

Delivering an Oil-Free World Economy (v. 2.0)

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Abstract

We are fighting climate change the hard way, thanks to our failure to recognise that there are two types of heat engine and not one. The second type imitates the Earth's weather systems, by moving fluid matter that contains internal energy from high pressure to low pressure, rather than moving thermal energy from warm to cold, without the movement of matter. Matter moves in accordance with Newton's laws of motion and not the second law of thermodynamics. Thus, the second type of heat engine contradicts the standard textbook teaching that, 'All heat engines must obey the second law of thermodynamics.'

The textbooks also tell us that it is impossible to build a heat engine that extracts thermal energy from the environment and convert it into another form of energy, because this would 'violate the second law of thermodynamics'.

However, once we recognise that this law does not apply to all heat engines, converting environmental thermal energy into mechanical energy becomes a realistic goal.

Mother Nature has been using the second type of heat engine for the last four billion years, but we have failed to learn from her.

Our failure to learn from nature is a consequence of a series of mistakes made by scientists developing thermodynamics in the years around 1850. This article identifies the mistakes and explains how we can build an oil-free world economy after correcting them.

We already use heat engines that run on environmental thermal energy, but we have failed to recognise them. Seven of these hidden heat engines are briefly described and their merits combined, to create a more powerful design.

The proposed heat engines will be more reliable than wind turbines, cheaper to build and generate electricity locally, where and when required. This will enable humanity to reach net zero carbon emissions well before 2050, while simultaneously boosting the world economy.

A selection of the applications that will boost economic growth, while helping us to achieve our net zero goal are outlined in Section 5.

COTENTS

- 1 The mistakes that led scientists astray
- 2 Resolving the doublethink contradictions
- 3 Existing Class 2 heat engines that run on ambient temperature thermal energy
- 4 Closed loop Class 2y engines
- 5 A selection of Latent Power Turbine applications
- 6 The historical cost of failing to recognise Class 2 heat engines

1 The mistakes that led scientists astray

In the years around 1850, scientists were abandoning the caloric theory of heat in favour of a new theory called thermodynamics.

However, in their enthusiasm for change, the thermodynamics pioneers changed the definition of *heat*, making it difficult to recognise the need for two types of heat engine.

1.1 The caloric era, circa 1760-1850

Based on Joseph Black's work on *specific heat* and *latent heat* in the 1760s, the concept of *heat* as a measurable scientific quantity emerged.

One of Black's students, Cleghorn suggested that heat is a self-repellent, weightless fluid that could be stored inside bodies and flowed from hotter bodies to colder ones.

The scientific community broadly accepted Cleghorn's theory. Subsequently, to distinguish 'scientific heat' from the physical sensation of heat, Lavoisier invented the term '*caloric*' in 1787.

During the late caloric period, the modern concept of *energy* as 'the ability to do mechanical work' emerged.

However, according to caloric theory, heat is a substance and not a form of energy.

1.2 The thermodynamics era, from the late 1840s onwards

During the 1840s, J. P. Joule challenged the caloric theory, by providing experimental evidence that there are precise numerical relationships between heat, electrical energy and mechanical work.

This evidence, combined with increasing awareness that matter consists of atoms and molecules, led to thermodynamics replacing the caloric theory of heat.

The thermodynamics revolution radically changed the physics of heat. However, there was no clean break between the two theories, because the existing mathematical framework remained valid. Many caloric era terms such as *specific heat* and *latent heat* were retained by the new science, with new terms such as *thermal energy* and *internal energy* being added.

1.3 How the thermodynamics revolution went badly wrong

During the gradual dismantling of the caloric theory in the years around 1850, scientists concluded that two forms of energy would be required to replace the role of caloric as a substance. Thus, one would relate to the energy stored inside a body, and the second would relate to energy in transit from a warm body to a cooler body.

Unfortunately, the thermodynamics pioneers chose to use the early caloric era term '*heat*' for energy travelling from warm to cold.

This retrograde step caused double confusion. Thus, *heat* meant a substance in caloric theory, and something different again in childhood learning.

During early childhood, we all encounter heat as a nervous sensation and need to distinguish between its dangers and pleasures, if we are to survive to adulthood.

The word '*heat*' also has great cultural importance in Germanic languages because it has its roots in Old English, German, Dutch and Old Norse.

Thus, it was unrealistic to expect anyone, (except for perhaps, a thermodynamics champion), to cast aside their childhood learning and use the term '*heat*' in a new scientific way, without becoming confused and making cognitive mistakes.

Here is an illustration of how thermodynamics clashes with deep childhood learning.

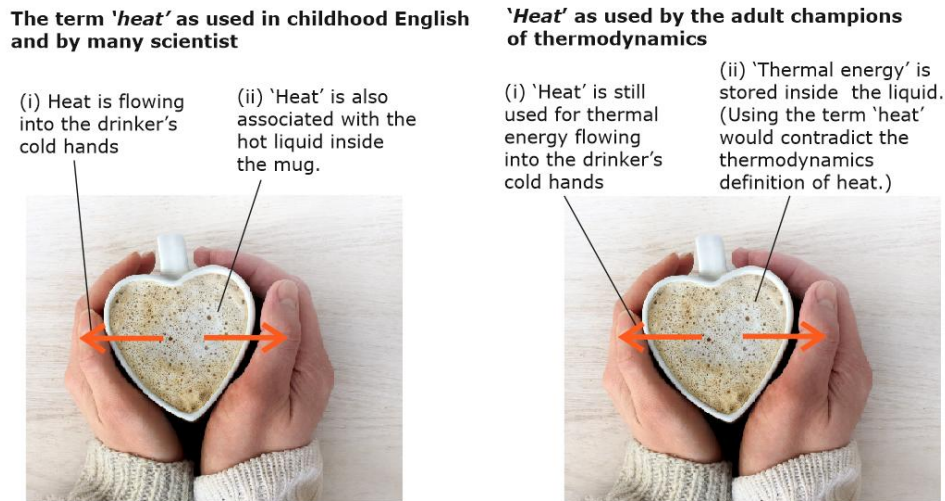


Figure 1. Childhood sensory learning is the deepest form of human learning. Consequently, cognitive errors can occur when adults try to use the term '*heat*' in a new way. This is not due to a lack of intelligence, but emerges from the heuristic way in which the human mind simplifies complex information.

Here are some examples of how thermodynamics has degenerated to Orwellian doublethink, thanks to cognitive confusion:

(i) Reputable science journals commonly publish papers that refer to '*heat*' as a property of a body, even though this contradicts the thermodynamic definition of heat. For example, '*Ocean Heat Content*' (OHC) is regularly cited as a reliable indicator of climate change.

(ii) Other thermodynamics terms that amount to doublethink by referring to heat inside a body includes *latent heat* and *specific heat*.

(iii) The following statement is either true or doublethink nonsense, depending on which definition of heat is used.

'Heat can flow 'the wrong way', from cold to warm, provided that it travels as the internal energy of a fluid.'

(iv) The most serious doublethink problems relate to the ambiguous term '*heat engine*.' These have led the scientists fighting climate change seriously astray. They will be discussed in detail below.

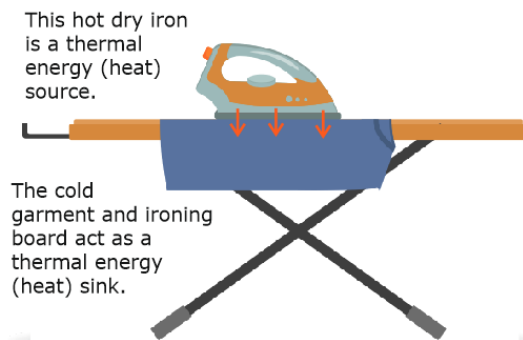
2 Resolving the doublethink contradictions

2.1 The two types of thermal energy transfer

These examples may appear to be trivial, but they highlight the two types of thermal energy flow that lead to the requirement for two types of '*heat engine*'.

Thermal energy flow WITHOUT matter flow

Thermal energy (heat) flows from a hot source to a cold sink, in accordance with the second law of thermodynamics.



Thermal energy flow WITH matter flow

The matter acts as a vector, carrying thermal energy from an internal energy source to an internal energy sink. The matter flows in accordance with Newton's laws of motion.

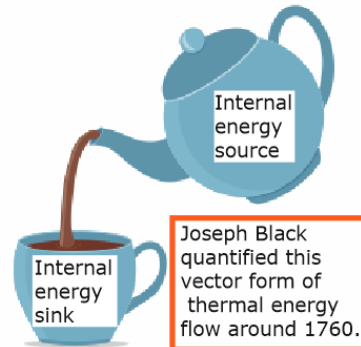


Figure 2. Newton's laws of motion explain how matter moves from an internal energy source to an internal energy sink. Specific heat calculations then provide information about the amount of thermal energy transferred from the source to the sink.

A second feature of the vector transfer of thermal energy is that the energy can travel 'the wrong way' from cold to warm.



The liquid being poured is acting as a vector. It transfers thermal energy from the flask to the mug.

It makes no difference, whether the liquid is warmer or colder than the mug, we still end up transferring thermal energy from the flask to the mug.

Thus, thermal energy can travel 'the wrong way', from cold to warm, provided that it is carried by a vector.

Figure 3. The vector transfer of thermal energy is not constrained by the second law of thermodynamics.

Scientists and engineers have been aware of the vector transfer of thermal energy since Black's work in the 1760s. However, they have ignored the role of vectors in moving thermal energy through some heat engines. Consequently, they have failed to recognise that there are two types of 'heat engine'.

2.2 The two classes of heat engine

Once the role of vector flow in heat engine theory is recognised, it becomes clear that there are two classes of heat engines.

The first class of heat engines is characterised by the working fluid remaining permanently sealed inside the engine, and thermal energy flowing in and out of the engine, in accordance with the second law of thermodynamics.

This class includes Stirling and Carnot engines, but is otherwise uncommon. Nevertheless, the thermodynamics textbooks claiming that all heat engines fall into this class.

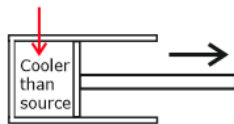
The second class of heat engines is characterised by the working fluid acting as a vector that carries thermal energy in and out of the engine. This class is common, and includes steam and internal combustion engines.

Class 1 heat engines

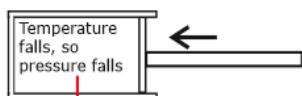
The working fluid is permanently sealed inside the engine.

Illustrative example: A Carnot engine.

- ① Thermal energy flows in from a high temperature heat source, in accordance with the second law of thermodynamics.



②



Thermal energy flows out to a heat sink, in accordance with the second law of thermodynamics.

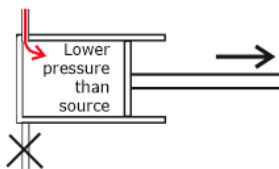
The boundary condition is that the heat sink must be at a lower temperature than the rejected thermal energy. Class1 engines can never be 100% efficient because some thermal energy has to be rejected, so that the piston can return to its original position at the start of the cycle.

Class 2 heat engines

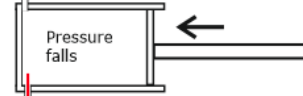
Fresh vector fluid flows in and is then ejected in regular cycles.

Illustrative example: A steam engine

- ① Steam possessing internal energy acts as a vector. It flows in from a high-pressure steam source.



②



Lower pressure steam, possessing less internal energy, exits to an internal energy sink.

The boundary condition is that the internal energy sink must be at a lower pressure than the exhausted vector fluid. Class2 engines can never be 100% efficient because the exhaust fluid carries internal energy away..

Figure 4. These engines are called '*heat engines*', but pressure is the variable linking them to mechanical work, thus:

$$\text{Mechanical work output} = \text{Pressure change} \times \text{Volume change}$$

The standard thermodynamics heat engine diagram that originated in Carnot's 1824 work, needs correcting to allow for the two classes of '*heat*' engines.

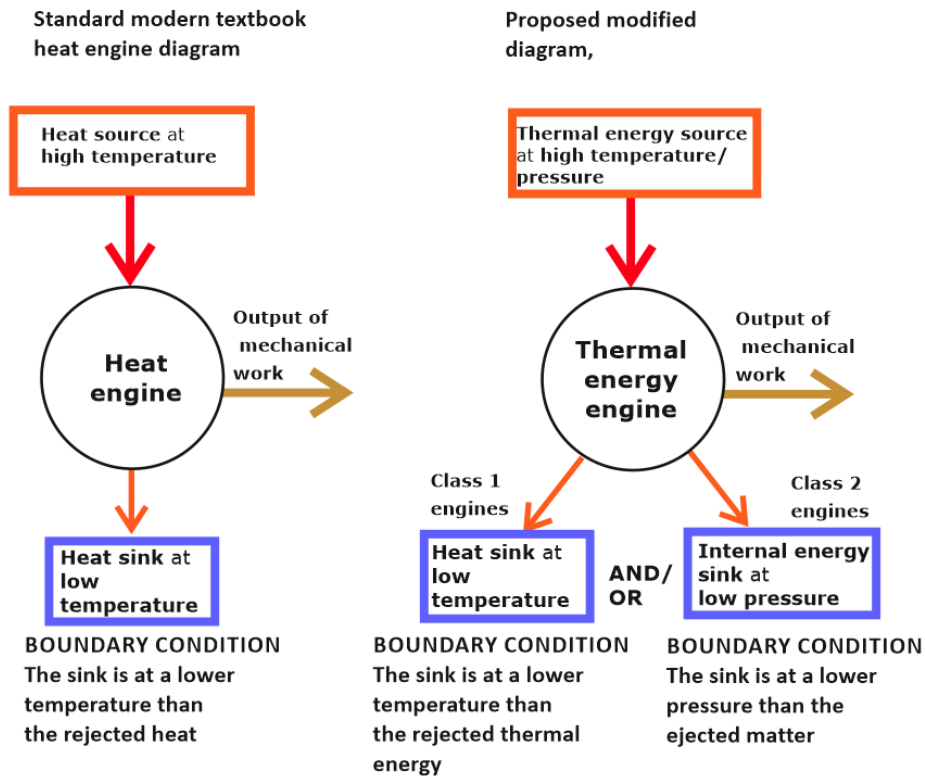


Figure 5. Some heat engines that are strictly Class 2 engines also incorporate heat sinks to prevent overheating. For example, internal combustion engines in most road vehicles incorporate both an exhaust system and a radiator. [However, the term ‘radiator’ provides a good example of cognitive confusion, because car ‘radiators’ work primarily by forced convection!]

Class 2 heat engines have several advantages over Class 1 heat engines because they are not constrained by the second law of thermodynamics.

- The thermal energy carried by the exhausted vector fluid can be recycled, if the fluid remains chemically stable throughout the cycle. (E.g. it is not chemical changed caused by combustion.) This feature will allow us to construct closed loop heat engine that are analogous to nature’s convection current loops.
- Closed loop heat engine can run on thermal energy extracted from the ambient temperature environment.
- Closed loop heat engines can operate efficiently, even if there is only a small temperature drop across the engine, because the rejected thermal energy is recycled.

3 Existing Class 2 heat engines that run on ambient temperature thermal energy

These examples suggest concepts that can be integrated to create a practical heat engine that converts ambient thermal energy into electricity.

3.1 Pneumatic power tools

Compressed air tools are cool running Class 2 heat engines.

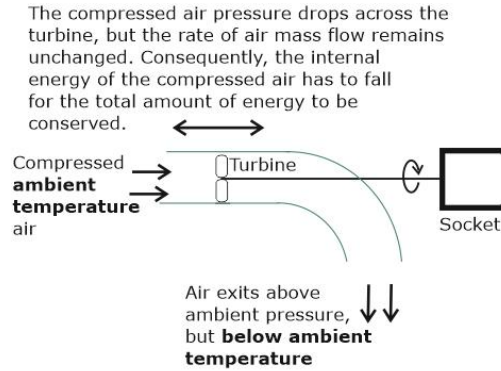


Figure 6. The common perception is that pneumatic power tools are mechanical devices.

In reality, they are Class 2 heat engines that do mechanical work, at the cost of the internal energy of the compressed air falling.

3.2 Hose pipe water jets



Figure 7. According to the textbooks, the kinetic energy of the ejected water increases at the cost of the '*pressure-energy*' of the water falling. However, the textbooks fail to provide a molecular level explanation of '*pressure-energy*'

A deeper understanding is possible if we view this as the kinetic energy of the ejected water increasing, at the cost of its internal energy falling.

3.3 Fluid flow through insulated converging-diverging pipes

When fluid flows smoothly through an insulated a converging-diverging pipe, the dynamic fluid pressure falls as the fluid speed increases.

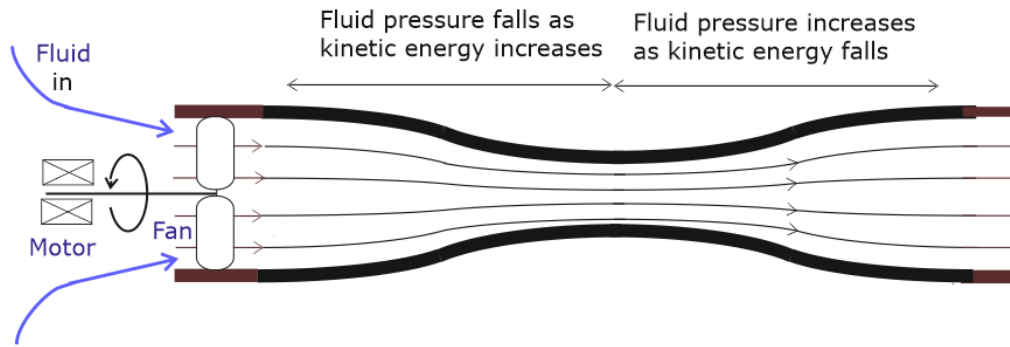


Figure 8. The mathematical relationship between speed and pressure was quantified in Bernoulli's equation in 1758, but the physics behind the link was vague. However, after the discovery of the law of conservation of energy in the nineteenth century, scientists concluded that a new form of energy called '*pressure energy*' was involved. Thus, as the fluid accelerated, its kinetic energy increased and there was a corresponding fall in pressure energy. However, simply creating the term '*pressure energy*' did not explain the underlying physics.

The present writer argues that there is no fundamental mechanics quantity called *pressure energy*, and the pressure term in Bernoulli's equation is just a dummy variable that stands in for the internal energy of the fluid.

This implies that the converging section acts as a Class 2 heat engine, and the diverging section acts as a Reverse Class 2 heat engine.

The following diagram illustrates the transiting fluid is dry air.

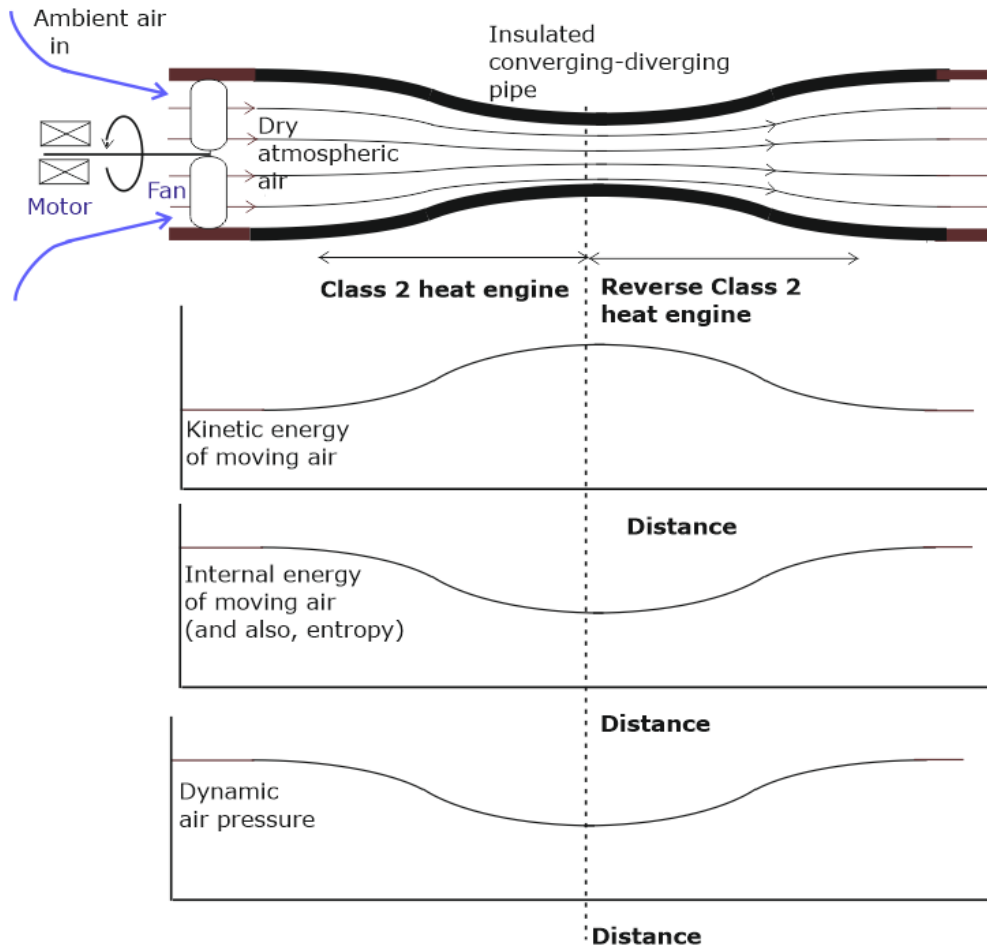


Figure 9. The converging section of the pipe acts as a Class 2 heat engine when air flows through it in a steady stream. However, this heat engine contradicts the standard thermodynamics teaching that all heat engines increase the entropy of the universe.

3.4 Converging-diverging pipes with thermally conducting walls

This arrangement can act as a basic heat pump.

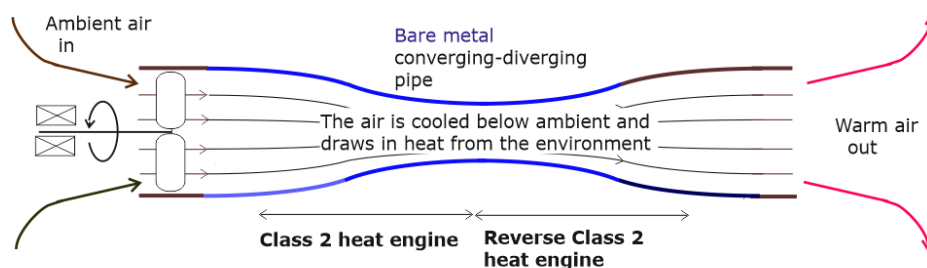


Figure 10. This heat pump only produces a modest increase in air temperature and is not suitable for indoor space heating. However, as explained below; it could play an important role in clean power generation.

3.5 How aircraft wings incorporate Class 2 heat engine features

The Bernoulli principle plays an important role in keeping winged aircraft aloft.

The following diagram shows a cross section through an aircraft wing. The bulge on the upper surface of the wing alters the airflow in a similar manner to a converging-diverging pipe.

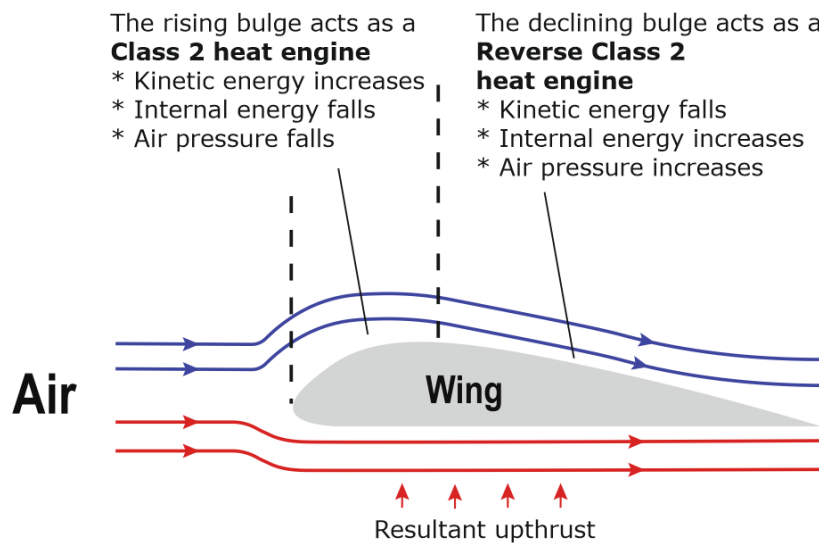


Figure 11. The pressure difference between the upper and lower surfaces of the wing produces an upthrust force.

3.6 Wind turbines

According to the textbooks, wind turbines are mechanical devices that convert the kinetic energy of the wind into electricity, but this is wrong.

If the air lost kinetic energy, it would need to slow down. Consequently, the air molecules would need to move away from the wind turbine at a slower rate than they are approaching it.

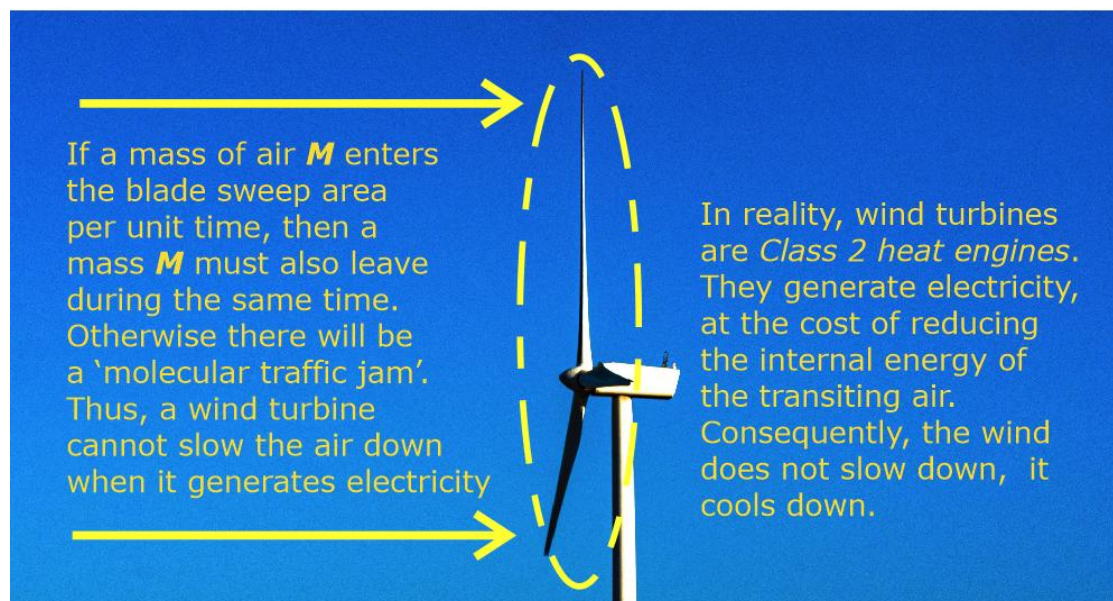


Figure 12. Wind turbines are Class 2 heat engines that convert internal energy from the moving air into electricity.

The following diagram explains how the rotating blades cool the transiting air.

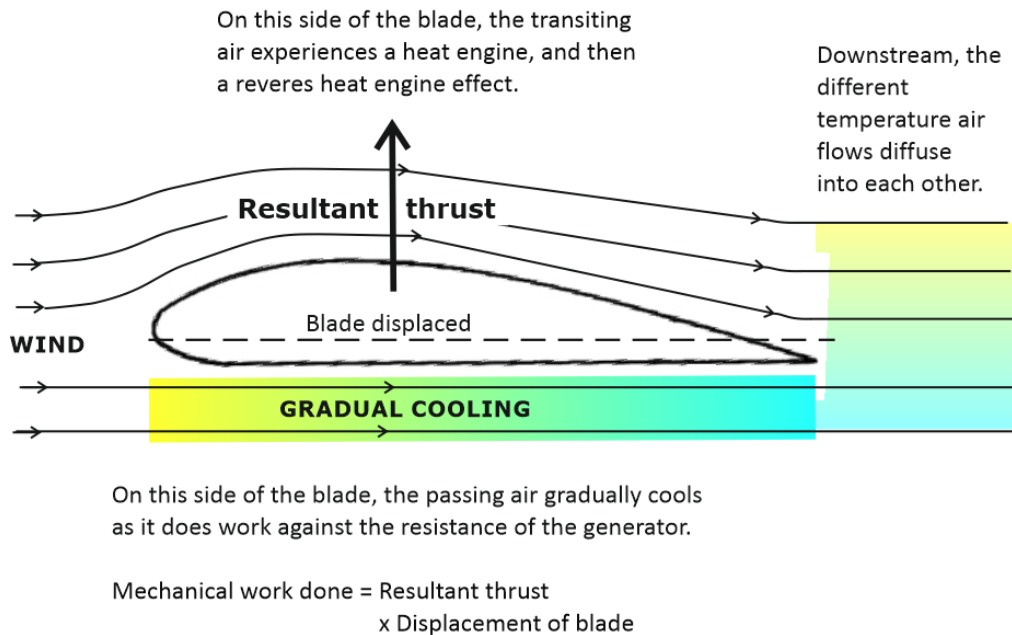


Figure 13. Wind turbine blades act as complex heat engines, incorporating two Class 2 heat engines and a Reverse Class 2 heat engine.

3.7 Convection current loops

These are complex heat engines incorporating Class 2 heat engines, reverse engines and the second law of thermodynamics.

Here is a night-time coastal example, with the ground level wind blowing in the opposite direction during the day.

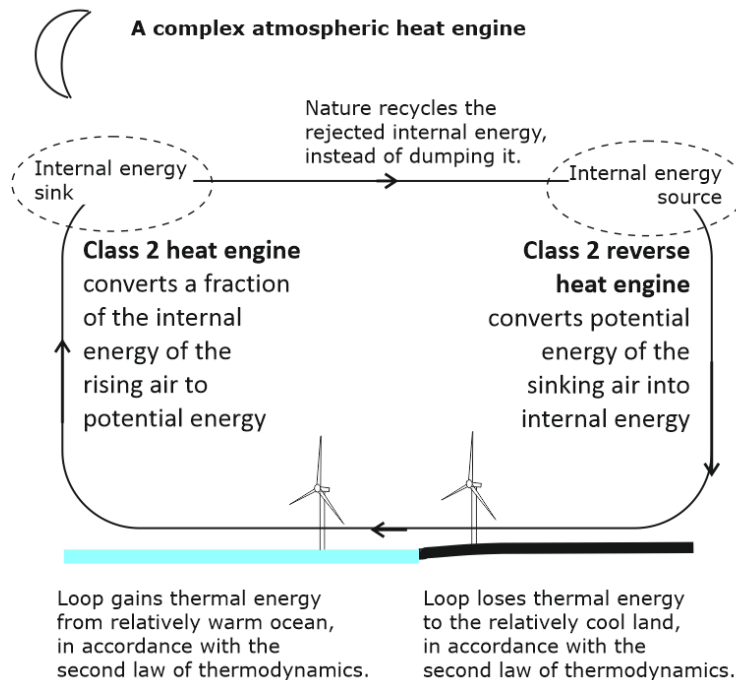


Figure 14. The two wind turbines are tapping into atmospheric thermal energy, but they have severe limitations.

They rely on the temperamental wind; they are large, expensive, commonly disliked by local inhabitants and usually at distance from where the electricity is required.

4 Closed loop Class 2y engines

On the writers Cheshire Innovation website (www.cheshire-innovation.com), manufactured closed loop Class 2 heat engines are referred to as a '*Latent Power (LP) Turbines*'.

They incorporate the following design features:

- (i) They generate electricity using small 'canned' wind turbines.
- (ii) The turbine is located at the throat of a converging-diverging bare metal pipe.
- (ii) A fan is used to force the internal air to circulate.

4.1 The basic Latent Power Turbine design

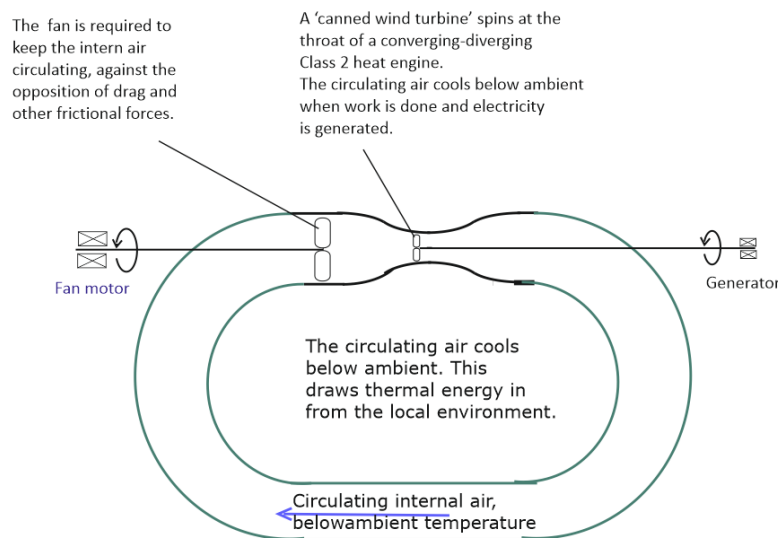


Figure 15. The Latent Power Turbine produces a net output of electricity. As a consequence, the circulating air cools to below ambient temperature, and replacement thermal energy is drawn in through the bare metal pipe walls.

There are three options for the type of turbine used.

It can employ aerodynamic lift, rely on momentum transfer or combine both principles.

For an aerodynamic lift turbine, the main purpose of the fan is to overcome drag and other friction forces.

For momentum transfer blades, the fan also has to restore the kinetic energy of the air, after it has passed through the turbine. By locating the turbine at the throat of a converging-diverging pipe, with a constriction ratio of n , the power output from the turbine is linked to the power input to the fan by

$$\text{Output} = \text{Input} \times (n^2 - 1)$$

(The kinetic energy of the air is proportional to the square of its speed.)

4.2 Compact Latent Power Turbine designs

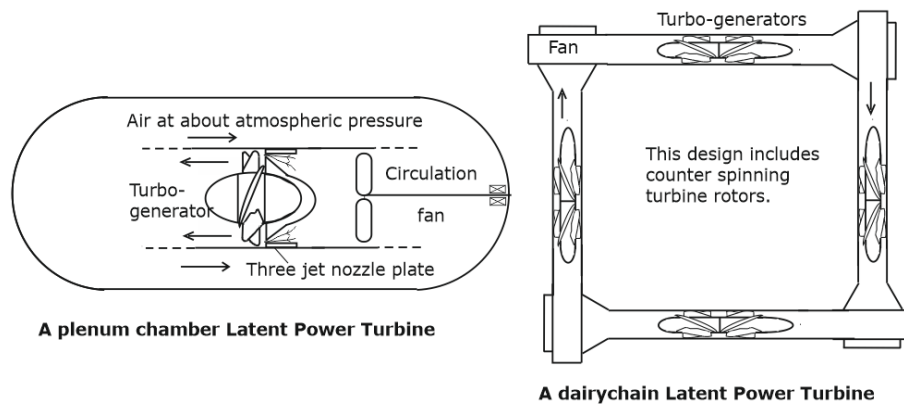


Figure 16. These are just two of the many variations on the Latent Power Turbine concept that are possible.

All designs running on thermal energy extracted from ambient temperature air produce three outputs: electricity, cooled air and condensation.

In cool weather, the condensation can turn to ice on the metal surfaces. Heat pumps have been experiencing this icing-up problem for many years and a number of solutions have been developed.

4.3 Avoiding icing-up problems

Here is one solution to the icing-up problem. It can be adapted for LP Turbines running on thermal energy extracted from cool atmospheric air, fresh water or seawater.

In this basic design, the roles of *thermal energy capture* and *the conversion of thermal energy into electricity* are separated out. In addition, a very basic thermal energy capture chamber is used.

When operating in air, this ice scraper peels off the ice at the lowest point in the cycle. When operating in water, the scraper and heating element are repositioned, so that ice is peeled off at the highest point in the cycle.

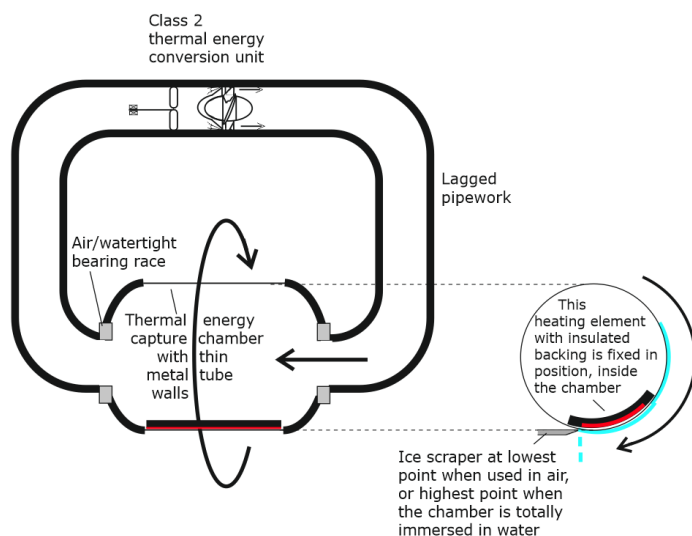


Figure 17. The ice is scraped off the rotating metal tube, after electric heating has weakened its adhesive bond with the metal.

Variations on this design include fitting the hemispherical ends to the chamber with heating elements and scrapers, and inserting the thermal energy conversion unit inside the rotating chamber.

4.4 The Kelvin-Planck statement of the second law of thermodynamics

This states that, 'It is impossible for any device that operates on a thermodynamic cycle to receive heat from a single thermal reservoir and produce a net amount of work without rejecting some waste heat to a lower-temperature reservoir.'

This statement remains true for all Class 1 heat engines that receive thermodynamically defined *heat* from a heat source. However, it does not apply to Class 2 heat engines, because they receive *internal energy* from an internal energy source.

Consequently, the Kelvin-Planck statement of the second law of thermodynamics is of limited practical value, because most heat engines are Class 2 heat engines. Nevertheless, the statement is important, because it has been leading scientists and engineers astray since the early 1850s.

5 A selection of Latent Power Turbine applications

Further details of these and other applications are available on the Cheshire Innovation website, www.cheshire-innovation.com

5.1 Low cost, pollution free energy

LP Turbines can run on thermal energy extracted from

- (i) The air around us,
- (ii) Shallow ground,
- (iii) The ocean,
- (iv) Industrial cooling processes.

LP Turbines are very benign. No high temperatures, high pressures, toxic chemicals or expensive construction materials are required.

Depending on their size, power output can vary between several kW and several MW. Ideally, all buildings that consume more than a few kilowatts of electricity will be fitted with their own LP Turbine.

Ideally, local networks of LP Turbines will pool their electricity to ensure energy security and provide 'free' off-peak electricity for energy-hungry processes, such as splitting water into hydrogen and oxygen.

LP Turbines are analogous to heat pumps, in that they can both run off thermal energy extracted from cold winter atmospheric air.

Here is a comparison between them.

- LP Turbines will be far more versatile, meeting all the heating and other energy needs for a household or business.
- Consequently, in cool weather, they will need to extract approximately twice as much thermal energy from their environment.
- Domestic LP Turbines will be bulkier than heat pumps, but most of the interior space will be occupied by circulating air, so they will weigh about the same.

- Their outer casing can be made from aluminium alloy or thin gauge steel, as for car bodies.
- LP Turbine purchase and installation will be price competitive with heat pumps, but there will be different add-on costs. For example, most LP Turbine will be sheltered inside a well ventilated out box.
- Their working life should be similar to that of a heat pump, and servicing costs similar.
- Other than servicing costs (and taxes), there will be no running costs.
- The saving on energy bills will allow them to pay for themselves far more quickly than heat pumps and lead to a boom in the national economy.

However, to avoid energy apartheid in regions with well-established electricity grid systems, it is likely that the government will eventually have to step in and nationalise the electricity supply system.

5.2 Boosting the economy by reducing energy costs

Energy costs should be far lower than they are today, but precise figures will be dependent on government taxes.

The following table was compiled using Google's AI assistant.

Sector		Energy as a % of total costs
Industry	AI and cloud centres operating costs	40-60%
	House building	4-14%
	Steel production	15-40%
	Glass production	14%
	Overall manufacturing	5-20%
	Defence	2-5%
Transport	Road transport	20-40%
	Rail transport	5-15%
	Air transport	31%
	Marine transport	Up to 50%
Agriculture	Food production	10-15%
	glasshouse horticulture	10-35%
	Vertical farming	50-60%
Health and home	National Health Service	4-8%
	Social care	6-12%
	School education	3%
	Full cost of bringing up a child	18-20%
Goods and service delivery	In person sale of goods and services	4-9%
	Online sale of goods and services	1-3%
	Hospitality and catering	4-6%
	Running a bed & breakfast business	8-15%
	Running a cinema complex	15-20%
	Running a television company	1-5%

5.3 An international strategy for building LP Turbines quickly and at minimal cost

A basic range of (say) five or six LP Turbine designs should be internationally agreed and their component parts standardised. This will allow the equipment for making LP Turbines to be mass-produced, bring down the cost of establishing LP Turbine manufacturing businesses.

5.4 'Free' indoor air-cooling

LP Turbines running on atmospheric air produce three outputs, electricity, cooled air and some fresh water condensation. The cooled air can provide an invigorating alternative to traditional air conditioning.

(Air conditioning units cool recycled air within sealed rooms. Consequently, there is a gradual build up of carbon dioxide levels from exhaled breath. This can impair cognitive functioning and induce drowsiness.)

For maximum LP Turbine health benefits, pollen would be filtered out of the incoming air, and atmospheric pollution would be minimised by cleaning the air in the local environment.

5.5 AI and cloud storage centres

Older centres use up to 40% of their energy for cooling, with new centres reducing this to around 7%, but at the cost of evaporating water to produce cooling instead.

LP Turbines will slash energy costs without evaporating water, because they will run on a combination of low-grade waste heat, and additional thermal energy extracted from their environment.

This will allow massive AI and cloud storage centres to be built anywhere on Earth, without affecting electricity or water supplies.

5.6 Creating a hydrogen economy

On weekdays, peak electricity demand is approximately twice as high as during off-peak periods.

Consequently, a nation that uses LP Turbines to meet its peak electricity needs will be able to produce a massive surplus of electricity during off-peak periods. A large proportion of this surplus could be used for splitting water into oxygen and hydrogen.

The hydrogen would find uses as a transport fuel and as a chemical feedstock.

TRANSPORT

5.7 Aviation

Hydrogen could be used to power either jet or propeller systems.

Propeller drive will probably be favoured, because it offers the greatest range for a given load of hydrogen.

The following LP Turbine will convert the energy stored in hydrogen into electricity far more efficiently than a fuel cell or internal combustion engine.

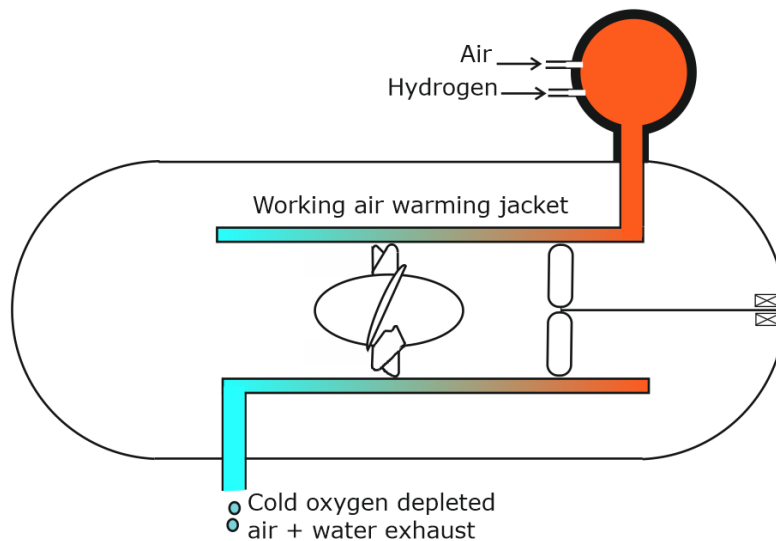


Figure 18. This LP Turbine runs on thermal energy produced by burning hydrogen. The only thermal energy wasted is the internal energy stored in the cold exhaust.

Very low temperature (-260°C) running LP Turbines could be immersed in the liquid hydrogen tanks and used to keep the fuel at cryogenic temperatures, both in the air and on the ground.

5.8 Road vehicles

A range of choices will become available.

Battery power: LP Turbines can provide green electricity for use at the charging point sites.

Battery + LP Turbine power: The vehicle would run on a combination of battery and LP Turbine power, with the LP Turbine continuing to run when the vehicle is stationary or parked, to recharge the battery.

Hydrogen power: The hydrogen can be produced locally, using surplus electricity from LP Turbines in the neighbourhood.

Hydrogen supplemented by atmospheric thermal energy:

In warm weather, thermal energy extracted from the atmosphere could supplement the thermal energy produced by burning hydrogen.

Minimising disruption for the carmakers and their employees

There is likely to be a period of poor car sales, while the manufacturers and customers adapt to the new choices for powering road vehicles. Meanwhile, there is likely to be a sudden rush to buy LP Turbines, followed by a drop in demand, as the majority of market needs are satisfied.

These problems could partially cancel each other out, if the carmakers temporarily moved over to LP Turbine production, while they develop their new vehicle designs.

However, the carmakers will be keen to produce LP Turbines at a faster rate than they can be installed on private premises

To avoid this bottleneck, the LP Turbines could be temporarily homed on fossil and nuclear fuel power station sites. They would run on the waste heat produced by burning fossil or nuclear fuels. Ideally, their temporary homes would take the form of horticultural glasshouses that could capture additional solar energy in summer.

5.9 Railways: Doubling their capacity, without building new lines

Onboard LP Turbines would allow electromagnetic forces to be used for both acceleration and braking. This would allow the capacity of the network to be (at least) doubled, without adding any new tracks or overhead power lines. For details visit www.cheshire-innovation.com. [Article title, The threat to railways from self-driving cars'.]

5.10 Shipping

Marine LP Turbines can run on thermal energy extract from the surrounding air or water. Thermal energy extracted from seawater will produce freeze-desalinated fresh water as a side product.

FOOD PRODUCTION

5.11 Manufacturing nitrogen fertiliser

Nitrogen fertiliser production requires large amounts of energy, with Russia and China being the world's largest exporters. This is a major problem for global food security and market stability. However, all nations could achieve nitrogen fertiliser self-sufficiency in an LP turbine era.

Cheap electricity could be used for Green Ammonia production via water electrolysis, paired with the Haber-Bosch process for large-scale operations, or Plasma-Activated Water (PAW) for on-farm, decentralised production.

5.12 Power generating horticultural glasshouses

Glasshouses traditionally protect crops from harsh weather conditions and insect pests.

LP Turbines will increase their benefits while reducing the disadvantages.

For example, in warm weather, the humid interior air can be continuously replaced by cooler atmospheric air. However, before releasing the stale air into the environment, it would flow over an LP Turbine, releasing the moisture and generating electricity.

5.13 Vertical farms

In vertical farm, crops grow vertically, in stacked layers inside controlled indoor environments rather than using open fields. They are extremely compact, allowing crops to grow in city locations.

Unfortunately, they are very expensive to run because they need heat to keep the crops warm, but air conditioning to remove the humid air. The conversion of electrical energy into biomass or sugar is also low, with around 97% of the electrical energy ending up as low-grade heat.

However, LP Turbines can run on this waste heat, supplemented by additional thermal energy extracted from the local environment.

In common with other forms of indoor farming, today's vertical farms incur higher labour costs than traditional outdoor farming. Consequently, all of the indoor farming suggestions made in this article will have to wait until automation replaces most of the human labour, before they become attractive to investors.

On the other hand, all form of indoor farming are likely to become more attractive if the world's weather deteriorates, due to climate change.

5.14 Stepped flats

Vertical farms can be combined with multi-story flats to create communities that are self-sufficient in many fruits and vegetables.

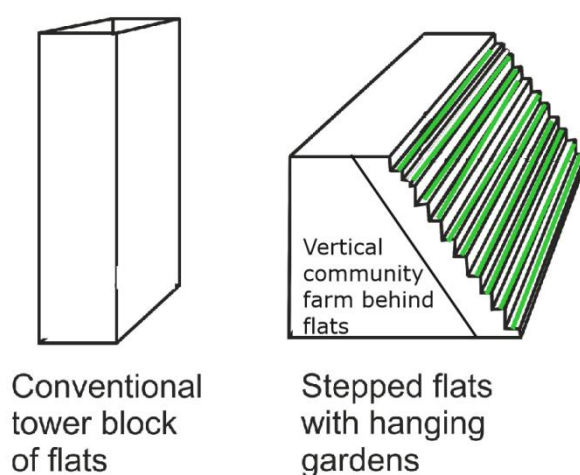


Figure 19. Stepped flats will be more expensive to build than traditional high-rise flats, but they will be better for mental and physical health, because they will create communities, rather than simply providing accommodation.

5.15 Cell culture replacements for farm animals

Several companies are currently developing cell culture alternatives to milk and meat production using farm animals.

However, cell culture in vats introduces new challenges that do not affect farming animals. Thus, the fermentation process produces metabolic heat that has to be removed, to prevent overheating, and the manufacturing process is expensive because of the large amounts of energy required for making hydrogen, to provide bacteria nutrient.

LP Turbines can help to reduce costs in several different ways. They can regulate the vat temperature by converting metabolic heat into electricity. This electricity can be supplemented with additional off-peak electricity from the local LP Turbine micro-grid, to split water, to produce hydrogen.

IMPROVING FRESH WATER SECURITY

5.16 Harvesting water from atmospheric air

For water harvesting purposes, atmospheric air can be considered as a mixture of dry air (mainly nitrogen and oxygen) plus a small amount of water vapour.

LP Turbines can only start to condense out water vapour once it the air has been cooled to its dew point, and the water vapour has become saturated.

The output of condensation can be maximised by using a heat exchanger that re-warms the air leaving the LP Turbine, while pre-cooling the atmospheric air before it enters the LP Turbine.

5.17 Reverse osmosis (RO) desalination

Energy costs typically make up 30% to 50% of the running costs for an RO desalination plant. Around 99% of these plants rely on burning fossil fuels to produce their electricity, because RO requires continuous, steady-pressure operation.

LP turbines would produce a similar steady output of electricity, while saving on the cost of buying fossil fuels.

5.18 LP Turbine based methods of desalination

New techniques that combine power generation and evaporative water distillation are described at www.cheshire-innovation.com.

5.19 Freeze-desalination of sweater

LP Turbines running on thermal energy extracted from cold seawater will produce freshwater ice as a side product.

Among other uses, this will provide 'free' ice cooling for perishable seafood products in storage and in transit in warm climates.

One commercially attractive option would be to use a freeze-desalination plant to power a reverse osmosis desalination plant.

REVERSING CLIMATE CHANGE

5.20 Cryogenic carbon capture

By using LP Turbines to cool atmospheric air to around -140°C, both carbon dioxide and fresh water can be harvested from the air.

The bitterly cold carbon dioxide and water vapour depleted air could be passed through a heat exchanger, to re-warm it, before it re-enters the atmosphere.

This cryogenic approach would make carbon capture a commercially viable green process, because it would generate electricity and produce a useful amount of fresh water.

5.21 Burning municipal waste in pure oxygen

Atmospheric air is a mechanical mixture of gases dominated by nitrogen (78.08%) and oxygen (20.95%).

When burning municipal waste in air, the relatively low fraction of oxygen is both a disadvantage and an advantage. For carbon capture purposes, it is a disadvantage because the carbon dioxide produced by combustion is diluted by the presence of the nitrogen. On the other hand, the nitrogen also has to warm to the combustion temperature, ensuring that the combustion chamber and other solid parts of the system do not overheat.

In an LP Turbine era, the splitting of water to produce hydrogen will generate oxygen as a side-product.

Municipal waste could be burned in this oxygen to produce a steady stream of carbon dioxide and water vapour.

LP Turbines could be used to cool the flue gases and condense out the water content.

Approximately 80% of the chilled carbon dioxide would be fed back into the combustion chamber, to keep the combustion temperature down and prevent overheating.

When municipal waste is burned in air, the flue gases require extensive treatment before they are pumped into the atmosphere. Flue gases produced by the proposed system would require a similar on-site treatment, to prevent acidic impurities corroding the flue gas transport pipelines.

5.22 Carbon recycling

Converting captured carbon dioxide into useful products is technically possible, but breaking the CO₂ molecules apart and then recombining them with hydrogen to make hydrocarbon chemicals is very energy intensive.

However, when combined with cryogenic carbon capture, it could become commercially viable.

5.23 Oil substitutes for chemical feedstock use

Approximately 20% of oil is used as a chemical feedstock in the manufacturing of plastics, paints, drugs, fertilisers and other products. Synthetic replacements for oil are already available but expensive. They will become commercially competitive if the energy component of their production is significantly reduced.

5.24 An ethical solution to the irregular migration problem

Current solutions rely on 'keeping the migrants out.'

A new solution based on LP Turbines, AI and smartphones, could offer a better deal for everybody.



Figure 20. According to extreme right-wing belief, these people are ‘Invading parasites’.

However, economic history suggests a more positive model. These people are willing to take great risks in the hope of achieving a long-term reward. This is similar to the risk-taking mindset of the entrepreneurs, who exploited new technology, to launch the industrial revolution.

LP Turbines, along with AI and smartphones are among the new technologies that could start an industrial revolution in the developing world.

Therefore, instead of putting all of our efforts into keeping the migrants out, we should encourage them to stay at home and become micro-entrepreneurs in this new industrial revolution.

Britain and other European countries need to think imaginatively, about how they can stimulate this ‘stay at home and prosper’ mentality.

Ideally, the cost of buying an LP Turbine plus the equipment to start a small business needs to be competitive with the total cost of migrating to a new country.

If there is a sudden boom in business enterprise, business equipment theft could become a serious problem that hampers growth. Proposals for an international scheme to minimise equipment theft are made at www.cheshire-innovation.com. [Article title, ‘*The boat people: Give them hope, not hotel accommodation*’.]

The two primary causes of irregular migration are conflict and poverty. Fortunately, LP turbines can help in reducing both of them.

Conflict

- (i) A large fraction of the world’s military conflicts are funded by the sale of fossil fuels.
 - (ii) Fossil fuel ownership rights are also a source of conflict.
 - (iii) Tribal, ethnic, and religious conflicts are often aggravated by food and water shortages.
- Thus, by replacing fossil fuels with LP Turbines, and using them to improve food and water security, many conflicts will be avoided.

Poverty

Data from the Mixed Migration Centre shows that roughly, 50% to 70% of irregular migrants are fleeing poverty. Their research also suggests that 43% of the migrants acquire a smartphone before leaving home, with those coming from better-educated backgrounds having the highest level of ownership.

So, as soon as LP Turbines come onto the market in the advanced world, social media should be used to start a conversation about using LP Turbines in the developing world.

6 The historical cost of failing to recognise Class 2 heat engines

6.1 The missed 1860 opportunity

Around 1850, scientists fell into the trap of belief that all heat engines rely on a temperature difference and must therefore obey the second law of thermodynamics. This was surprising because the steam engines of the time relied on a pressure difference, and did not need to obey the second law of thermodynamics.

However, even if the 1850 scientists had realised their mistake, we would still have had to wait until 1860, for the arrival of modern electric motors and dynamos, for the conversion of atmospheric thermal energy into electricity to become a reality.

Thus from around 1860, industrial expansion could have been powered by cheap clean electricity, instead of coal.

6.2 The heat engine mistake and colonial expansion

By 1914, European countries had colonised 84% of the Earth's land, with the biggest surge in colonial expansion taking place during the age of *New Imperialism* after 1870.

This land-grab was supported by a moral argument known as *climate and environmental determinism*.

Thus, writers such as Immanuel Kant and Friedrich List argued that the intense heat in the tropics directly degraded human physiology and morality. Consequently, the inhabitants were naturally lazy and incapable of making technical progress. Therefore, the Europeans needed to take the natural resources from the tropics, turn them into finished goods in Europe, and then sell them back to the people in the tropics.

By 1899 this 'noble task' was referred to as 'The White Man's Burden'

The two economic drivers behind New Imperialism were the need for raw materials for European industries, and the need for captive overseas markets where the manufactured goods could be sold.

However, New Imperialism is unlikely to have happened, if heat engines powered by atmospheric thermal energy had replaced steam power.

Steam based industrialisation was concentrated in Europe (including Britain) and North East America. These regions had abundant coal reserves, access to finance and mild temperatures that allowed mechanical machines to run smoothly.

Countries nearer to the equator possessed many natural resources, but they lacked coal, and the high temperatures caused problems for both workers and factory machines.

This made them vulnerable to colonisation by the Europeans, who were seeking both raw materials and captive product markets.

However, many countries in the tropics rejected the 'White man's burden' argument and tried to oppose colonisation by implementing '*defensive modernisation*'. These countries included Siam, Egypt, Ethiopia, Madagascar, Zanzibar, the Asante Empire (West Africa), and the Ottoman Empire.

Ultimately, *defensive modernisation* failed for a combination of technical, financial and political reasons.

However, there is a strong chance that colonialism would have been replaced by international business partnerships, if atmospheric heat engines had been available.

Atmospheric heat engines such as LP Turbines produce three outputs: electricity, cooled air and condensation.

- (i) Electricity would have allowed machines to run in tropical climates, without burning coal.
- (ii) The cooled air output would have provided a fresh air alternative to indoor air conditioning. This would have kept the workers cool, allowing them to work more productively.
- (iii) In addition, lower temperatures would have allowed industrial machinery to operate as reliably as in the temperate zones.
- (iv) The condensation would have provided a safe supply of drinking water.

The transition from low-density rural living to high-density urban living would have posed many new problems such as a lack of dung and firewood for cooking and higher levels of food wastage in the long supply line from the farm to the plate.

One way or another, LP Turbines could have eased these problems, for example, using electricity for cooking food in bulk and making ice, for keeping food cool.

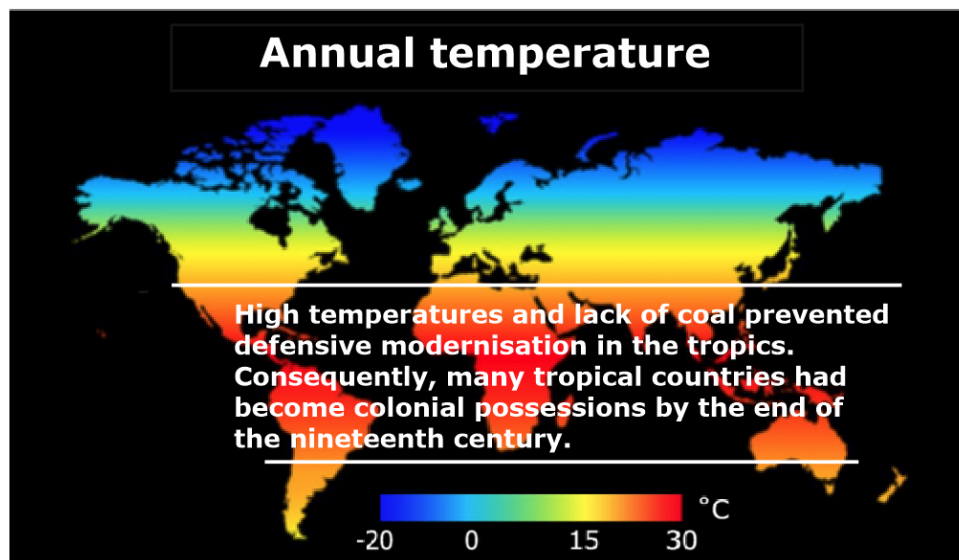


Figure 21. The lack of coal for steam engines, metal corrosion and lubricant instability at tropical temperatures, all conspired to discourage industrialisation in the tropics.

However, if electricity had replaced steam power and chilled air had kept the machinery cool, production parity with the temperate regions could have been achieved.

The industrialisation of the tropics would have threatened European manufacturing, but low cost energy would have allowed the Europeans to prosper in many new ways, including developing thriving service industries.

6.3 How the heat engine mistake blighted the twentieth century

The failure to develop Class 2 heat engines that run on atmospheric thermal energy probably kept the developing world in poverty for 100 years longer than necessary. The imperial powers suffered less hunger, but they paid for the mistake in other ways.

France, Germany and Belgium all acquired new empires after 1870, with the British, Russians and Austro-Hungarians adding significantly to their existing empires.

In the course of acquiring these empires, national armaments industries expanded, national pride evolved into jingoism and fateful alliances were made.

All this resulted in the clash of the imperial powers that became the First World War.

Without the First World War, there would have been no Second World War, no Holocaust and little incentive to invent the atom bomb.

Then, along came climate change.

Moreover, all of this happened because scientists failed to recognise that there are two types of heat engine.