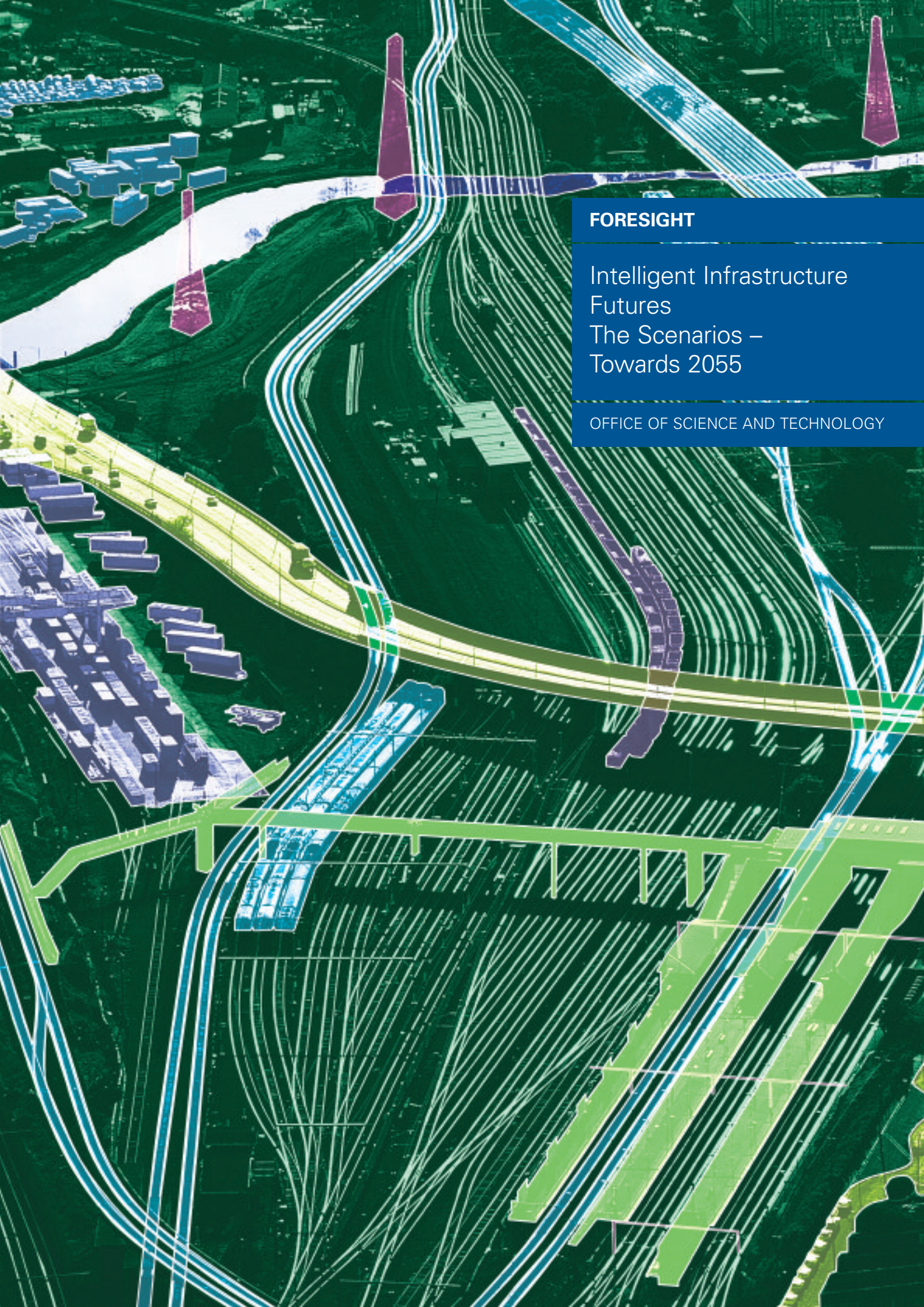

FORESIGHT

Intelligent Infrastructure Futures
The Scenarios – Towards 2055

OFFICE OF SCIENCE AND TECHNOLOGY

Intelligent Infrastructure Futures

The Scenarios – Towards 2055

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Executive Summary

Intelligent Infrastructure Systems Project

The Foresight Project on Intelligent Infrastructure Systems (IIS) set out to examine the challenges and opportunities for the UK in bringing 'intelligence' to its infrastructure – the physical networks that deliver such services as transport, telecommunications, water and energy. In particular, the project explored how, over the next 50 years, we can apply science and technology to the design and implementation of intelligent infrastructure for robust, sustainable and safe transport, and its alternatives.

The technological opportunities and social factors are such that IIS can develop in many different ways. The direction will depend on the direction that society takes. The Foresight project investigated many alternative futures and identified 60 different 'drivers for change' (see Appendix). It is difficult to say how these drivers will change the future. However, to illustrate the possibilities, and guide its thinking and analysis, the project created four scenarios of how the future might look.

Scenarios

This report describes the four scenarios and related 'systems maps' that were developed to investigate how science and technology might be applied to infrastructure over the next 50 years.

Experts from the research community, business and the public sector took part in workshops that identified the key drivers and trends, and explored possible futures based on future uncertainties. The main uncertainties we used were: whether or not we will develop low-environmental-impact transport systems; and whether or not people will accept intelligent infrastructure.

In considering how IIS could contribute to robust, sustainable and safe transport, and its alternatives, environmental issues were high on the agenda. In particular, no discussion of the future of infrastructure can ignore the issue of climate change and global warming.

For all scenarios, we assumed that climate change would be an important factor. This is in part a reflection that transport, with its need for convenient and portable fuels, will find it harder than other uses of energy to switch to low-carbon sources and that, if current trends continue, transport could be responsible for a steadily increasing percentage of all emissions of greenhouse gases.

Many experts consider that global warming will lead to more extreme climatic events, so the scenarios also explore how this could challenge, stretch or undermine the reliability and integrity of the transport system and other parts of the infrastructure.

Information and intelligence

Information, and its collection and management, is at the heart of the development of an intelligent infrastructure. Indeed, it is the application of information and communications technologies (ICT) that makes the infrastructure intelligent. However, this project looked beyond this application of 'intelligence' to infrastructure. We also considered the role of intelligence in the design and use of our infrastructure. Thus, the scenarios allowed us to investigate:

- the intelligent design of infrastructure
- the design of infrastructure to deliver intelligence (information)
- designing intelligence into infrastructure
- the intelligent use of infrastructure.

An important attribute of an intelligent system is that it uses the resources as effectively as possible to deliver maximum return for minimal investment of effort. For example, the scenarios explore how the *intelligent design* of urban environments for reduced travel could improve the performance of the infrastructure. Similarly, sensors and other technologies may be built into infrastructure to deliver intelligence about infrastructure performance.

The futures work identified significant benefits of collecting and processing that information, such as using the information so that travellers, operators and owners can make better use of the infrastructure.

We could also benefit from *intelligent infrastructure* that can respond autonomously and intelligently to external stimuli within a set of rules. In the transportation context, transport can then become an integral connected part of the wider infrastructure system.

Finally, there is *intelligent use*, as the action of users has a significant effect on how effective those designs are in practice.

Foresight futures

The workshops of experts narrowed the discussion down to four scenarios that make it possible to investigate the ways in which the 60 key drivers of change might play out over the next 50 years. The future is unlikely to look like any of these individual scenarios and may well contain elements of all four. While the scenarios do not purport to predict the future, they do allow us to see how

certain combinations of events, discoveries and social changes could change the future. As such, the scenarios allow us to see what we might need to prepare for and the opportunities that await us if we set the right path ahead.

We have labelled the scenarios:

- Perpetual Motion
- Urban Colonies
- Tribal Trading
- Good Intentions

The names we have given to these scenarios are designed simply to help people to remember them. Concise names are essential if the scenarios are to become part of a strategic conversation between an organisation and its internal and external stakeholders.

These scenarios arise from assessing the drivers of change in the context of two 'axes of uncertainty' that reflect the most important uncertainties. These axes encapsulate the range of uncertainties for the future, together with the range of possible outcomes. After some debate, the project workshops fixed on the degree of acceptance of intelligent infrastructure and the availability of transport that has a low environmental impact as the two axes.

The scenarios therefore reflect their position on the two-dimensional grid (see Figure 1, page 8). The names of the scenarios are intended as shorthand labels that capture the essential feature of each 'possible future'. It is worth restating here that these scenarios are just that, pictures of how the future could develop, with no special preference for a particular outcome, nor any likelihood that the real future will resemble any of these 'science fiction' views of tomorrow.

Perpetual Motion

Perpetual Motion describes a society driven by constant information, consumption and competition. In this world, instant communication and continuing globalisation have fuelled growth: demand for travel remains strong.

New, cleaner, fuel technologies are increasingly popular. Road use is causing less environmental damage, although the volume and speed of traffic remains high. Aviation still relies on carbon fuels and remains expensive. It is increasingly replaced by 'telepresencing' technology (for business) and rapid train systems (for travel).

A precondition of the 'always on' world of Perpetual Motion is energy supply, emission-free and preferably low cost. Here, we explore the use of hydrogen as an energy vector, but there are other candidates. The benefit of zero emissions at point of use that hydrogen gives us is a major advantage in this future.

Technology in all its aspects is a large but not exclusive part of the picture, and the human capacity to cope with such a world resists full-scale adoption. In this scenario, technology achieves levels of interoperability, resilience and ubiquity that renders it effective and trustworthy.

The strong economic position reflects a return on the investment made to deliver this technology and an energy-rich world. But, of course, problems still exist, arguably because technology is applied without regard to the design of the physical environment or its waste footprint. People are also too busy to think about efficient use. Crime adapts to a more connected world, as does law enforcement.

Urban Colonies

> *In Urban Colonies, investment in technology primarily focuses on minimising environmental impacts. In this world, good environmental practice is at the heart of the UK's economic and social policies; sustainable buildings, distributed power generation and new urban planning policies have created compact, sustainable cities.*
>
> *Transport is permitted only if green and clean – car use is still energy-expensive and is restricted. Public transport – electric and low-energy – is efficient and widely used.*
>
> *Competitive cities have the IT infrastructure needed to link high-value knowledge businesses, but there is poor integration of IT supporting transport systems. Rural areas have become more isolated, effectively acting as food and bio-fuel sources for cities.*
>
> *Consumption has fallen. Resource use is now a fundamental part of the tax system and disposable items are less popular.*

Urban Colonies identifies that improved urban design, organising ourselves to minimise the need for travel, has a contribution to make. In part, this is a response to environmental concerns and climate change, but it is also driven by suspicion about intelligent technologies, which means we have reason to find alternatives to travel. Cleaner technologies and low-emission energy create an environmental benefit, but the overall economic focus is more city-based than global, with medium economic growth. Societal benefits accrue from a society integrated more at the local level. Because of technology-resistance, safety benefits are limited and systems' resilience is uneven, itself arguably reducing global competitiveness. Clearly people in this scenario are environmentally aware and more careful in their use of resources.

Tribal Trading

Tribal Trading describes a world that has been through a sharp and savage energy shock. The world has stabilised, but only after a global recession has left millions unemployed. The global economic system is severely damaged and infrastructure is falling into disrepair.

Long-distance travel is a luxury that few can afford and, for most people, the world has shrunk to their own community. Cities have declined and local food production and services have increased. Canals and sea-going vessels carry freight: the rail network is worthwhile only for high-value long-distance cargoes and trips. There are still some cars, but local transport is typically by bike and by horse.

There are local conflicts over resources: lawlessness and mistrust are high. The state does what it can – but its power has been eroded.

The world of Tribal Trading is overwhelmed by shocks, initiated by a sharp energy shock and global competition for resources. In consequence, intelligent infrastructure is not on the agenda. It seems to be a world of opportunities not grasped and challenges ignored until too late. Some places fare better than others, but universally the focus is on making the most of the resources available, particularly locally, and being patient. Recycling is not just a good idea but an economic necessity. Technology is limited to that which is robust and able to cope with fluctuations in energy supply, and legacy infrastructure is patched and patched again. Society starts to recover eventually, but it is a long hard path.

Good Intentions

Good Intentions describes a world in which the need to reduce carbon emissions constrains personal mobility. A tough national surveillance system ensures that people travel only if they have sufficient carbon 'points'. Intelligent cars monitor and report on the environmental cost of journeys. In-car systems adjust speed to minimise emissions. Traffic volumes have fallen and mass transportation is used more widely.

Businesses have adopted energy-efficient practices: they use sophisticated wireless identification and tracking systems to optimise logistics and distribution. Some rural areas pool community carbon credits for local transport provision but many are struggling.

There are concerns that the world has not yet done enough to respond to the human activity which has caused the environmental damage. Airlines continue to exploit loopholes in the carbon enforcement framework. The market has failed to provide a realistic alternative energy source.

Good Intentions is a world initially hamstrung by trying to satisfy all interests, where consensus on the action required to minimise environmental impact is lacking until extreme weather has become so common that economic well-being is undermined by the impact on the environment. However, response is still delayed until drastic action becomes necessary and it becomes a struggle to maintain the previous levels of economic activity. Over time, technology systems become essential to deliver efficiency and allow use of individual CO_2 allowances. In the end, the world becomes dominated by carbon budgets in the absence of cheap low-emission energy. Slowly, the importance of designing the urban environment for less travel and efficient use of resources achieves sufficient importance.

Responses to scenarios

The project presented the four scenarios to groups of stakeholders and interest groups, ranging from local and regional government to sixth-form students and representatives from businesses involved in retail, logistics and distribution.

There was a range of reactions to the scenarios. The students from Eastwood School were clearly concerned about sustainability and wanted greater importance to be attached to delivering environmental sustainability. They looked to government and business to lead changes in behaviour, making unpopular choices if necessary, to protect the environment.

For local and regional government and business, the scenarios highlighted some of the opportunities and challenges ahead. They too wanted a clear future direction, to plan how they might benefit most strongly, but also to manage the delivery of a wide range of services, for example, effective high-quality public transport services. Open challenges included rural and social divides that technology might increase rather than address. Skills development was high on the agenda. For both, the West Midlands region and the Borough of Telford and Wrekin, the focus was on economic growth before the environment.

The time horizon for those involved in retail, freight and logistics is typically much shorter than the 50 years of the scenarios. The issues that they raised are the issues of now, such as congestion, regulation and skills. Their concerns about the environment were very much in the context of the impact on profits and margins. The sector responds to challenges and adopts technologies where there are clear cost-benefits, but their primary focus is clearly on economic growth.

Scenarios overview

Introduction

The uncertainties about the future of intelligent infrastructure systems include: what will happen in science and technology; the role of business and government; and social attitudes. To help to understand how these factors might interact, we produced four scenarios of the future. The scenarios were underpinned by the development of 'systems maps'. These allow us to look beyond the detail of each scenario and to think about why the trends and events they forecast might happen.

The scenarios do not set out to predict what will happen or to suggest a preferred future. They are stories that offer various possible, even extreme, outcomes. The scenarios are designed to stimulate thought, to highlight some of the opportunities and threats we might face in the future and to inform today's decisions. The full details of the scenarios can be used to judge the risks and opportunities of policy relating to the future management of intelligent infrastructure.

Axes of uncertainty – a matrix of options

After workshop discussions, the project concentrated on the degree of acceptance of intelligent infrastructure and the environmental impact of transport as the most important uncertainties in the future application of IIS in transport. The scenarios were set along two 'axes of uncertainty'. These axes encapsulate the uncertainties for the future, together with the possible outcomes (see Figure 1).

The axis Accepting of intelligent infrastructure ⟷ *Resistant to intelligent infrastructure* describes social attitudes.

At one extreme, there is the 'digital native' generation, which has grown up using technology and is confident that technology will continue to deliver and protect. Personal data and identity are protected; and continuous investment in physical and IT infrastructure allows the development of systems that are flexible, adaptive and integrated. Businesses take advantage of the integrated intelligent infrastructure to form wide-reaching networks.

At the other extreme, intelligent technologies are in place, but are not integrated. Terrorism, viruses, identity theft and fear of disruption and instability mean that people are mistrustful of integrated intelligent systems. Economic uncertainties add to their risk aversion. People rely on legacy infrastructure – or even bypass it where possible. Groups of businesses, and the affluent, use private networks and services.

The axis *High-impact transport* ⟷ *Low-impact transport* describes the consequences of transport on the environment, economy and society.

At one extreme on this axis, high carbon emissions, continuing dependence on oil, and a significant waste footprint all contribute to high environmental impact. Social impacts – noise levels, land take and lower social and community cohesion – are prevalent.

At the other extreme, clean-fuel technologies have reduced carbon emissions, the waste footprint has shrunk and resource constraints have forced manufacturers to emphasise product longevity. The social impact of faster transport, however, remains equivocal and segments of the community may still be excluded because of uneven access to transport.

Scenario comparison

The whole idea of working with scenarios is to look at alternative futures. In this project, the aim of the scenarios was to investigate how the various drivers of change might play out, and how they might influence the five key measures that the project set out to examine: economics, society, environment, safety and robustness (see Table 1).

Figure 1: **The axes of uncertainty and the four scenarios defined by combinations of those axes**

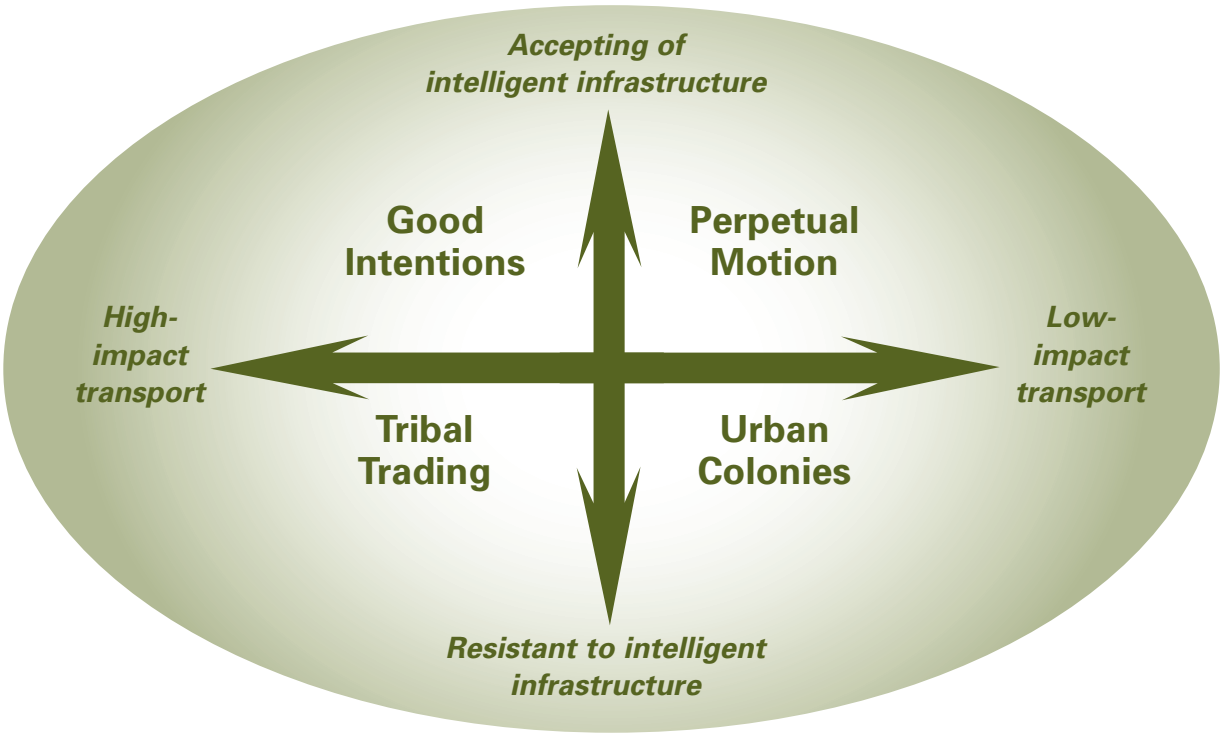


Table 1: Comparison of Scenarios against Key measures

	Good Intentions	Perpetual Motion	Urban Colonies	Tribal Trading
Economics	Continued economic growth, but not within environmental limits	Globalisation and technology drive economic growth	High-value knowledge jobs combined with strong local services drive	Deep global recession caused by energy shocks
Society	Slow to accept the need to change its behaviour	'Always on' society – growing divide between	Pursuit of socially inclusive society	Fragmented and focused on local communities – some
Environment	Concerns force governments to collaborate to minimise damage	Clean energy leads to reduced environmental damage, but the	Some improvement due to policies designed to reduce travel and	Limited travel and alternative forms of transport reduce emissions
Safety	High – though some concerns due to ageing infrastructure	Investment creates high level of (automated) safety systems	High in locally controlled systems. Interoperability issues between	Unsafe, insecure world. Infrastructure degrading
Robustness	Patchy investment affects interoperability	High – standardised, interoperable systems	Mistrust of IT systems reduces integration – but maintains	Little robustness – local solutions to local needs and no co-ordinated effort

The three-horizon approach

The three-horizon approach is fully described in the *Intelligent Infrastructure Futures: Technology Forward Look* document.

This method allows us to break the 50-year horizon of the project into three distinct phases (to 2025; to 2040; and to 2055), and to highlight the trends and drivers that will be critical in the transition between each phase.

The first horizon (Invent, Develop, Deploy) covers the roll-out of new, but understood, technical capabilities.

The second horizon (Research, Demonstrate, Disrupt) is the domain of current public and private research, which may result in innovation and invention, and may lead to market disruption.

The third horizon (Envision, Explore, Embody) is beyond the horizon of known science. It may focus on a capability that we know we will need in order to deliver a vision, and that we feel might be possible if our future efforts are focused. It is the exploration of unknown territory.

Scenario: Perpetual Motion

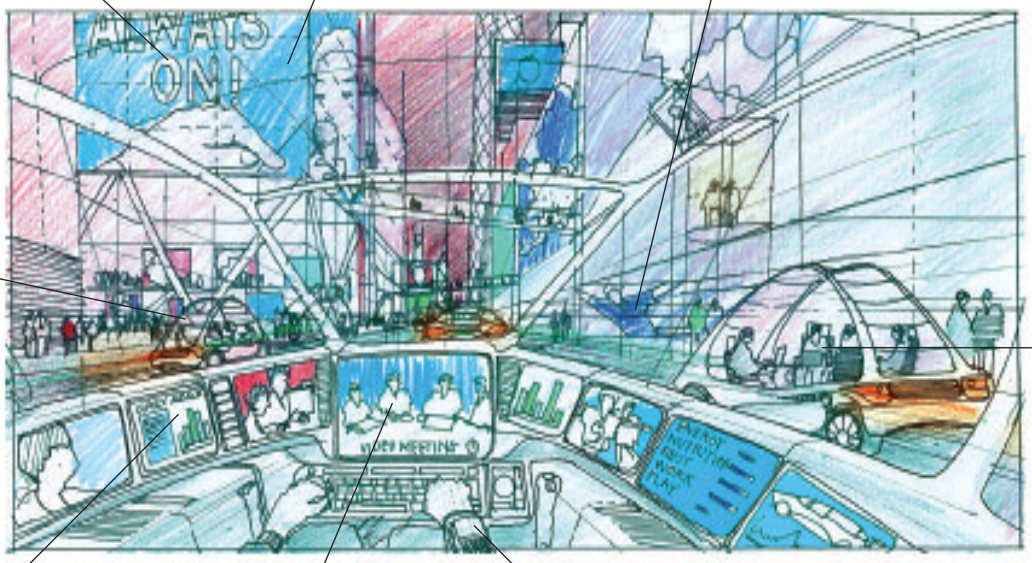
An artist's impression of Perpetual Motion in 2055

'Always on' culture

Interactive displays communicate with your personal digipad device and display media that is

Building facades become interactive as they turn into

Lots of private vehicular traffic, but low-emission vehicles are the norm and sustainable forms of energy are



Narinder Sagoo/Foster and Partners

Access to your diary, contacts, and financial information is available at all times

Fully guided vehicles allow you to dispense with a steering wheel altogether, allowing you to conduct video meetings and work while you are on the road

Personal digipad devices give you instant access to messages and individual media, allow you to interact wirelessly to the world around you and also to store

Flexible seating means that you can have face-to-face meetings while you are on the move, and frictionless vehicle technology ensures a smooth ride. This

The big picture is of a very busy city with lots of private car traffic, all running on clean forms of energy. Everyone is plugged into the grid and is 'always on', always in touch, and ready, willing and able to travel using clean forms of energy.

High-density cities and low-density suburbs

Timeline: Perpetual Motion

2055

2053 Auto-delivery systems increasingly replace humans in service jobs

2049 99.2% of UK citizens possess encrypted ID devices

2042 Sustainable housing more commonplace but costly

2040

2038 Growing resistance to 24/7 working patterns

2036 'LifeServe' technology incorporated into ID devices

2030 Tackling identity theft becomes EU's first priority

2028 Inter City Europe (ICE) rapid train system connects SE & Birmingham to Europe

2025

2021 Chief Wellbeing Officer's Report on stress levels released

2020 Real-time telepresencing perfected

2018 Enhanced ground-based GPS

2016 Hydrogen-fuelled guided buses trialled

2015 Encrypted ID devices tested

2013 Construction of nuclear power plants starts

2009 National Wireless Network connectivity

2005

'Everything and everyone should connect. Only time will tell whether this is desirable or not.'

John Miles and Janet Walker, (2006) State of Research Review[1]

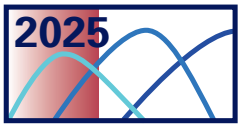
Perpetual Motion describes a society where the norm is constant information, consumption and competition.

Instant communication and continuing globalisation have fuelled growth: demand for travel remains strong.

New, cleaner, fuel technologies are increasingly popular: road use causes less environmental damage, although the volume and speed of traffic remains high. Aviation still relies on carbon fuels and remains expensive. It is increasingly replaced by telepresencing technology (for business) and rapid train systems (for travel).

Increased nuclear capacity and the development of renewable energy sources have further reduced dependence on carbon-based fuels.

Work, however, is intensive: stress is a growing problem in the developed economies. Many workers are considering ways to downshift, raising questions over the long-term viability of continued economic growth.



In 2025, the hypermobile world – long predicted by geographers – has arrived, fuelled by a cocktail of electronic infrastructure and significant developments in materials technology. It is 'hyper' in all senses of the word: people are 'always on', with messages and individual media streamed continuously to their digipad.

The foundations of hypermobility were laid in 2009 with the development of a range of intelligent miniature devices that connected consumers directly, and continuously, to UKNAN, the first national area wireless network. This has been driven by elements of the public and private sector, due to interoperability of service standards. Some parts of the country are well served by the so-called 'bubble' of local and national wireless services, but others receive no service at all. Trust in the electronic infrastructure was low at first, but once the lifestyle and retail advantages of an 'always on' connection – whether at home, in the office, in the street or in the shops – became clear, many individuals put their concerns regarding privacy and reliability aside. Sales boomed.

Government and business have collaborated to explore the possibility of intelligent, encrypted support devices for every citizen over the last few years. The pilot scheme in Manchester was four times oversubscribed and take-up since the roll-out has been strong. One of the most popular features of the devices is their ability to manage owners' finances, using 'agent' technologies to automatically switch funds between different assets to maximise short-term returns.

1 See Miles and Walker (2006) *Artificial Intelligence in Transport*, IIS Foresight state of research review, www.foresight.gov.uk

Furthermore, there has been no shortage of private sector service providers seeking to integrate their own smart technology with the government-backed scheme in recent years.

On-board driver assistance

Ambient intelligence – intelligent and intuitive interfaces supported by computing and networking technology which is embedded in cars, roads and driver's clothes – and artificial intelligence combine to provide on-board driver assistance. The result is a system that supports and enhances human decision making in the car.

The in-car system communicates with the national array of sensors to provide real-time data on traffic and network performance. The information itself is useful to drivers, but the car operates most efficiently when it is given control and itself chooses how to respond to the data.

Automated highway systems are now operating on major commuter routes, creating trains of automatically controlled cars that travel close together at high speed.

Governments and local authorities worked with car manufacturers to integrate disparate vehicle management systems designed to even out traffic flows and reduce congestion. Integration was patchy at first,[2] and some pilots less successful than others, but the pan-European agreement on communications standards and language use was a major step forward.[3] The integration of advanced ground-based global positioning system (GPS) receivers with wide area augmented system (WAAS) capability in 2018 enhanced reliability and range of coverage significantly. But, if the systems helped people to manage their way around congestion, improving their experience of commuting, they were a disaster environmentally.

More people bought bigger cars and travelled further using the new systems, increasing carbon emissions. By 2020, 50% of CO_2 emissions came from road transport and the Government's commitment to reducing CO_2 emissions by 2050 looked dangerously threatened. Aviation was doing little to help the situation. This, coupled with increasingly erratic oil and gas supplies, finally persuaded the Government to invest in the development of the applications – already functioning in prototype – that enabled the shift away from a dependence on carbon-based energy supplies.

Some applications were already being tested on the streets. GOALS, the Government for London and the south-east, had started the transition in 2016 to a full fleet of guided buses across the region, financing it from the proceeds of the Journey Enabler Levy (as the Congestion Charge had become known) to help meet the cost of implementing a widespread hydrogen fuel supply infrastructure.

2 See 'European carmakers struggle to deliver pan-European in-car telematics' *Automotive News,* 2 September 2005, which highlights problems concerning the lack of European communications standards, multiple languages and the failure of the industry to agree on a definition for telematics.

3 See McDonald (2006) *Delivering Information for Transport Management,* IIS Foresight state of research review, www.foresight.gov.uk.

Now, central government developed a complex set of sanctions and incentives to encourage oil companies and car firms to invest seriously in the development of consumer hydrogen cell applications.

Hydrogen fuel cells

Hydrogen tablets – safe, easy to store and to transport, energy-cheap to make – are now used widely in public and commercial vehicles. The economics of production still means they are expensive for widespread use – but not prohibitively so and sales of domestic hydrogen cars are increasing.

The tablets are extremely stable, so distribution from regional conversion plants is straightforward. They are also reusable – catalysis can take place locally.

The tablets are increasingly used to provide heat in public buildings, but the technology needs to be adapted and it is still an expensive option. Planning regulations also require optimised rainwater recycling and solar panelling.

For the car manufacturers, struggling with over-capacity and falling productivity, this was a lifeline. They responded to these incentives by investing heavily in a range of technologies that reduced the environmental impact of motor vehicles.[4] Gradually, more hybrid or complete hydrogen cars can be seen on the UK's roads, but they remain restricted to urban areas due to the infrastructure required to support them. Arguments continue about who should fund the refuelling stations in more rural parts of the country; everyone wants to see it done but no one seems prepared to put up the cash, as yet.

It's not just in transport infrastructure that the impact of hydrogen can be seen. Hydrogen cells, with hydrogen generated by capturing local solar and wind energy, are also being used to power some showcase new-build developments in Leeds and Edinburgh. Hiring the architect behind the Malaysian sustainable housing prototypes proved to be a wise decision.[5]

Materials technology

The introduction of smart materials into concrete has increased its reliability and provides a better performance. Sensors embedded in concrete structures monitor deterioration levels and can trigger self-repair.

Self-ordering silicon-based materials, which reproduce to produce dendritic networks with sufficient connectivity to create an electrical circuit, are now commonplace. Large-scale buildings and new housing developments are coated in 'silicon paint', providing a solar photovoltaic collector for solar-powered electrical energy.

4 See comments by former Belgian transport minister, Isabelle Durant, EU round table 'Roads to climate-change transport are many', organised during European Commission's Green Week, 29 June, 2005 www.euractiv.com

5 '…a growing belief that the real 21st century revolution in sustainability will come from the so-called 'Third World.' These nations are going to be first to be hurt by the ravages of climate change, and won't have the resources to adopt – or time to wait for – Washington-approved technologies and practices.' 'Malaysian Solar-hydrogen house' Jamais Cascio, 20 April 2004, www.worldchanging.com/archives/000604.html. See also 'Bordering on Chaos' *Wired* magazine, July 1997, 'It's…clear the so-called developed world is losing its once-exclusive claim on innovation and efficiency.'

Progress on the cleaner plane has been far slower than on the cleaner car. Energy efficiency – long a priority for designers – improved by 20% through the first decade of the century but these gains were more than offset by a 50% rise in demand over the same period.[6] By 2020, it became apparent that growth in the aviation sector needed to be curbed if the UK was to meet its CO_2 obligation.[7] Government's response – tightening the cap on air-travel emissions – forced fares up when combined with the rising oil price. At the same time, UK industry and consumer associations – furious at the additional pressures for carbon neutrality placed on them by aviation's continued growth – waged a campaign in support of alternative methods of travel. Consumer demand for short-haul flights tailed off as prices increased and attitudes hardened.

While the building of new airports is clearly off the agenda, seven new nuclear reactors are being built. Three of the reactors are finished and are currently undergoing final safety and security checks; two are behind schedule because of contractual wrangling, and the one being built on the Thon site has been dogged by delays since the citizen protests throughout the early stages of its development.[8]

With air travel seen as a less viable option to get to Europe, the ICE rapid train system has become a popular option. The Government is preparing to connect the south-east and Birmingham to the ICE network, which already runs through to Frankfurt and Basel. EU Structural Funding has made this a viable and affordable investment for the first time.

The expanding rail networks have taken on further significance for consumers since the first real-time telepresencing technology was launched in 2020. While adequate technology had been in use – on a very limited scale – for several years, the system is now finally of a standard that business finds acceptable, making the concept of remote working from parts of Europe while telepresencing with UK colleagues a reality.[9] It is too early to tell if the technology will start to change individual or business behaviour – many people still prefer face-to-face contact – and it will take time for the 'social learning' to have a significant impact on travel patterns.[10]

6 The Government's White Paper, The Future of Air Transport, published in 2003, predicted that Britain's passenger numbers will more than double from 180 million to 475 million over the next 25 years.

7 Tyndall Centre, report on climate change.

8 Friends of the Earth campaigner, Bryony Worthington: 'We have never built a nuclear reactor in this country on time or to budget or that has succeeded in achieving the levels that were expected.'

9 See Teledrive system, developed by nine partners from four EU countries.

10 See Banister and Hickman (2006) *'How to Design a More Sustainable and Fairer Built Environment'* IIS Foresight state of research review, www.foresight.gov.uk

Telepresencing

Telepresencing combines videoconferencing and virtual reality to create three-dimensional, high-speed, fluid interaction across different geographical locations.

The software automatically stitches together feeds from several cameras by integrating the visual data with the camera's location and the direction it is pointing.

In this highly connected world, life and work are intense, and the boundary between them is blurred. Some thrive on the buzz of activity that results, but early burn-out is common and stress is a way of life for the vast majority of the UK population;[11] even low-paid service workers are so used to being 'always available' that their holidays are no longer a real break.

In order to meet the increasingly diverse and demanding business, social and leisure needs of such an affluent, 24/7 society, a growing number of service workers are forced to work anti-social hours. So far, there has been little protest: however, as such conditions are generally considered another aspect of the 'work hard, play hard' ethos which permeates through all levels of society. Not everyone finds it easy to 'keep up' with the growing competition for the most desirable, highly paid jobs. The use of prescription and non-prescription drugs to manage stress continues to boom, even in the face of increasing evidence, and knowledge, of side-effects.

In 2021, stress is undoubtedly the new obesity with a raft of reviews on the subject by the Government; the Government's Chief Well-being Officer (CWO) released a research report which estimated that the cost of stress to the economy was well over 1% of GDP, and linked high stress levels to a sharply increased likelihood of Alzheimer's disease in later life.[12] The CWO and the Department of Well-being's efforts to staunch the 'always on, always looking' culture with a 'You don't have to be on' campaign met with little success, for which the advertising agency took the blame. It had received only lukewarm support from the Treasury, who wanted to maintain the strong economic growth of recent years. The CWO's recommendation to 'zone out', disconnecting from the network for at least 20 minutes a day, has been followed by a few.

While a significant number of, mainly younger, people thrive on the buzz of living in the urban hubs, telepresencing and ever more powerful miniature communications devices are increasingly allowing the more affluent to move to the outskirts of towns or to rural areas. They can remain connected, but are able to reduce the 'hamster wheel' feeling that is sometimes overwhelming in the city centres, by being closer to the open space of the countryside. While this has had

11 'Managing work–life balance comes up time and again as one of the major challenges facing people today. It causes stress to the individual concerned and also to the people around them.' 'Stress and work–life balance: seven steps to supporting a client's work-life balance.' By Helen Whitten, *Stress News,* 2003, Vol. 15, No. 4.

12 Study by Rush University Medical centre in Chicago, as reported in the 25 January, 2005 issue of the *Journal of Neurology* (scientific journal from the American Academy of Neurology).

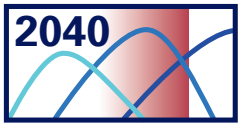
significant benefits for several rural communities which had been on the brink of extinction, some urban councils are expressing concern at the development.

They fear that town centres could be left with an unstable and polarised mix of residents: affluent urbanites, thriving in their wired and highly strung world, and those at the other extreme – the disenfranchised, who have shunned or been denied ID and have become increasingly cut off from mainstream society. As well as continuing identity theft problems, there are those threatening ID deletion. The more information held by the ID devices, the more valuable they become. There are already pockets of extreme and often random violence, with fears that it could get far worse. Although electronic surveillance should deter such behaviour, devices which 'fog' the electronic systems are available cheaply everywhere. And while the police technology improves, so do the skills of the hackers. For most police forces, it's a question of priorities; clamping down on possession of a fogging device isn't their biggest problem right now.

In response, some communities are implementing their own measures. They are putting in place community or street-level quiet zones,[13] restricting vehicles to 10 mph and barring individuals who are not known to residents.

Critical issues going forward from 2025

- Affordability and roll out of fuel cells
- Impact of telepresencing on travel
- Extent to which 'big brother' technology will be embraced by citizens
- Desirability of city centres as a place to live
- Fuelling the 24/7 society
- Competing policy objectives to increase productivity and reduce stress



By 2032, ID devices were well and truly embedded in people's lives. Since then, a raft of new services has been added: owning a device is now essential in order to play a full role in society.

The leading ID device provider – InDispensible Inc. – has recently incorporated sophisticated 'LifeServe' software into its devices.[14] With such services making life increasingly slick and secure for individuals, it is easy to see why the number of citizens without ID devices is now negligible. Those without devices have either been refused on security grounds or for mental health reasons.

13 'Many urban streets in North America, Asia, Africa and Latin America are now privatised and self-contained rather than open and inter-connected…these are carefully segregated and "fortressed" from the rest of the city through walls, gates and high-technology surveillance systems, yet sustained through guarded, dedicated highway gates, customised and water and energy connections, and telecommunications grids, that selectively connect them to the wider urban constellation and the universe beyond…one gated community near Phoenix now even operates its own fleet of electric vehicles which can not be used outside its boundaries on public highways.' Kirby (1998), cited in Graham and Marvin (2001), *Splintering Urbanism* Routledge, London.

14 See Gelenbe (2006) *Users and Services in Intelligent Networks*, IIS Foresight state of research review, www.foresight.gov.uk

LifeServe

LifeServe brings ambient intelligence to the workplace, the home or to wherever users are.

The agent-based software can alert parents when their children leave the school grounds, calculates the most cost-effective transport route for every journey and automatically schedules telepresence meetings, with colleagues, family, friends, GPs or whoever.

Users can access different service levels – connecting to national sensor networks, local sensor networks or specialist sensor networks, monitoring, for example, air quality, water quality or commuter levels.

Despite high levels of trust in ID devices, tackling identity theft has rapidly become the European Union's first priority. Levels are just about being contained, but there is a real danger that consumer trust in the system will be permanently damaged if fraud levels cannot be better controlled. The EU Intelligent Fraud Tracking Centre, based in Finland, is constantly trying to keep up with the everchanging blocking devices which protestors continue to use, with some success. Disputes seem to focus increasingly on claims of inaccuracy in the system.

The hydrogen economy has now become the reality, and in a way that assuaged the earlier fears of many environmentalists. The combination of increased nuclear capacity and the development of renewables had reduced dependence on carbon-based fuels. Clean-coal technology, combined with effective carbon sequestration, smoothed demand at power stations and mitigated much of the carbon impact by dealing with it at the top of the supply chain rather than at the end of the exhaust pipe. The re-opening of many of Britain's coal mines came as a surprise to some; and there were bitter opponents to the New Coal Build programme in many of the long-regenerated and long-greened former mining areas. It was hard, too, to find people willing to work underground, which had got little safer in the intervening 60 years. High wages attracted some.

Carbon sequestration

Carbon sequestration is a means whereby gases that are contributing to climate change are captured from power stations, separated and stored deep underground in suitable porous rock layers, such as depleting gas and oil fields.

As the gas never reaches the atmosphere or the ocean, it cannot contribute to climate change.

Such an initiative is a potential solution to the carbon dioxide problem, at least while renewable energy capacity is being brought online.

Some 40% of global fossil fuel CO_2 emissions are captured and stored this way, including 50% of electricity generation and 40% of industrial CO_2 emissions.

Over the last 20 years, full operation of the seven nuclear power reactors has reduced the UK's greenhouse gas emissions by just under 5%.[15] The picture is similar across Europe, where most countries followed Finland's commitment to new nuclear power in the early 2000s. What to do with the waste remains an issue, despite the fact that the amount of waste produced by the modern reactors is significantly less than from plants such as Sizewell B in the past.[16]

It's not just nuclear waste that is a potential future problem. Ever increasing consumption of goods and high-impact services means that society's waste footprint is growing inexorably and unsustainably. Critics continue to insist that more effort should be put into reducing energy use than to continue to pursue an energy policy based on 'predict and provide'.

With ID devices the only means of making reservations and paying for a seat on all ICE rapid trains, journeys such as those from Birmingham to Basel are seamless and quick, as well as relatively low-cost in environmental terms. Further routes continue to be added across the continent.[17] Long-distance guided vehicle systems have also helped. Some travellers simply lock their car into the guided lane of a motorway and go to sleep while the vehicle takes them there, sometimes overnight – a phenomenon that's known as 'night-riding'. The system is now far safer than it was, and earlier problems about risk and liability were removed when the Treasury calculated that the cost of underwriting any liability was far less than the social and environmental benefits of doing so.

More locally, public transport has mostly been replaced by the Swarm; a type of integrated mass taxi system. Local people-carrier vehicles are despatched into specific areas of city, and are alerted to user locations and journey requests through their positionally enabled mobile phones. The network calculates the most efficient way of collecting and delivering multiple passengers, and allocates the fare. In a world of integrated intelligent technology, security for the traveller is ensured because the identify and provenance of each passenger is known as soon as they make their journey request.

15 Friends of the Earth has stated that doubling our nuclear capacity – to something like 28 new power stations – would reduce greenhouse gas emissions by 8%. Keith Parker, Chief Executive of the Nuclear Industry Association, believes it would be more. BBC 'Is Britain's future really nuclear?' www.bbc.co.uk.

16 Michael Meacher, former Environment Secretary – 'There is still no practical method for dealing with radioactive waste from nuclear power stations.' BBC 'Is Britain's future really nuclear?' www.bbc.co.uk. See also comments by Mike Parker, Group Chief executive of BNFL, 'nuclear waste from these modern reactors would be dramatically reduced.' www.spectator.co.uk/bnfl/article1.html

17 'Prior to the early 1990s there was little significant commuter rail traffic in Spain at all but it has now grown enormously following heavy investment in new trains and stations, in particular.' The Association of Train Operating Companies, *'Ten-Year European Rail Growth Trends'* July 2004.

Swarming buses

Autonomous swarming networks of buses are being tested in several locations.

The networks can process large amounts of information about traffic conditions and points of demand – the latter from tracking passengers' mobile devices.

The buses can modify their routes to speed up journey times and to collect passengers from pick-up zones, which are relatively large – rather than from dedicated stops.

Passengers can get on any bus that contacts them, rather than having to wait for a particular number.

The biggest barrier to take-up is the reduced anonymity – the vehicles are closer to cars than buses in size and the proximity between passengers is increased.

But there have been significant changes in social behaviour as a growing number of individuals started to fight back against the pervasive 'always on' culture which threatened to subsume them. More and more businesses utilise telepresencing to reduce the number of flights required by their employees.[18] Not only does this save significant flight costs, but it also makes clear business sense; workers are less tired from long flights, see their families more, are better rested and have improved work–life balance. This in turn results in less-stressed employees, greater productivity and a lower healthcare bill for the company. Not all organisations have seen the light, but the tide has started to turn. The Campaign For Family Time, initially started by the Salvation Army, has attracted a surprising number of supporters and the group's political clout is growing.

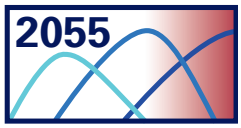
Growing home working and telepresencing have not reduced levels of travel as much as some had hoped, however. It seems individuals still enjoy the sense of leaving the home, as well as the desire to explore. Individuals are still seeking stimulation and excitement and it's not always easy to find it when the people you pass on the street are caught up in their own virtual world.

Workers are pushing back in other ways too. The suicide of the high-profile CEO of one of the UK's largest management consultancies proved a turning point. Some have begun to re-evaluate their life and their priorities, and are starting to insist on utilising their full holiday entitlement every year. Virtual-reality sleep software has also become popular. Whatever the benefits of affluence, the personal costs of the technology it brings with it are increasingly visible.

18 BT, 'Broadband – the role of communications in beating congestion' p11 www.bt.com/travelsubstitution. One respondent in the SUSTEL European research project on teleworking said, 'travelling less = more time at home = balance of home/work priorities = less stress = better performance.'

Critical issues going forward from 2040

- Low-emission energy generation and efficient energy use
- Liability if some of the smart systems go wrong
- Extent to which public transport can justify itself
- Extent, scope and pace of backlash against the 24/7 society
- Finding ways to cope in the 'always on' society
- Lowering the environmental impact of consumption



It's 2 August, 2055. A raft of developments in ICT and intelligent transport throughout the 2010s and 2020s have helped to fuel the 'always on' society of the past 50 years. Intelligent positioning systems, encryption technology, real-time telepresencing and a shift towards a low-carbon economy have all played their part in driving the rampant consumerism that shows few signs of abating.[19] If energy issues have been addressed, other sustainability problems have not. Europe's waste footprint is still far larger than Europe is; we are still a 'three-planet' society, sustained only because, globally, the poorest are poorer than ever. In a far richer society, there is a vast service sector, increasingly offering high degrees of personalisation.

Jill's journey

Jill was awakened in her Oxford Hotel by her digipad and informed that her flight had been cancelled and she was rebooked on the earlier one – leaving her no preparation time before heading off for the airport. Fortunately, her route included a stretch of automatic car train where she could switch in – and gain 20 minutes to make notes of the important points and forward them to her staff in Birmingham.

As she sat back on the plane to Edinburgh and received her in-flight email, Jill noticed she was increasingly feeling wrung out by the accelerating pace of life. She resolved to persuade her colleagues to telepresence more. Her partner had been pressuring her for some time to opt out of the 'travel anywhere at the drop of a hat' business culture – and if it took off, she could relocate to one of the virtual commuter villages out of town.

When she returned to her car at the end of the day, she switched off all the systems, got out an old-fashioned dog-eared map and plotted a longer way home down a series of by-lanes. 'I'll claim system failure if they try to fine me' she thought. 'Anyway, we should have the right to switch off'.

19 'The transition to a hydrogen economy... is the checkmate move in the Oil Endgame.' Amory B Lovins et al, 2004, *Winning the Oil Endgame* Executive Summary, Rocky Mountain Institute.

Encryption technology is responsible for one of the biggest changes in society; intelligent ID devices have been phased in over the last 30 years and over 96% of UK citizens now possess a device that does everything from advise them on entitlement to public benefits to alerting them when their children leave the school grounds. The technology was not without its problems – most notably with regard to identity theft, which threatened to spiral out of control for a period in the early '20s – and a hard core of 'refuseniks' remain ardent in their opposition to a system which they believe is so susceptible to abuse.

Demand for travel and transport has remained strong in this 'always on' world – transport is now well connected, semi-automated and (mostly) friction-free. However, with new technologies – which combine low or zero emissions with energy 'vectors' that ensure efficient energy capture and storage – ensuring that environmental curbs on car use are unnecessary, traffic management remains a critical problem.[20] Motor manufacturers' success in developing hydrogen-fuelled vehicles has helped to meet the desire for more cars, but they are not cheap (and neither are the sustainable housing developments which also utilise hydrogen storage of energy). However, cyclists and pedestrians continue to have a tough time – even without the afterburn of diesel or petrol in the air, the volume and speed of traffic still means that many urban environments are not pleasant places to cycle or walk in. So-called 'intelligent vehicle management', in which motorists are required to switch over control of their vehicle to local guided transport systems, seem to make cars less predictable, not more so. At least in the old days a cyclist could catch a driver's eye to make sure they'd been seen.[21] More broadly, transport use and benefit remains as polarised as it was at the end of the 20th century.

20 See Siemens 'Pictures of the Future', *Strategic Visioning* p9 & p21.

21 See Simon Norton, response to the World Business Council for Sustainable Development report, 'Mobility 2030: Meeting the challenges to sustainability': www.ecoplan.org

Family get-together

Andrew was looking forward to the family reunion. He had spent many hours juggling with the integrated travel system to find the easiest and cheapest way to get his two sons and his five grandchildren together for 24 hours.

They were coming from Southampton and Glasgow to near Nottingham using the latest fashion, the 'family meeting caravanserai'. These were located at different hubs in the country designed on the lines of a hi-tech village with actual and virtual gathering rooms and accommodation. They were specifically designed to make use of the new intelligent modal integration which had evolved over the past 20 years to make use of the breakthrough in low-cost transport energy.

He remembered his own childhood, when it had been difficult and expensive to meet up for family events because of the high cost of fuel and the fragmentation of travel systems. His two sons, however, were plotting to persuade him that the twice-a-year get-togethers be reduced to one and instead to install the new 'home virtual meeting' system so that they could schedule impromptu exchanges. Then they wouldn't need to be tied up helping him to play with his grandchildren.

It was proving hard to persuade him that a virtual hug was a good as a real one. His response was to try persuading them to spend the money on one of the new hydrogen-powered cabervans that he could plug into the automated motorway network and drive safely to see them despite his age.

The negotiation is still proceeding!

The speed and efficiency of the ICE rapid train system has made it extremely popular, and it now stretches across large parts of Europe, including the north and the midlands of England, and to Edinburgh. The perfection of telepresencing has gone some way to reducing business travel, but the individual desire for mobility remains a strong one. Safety concerns around new technologies and increasingly fast travel were often raised in the 2010s and 2020s, fuelled by glitches in the system, but also by misuse and, sometimes, malicious damage by disenfranchised groups in society. But trust in technology is the rule rather than the exception, largely because of the legacy of the 'online from birth' generation.

Individuals are empowered inasmuch as they are increasingly able to take control of their own education and careers; many thrive in such a world. Work and leisure have blurred; this is a world which is 'always on' and people are often expected to be always present, at least electronically. High-intensity work experiences are matched by high-intensity leisure, in the form of multi-user games and designer stimulants. However, the need to maintain their skills in such a competitive environment, along with fewer opportunities to switch off

from work, has taken its toll on many. Stress-related illnesses, use of illegal performance-enhancing drugs in the workplace and obesity levels continue to rise.[22]

While technology has enabled some individuals to move out of the city centres away from the constant buzz of life – this has left some urban centres vulnerable. Inhabited by the highly stressed and affluent, but also those outside mainstream society who survive largely by stealing, or as they put it, sharing, the identity of others, they have seen a rise in criminal attacks and violent behaviour.[23] Some have moved to the 'whitespaces', the remote rural areas beyond the electronic network, and preach the virtues of self-sufficiency.

As a society, we are richer than ever, more than twice as affluent as we were in 2005, and one consequence is that there are different attitudes among some to the value and purpose of work. Another is that it is increasingly hard to fill jobs that involve working anti-social hours. Even when migrants who have the language skills needed in the service sector can be hired, they stay only for a few weeks or few months before moving on. With fewer people needing the pay from such jobs, and a growing realisation of the social costs of such work on family life and social relationships, many service deliverers have been forced to put in place sophisticated auto-delivery systems in order to continue to provide the levels of service and frequency of delivery their customers have come to expect. And the 'Tune Out/Drop In' campaign, regarded as the work of mavericks and eccentrics when it started in 2025, is becoming increasingly mainstream…

22 'Not necessarily the fastest or strongest, but those with stamina are the most successful. This means an increasing exposure… to chronic stress.' 'Stress, a male status symbol?' by Professor Sepp Porta, *Stress News*, April 2004 Vol. 16 No. 2.

23 See Graham and Marvin, *Splintering Urbanism* (2001), Routledge, London.

An urgent delivery

Mike needed that spare part urgently. Yesterday to be precise. His client was expecting 24/7 service, but the world of bits and world of atoms are different, Mike mused. He had noticed that the more people used virtual services for information and knowledge, the more they seemed subconsciously to expect anything from food to spare parts to appear instantly at the push of a button. Distribution systems had indeed become amazingly efficient as eventually business people had grasped the implications 20 years ago that their supply-chain systems were primitive, despite the gloss of digital technology.

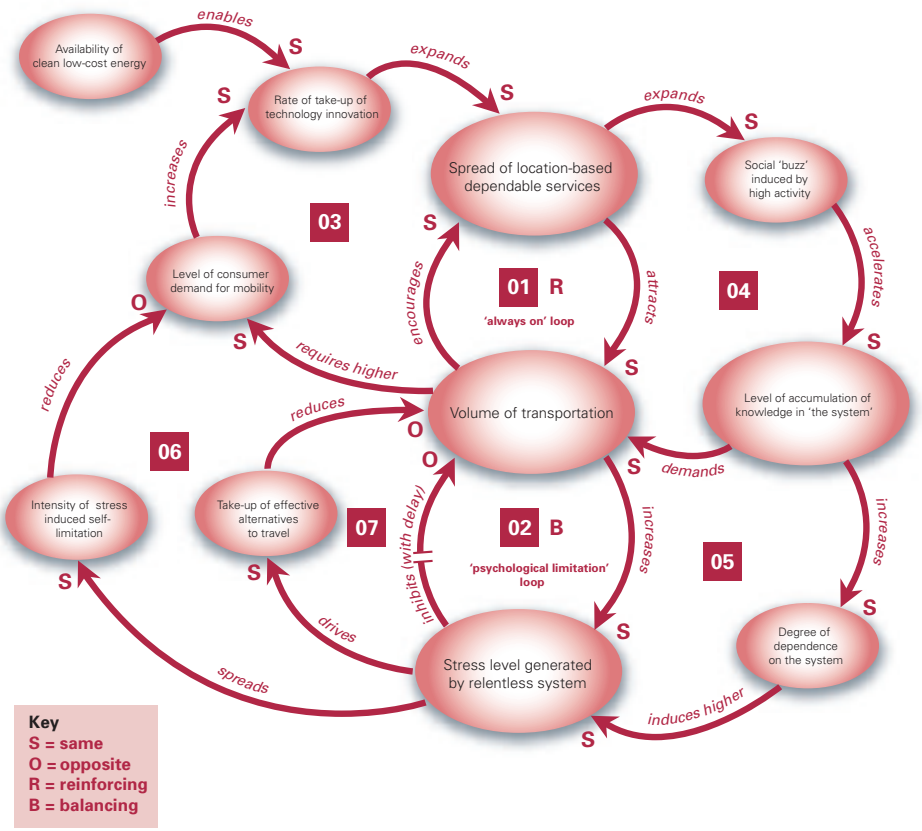
Mike did another search for a fast match between requirement and supply. He had just invested in the new generation of intelligent agent that was supposed to always hit the optimum routing for small to medium packages. The intermodal transfer of packages had developed into a 'Parcel Internet,' which claimed to have the routing pathway flexibility of the digital Internet. The innovation had done for parcels and goods flows what TCP/IP protocols had done for digital telecoms.

Bingo! The search showed there was a way to route the delivery by getting the same component from an unexpected source. And the cost was reasonable. A few moments later the deal was done and Mike turned to the list of other priorities streaming across his wall-sized screen. As a youth he had excelled in complex video games and had pioneered new frontiers of interactive gaming as a beta tester. So manipulating a complex interactive distribution service was like a reflex to him.

Today, though, he found himself suffering a bout of what psychologists used to call 'cognitive breakdown'. Somehow the dancing symbols on the screen, the flashing alerts and the flowing pathways just didn't seem to connect. An image came to his mind of a foaming glass of real ale. He switched the system to robot mode – accepting that he would make 20% less money this afternoon – locked the control room and walked across the park to the cyberpub which had its own micro-brewery and a secluded garden where use of wifi equipment was forbidden. He sat under a tree and contemplated his life.

Core and major causal loops

The 'always on' loop stimulates demand and traps behaviour in a supply-and-demand escalation. The 'psychological stress' loop limits the pace of innovation and development, but the effect is delayed. Noticeably, the key enabler is the availability of clean low-cost energy. The logic of this system has been applied to provide structure to the scenario.



01	'Always on' Loop	Stimulating demand and trapping behaviour in a supply/demand escalation
02	'Psychological limitation' loop	Pushing back on pace of innovation and development
03	Technology consumption loop	Interest in consumer electronics and vehicle technology drives innovation
04	24/7 Infective loop	Sucks people inexorably into the hyperactive way of life
05	'Road Warrior' loop	Leads people to become overdependent and trapped by the pace of life
06	Opt-out loop	More and more people reaching a saturation point and simplifying life
07	Information technology loop	Penetration of ICT remote working and collaboration systems

Scenario reflections

The underlying narrative in this scenario – of constraints overcome by technology and innovation – represent the dominant discourse in western culture for at least the last 150 years. Such a world is best reflected in the values and aspirations captured in our stories about engineers such as James Watt or Thomas Edison.

The familiarity and comfort of the theme of 'constraints overcome' is perhaps why this scenario appealed so much during the testing phase of the work to both the business community and to technologists and scientists.

However, some of the critical assumptions behind the narrative need to be considered. In particular, it is evident that there is a resource constraint which will play out at some point in the world of Perpetual Motion. Although the environmental impact of travel is lower per kilometre travelled in the scenario, its overall impact still remains high. There is also a high level of consumption of other goods and services, which have resulted in the unsustainable 'three-planet' waste footprint described in Perpetual Motion. It may therefore be sustainable only if production becomes sustainable – through the 'zero-waste' world described by some theorists – and if there is also a dramatic shift towards reducing the environmental impact of services. This in turn must raise significant questions about the desirability – and the longevity – of the scenario, and about the types of incentives that would reduce environmental impacts.

For this reason, social impact is also a concern. The scenario as portrayed suggests strong polarisation within the UK, and also between richer countries, which can afford the investment implied within the scenario, and poorer ones. The gap would widen between the haves and have nots.

Alternative energy sources are critical to drive the consumerism inherent in this scenario. The uncertainty is about whether these will produce the sheer scale of energy required in this world, and whether this can be done in a way that reduces carbon consumption rapidly enough. There are uncertainties about the speed at which the science can be translated into applications – and the speed at which applications move from initial adoption to the mainstream – and whether, as a society, we are willing to tolerate the investment cost of this and the social disruption it implies in the first part of the scenario, over the next quarter of a century.

Perpetual Motion is a possible world only if we can develop sufficient low-environmental-impact alternatives to the carbon economy quickly enough to enable continued widespread individual travel. This is one critical dynamic of the scenario which prevents it from reverting to Good Intentions, at the other extreme of the horizontal axis. Potentially, it also carries within it the seeds of the 'overshoot and collapse' scenario represented by Tribal Trading. The progression of science and technology towards a low-carbon world is finely balanced within the scenario.

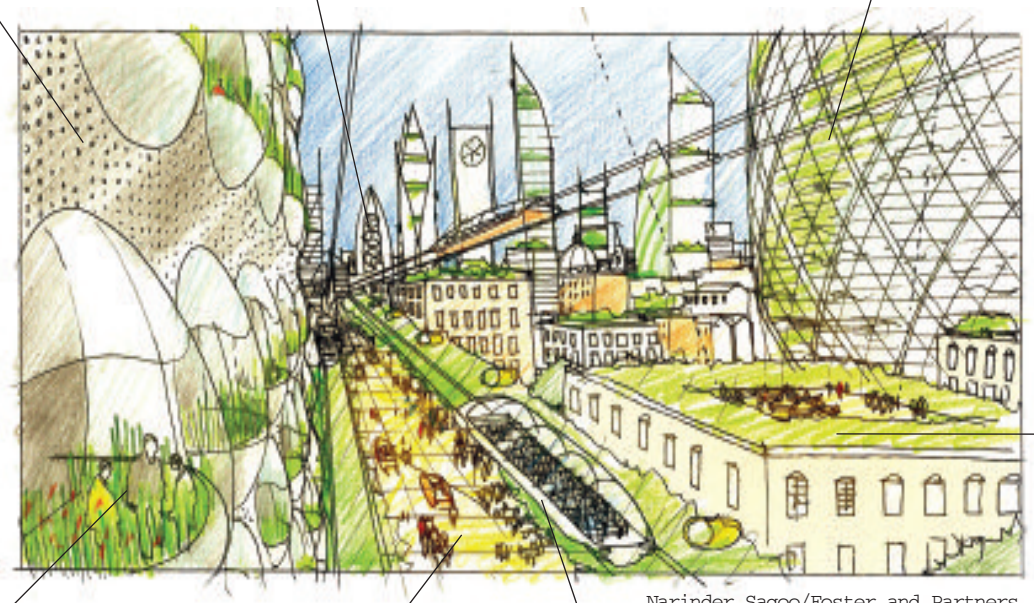
Scenario: Urban Colonies

An artist's impression of Urban Colonies in 2055

Photovoltaic building skins are a standard feature

Building-integrated energy generation systems are a standard feature of all new buildings

Sky gardens – 20th-century tower buildings with atria are exploited to provide even more green



Narinder Sagoo/Foster and Partners

Truly green design: Building facades have hydroponic facades and integrated gardens that help supply the city with locally produced fresh fruit and vegetables

The decline in private automobile use has led to the pedestrianisation of streets and a better quality of public life

Cycling and walking are an integral part of everyday life, and hydrogen-powered public transport systems are widely used by all

Green roof to help reduce the 'urban heat island' effect, serve as elevated parks for people and also provide opportunities for

The big picture is of a high-density (but not necessarily high-rise) green city with a lot of locally produced goods and efficient public transport systems. Buildings are sustainable and the public realm is active and vibrant.

High-density, mixed-use, compact cities

Timeline: Urban Colonies

2055

2051 75% of UK tax revenue comes from resource-based taxes

2049 Beijing evacuated after dust storms

2042 Full-cost accounting becomes standard accounting procedure

2040

2038 20th city connects to global intercommunications network

2036 Last UK Council opts in to 'freecycle' scheme

2030 15% of UK power comes from 'microgrids'

2026 Consumer Goods Act requires that goods are repairable

2025

2022 Government meets revised Kyoto targets

2021 Europe-wide virus attack collapses system

2017 Mobility rights enshrined in legislation

2015 Nationwide road pricing

2010 Planning guidelines further revised

2005

'The future of cities is one of resource efficiency in which cities can show that their very existence as dense centres of human habitation is actually beneficial for the global environment. The jury is still out on this question.'

Herbert Girardet,

'Reinventing London,' City*, Issues 3–4, 1996*

In Urban Colonies, technology investment and development is primarily focused on minimising environmental impact. Good environmental practice is at the heart of the UK's economic and social policies and sustainable buildings, distributed power generation and new urban planning policies have created compact, sustainable cities.

Transport is permitted only if green and clean – and car use (still energy-expensive) is restricted. Different cities have developed their own public transport – electric or low-energy – which is efficient and widely used.

Competitive cities have the IT infrastructure needed to link high-value knowledge businesses, but poor integration of public systems means that private networks are most trusted.

Rural areas have become more isolated, effectively acting as food and biofuel sources for cities.

Consumption has fallen – resource use is now a fundamental part of the tax system and disposable items are less popular.

At the end of the first decade of the 21st century, the Government had realised that meeting its international emission reduction targets wouldn't be done by technology alone, and that it was necessary actively to encourage people to travel less; and that this in turn required public policy intervention to help households and individuals to change their lifestyles, and businesses to change their expectations.

Even before nationwide road pricing was introduced in 2015, charges and tax penalties were imposed on motorists' benefits such as 'free' parking. The initial outcry was damped when the Government, following the lead of New Zealand, ran an expensive advertising campaign on the back of research which showed convincingly that – quite apart from the impact of vehicles on climate change – the revenues it received from road taxes and fuel duty represented only about half of the cost of driving in the UK, especially once health costs were taken into account.[24]

24 Booz Allen Hamilton with Institute for Transport Studies, University of Leeds and associated consultants, *Surface Transport Costs and Charges: Main Report*. New Zealand Ministry of Transport, March 2005. [www.beehive.govt.nz/ViewDocument.aspx?DocumentID=22579URL [accessed 4 August 2005].

Chicken and eggs

The move to a new transport technology tends to be slow because new vehicles need new infrastructure (for example, different types of fuel infrastructure).

Manufacturers are reluctant to market vehicles without infrastructure in place. But infrastructure development needs demand to justify the investment.

This can create a market failure and public intervention is required to close the circle.

Other trends also influenced this change. One was a political culture which was increasingly interested in the problems of social, economic and political exclusion, of which access to transport was now strongly identified as a main cause. 'Mobility rights' were argued to be a principal barrier to economic and social participation in society.[25] As with other services where universal provision was deemed to be important, it was simpler to design them to be accessible, whether or not the end-user had personal access to a car.

The global trend to urbanisation has been reinforced in the UK, as planning guidelines were further amended, along the lines of the ABC location policy used in the Netherlands,[26] to encourage greater building density and co-location of businesses. So it was that the UNCHS[27] estimate that the UK urban population would hit 92.4% by 2030 was passed in 2022! However, the way that cities and towns have grown has not been uniform, as each region found its own way to meet sustainability and growth targets within planning limits.

Changes in infrastructure have had a significant part to play as cities have invested in public transport and cycle paths, and more people are getting out of their cars as the overall image of public transport improves. Transport innovation came at the local level rather than the national: as with the alternative food movement, and indeed with energy in the early part of the 21st century, local agencies were simply more responsive to innovation.[28] Their relative diversity helped. It was a local authority that was the first to replace its city centre bus fleet with hybrid electric/NPG buses, and install the fuel infrastructure needed to do so – and opened up that infrastructure to private motorists with similarly powered vehicles. In doing so, they were following in the footsteps of the 'strategic niche management' approach, advocated by Hoogma and others, of seeding potential new technologies to understand their potential.

25 Noel Cass, Elizabeth Shove, and John Urry, 'Social exclusion, mobility and access', *Sociological Review*, 2005. The 'entitlement' debate is currently well represented in the area of culture. See Tessa Jowell, *'The Value of Culture,'* DCMS, 2004.

26 The Netherlands ABC policy sets conditions on where businesses can locate in order to control mobility. From Bannister and Hickman (2006) *How to Design a More Sustainable and Fairer Built Environment*. Foresight Review.

27 United Nations Centre for Human Settlement (2001) 'Cities in a Globalizing World: Global Report on Human Settlements: Earthscan'. Quoted in Graham S (2004) *The Cybercities Reader*. Routledge.

28 Robin Murray, 'The New Political Economy of Public Life', Lawrence and Wishart, Journals, 'New Foundation', September 2004. www.l-w-blcs.co.uk

'The shift into a new, more sustainable technological regime presents a huge problem for public policy-makers… The task is no longer to control or promote a single technology but to change an integrated system of technologies and social practices.'[29]

Strategic niche management

What is it?

'Strategic niche management is the creation, development and controlled phase-out of protected spaces for the development and use of promising technologies by means of experimentation, with the aim of enhancing the rate of application of the new technology.'

Why use it?

'It enables the planned development of protected spaces for certain applications of a new technology, enabling learning and adaptation. This gives the technology a chance to develop from an idea into a technology that is used.'

(Kemp, Schot and Hoogma, 1998)

Not all public transport innovations were successful. Within outlying urban areas more flexible and demand-responsive public vehicles evolved as a hybrid between buses and taxis. Although early results had shown a significant reduction of congestion, pilot testing of fully automated hybrid vehicles halted when newspapers reported that in trials a car had hit a pedestrian. The unions welcomed the re-introduction of drivers, and their warnings about over-reliance on autonomous systems struck a general chord. Plans for a dual-mode long-distance commuting systems using hybrid vehicles[30] linking larger conurbations were shelved indefinitely.

The transition was not driven only by the public sector. The commercial and economic opportunities of sustainable design – established since the 1990s – now began to be understood by businesses, and its lessons applied.[31] Sustainable service delivery stripped out cost by removing packaging waste and unnecessary stages in production, while also enhancing corporate reputation. Buildings which incorporated sustainable design principles were cheaper to maintain, so their lifetime cost was lower, and led to more satisfied staff.[32]

This is a world where on one hand the public culture is concerned about entitlement to access, but also has substantial concerns about privacy, data protection and too much reliance on intelligent technology. With some reason: trojans, viruses, and identity theft all flourish, in a world where almost all online

29 Kemp, R, Schot, J and Hoogma R (1998) 'Regime shifts to sustainability through processes of niche formation: the approach of Strategic Niche Management', *Technology Analysis and Strategic Management*, 10, 2: 175–195.

30 see /sitefeatures/viewpoints/hitech9.asp

31 See Hawken, Lovins, and Lovins, *Natural Capitalism 1999* for examples.

32 A possible transition path is discussed in Andrew Curry and Larissa Howard, 'From Services to Sustainability', in *Professionals' Choice*, RIBA/CABE Future Buildings Project, 2004.

access is via broadband, much of it poorly secured. Distrust of the Internet has burgeoned. Where liability agreements are in place, it's hard to get them to stick in court. Failure to integrate the intelligence of the infrastructure does mean that the individual components are less vulnerable to knock-on effects, making systems more robust than they would otherwise be.

Globally, competition is increasingly between cities, not states, and the winners are those that are able to link high-value knowledge assets with a desirable workforce, good quality of life, and appropriate public assets such as cultural and educational resources. Cities are changing, driven by the twin pressures of competition and the Government's continued push to make it safer and easier to access jobs, shopping, leisure facilities and services by public transport, walking, and cycling.[33] Society embraced this new world where people do not travel as extensively.

Population, housing density and employment in the big cities are rising faster than before. Cities are more compact, widening the range of local opportunities and activities that are accessible without using the car as a result of the private sector's investment in information and communications technologies, and the proximity to national transport networks has increased sustainability, while maintaining the infrastructure required to create wealth from knowledge.

As was observed at the time, it was a classic example of unintended consequences, but one whose effects were benign. An 'urban renaissance' strategy, originally stimulated by a desire for economic regeneration, has proved vital for managing environmental impact and sustainability.

33 *Planning Policy Guidance 13: Transport*, Office of the Deputy Prime Minister. www.odpm.gov.uk

Prof. Stefan Behling/Marylis Ramos, Foster and Partners

A comparison of two dominant urban forms

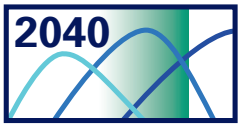
SPRAWL		COMPACT CITY
Low density	vs	High density
Zoned development		Mixed-use development
Segregation of functions for living, working, recreation	vs	Integration of functions for living, working, recreation
Segregation of demographic and economic groups		Mixed-income communities
Car dependence		Predominance of pedestrians and cyclists
Disconnected public spaces		Interconnected walkable network of large- and small-scale public spaces
High-speed transport networks and increased road infrastructure	vs	Minimised need for transport and planning for walking and cycling
Parking, buildings and freeways		Parks, landscaping and cycle paths
'Minimum parking spaces' requirement		Parking space capping for new developments
Sense of anonymity		Sense of community
US urban model		European/Asian model
Developed from about 100 years ago	vs	Developed from about 9,000 years ago
Large Scale Developments		Neighbourhood/human scale developments
		Corner shops, local shopping areas, farmer's markets
Superstores and big shopping complexes	vs	Mixed-use and mixed-income neighbourhoods and communities
Mass housing and commercial/industrial districts Unlimited retail space per occupier		Capping of allowable space for groceries and retailers to preserve neighbourhood scale
Driven by market forces	vs	Driven by vision and masterplan
High energy	vs	Low energy
High CO_2 emissions	vs	Low CO_2 emissions

From an economic perspective, the impact on business was uneven. Those with heavy freight usage, with complex logistics based on centralised warehouse systems, found their costs spiralling; the rumours that money from such companies found its way into the slush funds of the radical oppositional motorists' campaigns were never proved.

At the same time, places designed around the car, where it was difficult to increase density, found it hard to adapt their existing transport infrastructure, which increased costs for local people. And while market towns found themselves – to some extent – rejuvenated by the increasingly local delivery of services, rural areas became more isolated even as the complexion of the countryside began to change in response to demand for more local crops, for food and for biofuels.

Critical issues going forward from 2025

- Policy objective to improve access for all and to change travel and mobility-related behaviour
- Further changes in planning regimes to enforce mixed-use development, non-car access and increased density
- Policy objective to meet or exceed agreed targets for reduction of carbon emissions and greenhouse gases
- Development of ubiquitous local (and 'real-time') information systems
- 'Seeding' of low-emissions technologies in environments where there is the opportunity for development and use (for example, through public procurement and service delivery)
- Whether the locus of control of personal information remains with or passes from the individual to the state
- Increased understanding within the commercial sector of the business benefits of sustainable design – in both buildings and service delivery



The first visual clue to the transition from the second horizon is that sustainable buildings are now the norm, rather than the exception, especially commercial and public buildings. This didn't happen overnight; but the replacement cycle – whether being rebuilt or refurbished – on commercial buildings is about 30 years, and legislation introduced in 2014 to mandate 'the new sustainability' has now had its effect.

The slower replacement rate of the housing stock has meant that the visual effect in more residential areas is patchier, but even here the incentive schemes available to encourage solar heating systems and improved insulation have had their impact.

34 See, for example, 'Microgrids as peer-to-peer energy', *BBC News*, 25 September 2005.

One effect of this has been to transform the energy supply model; once a centralised model, built by the state and later privatised, now it is a distributed one, as the economics of energy production have been transformed by microgrids.[34]

Distributed power generation

Microgrids – small community networks that integrate wind and solar power into the electricity network – now generate over 50% of household electricity in cities.

Generator sizes are similar to loads and are highly efficient. They are more capable of managing fluctuating power demands than the national grid, and having generators close to demand cuts down the cost of getting energy from a remote power station to the household.

The smaller networks also allow unused power to be stored.

Ownership varies. Some microgrids, particularly outside the cities, exist as stand-alone power networks; others are owned and operated by the existing power suppliers.

Energy was not the only system to be transformed. The practice of open source has spread well beyond computer systems to the software and technology that underpins much of the city infrastructure. Different delivery models for public services, which engaged service users as producers, meant that the leasing model which underpinned the public private partnerships of the early 21st century have evolved into more complex and more diverse models.

Effective electronic networks have led to an increase in mutually owned or member-owned organisations. At the same time, the decline in availability of cheap and rapid long-distance travel, with the failure so far to find a low-emission solution to rapid air flight, has meant that even those global and European companies which still exist tend to be much more devolved, and more local, than they were previously.

The notion of 'waste' has almost disappeared from the vocabulary. Instead, everything either gets recycled as a raw material for another production process, or returned, clean, to the earth or water. Every council runs its own 'freecycle' scheme to help people who have things they want to dispose of find a willing recipient. And because resource use is now a fundamental part of the tax base, people prefer not to buy disposable items any more. The requirement for goods to be repairable, which manufacturers had lobbied hard against when it was included in the Consumer Goods Act of 2026, is now regarded as a source of competitive advantage. In some places, companies have gone into partnership with users and customer advocates to create and publicise local repair networks.

There is also a wider change underpinning much of this, a shift from the economic models used to build policy frameworks in the late 20th century, to systems-

based models. By 2040, organisations have to think about the wider impact of their decisions on their users, and do so as a matter of operational routine.

Beyond economic models

'The paradigm of neo-classical economics is particularly hegemonic at the moment… Looking ahead, it is highly likely that other disciplines will become dominant diffusers of ideas. Ecological and systems ideas may prove a strong contender – it is possible that where most policymakers today see markets of consumers and producers, in 10 or 20 years' time, we will all automatically see systems of matter, energy and waste. At the moment ecology is being squeezed to fit into economics. In the future the reverse may be true.'

Geoff Mulgan, 'Global comparisons in policy-making: the view from the centre', *Open Democracy*, 12 June 2003.

Under the terms of the Contraction and Convergence Agreement, individuals each received an entitlement, which had been negotiated and agreed between the regions of the world.

The entitlements, in the form of international energy-backed currency units (EBCUs), operate as a parallel currency.

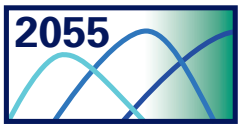
See the Global Commons Institute, www.gci.org.uk, for further information.

Full-cost accounting has become the standard accounting convention, and GNP and other economic growth indicators are no longer used as shorthand for an indication of social benefit. One outcome – as with energy – is that there is less centralisation of services.

The evolution of building technologies means that the UK is now a leader in this sector. Although the UK's agricultural sector is more diverse, and healthier, than for a century, few people want to work there. These jobs are filled by migrants.

Critical issues going forward from 2040

- Sustainable long-distance transport systems
- 'From econometrics to systems': the dominant public policy paradigm changes
- Implementation of full-cost accounting and other output measurement systems which measure overall quality of life
- Building infrastructure – especially commercial and public buildings – is overwhelmingly sustainable
- Capture by the public authorities of increases in land value created by planning intervention



It is 9 May 2055. Four decades after the UK decided to put clean environmental practice at the heart of its economic and social policies, the country has been transformed. Mostly this has been for the good, and the cities, especially, have prospered. The picture is more mixed in the countryside.

We are, to a large extent, in the world that was envisaged in many of the UK regional spatial strategies of the early part of the century. New housing has been built within existing cities on brown-field sites and through intelligent re-development, rather than through new housing on city edges and beyond. And planning rules have changed to ensure that all developments are mixed-use. Environmental impact is the first question asked by planners and developers.

Journey to a business meeting

It was a pleasant day with occasional showers. Jill was walking the short stretch from the automatic transit system (a kind of sophisticated tram system) that ran around the city. The showers were no bother because the walkways were covered but with occasional openings to small squares planted with trees, benches and hot-drinks dispensers. In fine spells, Jill noted more and more business meetings going on in these spaces as well as in the cafés further into the centre of town.

Living only 10 minutes' away from her work was a huge change from when her father had commuted for three hours a day for years until the commuting system broke down and he decided to take the family to a provincial city. About that time the new urban planning philosophy was being implemented in some locations and, 20 years later, the benefits the more relaxed and healthy life style were becoming clear. Bicycle and pedicab tracks criss-cross the city.

Jill entered the meeting centre just ahead of her colleagues from two other cities who were pleased with the upgraded intercity devices that linked some of the more flourishing urban centres together. This had happened when, anticipating the end of the era of low-cost flights, some cities had made bilateral agreements to raise substantial capital and invest in a high-speed rail link beyond the rather constrained national upgrade programme.

However, one colleague called in to say that she had been delayed by poor road conditions coming from a different place where the local groups had resisted the urban redesign policies and attempted to maintain the status quo. 'I know you can't wait around' she said, 'but we need to be part of the new trading group.' Jill sighed. The current fragmentation of logistics was becoming a nightmare, but they had to strive for integration to grow the economy. However, the day was pleasant so they decided to postpone the meeting and take a short bike tour of a local park.

35 For examples, see among others, John Elkington, (1998) Cannibals with Forks, and Paul Hawken, Amory Lovins and Hunter Lovins, (1999) *Natural Capitalism*.

What's striking about this world, therefore, is that the visitor from the start of the 21st century would recognise much of what they find. If sufficiently advanced technology is, as Arthur C Clarke once remarked, indistinguishable from magic, this is not a magical world. Instead, it is the product of the evolution of technologies that were visible, at least in some places, in the first half of the century. Their development has been encouraged by a mixture of innovation policy, economic development policies that made quality of life for residents and workers a critical issue, sanctions on environmentally damaging practices, and fiscal incentives for use of technology.

This shouldn't be surprising: the rise of the city was the product not of policy but of long-term economics (increasingly people spent more of their income on services close to home) and of competition (high-value knowledge flowed better between people who lived and worked close to each other). The result is a world in which the main aims of policy are to reduce energy consumption and eliminate waste.

Family get-together

Andrew, his wife and the whole family rode their bicycles to the intercity station. They were excited that uncles, aunts and grandparents were all converging on this day for an annual family reunion. Since the big shift in the past 20 years – to really expensive fuel for transport and the redevelopment of the urban centres into more family-friendly living/working/shopping designs – life had got better for the Johnson family. However, it made it harder to get together with the other branches of the family who had dispersed to the economic centres that best suited their talents.

As usual, the new interurban services were on time and the old intercity delayed by an hour. The reliability of cross-country travel was uneven. Eventually all were assembled. The younger members opted to hire bikes to ride back to the zone-5B urbovillage, whereas the elders opted for the automatic transit system. The race was on as the cyclists took the short cuts on the cycle track.

After the usual tea and cakes, they all opted to hire pedicars to make a tour of the new high-level cycle track around the city, stopping off to shop and also to enjoy the new botanic gardens that had been planted on the roof of the new in-town manufacturing complex. 'It's amazing what you can fit into a day *and* keep fit compared to your days, mother,' mused Andrew. 'All right for you young folk with legs. I don't know how you manage without an electric town buggy,' she replied.

People travel, but not as far, and often by foot or cycle. Transport is permitted if it is 'clean and green', but not otherwise. For some transport, this has proved easier than others. Local electric vehicles are ubiquitous, and local light rail schemes are common.

If increased density is one of the main ways that energy consumption has been reduced, it has meant that social policy has had to be effective. If people are living close by, a sense of social equity is one of the few things that prevents

36 Lester Brown (ed.) (2008), *The Earth Policy Reader*, Earthscan! See also updates at www.epi.org.

society slipping into conflict and crime. Vehicles need to be controlled to ensure equity between drivers and vulnerable road users, to reduce noise, and to encourage community cohesion. One policy test is whether children can play on the streets in residential areas.

Materially, fewer goods, but more services, are consumed than in 2005. And people also value possessions that will last more than they did then, not least because the tax system has been fundamentally redesigned so that people are taxed principally on the resources they use up, rather than the money they earn or what they spend.

In this world, corporations have retreated from the high water mark of influence they enjoyed at the end of the 20th century. They have only themselves to blame. They read too late the shift in the public agenda towards taking a longer-term view, and their short-term financially driven behaviour meant that they failed to engage with it. In particular, their strategies for managing sustainability were driven too much by compliance and risk management, instead of engaging with the opportunities provided by sustainable business.[35] New partnership vehicles were built – and have lasted – which align private money and the longer-term public interest.

Although intelligent infrastructure is widely deployed, it is not integrated. There have been too many system failures, too many network crashes. Privacy has been breached too many times. The result is that in a world where technology systems are treated with some suspicion, it is a source of competitive advantage if yours is self-contained, and therefore less likely to fail because of failures elsewhere. In any case the experience of integration has not been a happy one; sometimes it has failed simply because the systems are too complex for our ability – human, mathematical, technical – to process them.

In the long-distance world, speed is less important than energy conservation. Even if transport is no longer fuelled by oil, clean energy is still far more expensive than petrol or diesel ever were. Large slow-moving 'road trains' are a common sight in their own guided tracks in motorway lanes, controlled by their own information network as they leave the ports for their inland destination. The lack of integration of systems means that generally transport is poorly integrated, with different systems controlled by different organisations. Freight, perhaps, was lucky that it was valuable enough to justify the infrastructure investment; for individual drivers, the mass traffic management systems which were widely predicted in the late 20th century were too unreliable to work, and were abandoned after a succession of mass pile-ups. Individual satnav systems seem only to move congestion to new bottlenecks. And there is a cultural factor at play as well; people who live in cities which are increasingly green, don't like to feel that their business or leisure or travel is environmentally destructive. Companies include a whole range of environmental indicators in their product information

codes, knowing that enough customers will look for them with their product scanners, and will publish the results if they don't like them.

Globally, most economic value resides in 'knowledge hubs', which emphasise the importance of attracting the best people to learn, and to work, in your city. Competition between cities is about quality of life. In this respect, Europe has done well, developing its cultural resources and social philosophies to create cities that are envied everywhere. The judiciously applied migration policy of free movement within Europe, with a proportion of 'investment visas' for those from elsewhere, has helped to manage its ageing population while attracting the best young talent from the countries of the south and east. Many of these Chinese, escaping from the duststorms which routinely choke Beijing or the water shortages which have crippled Shanghai.[36]

In a world where the public Internet is used only for public messages, the most successful cities are connected together by VPN50, a high-speed and high-quality virtual private network system that offers rapid and rich media connections. But the investment required is significant, and the economic criteria for joining are rigorously enforced by the consortium of cities that manages it. Long distance travel is harder than it was, and more expensive. People do travel, but they tend to stay away for longer when they go. Young people, the childless and those sponsored by their companies or organisations are most likely to take advantage of this. Some have built up wide international personal networks that stay with them for life.

The story in rural areas is mixed. There is more agricultural work than there was in the 20th century and more people are employed on the land. But it is still poorly paid and few want to do the work. As with city service infrastructure, many of those who are employed are migrants. Rural areas also suffer from poorer communications. Some market towns have invested in rapid 'comms spurs' to link to the cities to create remote office centres and attract employment. Generally, it is expensive and inconvenient to live in the countryside and work in the city, unless the regional government is one of the few that has invested in light rail links. The 'new landed gentry', who have made money in the city and moved out, are widely disliked. The rural poor remain poor and not very happy.

An urgent delivery

'You want it that quickly and you're not on the vacuparcel network,' exclaimed Mike. 'Well there's no delivery permission in your zone at this time. The next one is tomorrow morning.' A pause. 'You mean that's too late. Well, the only option is I drop it off on my way home. Quite a detour, so it will be a premium delivery. Let me check a route on the cyclenet and I'll zap you a quote.'

Mike found the zoning and timing of the delivery-drop periods, instigated by the Wolverhampton city authorities to ensure no congestion and low-energy consumption, a bit of a drag. His colleague in their Newcastle office could deliver stuff whenever he wanted since their local communities had not gone along with the more draconian urban redesign and mobility rules.

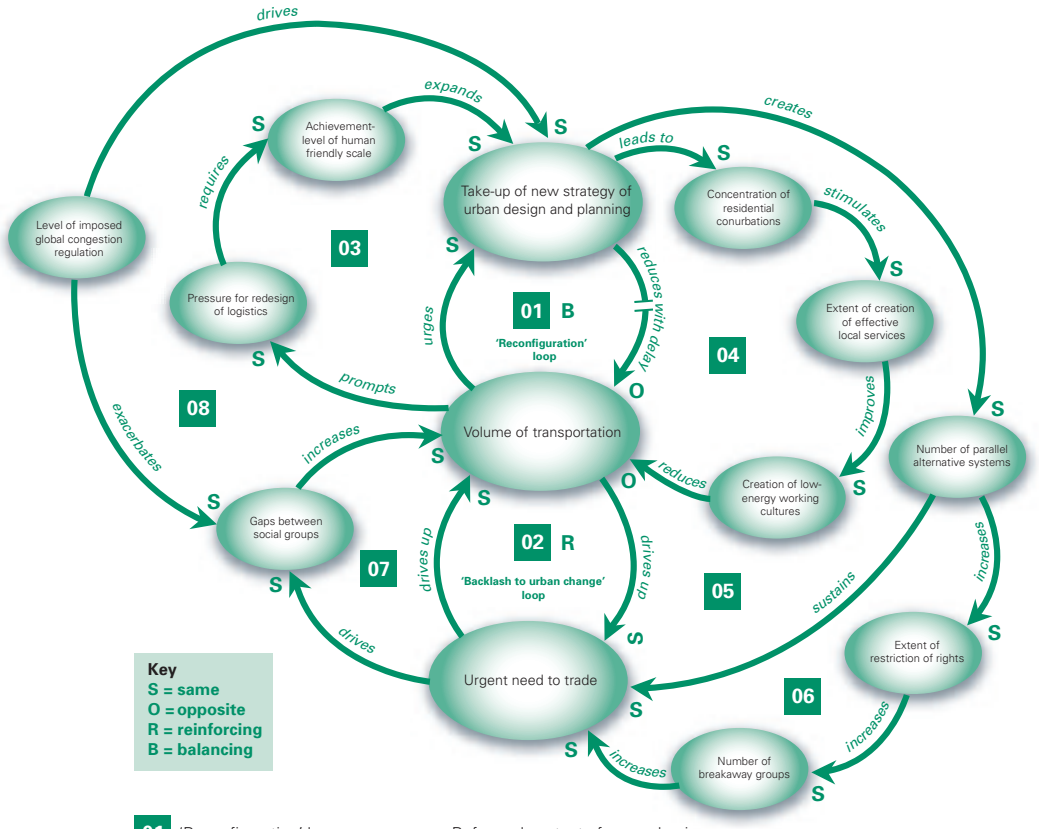
The bike was OK for the odd delivery, but he reckoned it might make sense now to invest in one of those quad-bike vans with electric assist. His business was growing rapidly in the cluster of urbovillages 5A, 5B and 5C so its carrying capacity and freedom from delivery-zone restrictions would give him much more flexibility. The vacuparcel system was only suitable for small stuff.

At that moment, the robotic pickup car signalled its approach and Mike's thoughts were interrupted by the necessity to wheel out his interurban shipping container to be delivered overnight to his Newcastle partner.

37 Lewis Mumford, *Landscape*, quoted in Peter Jukes (1990), *A Shout in the Street*, London, Faber.

Core and major causal loops

The new policies of infrastructure planning hold in check the expansion of transportation through the 'reconfiguration' loop. Actual reduction of traffic, however, is less than hoped for through the 'backlash' loop through which people resist the required change in lifestyle, reasserting mobility in accustomed ways. As this scenario develops, the new urban structure begins to lock in the new behaviour for the majority.



01	'Reconfiguration' loop	Reframed context of new urbanism
02	'Backlash to urban change' loop	Locations trying different approaches
03	Radical redesign loop	Intelligent systems make possible a shift away from the high-mobility model
04	New life-style loop	Strengthening effect of implementation and success
05	'Avoiding change' loop	Some groups object and resist or pursue alternatives
06	Social conflict loop	Imposition of rules and conditions restricts non-participants as misfits
07	Fragmentation loop	Exclusion creating pockets of disconnect or alternative islands of connection
08	Externally imposed conditions	International regulation constraints

38 Adair Turner, (2001), *Just Capital*. City, Place.

Scenario reflections

At the heart of the scenario narrative in Urban Colonies is an acceptance that the relationship between energy and productivity will change fundamentally. Or, in current policy language, that the relationship between economic growth and transport will be decoupled. It is a scenario that is about 'constraints reframed' – a problem dissolved rather than a problem solved.

The underlying discourse within the scenario is about the relationship between physical space, community and the quality of life. This represents a significant strand of minority opinion over the past 100 years, and is well represented among sociologists, geographers, and architects. It carries within it an implicit critique of market capitalism and conventional economics.

The guiding spirits of this scenario might include the Victorian socialist, William Morris (who once wrote, 'Dream of London, small and white and clean. The clean Thames bordered by its gardens green'), Jane Jacobs, author of *The Life and Death of American Cities*, or the urbanite, Lewis Mumford, who wrote that the function of the city was 'to encourage and incite the greatest possible number of meetings, encounters, challenges, between all persons, classes and groups, providing, as it were, a stage on which the drama of social life may be enacted'.[37]

Indeed, one of the striking things about the scenario is that it is a response to, even a *critique* of, problems of both technology and transport, embedded in urban design. Another striking thing about it is the extent to which it is also represented, at least incipiently, in some parts of current public policy. The antecedents of the Urban Colony can be found in regional development strategies built around notions of 'urban renaissance'.

It represents, therefore, a different view of a competitive future from that expressed in Perpetual Motion. It proposes that economic development can occur within a social environment that is both inclusive and sustainable. At a more abstract level, it could be argued that the difference between the Perpetual Motion and Urban Colonies scenarios represents the underlying philosophical difference in the narratives of the future of the EU on the one hand, and Asia and the United States on the other. While it is invidious to attach present-day labels to futures scenarios, Urban Colonies nonetheless is more likely to be a story of a future Copenhagen than a future Seoul or Hong Kong.

It has attractions. Apart from its environmental benefits, it is embedded deeply in some significant existing drivers of change, including the increase in the desire among consumer-citizens for well-being, and the rise of the city as a locus of economic and social power. As Adair Turner has described it, 'A far larger proportion of what goes on in a city or region is now consumed in that city or region than was the case 50 or 100 years ago; a bigger share of economic

activity occurs in the retail outlets, schools, hospitals, restaurants, sports centres and the like whose output is consumed in the region; a smaller share occurs in the factories which produce goods which are then shipped to other factories.'[38]

It is also located within a set of arguments within the economics profession about the relationship between income and utility, possibly best represented by Richard Layard's recent book, *Happiness*, which can possibly be summarised crudely as 'Once you've got enough, more money doesn't make you happier.'

Other strengths of the scenario are that a number of the required changes can be implemented at a city level, without needing policy changes at national level. London has already shown that political leadership can make a difference to a city's transport dynamics, at least in cities with regulated public transport systems. There are already examples of cities across the world implementing local clean transport systems. Similarly, there are examples of innovative local approaches to decentralising the management of power and waste, and producing heat and energy from the latter.

However, the barriers are significant. Existing transport infrastructures are deeply embedded in existing patterns of vehicle ownership and use. This is changing, and by incremental steps the car is increasingly restricted and even excluded from parts of the town or the city in the UK. But the scenario requires large-scale infrastructure change, which suggests that early intervention is required, coupled with relatively bold action. The particular politics of London at the moment of the inception of the Congestion Charge are unlikely to be repeated, and both in London and elsewhere other proposals for significant reconfiguration of local transport management regimes are as likely to get lost in a fog of regulatory, budgetary and not-in-my-back-yard objections.

Secondly, the scenario suggests that planning regimes which have developed and been reinforced over 40 years, built on motorised access to in-town, edge of town or out-of-town locations, will be reversed. It is not clear that this will be the case. Individuals have become used to the lifestyle which is thus enabled, and the commercial beneficiaries of the planning regimes are often large, sometimes global, companies with deep experience of planning laws and effective lobbying expertise. One of the issues identified when this scenario was tested was that it required a significant rebalancing of power away from national government and the private sector towards local and regional leaders. Both of the above issues suggest that it is not a big step from Urban Colonies to Good Intentions.

Finally, even if the scenario does lead to greater inclusion within the urban colony (and it may not), the cost is felt elsewhere. Rural areas appear to continue to lose in share and value, even if more is grown there. And the other significant losers are those parts of the country that developed rapidly during the years of the car's ascendancy and have spatial policies that follow from this. For them, there is no easy way down.

Scenario: Tribal Trading

An artist's impression of Tribal Trading in 2055

Wind turbines are commonplace and the technology has evolved so that each community can construct them very easily

It's hard to survive in the tribal trading world, even harder if you are struggling to survive on your own. People live in smaller, very close-knit insular communities, in self-sustaining 'pods' that generate enough food and power to sustain each of

Building materials have gone back to the use of renewable and hand-worked materials, such as timber and clay, but this does not mean a return to mud-huts – humanity will always strive for innovation with whatever they have at their disposal and this leads to an emergence of new approaches for building using traditional materials

Narinder Sagoo/Foster and Partners

Each community runs their own biodiesel harvester, which supplies power to the pods

Fields of biofuel-yielding crops, like sunflowers, dominate the rural areas

The big picture is of a world that has undergone a huge energy crisis and has achieved tranquil equilibrium through simple lifestyles that no longer rely on being supplied power through a national grid. Former city dwellers still need to live in communities where they are in close proximity with others. These dense social conditions allow the community to share resources more efficiently and help to preserve the maximum amount of green areas for agricultural use.

Empty cities and clustered, compact rural housing

39 Peak Oil is defined as the year in which world oil production reaches peak output. The current range of estimates is between 2006 and 2020. See www.peakoil.com for background and commentary.

Timeline: Tribal Trading

2055

2052 Final commercial aircraft flight

2045 Regional conflicts over natural resources continue to increase

2043 UK population stands at 42 million, according to best estimates

2040

2032 West Midlands sets up regional borders to collect transport revenue

2028 Asian flooding permanently displaces 2 million

2026 UK banking system collapses

2025

2022 UK GDP falls to 80% of 2005 level

2018 Power cuts and outages are routine

2015 Oil reaches $200 a barrel

2011 The year of Peak Oil

2005

40 'Asia: in the pipeline', *Le Monde Diplomatique*, May 2005.

'"Who would have thought Western Europe would have been the first to go?" "Anyone who looked at a population density map, that's who', said Ax."' **Gwyneth Jones, (2003), *Castles Made of Sand*, Gollancz**

Tribal Trading is a world that has been through a sharp and savage energy shock. The world has now stabilised, but only after a global recession that has left millions unemployed.

The global economic system is severely damaged: infrastructure is falling into disrepair.

Long-distance travel is a luxury that few can afford: for most people, the world has shrunk to their own community.

Cities have declined: local food production and services have increased.

Canals and sea-going vessels carry freight: the rail network is worthwhile only for high-value, long-distance cargoes and trips.

There are still some cars, but local transport is typically by bike and by horse.

Local conflicts recur over resources: lawlessness and mistrust are high. The state does what it can – but its power has been eroded.

It is 2025. The energy shock has been sharper and more savage than anyone except the pessimists imagined. 'Peak Oil'[39] came and went, and the reserves figures turned out to be as fragile as the critics had insisted. Oil and gas prices have spiked and then spiked again. Attempts to secure supplies from Russia failed as the Russians have turned instead to their customers in the east:[40] for a short while, the BRIC nations (Brazil, Russia, India, China) hold the balance of trade and diplomatic power.

Gary Snyder, poet and environmentalist

'What is to be done? Learn to be more self-reliant, reduce your desires, and take care of yourself and your family'

Two years of routine urban power cuts have made people realise that this is no longer a temporary blip, despite government assurances. And it's not just about energy supplies; the increasingly common 'freak' weather conditions have stretched the infrastructure beyond its limits. With energy shortages and repair costs have come higher prices, unemployment, and a depression as sharp as that in the 1930s. Perhaps sharper; for the economy of the 2010s was far more dependent on constantly circulating credit and promise of continuing economic growth than that of the first half of the 20th century. Millions are unemployed, and with little prospect of improvement; the world's economic system is not designed for declining economies.

41 For reference, only one-fifth of the energy used by the US food industry goes on growing food (Earth Policy Institute, 2005). The rest is used in transport and packaging, and so on.

42 Cuba imposed a similar scheme in the wake of its oil shock in the 1990s, although it implemented it with people (the so-called

Consumer confidence in the banking system was one of the first casualties; local banks and investment unions have sprung up in their place in some areas, but they have barely managed to mitigate the worst effects. Currency is increasingly in bartered goods and services, and sometimes in time, rather than in money. In some places infrastructure has been dismantled and sold or melted for its scrap value. Food supplies are increasingly erratic as energy-intensive distribution models have been slow to change.[41] Those who can leave the cities have done so.

Travel is hard, not just in the UK but in Europe as well. The UK Government has adapted the existing congestion charging technology simply to prevent travel where necessary, at least when power cuts allow. The World War 2 question, 'Is your journey *really* necessary?', is heard and seen again in broadcasts and posters. The RFID-based travel cards ensure that people are credited for taking passengers (a form of state-sponsored hitch-hiking), even if they are also compelled to do this by law.[42] If the UK is now meeting its Kyoto targets, few people have noticed, and fewer care.

Policy: Oil depletion protocol

The oil depletion protocol (also known as the Rimini Protocol) is a proposed international agreement first published in 2003 that is designed to manage both oil production and consumption in a world after the moment of 'peak oil' in which production is declining.

Its advocates argue that declining global production would lead to price volatility and profiteering if left to conventional market mechanisms. For producers the protocol requires that they limit production to their current 'depletion rate', which is broadly in their long-term interests. Importing countries have the tougher requirement to reduce consumption in line with falling production.

This should, however, act as an incentive to reduce consumption, increase efficiency, and so on. Protagonists believe that any country that adopts the protocol will gain – because of the energy efficiencies involved – regardless of whether other countries also do so.

www.peakoil.ie/protocol

Health outcomes are declining,[43] and the ageing population is suffering in an age where healthcare is more likely to be provided to someone with longer-term prospects, and who can pay.

'yellow men') rather than technology.

43 In Russia, in 1995, 51,000 new cases of diphtheria were reported. In 1975 the figure had been 100 (one hundred). www.cdc.gov

44 Again, Russia provides clues. Marvin and Graham (2001), *Splintered Urbanism*, Routledge, London, recount infrastructure being stripped during the 1990s by criminal gangs.

45 See Nepal Wireless, www.nepalwireless.net. Global Ideas Bank Social Ideas Award winner, 2004.

In the face of this partial breakdown, some degree of lawlessness has surfaced. Some utilities have found their infrastructure stolen for re-use or sold for scrap.[44] International tensions have run high, with increasing competition for oil supplies being backed by military stand-off and intense diplomatic manoeuvring. Oil states have learnt the lessons of the 1990s ('speak quietly and carry a big stick'), and the effects are marginal; the logic of peak oil, and of higher energy costs of recovery of oil, mean that any energy gains for an energy-consuming state are temporary. Some regret that the UK was not more active in promoting the Depletion Protocol when we had the opportunity. An unexpected beneficiary is Cuba. A state that was long used to exporting workers to help with 'barefoot health' programmes, now its advisers can be found consulting on how to cope with rapid decompression of energy supplies, a journey it travelled in the 1990s.

And repeated lobbying for a new nuclear power programme has fallen at three hurdles: the time taken to get the power on stream, the huge costs involved, both short and long term, in a society that is poorer than in 2005, and the serious risks of nuclear proliferation in a world that is far more unstable and even more prone to violence.

But – and this seems surprising to some – the picture is not one of unremitting gloom. In the face of food and energy shortages, self-help communities have started, tentatively, to emerge. Even as the grid has become erratic, small self-powered communities have started to emerge, especially in the countryside, using wind, water, and solar power. Millraces are running again. Individual windmills have sprouted in back gardens, even while the Government encourages households to connect their surplus output to the grid. Local food production is also on the up; even if production is sparse, it makes work for people who would otherwise be workless.

The same spirit has been seen in the emergence of low-powered communications technologies. Wireless mesh networks, tried and tested in places like Nepal, work fine in Britain too.[45] And the world has been turned upside-down in other ways: communities which are used to hardship, and where people still have mechanical and technical skills, seem to be doing better than those that had become part of the knowledge economy. Barnsley is coping better than Bath; the sometime coal community of Easington is a better place to be now than Durham. Social cohesion matters, more than ever.

Low-powered communications

Wireless mesh networks are point-to-point-to-point networks. Each node can send and receive messages and can function as a router relaying messages for its neighbours. A mesh network offers multiple redundant communication paths – if one link fails, for any reason, the network automatically routes messages through alternative paths.

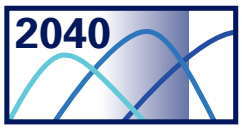
Shortening the distance between nodes increases the quality of the link and decreases the power requirement in individual nodes. Adding more nodes extends the reach, adds redundancy, and improves the general reliability of the network.

But in the areas hit hardest, with fewest resources in the lower-energy economy, social breakdown is rapid. Armed gangs roam the roads and the army and police do little other than containment, unless officers are shot at. They are spread too thin. Gated communities are no longer just for the more affluent.

Critical issues going forward from 2025

Because of the nature of the scenario, these are usually branching points where society has failed to implement a change in practice or policy:

- Significant policy decisions to reduce carbon use by corporations and individuals by public intervention (e.g. fiscal measures)
- Transition to distributed energy: to incentivise the delivery of energy into the grid from multiple sources. Let a million windmills sprout… Diversity is an asset
- Promotion of the Depletion Protocol among high-energy-consuming states
- Governments and regional authorities, and companies, will be as aware of metrics show that environmental impact and environmental distress as they are currently of economic signals
- Environmental costs will be included in prices: economic indicators will be re-designed so they do not confuse price with social benefit, or depreciation of habitat with income
- Distributed money: multiple sources of money within economy, including local payments and investment models and sources that are not linked to 'recycling interest'. The existing and emerging infrastructures around telecoms will enable this
- Design, or redesign, of infrastructure systems so they 'degrade gracefully' under pressure



Early morning on the Severn, at the border post by the Iron Bridge. Another boat seeks to pass through on its way north. It's always the same routine; the boat can't pass until it's paid

its transit fees, and it's got to be checked to make sure that it's not carrying stowaways or vagabonds who might cause trouble locally. A radio call to check the claimed identity of the crew with the local border police, and a Morse message comes back, conveniently converted into text on the visual display screen. The boat crew is who they say they are, and their credit is good.

The collapse of societies

The writer Jared Diamond identifies five consistent themes in the collapse of societies:

- environmental damage
- regional or local climate change
- increase in hostilities with neighbouring states or societies
- decline or collapse in trade with other societies
- cultural response (or the lack of it) to signs of change.

Jared Diamond, (2005), *Collapse*, Penguin.

Borders are important in the world of 2040, for reasons of security and of revenue; tariffs on transport are one of the most reliable ways of raising taxes. The power of the state has eroded, because it can no longer guarantee security or stability. Instead, the world has fragmented into smaller communities, often delineated by natural landmarks, and barriers, and by local resources.

Diversity is everywhere, for the scale of the change since 2005 is large, and almost every community has tried – is still trying – different solutions to managing in the disrupted low-energy world they are living in.

Much of the 20th century infrastructure has been eroded now (much of it was already old in 2005), but that doesn't mean that communities have retreated to a new mediaeval brutalism. Much of the knowledge of the technology which drove the 'Great Economy' of the 20th century is still in people's heads. If some components are no longer viable (the last chip fabrication plant closed a decade and a half ago), invention has found ways of adapting.

Some of the models already existed: the computer network, with the central server and 'dumb' (or simple) terminals used far less energy and generated far less waste than the proliferating personal computer, was well understood in 2005. Short-hop wireless systems have proved to be resilient. Above all, the groups who make communications function are highly valued, and highly incentivised. This is an area of constant innovation. The huge clean microchip-making plants of the early 21st century have long closed, but there is still a supply of chips, and other technology fragments, from the so-called 'chip monkeys', who forage in waste tips for them, stripping cars and toys. It is a lucrative business, if an unhealthy one.

46 David Dickson, (1978), *Alternative Technology*, Glasgow, Fontana.

Recycling technology

It is a commonplace that there is more processing power in a musical birthday card than in the first moonshot in 1968. In a post-consumer world, the technology currently found in cheap consumer items would attain a significant social value. The designers, Usman Haque and Adam Somlai-Fischer, have reported on their use of such technology to build low-tech design and installation prototypes.

They developed a range of sensors and other devices, typically 'hacked' from toys and other devices, a process which, they say, required little specialist knowledge. The devices they hacked included remote controlled cars, torches, walkie-talkies, 'sound-responsive' cats, and solar-powered garden lights.

Usman Haque and Adam Somlai-Fischer, (2005), *Low Tech Sensors and Actuators*, lowtech.propositions.org.uk

Transport is slow: energy efficiency matters far more than speed. Canals and sea-going vessels are used for freight; the rail network still exists, but is worthwhile only for high-value, long-distance cargoes and trips. The few remaining airplanes in their last few years of life have become the preserve of the 'super-rich', as they were in the 1930s. Small point-to-point flights are more common than the vast 'hub-and-spoke' systems which were once thought to drive economic growth, at significant environmental cost. But the airship entrepreneurs seem to be making progress with new models. Some cars still function, although most have had to be rebuilt after their electronics failed; some have been adapted to steam.[46] Local transport, typically, is the preserve of the bike (sometimes electric-aided) and the horse.

Distance matters, but less than it might. The world that fragmented when the energy collapse came was already diverse and multicultural, and those social links produced social value. The groups which had the largest diasporas (especially Asian groups) gained influence because – in a low-trust world where identification was important – they were more likely to know what was happening elsewhere, and who was likely to know about it. Such social groups were also more likely to be involved in trade between communities.

But there are still high degrees of mistrust in this world, and with good reason. These problems are to be found across the globe. The growth of the Chinese economy came to an abrupt halt in the face of falling demand and the rising costs of its manufactured products, and has since succumbed further to the environmental impact of water shortages in the south, the spreading deserts of the north, and food shortages everywhere. India has been overwhelmed by the spread of millions of environmental refugees from Bangladesh and other low-lying neighbours.

Sonia Shah, Crude

'Sun, wind, silicon, aluminium: these resources are distributed more or less equally around the planet. A society run on renewable energy might be much less lavish, much more provincial, and far less elaborate … but a slow-growing society might be a lot longer-lasting and equitable'.

And population density is still too high for the low-energy society we have become; some areas have managed to stabilise themselves, but others still suffer shortages, especially of food and energy. Border skirmishes are common. It is not surprising that the Kalashnikov and its many copies is one of the most successful of industrial products, simple to produce, simple to repair, and fairly easy to modify. Every community with a decent share of resources needs its own defence force. For its part, the 'Kalashnikov' approach is almost universally applied to any technology, from heating to transport to energy production.

Oil is still used, but it is more expensive now, and is used little for transport. Late in the day, we have learned, as Kenneth Deffeyes once said, 'Crude oil is much too valuable to be burned as fuel... In the long run, the eventual use for oil will be for manufacturing useful organic chemicals.'

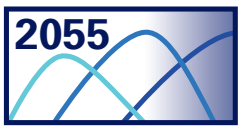
There's diversity elsewhere; many of the business parks and trading estates that populated the edge of towns have become 'new communities', which offer land and shelter to those who don't fit, or choose not to fit, into their local societies. Their location, close to the big roads which are still there, through degrading, means that they are meeting points and resting places for travellers.

Critical issues going forward from 2040

The 'tribal trading' world of 2025 can easily get trapped in a cycle of barbarism. If 'civil society' is able to re-emerge, beyond isolated communities, and support a reasonable population, it requires above all effective food production and effective trade (and therefore effective communications and transport). In terms of intelligent infrastructure, the significant policy and technology issues are:

- How does ICT work in a low-energy society where individual computing resources are unlikely to be sustainable and large-scale fabrication plants are unlikely to be viable?
- How do such 'computers' communicate with each other?
- What are the possibilities for energy-efficient transport, above and beyond human and animal power?

We anticipate that a better understanding of these issues would also be applicable in the UK's response to other scenarios.



It's been long and it's been hard. It is two generations since the Great Disruption stripped the veneer away from civilisation, and made us realise how thin it had been, how dependent it had been on cheap energy and complex systems. Some places had survived better than others as the dense and concentrated urban world of the late 20th century unravelled in the face of shortages and system failure; and not always the obvious places. It wasn't just a matter of local natural resources. Local skills and traditions, and local cohesion and culture counted for a lot as well.

This is a world that seems to have stabilised, but the change has been traumatic. By 2055, many have died, from illness as much as the endless skirmishes over energy and food, and more have migrated, often unsuccessfully, in search of places with resources where they can settle.

The world now is more local than it was. The world awash with cheap energy is a distant memory, and lifestyles have changed accordingly. If people travel as much as they ever did, they do it more slowly; they don't travel so far. Work is closer to the home; indeed, in some places, living patterns have reverted to the pre-industrial, with the home and the workplace being the same. People – certainly in Europe and the United States – are colder and hungrier than they were 50 years ago. But more appropriate building design has compensated for some of the cold, and diet is better. Less energy means that there is more physical work to be done, so people are fitter too.

Journey to a business meeting

It was becoming urgent that Jill made a visit to her major customer to sort out a deal that was going nowhere. No amount of voice over internet protocol (VOIP) or texting was sorting it. She needed an eyeball-to-eyeball meeting. The problem was she was in Portsmouth and her client was in Liverpool. Travelling that distance these days was a nightmare. The various options of car, train, even bus were increasingly disjointed and run by intensely rival business families with degenerating co-ordination between them.

She called her brother in Birmingham to see if he had any connections with the rumour of a fast car transit service based on high-speed people carriers powered by hybrid engines that she had heard could make 200 miles per gallon of gasoline. The significance of this was that most gas was selling at £20 a litre and only the very rich or the subsidised authorities such as police and medics could travel more than a few miles a week.

Her brother had an uncle who knew one of the operators in Manchester and, through family connection, procured a privilege pass. This would enable Jill to make it there and back without losing too much valuable time looking after her other deals. She surprised her customer by announcing she would stop by tomorrow to sort things out. The audible spluttering on the other end of the call confirmed Jill's view that she had better be ready for a mess. People were not used to such rapid face-to-face responses any more.

If the ubiquitous communications technologies of the late 20th century (at least in the north) have disappeared, information is still stored and transmitted. Because travel can be dangerous, there is a huge incentive to ensure reliable information. Much of the copper that we had buried in the ground is long gone (the stuff that hasn't eroded was stripped in the Second Great Depression). Many of the fixed-line exchanges were looted too; the 'dark' fibre under the ground is destined to remain dark. In its place wireless and low-power network systems have emerged, powered by renewables, mesh-type systems with high levels of redundancy, linking simple terminals to central servers.

Buildings have also gained from innovation. If a building is now required to generate its own energy and process its own waste, most of the underlying principles were well understood in the last part of the 20th century, and much of the technology is straightforward. Indeed, the developing knowledge of the new building technology, and the self-adjusting natural systems required to make them work, was one of the most valuable assets exchanged over the information networks and by traders.

Carbon emissions have contracted, mostly, simply because far less energy is used than in the later 20th century, although coal is burnt again for heat and some power, at least where it can be recovered.

Vehicles for local use combine human power with electricity, for those who desire such luxury; the fastest vehicles on the road are steam-powered; although there are precious few of those, they are well-suited to the wide, if battered, roads that remain from the later 20th century. Air travel is a luxury for those few still employed by global enterprises, mostly energy companies enjoying the last profits from their lucrative oil and gas reserves, flitting between expensively maintained and well-defended airport compounds.

For those who do not have such luxury, life is simpler. This is a world in which the 'energy cost' of everything, goods or services, has to be paid for. People own less than they used to, and they repair more than they used to. Every community has its smiths and its seamstresses. Waste is minimal, not out of ideological concern but simply because it is a luxury; when things reach the end of their functional lives, they are re-used or recycled. People also trade less than they used to; however, they do trade the things they can't make locally.

Family get-together

The garden was looking particularly beautiful this late summer day. Vegetables, salad stuff, potatoes, beans were growing in abundance. Andrew walked around the garden planning what he would harvest to feed his daughters, who were braving the vicissitudes of cross-country travel as their mother was seriously ill. The garden had been a pretty spacious suburban lawn until the oil crisis and energy poverty took the middle out of society and the cost of food miles brought the end of the 'every day low-cost' supermarket boom.

The phone rang. 'Dad, we've got stuck. The train is cancelled and there are no coaches. We're still 50 miles away. Help!' Ten years ago, 50 miles was a relatively easy 100-mile round trip. But today there were few people, given the rationing of fuel, who would make unplanned trips of that scale. Everyone carefully worked out their private car travel portfolio to get through the month. 'I'll see what I can do,' said Andrew.

He was a member of the Sustainable Gardens Association and consulted his directory. He found a member half way to his stranded daughters, phoned and found they were carrying out a delivery to the area. A lift back was no problem. That was half way. The next step was a post office bus that was scheduled for a late day delivery to within 10 miles. A place was booked and then for the last 10 miles? Andrew's boss had a hybrid car and was willing to help out with a 20-mile round trip, providing that Andrew supplied the 0.3 litres of petrol for the trip.

They finally arrived after dark and Andrew held his daughters close as he took them to his wife. It had been so long!

Localism also makes for diversity in political and economic systems, even if the fizzing experimentalism of the second quarter of the century has diminished as some local social systems have shown themselves to be more robust than others.

But the other side of this is the recurring local conflicts over resources. As the population levels have settled, these conflicts have become less intense, but those communities blessed with good local energy sources and good agriculture are still vulnerable, even if they are also the communities most able to afford the manpower to defend their boundaries.

The legacy of the Great Economy of the 20th century is seen in unexpected ways. Climate change means that weather can be intense, especially rainstorms, and water courses are common. There is news, too, of local disasters from 20th-century legacies; the landfill residues that leach into an aquifer and poison a water system … and people still remember Chernobyl.

An urgent delivery

The consignment of vegetables had been gathered from the local allotments, which now took the place of what had been the local park. They were destined for the coastal town some 30 miles away, a place with no rail and a limited bus link. The consignment of fish he was bringing back in return was waiting. They should have been there two days ago but the picker gang had not appeared and Mike ended up doing an extra day with a wheelbarrow rather than running his distribution business. Plus, his gas van had blown a gasket and the local mechanic was off sick.

He considered his other options. First, the BIKE-IT service could provide two bikes with trailers to pedal it there in a day. Slow and expensive on labour, being equivalent of four man-days. Never mind that part of town not being too safe, the fish would be worthless by the time they got back. There was the OMNIVAN service that took mixed goods and people along prescribed routes, but that part of town was way off its usual run. That would cost a premium, and they didn't have a cool box. Then there was the YORVAN hire company that could be quick and efficient, but meant finding five litres of biodiesel, as they would only rent if you provided the fuel. Biodiesel was getting very expensive in this area as the local production plant was small. It was a mess!

Mike called the store. 'We're really short of vegetables and I have other customers asking for fish, but I don't need what they have as much as I need vegetables. Is there no way you can get it to us?' came the response. 'Look,' said Mike 'I don't use biodiesel – do you know anyone?' 'Well, there is a fisherman who will sell me some – I don't know where he gets it from and I don't ask.' 'OK, deal. If you can replace the fuel, I'll persuade YORVAN to do the trip. Can you make sure the van is expected?'

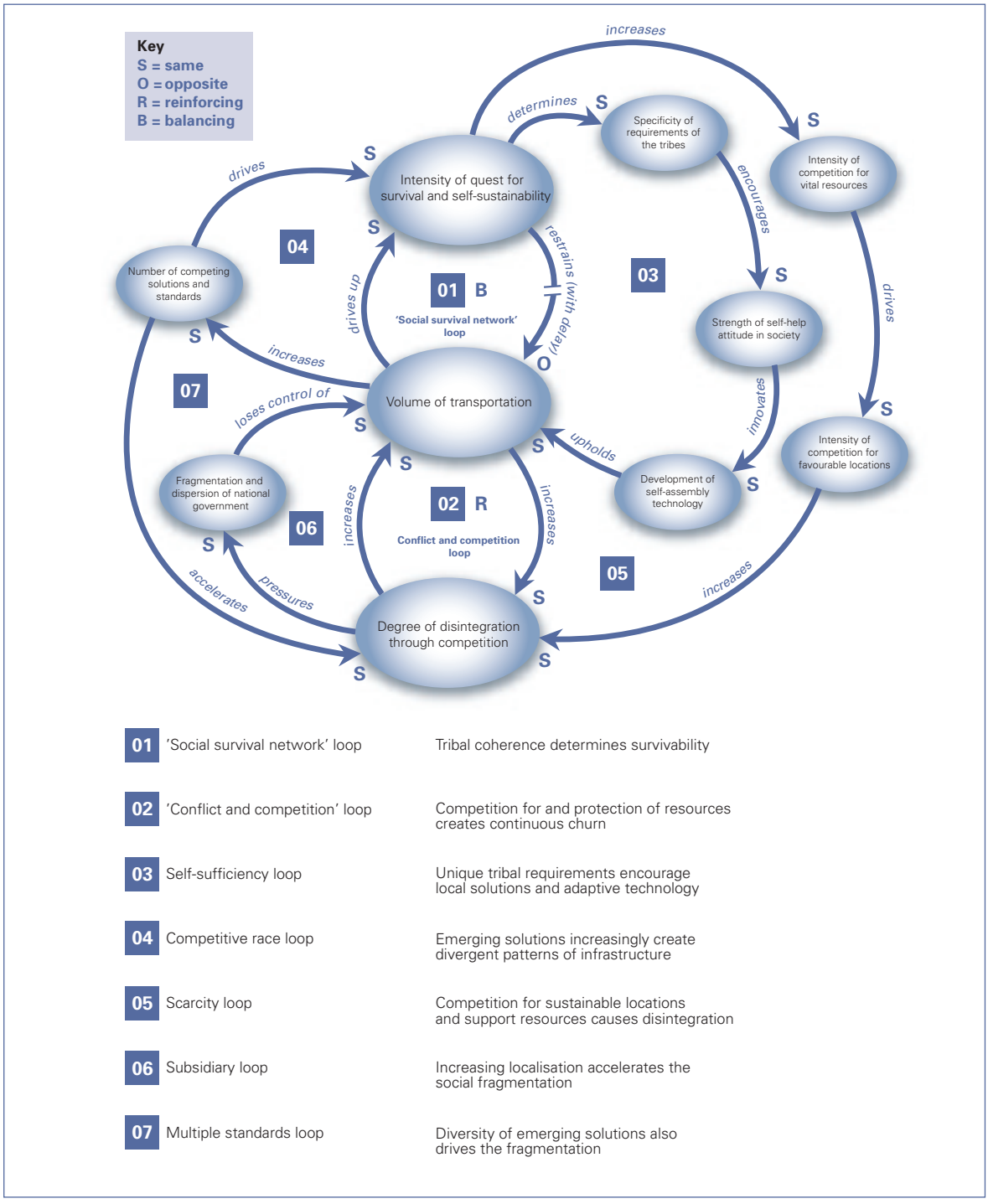
Somehow they got by these days, but what a struggle compared to the days of low-cost fuel and ubiquitous transport. If only we'd taken Peak Oil seriously!

47 Quoted in *The Economist*, 23 October 2003.

48 Donella Meadows, Jorgan Randers, and Denis Meadows, (2005), *Limits to Growth: The 30-year Update*, p164. London, Earthscan. Also www.rmi.org.

Core and major causal loops

Energy supply increasingly cannot keep pace with demand, creating shocks which evoke the 'Social survival network' loop. This constrains transport of necessity but many groups still assert autonomy to remain highly mobile. The resulting "Conflict and Competition" loop makes this a scenario of continual tension emerging in rapidly changing patterns.



01	'Social survival network' loop	Tribal coherence determines survivability
02	'Conflict and competition' loop	Competition for and protection of resources creates continuous churn
03	Self-sufficiency loop	Unique tribal requirements encourage local solutions and adaptive technology
04	Competitive race loop	Emerging solutions increasingly create divergent patterns of infrastructure
05	Scarcity loop	Competition for sustainable locations and support resources causes disintegration
06	Subsidiary loop	Increasing localisation accelerates the social fragmentation
07	Multiple standards loop	Diversity of emerging solutions also drives the fragmentation

49 Donella Meadows, Jorgan Randers, and Denis Meadows, (2005), *Limits to Growth: The 30-year update*. London, Earthscan.
50 Richard C Duncan, 'World Energy Production, Population Growth, And the Road to the Olduvai Gorge', *Population and*

Scenario reflections

'The Stone Age did not end for lack of stone, and the Oil Age will end long before the world runs out of oil.'

(Sheik Yamani)[47]

In the way it is described here, Tribal Trading gets worse before it gets better; and even then gets only a little better, at least when compared to the living standards and expectations of the population of the countries of the north in 2005.

Tribal Trading is the most extreme of the scenarios to emerge from the drivers-based process that created this set of scenarios. In some of the testing workshops, there were questions as to the likelihood of the scenarios. In particular, participants considered that we would be unlikely as a society to get to the point of social breakdown through energy shortage without an extreme political response, such as the use of military force to secure additional energy supplies or a crash programme to build additional nuclear capacity.

Consideration of these particular options suggests that by the time they occur, they are likely to increase the economic and political instability inherent in the scenario; the time lags involved in building nuclear capability are such that it would increase volatility without resolving the underlying issue. By the time the power stations were on stream, there is a significant risk that it would be hard to guarantee the political stability needed for a civil nuclear energy programme.

Other participants suggested that the scenario was implausible because there would be a political response prior to the series of events that trigger the scenario. On this point it is worth noting that, in the most recent update of *Beyond The Limits*, the authors note that the 'overshoot' scenario is the most frequent out-turn when they run their 'World3' model. Overshoot occurs as follows:

'If the signal or response from the limit is delayed and if the environment is irreversibly eroded when overstressed, then the growing economy will overshoot its carrying capacity, degrade its resource base, and collapse. The result of this overshoot and collapse is a permanently impoverished environment and a material standard of living much lower than what could have been possible had the environment never been overstressed.'[48]

Their thesis is that our current combination of population growth and economic growth, together with a limited resource base and the long delays in the response of biological and other critical systems to stressing, is a system that is inherently structured for overshoot and collapse. This combination, they say, is 'literally unmanageable'. It would require intervention to prevent this.

Importantly, however, from the perspective of a scenarios project, they also note, 'Overshoot can lead to two different outcomes. One is a crash of some kind.

Environment, May–June 2001, Vol. 22, No. 5. [accessed 16 August 2005].

51 In the original 1972 projections, peak year for Industrial Output per Capita was 2013.

52 Gilberto C Gallopin, 'Scenarios, Surprises, and Branch Points', in Lance Gunderson and CS Holling, (eds), *Panarchy*. Washington DC,

Another is a deliberate turnaround, a correction, a careful easing down.'[49] The easing down, however, requires structured policy intervention.

In his review of the competing views on the (human) carrying capacity of the planet after the age of abundant fossil fuel, Richard Heinberg suggests that it is likely to be in the order of 2 billion – although this may be pessimistic. Richard Duncan, an electrical engineer by background, deduced from analysing data on population and energy use worldwide, that world energy production per capita peaked in 1979, and is currently falling slowly. His model, however, suggests that the rate of decline will increase sharply after 2012, with consequent widespread electrical power shortages.[50] The 'Limits to Growth' World3 model suggests that industrial output per capita will peak in 2014.[51]

One of the significant issues within the scenario is that of Peak Oil, the year when half of world oil reserves are used up. The scenario assumes that this happens soon, within a decade. The data simply isn't good enough for us to know – the size of oil reserves are often restated for political or business reasons, rather than being based on testable or public information. But Peak Oil sceptics have suggested for some years, based on the ratio of discovery to extraction, that Peak Oil could be as early as 2010. The surge in demand for oil from China and other developing economies has led some to bring these dates forward.

While the year of Peak Oil means only that after that date global oil production will start a slow decline (2–3% per year), the global response will define how that affects economies. An unmanaged market, against a background of continuing increases in global demand, could cause extreme economic turbulence.

One further reflection on the scenario trajectory may have value. In an article reviewed by the project team after the conclusion of the scenario development and testing process, Gilberto Gallopin analyses a set of global development scenarios which he had been involved in creating (based on a slightly different methodology from the present one). As a frame of analysis, he used the 'Panarchy' model, which relates the potential within a system to its level of connectedness.[52]

There were three pairs of scenarios, grouped into the following clusters; 'conventional worlds', 'barbarisation', and 'great transitions'. 'Great transitions' included two variants: one called 'new sustainability', and another called 'ecocommunalism'. The latter has reasonable similarities with the 2055 world of Tribal Trading.

Although on the face of it, the 'barbarisation' pair appear very different from those in 'great transitions', Gallopin suggests that 'ecocommunalism' could evolve from a reorganisation of social elements and structures following a social collapse at the end of a 'barbarisation' scenario.[53] Furthermore, there are circumstances in which 'ecocommunalism' is able to become stable.

Island Press, 2002. The Panarchy model was developed as a way to understand the resilience and recovery of ecological systems.

53 'It is difficult', writes Gallopin, 'to imagine a trajectory leading from the current world situation directly to an Ecocommunalism future. Too much is committed, and Ecocommunalism would imply a voluntary dismantling of much of what has been built by civilisation, as well as strong reductions not only in population growth, but also in population size'. (Gallopin, 2002)

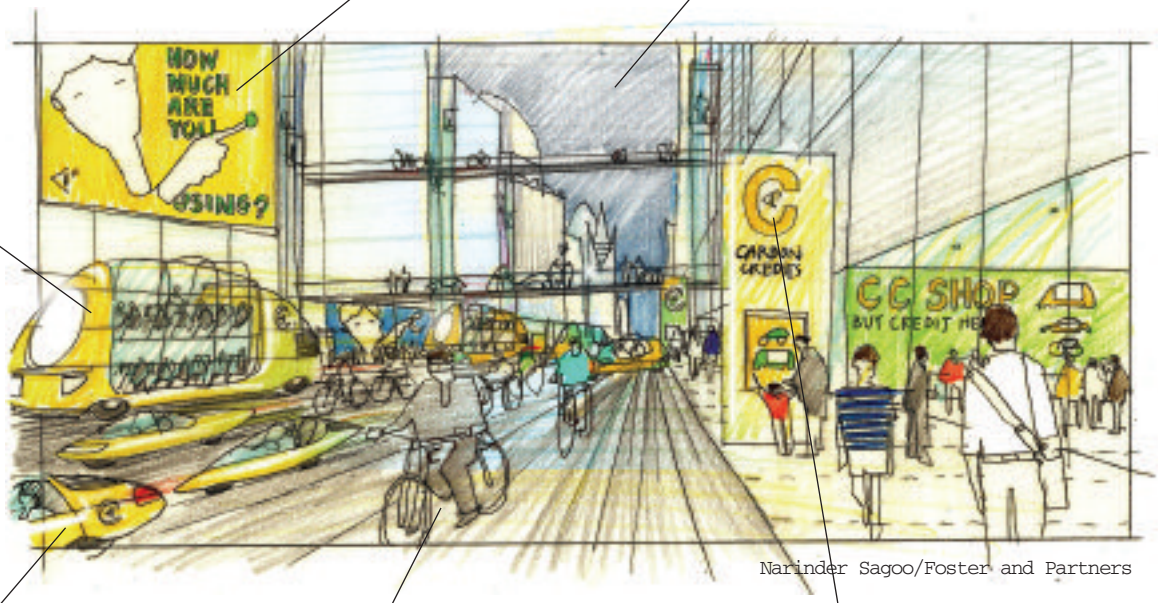
Scenario: Good Intentions

An artist's impression of Good Intentions in 2055

Everyone is aware (or made aware) of their own personal carbon emissions and it is a decision-making factor for the way

Years of energy guzzling have left their mark... the skies are grey from the

Multi-level people carriers transport lots of commuters



Narinder Sagoo/Foster and Partners

Vehicles are, by necessity, designed for ultra-energy-efficiency and only provide as much space as needed, therefore they are smaller, ultra-lightweight and biodiesel powered. The consumption is also closely

Cycling is now a way of life, not only for those who want to save the environment and keep fit, but also those who have run

Carbon is the new currency – carbon credit top-up points are now as ubiquitous as

The big picture is of a big city where people's lifestyles are determined by a strict and enforced scheme of carbon consumption control. Biofuel is the primary alternative form of energy, but the need to reduce energy consumption is now a matter of survival in a rapidly degrading environment. Cars are lighter, smaller and more efficient, and more and more people are cycling, even for long distances.

High-density cities and empty suburbs

Timeline: Good Intentions

2055

2051 Worldwide citizen protests for more stringent carbon emissions targets

2046 UK citizens campaign for greater action on climate change after freak storms

2045 Increasing migration from parts of the UK and Europe subject to frequent flooding

2042 Contraction and Convergence Criteria Re-evaluation Summit

2040

2039 Gridlock on carbon emissions negotiations at G12 Summit

2038 Biodiesel bus network in place across much of the UK

2036 Census 'Social and economic inequalities across the UK significantly reduced'

2030 Personal CO_2 allowance introduced as part of Contraction and Convergence Agreement

2025

2024 G10 Contraction and Convergence Agreement reached; harsh intra-G10 sanctions for those who fail to comply

2022 Dynamic Traffic Flow Management System rolled out nationally

2020 Environmentally driven airport landing taxes introduced across the EU

2009 Dynamic Traffic Flow Management System pilot in West Midlands

2005

'Mobility is the last sacred cow of modernism'

Peter Newman, Chair of the Western Australian Sustainability Roundtable[54]

Good Intentions is a world in which the need to reduce carbon emissions constrains personal mobility.

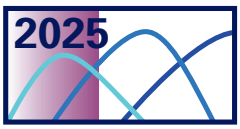
A tough national surveillance system ensures that people only travel if they have sufficient carbon quotas; intelligent cars monitor and report on the environmental cost of journeys; and in-car systems adjust speeds automatically to minimise emissions.

Traffic volumes have fallen and mass transportation is used more widely.

Businesses have adopted energy-efficient practices and use highly sophisticated wireless identification and tracking systems to optimise logistics and distribution.

Some rural areas are able to pool community carbon credits for local transport provision, but many are struggling.

There are concerns that the world has not yet done enough to respond to the human activity that has caused the environmental damage. Airlines continue to exploit loopholes in the carbon enforcement framework. The market has failed to provide a realistic alternative energy source.



The past 20 years have seen limited changes to the UK's transport infrastructure. Few long-term infrastructure projects have had the political commitment or investment required to become a reality. The ageing infrastructure is becoming an increasing financial burden on the state and business has become concerned about the impact on the UK's long-term economic competitiveness.[55] Furthermore, air pollution from traffic-related emissions is damaging London's reputation as a highly desirable tourist destination.[56] Successive governments have been reluctant to tackle the growing threat posed by climate change, fearing the consequences from an electorate that still wants the right to travel where, when and how they want.[57]

Fuel efficiency

Vehicles are now 90% efficient at energy conversion.

Use of alternative fuels and ultra-light materials – such as aluminium, plastics, magnesium, carbon fibre, and metal matrix composites – are two key ways that fuel efficiency is increased.

Car manufacturers have overcome the challenges of hydrogen storage, and are working towards hydrogen fuel-cell vehicles, as well as biodiesel and SVO (straight vegetable oil) engines. The constraining factor remains the fuel infrastructure.

54 Newman is also Sustainability Commissioner in New South Wales. Quoted in response to the World Business Council for Sustainable Development report 'Mobility 2030: meeting the challenges to sustainability' www.ecoplan.org. See also *The Engineer Online*, 'If we want to enjoy unrestricted, exponential growth in our use of the national infrastructure, are we prepared to pay?' 11 July, 2005 www.theengineer.co.uk/Articles/291220/Basic+truths.htm

55 "Productivity isn't everything, but in the long run it is almost everything." Paul Krugman, quoted in ESRC Seminar Series: Mapping the public policy landscape: The UK's Productivity Gap p1 www.esrc.ac.uk/policyseminar

56 See Bell (2006) '*Environmental Factors in Transport*' IIS Foresight state of research review, www.foresight.gov.uk

57 'Mobility is the last sacred cow of modernism' Peter Newman, Chair of the Western Australian Sustainability Roundtable and Sustainability Commissioner in New South Wales, Response to the World Business Council for Sustainable Development report 'Mobility 2030: Meeting the challenges to sustainability' www.ecoplan.org. See also *The Engineer Online*, 'If we want to enjoy unrestricted, exponential growth in our use of the national infrastructure, are we prepared to pay?' 11 July, 2005 www.theengineer.co.uk/Articles/291220/Basic+truths.htm

Where effort has been made to improve the quality and intelligence of the network, it has often felt like one step forward and two steps back. The first large-scale dynamic traffic flow management system pilot, for example – introduced in the West Midlands in 2009 – was initially hailed as a success but quickly ran into technical problems.[58] Insufficient resilience caused system failure and complete gridlock in Birmingham on more than one occasion. The failures quickly reopened debate on the robustness and reliability of the technology, forcing the Government to revise the timeframe for roll-out nationally.[59]

Pay As You Drive

Vehicles fitted with electronic vehicle identification (EVI) chips calculate and assign premiums based on actual vehicle use. The driver's monthly bill is calculated according to their driving data – distance travelled, premium toll roads chosen and emission level.

The tax disc system has been abolished.

It was four years before the West Midlands pilot was declared a success by Government – speeding travel times, smoothing flows on the network and reducing accident rates by up to 30%, according to the evaluation[60] – but their endorsement was not sufficient to placate the growing numbers of citizens who were becoming increasingly vocal about the perceived threat to their right to mobility. Of course, these concerns were related as much to the Pay As You Drive element of the scheme as they were to the (so called) Choose Where You Go system. Government pressed on nevertheless, and by 2022, the scheme was in place across much of the south-east, the Midlands and Manchester.

It is still too early to tell how effective dynamic traffic flow management will be. The technology remains susceptible to system failure and vulnerable to attack. Problems with interoperability and inefficiency – the result of unresolved issues around standards and exchange protocols between operators – remain. So too does the question of ownership of the personal data that is collected through the system. The protest lobby is growing and becoming increasingly radical as it does so. It has been buoyed in its protest by support from a leading tabloid newspaper, which vociferously opposes the curbs on individual freedom, the iniquity – as it sees it – of paying to use roads and the storage of information on every driver in one centralised database. It has particularly fanned the flames with its claim that the primary aim of the scheme is to deploy Traffic Alert Generator (TAG) systems widely and use the data to control flows in real time.[61]

58 'Those who think it is just a question of the Government making brave choices need to think again. Large technology projects are always tough to get right.' Secretary of State for Transport, Alistair Darling 9 June 2005. See also 'A beacon method for charging', *Guardian* 9 June 2005, which discusses Germany's road-charging scheme for lorries: 'it was meant to start in August 2003, but the initial version failed, and integration work… took much longer than expected.'

59 'Combating Gridlock: How Pricing Road Use Can Ease Congestion' Deloitte p2 www.deloitte.com/dtt/cda/doc/content/dtt_research_GridlockExecSumm_110303.pdf See also Royal Academy of Engineering, *'Transport 2050: the route to sustainable wealth creation'.*

60 Freeway management systems that detect congestion, initiate lane controls, and warn drivers of slow traffic can decrease accident rates by 23%. US Department of Transportation, 8 August 2005.

61 ITIS to supply live traffic data to Transport for London, *Telematics Update*, 26 August 2005.

Road traffic flow management

The road traffic management system utilises commuters' 4G devices, GPS and GSM technology in commercial vehicles and RFID sensors to gather and transmit data in real time about traffic flow, optimal journey times and route choices.

4G WiFi networks, MANETs (Mobile Ad-hoc NETworks) and satellite technology connect the deployed infrastructure to the web. Data is transmitted back to travellers – before or during their journey – and picked up using mobile phones, PDAs, web or telematic TV. Drivers can choose to let the in-car navigation system select the optimal route – and can customise the algorithm for timing, pricing and speed.

The Government is slightly taken aback by – and unprepared for – the scale of the opposition to its traffic flow management scheme. In response, it appears to moderate the final phase of its roll-out programme. Furthermore – and with an election not too far away – its critics are beginning to raise sharp questions about the Government's overall transport strategy.

Perhaps they are right to be concerned. Airline passengers suffered a huge price hike nearly a decade ago and have watched prices continue to rise constantly ever since. On top of that, environmentally driven passenger airport landing taxes – introduced across the EU in 2020 for all planes with CO_2, CO, NO_x or VOCs emissions above Clean Air Standard (CAS) and collected at the point of arrival regardless of point of departure – have resulted in increased costs, delays, re-scheduling and complaints as airlines seek to offset costs by utilising cheaper regional airports.[62] A growing number of small businesses now claim that this latest 'stealth tax' is raising a significant barrier to entry in UK markets. Big business is equally concerned about the effect on competitiveness.

For their part, the car manufacturers, still suffering from global over-capacity and low profits, protest loudly that they need a long-term strategic commitment from the Government, or even fiscal incentives, to help overcome the continuing technological and financial problems associated with the widespread introduction of fuel-efficient vehicles. Government's continued reluctance to intervene in the market – arguing that it is not in the business of subsidising industry – is missing the point: low-emission vehicles will remain economically non-viable until people are prepared to pay for environmental protection.

Railway passengers aren't happy either; years of rising fuel costs and under-investment in public transport mean that the networks are – still – stretched to their limits. Public pressure for investment in public transport is growing and there is mounting concern about the continued use of old, high-SO_2-emission electric traction on regional (and some long-distance) journeys.

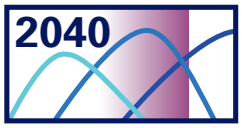
62 See, for example, 'EU plan airline CO_2 reductions', *BBC News*, 27 September 2005. Aircraft are responsible for 3% of EU carbon emissions and forecasts suggest that they could make up 25% of the UK's total contribution to global warming by 2030. The European Commission has recommended that airlines should be included in its carbon dioxide trading scheme.

Across the transport infrastructure, the rhetoric may have been there, but there has been little substantive action. It is therefore hardly surprising that the UK Government – like other major world powers – is now feeling the political heat on climate change. The Contraction and Convergence Agreement (CCA) signed by the G10 last year, could be our best chance to tackle the problem.

While the Government has understood the need to educate citizens of their collective responsibility, its sporadic attempts have had little impact; perhaps the promise of significant trade sanctions from other G10 nations if we fail to comply with the Agreement will be the incentive the Government needs to act swiftly and decisively.[63]

Critical issues going forward from 2025

- Interoperability and inefficiency in traffic flow management
- Continued resistance and citizen protest to protect 'right to mobility'
- Competitive landscape between service economy and retail
- Government commitment to fuel-efficient vehicles
- Policy commitment to long-term infrastructure planning
- UK competitiveness in light of ageing infrastructure
- Robustness of contraction and convergence criteria



Fifteeen years on, the economic, environmental and social consequences of signing up to the CCA are clear. The economy has continued to grow, despite a significant reduction in the amount of travel being undertaken, much to the surprise of some economists; GDP and transport growth are not as closely coupled as they were once believed to be.

Contraction and convergence

This international policy framework, originally developed by the Global Commons Institute, based in London, was first proposed to the United Nations as far back as 1990.

The first agreement, in 2024, was for a full-term contraction budget for global emissions consistent with stabilising atmospheric concentrations of greenhouse gases at a level of 450 parts per million by volume. The intent was that all countries converge around more sustainable emissions targets.

See the Global Commons Institute, www.gci.org.uk, and 'Contraction and Convergence' by John Broad, Chairman of the Global Commons Trust, *The Ecologist* (March/April 1999), for further information.

63 Kenneth Deffeyes, author of *Beyond Oil: The View from Hubbert's Peak*, as discussed in 'The End of Oil?' by Mark Williams, *Technology Review*, February 2005 'Deffeyes is optimistic about the long term only because he believes that by 2010, pressures will grow so intense that they'll create the resolve necessary to develop a new energy economy.'

The G10 nations have all successfully met the CCA targets on carbon emissions and some of the most pessimistic outcomes of climate change have been avoided. This is a cause for celebration among the world's political leaders, but the environmental and scientific communities remain concerned about two critical issues: are the developed nations still doing enough to reverse the legacy of neglect and were the assumptions behind the 2024 CCA targets robust enough in the first place? The carbon measurements in the atmosphere are still rising, probably because of inaction a generation ago, and it is hard to gauge whether contraction and convergence will be enough.

Individuals are concerned too; especially those at the sharp end, where the consequences of climate change can be both seen – on the LMES (local monitoring for environment and security) systems[64] – and felt: recent government figures show that net migration from the parts of the UK with the highest risk of flooding is increasing by 7% annually. Populist protests are now a regular feature of life in European cities and the Parliament as citizens continue to press for more stringent carbon targets.

Carbon entitlements

Under the terms of the CCA, individuals each received a carbon entitlement, which had been negotiated and agreed between the regions of the world.

The entitlements, in the form of international energy-backed currency units (EBCUs), operate as a parallel currency.

See Global Commons Institute, www.gci.org.uk, for further information.

The results of the 2036 census showed the social impacts of CCA to be more dramatic than anyone had predicted. Notably, the gap between the poorest 10% of the population and the rest narrowed significantly as individuals who used little carbon successfully traded their entitlement – allocated as UCEs, or 'Units of Carbon Entitlement' – for cash. Moreover, the health outcomes for the poorest 10% have risen and are now only 2% below the UK average.

Carbon entitlements have affected middle-income families too, forcing many to change their lifestyles in order to make best use of their EBCUs. Two-car families are in decline, bicycle sales continue to soar, home working is increasing[65] and many families are rediscovering the need to budget carefully in order to purchase the travel credits required to go on holiday. UCE trust funds have become popular – particularly as a gift to newborns – with returns that offer the promise of cheap and easy future travel – just like the good old days! UCE exchanges are big business too – especially for those entrepreneurs who act as middlemen or

64 Global Monitoring for Environment and Security (GMES) represents a concerted effort to bring data and information providers together with users, so they can better understand each other and make environmental and security-related information available to the people who need it through enhanced or new services. GMES is maintained under the directives of the European Commission Directorate General Enterprise by the GENACS Consortium.

65 BT, 'Broadband – the role of communications in beating congestion' p3, www.bt.com/travelsubstitution

brokers. There is a tidy profit to be made by setting up exchanges within communities or between corporations. And some things never change, with most people putting their new found wealth into property.

The renaissance of homeworking has created demand for better local infrastructure and services. Many local authorities have responded with extensive carbon-free infrastructure development programmes. Biodiesel buses have been a particular success in the face of insufficient carbon credits.[66] Rural areas with strong communities and local leadership have fared better than expected due in large part to the pooling of community carbon credits for local transport provision, such as school buses. Less-cohesive rural communities are, however, struggling and many face an uncertain future as residents are forced to consider relocating closer to the jobs.[67]

The decline of so many rural areas has encouraged many individuals to join the ranks of those opposed to UCEs, and the protests have taken on an increasingly disruptive form, with illegal infiltration of online UCE accounts depressingly common.

Companies that adapted their business model prior to the 2024 Agreement are coping well.[68] As with earlier environmental regulation, understanding the impact early on has led to competitive advantage. However, there is considerable consolidation in the freight market as the margins get ever thinner. Supermarkets have faced many challenges too – they have a maximum allocation of non-local and non-seasonal stock, enforced by ubiquitous wireless stock-tagging schemes, which are monitored in real time by the Environmental Inspectorate. At its height, food transport accounted for 12% of total emissions from the road network.[69] It is no longer viable to fly produce in from further afield.

Supermarkets are not alone in having to change their use of the airways. Flying is increasingly becoming a luxury for the rich; and for a growing number of citizens, it is socially unacceptable even if it is affordable; frequent flyers are demonised in the same way that smokers were at the turn of the century.[70]

The national traffic flow management system means that there is no escape for those who still use their cars.[71] New in-car technology is having an impact too – the two green dials on every dashboard tell the driver both the environmental cost of each journey and the true economic cost. In addition, sensors in the vehicle can send a distress signal to the police if the vehicle is involved in a crash

66 London Metropolitan Police already has at least six filling stations in London where its biodiesel fleet can fill up. *Guardian*, 21 April 2005, and 'It's time for the yellow solution,' *Independent*, 16 June, 2005.

67 IIS Advisory Group discussion, 8 June, 2005.

68 Amory B Lovins et al *Winning the Oil Endgame* Executive Summary, Rocky Mountain Institute, 2004.

69 A key finding of Defra's report *'The Validity of Food Miles as an Indicator of Sustainable Development'* (July 2005) is that food transport has a significant and growing impact on the environment. The report notes that food transport in 2002 accounted for 8.7% of the total emissions from the road sector. We have assumed an increase of just under 40% to describe the peak figure.

70 Aviation could be up to a third of UK climate change impact by 2050, *Climate Change and Transport*, DfT June 2005 (Stephen Hennigan, Policy Adviser).

71 See Independent Transport Commission *Transport Pricing – Better for Travellers* www.trg.soton.ac.uk/itc/tp_concs.htm and also *Combating Gridlock: How Pricing Road Use Can Ease Congestion* Deloitte p2 www.deloitte.com/dtt/cda/doc/content/dtt_research_GridlockExecSumm_110303.pdf

while travelling at over 25 mph.[72] The insurance industry has had a key role to play here – it's a strong force for greater use of technology to enforce changing behaviour. Individuals who remain opposed to the traffic management system find that smart disruption devices are fairly effective in exploiting weaknesses in the software, ensuring that they are one step ahead of the enforcement agencies. The police, however, have the powers to levy steep spot fines on any motorist detected using the devices.

Biodiesel and also bioethanol buses face no such problems and are starting to become more popular, although they remain 'niche transport'. The biggest limit on the growth of biodiesel is its agricultural impact, reducing the amount of land available for producing food closer to where it is eaten. The declining numbers of fast-food restaurants have long since entered into agreements to recycle all their surplus cooking oil into the vehicle network. The UK is importing growing amounts of ethanol from South America to meet growing demand among car owners.

Biodiesel and bioethanol

Biodiesel – typically made by adding processed waste cooking oil to normal diesel, contains 5% vegetable oil.

Biodiesel works in the same way as conventional diesel. However, emissions of nitrogen oxides can increase when using biodiesel. This is a concern as such emissions can produce ozone.

Widespread use of biodiesel by the bus network requires the fuelling infrastructure to be in place.

Bioethanol is the alcohol produced by fermenting sugar. Brazil is the world leader in bioethanol production, and puts 100% sugar-based fuel into more than half its new cars. (Maximum levels in Europe are lower, due to the need to ensure ignition in cold weather.)

Future supply of bioethanol will come from countries with hot climates.

See www.futurepundit.com and *Observer*, 'Sweeter by the gallon' 12 June, 2005.

A growing number of commuters are willing to suffer long bus journeys during the week, in order to spend their carbon entitlements on enjoying themselves at the weekends. Using the trains is more pleasant and efficient than it used to be after increased investment in latest-generation fuel cells (reducing pollution and improving performance) and satellite positioning systems (improving safety and efficient movement on low-density routes)[73] However, train operators are once more complaining that they are at capacity, despite the increased volumes of traffic afforded by network technology. In the face of threats of price increases, the Government is considering a rationing scheme instead, easily enforceable through people's smart travel cards.[74]

72 'Beyond Congestion Charging' by Simon Linnett, Independent Transport Commission, May 2004 p3, www.trg.soton.ac.uk/itc. See also Siemens press release, 'Siemens to join the call for more safety on Europe's roads' 14 June, 2005

73 'Satellite keeps railway safety and efficiency on track', EurekAlert, 19 August 2005.

The national traffic flow management system and the CCAs have forced many businesses and freight companies to seek more cost-effective and energy-efficient means by which to transport their goods across the UK and to Europe. Highly sophisticated wireless identification devices have allowed them to optimise logistics and distribution with the large UK ports, and many now use the UK's waterways as their key means of distribution.

Fears from car manufacturers that the lack of government support for fuel-efficient vehicle technology would make it difficult to encourage consumer take-up have proved to be well founded. Without government support to try and change consumer behaviour – either through the tax system or via social marketing – the financial models have never been viable.[75] London and Paris have led the way for further reducing speed limits in cities – and have threatened to impose legislation in this area if car manufacturers do not commit to building intelligent speed adaptation systems (ISAS) into all models.[76] Increasingly, cars are restricted to 15 mph in residential zones and 25 mph on the outskirts of towns and villages, and the technology is integrated with the national digital speed map. Vehicles download the latest version of the speed map as part of their daily software update and automatically limit their speed when entering or exiting different zones.

As the freak weather conditions show, it's increasingly apparent that the assumptions behind the original 2024 Contraction and Convergence targets were not robust enough. Worldwide activist pressure for more stringent measures continues, but it was not enough to prevent deadlock at last year's summit meeting of the newly enlarged G12 group of advanced nations. It's clear that the Contraction and Convergence Criteria Re-evaluation Summit (CCCRS) scheduled for 2042 cannot afford to fail…

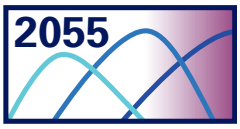
Critical issues going forward from 2040

- Extent of uninhabitable parts of the UK due to climate change
- Policy objectives to retain strong rural communities
- Extent to which social inequalities continue to narrow
- Policy objective to strengthen Contraction and Convergence criteria
- Policy commitment to long-term infrastructure planning
- Extent of citizen protest for greater action on climate change

74 The Association of Train Operation Companies, Director General George Muir, BBC Radio 4 *Today Programme* 21 June 2005, '…there will come a point, and we are not far from that point, where we have reached capacity, and at that particular time if road use pricing then comes in, it clearly has a knock-on effect on the pricing of other modes.' See *Looking Forward: Contributions to Railway Strategy*.

75 Michael Yeates, Convenor, Public Transport Alliance and Bicycle User Research Group, Brisbane, Australia, comments on '"business-as-usual with technological responses' which is exactly the demonstrated expertise of the car industry over its history…" Response to the World Business Council for Sustainable Development report, *'Mobility 2030: Meeting the challenges to sustainability'* www.ecoplan.org

76 Dave Holladay, Transportation Management Solutions discusses limiting speed of vehicles in Response to the World Business Council for Sustainable Development report, 'Mobility 2030: Meeting the challenges to sustainability'.



It is 9 May, 2055. After half a century of contention, the 'road wars,' which have dominated transport policy since the early part of the century, finally seem to be over. The largely unrestricted personal mobility that people enjoyed in the early years of the century is now a distant memory. After bitter political conflicts, sometimes violent, a tough national surveillance system means that people only travel if they have sufficient carbon quotas – and these are increasingly tightly rationed. If critics in the late 20th century said that the Government should pay less attention to the transport freedoms of the individual, and more to the costs of transport to society and its inclusiveness, no one could argue that now. Traffic volumes have shrunk hugely, and will fall further as the carbon ration continues to be reduced. There are even days when people have insufficient carbon credits to get to work, or so they say.

Jill's journey

'Oh No!' exclaimed Jill 'Not again'. She had just run into her third gridlock that week.

The problem was, it happened in a different place each time. The traffic flow system simply couldn't cope with the complex dynamic caused by people trying to avoid congestion. Instead, it created an unstable world where the problems just shifted around. People were still trickier than software...

Jill sighed. 'Enough is enough!'

Next day, Jill registered for the Superway route to head office. It cost an arm and a leg – but then so did repeated gridlock. At least she could get into work now for the crucial meetings on reorganising the firm, part of which was about the increasing cost of distribution delays as the efforts to contain congestion and pollution created unintentional side-effects.

What was emerging was a multi-tiered system where you could have mobility if you were prepared to pay (heavily) for it, otherwise reliability and predictability were just getting worse and worse. Companies who didn't pay the extra were in danger of becoming uncompetitive. So were companies who did...

Jill sighed again. Surely there's a better way?

Those commentators who argue that government policy has assailed individual freedoms are right – but unfair. Governments across the world have finally found the will to act, in the face of increasingly savage environmental projections, but they have had to do so because individual citizens and consumers who had access to all the same climate information as their governments did, had chosen not to act on it, or at least not to act fast enough.

Regions and local authorities have followed the lead of their governments and run local initiatives to reduce travel demand; and very few governments have opted out of the international Contraction and Convergence Agreement to reduce global emissions. Political and economic sanctions are imposed through the United Nations on rogue states that don't comply.

At a national level, much of the implementation is based on satellite surveillance and a huge processing capacity, which can monitor every car on the road, if need be. This is coupled with a carbon credits smart card, which is needed by any citizen who wishes to use any kind of carbon resources, from having a shower, to driving, to eating out, to listening to a digital music system. Those who are short of credits have to buy them; those who have changed their lifestyle sufficiently and have credits to spare, or who are financially poor and who have little need for travel, have prospered by selling their excess credits. Since the individual carbon level continues to be cut each year, there are always willing buyers, at increasingly attractive prices.

One of the effects has been to create a 'Mr Toad' culture where the rich acquire carbon credits and drive ostentatiously around town in surprisingly large vehicles. These sometimes get vandalised where they are parked, by the 'ecos', a goth-type group of young people with strong views on environmental damage. The police seem unwilling to press charges even when there are witnesses.

Family get-together

'See you on Sunday, then'. Andrew was not looking forward to his monthly visit to Grandma at this time. In fact, the reliability of getting there and back on a Sunday had got so bad he was booking a B&B on Saturday so he could travel the day before. Costly, but at least it worked. He had to be back by Sunday evening.

He had given up the car for the journey because the emissions charges were very high for his old model. Young people generally were less and less 'on the road' these days because they could not afford the new generation of cars that met tougher emissions standards. Even well-kept old bangers were becoming unaffordable to run, even though they cost almost nothing to buy.

Much to his surprise the coach service was bang on time in both directions. He wondered why. Then it was on the news. That very weekend a new traffic management scheme had been established on the route to his gran's. The result was a priority routing for the intercity coach route that was putting it on a par with the train and beating most of the car traffic.

Next month he booked a round trip on a Sunday and found it worked. 'But for how long?' he wondered.

A rather different part of youth culture is 'stealth bombing'. This involves loading a vehicle with complex electronics to shield it from surveillance devices, hacking the carbon control circuit, and racing along deserted motorways in the small hours. Even while disapproving on environmental grounds, it's hard not to admire the sheer quality of the technological expertise involved. Some former 'stealth bombers' have become lucratively paid traffic systems management experts, sometimes after a short period in jail.

There are also some black-market carbon entitlement exchanges operating offshore. The Government has tried to close these down, but is hampered by the International Trades and Services Rules, which enables competition in business services.

The same rules have also enabled airlines continue to enjoy loopholes in the carbon enforcement framework, which mean that they are not fully assessed for their carbon impact, even though the sector is now – by far – the largest producer of carbon emissions and associated pollution worldwide.

One of the biggest incentives to change behaviour and reduce carbon consumption was the change in the tax system, which started to have a significant effect from the early 2030s. Instead of being taxed mostly on earning and spending, as under the old income tax and VAT systems, most tax is now raised against resource consumption. The EU led the way by replacing VAT with RUT (resource-use tax). The result has proved to be far more progressive, with far greater distributional effects, than the old system ever was, and far easier to police.

But despite such environmental enforcement, the scientific community remains pessimistic. Antarctica continues to shrink, and there are new stories, constantly, about carbon released into the environment as the ice retreats in the north. The sustained unpredictability of global weather patterns continues to have huge social and economic consequences.

The Carbon Clock is still ticking closer to doomsday, or so the scientists say. CHASM, the Concerned Humanists, Artists and Scientists for Mankind organisation, sets it every year depending on the rate of change of damage to the atmosphere. The parts per million are continuing to rise, ever closer to the critical levels that could take us into uncharted and unpredictable climatic territory. At a news conference in Paris, the organisation's global chairman announces that the clock has just ticked on to 2 minutes to midnight. The world of the cold war and nuclear threat never felt as ominous as this…

An urgent delivery

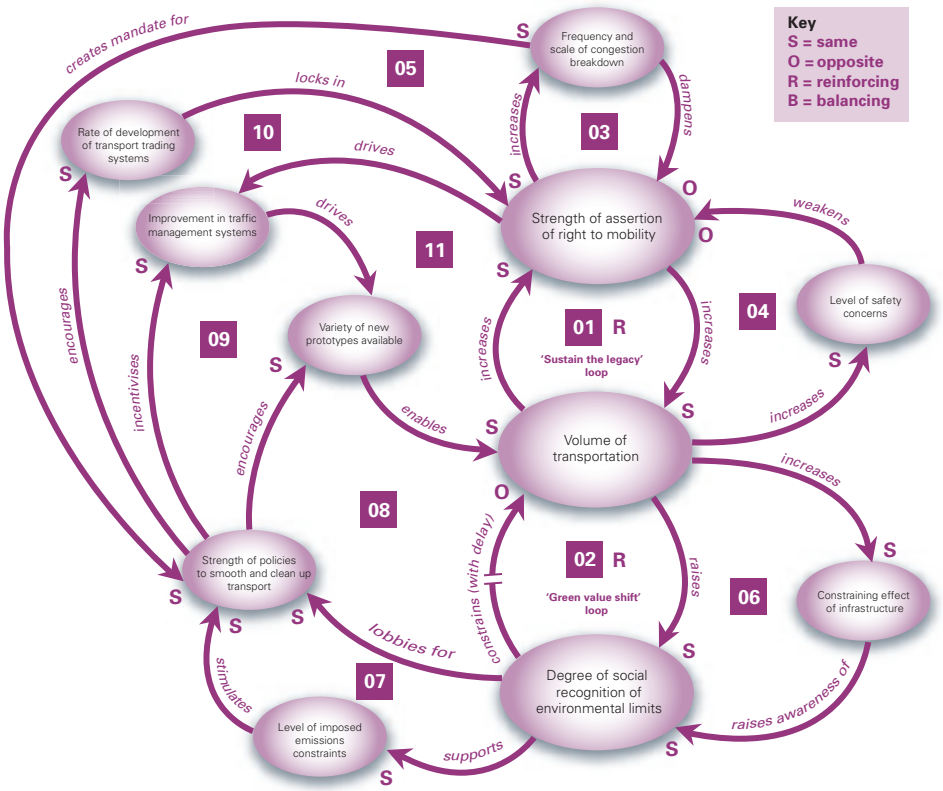
The new fleet of white vans stood in the vehicle park below his office window. Mike was pleased he had managed to arrange the finance to replace his old fleet. These new vans were way better than the new emissions standards and should last for some time within the tax relief bracket. Also, they were hybrid powered and had quite different mpl rating. The question was, will the roads continue to clog up and frustrate the potential savings. Investment in satellite navigation and priority pass electronics for the main routes would help, but all this cost money too. He also wondered whether the investment cost of meeting new standards for the benefit of all was actually really going to pay off. Well, he had taken the risk if only because the cost risk of going on with the old fleet was greater. Distribution was increasingly getting to be a business between a rock and hard place!

The phone rang. It was from a major Internet shopping provider. It turned out that they had approached his firm because it was in the vanguard of energy and environment responsible distribution, which was valuable to the Internet retailer as a customer service related image factor. The consumers were getting more and more picky about the total environmental impact of the goods they bought, even the Internet.

Three months later, with a major delivery deal signed, Mike was thinking maybe the risk of a new fleet would pay off. He had spotted the trend of increasing pressure for policies to clean up the impact of exponential traffic growth. He was ahead of the curve.

Core and major causal loops

The critical role of infrastructure, in society and the economy, captures investment in the 'sustain the legacy' loop. Even though this enables more and more loading on the system, expansion becomes constrained, increasing public concern over environmental impact, which energises a restraining 'green value shift' loop. This is a scenario of well-meaning action with unintended consequences.



01	'Sustain the legacy' loop	Reinforcing and squeezing a stuck system
02	'Green value shift' loop	Enabling transport-smoothing and limiting policies
03	Congestion frustration loop	Tending to make people seek alternatives to travel and support congestion policies
04	Risk deterrent loop	Causing people to be cautious about travel
05	Policy incentive loop	Pushing public authorities to invest in improvements
06	Limit to growth loop	Limiting carrying capacity of infrastructure
07	Pollution restraint loop	Constraining effect of emissions control
08	Innovation encouragement loop	Stimulating opportunities for technical improvements for the users
09	Intelligence application loop	Stimulating technical innovations to implement policies
10	Market mechanism loop	Creating market mechanisms to smooth demand and supply
11	Entrepreneurial loop	Exploiting opportunities for increasing user satisfaction

Scenario reflections

The broader discourse in this scenario is about the limits of individual choice and freedom, a world–view that is deeply unfamiliar to late 20th-century consumer thinking. However, such philosophy is well embedded in strands of western political thought, most notably John Stuart Mill and John Locke.

Such thinking helps us to understand the underlying logic in this scenario. The initial failure to curb the rights of the individual, most notably the right to mobility, and re-assert the rights of the community, leads to 20 years with little significant change, before the scenario evolves towards implementation of technology as control. Technology – with intelligent infrastructure systems at its core – is used to police the consequences of the individualist society.

However, a critical issue is the length of the delay before control systems are implemented effectively. The delay between carbon emissions and atmospheric effect is around 30 years, so (assuming human agency) the parts per million in the atmosphere will continue to rise for some time after carbon emissions are curbed. Although the UK represents only a small part of these emissions, this effect would be significant if this pattern ('done too much, much too late') was repeated across the developing world.

Extensive testing of this scenario and its underlying logic with workshop participants suggested that it was in some respects the most plausible scenario. Most notably, the individual's belief in their right to mobility was considered an enduring one, which would require significant sticks – rather than carrots – to shift.

The potential improvement in the 'social equilibrium' of society is sometimes overlooked in this scenario. Research indicates that individuals on lower incomes generally travel less, suggesting that they would be well placed to trade their surplus carbon entitlements. Many of the excesses of the very wealthy – private jets, for example – would necessarily be curtailed in this world, and the resulting reduction in wealth inequalities has the potential to create a greater sense of society among citizens in this scenario.

Case studies

'The stakeholder workshops provided an excellent opportunity for us to explore the future of intelligent infrastructure systems across the West Midlands, as well as allowing us to consider how such issues impacted on the Telford and Wrekin area in particular. The sessions were stimulating and thought-provoking for all stakeholders, and have ensured that we have a clearer understanding of the critical uncertainties we must address going forward.'

Heather Crocker, Transport Policy Advisor, Advantage West Midlands

The project held four 'stakeholder' workshops to better understand how the scenarios might play out in their areas of interest. The stakeholder groups were:

- sixth-form students (Eastwood School, Nottinghamshire)
- regional and local governments, NGO, business and research representatives from the West Midlands regional governments area
- local governments, NGO, business and research representatives from the Telford and Wrekin local authority area
- business, governments, NGO and research respresentatives from the retail, freight and logistics sector

In each case, we immersed the group in the scenarios and explored the implications arising to them from each one. We wanted to hear what sixth-form students thought would be the key issues for their generation. With the groups from both regional government and the local authority, we wanted to consider the implications of the scenarios for their own spatial, economic and transport planning. And we were interested in the wider implications of policies for the retail, freight and logistics sector.

Sixth-form students

The key challenges for the region that the students from Eastwood School identified and presented at the workshop were:

- achieving sustainable communities
- ensuring access for all
- securing economic well-being
- increasing individual awareness
- integrating transport with land use.

Transport issues that concerned this group included congestion, safety and pollution. They also thought that in the future we would need to address climate change, social exclusion, rural isolation and accessibility.

Having explored the scenarios, the students believed that Government and business must lead a change in behaviour if we are to realise a low-impact future. Government must work with other countries to stop global warming, must be prepared to make unpopular choices if it means a better environment and must make sure that roads and cities do not get too congested. They also believed that people must be willing to pay more tax to fund environmental protection. Businesses must care more about the environment than they do today and should develop environmentally friendly policies such as home working. People need to try to keep travel for work as low as they can – and must be prepared to pay higher taxes so that the Government can look after the environment.

Regional and local authority

We chose the West Midlands region, and the Borough of Telford and Wrekin that it encompasses, because of the range of challenges they represented. The large conurbation of Birmingham has achieved a critical mass that attracts much of the business interest. Telford bears some resemblance to Milton Keynes as a growth area being 'built for the car'. Telford has not really grown as expected, possibly due to the gravitational effect of Birmingham, but also by being slightly 'off the beaten track,' to the west of the region. A wide variety of rural and urban environments exist across the rest of the region.

The participants in the workshops identified significant opportunities for the West Midlands from the development and use of new technologies, such as those needed for road-user charging. Charging for infrastructure use could also significantly benefit the region, given its central location and the amount of transport passing through.

Above all, participants felt that intelligent infrastructure systems could provide numerous opportunities to improve services, with positive impacts on the region and the Borough. However, the technology was not sufficient on its own to ensure future prosperity for the area. The individuals, communities and leaders of the West Midlands will need to work together to develop and fully exploit intelligent infrastructure for their maximum benefit.

People thought they would benefit locally from low-impact transport and urban planning for less travel. Reduced car use could, however, affect the social fabric of mixed rural and urban areas like Telford and Wrekin. Many individuals rely on the car for their daily commute or to connect them with larger urban areas to access leisure facilities: participants worried about isolation if consideration was not given to alternatives ahead of time.

Improving the image and efficiency of public transport was a critical issue for the groups. Participants felt that this needed to be tackled in the short term at both

the local and regional level, to anticipate and forestall some of the negative aspects identified in the scenarios. In particular, it was evident that the 'carrot' of public transport could not be truly effective if residents did not feel that they could rely on consistent high-quality service.

Participants expressed concern about rural and deprived urban areas, most notably in the Perpetual Motion scenario. While technological innovation could make remote working and telepresencing a reality for many, it could again increase isolation for others, leaving older individuals particularly vulnerable, for example. There was also a risk of polarisation within urban areas themselves – in both the Urban Colonies and Perpetual Motion scenarios, as some groups within society benefit at the expense of others.

The groups also discussed skills and deprivation. For example, there are pockets of deprivation in Telford and Wrekin, with a significant number of individuals who do not currently have the means by which to reskill or retrain as necessary. Such areas would be especially vulnerable going forward, as the scenarios indicate that an adaptable and flexible workforce may be critical to future prosperity.

The scenarios demonstrate clearly that individuals with flexible skills are most likely to prosper: participants felt it was important that the region and the borough started to take steps to ensure that the area was well placed to help individuals gain these skills. The service industry was felt to be a clear 'winner' in Perpetual Motion, along with many other businesses, but fared far worse in the scenarios where individuals do not accept integrated intelligent infrastructure. Participants thought they should not take the current high employment for granted.

Local residents across the wider region could also lose out if they were to be priced out of buying property in the communities where they had grown up. This was felt to be a distinct possibility in Good Intentions and Urban Colonies, where quality of life was not felt to be good for all. In turn, this could affect the ability of companies to hire high-calibre employees if the local labour pool was either minimal or of poor quality.

The rural–urban divide, isolation of rural communities and the need to pursue the urban agenda (urban renaissance, prosperity for all) were issues to be tackled directly. The participants saw the workshop as a valuable first step in assessing some of these issues and how they might develop. They provided an effective 'wake-up call' for many organisations and individuals in the West Midlands. Partnership working – at the local, regional and national level – will be crucial in tackling such issues.

On a more positive note, it was felt that the geographical distance between the West Midlands and the south east of England could stand it in good stead in the Tribal Trading scenario. Potentially, the area would not be as overcrowded as the south east, and the surrounding countryside, with its natural resources, would be valuable in ensuring that local communities thrived. The area's superb canal

network could also be invaluable, although thriving commercial use of canals seemed remote under other scenarios.

In the extreme, there might even be a case for the area to consider defensive or trading borders to prevent newcomers from settling in the area at a time when resources were precious. While Tribal Trading was considered the most undesirable scenario, it was also the one that perhaps had the greatest potential to develop community spirit, as groups of individuals would have to work together to thrive.

Across both workshops, there was a clear sense that 'Good Intentions is not good enough,' either for the West Midlands region, or for Telford and Wrekin. This scenario was seen as one that the region – and indeed the country – might drift into by virtue of failing to make the necessary courageous decisions. Participants were keen to take active steps locally to stop this happening.

As a diverse region with significant rural assets and natural resources, as well as urban centres, the West Midlands would be well placed to adapt as required, whatever the future holds.

Retail, freight and logistics

The short-term nature of the retail sector was a recurring factor during the workshop and one that may affect the sector's ability to prepare for longer-term threats such as alternatives to fossil fuels. On current evidence, the sector appears to be heading for a Perpetual Motion world as the one it believes is most favourable.

Continued congestion, seen most strongly in Perpetual Motion, represents a real problem for the retail and freight sectors: it would make smaller companies struggle to be cost-effective. In most scenarios, participants thought consolidation of the freight industry likely, coupled, for example, with significant growth of online shopping. With more home deliveries, the concept of 'street concierges', who look after such things as shopping deliveries for all residents on a street, becomes plausible. Filling spare capacity and finding ways to avoid road use at peak times were viewed as important issues.

In Tribal Trading, it was evident that 'traditional' retail and logistics mechanisms would be severely disrupted and might disappear all together in some parts of the UK. In their place would come community-based schemes to grow food, with bartering and alternative currencies coming to the fore.

Where intelligent infrastructure is accepted, it could make differential distribution possible between rural and urban areas. The potential to use ICT to link up elements of a supply chain from supplier to retail is not yet widespread, but could be in the future if connectivity, interoperability and integration issues are resolved.

Participants speculated on effective ways to encourage consumer adoption of technology, arguing that there might be a role for state provision, or at least state investment to allow poorer or more isolated communities to benefit. Currently small and medium-sized enterprises (SMEs), particularly small retailers, were felt to be considerably behind larger companies in their use of IT.

Consumer and competition policy was discussed in the context of sustainability, with participants arguing for a national debate. Many felt that the scenarios, particularly Perpetual Motion, implied a far greater amount of waste to be dealt with in comparison to current levels. Without regulation, such an outcome was not considered sustainable over the long term.

Regulation was also discussed in the context of working hours and compensation. The freight industry has a growing problem of driver recruitment due to anti-social working hours and lingering image problems. Participants thought this was unlikely to improve. They also felt that there was a significant lack of secure overnight lorry parking, particularly in urban areas. Planning and other regulations were a burden affecting the viability of SMEs in this sector. Constraints on deliveries at night were a current issue.

Other factors that participants highlighted were:

- As environmental and energy constraints increase, the future of out-of-town shopping centres may be limited.
- Greater use was likely to be made of the UK's ports and rivers.
- Sophisticated RFID would be required to reduce costs and optimise supply chains and logistics.
- Constraints on air travel might also reduce the choice and range of food available.
- The forces of globalisation could threaten competitiveness.

Whatever the future holds, companies involved in retail, freight and logistics are likely to respond and to continue to focus on profits. While the sector may not look far ahead, the incremental changes it makes will continue to have a profound effect.

Drivers for change

Many factors will affect the future of transport and how we use intelligence to support movement. These factors, which can range from rising tensions between freedom of information and privacy to autonomous vehicles becoming safer and more efficient, are generally referred to as drivers for change. Preliminary workshops for the project identified some 60 key drivers that could influence the future direction of intelligent infrastructure. All of these are played out within the framework of the scenarios.

Growing demand for mobility – passengers and goods

Growing skills shortage as infrastructure acquires the skills

Increasing migration (and emigration)

More frequent clashes of multicultural values – faith vs. secular, for example

Growing awareness of the importance of 'employee liveability'

Increasing importance of the knowledge economy

Ageing, yet more active, population

People face increasing time-intensity

Growth in 'cyberfraud'

Emergence of better physical and virtual management systems

Satellite location devices

Smart antennas

Increasing use of 'telepresence' technology

Converging revolutions in biotech, nanotech, infotech and cognitive science

Culture of control

'Real time' everywhere

Growing debate on housing density in inner cities

Growth of Asian economies

Growing global energy deficit – increased demand and consumption

Emergence of radical solutions to climate change

Declining trust in institutions

Growing crisis in higher education puts the science base under threat

Decline in power of national governments

Increasing world trade

Emergence of networked organisations, clusters and supply chains

New decision-making frameworks

Proliferation of choice

The rise of pan-regional hubs

The end of affluence

Increasing emphasis on sustainable design

Rise of 'zero waste' movement

Changing patterns of demand for housing in some areas

E-commerce continues to grow

Increasing focus on tourism and its contribution to climate change

Decoupling of tourism and transport

Rising tension between freedom of information and privacy

Emergence of megacities

Changing family and household structures

The rise of 'slow'

Growing utilisation of 'embedded' technology

Continued growth of an 'always on' culture

Semi-autonomous/autonomous vehicles becoming safer and more efficient

Grids and networks create shared capacity

'Digital natives' – growing up accustomed to technology

Reducing cost of ICT and enhanced data processing

High-speed rail travel

Growing gap between rich and poor

Continued capital underinvestment

Growing (impact of) climate change

Increasingly localised/decentralised energy production

Relatively low spend on energy research and development

Increasing consumer desire for social and environmental responsibility and transparency

Growth of the surveillance society

Complex just-in-time models are vulnerable to external shock

Demand management of transport provision

Changing data storage: from desktop to network

Movement away from office-based working

Emerging debate around provision of 'citizen's income'

Rising importance of local provision

Taxation increasingly based on resource consumption rather than income

Move towards full-cost accounting

Emerging infrastructure, emerging cultural form

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