

Q1: Outline what is meant by sustainable transport. (1.1) Sustainable transport in the first instance may be seen as any form of transport that does not unnecessarily damage the environment or people, for example through producing polluting gases that damage health or cause climate change and global warming. It is more than this, however, as all sustainability issues have three main strands, Social, Environmental and Economic, it is essential to SEE if methods of transport are sustainable or not. Socially sustainable transport systems should take account of people and the societies they live in, their health, prosperity, freedom, and education. It should not have negative effects on peoples livelihoods, their quality of life and culture, and certainly should not increase any inequalities that exist in the society. Any environmentally sustainable transport system must not damage the environment in terms of pollution or greenhouse gases that cause global warming, and ecosystems and habitats should not be endangered nor should biodiversity. The transport system, however, also needs to be economically sustainable and not be detrimental to the economic growth and prosperity of the society, it should enable the economy to become more circular, produce less waste and preserve jobs.

It is now accepted that 7 key indicators need to be looked at when designing a sustainable transport policy and system and it is not always easy to strike the right balance between these ideas:-

1. Levels of emissions

The sustainable transport system should not produce large amounts of emissions. This may be in the form of particulates that impair health or gases that cause atmospheric damage such as acid rain or enhance the greenhouse effect to cause global warming and climate change.

2. Energy efficiency

The system should be as energy efficient as possible so that the worlds energy resources are not depleted, using renewable energy sources where possible.

3. Health and well-being

Sustainable transport should not negatively impact the health and well-being of either people using the transport or those living in proximity to the transport system. The internal combustion engine is known to impact the health of people by impacting on their respiratory systems and increasing heart disease. it must be remembered, however, that electric vehicles themselves may be emission free, but generating the electricity required for them may be done by burning fossil fuels. Congestion of traffic can also cause stress related illnesses.

4. Affordability/accessibility

Any sustainable transport system must be extensive enough to reach all the places people and goods need to come from and reach, and it must be economical enough to not exclude the poorer sections of society. This may involve investment in subsidised public transport, but the finance will need to come from somewhere, possibly tax rises which may effect the economy.

5. Meeting users needs

Sustainable transport systems must meet the needs of the population, getting them to and from work or engaging in leisure pursuits, but it must also meet the needs of the economy, transporting goods and materials from country to country and within a country.

6. Transport infrastructure maintenance costs and emissions

The transport infrastructure also needs to be considered. A road network may need to be built and maintained, and this will require materials and labour, and even increased emissions since concrete manufacture releases large volumes of carbon dioxide. New rail or tram systems will also need steel for the rail itself with all its manufacturing emissions.

7. Collective impact

It is clear from the 6 points above that there is no simple answer to introducing sustainable transport, success in one of the aspirational indicators may negatively impact one or more of the others, occasionally they may work in harmony. Individual countries and communities need to work out the most sustainable transport solution for their situation.

The sustainable transport system should aspire to do the best it can for people and society across all 7 areas.

These 3 sustainability principles and 7 aspirations can relate well to each other, but this is not always the case and assessments may need to be made between them and the individual UN Sustainable Development Goals (SDGS.) The UN has always acknowledged the importance of sustainable transport in its vision of overall sustainable development and it is embedded in most of the 17 SDGS.

A modern way to look at the SDGS (sei.org) is to look for synergies, where particular goals or items within goals complement each other and trade-offs where improving one SDG will be to the detriment of others. This can be applied to sustainable transport, for instance, poverty reduction and improved quality of life can be attained by increasing rural accessibility, subsidising public transport to give greater access to health and education services, and improving transport to increase food security. The trade-off, however, may be increased carbon emissions the major contributor to global warming. Looking at synergies and trade-offs may inform the decision making process, so that smarter, more cost effective and more successful sustainable transport policies can be implemented.

Q2: Identify sustainable transport methods. (1.2) The difficulty in defining what is meant by sustainable transport is mirrored

by any attempt to identify sustainable transport methods. Because there are social, environmental and economic aspects to sustainable transport, since different methods address these aspects in different ways, and because it is difficult to quantify, in a relative way, the importance of less emissions against cost to passenger or the connectivity and convenience of the network, ranking the most sustainable methods of transport is extremely complex. It is possible to rank methods of transport in terms of the carbon emitted per kilometre travelled but this does not take into account the infrastructure needed for that method to function, the road or rail network, the ports or airports, nor does this simple measure address the social or economic impacts in any way.

There is no simple answer to identifying sustainable transport methods, as each method has advantages and disadvantages depending on the reason for, the route and the distance of the journey. Walking would be listed by many people as the most sustainable method of transport, no pollution, no cost and improves the health and well-being of the walker, but there are severe limits on the distance a walker can go, and the speed they can move at which limit its usefulness in society. It is not possible for most people to shop at a large supermarket and carry large quantities of groceries on foot, large quantities of goods cannot be delivered on foot and holidays abroad would be impossible, certainly from the UK, by walking. In urban areas, however, walking should be encouraged by introducing mixed use neighbourhoods where homes, schools, work and leisure facilities are in close proximity, as is the case in many new brownfield developments.

Cycling is also seen as extremely sustainable, no pollution, low cost and improves health. It is possible to travel further, faster and carry more than walking, but there are still serious limits on its usefulness for long journeys and when moving heavy goods. In towns and cities there is certainly a place for cycling, journeys to work, school and leisure are possible and many local authorities have introduced cycle lanes to make it easier, faster and safer, despite this there are obvious safety and inclement weather problems. Some large cities such as London and Manchester have introduced schemes to get more people to cycle by making hire cycles available at docking stations around the city centre, and many cities have e-bikes for hire.

Rail networks, at present using electricity but still diesel in some cases, are the most sustainable way of moving large numbers of people and heavy goods around a country and between countries. The ability to do this, however, depends on the extent of the rail network which is limited in some countries and areas, and the cost which can be prohibitive. Extending rail networks is very costly, as successive UK governments have found in recent years in planning the new HS2 lines to the north. Although electric trains create no emissions, there is still the problem of how the electricity is produced, whether that is sustainable and batteries that have a limited life span.

Cars cannot be included in any list of sustainable transport methods. Anyone who has sat alone in his or her vehicle in the congestion of the morning or evening rush hour of any town or city and looked across at other frustrated lone drivers must realise this. Some people have seen hybrid and electric vehicles as the answer, however, while they cut driving emissions they do not get away from the emissions that may be caused by producing the electricity and certainly do not solve the social and economic sustainability problems of traffic congestion. The same can be said for new innovative technologies involving biofuels, hydrogen or nitrogen fuelled vehicles, emissions are reduced or stopped but the other issues remain. It may be that these new technologies have more of a place in heavy goods vehicles and buses which will continue to be essential on the road systems of all countries moving goods, materials and people.

Improved public transport systems in urban areas are certainly much more sustainable than the motor car. Many towns and cities have introduced bus lanes and subsidised buses to tempt people out of their cars and rapid transit systems, metro systems and tram systems are now common in many of the largest cities both in the UK and around the world. This can be very costly and may depend on local and national taxes to subsidise it and the journeys that can be undertaken are dependent on the existing network.

It is not possible to escape the fact that in an increasingly and irreversibly globalised world goods and people will always need to be transported long distance between countries and continents by sea or by air. It is hard to see that any methods used for this will be truly sustainable. Sea transport is more sustainable than air, particularly for large volumes of materials and goods over great distances, but air transport is much quicker. The only way forward would seem to be designing the most sustainable sea and air transport systems and reducing air transport as much as possible.

Q3: Explain the importance of reducing transport vehicles. (1.3) It is vitally important to reduce the number of transport vehicles because of the negative environmental, economic and social impacts they are having, and this is particularly the case in urban areas, cities and megacities. Fossil fuels still dominate as a fuel source for motor vehicles, as does the internal combustion engine with all its associated emissions and pollutants. This affects urban atmospheric environments in particular, but it also has a negative impact on world climate, contributing significantly to global warming and climate change. The economic cost is high, both to individual workers who lose time to congestion, but also businesses that lose employee hours and productivity, and suffer due to late deliveries of goods and materials. The pollution has an impact on people's health causing respiratory diseases and reducing the quality of life.

Liveability and the liveability index is a relatively recent way of looking at quality of life in the world's major cities. It considers several criteria including infrastructure, environment and health and it is interesting to note the countries that score highly and those near the bottom of the list (media.heraldsun.com.au). Zurich (3rd) and Oslo (23rd) have made strenuous efforts to improve traffic and traffic flow, whereas Mexico city (106th) and Istanbul (113th) while they have tried to improve their transport situation have been less successful.

Mexico City the capital city of Mexico with a population in 2021 of around 22 million has been called a congested megacity and it illustrates extremely well the problems caused by an excess of transport vehicles and why they should be reduced (repository.usfca.edu). Rapid rural-urban migration is causing the city to expand rapidly to the extent that it is now a primate city, much larger than any other city in Mexico, with all the functions, government, administration, business and industry concentrated

there. It is estimated that there are an average of 5.5 million vehicle journeys a day in Mexico City with 4.5 million commuters moving into the city and the industrial areas.

The environmental impact of all this traffic in the city is immense. Emissions to the atmosphere are very large and often the pollution is contained in the city basin by a temperature inversion. 60% of all pollution and 58% of CO₂ (carbon dioxide) emissions come from vehicles, other pollutants include CO (carbon monoxide), ozone, VOC's (volatile organic compounds) and NO (nitrous oxide), often reacts with sunlight to form a toxic photochemical smog.

The impact of excess traffic on health is profound. Accidents cause around 1000 deaths a year, but this pales beside the 100,000 children that die each year through pollution related illnesses. The health issues caused by traffic, respiratory and heart problems, also put a strain on the health services and lead to an overall lowering of life expectancy.

Economic growth of Mexico City, the main economic and industrial centre of Mexico, is also slowed by excess traffic.

Congestion means that the average resident loses 158 hours a year trapped in traffic jams, affecting their working hours and their income. Businesses struggle with the same problem and also find it time consuming and costly to move goods and materials around the city. The health issues created by emissions also puts a severe financial strain on the health services offered by the city.

Q4: Identify vehicle fuels that are not derived from petroleum. (2.1) In identifying non petroleum vehicle fuel sources it is important to differentiate between non petroleum and sustainable. At present vehicles are primarily fuelled by fossil fuel based methods which come from crude oil, petroleum, notably gasoline/petrol, and this is undoubtedly unsustainable as it is based on finite earth resources. Natural gas can form in association with crude oil, but it can also form in a non associated way when it is often called dry gas. This is not considered petroleum/crude oil based, but neither can it be considered sustainable. It is, however, significantly cleaner than petroleum fuels causing far fewer emissions than associated gas or other petroleum based fuels, but it is carbon based and therefore does come with some climate change problems. Non associated natural gas has been seen by some as a possible 'bridge' to fill the gap until fully sustainable alternative fuels can be developed (unep.org/nep-and-stories/).

The Office for Zero Emissions Vehicles (OZEV) in the UK (www.gov.uk) is to oversee the phasing out of the sale of new petrol or diesel cars from 2030-35 and it is clear that hybrid vehicles which combine the internal combustion engine with battery power, in whatever form, are not a long term answer, as alternative-fuelled vehicles (AFV'S) will need to be developed. Zero emission electric vehicles can be a possible solution, but growth has been slow due to the high initial cost and range problems. These E-vehicles, however, can only be considered truly non petroleum if the electricity they use is produced by renewable methods. Biofuels may fit the bill, made from vegetable oils and plant material which are obviously renewable, bio-diesels and biogas can be produced particularly for HGV's. They reduce emissions to a large degree, especially carbon dioxide, but being carbon based there is still some release of greenhouse gases.

Hydrogen is seen by many as the future for vehicle transport (rac.co.uk), either in a combustion engine where the emissions are only water or using hydrogen fuel cells to produce and use electricity without the need for batteries and the associated resource implications and disposal problems. This could be a long term solution, but at present the technology is still expensive and no infrastructure exists. Nitrogen, in the form of liquid nitrogen may be a better option than hydrogen, although at present only demonstration vehicles have been made (ecoticias.com). Nitrogen is the major constituent of the atmosphere so it is eminently sustainable and estimated to be 700 times cleaner than hydrogen. The liquid nitrogen expands to a gas which powers the engine, fuelling can be done as easily and quickly as at present once the infrastructure is in place, and the only output is air!

Q5: Explain the factors to be considered when assessing alternative fuels as sustainable options. (2.2) When assessing the sustainability of alternative fuels there are 4 main considerations:-

1. The need for the fuel to be renewable or easily mass produced. If the fuel source is dependent on fossil fuels such as petrol/gasoline and diesel then it is clearly unsustainable as there are finite resources. If the source is not renewable then it must be easily produced and must not involve the depletion of any of the earth's resources.
2. When the fuel source is produced it must produce zero or minimal emissions. Present fuels are based on crude oil and when they are exploited, transported and processed they produce greenhouse gases. Alternative fuels need to be produced without emissions of greenhouse gases and other atmospheric pollutants.
3. When powering the vehicle the alternative fuel must produce zero or minimal emissions. The present vehicle fuels produce large quantities of particulates, and gases including carbon dioxide, carbon monoxide and nitrous oxide that cause atmospheric and health problems including climate change. Alternative fuels need to be green and clean.
4. Alternative fuels need to be affordable and viable. The alternative fuel must be relatively cheap to produce, to purchase and cost efficient in terms of miles per unit of fuel. To be a viable alternative the new methods must be accessible to the users including the general public and include an extensive infrastructure to deliver the fuel.

Electric vehicles, e-vehicles are seen by many as the best and fastest route to a transport system not based on petroleum fuels. The problem is that much of the electricity produced around the world is through the burning of fossil fuels. At present only around 30% of the world's electricity is made by renewable energy sources (www.guardian.com), although the picture varies from country to country, in the UK about 50% is made from renewable sources, but in Russia the figure is only 36%, in China 35%, and Qatar as low as 5%. Some countries produce most of their electricity from renewable sources, Iceland, almost 100% from geothermal energy since it sits on a plate boundary, and Norway 95% from hydroelectricity since it has high mountains and heavy precipitation. This uneven global picture means that it is difficult to see electric vehicles as truly sustainable until the

renewable production of electricity is dominant. On a more positive note the electric engines themselves produce little or no emissions,

Electric vehicles are still more expensive than conventionally powered vehicles which is slowing down their spread, and there continues to be issues with the range that they offer between charges. Charging and cost per mile compares favourably with conventional fuels, but the network of charging stations is still not extensive enough and charging times can be slow. There are still resource implications with battery manufacture, since most are based on rare metals such as lithium and recycling will need to be increased.

Biofuels such as biodiesel come from used oils and plant based materials and as such are sustainable. Crops can be grown to be used to create biofuels, but this can be expensive. Conventional engines can be used with biofuels which makes their introduction relatively cheap and easy, and the existing infrastructure of filling stations can be utilised by simply adding biofuel or biodiesel pumps. The generation of biofuels can be expensive and produce emissions, however, since it involves transport, fermentation and processing. There are some emissions produced when running engines with biofuels, but it can be up to 80% less than conventional fuels although this does depend on the variable quality of the biofuel.

Hydrogen was touted as the best alternative and Honda made the Clarity range in the early 2000's which became popular in California for a time and it can be used conventionally or as a fuel cell creating electricity. Hydrogen is extremely abundant, especially in water (H₂O) or methane (CH₄) which makes it sustainable (defra.energy.gov), but it is expensive to produce by electrolysis and this requires energy that may be produced by unsustainable methods. It can be produced by thermochemical or biological methods which may make it cheaper, but all these processes create emissions.

An alternative fuel for the future may be nitrogen. As a major constituent of the air it is readily available and could work as a conventional engine does by expanding from liquid nitrogen into the gas to drive the motor. The separation of nitrogen using fractional distillation is very expensive and does use a great deal of energy, and storing liquid nitrogen could be difficult and expensive, future innovations may, however, make it a viable proposition.

Q6: Explain the economic, environmental and social aspects of the use of sustainable fuels. (2.3)

a) Economic ECONOMIC

Although there may be a loss of jobs in the traditional areas of the transport industry and the petroleum sector, the introduction of sustainable fuels will bring its own job opportunities. It has been estimated that there will be 24m jobs created in the sustainable sector by 2030, and that these jobs will have a real future unlike those based on the finite fossil fuel reserves. New jobs will also be created in the new fuel technologies which will guarantee incomes for workers which in itself will be a boost for the economy with the increased and reliable spending power. Many of the new biofuel developments will be labour intensive and this increase in jobs will lower poverty levels in some developing nations.

The new transport technologies will stimulate further innovation which will bring new start-up companies onto the scene and it is likely that this innovation will ripple out into other sectors bringing further growth, new opportunities and new markets.

If the new transport initiatives and sustainable fuels bring cost savings to firms involved in transport that will stimulate further economic growth in the economy, tax revenues in countries may increase allowing further investment and growth.

b) Environmental ENVIRONMENT

Vehicles with the conventional internal combustion engine using petroleum based fuels cause many polluting emissions, the main ones are carbon dioxide, carbon monoxide, sulphur dioxide and nitrous oxide. This poisonous mix will be reduced by a move towards sustainable fuels and the damage that these emissions do to the environment will be reduced. A reduction in carbon emissions could go some way to stopping climate change and global warming that affect the environment, threatening habitats and ecosystems and endangering species. It will also slow the rise of sea level that is presently threatening coastal habitats, and if sea temperature rises are moderated coral reefs and their extensive biodiversity may be saved.

The gases emitted by conventional fuels particularly sulphur dioxide (SO₂) and nitrous oxide (NO) also cause acid rain which can inflict habitat damage, this should be lessened by the use of sustainable fuels. Acid rain can lower the pH of soils and lead to the excess leaching of nutrients that can harm plants, the acidic water can also leach aluminium out of soils into nearby water courses damaging aquatic ecosystems and killing fish. In developed nations the levels of SO₂ and NO have been falling this century and the problem of acid rain has been declining, this has not been the case in developing nations, however, where car use has expanded rapidly.

c) Social SOCIAL

Since 20% of all CO₂ emissions come from transport any change to sustainable fuels could have a marked impact on global warming, since CO₂ is the main greenhouse gas. Attempts to follow the Paris Agreement need a movement away from petroleum based fuels as climate change continues to affect people and society in a negative way.

Global warming is leading to an increase in extreme weather events, heatwaves, droughts and floods caused by periods of intense rainfall are becoming more frequent. 2024 saw the world break 1.5 C above pre-industrial temperatures for the first time and recent events in California have clearly shown the social impact. The unprecedented wildfires in Los Angeles are undoubtedly influenced by climate change, last summer was extremely dry, the usual winter rainfall didn't materialise and fires in the tinder dry vegetation were fueled by strong dry Santa Ana winds from the east. 25 people have been killed, around 180,000 have had to evacuate the area and 1000's of buildings (at the time of writing) have been destroyed including homes, schools, medical centres, retail outlets, churches and places of work, a devastating social impact.

Sustainable fuels, by reducing the pollution by conventionally fueled vehicles will reduce the negative effects of traffic on the health of citizens, particularly those living in urban areas. At present people can suffer from respiratory illnesses and heart disease, causing increased deaths, poor health and putting a strain on health services. An increase in heatwaves caused by

greenhouse gas fueled global warming can also have a detrimental effect on health. Elderly people and those with pre-existing health conditions are most at risk (imperial.co.uk) and in the past 5 years a survey found that 1 in 5 UK residents had suffered ill health due to extreme heat. The summer of 2022 was the hottest on record in the UK, with temperatures exceeding 40C for the first time, and nearly 3000 people were killed by heat related illnesses, the highest figure ever. This should all begin to reduce, or at least not worsen, with the change to sustainable fuels.

It is recognised that there are synergies between the UN SDGS, some of them complement each other, as one improves so does another (sdgs.un.org). The use of sustainable fuels in transport will bring improvements in other areas of the SDGS, notably economic growth which should bring more investment in health, education and social services. Job growth in a green economy will improve public transport, bring more stable incomes and improve accessibility which will reduce poverty and increase equality and the quality of life.

Q7: Explain the economic benefits of reducing the use of vehicles. (3.1) Reducing vehicle use has marked economic benefits for the country, businesses and the individual.

Fewer vehicles on the roads would mean less wear and tear and less cost in road maintenance, dealing with potholes and resurfacing. It is estimated that in the state of California in the USA \$500 million is spent each year maintaining the road system, and in the UK local authorities spend a staggering £4.5 billion annually on maintaining roads.

With fewer cars fewer new roads and motorways will need to be constructed and this will also bring cost savings. In the UK for instance a new motorway costs up to £30 million per mile (Highway Agency). Savings will also be made in NHS costs as fewer accidents will occur and fewer people will suffer from traffic and pollution related ill-health, which at present costs £100 million per annum. Governments and local authorities will have this money to invest in public transport systems and other life improving initiatives for citizens.

Businesses will also benefit economically as employees will spend less time stuck in traffic jams which will increase productivity. Goods and materials will also move more smoothly around the road system bringing further savings. In city centres less traffic and greater pedestrianisation have been shown to bring increases in footfall, increased business, and a study in 2016 (euroinews.com) showed profit increasing by 49%. There also appears to be an increase in land values for both commercial and residential properties in pedestrianised city centres.

Individuals will also benefit economically. In 2017 the average US household spent \$9000 each year on their car, fuel, insurance, maintenance, and going car free would free up more disposable income to be spent on leisure, entertainment, holidays and the other pleasures of life.

Q8: Explain the environmental benefits of reducing the use of vehicles. (3.2) Fewer vehicles on the roads would have a positive impact on the environment. It is important to consider all aspects of the full life cycle of a vehicle, construction, use and disposal when considering the environmental impact, not just its use on the road. When being driven vehicles produce various emissions; carbon dioxide, carbon monoxide, nitrous oxide, sulphur dioxide and particulates, and 85% of the total output of carbon from vehicles comes from their use. 10% of the carbon is produced when the vehicle is manufactured, making the steel, glass, plastic, rubber, and 5% from the disposal of the toxic batteries, oils and plastics.

By reducing the construction and use of vehicles far less carbon dioxide, which is the main greenhouse gas responsible for climate change, will enter the atmosphere decreasing the speed of global warming, and the associated negative impacts on ecosystems and habitats should reduce. This is not the only pollutant affecting ecosystems and biodiversity, nitrous oxide and sulphur dioxide cause acid rain that damages vegetation and aquatic habitats. Reducing vehicle ownership may lead to more pedestrianisation, more open space and less need to build additional road infrastructure with its destruction of habitats, flora and fauna.

Air pollution is not the only type of pollution that will be reduced if vehicle use falls. There will be less noise pollution and less visual pollution of roads and motorways carving across the countryside. There will also be far less microplastic pollution generated from the wear and tear of vehicle tyres which is washed from roads into streams and rivers and eventually the oceans, damaging ecosystems and fauna, possibly endangering some species.

Q9: Explain the social benefits of reducing the use of vehicles. (3.3) Reducing the use of vehicles will have positive social impacts in urban areas and help countries address aspects of the UN SDG 11, sustainable cities. This could be achieved by improving public transport systems, increasing the frequency, routes and connectivity and keeping fares competitive. An increase in the use of public transport may also bring increased revenues which could be invested in improving connectivity further, reducing fares and investing in other city improving schemes to benefit the residents. It will also bring community benefits and perhaps lower levels of deprivation and reduce socio-economic inequalities.

Reducing vehicle use would also involve more cycling and walking and this would have a positive effect on health, improve fitness, well-being and quality of life. Fewer people would be experiencing the stress of congestion in commuter traffic and levels of air and noise pollution would decrease significantly. If we include safer streets, the reduction in accidents and a fall in respiratory and heart conditions, life expectancy could rise, and it has been estimated (climatexchange.org) that it could save the NHS £27.5 million annually.

There could be significant cost savings in reducing car use especially for commuting, and certainly if more people can live without a vehicle. In this case more money could be spent on other aspects of their lives, homes, leisure, entertainment etc

which will improve the quality of life. Pedestrianisation of city centres has been shown to reduce stress and carbon emissions while maintaining footfall and revenues while giving people a pleasant experience. Overall reducing car use can bring greater social cohesion to communities, and make them happier, healthier and safer places .

Q10: Explain the ways in which organisations use and interact with transport systems. (4.1) All organisations need to interact with transport systems in some way and to some degree, whether it be land, sea or air.

Except for a one-man business, nearly all organisations have a workforce. Although there are increasingly cases of organisations where employees work from home, interacting with the business and customers through the internet, workers commuting to an office, factory or other place of work is still the norm. Most of these commutes take place by car, some by public transport and some on foot or by cycling.

Most organisations require raw materials to be delivered to a site or sites where manufacturing, processing or construction takes place. The method of transport will depend on the size, weight and perishability of the raw materials. While some businesses can transmit their products online most still have a product that must be transported to the market or customer. The method of transport will again depend on the product size, weight, fragility and perishability.

These ideas can be illustrated by looking at the steel industry in Scunthorpe. Run by British Steel, a private company, it is a heavy industry producing semi-finished and finished steel products. Traditionally heavy industries like steel have been located at what are called least cost locations, dependent on the transport of raw materials and finished products. The raw materials, iron ore, coal and limestone are bulky and low cost, and have to travel large distance often from abroad. Transport by sea is the only cost effective way to transport these bulky raw materials which are transported to a deep water terminal at Immingham. This allows large vessels to be used which brings economies of scale. The raw materials are then shipped by a merry-go-round rail system to the 'quasi-coastal' site at Scunthorpe. On site transport of raw materials, waste and products is by conveyor belt or the internal rail system.

The workforce is local and commutes daily on a shift system mostly by car, but also on foot, cycle and the local bus service. There are other sites around the country and abroad for distribution centres, sales offices and research and development, so some business links are probably made by air travel. Products tend to be finished or semi-finished steel rods, wire or construction materials which are transported around the UK by HGV's.

Q11: Explain the impacts of transport on the environment. (4.2) Transport takes place for a variety of reasons, business, commuting for work, freight and goods transport and leisure (holidays, entertainment, shopping, and by a variety of methods, air, sea and land (car, van, bus, HGV, tram, rail). Each of these has varying degrees of impact on the environment, and the reasons for and methods of transport will vary greatly around the world.

A UK survey in 2019 (www.gov.uk/statistics) found that for individuals the reasons for journeys were business 9%, leisure 30%, shopping 20% and commuting 15%, with other reasons being education and personal business. These are only rough estimates really as they do not take into account the length of journeys, the methods of transport and it is only looking at one part of the world at a certain level of development.

The course resources quote a different figure for business travel, by road, air and rail, and put the average figure at 20%. The reasons for the travel are meetings, conferences, overseeing projects etc. and often the fastest method of transport, regardless of cost, is chosen so that time is not wasted travelling. This is particularly the case with transnational corporations who will have sites in a number of countries and air travel will be important.

Although air travel accounts for just 2% of the total carbon emissions created by transport it is, in fact, the least sustainable method of transport. There are marked regional differences in the amount of air travel undertaken, in less economically developed countries people are unlikely to be able to afford it, whereas in developed nations such as the USA it will contribute a larger percentage to an individuals carbon footprint.

Commuting is a major contributor in atmospheric pollution and carbon emissions worldwide. Travel into and out of cities in the rush hour by rail, tram, bus and primarily by car (68% of UK commutes are still by car) causes a great deal of city pollution and in the UK it is estimated that 25% of all carbon emissions are due to commuting.

Freight transport by land sea and air also contributes greatly to environmental damage. Air transport is best for high value, low bulk goods where speed is essential, cargo vessels will move low value, high bulk goods and materials efficiently but more slowly, and road and rail transport low and high bulk goods quickly and relatively conveniently. It must be remembered that vehicles cause both direct and indirect emissions. Direct emissions occur through the use of the vehicle itself and indirect emissions are due to the manufacture and disposal of the vehicle.

Transport systems also need varying degrees of infrastructure. This may involve the building of roads and railways and the habitat destruction that causes, the building of airport terminals and runways again hitting local habitats, and port facilities that may have a negative impact on coastal ecosystems including coral reefs and estuaries. Although the emissions from freight journeys in the UK fell by 15% in the period 1990-2019, the emissions are still very high and account for 20% of the total produced by transport (transportgeography.org).

Carbon emission by transport have a significant negative impact on the environment being mostly responsible for global warming and climate change which put habitats and ecosystems under stress and can lead to biodiversity loss. It is not only the carbon emissions, however, Nitrous Oxide (NO) and particulates are also emitted by vehicles, in fact in 2021 transport accounted for 32 % of all NO emitted in the UK. Acid rain is a consequence of this and it can kill trees and damage aquatic ecosystems.

Other environmental problems caused by transport emissions are ozone depletion and smogs, which in cities such as Los

Angeles and Mexico City can react with sunlight to form a toxic yellow mix known as a photochemical smog. Water pollution and damage to aquatic ecosystems and biodiversity loss in rivers and lakes can be caused by oils and chemicals being washed off roads into nearby water courses. Finally, microfibrils from the wear and tear of vehicle tyres can wash into rivers and eventually reach the sea where these microplastics can be absorbed by animals and moved through the food chain to endanger species and make oceanic biodiversity less able to cope with the stresses of climate change.

Q12: Describe ways organisations can incentivise staff to reduce usage of transport. (4.3) Organisations can incentivise staff in two basic areas, one is to try to cut down on the use of transport by staff while at work, travelling for work, meetings, sales etc. the other is to try to cut down on the use of transport by workers commuting to and from work.

There are 5 ways and policies an organisation can introduce to incentivise staff to reduce vehicle usage.

1. Subsidise public transport
2. Promote active transport
3. Support alternatives to business travel
4. Promote car pooling
5. Disincentivise or penalise car use

1. In an attempt to move people from commuting by car to public transport organisations offer free or discounted use of the local bus or tram services. For this to be effective the city or urban area need to have a public transport system in place that is capable of filling the needs of commuters. Individual companies can help the process by allowing staff to work flexible hours to enable them to travel outside the rush hour periods when their journeys will be easier and faster. The companies can educate staff about the public transport opportunities and encourage staff to take up these opportunities by offering time off and staff discounts.

It is better if these policies are introduced along with the local authority or city councils. In the USA great efforts have been made to move commuters onto public transport as at present 76% of all commutes are by single occupants in a car

(smartcitydive.com), and only 5% take public transport. In Seattle they have introduced a Transit Incentive Program (TIP) which offers a number of free rides annually to any household that has a vehicle registered to it, so it directly targets car owners.

2. Active transport is walking and cycling and organisations are beginning to promote both of these as environmentally friendly and healthy ways of getting to and from work. At present in the UK only 5% of all journeys by distance are undertaken by foot, and around half of all journeys in towns and cities under 5 miles are still by car (www.gov.uk). Individual organisations on their own can only do so much and depend on the government and local authorities to invest in the facilities and infrastructure required to walk and cycle safely and efficiently around towns and cities.

There are some policies and procedures that organisations can implement, however, to encourage active transport among their workforce. This could be the provision of safe storage areas for cycles, and showers and changing rooms for both cyclist and walkers when they arrive, some companies may even go as far as providing equipment for staff to use or hire. A degree of flexibility in working hours may help staff by allowing them to travel outside rush hours when it will be safer and incentives may be offered such as a cycle allowance. To be successful the organisation needs to educate and inform staff (citma.org.uk) to create a community spirit among staff, perhaps conducting employee travel surveys to introduce a small competitive element.

3. As part of a total travel policy review within the organisation any business travel undertaken by staff should be closely monitored to prevent unnecessary journeys. Alternatives to normal business meetings must be considered and since the Covid restrictions more staff are aware of the possibilities that exist other than face to face contact. Telephone meetings and internet 'virtual' meetings can be just as effective and do not involve the cost of time, money, pollution and possible congestion of a normal business meeting. Staff that do need to travel should be encouraged to choose a more sustainable option than the car, and more meetings that do take place should involve a number of activities to cut down corporate travel.

Organisations should introduce a green business plan (businessclimatehub.uk) that encourages alternative to face to face meetings and creates a travel hierarchy for any staff who need to travel for work. This includes a phone call or a video-conference, public transport of rail, hiring an electric vehicle, cycling and as a last resort personal vehicles.

4. Organisations can actively promote or facilitate car pooling to reduce the use of vehicles especially for commuting to and from work. It can be linked to a system where employees are able to work flexible hours, enabling them to group together, organise their hours and transport, outside the rush hours if possible. Employees will benefit through lower transport costs and a cut in maintenance required for their cars.

Companies themselves can organise this through their intranet or by designating a lead member of staff to coordinate, organise and inform. 'Apps' now exist so that longer journeys can be coordinated, and the intranet/internet now make organisation and coordination easier.

5. Organisations can make it more difficult or more expensive for employees to use their car to commute to work. This may include not offering subsidies for parking, reducing the car parking spaces available, increasing the cost of parking, or for staff using their car for work, reducing the mileage expenses. An organisation should be careful when introducing any of these policies, however, as they may be interpreted by staff as punitive and staff morale and attitudes of staff towards the organisation may suffer. These schemes should only be introduced as part of a larger endeavour to educate staff about the problems of excessive car use to keep them in tune with the company ethos, and any savings made by the organisation should be openly re-invested in staff to improve morale.

Q13: Describe incentives that can be offered to the public to reduce vehicle use. (5.1) 1. Low cost or free public transport
This would seem to be the best way to tempt people out of their cars and onto public transport, and it should be particularly

useful in cities where there is mass commuting to and from work during the rush hours. Reductions in fares or free fares should get people on the bus, tram, rail or subway systems, but evidence from examples where this has been trialled show that the results are only partially successful.

In 2022 Germany introduced a €9 monthly rail fare, a very low fare for a developed country such as Germany, in fact it was called the 'almost free fare' (eurostar.eu/bitstream). Although rail traffic increased by 35% during the trial, road traffic only reduced by between 1% and 5% and it seemed to have little impact on rush hour traffic. The rail system itself suffered during the trial as the increased usage caused substantial delays.

It is clear, then, that financial factors are not the only ones governing use of public transport, although cost may be important in countries and cities with large inequalities in socio-economic status of citizens. Other non-financial factors could be more important (centreforcities.org), such as the coverage of the network so that more people live near to it, or building new housing developments close to existing networks. Increasing the frequency of the service and integrating different systems, bus, rail, tram and subway to improve door to door times, along with quality and reliability improvements are seen as vital to incentivising people to abandon their vehicles and use public transport.

Park and ride schemes have had some success in reducing vehicle use in cities. They often offer free out of town parking and subsidised public transport into the centre, but some research has shown that they can increase traffic if users drive some distance to the parking site, the best schemes offer the parking sites closer to the origins of users rather than the destination. To be really successful it would be best to take a carrot and stick approach, offering the park and ride while reducing city centre car parking spaces and perhaps introducing a congestion charge.

Two northern cities in the UK, Leeds and Manchester have introduced park and ride schemes. In Leeds (iylsleeds.ac.uk) the scheme has been running for 10 years with free parking and a standard £4 bus fare of around 15 minutes, and recently hit its 5.6 millionth journey with 7.5 million cars not driven into the city. In Manchester the scheme has almost 80 free car parks that link to the extensive tram, train and bus network, and car and pollution have both been reduced on the city streets. The scheme could be even more successful if combined with congestion and low emission zone charges, but strong public opposition to this has so far stifled the political will to press ahead with their introduction.

2. Vehicle sharing schemes

Far too much rush hour traffic in towns and cities consists of cars occupied by one person. Since most cars can carry 4-5 people comfortably any system that encourages car sharing will take many vehicles off the road. Usually this is done informally by small groups of family, friends or colleagues employed at the same or reasonably adjacent businesses or organisations, but there has been a recent increase in formal sharing schemes. This may involve facilitating the contact between people who could benefit from sharing, businesses themselves introducing car sharing initiatives for their employees, but increasingly specialist vehicle sharing firms are using the internet and 'apps' to offer sharing opportunities.

Sharing can go beyond the usual car sharing and many cities around the world such as London, Manchester and Milan have introduced cycle and e-bike sharing schemes where 'docked' cycles can be hired in city areas for a reasonable price, incentivising people to leave their cars at home.

Q14: Describe incentives that can be offered to transport providers to reduce vehicle use. (5.2) Transport providers must provide an alternative to private vehicles that attract the public through the cost, network size and accessibility, and convenience to help reduce overall vehicle use. Subsidies in the form of financial support from the government to keep fares low and improve networks include the direct transfer of money to transport operators (provider-side subsidies), differential fuel taxation that favours public operators and lowering VAT, which is currently zero rated in the UK for bus and train fares. This could allow operators to offer cheaper fares or maintain services that are not economically viable, where fares do not cover the cost of the journey.

Deficits run up by transport providers may be met by government and providers can also access capital grants for setting up or maintaining mass urban transportation schemes. The UK government offers grants, fare caps and funding for improvements and innovations (www.gov.uk). The rural bus subsidy is important in maintaining services in isolated areas where residents would be unable to access services without the use of a car, and the Bus Service Operators Grant and Grant Plus (BSOG) allows the recovery of some fuel costs. The BSOG keeps bus fares down and enables the continued running of money losing services. Recently the Zero Emissions Bus Regional Area scheme (ZEBRA) has been introduced to help fund the introduction of zero emission buses and the infrastructure they need, and a £3 national bus fare cap has been proposed on some routes.

Q15: Describe schemes to penalise vehicle use. (5.3) 1. Road tax.

In the UK road tax is a tax on the ownership of vehicles. The rates are now quite complicated as they have been adjusted to take into account the age of vehicles, their size and the emissions they produce, cleaner vehicles pay less with electric cars paying nothing. This should encourage the ownership and use of smaller, cleaner vehicles, particularly hybrid and electric vehicles. The sales of electric vehicles is increasing in the UK, from around 7% of total car sales in 2020 to almost 20% in 2024, but car tax changes will be only one of the factors considered when a motorist chooses a vehicle.

2. Congestion charges.

These have been introduced in some cities often in conjunction with low emission zones to deter motorists, particularly commuters, from entering the city at certain times.

The London congestion charge was introduced by Transport for London in 2003 and it is still in place although the coverage, time frames and charges have evolved over time. An attempt to cut pollution and congestion within London, in 2022 the standard charge was £15 between 0700 and 1800hrs on weekdays and between 1200 and 1800hrs on weekends. Cameras

record plates and these are checked against the register of cars and penalty charges of £160 are implemented (tfl.gov.uk). A Low Emission Zone (LEZ) was introduced in 2008 and an Ultra Low Emission Zone (ULEZ) in 2019 to cut down on the most polluting vehicles with a charge of £100 a day for vehicles that don't reach the emission standards, and since 2021 the ULEZ has covered the whole of central London. The impacts on congestion have been limited, car mileage reduced by 1 billion but this has been replaced by the increase in light van mileage and taxi journeys. The best that can be said is that the traffic situation has stabilised and would, perhaps, be worse without the scheme. The LEZ and ULEZ system has worked, however, in discouraging older, less efficient, more polluting vehicles from central London. 94% of all vehicles entering the ULEZ meet the standard and there has been a 20% reduction in diesel vehicles, the air is now cleaner, less polluted with fewer emissions. In 2021-22 the ULEZ took in £11 million and the LEZ £34 million and Transport for London is investing this money in low emission and zero emission buses and aim for the entire fleet to be zero emission by 2034.

3. Parking charges and restrictions.

The aim of these policies are to deter motorists from entering urban areas. There are several approaches that can be taken, increasing parking charges especially at peak times, parking levies on workplace parking and reducing the parking capacities in city centres (climalexchange.org.uk). In Amsterdam this has been put in place with a degree of success. In 2018 on-street parking prices were increased by 66% and parking spaces were reduced by approximately 1%, and this led to a fall in on-street parking demand of 17% and a fall in rush hour traffic of 2-3%.

Q16: Explain barriers that may inhibit the public from reducing vehicle use. (5.4) There are a number of reasons why people find it difficult to break up their love affair with the car. These include the cost of public transport, difficulties with access to public transport, the limited network of public transport in many areas and the convenience of the car giving door to door journeys.

Some people feel that they are 'forced' into car ownership, perhaps through a disability that inhibits them from using public transport or by living in areas where it is not possible to conduct normal activities and live a normal life without a vehicle because of the very poor public transport system.

Many people understand the problems caused by their vehicles and the internal combustion engine in particular and would like to lower their carbon footprint but consider other factors of greater importance (assets.publishing.services.gov.uk). People feel the need to access jobs, education and training, shops and services and not live in social isolation meaning that owning a vehicle is essential. Walking and cycling would be considered by many if it were not for the range, safety, inclement weather and carrying capacity problems.

The inability of public transport to satisfy customers in so many ways seems to be the main barrier to the public reducing vehicle use to any great extent. People have a list of requirements for any transport system and a public transport system be it bus, train or tram too often fails to fulfil them. People value punctuality, reasonably speedy journeys and low cost as essentials, but they are also concerned with safety, comfort, flexibility and the ability to carry children and/or goods and materials which they associate with owning their own vehicle.

Q17: Identify the different types of leisure travel. (6.1) Leisure travel can be classified in several ways depending on how long it is for and how it is organised, where the travel is to, and the reason for the travel. A simple initial classification is:-
Short breaks. This usually involves 2 or 3 days away, possibly at the weekend and may be domestic or abroad.
Package holiday. Organised by a travel and tourism company, flight, hotels and perhaps even activities are booked and organised by the company. It may even be 'all inclusive' where everything in the hotel or complex is pre-paid.
Independent travel. Individuals, families or groups make their own travel arrangements, book their own accommodation and activities.

The destination of the leisure travel can also be used to identify 3 categories of travel:-

Domestic. Travel to a destination within the same country. Easier to organise and can be more spontaneous as it does not require passports, health checks or inoculations.

Inbound. International leisure travel into one country from another. It involves crossing international borders and may require passports unless it is within a unified bloc of countries. Visitors traveling into London from abroad to see the 'sights' is an example of this.

Outbound. International travel that involves travelling to another country as with the millions of British people who go to the Spanish Costas each year.

Within each of the categories identified above it is possible re-classify based on the reason for the leisure travel. The following are not mutually exclusive as any particular journey may be for several reasons.

Leisure

This is where people travel to enjoy their free time in a different environment and it may involve some or all of the following categories. People may be travelling to enjoy a beach holiday or be travelling to engage in particular activities.

Cultural

People often visit a country or a city to experience a different culture and way of life. This may involve looking at the heritage and history of that country or city and perhaps visiting world heritage sites. It may also be eco-tourism if the visitor wishes to experience the environment and culture without impacting on it as most tourism does.

City/Urban breaks

People will often book a trip to a particular city often as a short break. This may be to experience the culture, history and heritage, but it may also be for a retail experience.

Adventure/ Sports

Activity holidays can take many forms and the destination will depend on the activity or activities involved. Skiing will be to a mountainous country, diving perhaps to a warm coastal country with accessible coral reefs.

Mountains

Travel to mountainous areas can take many forms. It may be an activity holiday if it involves skiing or climbing, but it may be a more relaxing sightseeing trip to soak up the atmosphere and scenery.

Rural

Rural leisure involves the countryside. This may be a semi-educational trip to a farm, or just an escape from the pressures of city life. It could be camping or glamping or it could involve eco-tourism where the environment is left untouched.

Q18: Describe sustainable options for leisure travel. (6.2) Leisure travel can have an impact on a variety of scales from global to regional to local. Leisure travel also has 3 main aspects of sustainability that it affects, environmental, economic and finally socio-cultural. The impact of leisure travel on sustainability does not just depend on the method of transport used to get to the destination, but also the activities that take place at the destination.

The method of transport to the leisure destination obviously has an important impact on the environment, as all methods except for walking and cycling, produce carbon emissions that contribute to global warming and climate change. Air travel is the least sustainable method producing the most emissions per person per km, bus and train are less polluting and cars are the worst. Sea transport, particularly cruise ships, produces more emissions than any other method of transport except for air, and the discharge of oily wastes into the ocean can significantly impact on oceans and coastal habitats. Transport systems also require substantial infrastructure developments, airports, ports, roads and railways and each of these has a negative impact on local environments, destroying habitats on land and sea.

Construction in resort areas, hotels, cafes, bars and entertainment facilities will destroy local habitats, endanger local biodiversity and bring noise and air pollution to the local area. Activities for travellers can also damage local nature and beauty spots by over-commercialisation. Ideally leisure travel should have a minimal impact on local environments.

The economy of tourist destinations should be boosted by leisure travel and some developing countries even see tourism as a route to economic development. The building of airports, ports and other infrastructure often produces a multiplier effect as other economic activities are also attracted, increasing local employment in the leisure industry and other areas bringing more money into the local economy. Tourists spend money on local products and local farmers may supply food to hotels and cafes and the whole economy grows.

The social/cultural aspect of sustainability is a more problematic area, as jobs will bring money to locals but it may be on minimum wages and the work may be seasonal. Local culture may be overwhelmed by visitors and local customs may remain only as a sideshow for tourists. The popularity of a leisure destination often means that property prices rise significantly which may put quality accommodation out of the reach of locals.

Leisure travel to Kenya can be used to illustrate the sustainability issues and options. Kenya is a developing nation which has used mass tourism as a route to economic development and in the year 2022-23 the revenue from tourist and tourist related activities was \$2.7 billion, and over 1 million jobs depended on the sector. Kenya has developed the airports and infrastructure to cater for travellers to the safari parks of the interior and the tropical coastal resorts on the Indian ocean. Large game reserves and national parks such as the Masai Mara have been established to allow visitors to see the big 5 animals, lions, elephants, rhinos, leopards and buffalo, but the influx of visitors has brought problems of soil erosion by vehicles in the interior, and coral reef damage on the east coast.

Attempts are being made in Kenya to introduce eco-tourism into the wildlife safari holidays, with the aim to minimise the impact on the environment, wildlife and culture of the locals. Local materials are used to construct campsites that do little damage to ecosystems, solar power is used for energy, garbage is composted and water management schemes prevent the overuse of this precious resource. Employees are all local and permanent, low impact activities take place and the overall aim is to conserve the environment, the wildlife and the culture and well-being of locals.

Q19: Compare carbon dioxide emissions of plane, rail, car, bus/coach for a journey within your own country, which can be undertaken by any of these methods. If this is not possible in your country, please choose another setting with which you are familiar. Please detail the source(s) you used to calculate this. (6.3) For a journey from London to Edinburgh a distance of 534km (the actual distance by rail and road is further, and even a plane will not fly as the 'crow flies') the carbon dioxide emissions per km and total emissions for the journey per person are shown below:-

plane 240g per km total 128160g per person

rail 35g per km total 18690g

car (ice) 170g per km total 90780g

car (hybrid) 68g per km total 36312g

car (electric) 47g per km total 25098g

bus/coach 27g per km total 14418g

In order, least emission to most : bus, rail, electric car, hybrid car, car (ice), plane

Q20: Explain the impact of the carbon dioxide emissions of different types of transport. (6.4) Collectively approximately 20% of total carbon dioxide emissions are due to transport. The figures for the main methods of transportation individually are (ourworldindata.com); Road (passenger) 45.1%, Road (freight) 29.4%, Aviation 11.6%, Shipping 10.4%, Rail 1% and others (mainly pipelines) 2.2%. Altogether road transport contributes almost 75% of the total carbon emissions from transport! Although air transport only contributes a relatively small percentage of the total emissions caused by transport, individually aviation is the most polluting type of transport. A return flight from London to San Francisco produces twice as much carbon dioxide as one family car does in a whole year. The length of flights has an impact on emissions as a long haul flight causes lower emissions per kilometre compared to a domestic flight, as more CO₂ is produced during take off and landing than level flight at altitude. There are also distinct regional variations in the number of flights taken in different parts of the world. Wealthier, developed countries such as the USA contribute far more aviation induced carbon than poorer developing nations. Road transport is the largest emitter of CO₂, in fact 15% of all global emissions from all sources comes from cars, buses and freight vehicles (HGV's). The internal combustion engine still dominates road transport, fuelled by petrol and diesel emitting large volumes of carbon. Electric vehicles (EV's) are less polluting than conventionally fuelled vehicles and are becoming more popular, in fact 7.8 million EV's were sold in 2021 (sciencedirect.com), but the difference is not as large as some people think. During the complete life cycle a conventionally fuelled vehicle emits around 24 tonnes of CO₂, whereas the figure for an EV is 18 tonnes. The difference comes from comparing direct and indirect sources of carbon, conventionally fuelled vehicles produce most from direct emissions, whereas EV's cause most emissions during construction and battery manufacture and disposal. In fact it is estimated that 82% of an EV's lifetime emissions are due to battery manufacture and disposal. It must also be remembered that in many countries the majority of electricity is still not generated by renewable methods. Rail and public transport by bus are generally seen as the most sustainable types of transport (except for walking and cycling which produce no CO₂) due to the large numbers of passengers and also, in the case of rail large amount of freight. A bus carrying 50 people should be compared to the 50 cars each carrying one person that would be needed to replace it. This illustrates the importance of car sharing schemes to reduce car use, particularly during commuting.

Q21: Describe methods to promote more sustainable methods of transport. (6.5) There are 4 main ways to promote more sustainable methods of transport.

1. Regulation

Regulation by central government and local authorities is needed if a country is to attain its sustainable transport targets, such as the UK reaching net zero emissions from the transport sector by 2040. The UK introduced a Transport Decarbonisation plan in 2021 to help the country reach its overall net zero targets. The aims of the plan are very ambitious and the previous government made significant funds available to make them achievable. Increasing non polluting cycling and walking is an important cornerstone of the plan and by encouraging new schemes in cities it is hoped to make 50% of all city journeys by foot or cycle by 2030. The sale of new internal combustion engine cars fuelled by petrol or diesel will be banned from 2030 onwards, and new vehicles such as e-vehicles will have to meet stringent new emissions targets. It is hoped that these initiatives on cars and a move towards zero emission buses will counter the problems that may occur in cities if traffic grows by 22% from 2022 to 2035 as predicted. Diesel railway engines will be phased out by 2040 as electrification of the rail system continues, and plans are being made to address the complex area of decarbonising the maritime and aviation sectors.

2. Making emissions information clear to service users

Users of transport need to be made fully aware of all the facts relating to the carbon emissions caused by the travel options they may choose as it is only by being given valid information that informed choices can be made. Potential users must be able to easily find out the carbon cost or carbon footprint of the available choices they may have for a journey. This will be particularly important in the future in the problem area of flights for leisure and holidays which is possibly the worst of all carbon emitters. Travellers need to be aware that the choices they make have a marked impact on emissions of carbon and therefore on climate change and all its problems. They need to be aware that business and first class are worse than economy as they take up more room on the aircraft and involve more weight which increases the emissions per person. The choice of airline can also be important as some, particularly the low cost airlines, carry more people and are more likely to attempt to introduce more sustainable aviation fuels.

It is becoming more common for travel companies to advertise carbon initiatives, perhaps by using carbon labels and making carbon footprint information clear. Some airlines are also advertising carbon offsetting opportunities where the carbon caused by flights is balanced by investments in carbon capture initiatives such as tree planting.

British Airways (BA) are advertising the fact that they are buying carbon credits and offsetting the emissions from their flights (mediacentre.britishairways.com). BA are committed to reaching net zero by 2050 and aim to do this by using carbon removal credits that invest in carbon capture projects, and actually reducing emissions by investing in newer, more efficient aircraft and sustainable aviation fuels.

3. Improving the quality of sustainable transport options

Sustainable transport systems and methods need to lessen the environmental impact they make, emissions and pollution must be reduced, and there should be less noise and less congestion. In cities it is important to make bus or tram systems and journeys more attractive to commuters who may suggest that they want to use public transport but are not so keen to actually

make the change. When commuters consider the choice between car and public transport they think seriously about the cost and convenience factors such as comfort, how long the journey takes and whether the available routes fit their needs. To incentivise commuters to move to public transport the network of routes need to be extensive, times of buses/trams regular and reliable and prices subsidised to make the change more attractive. Cities may introduce disincentives to the motor car including increased parking costs, banning cars from certain routes or areas, and introducing commuter charges.

4. Integrating sustainable transport systems

Buses and/or trams may be more sustainable and environmentally friendly methods of transport but they must be integrated into the whole system, especially in cities. It is one thing to set up the sustainable systems but they must be attractive to and usable by travellers. Residents and visitors must be able to access the system effectively and efficiently and it must be both easy to use and easy to know how to use with clear instructions and signage. The case study I outline below, Curitiba in Brazil, illustrates the successful integration of a sustainable transport system.

Curitiba in Brazil is an excellent example of a city that has managed to introduce and maintain a city wide sustainable transport system. The city has done this despite the problems that cities in the developing world have, unlike cities in the developed nations where total city populations are stagnant or declining, in Curitiba rampant rural-urban migration continues. In 2019 the city had a population of almost 2 million, and in the metropolitan area it was 3.9 million, and it had grown by 25% in the preceding 10 years (sustainablemobility.iclei.org).

The city has an Integrated Transport Network (RIT) that is based around a Bus Rapid Transit system (BRT) of citywide transport routes (gtai.de/resource). The BRT system consists of 252 routes across the city including radial and rings roads, some are exclusive fast lanes for the large, comfortable bendy-buses which are accessed by covered tube bus shelters. The express bus lanes are centrally located making public transport faster than journeys by car, and passengers pay a single pre-paid fare for journeys which makes the system very efficient. Functions within the city have been decentralised to prevent rush hour traffic tides into and out of the city centre, and some commercial and business centres have been located adjacent to the BRT.

The BRT has reduced congestion in the city and cleaned up the environment, it is estimated that 25% fewer emissions of carbon take place in Curitiba compared to other Brazilian cities. Recent innovations have been introduced to keep the system sustainable, cycles and e-scooters are available at bus stops and the bus fleet is being electrified. Accessibility at bus stops has been improved to all people of all ages/disabilities to use the BRT, and there is now a central computerised control system to maintain the efficiency of the citywide system.
