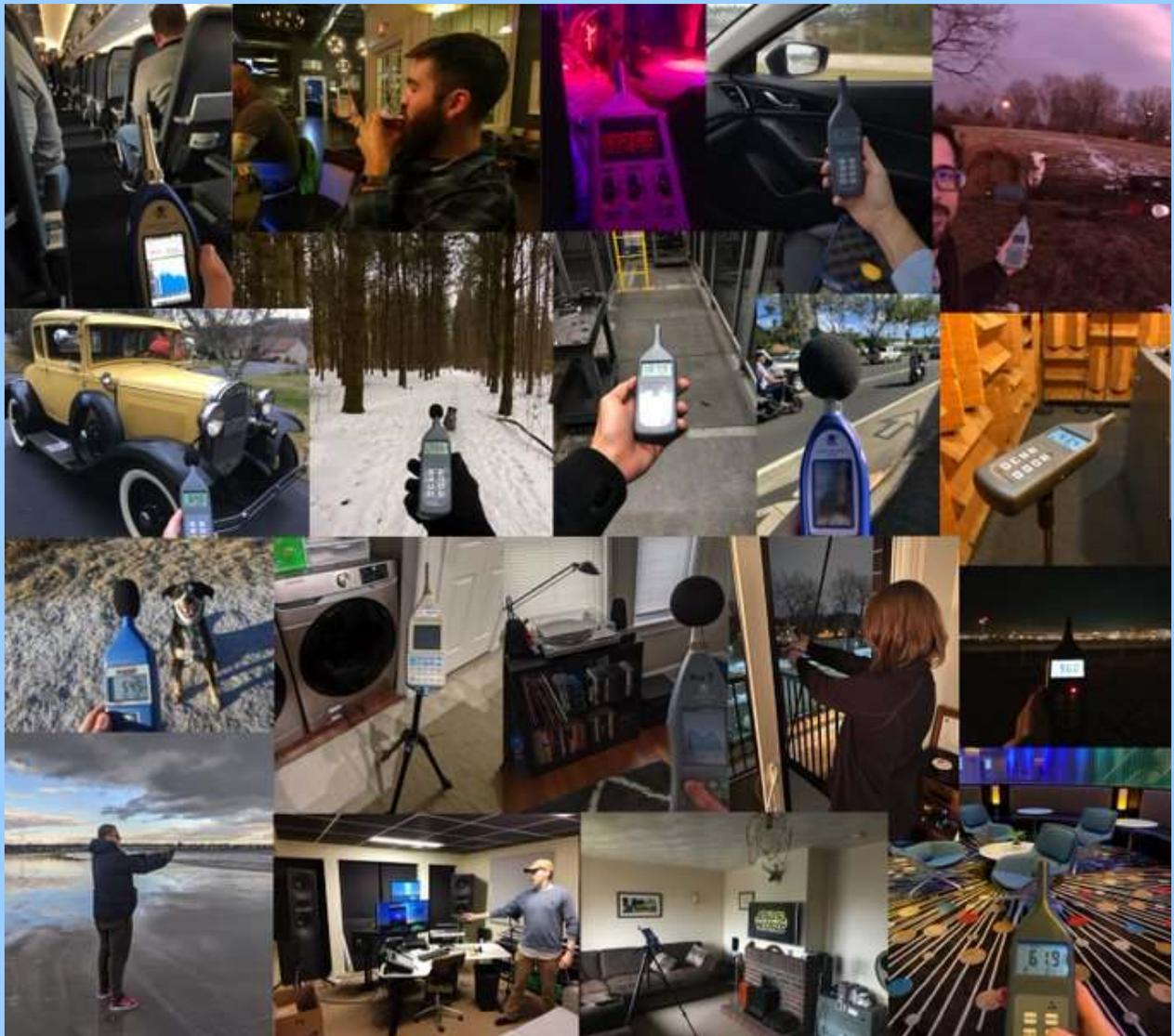


The Case for a Noise Audit



Calling for a noise audit of
all **energy** and **transport** plans

Written by John Stewart

John Stewart has been active in the fields of transport and noise for over 35 years. He is the main author of *Why Noise Matters* (Earthscan 2011). He currently campaigns on aircraft noise issues. He chairs the UK Noise Association and is a member of the EU's Noise Expert Panel.

Why a Noise Audit?

Technology is changing. A lot of it is driven by the need to deal with climate change. That certainly needs doing. But there is a real danger that it may be done at the expense of noise. We could end up with emissions under control but noise levels higher than ever. To prevent this, we argue a noise audit is required of all the technology on offer.

We have concentrated on energy and transport because these are the areas where the conflict between emissions and noise is most likely to occur. This publication is neither very long nor especially technical. Its purpose is to act as an early-warning system before too many decisions are set in stone. It also, though, explores solutions, highlighting policies which could deal with both climate and noise but also outlining the areas where difficult choices will need to be made.

Noise Matters

Across the world more people are disturbed by noise on a daily basis than by any other pollutant (1).

It may be surprising fact. Noise regularly tops the list of complaints in Rio de Janeiro (1). And Rio is not untypical. In Europe hundreds of millions are exposed daily to noise levels which the World Health Organisation (WHO) regards as unacceptable (2). The most recent statistics from the UK Government reveal that, although 72% of respondents had a positive attitude to their local noise environment, 48% of people feel their home life is spoilt to some extent by noise (3).

In the UK:

5 million people are significantly impacted by road traffic noise;

7 million by neighbour noise;

2.5 million by aircraft noise.

That is not to say that all these people are disturbed by the noise. We can be *impacted* by noise but not *disturbed* by it. The German psychologist and noise expert Rainer Guski estimates that, typically, 10% of people are particularly noise sensitive (4). As we will show in the wind farm section, that percentage can rise when there are high levels of low-frequency noise present. And the fact that almost half of people in the UK feel their home life is spoilt to some extent by noise indicates that, while only a minority may be *disturbed* by noise, a lot of people can be *annoyed* or *bothered* by it.

Health Impacts

Noise can affect people's health but we must be transparent about the way we use the statistics.

There is always a temptation in all fields to use figures to over-dramatise a case. I'm wary, for example, of stats like "1 million healthy life years are lost each year as a result of traffic-related noise." This is talking about premature death and often includes a lot of older people dying as little as six months before they otherwise would. As someone not in their first flush youth, I can confidently say that is not what we want to happen! But equally it is misleading to suggest it has the same impact as, say fatal road crashes, where so often it is the young and the middle-aged who are killed. Nevertheless, as the World Health Organisation has shown, noise can impact people's physical and mental health (5). Just as the human digestive system can be overwhelmed by the sugar and calories packed into contemporary diets, noise pollution experts say the human brain and nervous system can be overwhelmed by the amount of ambient noise packed into contemporary life. There is increasing evidence that ambient-noise exposure can contribute to metabolic disorders like type 2 diabetes, high blood pressure, heart disease and strokes as well as poorer mental health (5).

Noise and Energy



Five areas are looked at:

Page 5: The answer is (not always) blowing in the wind

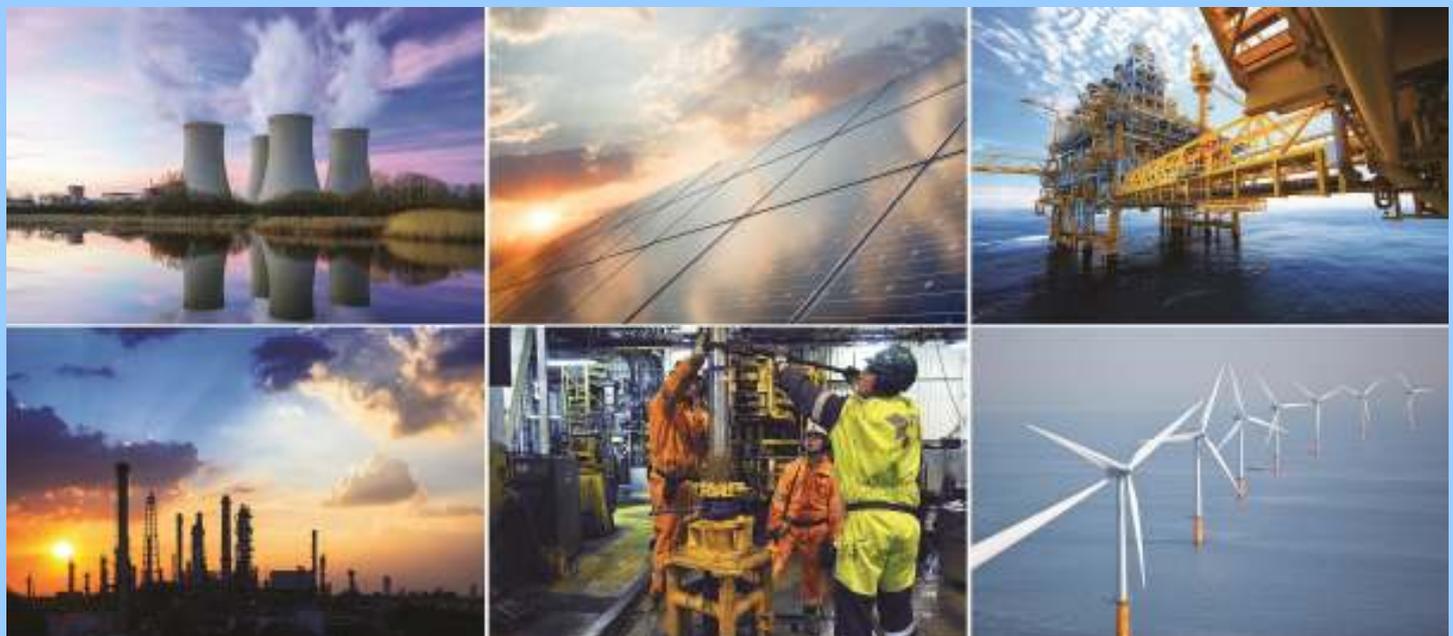
Page 6: So how quiet is solar?

Page 7: Oh! For some fracking clarity!

Page 8: Whisper it, nuclear could be the silent solution

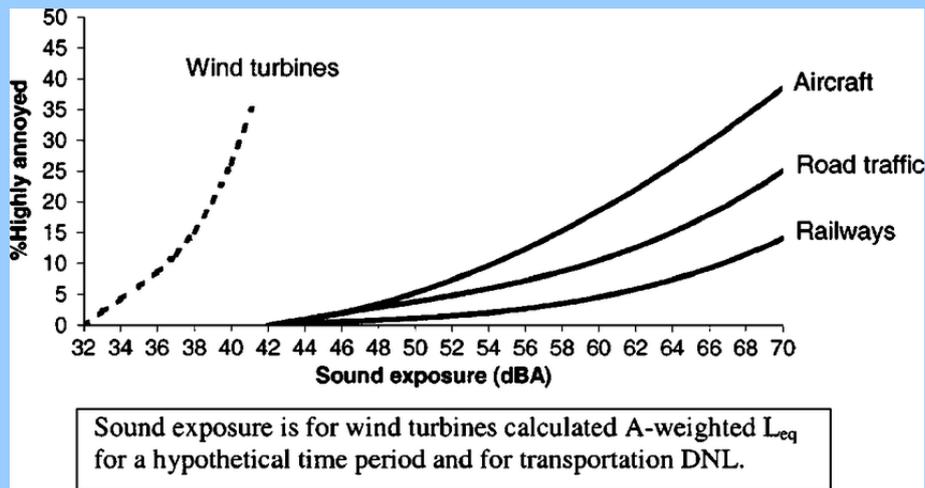
Page 9: The heat pump revolution...that sends shivers down the spine

We don't look at other energy sources but they should be included in any audit.



The answer is (not always) blowing in the wind

Wind turbines create noise problems. It is a fact which should never have been in dispute. It only ever was because a rapacious wind power industry, often buoyed by generous subsidies, claimed there was no problem. There is no point mincing our words. It was a lie. The World Health Organisation in its latest report (2) has shown quite convincingly that wind turbines cause noise problems. In fact people start to get annoyed at lower levels by wind turbine noise than by any other noise. This is due in part to the high level of low-frequency in wind turbine noise.



This World Health Organisation chart shows that people get highly annoyed by noise from wind turbines at lower levels than other noise sources, due in part to its high level of low-frequency noise

As early as 2006 I wrote in *Location, Location, Location* (6) about the serious impact wind turbine noise was having on some people. The industry has reluctantly admitted there may be noise problems and is talking about mitigation measures or offering people money who live beside turbines. And some governments are now insisting that turbines can only be built within so many miles from the nearest residential property. Distance can deal with the noise but not always. Low-frequency noise can travel further and can penetrate buildings.

Some years ago I met with Lord Whitty when he was the minister responsible for noise. He was deeply sympathetic about the issue but raised his eyebrows when I mentioned wind farms. Like many people he thought they were quiet. Not so. Here's how the experienced Swedish researcher Eja Pedersen puts it: "Wind turbine noise was more annoying than transportation noise or industrial noise at comparable levels, possibly due to specific sound properties such as a 'swishing' quality, temporal variability, and lack of night-time abatement" (7). Other researchers go further and argue that wind turbines have unique low-frequency properties which can destabilize the body.

Off-shore wind-turbines clearly have less impact on people. However, it may not be negligible given the distance low-frequency noise can travel. The research into their impact on fish and mammals is still quite limited.

We haven't touched on the other controversies surrounding wind turbines – their impact on local landscapes; how much land they occupy; the subsidies they have received; whether, given some of the materials used in their construction, they save as much CO₂ as is claimed. All these considerations needed to be factored when assessing any proposals for wind farms. As does noise. No comprehensive noise audit of wind has been done. It is urgent that one is carried out.

So how quiet is solar?

Solar energy can be created in two basic ways: either in a solar farm or from solar panels on the roof of a property.

We consider the noise from solar farms first.

The noise comes from the inverters and the transformer. A key study (8) found that the average noise at 10ft from the inverter face ranged from 48 decibels to 72 decibels. At 150ft the study showed that typically the noise didn't exceed background levels. Generally, there was a reduction of 6 decibels with a doubling of distance. This means that noise from solar farms is only heard close to the farm. It takes the form of a hum. The report explains: "The high frequency peaks produce the characteristic 'ringing noise' or high frequency buzz heard when one stands close to an operating inverter. The tonal sound was not, however, audible at distances of 50 to 150 feet beyond the boundary. All low-frequency sound from the inverters below 40 Hz is inaudible, at all distances". The available evidence, therefore, suggests, as long as solar farms are not sited within a few hundred feet of a property noise should not be a problem.



What about noise from rooftop panels?



There is less unanimity about the noise from rooftop panels. What is agreed is that inverters will make a humming noise while converting energy. And that could create a noise nuisance in a person's home. One resident said: "A solar system was installed in April. A few weeks later, we started noticing a hum noise inside the house. It is more noticeable inside the house (as opposed to outside). The loudness of

the hum is approximately the same in each room, upstairs and downstairs, as well as in the garage". That reaction may not be typical as solar panels have not generated the level of protest which noise from wind turbines have. What is clear, though, is that in rented properties where tenants have little control over the siting of inverters or in blocks of flats where the panels may belong to somebody else there could be problems. **The noise problems created by solar are less than wind but a noise audit is needed so is clear just how much of a noise advantage solar has over wind.**

Fracking

Oh! For some fracking clarity!

Fracking is not a renewable source of energy but we have included it for two reasons: it is regarded by some people as a useful transition between coal and renewables; and its noise impact is hotly disputed. If there is any area where an independent noise audit is required, it is fracking. There is no argument that fracking causes noise. The dispute is around the extent it can be mitigated.



Because fracking has generated so much controversy it has been hard to pinpoint the level of noise it generates and whether it can be mitigated

There are two distinct phases when the noise occurs. During the initial drilling of the wells there is a continual loud noise for four or five weeks. When operational, the gas compressor stations produce a low rumble. Some noise experts argue that, once a site has been established, it would not cause problems if solid planning safeguards are in place. They point to oil and gas drilling activities that have been taking place in the UK for many years with minimal noise impact. Other experts argue that noise

from the site could continue to be a problem. There is also the separate problem that heavy lorries serving a site could be disturbing.



The fracking revolution in America has certainly caused some severe noise problems. But it was a bit like the gold rush all over again. Minimal rules and regulations meant that exposed fracking sites were in some cases sited very close to people's homes causing real noise problems. But the conditions

set out in the UK are much tighter than those which existed during America's rush to crack.

It is difficult for the layperson to understand whether a properly managed site can be acceptable in noise terms. Fracking has generated such fury from climate activists and an equally strong defence from the industry that hard facts have been difficult to come by. The activists would not be willing to tolerate fracking under any circumstances. But from a purely noise perspective it would be interesting to know whether a well-managed fracking site, once up and running, would generate less noise than, say, badly-sited wind turbines. **Only a noise audit would tell us that.**

Nuclear

Whisper it, nuclear could be the silent solution

In noise terms, nuclear wins hands down – over wind, fracking and solar. It has been described as “the silent giant of today’s energy system.” There is not much more to say about its noise impacts. However, it has been a controversial source of energy so it is worth exploring other aspects of nuclear.

Isn’t n-n-nuclear too dangerous, too creepy?

Well, no, argues Goldstein &

Qvist (9): “It’s thousands of times safer than coal, which kills hundreds of thousands of people each year. Actually, nuclear power is the safest form of energy ever used, in terms of deaths per unit of energy. Nuclear also generates far less waste than other energy sources, including renewables. The spent fuel from a lifetime of electricity use by an average American generated entirely from nuclear power would fit in a soda can. Someday we’ll bury it, but for now the waste can be left safely in its dry casks, certified for a hundred years, while we attend to bigger issues like saving the planet”.

Too expensive? Goldstein & Qvist again: “Existing U.S. nuclear plants, which generate one-fifth of the nation’s electricity, produce less expensive power than either coal or gas. In South Korea, electricity from nuclear power costs less than 4 cents/kWh, which is cheaper than that from any other source. The key to replicating South Korea’s low costs is to focus on repeatedly building a standardized design, which brings costs down to \$2 billion per gigawatt. That’s about double the capital cost of a U.S. natural gas power plant, but half that of a U.S. coal plant and less than half of wind and solar power facilities with equivalent production. The problem in North America and Europe is that older nuclear plants cost much less than new ones, even though we have better technologies today. The latest U.S. attempts to build nuclear power escalated to \$12 billion per gigawatt. But then unlike South Korea, the United States has gone decades without practice. Both Sweden and France have powered growing economies for decades on cheap nuclear power. Both transitioned off fossil electricity in less than 20 years. There is no reason the world can’t do the same now”.

And how would it deal with climate emissions? According to the environmentalist Mark Lynas, it is essential (10): “Nuclear is an essential if we are to deal with climate change. Renewables are a crucial part of our toolkit, but not enough on their own. The battle of the energy titans comes down to one great contest: nuclear vs. coal”. Goldstein & Qvist agree: “Based on our analysis of many countries’ experiences, what might take a century to do with renewables alone could be done in 20 years with nuclear power”.

Nuclear won’t sort out climate change by itself but climate won’t be sorted without nuclear. And it will do so silently.



Small nuclear reactors look like being the future

Heat Pumps

The revolution...that sends shivers down the spine



Fossil fuel heating systems - oil and gas boilers - will not be allowed in new homes in the UK from 2025. Their main replacement is likely to be heat pumps. These are like air conditioners which pump out heat. And most of them are situated outside. There are significant noise concerns.

'we simply cannot risk installing heat pumps in properties until we are certain they will not cause noise problems'

Thomas Lefevre, the director of Etude, which was commissioned by the Greater London Authority to study heat pumps (11), said, "The noise coming out is not huge, but it is not negligible. People who say they will not introduce any noise risk at all are wrong." A report by the European Heat Pump Association admitted that the fan noise is a key problem. Mike Stigwood, the director of the consultancy MAS Environmental told the journal Noise Bulletin (12) that the tonal and low-frequency noise from noise pumps would be a problem. Where they are located is also important but in flats the choice of location can be very limited indeed.

'those on lowest incomes living in multi-occupancy properties and flats who are likely to be worst hit'

There is an expectation that the technology might improve as the mass market justifies and stimulates investment in quieter pumps but we simply cannot risk installing heat pumps in properties until we are certain they will not cause noise problems. Otherwise their constant low-frequency noise will create untold misery. And those on lowest incomes living in multi-occupancy properties and flats are likely to be worst hit.

It is essential that the Government carries out an urgent noise audit of heat pumps. At present it looks impossible for them to be installed without causing widespread noise problems.

Noise and Transport



Four areas are looked at:

Page 11: Car of my Electric Dreams

Page 12: Low-tech solutions in a high-tech world

Page 13: Electric planes make a noise

Page 14: Less conflict on the rails



Car of my Electric Dreams

Electric vehicles are effective in dealing with air pollution but are only part of the answer in reducing noise and climate emissions. The health damage from air pollution associated with electric vehicles is around 20 times less than diesel ones because battery electric cars produce zero tailpipe emissions (but are liable to non-tailpipe emissions from tyre, brake and road wear, just like



conventional fossil fuel vehicles), according to a study from Oxford University (13) estimated. However, the noise and climate benefits are more mixed.

Turning to Noise. Vehicle noise is created by a combination of rolling noise (arising from the tyres interacting with the road) and propulsion noise (comprising engine noise, exhaust systems, transmissions and brakes). As a rule of thumb, tyre-road interaction is the main source of noise above 25 - 35mph for cars and above about 40 - 43mph for lorries, with engine noise predominating at lower speeds. Electric cars will cut engine noise. At very low speeds the cars will be very quiet; and remain less noisy than conventional vehicles until they reach between 25 to 35mph. They will be so quiet at the lowest speeds that both the EU and America are requiring artificial noise to be added to warn people of an approaching vehicle. **Electric vehicles are part of the answer to cutting noise on the roads but no more than that.**

On climate. Cars and lorries are a major cause of CO₂ emissions. According to Government figures (14), transport accounts for 27% of total UK emissions; 33% if international aviation and shipping are included. Moreover, while total CO₂ emissions have fallen significantly since 1970 from 594.1Mt CO₂e to 333.9Mt CO₂e, emissions from transport have remained about the same. Cars account for 57% of the transport emissions (excl. international aviation and shipping) and lorries and vans 31% of it.

Will electric vehicles change things? They will help but are only a partial answer. The carbon emissions of driving 10,000 miles in an average electric vehicle is 0.96t CO₂e compared to 2.99t CO₂e in a petrol car and 2.88t CO₂e in a diesel car (15). While no greenhouse gas emissions directly come from electric vehicles, they run on electricity that is, in large part, still produced from fossil fuels in many parts of the world. Energy is also used to manufacture the vehicle – and, in particular, the battery (16). **If energy sources decarbonise, electric vehicles will contribute more to CO₂ reductions, but at present they are only part of the answer.**

What about hydrogen fuel cell cars? Hydrogen fuel cell cars work very differently to conventional internal combustion engine (ICE) vehicles, in that they are essentially an electric hybrid - but with fuel cells replacing the noisy combustion engine. But how does this affect their sound? If you were stood on the side of a road when a hydrogen car went by, the main noise you would hear would be tire noise (and maybe wind passage noise too, depending on the car's speed). They do have a definite, low-decibel sound due to their fuel cell systems, but this might be masked by tyre and wind noise (17).

Cars

Low-tech solutions in a high-tech world

The solutions exist to cut car and lorry noise with or without electric vehicles. It has been the political will that has been missing.

Lower speeds

- Cutting the urban speed limit from 30 to 20mph could reduce traffic noise by more than 50% (18).
- Cutting the motorway speed limit from 70mph to 60 mph could cut noise by more than 25% (18).

Quieter Road Surfaces

The use of quieter road surfaces could halve the noise from traffic. Quieter road surfaces like porous asphalt cost more than traditional road surfaces but are 3-10 times more cost-effective than mitigation measures such as home insulation or the construction of noise barriers (19).

Noise Barriers

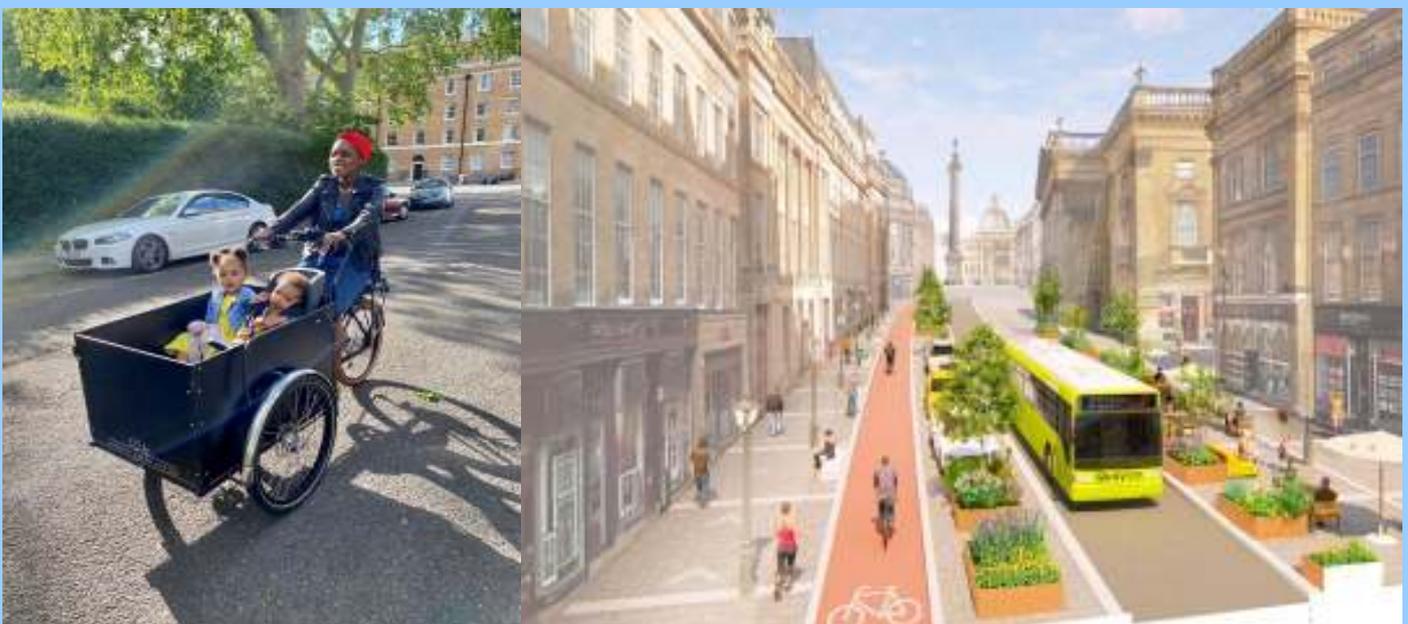
These can be expensive but are essential at noise hot spots. At their best, they can cut noise by 75%.

Traffic Reduction

Fewer vehicles on the roads would cut traffic noise as long as lower speed limits were introduced. It would also reduce air pollution, road danger and climate change emissions.

And traffic reduction *is* possible. Half the journeys we make are under two miles long; 75% are less than 5 miles (20). A mix of investment in walking, cycling and the new disruptive technologies like cargo trams and freight delivery bicycles, lower fares on public transport plus some form of road pricing could both improve the quality of life in our towns and cities and make them better places in which to do business – for example, the annual cost of congestion to the London economy was put at \$8.5bn in 2013 and rising (21). Noise, air pollution and climate emissions and road danger would be cut.

With the right measures in place, annoyance caused by traffic noise could be reduced by 70% (22).



Electric planes make a noise

They could be here sooner than we think but might do little for noise.....

In less than 20 years electric planes could be using our airports. A new report (23) from the CAA (Civil Aviation Authority) suggests some short-haul flights could be using electric aircraft by the early 2030s. However, the larger long-haul planes are not expected to be electrified until at least 2050. Electric aircraft would reduce the air pollution and climate emissions coming out of each plane.

But there is much more doubt about their noise benefits. The report says “There is still

a clear need to undertake noise measurements of the full scale commercial electric planes once they are available to fully understand their noise characteristics” adding “it is still unknown whether the noise exposure from electric aircraft will be an improvement from conventional aircraft.”



“It is still unknown whether the noise exposure from electric aircraft will be an improvement from conventional aircraft.” Civil Aviation Authority

The CAA report identifies the main sources of the potential noise from a fully electric plane: the battery systems, the motor and air frame. Early modelling suggests the planes may be quieter on departure than current aircraft but noisier on arrival. But, because of their batteries, they will be heavy and are expected to climb more slowly after take-off which might off-set any noise gains at source. All of this would be problematic for communities under flight paths. The technology which could clean up the industry could make things worse for them. They will be concerned that, driven by the need to cut emissions, the aviation industry may rush into a technology which may do little or nothing for noise.

Developing new aircraft, whether or not they are electric, often means noise and emissions are at odds with each other. It’s a tough challenge for the aviation industry which aims to develop technologies and operational practices which will reduce aircraft CO₂ emissions per passenger kilometre by 75%, noise by 65%, and NO_x by 90%, by 2050, benchmarked against a typical new aircraft in 2000. The industry body Sustainable Aviation says (24): *“Achievement of any one of these three targets would be challenging, but to achieve all three simultaneously will require considerable ingenuity and a clear understanding of the inter-dependencies between these three key drivers”*.

The CAA summed it up like this (25): *“Concerns in relation to climate change, carbon dioxide emissions, and local air quality could also have an impact on noise performance. Although there is not a direct correlation, and noise performance has previously been reduced alongside emissions reductions, as gains become more marginal in future, the potential requirement to trade off emissions and noise performance is likely to increase.....the Sustainable Aviation Noise Roadmap22 for example, highlights that there are two conceivable paths for future aircraft design, low-carbon designs and low-noise designs. Whilst low-carbon designs may be quieter than existing aircraft, they may not be as quiet as low noise designs”*.

Given the potential conflict with CO₂ is essential a noise audit carried out on each new aircraft design.

Less conflict on the rails

Manufacturers don't usually face a conflict between designing quieter or greener trains.

The new trains are both quieter and cleaner. For example, the combined diesel-electric system that also incorporates batteries which Rolls Royce has been developing has been found to be 25% more fuel-efficient than current trains and much quieter



(26). Or again, the new fleet of 33 trains for the Midlands Mainline being built, which draw on Japanese bullet train technology, are quieter and greener, meaning lower carbon emissions and a better environment for passengers, stations, and communities along the route (27). And the new hydrogen trains which have started running in Germany are much quieter and a lot cleaner.

There will be pressure to build more high-speed lines in many parts of the world to provide a greener alternative to short-distance flights. There can be particular noise problems with high speed trains: "Not, though, when they are travelling at lower speeds, i.e. not much faster than conventional trains. At those speeds they are likely to make less noise than the conventional ones because they will be fitted with all the latest noise-reducing features. The problem arises at speeds of more than 250/300 kilometres per hour. That is where aerodynamic noise starts to kick in in a big way. Travel at these speeds can also generate ground vibrations, similar to the sonic boom associated with supersonic aircraft. And there is the problem of brake screech as the trains slow down or come to a halt" (28). However, the noise does not last long and tends to be confined within about 1,000 metres from the track. Noise from high-speed trains can be managed through the speed of the train, the route of the line, the number of trains permitted and where necessary, the provision of tunnels and noise barriers.

A chance to get on top of noise

Noise is nothing new. It has always been with us. We have only to read accounts of noise on the streets of medieval Europe. But the noise was different to that of the modern world – what Emily Thompson has called "the organic sounds created by humans and animals at work and at play" (29). It was the spread of industrialization that changed the kind of noises which came to dominate people's lives: "The air belongs to the steady burr of the motor, to the regular clank of the elevated, and to the chitter of the steel drill. Underneath is the rhythmic roll of the clattering of the subway; above, the drone of the airplane. The recurrent explosions of the internal combustion engine, and the rhythmic jar of bodies in rapid motion determine the tempo of the sound world in which we have to live" (30). We still haven't taken effective action to deal with a lot of this noise. **As technology moves into another new age, we need to learn from the past and conquer noise at an early stage.**

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