Resource File: Delivering an Oil-Free World Economy

Bill Courtney
Cheshire Innovation
Web site www.cheshire-innovation.com

Abstract

Thermodynamics is the branch of science that deals with heat. It evolved in the 1850s, but the public only became widely aware of its importance with regards to climate change around 1988, more than a decade after scientists had started using the term 'global warming'.

However, this science is not quite as clear-cut as we would like to believe, because when examined closely, it degenerates into doublethink with meteorologists and engineers contradicting each other..

As a consequence, we are fighting global warming the hard way, because we have failed to spot a simple solution that has been sitting under our noses.

Thanks to global warming, the Earth's atmosphere is storing more thermal energy than at any other time in the last 120,000 years. We could meet all of our energy needs for many centuries to come by converting this excess energy into electricity and other useful forms of energy.

This would allow us to reduce the global warming problem, while simultaneously lifting people out of fuel poverty. Thus, extracting atmospheric thermal energy would produce a modest reduction in global temperatures while providing free fuel for powering a new class of electricity generators.

The only reason we are solving our energy problems the hard way, while keeping the poor impoverished, is that scientists made some 'sloppy' mistakes 170 years ago and have failed to correct them.

In this article, the mistaked will be explained and some surprising historical consequences revealed. A new class of electricity generators that siphon off some of this unwanted global warmth will be suggested for royalty-free development.

What is in it for you?
The intellectual property published in this paper is royalty-free. This means that you are free to reproduce it elsewhere, use it as the basis for research projects or exploit the designs in Section 3 to found a profitable green energy business. However, if you make a good profit from these designs, the original inventor Bill Courtney would appreciate a one-off payment being made to him or his estate.

Please note: The writer's long battle against poor science has affected his health and he has become partially sighted. So, if this resource file arouses considerable interest, the chances are that he will be overwhelmed with questions and will not be able to respond. One possible solution to this problem is that a philanthropic organisation could fund email-answering support for the writer.

Executive summary

The 'sloppy' mistake boils down the careless use of two scientific terms '**heat'** and '**heat engine'.**

During the 1850s, the well-established caloric theory of heat started to give way to the radically different science of thermodynamics. Unfortunately, the champions of the new science accidently reduced thermodynamics to doublethink because of their decision to give the term '**heat**' a new meaning.

The propensity to give old terms new meanings is common in special identity groups ranging from religious sects and teenage gangs to pioneering scientists making a break with the past. In most cases, this language adaption strategy creates a sense of mystique, but in thermodynamics, it has caused confusion.

The term '**heat'** that had meant *warmth* in Anglo-Saxon English, was now confined to the case where warmth is travelling from a warm body to a colder body.

However, the engineering scientists who had to communicate with a wider public sometimes used 'heat' in the old way and sometimes in their new. This resulted in the term '**heat engine'** that had been in use since 1824 ending up with two meanings in the 1850s.

According to the new definition of heat, traditional steam engines are still legitimately referred to as 'heat engines' because they are external combustion engines where heat flows from the externally combusting fuel and into the cooler boiler. However, in 1853 two Italian scientists created a radically different type of steam engine that did not require a boiler or heat flowing from hot to cold. Instead, Barsanti and Matteucci created the world's first internal combustion engine. This chemically produced steam inside the piston chamber by igniting a mixture of oxygen and hydrogen. Thus, it did not meet the strict thermodynamic definition of a heat engine. However, an internet search reveals that internal combustion engines are generally referred to as 'heat engines'. For example, on the otherwise excellent University of Calgary Energy Education website, students are informed that

> 'Internal combustion engines are the most common form of heat engines.'

If the term 'heat' is used in its broadest sense, so that it includes thermal energy stored or created inside an engine, as well as thermal energy flowing from hot to cold, then, yes, internal combustion engines are heat engines. However, in this case you also have to concede that heat can flow from cold to hot if it is stored in flowing matter. In this case, you also have to concede that it is possible to imitate nature and build a heat engine that runs on atmospheric heat.

However, on another University of Calgary webpage you are informed that,

> 'Heat is the transfer of thermal energy between two bodies at different temperatures. '
>
> [The University of Calgary website has been quoted because of the clarity of its text, not because it is in any way inferior to other university websites.]

This careless use of the terms '**heat**' and '**heat engine**' has reduced engineering thermodynamics to Orwellian Doublethink because most manufactured heat engines are not heat engines.

Meteorologists have created a different form of doublethink because when they use the term 'heat engine', they are usually referring to convection current loops where both heat and **internal energy** processes are involved. This equally careless use of terms also led scientists astray because heat can never flow from cold to hot, but internal energy can. (This statement will be explained in Section 1 below.)
For example, on the NASA Earth Observatory website you will read,

> 'The atmosphere and ocean work non-stop to even out solar heating imbalances through evaporation of surface water, convection, rainfall, winds, and ocean circulation. This coupled atmosphere and ocean circulation is known as **Earth's heat engine**.'

Comment: This statement echoes the contradictory thinking about manufactured heat engines. Thus, the term 'Earth's heat engine' is valid if 'heat' retains its old caloric era meaning of 'warmth'. However, if heat is used as a thermodynamic term to mean 'the flow of thermal energy from a warm boy to a cooler body', then the term 'Earth's <u>thermal energy</u> engine' would be more appropriate.

Thanks to doublethink thermodynamics, we have ended up in the bizarre situation where engineering scientists are adamant that it is thermodynamically impossible to build a recycling heat engine that can convert atmospheric heat/thermal energy into mechanical energy or electricity. Meanwhile, the meteorologists can only make weather forecasts by treating the atmosphere as a giant assembly of recycling heat engines that are extremely good at converting atmospheric heat/thermal energy into other forms of energy.

This article discusses how we can climb out of the doublethink trap and take a fresh approach to fighting global warming.

The article adopts a historical theme and suggests how the world might have been a far better place after 1850, if we scientists had not made the fatal mistake of giving entirely new meanings to well established scientific terms.

****

A More Detailed Discuusion

Contents

1 The caloric theory to thermodynamics transition

1.1 Before around 1850

Since Anglo-Saxon times, the term *heat* has been synonymous with *warmth* in everyday English.

In 1783, Lavoisier tried to take the vagueness out of this term when published his caloric theory of heat. [*Calor* is Latin for heat.]
Lavoisier suggested that the observable properties of warmth were due to the presence of an invisible weightless fluid that he called caloric. This caloric theory of heat dominated science for about 70 years, but was falling out of favour by the 1850s.

The caloric theory was a very useful thinking tool because it enabled scientists to envisage heat transfers in the concrete terms of flowing fluids. Consequently, even today, we use the concept of heat as a fluid in our everyday discussions.

The weakness of caloric theory is that it fails to give us a deeper understanding of the nature of heat. For example, we learn nothing new about the science behind pouring a cup of tea if we describe it in terms of *1783 caloric* instead of *Anglo-Saxon heat*.

Figure 1. The use of the term *caloric* certainly adds mystique to an explanation of the science of tea pouring, but it adds nothing to our deeper understanding.

By the 1850s, most scientists had accepted that matter is made of atoms and molecules, with heat being associated with the properties of these particles.

According to atomic theory, solids consist of atoms that have fixed positions relative to each other, but are in a constant state of vibration. As the temperature rises, the atoms vibrate more and more violently, eventually overcoming the bonds that hold the solid together, resulting in the solid melting to form a liquid.

This modern understanding of matter played an important role in helping thermodynamics to replace caloric theory. However, we should not think of this as a sudden transition because caloric theory lingered on in popular science literature until the end of the nineteenth century, when the atomic theory of matter was finally accepted.

1.2 After around 1850 and the ascendance of thermodynamics

In thermodynamics, the single concept of a caloric fluid is replaced by three new concepts, **thermal energy**, **internal energy** and **heat.**

(i) **Thermal energy** is the kinetic energy of vibrating atoms in solids and the kinetic energy of molecules whizzing around inside liquids and gases.

(ii) **Internal energy** = thermal energy **+** chemical potential energy of matter.

Chemical potential energy is the energy stored in the chemical bonds of a substance. For example, fossil fuels store large amounts of chemical potential energy that is released to produce thermal energy, when the fuel is burned.

(iii) The term **heat** loses its broad Anglo-Saxon meaning of *warmth* and is now exclusively used for situations where thermal energy that is flowing from warm to cold, without using matter as a vector to carry it.

This is how the scientific description of a simple tea pouring process changes if we use thermodynamic term to describe it.

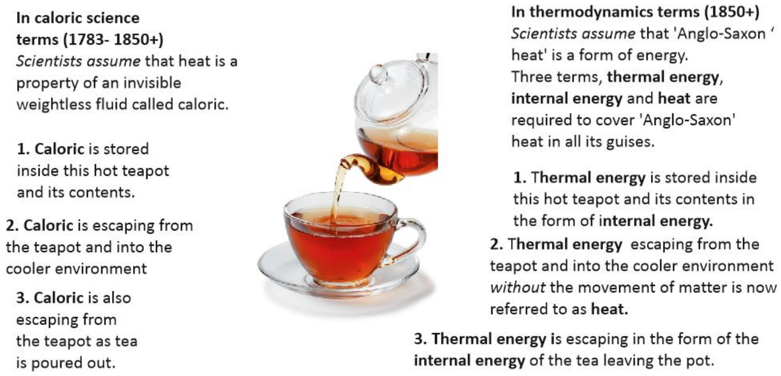


Figure 2. According to thermodynamics, thermal energy can escape from the teapot in two guises, either as heat or as internal energy.

When it escapes as heat, it must obey the second law of thermodynamics and can only flow from hot to cold. Therefore, if the surrounding air is warmer than the outside of the teapot, no heat can escape from it.

In contrast, when tea is poured into the cup, the flowing tea acts as a vector, carrying thermal energy with it. Consequently, the temperature of the cup is irrelevant and the tea would still flow, even if the cup was at a higher temperature than the teapot.

The thermodynamic significance of the vector transfer of thermal energy is that it allows thermal energy to flow 'the wrong way' from cold to hot.

Here is a teacup example of thermal energy flowing 'the wrong way', from cold to hot.

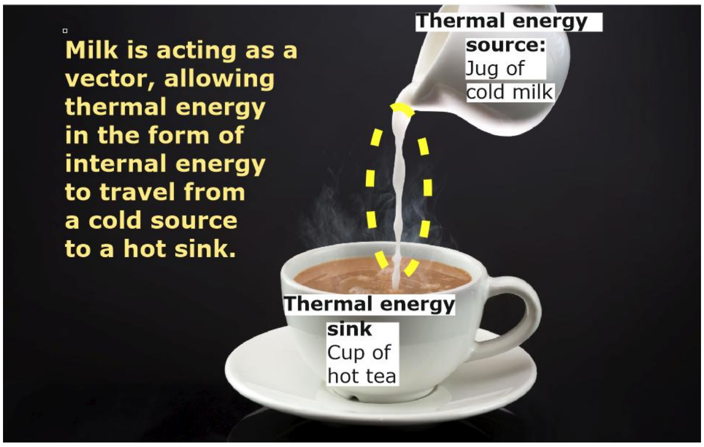


Figure 3. Adding cold milk cools the tea, but it also increases the total thermal energy content of the cup plus contents.

2 Doublethink Thermodynamics

2.1 Two contradicting heat engine concepts

In principle, we should be able to meet all of our energy needs by building heat engines that convert atmospheric thermal energy into mechanical energy or electricity.

However, an error crept into our understanding of *heat engines* during the 1850s, resulting in scientists believing that the construction of such engines is thermodynamically impossible.

The term h*eat engine* is misleading because these engines convert thermal energy into other forms of energy. Manufactured heat engines include petrol and diesel engines, natural heat engines include atmospheric and ocean convection currents.

However, thanks to this careless use of scientific terms, thermodynamics has degenerated into *Orwellian doublethink* with meteorologists and engineering scientists interpreting the *heat engine* concept in contradictory ways.

Meteorology concept of a heat engine
Nature's weather systems rarely Involve temperatures as high as 50°C. Nevertheless, tropical hurricanes have more destructive power than a nuclear warhead.

Engineering scienceconcept of a heat engine
Heat engine theory tells us that thermal energy at the temperatures produced by burning fossil fuels is required for generating electricity efficiently.
Waste heat at temperatures below 50°C is commonly dumped into the atmosphere.

Figure 4. Hurricanes and all other natural phenomenon involving convection currents can only be explained by assuming that they are *circular heat engine systems* that can recycle a large fraction of their rejected thermal energy.
In contrast, the engineering scientists who design manufactured heat engines work on the assumption that it is thermodynamically impossible to recycle rejected thermal energy.

A CARELESS MISTAKE
Scientists commonly revert to using the term '*heat*' in the old caloric era way, when according to thermodynamics terminology, they are referring to '*thermal energy*'. In the rest of this section, we will use the term *heat* incorrectly, because this is what you will commonly find in the textbooks. However, to signal that the term is being used incorrectly, it will be written as *heat(thermal energy)*.

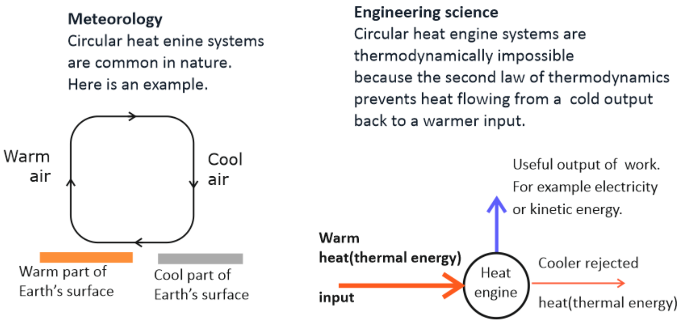


Figure 5. Meteorologists correctly believe that heat engines can form circular systems, while engineers falsely believe thinking that recycling heat engines are thermodynamically impossible. The engineers have got their argument wrong because they have used the term *heat* in the old caloric way when labelling the thermal energy input and output, but used it in the new thermodynamic way when asserting that heat cannot flow from cold to warm.

The engineers have only been able to get away with their flawed reasoning because all of the fossil fuel burning heat engines are unable to recycle their rejected thermal energy for other reasons. Thus, irreversible chemical changes take place inside internal combustion engines and steam engines involve evaporation at a high temperature, followed by condensation at a low temperature. Therefore, the latent heat released by condensation is too cool to aid in heating the boiler.

2.2 Heat sinks and internal energy sinks

Sadi Carnot is the so called 'Father of thermodynamics', because of his 1824 paper on heat engines. However this honaray title has probably misled later generations of scientists, because Carnot believed in the Caloric theory of heat. So, when he used the terms '*heat engine*' and '*heat sink'* he had caloric theory in mind. Unfortunately, when his modern counterparts are teaching students about Carnot's work, they fall into the doublethink trap, sometimes using 'heat' in the old way and sometimes in the new.
An important feature of this type of doublethink is that when Carnot used the term '*heat sink'*, he had in mind a sink where 'caloric era heat' could be dumped. So, when the term 'thermal energy' replaced 'heat' in thermodynamics, the term 'heat sink' should have been changed to 'thermal energy sink'.
However, on closer scrutiny, even the term 'thermal energy sink' is inadequate because two different types of 'thermal energy sink' are required depending on whether or not the heat(thermal energy) is being carried away by a vector.

- If the rejected thermal energy is carrird away as *thermodynamic heat,* a *heat sink* at a lower temperature than the rejected heat is required.
- If the rejected thermal energy is carried away using exhaust matter as a vector, then an *internal energy sink* at a lower pressure than the exhausted matter is required.

Here is an example of an internal combustion engine that requires both heat and internal energy sinks.
Note We are using *heat* in the thermodynamic sense here.

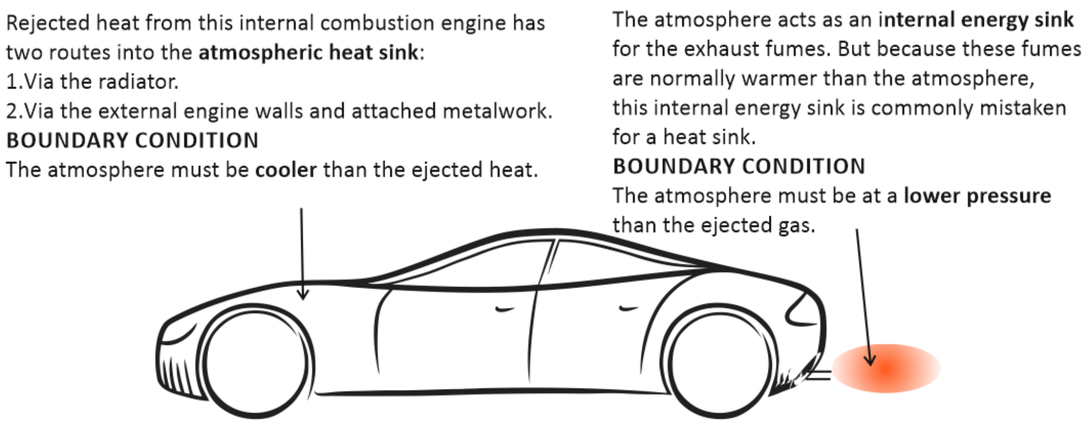


Figure 6. Strictly speaking, exhaust gases use the atmosphere as an internal energy sink. However, because the exhaust gases are warm, they create the illusion of entering a heat sink.

2.3 Adding an internal energy sink to the standard heat engine diagram

The standard diagram summarising the properties of *heat engines* is flawed because it involves '*heat'* being used in both the old carolic era and modern thermodynamic era ways.

However, the error can be removed by by using the thermodynamics terminology discussed in **Section 1.2** above and recognising that both temperature and pressure boundaries are involved.

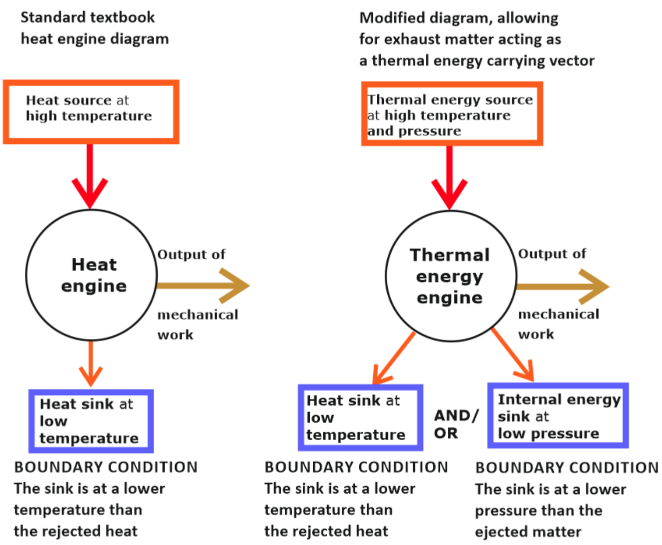


Figure 7. The term *internal energy* was first used by W. Thomson (Lord Kelvin) in1851 [2]. So we can tentatively give this as the earliest possible date at which an *internal energy sink* might have been added to heat engine diagrams.

2.4 Doublethink and convection current loops

2.4.1 Atmospheric convection current loops

We will continue to use the term *heat* as in standard textboks, but write this as *heat(thermal energy)*, to signify that strictly, according to thermodynamics terminology, the term *heat* is being incorrectly used.

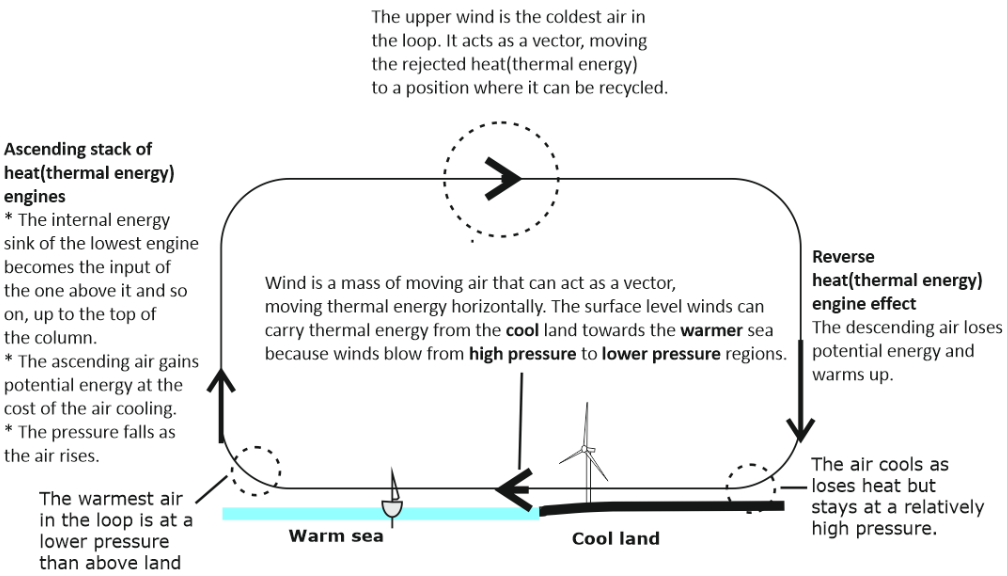


Figure8. The circulating air acts as a vector, carrying thermal energy around the loop.

- At the top of the rising air column, the atmosphere acts as a final internal energy sink for the stack of heat(thermal energy) engines. It then acts as a thermal energy source for the decending column of thermal energy.
- The cool land acts as a heat sink, absorbing heat from the warmer air flowing above it. The relatively warm sea then acts as a heat source, with heat flowing to the cooler air travelling above it.

2.4.2 Doublethink conditioning in school science

We condition young scientists into tolerating doublethink thermodynamics by introducing them to the central heating terms *boiler* and *radiato*r, and then telling them that the boilers should not boil and that radiators are primarily convection heaters.

Indoor space heating systems rely on the circulation of convection currents to warm parts of space that are out of the line of sight of the heat source.

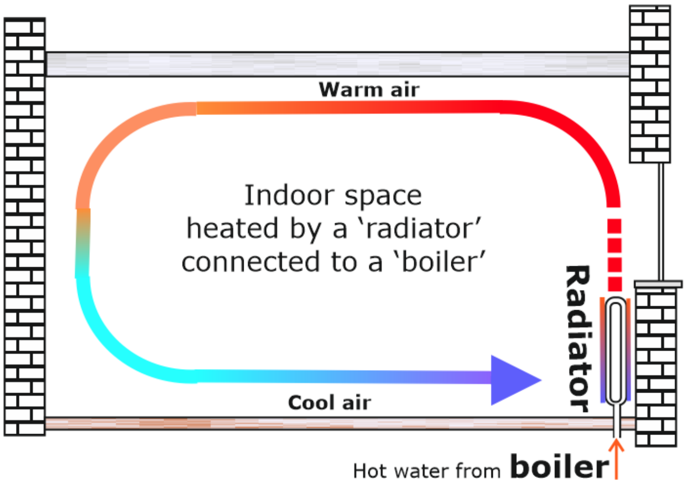


Figure 9. The standard central heating terms 'radiator' and 'boiler' help to condition young minds into accepting doublethink thermodynamics.

Thus:

- *Radiant heat* travels in straight lines. So a true radiator would only warm the parts of a room that are within its line of sight. In reality, the largest mass of objects in the room are warmed by circulating convection currents. [The term *radiator* was first used incorrectly in an 1834 patent describing a *convection* heater and we have been misusing it ever since.]
- Water must never be allowed to boil in the boiler because this would cause a dangerous buildup of high pressure steam inside the system.
- The ability of 'radiators' to spread warmth throughout a room is due to their role as heat sources, providing replacement heat for the heat lost to the sinks throughout the room. However, when learning about climate change, the aspiring young scientists are also taught that humanity must adapt to using intermittant power sources such as wind turbines and solar panels, because recycling heat engines powered by atmospheric thermal energy are thermodynamically impossible.

The next two examples illustrate how even trained scientists have been conditioned into believing doublethink nonsense about wind turbines and sailing vessels.

2.5.1 Wind turbines

An internet searh reveals that the established scientific belief is that wind turbines extract kinetic energy from the wind and convert it into electricity. However, the webpage visitor is expected to take this claim on trust, because it is never supported by a scientific argument.

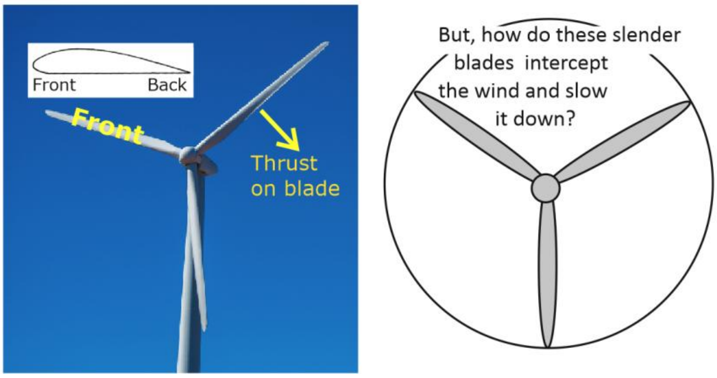


Figure 10. The standard explanation that wind turbines convert wind energy intoelectricity is full of riddles. Thus,

- In the steady state, the plain swept out by the rotating blades is always perependicular to the direction of the wind. This wind possesses momentum, which is a vector quantity that does not have a component perpendicular to its direction of air flow. Therefore, there can be no transfer of momentum from the wind to the blades.
- The blades are far too slender to capture the wind.
- If the wind did slow down, it would cause a 'molecular traffic jam', with air molecules approaching the wind turbine zone at a faster rate than they are leaving it. [The molecular traffic jam issue is essentially a modern understanding of Leibniz's 1701 continuity principle that, 'what flows in, must flow out'.]

Wind tunnel tests also tell us that the standard explanation is wrong.

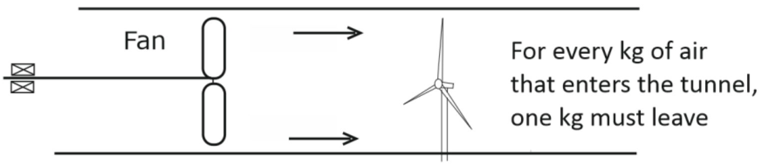


Figure 11. Engineering students commonly learn about wind turbines by doing tests on miniature wind turbines mounted inside wind tunnels. Any student who still believes that wind turbines convert wind energy into electricity after doing such experiments is accepting doublethink

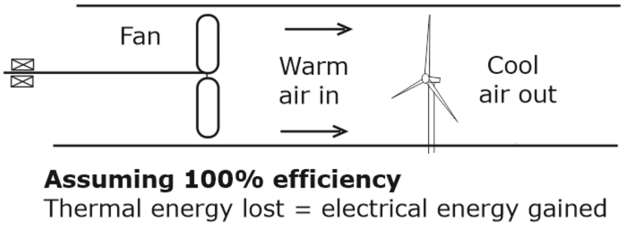


Figure 12. The correct explanation is that wind turbines are actually cool running heat(thermal energy) engines that extract thermal energy from the passing air.

They are only able to do this because the wind is forced to increase its speed on one side of the blade.

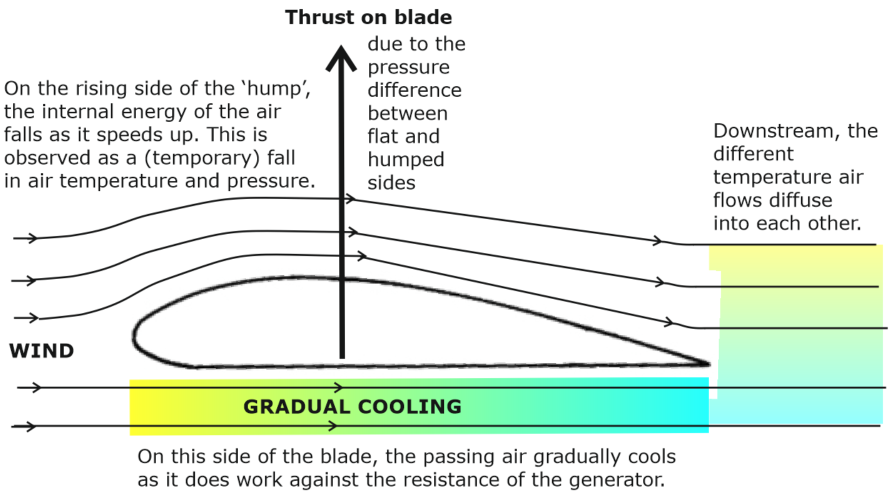


Figure 13. There is a very slight reduction in wind speed because cold air is denser than warm air. However, the dominant loss is a reduction in internal energy during the transit of the blade.

Thus, all of the UKs 11,500 wind turbines are visible proof that thermal energy can be extracted from ambient air, and then converted into electricity.

Their principle weakness is that the wind is a fickle source of moving air. Reliability is highest for offshore wind turbines, but their running costs are higher.
In Section 3, 'canned wind turbines' will be proposed as a lower cost and more reliable technology for generating electricity.

2.5.2 Sail powered boats

According to popular belief and website articles, sail rigged vessels are similar to wind turbines in that they convert kinetic enegy from the wind into the kinetic energy of a moving vessel. However, the same arguments about the conservation of mass and energy apply, with sailing vessels also being cool running heat(thermal energy) engines that run on thermal energy extracted from the atmosphere.

Figure 14. Sailing vessels are heat(thermal energy) engines powered by thermal energy extracted from the wind.

There are two types of wind interaction to consider.

(a) When the vessel is travelling at an angle to the wind, the sails billow to create an airfoil shape, producing a thrust on the vessel similar to that on a wind turbine blade.

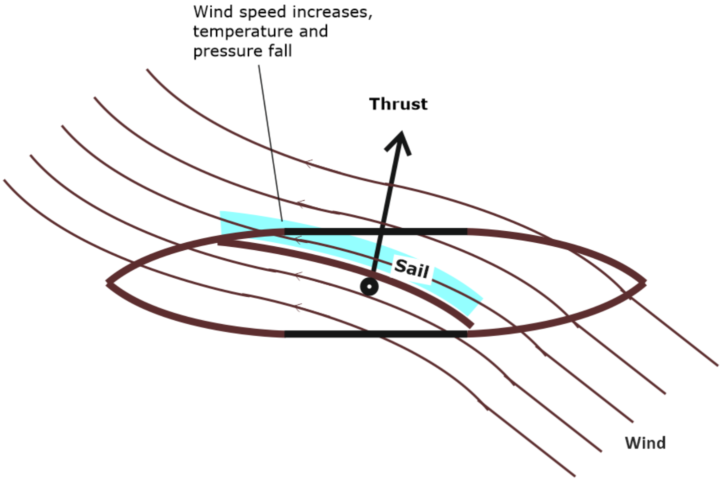


Figure 15. In this plan view, the sail bulges to form an airfoil shape, with the wind speed increasing over the front of the sail and the pressure falling. The thrust on the sail is equivalent to the thrust on a turbine blade. However, the mariner has an additional variable to steer the vessel because they can deflect the water flowing under the vessel by using a rudder.

(b) When the vessel is traveling in the direction of the wind, the heat(thermal energy) engine mechanism is slightly different.

Here is a plan view looking down onto a single sailed vessel travelling in the direction of the wind.

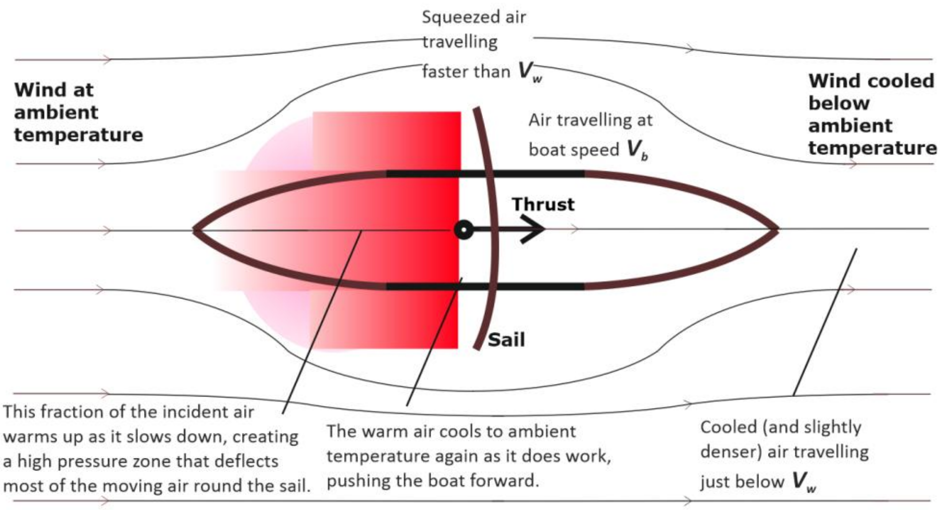


Figure 16. Sailing vessels are cool running heat engines powered by heat extracted from ambient air.

3 Royalty-free designs: Power generators that run on atmospheric heat

These generators run at a temperature below abient, allowing them to extract thermodynaic heat from their environment.

> The following designs are offered for opensource development and you are welcome to exploit them commercially. However, if you make a profit from them, the original inventor Bill Courtney would appreciate a one-off payment being made to him or his estate.

3.1 A proof of concept design

The test rig illustrated below was designed to demonstrate the feasibility of converting atmospheric heat into electricity. It is refeerred to as a '**Latent Power turbine'**. [Reference 3 at the end of Section 3.]

Unfortunatly,in the days of economic uncertainty following the British decision to leave the European Union, Latent Power Turbines Ltd was unable to win sufficient research funding to complete the project.

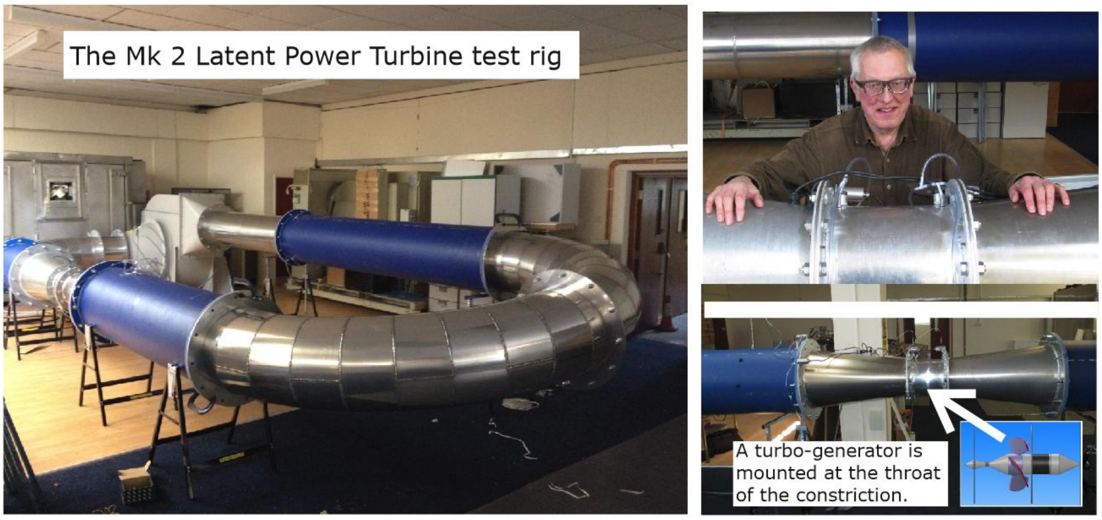


Figure 17. Work on this prototype ground to a halt during the period of investment uncertainty following the Brexit referendum. The test rig was gifted to a technical college for use as a wind tunnel and the patent protection covering the designs was allowed to lapse.

Here is a tour around the Latent Power Turbine loop.

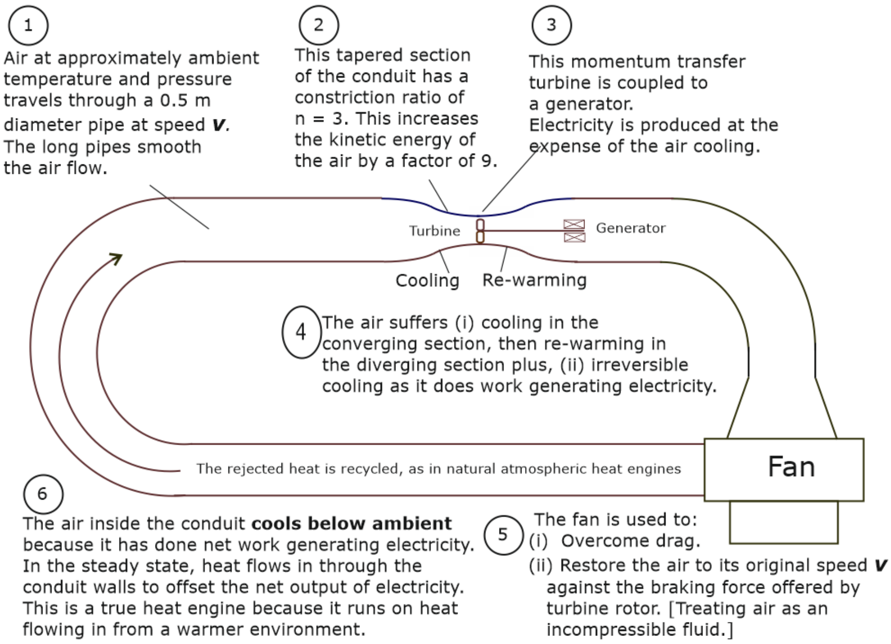


Figure 18. The surrounding atmospheric air cools to offset the net output of electricity. If completed, we anticipated a net power output of several kW.

These are the basic modelling relationships involved.

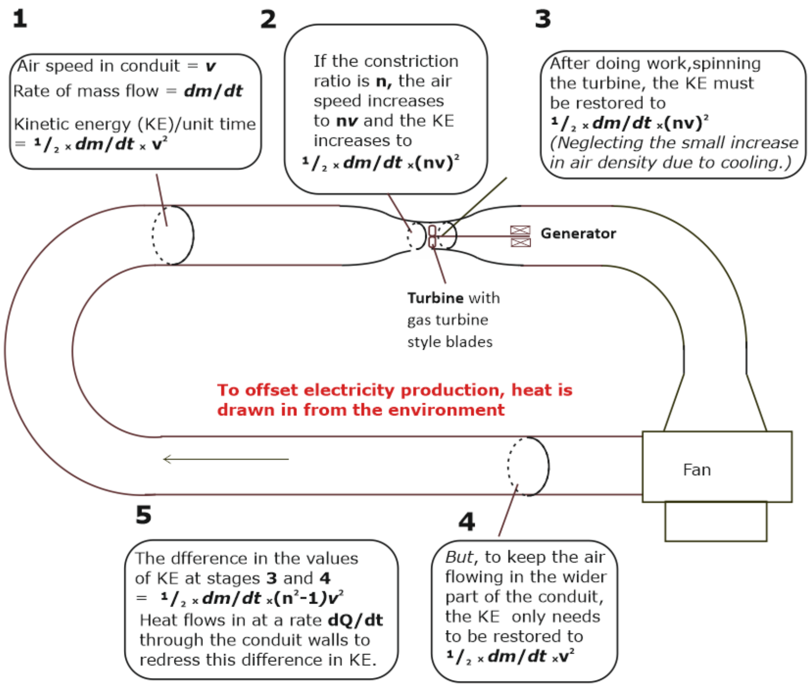


Figure 19. The thermodynamic equations involved are easy to understand and difficult to dispute. Nevertheless, engineering scientists are wary of the theory, because they have been conditioned into believing that atmospheric thermal energy powered ‘heat engines’ are thermodynamically impossible.

A note on fans

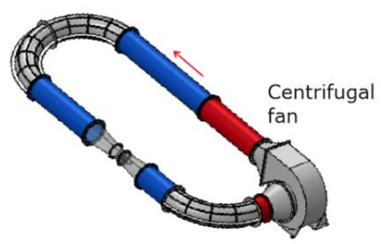


Figure 20. We incorporated a centrifugal fan in the loop purely because one became available. It had no other advatage over alternative fan designs.

3.2 A daisychain of cool running heat engines

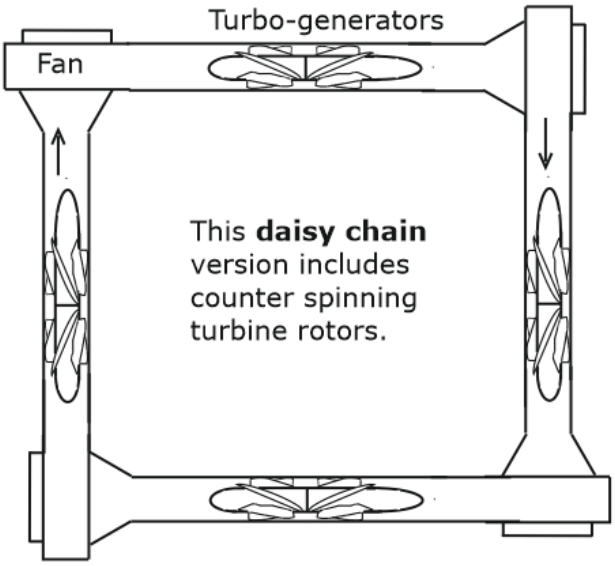


Figure 21 Centrifugal fans can be used to create a daisy chain LP Turbine including up to four fans.

3.3. A plenum chamber Latent Power Turbine

This is a compact LP Turbine design for domestic and small business use. The illustrative dimensions are a cautious estimate for an LP Turbine delivering a net power output of several kW. With luck, it may be possible to build far more compact design delivering a similar net power output.

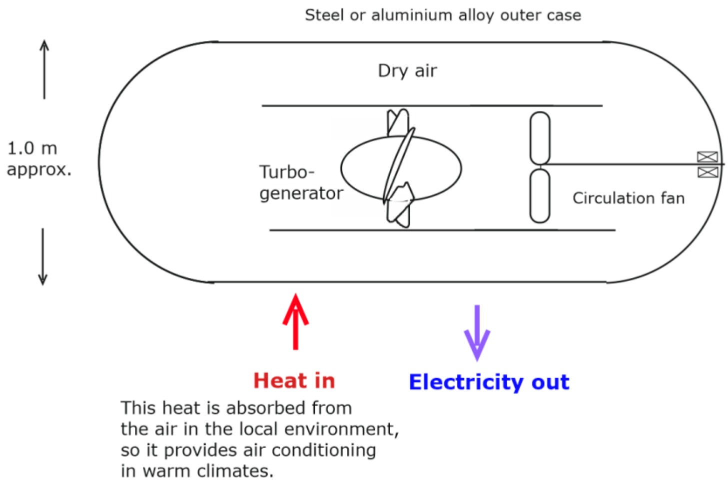


Figure 22. The basic plenum chamber design.
The thermal conductivity of the outer casing material is not critical. For example, if steel is used instead of aluminium, the tempertures inside the chamber will be slightly lower, but the rate of heat flow will be the same in the steady state.

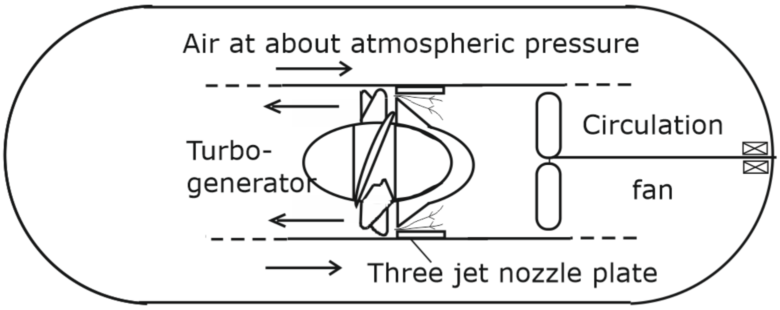


Figure 23. One option for increasing the power output for a given size of LP Turbine would be to use nozzles to concentrate the air impacting on the turbine blades.

3.4 Harnessing the cool air and condensation water by-products

To do this, the LP Turbine needs to be housed in an insulated box with limited atmospheric air access.

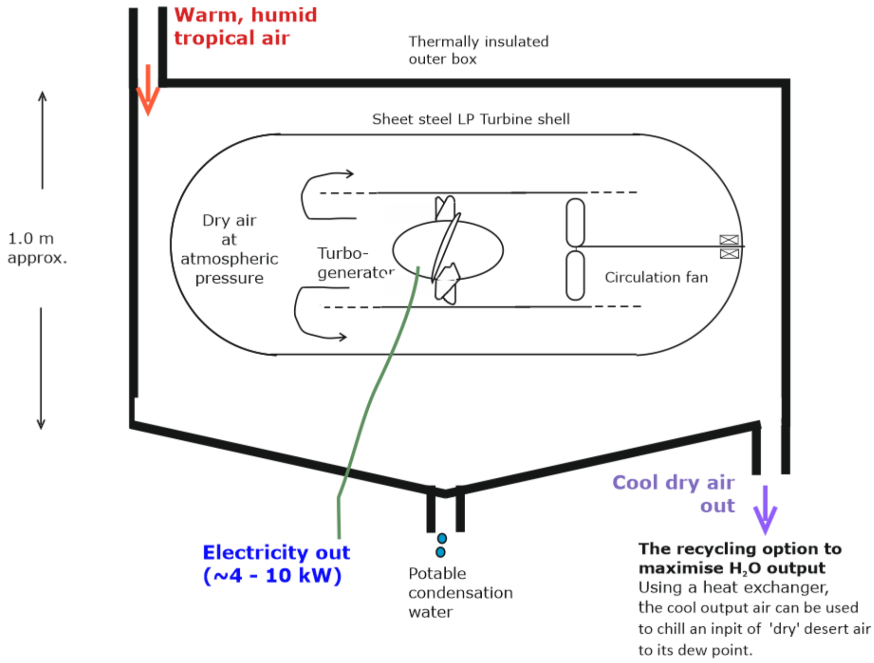


Figure 24. LP Turbine cooled air would provide healthier indoor air compared with air conditioning because it would provide a steady flow of fresh outdoor air instead of recycling the existing indoor air.

By pre-cooling dry desert air to its dew point of around 5°C, a 10 kW LP Turbine could yield aproximately 1 m^3 of potable water each day. In the long term, when eac residence has its own LP Turbine installed, all families, including those living in hot arid regions, could become self-sufficient in meeting their own potable water needs.

The icing up problem

The interior of the coldest parts of the loop will be several degrees below ambient, so icing up is likley to be a problem in environments cooler than around 10^{o}C or cooler. There are a number of techniques for resolving icing issues which we can discuss if there is scientific interest.

3.5 Some illustrative secondary applications of LP Turbines

A wide range of applications for LP Turbines can be found at www.cheshire-innovation.com. Here is a short selection.

3.5 .1 Desert greening
Around 37% of the Earth's surface can be used for agriculture , while 14% is unproductive hot desert. LP Turbines provide a number of routes to desert greening, including using LP Turbines to desalinate sea water and tropical greenhouse propagation. In addition to solving food shortage problems, desert greening would help to bring political stability to the Middle East, Sudan and elsewhere. Importantly, desert greening could begin on a small local scale, allowing the seeds of prosperity to be sown, even in regions that are torn apart by religious and tribal conflicts.

The following design would allow the whole of the Middle East to enjoy a new era of prosperity and stability based on green technology instead of oil.

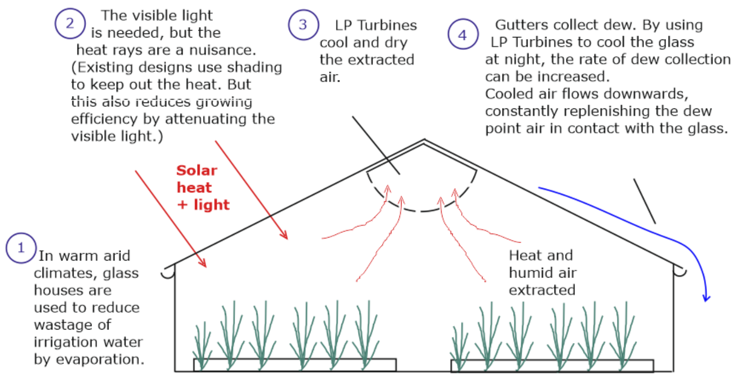


Figure 25. Generating electricity as a by-product of glasshouse horticulture would trigger an exponential growth in desert greening. For example, surplus electricty could be used for glass making using silica based desert sand. This could be used for building a second generation of glasshouses and so on. [This would require a small electrically powered desert sand fusing plant to be installed on site.]

Optically inferior sand could still be fused for conversion into building blocks and into thin sheets, for pulverising into building sand.

The electricity generated by the glasshouses could also be used for desalinating sea water and underground brackish water.

Desert greening will create local micro-climates that could influence weather patterms well beyond their boundaries. Therefore, in the early years, we should proceed with caution, concentrating on reclaiming land that has relatively recently been lost to the desert and limiting the size of virging green zones in pristine desert.

3.5.2 Carbon capture

A daisy chain of LP Turbines could be used for capturing carbon dioxide from flue gases produced by burning municipal rubbish.. Unlike existing systems, this process would generate electricity instead of consuming it.

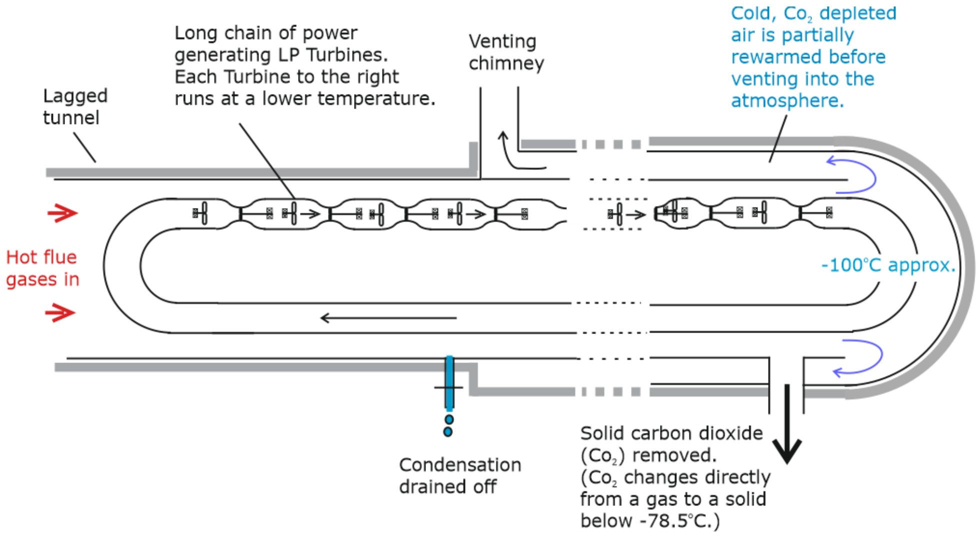


Figure 26 LP Turbines can generate electricity as a by-product of carbon capture.

The alternative for dealing with low combustion waste would be to burn the waste in pure oxygen. The required oxygen could be obtained as a by-product of manufacturing hydrogen by electrically splitting water.

The same principle can be used for capturing carbondioxide from atmospheric air.

The dry chilled air output would have many applications ranging from cooling data storage centres and frozen food storage warehouses to producing potable water using freeze-desalination methodology.

References

1 Carnot, L. N. S, 1824 *Reflections on the Motive Power of Fire*, English translation, Thurston, R. H., John Wiley & sons, 1897.

2 Thomson W. (Lord Kelvin) On the dynamical theory of heat, with numerical results deduced from Mr. Joule's equivalent of a thermal unit, and M. Regnault's observations on steam. *Trans. Edinb. R. Soc.*1851.

3 Courtney, W.A. Cool running heat engines, Journal of Biological Physics and Chemistry **21**, 79-87 (2021)
[A copy is published on the Cheshire Innovation website,

4 Did the heat engine error result in European colonial expansion after 1850?

In Section 4 the social and political consequences of doublethink thermodynamics will be discussed.

During the nineteenth century, Europeans made a profit out of tropical raw materials in a three-stage process. First, the raw materials were acquired and then shipped to Europe where they were turned into products in coal and steam powered factories. Then finally, the profit was made when the products were sold around the world..

The simpler option of processing raw materials in their country of origin did not seem possible for logistics reasons. In particular, nineteenth century industry relied on coal and Europe had been developing its coalfields for more than a century.

However, by the middle of the nineteenth century, steam power should have been on the verge of replacement by electricity, and atmospheric heat should have been replacing coal. In reality, this never happened thanks to the confusion caused by doublethink thermodynamics.

In this section, we will discuss some of the evidence that scientists have ignored, and the terrible consequences that have followed.

4.1.1 Brunel's atmospheric railway (1847)

Brunel's 1847 invention converted atmospheric heat(thermal energy) into the mechanical energy of a moving train.

Brunel faced this problem.
There is only a limited amount of grip between steel railway train wheels and steel railway tracks. Consequently, when climbing steep inclines, the wheels have a tendency to spin round instead of gripping the track. When faced with building a new railway line in hilly country, Brunel decided to sidestep this problem by using atmospheric air to push his train forward, instead of relying on the train wheels for traction.

As the atmospheric air did work pushing the train, its internal energy fell and its temperature dropped below ambient.

The ability of Brunel's engine to run on atmospheric heat was both its strength and its weakness. On a warm day, his engines were capable of keeping to a reliable timetable: moving trains along the hilly 20 miles (32 km) route from Exeter to Newton Abbott, at speeds of up to 70 m/h (113 km/h).

The reliability of the warm weather service provided proof that engines can convert ambient atmospheric heat(thermal energy) into mechanical work.

However, in cool damp weather, the engines tended to ice up and stop working, even at air temperatures several degrees above freezing.

The following diagram explains the heat engine concept behind Brunel's propulsion system.

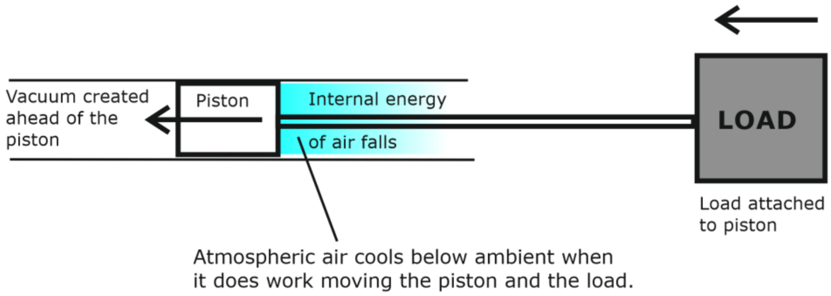


Figure 27. Essentially, Brunel's heat engine consisted of a cylinder with a piston inside. The section ahead of the piston was evacuated, and the section behind was exposed to atmospheric air. This pressure difference drove the piston and its load forward. But, as the air did work on the piston, the air was forced to cool, so that the total amount of energy remained constant.

The internal energy of the air provided free fuel for the heat engine, but fossil fuel was still consumed, powering the vacuum pumps.

In order to convert this into a practical heat engine that could move loads over long distances, the load needed to be moved well clear of the piston and cylinder. Brunel's solution involved the use of leather flaps, as shown in the diagram below.

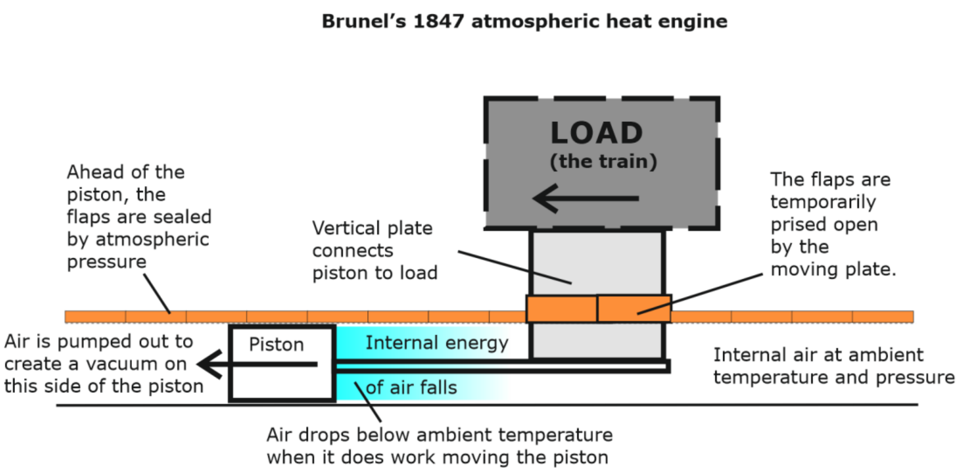


Figure 28. Brunel's 1847 atmospheric heat engine did mechaical work on the piston at the cost of the air inside the cylinder cooling below ambient temperature. Consequently, in cool damp weather, the flaps were vulnerable to icing up, even when the ambient air was several degrees above the freezing point of water.

Within a year of the service commencing, the atmospheric heat engines were abandoned and replaced with conventional steam engines.

Nevertheless, Brunel's notorious commercial failure should have taught scientists two important heat engine lessons.

(i) It is possible to build engines that convert ambient atmospheric heat (thermal energy) into other forms of energy.
(ii) The rejected heat can return to the same atmosphere that it came from because it takes the form of the internal energy of the cooled air.

4.1.2 More reliable atmospheric heat engines developed from 1853 onwards

In 1847, Great Britain was the world's leading industrial power and Brunel was one of its most highly respected engineers.

Consequently, news about the summer success and winter failure of his atmospheric heat engines would have been widely discussed at the time. This appears to have encouraged some positive thinking because in 1853, the London Telegraph Company adopted a simplified version of Brunel's heat engine concept for moving documents and small parcels around London.

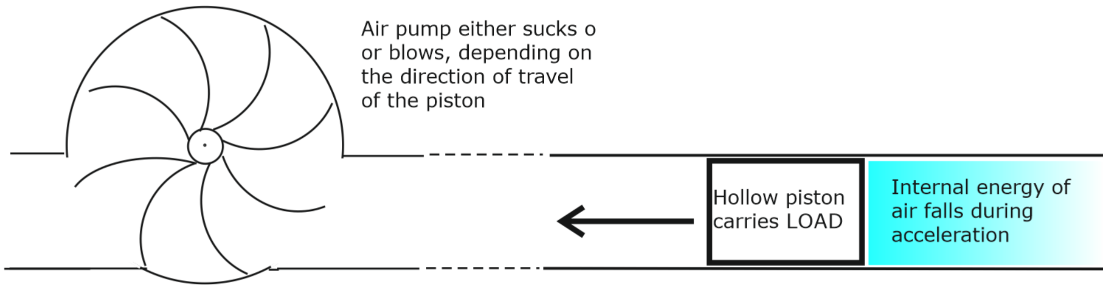


Figure 29. The London Telegraph Company's atmospheric heat engines were not vulnerable to icing up because they had no need for leather flaps.

In 1861, the design was scaled up to become an experimental pneumatic underground railway for carrying London passengers. A similar experimental pneumatic underground railway opened in New York in 1870.

The passenger carrying systems became redundant when reliable electric alternatives became available. However, pneumatic document and parcels carrying tubes are still in commercial use.

Consequently, it is both puzzling and perverse that nineteenth century scientists went on to develop a heat engine theory that rules out the possibility of building atmospheric heat(thermal energy) engines.

4.1.3 A timeline illustrating our heat engine confusion

1824 'The father of thermodynamics', Sadi Carnot realises that all heat engines require some form of heat sink where they can dump their rejected heat.
[However, Carnot's understanding of heat sinks is limited because the caloric theory of his day does not distinguish between heat and internal energy sinks.]

1843-5 Joule carries out a series of experiments that disprove the caloric theory of heat.

1847 Brunel builds an 'atmospheric railway' employing heat engines fuelled by atmospheric heat. It's essential thermodynamic feature is that it requires an internal energy sink, but no heat sink.

1853+ A series of atmospheric heat engines in the form of pneumatic tubes are developed for commercial use. Their common feature is that they all require an internal energy sink, but no heat sink.

1850s Industrial progress is dominated by ever-hotter running steam engines. During these years, engineering scientists use their developing knowledge of thermodynamics to update Carnot's heat engine theory. They ignore the need for internal energy sinks at a low pressure, teaching instead that all heat engines require a heat sink at a low temperature.

1860s Meteorologists publish early papers linking atmospheric phenomenon to thermodynamics. Eventually, this leads to a schism, with meteorologists only being able to explain atmospheric convection currents by assuming that they are circular heat engine systems with internal energy sinks, while their engineering colleagues remain adamant that all heat engines are linear systems that require heat sinks.

1871-90 Pneumatic tools become commercially available. These are ambient temperature heat(thermal energy) engines that convert thermal energy stored in compressed ambient air into mechanical work.

This cool running heat engine uses the atmosphere as an internal energy sink

1930s Fowler *rediscovers* Maxwell's 1871 argument that the three laws of thermodynamics [1^{st}, 2^{nd} and 3^{rd} law] are logically flawed as they stand and that an additional law is required at the beginning of the sequence to make sense. It is far too late to renumber the existing laws, so Fowler's 'new' law is referred to as 'The ZEROTH law of thermodynamics'.
This 80-year delay in recognising the true first law of thermodynamics should have acted as a warning that something was going wrong in the teaching of thermodynamics. The misuse of the terms 'central heating boiler' and 'radiator' should have provided further clues that the teaching was unreliable.

1950s Engineering scientists develop commercial wind turbines. According to the standard explanation, these turbines convert kinetic energy from the wind into electricity. However, this explanation violates the continuity principle. In reality, wind turbines are ambient temperature heat engines that extract heat (thermal energy) from the passing air.

2024 As a consequence of our doublethink understanding of heat engines, we are living in an overheating world where we remain hostages to the fossil fuel suppliers. Wars in the Ukraine and elsewhere are being funded by revenue from fossil fuel sales.

Fig .30. Brunel was one of the greatest engineering scientists of the nineteenth century and has a prestigious technical university named after him.

However, successive generations of engineering scientists have seen his atmospheric railway as a record blemishing failure that they prefer to forget. Consequently, he is not credited with providing the first commercial scale evidence that atmospheric heat can be converted into other forms of energy.

The professional 'Code of honour' that discourages scientists from facing up to uncomfortable truths lies behind climate change and several other tragedies since 1850.

4.2 How the world would have benefited if we had learned from Brunel's engine

Brunel, The London Telegraph company engineers and others should have led the way for other types of heat engines powered by atmospheric thermal energy to be developed. For example, after Siemens invented the modern dynamo in 1867, there is no technical reason why power generators similar to the one sketched below could not have been mass-produced. Such engines would have worked well in warm weather in Europe, and all the year round in the tropics.

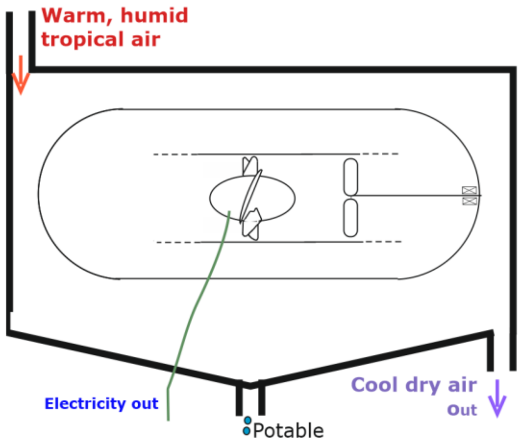


Figure 31 Power generators similar to this could supply individual work stations with power for weaving looms, lathes or other items of factory machinery. In the tropics, they could also have provided operatives with cool workstation air and drinking water, to maximise their working efficiency. [We will refer to this type of power generator as a Latent Power or LP Turbine,]

As far as LP Turbine based indoor temperature control is concerned, the big winners are people living in the tropics because they can generate electricity as a byproduct of indoor cooling. In contrast, people living in cooler regions willl need to generated electricity in order to provide indoor heating.
In the tropics, the triple output of electricity, cool dry air and potable water will create several types of positive output loop that will have far more economic impact than in the cooler regions.
For example, here is a positive feedback loop that applies to affluent households and cool storage warehouses that primarily install LP Turbines for indoor space cooling.

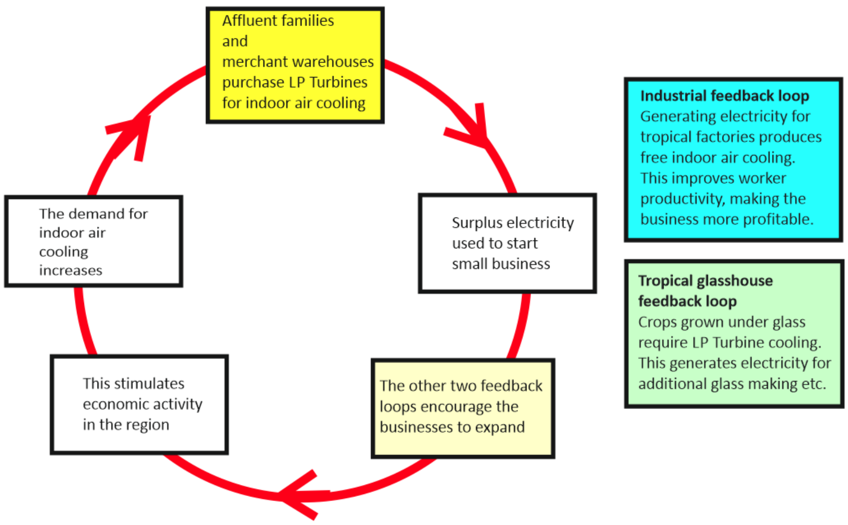


Figure 32. These feedback loops could have operating as early as the 1850s, if scientists had not been blind to the potential for converting atmospheric thermal energy into rlrctricity.

Thanks to positive feedback, the nineteenth century industrialisation of the tropics would have made exponential progress, stanting from very modest beginnings.

This industrialisation would have favoured the exploitation of local tropical materials, while the Europeans and North Americans would have benefited from exporting electrical goods to the tropics.

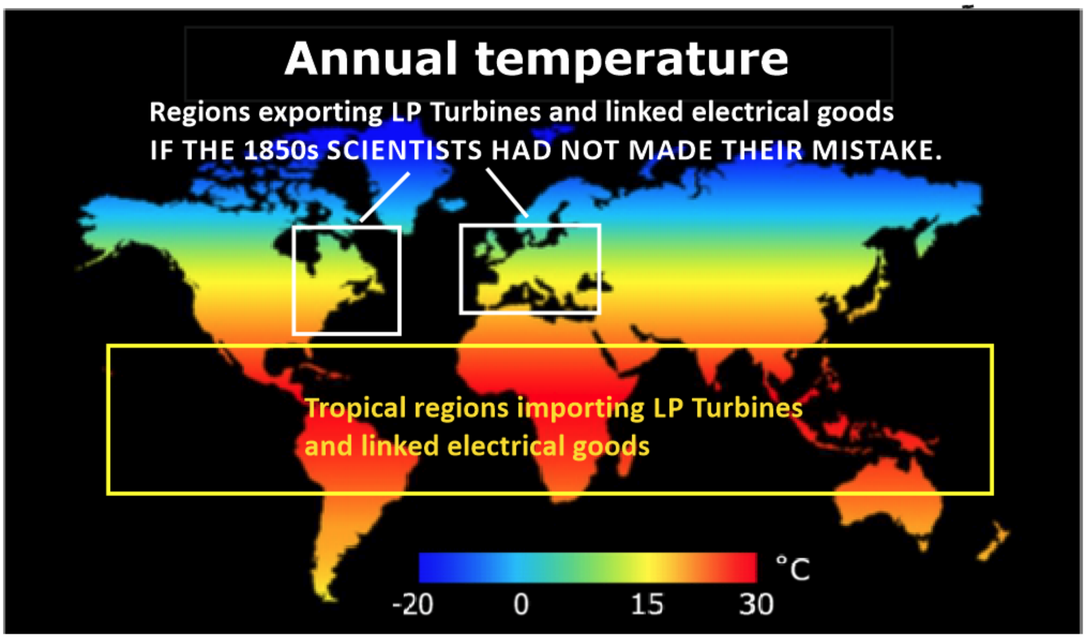


Figure 33. Thanks to their common inheritance of Enlightenment science, many European and North American countries would have competed to develop a wide range of electrical products, to take advantage of the new LP Turbine power supplies.

Electrical goods innovation would have encouraged free trade between Europe, North America and the tropics.

In contrast, the Imperial Empire model in which tropical raw materials are shipped to Europe for turning into higher value goods would have received very little support.

4.3 How a famous efficiency equation led engineering scientists astray

The 'Puffing Devil' steam engine built in 1800 was the first useful steam engine to employ high pressure, high temperature steam. Then, throughout the rest of the nineteenth century, improvements in materials technology allowed high-pressure steam engines to run at ever-higher temperatures and become ever more efficient.

The experimental evidence that heat engine efficiency increased with boiler temperature was given strong theoretical support in the 1850s when William Thomson (Lord Kelvin) published his ideal heat engine efficiency equation,

Maximum thermal efficiency, $\eta = 1 - T_{cold}/T_{hot}$

Where T_{hot} is the Kelvin temperature of the heat(thermal energy) entering the heat engine and T_{cold} is the Kelvin temperature of the rejected heat(thermal energy) leaving the heat engine.

Engineering scientists read two false conclusions into this equation.

(i) ‘A large temperature difference is required for high heat engine efficiency’.

This a ‘half-truth’ that only applies to linear heat engines. It does not apply to convection loops or other circular heat engine systems that offer thermal energy feedback.

(ii) ‘A temperature difference is required for a heat engine to work’.

This claim is commonly used to support the argument that a heat engine running on atmospheric heat is thermodynamically impossible. However, this belief confuses *cause* and *consequence*. In reality, the temperature of the working fluid falls as a consequence of its internal energy falling, as the fluid does external work. In 1850, Clausius and Kelvin working independently neatly summarised the correct relationship in the form of the first law of thermodynamics.

4.4 The heat engine error and imperialist expansion after 1850

Thanks to their heat engine errors, the engineering scientists accidently provided the technical (and tenuous moral) argument in favour of European Imperial expansion, claiming that the industrial exploitation of tropical resources would benefit the tropical inhabitants, as well as the Europeans. However, the manufacturing processes could only be carried out in Europe where there were widespread and well-developed coalfields.

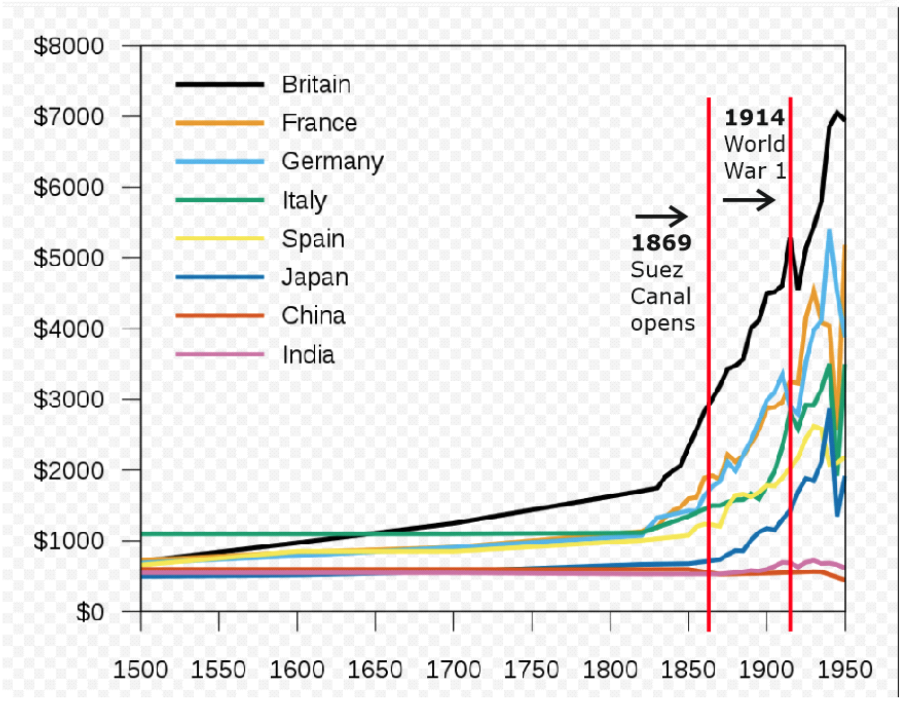
In their many guises, coal fired steam engines enabled small numbers of Europeans to dominate large numbers of less technically advanced people in the tropics.

Figure 34. One common feature of these images is that the copious amounts of smoke billowing from the chimneys is visible evidence that the atmosphere is acting as an internal energy sink at a lower pressure than inside the steam engine fireboxes. Unfortunetely, the engineering scientists failed to recognise their thermodynamic significance.

This blind-spot in our heat engine understanding continues to the present day, with the engineering science textbooks emphasing that all heat engines must have a heat sink, but making no reference to the need for internal energy sinks.

The following two sets of data illustrate how the European Imperial Powers benefited from exploiting their twin assets of tropical empires and coal, while Asia remained poor.

However, this boom in affluence did not last, with jealousy between the European imperial powers resulting in a world war in 1914.



[*Contours of the World Economy, 1–2030 AD. Essays in Macro-Economic History* by Angus Maddison, Oxford University Press, 2007, ISBN 978-0-19-922721-1, p. 382, Table A.7]

Figure 35. European per capita incomes rose rapidly in the period between 1850 and 1914. This growth was based mainly on industrialisation and adding vaalue to imported raw matterials.

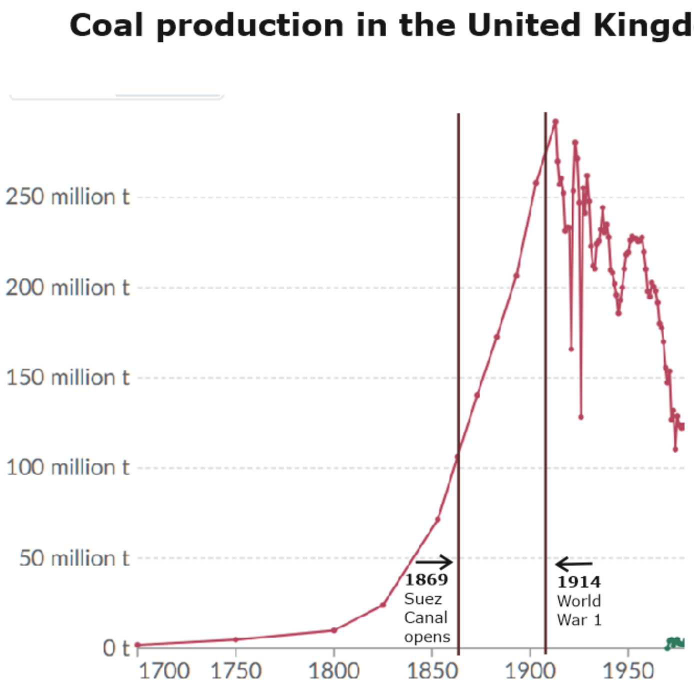


Figure 36. The UK was typical of the European Imperial Powers in that there was a massive increase in coal production in the period 1850-1914.

In an ‘alternative history’, in which manufacturing took place in the tropics, atmospheric heat would have replaced coal as the primary heat source. However, the tropical workers gain would not have been the European workers loss, because Europe and North American workers would be enjoying a paralllel boom in electrical goods manufacturing and all of the spinoff industries that this would have generated..

4.5 Linking the heat engine error to the two world wars and the Holocaust

Without the heat engine error, the international tensions that led to war in Europe in 1914 would not have emerged.

There would have been no imperial rivalries, no jingoism based on colonial possessions, and no need for the Europeans to lock themselves into alliances that allowed an assassination in Sarajevo to escalate into a world war.

Without the First World War, there would have been no post-war humiliation of Germany, no rise of the Nazi party, and no need to scapegoating the Jewish people. Consequently, the Holocaust and all of the other horrors of The Second World War would never have happened.