

This will make the cost of heating oil unaffordable in just a few short years.

Air to water heat pumps

A clean, cost-effective solution is available using Air to Water Heat Pumps. Air to water heat pumps use electricity very efficiently to produce heat. They do this by taking heat from the surrounding air. For each unit of electricity used, an air to water heat pump can typically produce between 2 and 5kW of heat output. This is a very efficient use of fuel.

Principle of operation - Heat Pumps



An Immergas Audax heat pump uses an electric motor to pump a refrigerant gas through an evaporator and condenser . The refrigerant gas acts as the heating medium.

- In the evaporator, the refrigerant liquid is turned into a gas. As it evaporates, it absorbs heat from the surrounding air.
- The refrigerant gas is then compressed under high pressure into high temperature gas.
- This hot gas passes through a heat exchanger (the condenser) where it condenses back into a liquid and as it does, it transfers the heat to the central heating system water.
- The high pressure liquid is then returned back to the evaporator through a special valve (called an expansion valve). As the refrigerant expands it again absorbs heat from the surrounding air.
- The cycle is repeated again and again to produce as much heat as is required.

The actual amount of heat delivered on any given day will depend on the temperature of the outside air and the temperature of the central heating system.

Heat pump possibilities

An Air to Water heat pump can produce huge savings as the cost per kWh of delivered energy is lower than with a traditional boiler.

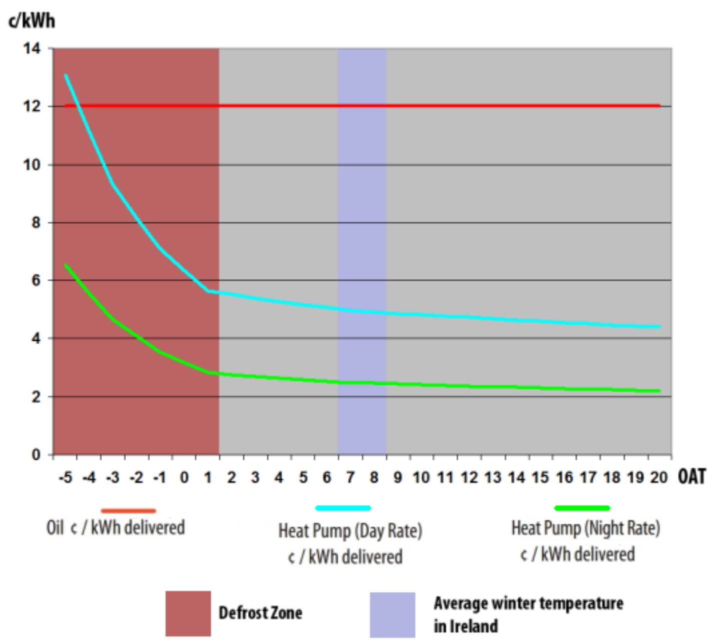
Time of Day	Electricity Cost	COP	Cost of heat from heat pump	Cost of heat from oil	Saving	% Saving
Day	17.50 c	3.5	5.0c	12.0c	7.0c	58%
Night	8.75 c	3.5	2.5c	12.0c	9.5c	79%

Real world applications

So what can be expected of an air to water heat pump?

The best way of comparing heat sources is by the amount it costs to deliver one unit (1kWh) of heat into the building. Traditional boilers are not affected by temperature to any large degree, so will cost almost exactly the same to run when it is cold outside as when it is hot outside.

However the efficiency of an air to water heat pump varies depending on the outside air temperature and several other variables. So a graph is needed to demonstrate the running cost at any given time.



The graph above shows the typical costs of running an air to water heat pump versus an oil boiler. The cost in cents per kWh delivered is shown on the side and the outside air temperature is shown across the bottom.

The cost per kWh delivered by the oil boiler is approximately 12c per kWh.

There are two domestic electricity prices available in Ireland, day rate and night rate. Day rate per unit of electricity consumed at time of writing was 17.5c/kWh and night rate was 8.75c/kWh. The heat pump then uses this electricity to draw heat from the outside air, producing between 2 and 5 units of heat for each unit of electricity used. So when it is mild, the cost cost per kWh of energy produced by the heat pump will be low, and when it is colder it will cost more.

The typical average outdoor air temperature in Ireland during the heating season is 7°C to 8°C. This is marked on the graph above with a purple background. During this time, as shown on the graph, the cost of running the heat pump on day rate would be 5c/kWh and on night rate would be 2.5c/kWh. These are major savings over runnign an oil boiler at 12c/kWh.

The defrost zone and other limitations

Air to water heat pumps have excellent potential when applied correctly. Consideration must be given when designing a system to some limitations of the technology.

A major issue is known as the "defrost zone". When the air temperature approaches zero, frost will begin to build up on the coils of the heat pump. The moist, humid climate in Ireland makes this a major issue.


Extreme case of coil freezing

When the coils are frozen then the heat pump cannot draw heat from the air. So in this situation the heat pump enters a defrost mode and it uses energy to defrost the coils. As a result, the effective cost per kWh will sharply rise, but more importantly, the amount of energy the heat pump can produce will fall.

If you expect a heat pump to produce 10kW when it is mild, then assuming that the heat pump must defrost for 30 minutes in every hour when outside temperatures are 1°C or below, the maximum a heat pump could produce in the hour is 5kW. This is compounded by the fact the heat pump would be using heat from the house to defrost the coils, lowering the capacity even further.

The "defrost zone" is marked on the graph with a red background. During this time it is not sensible to run a heat pump and an alternative heat source must be used.

Additional limitations of air to water heat pumps include:

- Air to water heat pumps do not work well at high system temperatures (> approx 45°C)
- They do not work well when there is a high instant heat demand in the building
- They are not good at heating domestic hot water

So a solution is required to address these limitations. The RVR hybrid heating system addresses these issues while still allowing the major cost savings possible from an air to water heat pump.

The solution - The RVR Hybrid Heating System

The RVR Hybrid system can provide a solution to these issues.

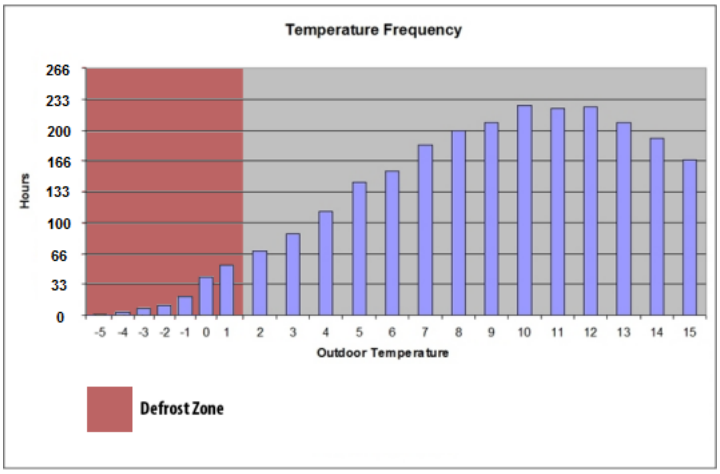
RVR Hybrid heating includes a heat pump, boiler, sophisticated control system and smart software. It can be installed as a new system or can be retrofitted to existing boiler systems.

- Most of the heating is done by a high efficiency Audax heat pump.
- When heat pump operation is not economic - heating is done by a boiler.
- A powerful control system collects large amounts of accurate data from the heat pump, boiler and other sensors, processes the data and determines the optimal heat production mix.

Every minute, the control system collects large amounts of accurate data from the heat pump, boiler and other sensors. The control system processes this data. The software calculates the cost of producing the energy required along with the capacity of the heat pump to deliver heat and determines the optimal heat production mix. Instructions are dispatched to the heat pump and boiler according to this optimisation decision.

Optimal heat production mix

The sophisticated control system analyses the system every minute. Based on the information it collects and processes, it makes a decision on how to heat the building.



Above is a typical graph of heating season temperatures in Ireland. It shows the number of hours per year that the temperature is 15°C or below, when central heating is needed.

The heat pump will typically perform well at all temperatures of 2°C or above. This is the majority of the hours in the heating season. The boiler will be used when temperatures are below 2°C, when the heat pump is in the "defrost zone".

RVR Hybrid Heating – Radiators or Underfloor?

The optimal heat production mix is also affected by the type of heat emitter used in the house - Radiators, Low temperature radiators, underfloor heating etc.

Each of these has a different temperature requirement. Radiators are usually sized so that they need the heating water delivered to them to be 80°C so that they can emit enough heat to keep the building heated when it is -5° outside.

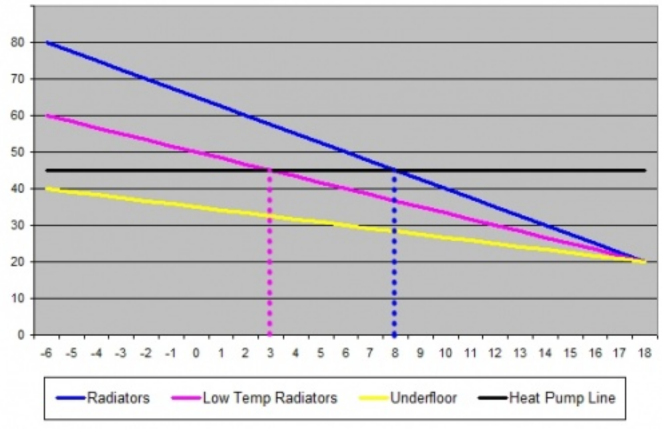
Underfloor is usually sized for 35-40°C and Low temperature radiators fall somewhere between the two, often at 60°C.

However, when the outside air temperature is warmer, the flow temperature required can be lower, while still heating the building, as there is not as much heat demand.

This has a major effect on the system as the heat pump will be at it's most economic when providing heating water at a flow temperature of 45° or below.

The graph below shows the heating flow temperature required at different outdoor air temperatures for Standard Radiators, Low Temperature Radiators and Underfloor.

The black line across the middle of the chart (45°) is the line below which the heat pump will be able to deliver the temperature required at a good efficiency.



On Standard Radiators, we can see that at outside air temperatures above approx 8 degrees the heat pump can supply the required temperature economically.

On Low temperature or oversized Radiators, the heat pump can work well at approx 3 degrees and above.

On Underfloor, the heat pump can supply the required temperature at any outdoor air temperature, however the defrost zone will be an issue at lower temperatures.

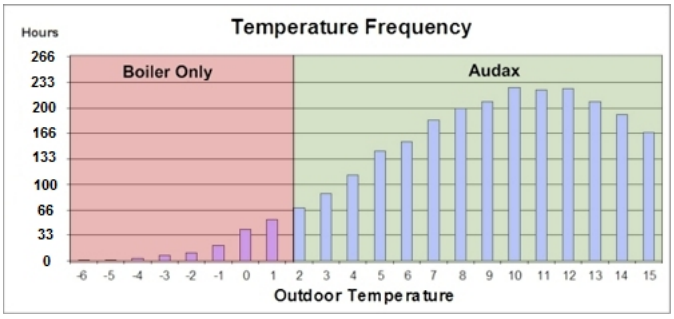
By using a feature called weather compensation, the sophisticated control system can determine the flow temperature required at any given time. In this way, the heat pump and boiler can combine to provide the optimal heat production mix even on standard radiators.

Heat source mix

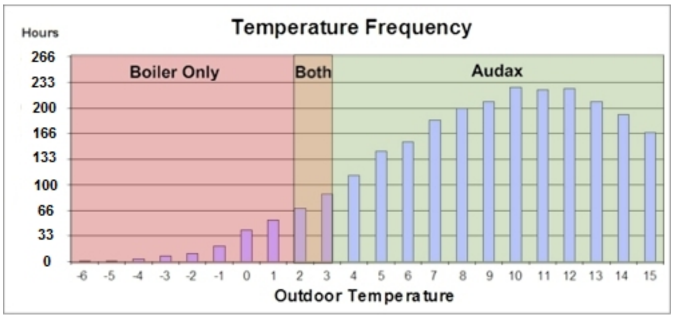
Another way of visualising how the RVR Hybrid System will work is as follows.

The graph below shows when the heat pump and boiler will usually run on an underfloor system. This is of course dependent on the hundreds of calculations run ever minute within the sophisticated control system, however it gives a good idea of what to expect.

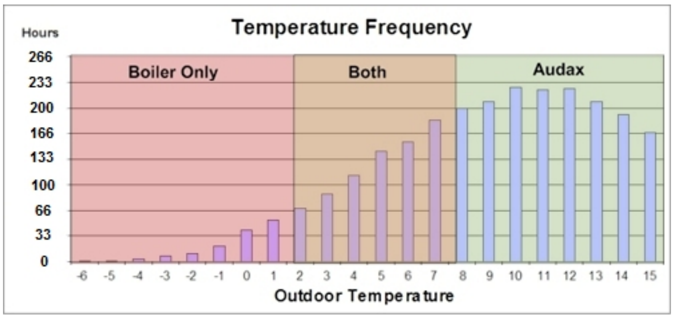
Primary heat source - Underfloor heating



Primary heat source - Low temperature radiators



Primary heat source - Standard radiators



Heat Pump potential

Based on the different heating system types in different buildings, the heat pump has the potential to run for the following amounts of the heating season:

	Hours	% of Heating Season
Heating Season Length (OAT<15°C)	2,540	
Hours Audax is viable on UF	2,402	95%
Hours Audax is viable on radiators sized for 60°C	2,578	88%
Hours Audax is viable on radiators sized for 80°C	1,649	65%

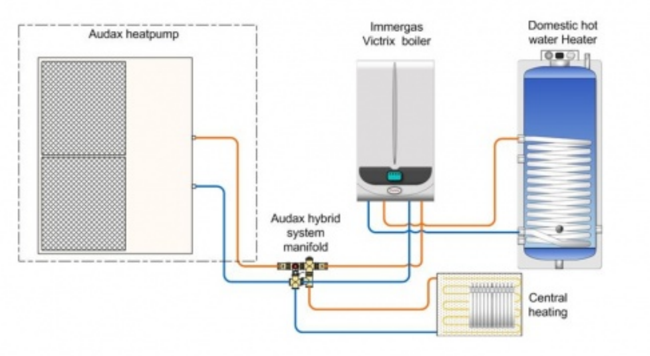
System Configurations

So, how is the RVR Hybrid Heating system applied?

There are two system configurations available. The **Standard Parallel System** and The **Advanced Combination Tank System**.

Hybrid Systems – Standard Parallel Configuration

In this system type, the Audax and the boiler are directly connected to the heating system.



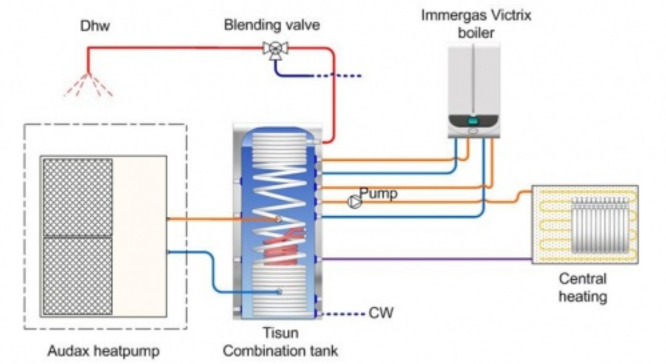
A special manifold is installed to connect the Audax heat pump and the boiler. The Audax is the primary heat source and the boiler will operate only when it is not economic to run the heat pump, or when there is a very high heat demand in the system. The boiler carries out the domestic water heating.

Advantages

- Simple compact installation
- Ideal when space is limited
- Simple connection of heat sources using connection manifold.
- Running Cost savings of up to 45% when compared with oil.

Hybrid Systems – Advanced Combination Tank Configuration

In this system type, the Audax and the boiler are both connected into a Tisun combination heat tank. Both the Audax and boiler may run independently or at the same time, depending on the demand for heat and on weather conditions.



This system also allows the use of a special “night rate heat boost” function. The night rate heat boost function allows heat, produced by the heat pump on low-cost night rate electricity, to be stored in the combination heat tank. The heat produced using night rate electricity can cost as little as 2 cents per kWh. Typically, the additional cost of choosing a combination tank type system can be paid back in under two years when using the night rate heat boost function.

A second advantage of the combination tank system is that the heat pump contributes about 70% of water heating. In a typical family home, this will save an additional €200 per year when compared to oil.

Advantages

- Audax and Boiler may run independently
- Audax also provides up to 70% of hot water heating
- Combination Tank stores heat produced with inexpensive night rate electricity.
- Running Cost savings of up to 60% when compared with oil.
- Payback of the additional cost of combination tank in less than 2 years.

RVR Hybrid System Manager

This is the system ‘brain’.

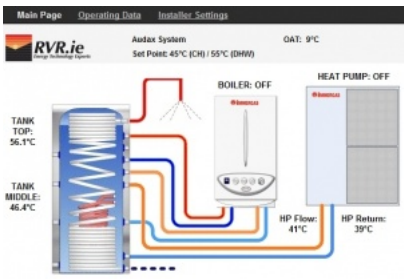
It calculates the current cost of electricity, the current cost of oil or gas, the correct operating temperature for the system.

Every minute, the control system collects large amounts of accurate data from the heat pump, boiler and other sensors. It also monitors things such as the outside temperature, central heating system temperature, hot water temperature, time of day, time of year.

The control system processes this data. The software calculates the cost of producing the energy required and determines the optimal heat production mix. Instructions are dispatched to the heat pump and boiler according to this optimisation decision.

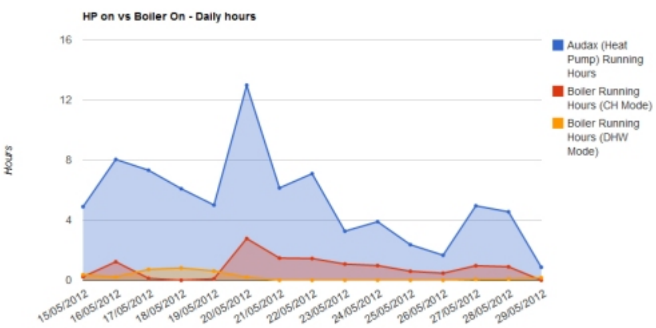
The information is also sent over the internet to the intelligent hybrid web site.

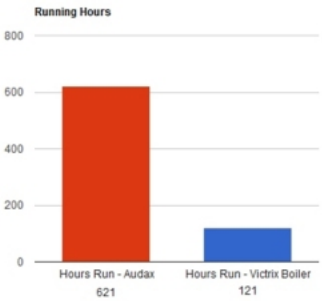
The RVR Hybrid Heating Website

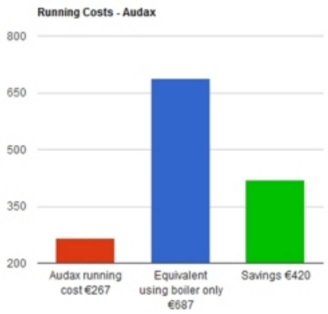


The RVR Hybrid Heating website allows the user to instantly see and control the operation of their system at any time.

The user can also see the savings in fuel and running cost. Detailed utilisation and cost saving reports can also be generated to clearly show the quick return on investment.







The user can log in at any time from anywhere, via smart phone, pad, or computer.

Reliability and customer care

The RVR Hybrid System manager continuously monitors the system. If there is a fault, it will email a designated person. A monitoring service is also available from RVR.

Case Studies

As systems are continuously monitored, running cost savings can be easily calculated.

Running cost savings of between €116 and €181 per month have been recorded from various residential sites during Winter 2011/2012.

Two case studies are outlined in the RVR Hybrid Heating Brochure, which may be downloaded here (http://www.rvr.ie/datastore/catalog/products/AHS001/literature/Hybrid_Heating_Systems_20120323b_web%20(4).pdf) .

Features and Benefits

- Large Verifiable Running Cost savings.
- Low capital cost.
- Compliance with Building Regulations.
- May be installed with underfloor or radiator systems.
- Easy to use, sophisticated Web controls.
- Continuous monitoring for maximum reliability.
- Irish developed system designed for Irish Conditions.

Further Information

To view a demo of the web interface, or to see the products, please click on one of the button links below.

VIEW DEMO

PRODUCT INFO (http://www.rvr.ie/Product_Groups/0_331_332/)

A brochure outlining the details found on this page may be downloaded here (http://www.rvr.ie/datastore/catalog/products/AHS001/literature/Hybrid_Heating_Systems_20120323b_web%20(4).pdf) .

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