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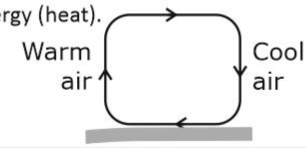
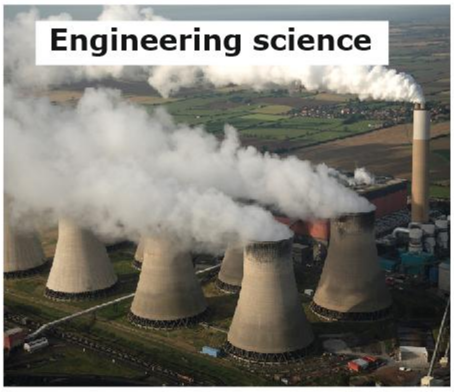
Doublethink thermodynamics and climate change

Evidence is presented that our current climate crisis could have been avoided if scientists had taken more care defining their terms during the nineteenth century transition from the caloric theory of heat to thermodynamics.

In particular, three caloric era terms, ‘**heat’**, ‘**heat engine**’ and ‘**heat sink**’ acquired new meanings in thermodynamics, but they are still commonly used in the old way.
This has reduced thermodynamics to a doublethink science with meteorologists and engineering scientists agreeing on the laws of thermodynamics, but disagreeing on the properties of heat engines.
Here is an c example of heat engine doublethink.

This tropical hurricane can only be explained by assuming that convection currents are *circular heat engine systems* that recycle a large fraction of their thermal energy (heat).





According to the engineering science interpretation of thermodynamics, heat engines can only form *linear systems* because heat cannot travel ‘the wrong way’, from cold to hot.
For example, this fossil fuel burning power station is typical of manufactured heat engines that dump their waste heat into the environment, instead of recycling it.

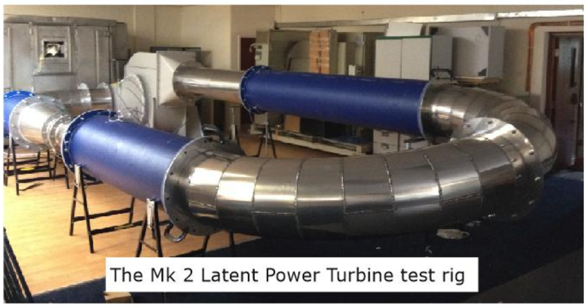
The clue to solving the above riddle is that two different definitions of **heat** are involved.

In the left hand diagram, heat is always synonymous with thermal energy. But in the right hand diagram, thermal energy is only acknowledged as being heat when it is travelling from hot to cold.

However, engineers who become aware of the doublethink problem will still find it impossible to build circular fossil fuel burning heat engines because of the chemical changes that take place during combustion. This prevents exhaust fumes being recycled in the manner of atmospheric air.

So, engineering scientists are correct when they claim that fossil fuel burning heat engines cannot recycle their waste heat, but the laws of thermodynamics are not to blame. Nevertheless, this doublethink is hampering clean energy development because it focuses creative engineering minds on hot heat engines, while shunning the concept of cool running heat engines as 'thermodynamically impossible.'

Starting in 2006, a small British team (the writer, Richard West and others) tried to correct this historical error by developing a new class of air recycling heat engines we refer to as Latent Power Turbines. A large fraction of their time (around 5,000 hours) was spent trying to attract partners and finance. But the doublethink mindset uncovered in this article proved to be impossible to shift.
In spite of many setbacks, the Latent Power Turbine project made progress until it was brought down by political changes within the UK.


The Mk 2 Latent Power Turbine test rig

We refer to this air recycling heat engine as a Latent Power Turbine.
It converts heat from room temperature air into electricity.
Unfortunately, the project had to be abandoned due to funding problems caused by Brexit uncertainty. The expensive patents were also abandoned, allowing others in more enlightened countries to develop the technology.

This article exposes the doublethink problems and provides information about Latent Power Turbines for anyone who wishes to develop them. Hopefully, the doublethink veil will fall from engineering scientists' eyes, inspiring them to develop other types of circular heat engines.

CONTENTS

1 **Latent Power Turbines**

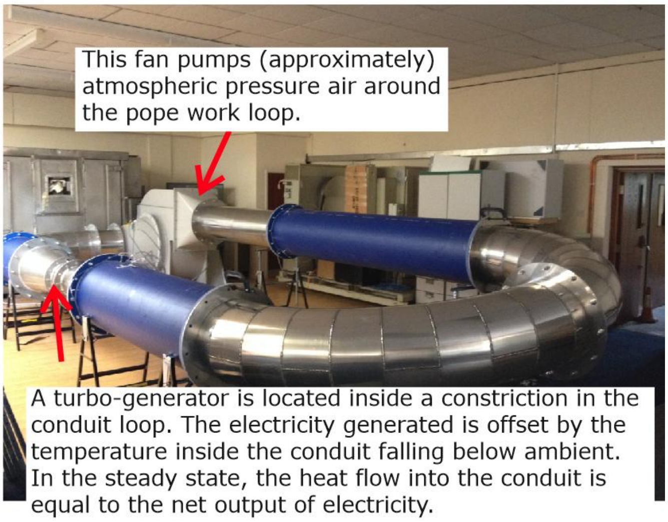


Fig 1.1 The atmospheric air circulating in the loop is cooler than the surrounding environment. In the steady state, the rate of heat flowing through the pipe walls is equal to the net output of electricity.

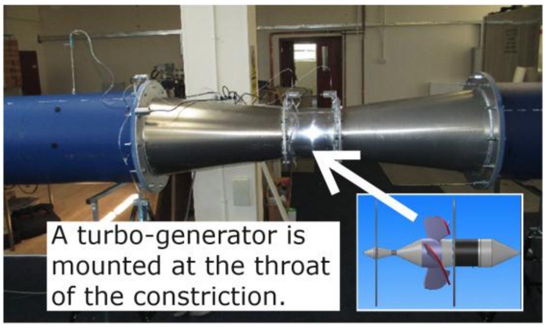
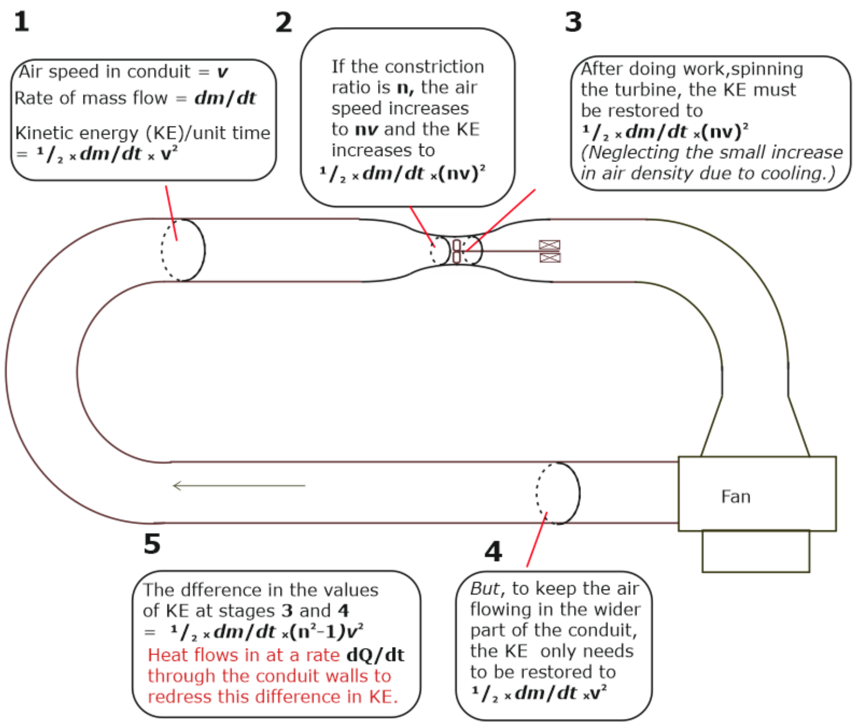


Fig 1.2 The air travels through the turbine at three times the speed that it travels through the fan. So, a well designed turbo-generator will produce a power output nine times the power input to the fan (neglecting friction and other losses.)
For the proof of principle experiments, an improvised set of turbine blades was used. The final stage of the project should have been the installation of a bespoke turbine rotor. A European partner agreed to undertake this work, but, following the outcome of the Brexit referendum, we were unable to raise the funding for this work.



Neglecting drag and other losses **Net Power**$_{Out}$ **= (n**^{2}**-1) x Power**$_{In}$

More precisely, **Net Power**$_{Out}$ **= (n**^{2}**-1) x(Power**$_{In}$**- ∆W)**

Where ∆**W** the work done against drag and other losses per unit time.

In the steady state, the **Net Power**$_{ou}$is also equal to **dQ/dt**.

Fig 1.3 The test rig was built for experimental convenience, but a range of more compact designs are possible. Here is one of them.

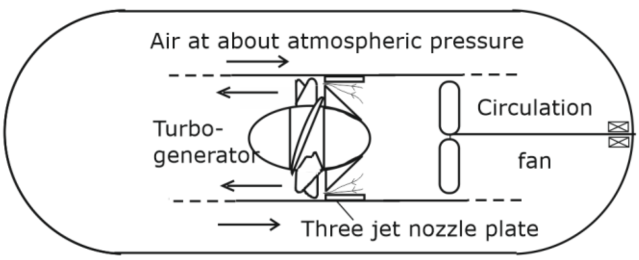


Fig 1.4 A plenum chamber Latent Power Turbine.

2 Heat pumps and wind turbines

These devices provide evidence that past scientists almost breached the doublethink barrier, but didn't quite make it.

2.1 Heat pumps
These pumps either work, or they don't work, depending on which of the two definition of heat you use.

Here are the two definitions:
First definition: **Heat** is the thermal energy of vibrating atoms in solids or randomly moving molecules whizzing around in liquids and gases.
(i) The more energetic these movements are, the hotter the body is.
(ii) When a hot body is placed in good contact with a cooler body, heat flows from hot to cold in order to reach thermal equilibrium.

Second definition: The term **heat** is restricted to thermal energy flowing from a warm body to a colder body.
This definition still acknowledges the existence of thermal energy inside bodies but packages it together with the potential energy due to inter atomic/molecular forces in one term **internal energy.**

Fig 2.1 Heat pumps extract thermal energy from cold winter air and use it to heat indoor spaces. They live up to their name 'heat pump' if we use the first definition of heat. But if we use the second definition, they violate the second law of thermodynamic by allowing heat to travel 'the wrong way, from cold to hot.

A similar argument applies if we want to extract thermal energy from cold air and convert it into electricity. Such a device is feasible if we use the first definition of heat, but thermodynamically impossible if we use the second definition.

2.2 Modern thin bladed wind turbines
In the 1950s, scientists invented slender bladed wind turbines that convert thermal energy from cold air into electricity. But, thanks to the doublethink interpretation of thermodynamics, many scientists fail to grasp what they have actually invented.

For example, the U.S. Department of Energy and several other websites mistakenly claim that wind turbines convert wind energy into electricity.

For this explanation to be true, the air would need to slow down as it transited the turbine blades. This would cause a 'traffic jam' with air molecules entering the turbine blade zone at a faster rate than they exit.

The accepted explanation also defies common sense because it is difficult to see how the narrow turbine blades could capture the air to slow it down.

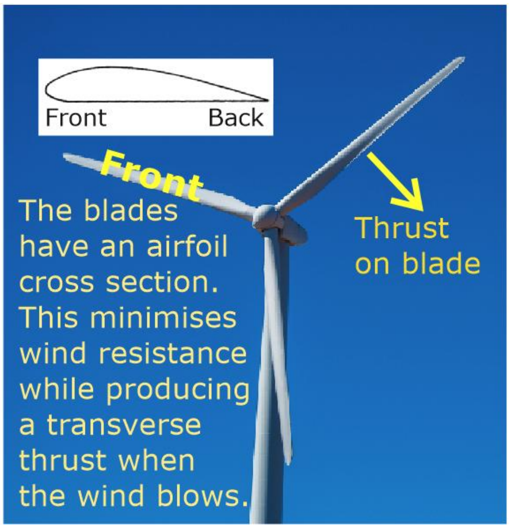


Fig 2.2 The correct explanation is that wind turbine blades spin round because they have an airfoil shape that reduces the air pressure on the hump side of the blade. The air on the other side of the blade pushes the blade round, allowing the turbine to do work. Thus, wind turbines are cool running heat engines that convert thermal energy (heat) from ambient air into electricity.

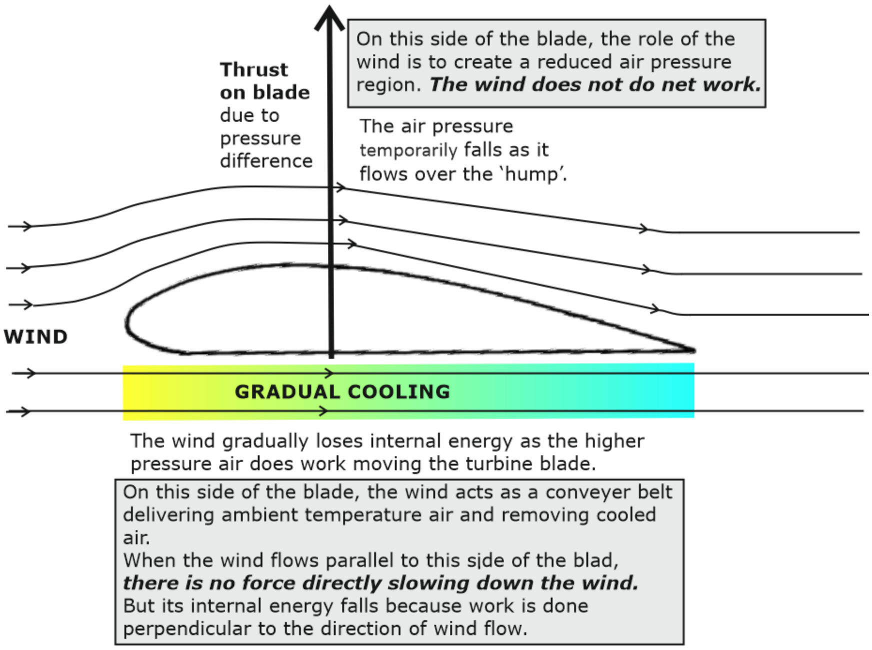


Fig 2.3 The internal energy of the air falls and there is also a very small drop in the kinetic energy of the wind, due to the fact that the air density increases as it cools.

3 **How thermodynamics degenerated into a doublethink science**

This essay is an attempt to remove a veil from engineering scientists' eyes.

The term '**heat engin**e' is used to describe any system that converts heat into mechanical energy (work). These engines are both the heroes and the villains in the climate change story.

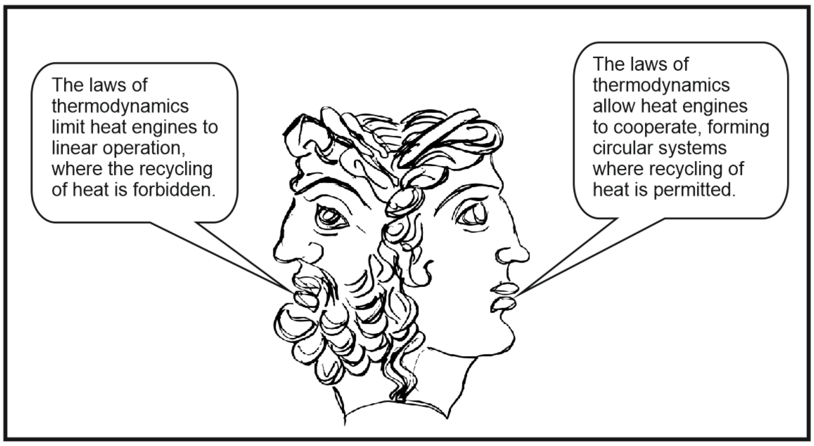
Our heroes are the natural heat engines that move atmospheric air around the planet, delivering fresh water to dry land. These are cool running (50^{o}C and cooler) circular systems that recycle a large fraction of their unused heat.
The villains are the hot running (100^{o}C and warmer) heat engines that burn fossil fuels. These are wasteful linear heat engines that dump unused heat plus CO_2 into the atmosphere.

But the pollution caused by fossil fuel burning heat engines could have been avoided because by 1879, the year the light bulb was invented, the core technology and knowhow required to build a heat engine that converted atmospheric heat into electricity was already available.

Unfortunately, the careless wording of some key definitions used in thermodynamics created a blind spot that prevented scientists from spotting an opportunity to imitate nature.

Clues to the existence of this blind spot can found by forensically analysing the terms '**heat**', '**heat engine**' and '**heat sink**'. All three terms turn out to be ambiguous, resulting in the two key disciplines involved in fighting climate change, meteorological and engineering science, having different concepts of a heat engine. This has reduced thermodynamics to doublethink, with both disciplines making great progress in their own specialist fields, whilst fundamentally contradicting each other.

> **Here is a summary of the doublethink thermodynamics we use today.**
> According to engineering science, heat engines are linear systems that cannot recycle their rejected heat. Their efficiency can only be improved by introducing the heat at a higher temperature.
>
> According to meteorological science, heat engines can form circular chains that recycle a large fraction of their rejected heat. This creates highly efficient systems even though the highest temperatures at the Earth's surface are around 50^{o}C.
>
> This doublethink interpretation of thermodynamics works perfectly well, proved that engineers stick to working with hot running heat engines. But it has created a blind spot, preventing them from inventing cool running heat engines that imitate nature.



The driving force behind the thermodynamics revolution was the need to make steam engines more efficient so that they burned less coal.
From 1712 onwards, steam engines helped the northern countries to become rich and enabled Europeans to control colonial empires covering 80% of the world.
Practical experience had taught engineers that steam engine efficiency can be increased by running steam engines hotter. Then, in the 1850s, thermodynamics provided the scientific justification to support this practical knowledge.
The petrol engine, invented in 1876, and all of the other important heat engines that followed (diesel, jet, steam turbine etc.) fell into line with the earlier 'hot is more efficient' observations.
All of these engines are linear systems that dump 50% or more of their heat into the environment as unproductive cool waste.
A great deal of research has been done, trying to recycle the rejected heat inside the engine, but all of the work has ended in failure. As a result, most engineers have concluded that recycling heat inside a heat engine is thermodynamically impossible

Meanwhile, the meteorologists can only explain the Earth's weather systems by assuming that atmospheric heat engines form circular loops that recycle a significant fraction of their rejected heat. This recycling is inevitable because the Earth only has one atmosphere. So rejected heat must go back into the same atmosphere from which it came.

Doublethink thermodynamics can be traced back to the transition period from the eighteenth century caloric theory of heat to nineteenth century thermodynamics. The introduction of a new term '**internal energy'** should have made thermodynamics clearer. But it created new problems because it was not compatible with the continued to use the old caloric era terms '**heat engine**' and '**heat sink'.**

According to the caloric theory, heat is an invisible weightless substance that permeates warm bodies and flows from warm bodies to colder ones.
Thermodynamics replaced heat as a substance with heat as the **therm**al energy due to the **dynamic** movements of vibrating atoms in solids and molecules whizzing around in liquids and gases.
Thermodynamics also recognises that in addition to thermal energy, bodies possess potential energy due to the forces bonding materials together. This led to the introduction of **internal energy** defined as follows:

Internal energy = of a body	**thermal energy** due to vibrations of atoms or kinetic energy of whizzing molecules	+ **potential energy** due to balancing of attractive and repulsive inter atomic/molecular forces

Over time, the introduction of internal energy led to two different definitions of heat evolving.

(i) The term **heat** applies to either thermal energy inside a body or to thermal energy flowing from a warm body to a cold one. [This broad definition is logical because it replaces the equally broad caloric era definition of heat being either caloric inside a body, or caloric flowing from a warm body to a cold one. It also fits in with the traditional concept of heat as warmth.]

(ii) The term **heat** is restricted to thermal energy flowing from a warm body to a cold one, with thermal energy inside a body being incorporated into the concept of internal energy. In full, this definition of heat is as follows,
'Heat is the flow of thermal energy from a warm body to a cooler body, without the transfer of matter and without work being done on the cooler body.'

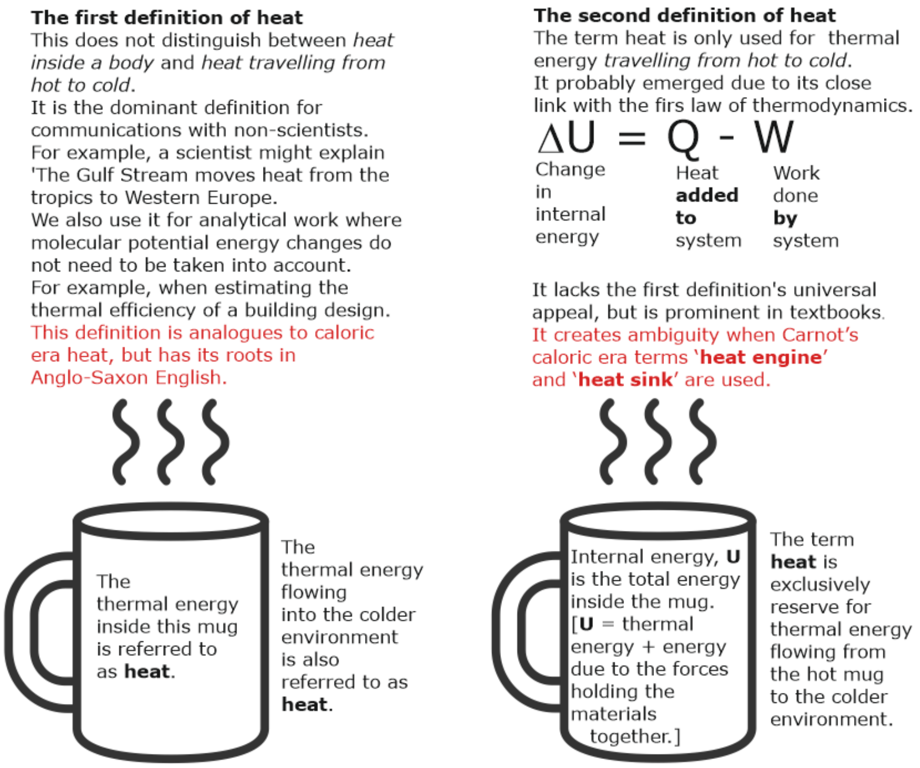


Fig 3.1 The link between dynamic movement and heat was introduced to us by William Thomson (Lord Kelvin) in his paper, 'On the Dynamical Theory of Heat, with numerical results deduced from Mr Joule's equivalent Theermal Unit, and M. Regault's Observations on Steam', *Transactions of The Royal Society of Edinburgh*, March 1851.

Then in 1857, Clausius was the first to clearly state that heat is the average kinetic energy of molecules.

Earlier, in 1824 Carnot had defined a **heat engine** as system for converting heat into useful mechanical work. This was during the caloric era, so Carnot envisaged caloric flowing from a hot reservoir to a cold reservoir. The working fluid (usually steam) that also flowed from hot to cold was the medium that carried the caloric. Then, during the thermodynamic era, the working fluid was envisaged as carrying thermal energy (heat) through the engine. This is not consistent with the second definition of heat because inside the heat engine, matter moves from hot to cold.
Carnot also realized that the conversion process could never be 100% efficient, so he proposed that all heat engines would require a **heat sink** where all the relatively cool rejected heat could be dumped. Again, this is only consistent with the first definition of heat, because any heat engine that has an exhaust pipe is also ejecting matter.

This means that any textbook, journal paper or website that defines hat as, 'thermal energy flowing from a warm body to a cooler body,' whilst also using the terms 'heat engine' and 'heat sink' without qualification is spreading doublethink science.

4 A more detailed discussion of the doublethink problems

4.1 A summary of the main doublethink issues

Term	Doublethink issue:
Heat: Two contradicting definitions	*First definition:* Heat is thermal energy (i) inside a body or (ii) flowing from a warm body to a cold body. *Second definition:* The term heat is reserved for thermal energy being transferred from hot to cold, with thermal energy inside a body being incorporated into internal energy. This definition is influential because it is an easy fit with the first law of thermodynamics.
Heat capacity	A body can only have a heat capacity according to the first definition.
Heat engine	This is a caloric era term that becomes doublethink when transplanted into thermodynamic without due care. It makes sense when used in collaboration with the first definition of heat, but not the second.
Heat sink	In thermodynamics, the caloric era concept of a *heat sink* needs to be replaced by *two types of thermal energy sinks*, to meet different boundary conditions. But this change is not emphasised in science teaching.
Ideal heat engine efficiency η	**η= 1 – (Temperature of heat rejected/Temperature of heat supplied)** This only applies to single engine stages and does not take into account the thermal feedback in closed loop systems. It is misinterpreted as 'proving' that all efficient heat engines must involve large temperature changes.
Bernoulli's equation	As written, this equation implies that during streamline flow, potential or kinetic energy can transform into pressure, even though pressure is not a form of energy. But when corrected, it provides useful clues for designing circular heat engine systems.

4.2 Further details on the two sink issue

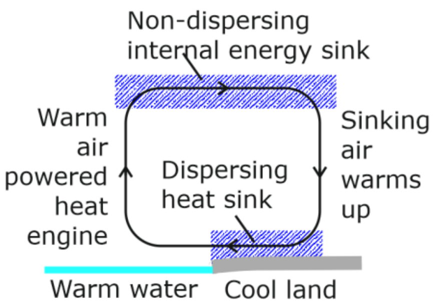
In thermodynamics, the caloric era concept of a *heat sink* needs to be replaced by *two types of thermal energy sinks*, to meet different boundary conditions. This has been recognised in meteorology [1], but not in engineering science.

[In the writers experience going back 58 years, the failure of fellow scientists and engineers to recognise the need for two types of thermal energy sinks is the greatest barriers preventing the development of circular heat engines.]

Here are the two types of sinks that the scientific community will need to accept before we can build atmospheric heat powered electricity generators.

(i) ***Temperature boundary heat sinks***
For heat engines where the working fluid remains inside the engine (e.g. Stirling and Rankine cycle engines), the rejected thermal energy has to cross a temperature boundary, to enter a a lower temperature **heat sink**. This rejected heat must be dispersed inside the sink, to keep the heat flowing.
(ii) ***Pressure boundary internal energy sinks***
If the rejected thermal energy is carried away as the internal energy of the working fluid, it has to cross a pressure boundary to enter an **internal energy sink** at a lower pressure.
All of the commercial heat engines produced to date have hot exhausts, giving the false impression that they require heat sinks. They are also dispersive because they dump their thermal energy into the environment.
But nature shows us that internal energy sinks can be non-dispersive, making circular heat engine systems possible.

Convection current loops include non-dispersing internal energy sinks. These allow thermal energy in the form of internal energy to be recycled.
But a dispersing heat sink is also required to keep the air moving.



Here are some examples to show we currently employ internal energy sinks in manufactured heat engines.

4.2.1 A cool running heat engine with a *dispersing internal energy sink*.

Fig 4.1 This pneumatic tool is powered by room temperature compressed air. A fraction of the thermal energy stored in the compressed air is converted into mechanical work. The unused thermal energy is dumped into the environment in the form of the internal energy of the (almost) decompressed air.

The exhausted air enters the atmosphere above atmospheric pressure, but at a temperature below ambient.
So, for this type of heat engine, the atmosphere appears to be acting as a **cold sink**, rather than a heat sink.

4.2.2.1 A cool running heat engine used to generate electricity.
This design includes a temporary *non-dispersing internal energy sink*.

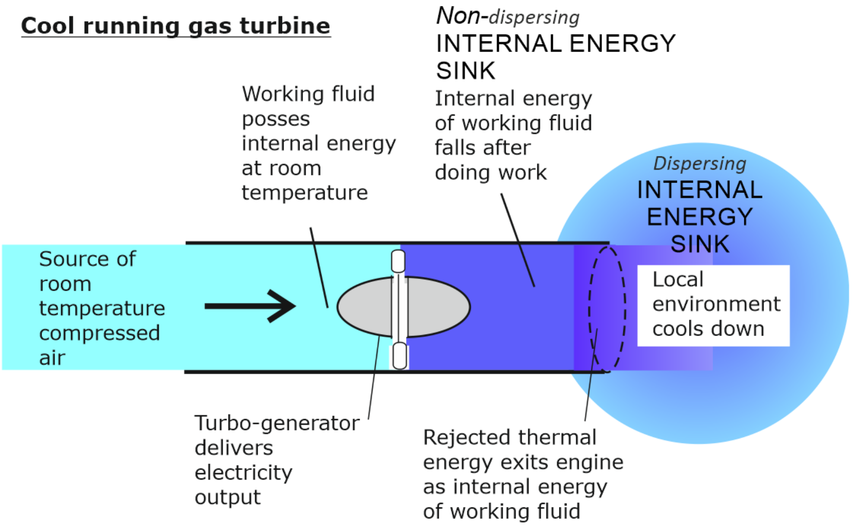


Fig 4.2 In principle, the air in the exhaust pipe could be re-compressed and fed back into the compressed air supply. But powering the compression pump would consume all of the electricity generated.
The Latent Power Turbine design shown in Figure 1.3 does not suffer from this problem because the air flows through the compression fan at a lower speed than it passes through the turbine.

4.2.3 A hot running heat engine with a *dispersive internal energy sink* that masquerades as a a *heat sink*.

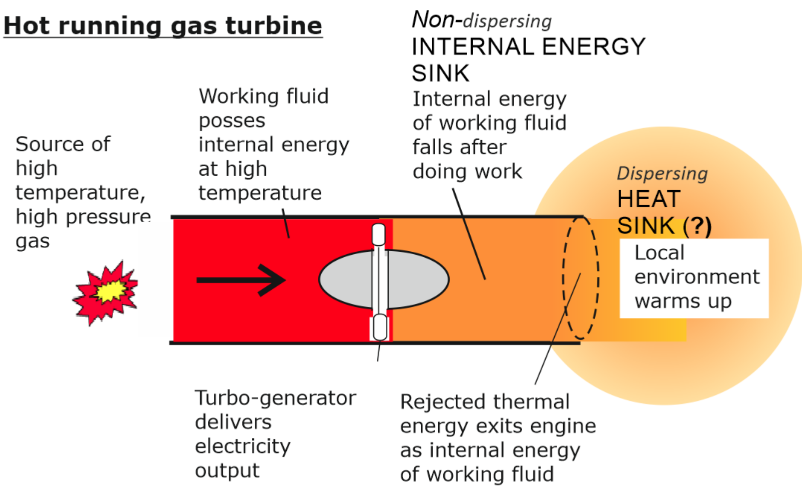


Fig 4.3 In reality, the environment is acting as a low pressure internal energy sink, not a heat sink. The temperature of this sink is only of secondary importance.

Essentially, there are two types of heat engine having different sink requirements.
(i) Heat engines that *do not* eject their working fluid require a heat sink.
(ii) Heat engines that eject their working fluid require an internal energy sink.

These differences can be summed up in diagram form.

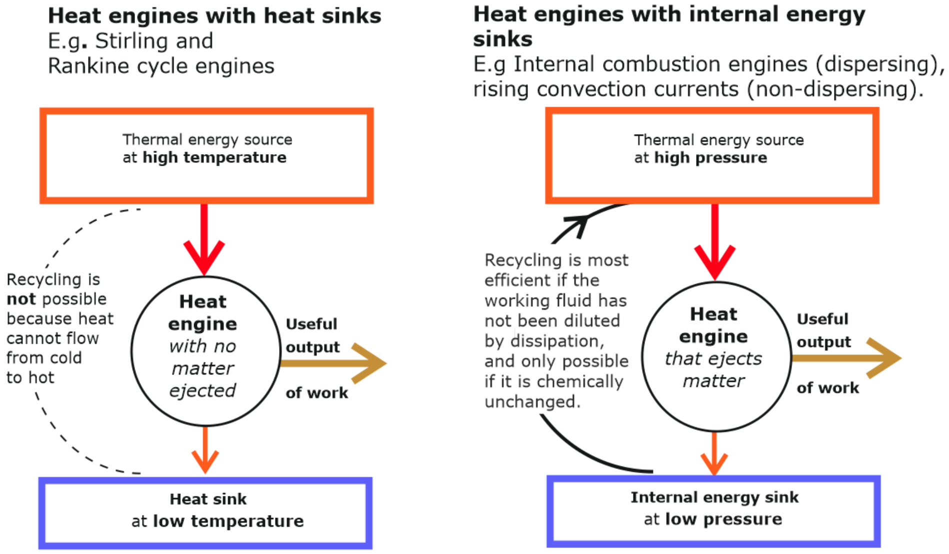


Fig 4.4. Some heat engines are hybrids. For example petrol and diesel car engines eject matter via their exhausts and lose heat via the engine block and radiator. Complete convection current loops are also hybrids.

4.3 Bernoulli's equation

Bernoulli's equation (alternatively referred to as Bernoulli's principle) is a prime example of doublethink because it has been verified by experiment on countless occasions since 1760, in spite of the fact that it disobeys the law of conservation of energy (1848) and the first law of thermodynamics (1850).

Bernoulli's equation states that for an incompressible, non-viscous fluid undergoing steady flow, the pressure (**p**) plus the kinetic energy per unit volume (½ x density, **ρ x** velocity^2, **v^2**) plus the potential energy per unit volume (density, **ρ** x acceleration due to gravity, **g** x height **h**) is constant at all points on a streamline [3].

Thus,

$$p + \tfrac{1}{2}\rho v^2 + \rho g h = \text{constant}$$

If taken as read, it tells us that the sum of two types of energy (potential and kinetic) plus pressure (which is not a form of energy) is always a constant. So, energy changes into pressure and vice versa along a streamline.
Once we get to the thermodynamics era, the doublethink response this violation of the law of conservation of energy was to replace 'pressure' with a new form of energy called 'pressure energy'. This form of energy has great rarity value because it is needed to make Bernoulli's equation work, but is not used elsewhere in science.
As the writer has argued elsewhere [2], a more logical explanation is that the pressure term, **p** is just a dummy term that stands in for internal energy.

So, if the pressure term **p** is replaced by the internal energy per unit volume **U**, the equation reads as

Internal Energy (**U**) + **Kinetic Energy** ($\frac{1}{2}\rho v^2$) + **Potential Energy** (ρgh) = **Constant**'

This version of the equation is useful for understanding circular heat engines, both natural and manufactured.

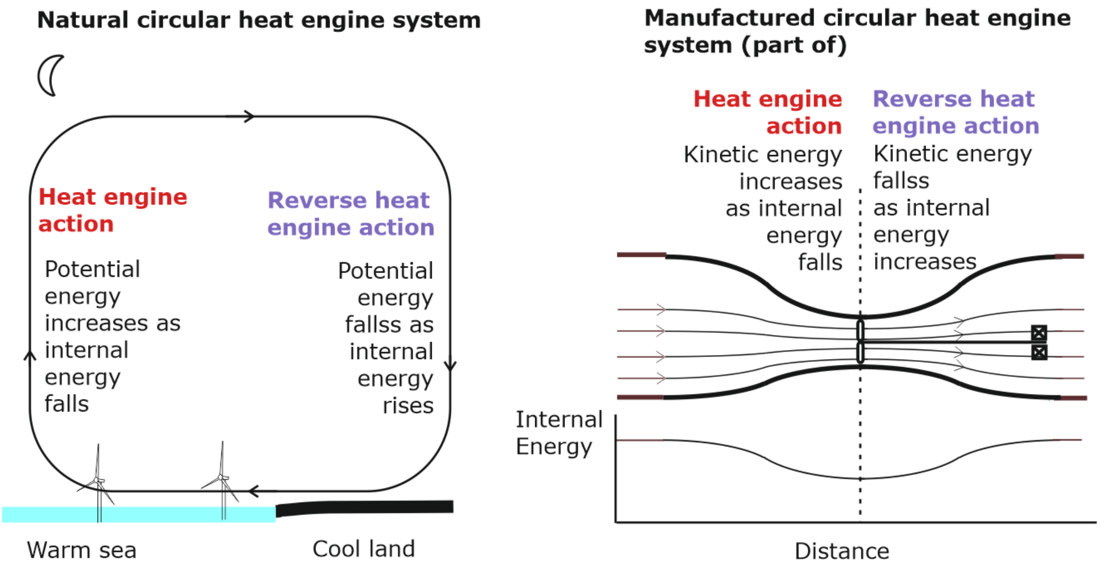


Fig 4.5 Manufactured circular heat engines will be far more compact than their natural equivalents because potential energy increases linearly with height, but kinetic energy increases with the square of air speed.

Understanding Bernoulli's equation in terms of internal energy allows us to write a conservation of energy equation that applies to all points around circular heat engine loop.

$$U + \frac{1}{2}\rho v^2 + \rho gh + Q - W = \text{constant}$$

Where **Q** is the net heat input and **W** is the net work output.

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