Teleworking and Teleconferencing

Introduction

This record of evidence forms part of the work undertaken by UKERC's Technology and Policy Assessment team relating to its project on policy strategy for carbon emissions reduction in the passenger transport sector. The material was produced alongside the project's main report and since it supports that report, it was judged appropriate to make this material available to a wider audience. The main report itself '*What Policies are Effective at Reducing Carbon Emissions from Surface Passenger Transport*?', and the supporting evidence can be found at:

http://www.ukerc.ac.uk/ResearchProgrammes/TechnologyandPolicyAssessment/TPAProjects.aspx

Explanation of Content

Evidence on this policy measure has been collected by the TPA team on the basis that it has, or may have, the potential to result in carbon dioxide emissions reductions in the passenger transport sector. This evidence document begins with a summarised description of the policy measure. The evidence itself follows the summary and is presented in table form.

Each piece of evidence has been assigned a separate row and tabulated using four columns:

- Year of publication, arranged chronologically, beginning with the most recent year
- Name of author, including where applicable additional cited authors (and year); and a Reference ID number.
- Type of evidence:
  - Evidence containing quantitative information is denoted by the letter 'Q'
  - Qualitative evidence is denoted by the letter 'C' for 'comment'
- The evidence itself

The evidence was originally gathered and assessed using several sub-headings. The purpose of this was primarily internal i.e. to facilitate the handling of evidence and the production of the main report. These sub-headings have been retained here as follows:

- Policy Measures and Carbon Savings
- Other potential CO_2 Impacts i.e. outside of the immediate policy influence
- Other Benefits e.g. air quality improvement or traffic congestion reduction
- Policy Costs and/or Revenues i.e. to local or national government
- Business and Consumer Costs
- Unintended Consequences e.g. rebound effect
- Reasons/Arguments for Carbon Savings Achievement or Failure
- Policy Suitability for the UK

A list of references follows the evidence tables. Note that the Reference ID numbers are allocated by Reference Manager, the referencing software used by the TPA team.

Any charts, figures and tables referenced in the evidence are not reproduced here but can be found in the original publication or evidence material.

Where no relevant evidence was found for a particular sub-heading, this has been noted.

Policy Description

The evidence recorded here covers measures to encourage using telecommunications to enable work to be carried out remotely (including telecommuting and also teleconferencing e.g. foregone business trips and meetings). This may involve the phone or email, audio, video or web-conferencing and interfacing with computers and equipment remotely. Employees may work part- or full-time from alternate locations, such as their homes or telework centres (offices with communications access to the main workplace, but closer to employee's home).

Evidence Tables

Carbon Savings and Policy Measures

Year	Author	Type	Evidence
			General
2007	Shaheen (ref 11192)	Q	Across three studies, estimated fuel savings per telecommuter range from 49 to 177 galons per year. This converts to approx. 0.5 to 1.7 ton CO2 reduction.
2005	Matthews and Williams (ref 4368)	Q	Telework has the potential to significantly reduce personal transport energy use. The consensus in the literature seems to be vehicle use typically reducing by around 50–70% on telecommuting days. Telework also affects energy use in commercial and residential buildings. Additional time at home implies increased residential energy use but some office space and associated energy can also be eliminated. Nevertheless, potential energy savings in the US and Japan - under very optimistic assumptions for long-term adoption of telecommuting - are only 1–2% of national energy use. The savings calculations shown in Tables 4 & 5 are based on various assumptions including: • That zero non-commuting travel is induced by teleworking • Three scenarios (1 = no self employed workers' 2 = high end current adoption including self employed workers; 3 = wide adoption of occasional telecommuting (50% of all information workers)
2003	Anderson (ref 11240)	Q	Table 6.1 of Anderson (2003) shows the potential carbon dioxide savings that might be achieved by the introduction of the individual transport tools including items 9 and 11, teleworking and videoconferencing. An increase in teleworking has the potential to reduce carbon emissions by 1.80% by 2010 (2.40 % by 2050); whilst an increase in video conferencing has the potential to reduce carbon emissions by 0.80% by 2010 (1.50% by 2050).
1997	TUD (ref 11586)	Q	The Netherlands Ministry of Transport has set a country-wide target of reducing peak hour traffic by 5% by 2015 via teleworking.
			Specific studies - Telecommuting

Year	Author	Type	Evidence
2008	VTPI/TDM (ref 11487) citing Nilles 1996 and citing Mokhtarian 1997	Q	A survey of U.S. teleworkers indicates that telework provides net reductions in VMT of 30 miles per telecommute day, with no evidence of increased sprawl (citing Nilles, 1996). If 10% of the workforce telecommutes, total vehicle travel would decline by 4%. A more realistic estimate is that 1-2% of car travel could be reduced, but long-term impacts may be even smaller if it encourages more urban dispersion (citing Mokhtarian, 1997).
2007	NCTR (ref 11471)	Q	A survey of an AT&T Telework Program indicates that in 2000 the program resulted in: • Avoidance of 110 million miles of driving to the office; • 5.1 million gallons of gas saved; • Reduction of 50,000 tons of carbon dioxide emissions; • 56 percent of participants teleworking at least one day per month; and, • 27 percent of participants working from home once or more per week.
2005	Matthews and Williams (ref 4368); and citing Mokhtarian 1998	Q	A 1993 US Department of Transportation study estimated that 5.2% of the work force telecommuting 3–4 days/week would save 1.1% of national fuel consumption. The authors also cite Mokhtarian (1998) who synthesized a model suggesting that 6.1% of the workforce telecommuting 1.2 days a week saves 0.5–1% of vehicle miles travelled.
2004	Wolfram 2005 (ref 11380) citing Cairns et al., 2004	Q	A study of BT teleworkers estimated a total reduction potential of 10-30% from substituting business travel and commuting by ICT. Average car mileage ‘saved’ by preexisting teleworking was 95 miles per week per teleworker. If future increases in frequency of teleworking were in line with predictions, further savings of 76 miles per week per teleworker suggested a potential future saving of 171 miles per week altogether. Another survey (814 BT staff, response rate 24%) found that c. 90% of teleworkers had reduced their commuting travel. The mean reduction per respondent was 253 miles per week. The net effect was to reduce travel by 193 miles per week per teleworker, further underlining the potential of teleworking (citing Cairns et al, 2004).
c.2001	BT (ref 11595)	Q	Teleconferencing also has the potential to replace public transport as illustrated by the BT scheme where 48% of the total trips replaced were public transport journeys. The survey also showed that 36% of the travel miles avoided due to teleconferencing were public transport mileage (undated c. 2001).
2000	Marshall (ref 417) citing TUD, 1997	Q	The Netherlands Ministry of Transport set a target of reducing peak hour traffic by 5% by 2015 via teleworking. Three experiments were set up in the period 1990 to 1994. Experiments 1 and 2 showed a clear reduction in trips made by teleworkers, while for

Year	Author	Type	Evidence
			other household members there were some increases in travel. Experiment 3 also confirmed the conclusion that teleworking can reduce the need to travel, reduce the distances travelled and reduce the time spent in travelling (citing TUD, 1997)
			Specific studies - Teleconferencing
2008; 2007	EEA (ref 11538); Anable & Bristow (ref 11297) citing James & Hopkinson, 2007	Q	Replacing business travel with teleconferencing has allowed BT to avoid over 860,000 meetings worldwide and saved c. 97,000 tons of CO2 emissions. Air travel accounted for 48% of avoided miles but only 8% of avoided trips (see Tables 17 & 18 in Anable & Bristow, 2007 adapted from James & Hopkinson, 2007).
2005	Wolfram (ref 11380)	Q	As shown in Table 5 of Wolfram (2005) an assessment of teleconferencing based on a sample of 771 BT employees indicated that 71% respondents' last conference call had definitely or probably replaced a meeting (with 52% being 'definite'), whilst only 5% stated that it had generated a meeting (citing Cairns et al, 2004)
1991	Hamer et al (ref 11534)	Q	In the Netherlands, during a year-long study, the total number of trips within a sample group of 30 households reduced by 17% and the distance travelled reduced by 16% due to telecommuting.

Other CO2 Impacts

Year	Author	Type	Evidence
2005	Matthews and Williams (ref 4368)	C	There are also nonlinear effects on transport systems that come with wider adoption of telecommuting, such as reducing congestion and idling time.
2005	Matthews and Williams (ref 4368)	C	If energy prices rise, increased telecommuting implies higher energy bills, which encourages greater efficiency, an area with huge potential gains.

Other Benefits

Year	Author	Type	Evidence
2008	VTPI/TDM (ref 11487) citing Pratt, 1999	C	Since Telework reduces commute trips it can reduce congestion and [fuel] & parking costs. Telework is highly valued by many employees and can increase productivity and job satisfaction. Many employers find it increases recruitment and retention, and can help deal with problems, such as employees with disabilities or other special needs (citing Pratt, 1999).
2008	VTPI/TDM (ref 11487)	C	Telework may increase community livability by reducing traffic and allowing more people to work and

Year	Author	Type	Evidence
			shop from home. It can improve accessibility for people with mobility constraints. It is relatively affordable compared with other transportation modes, typically costing a few hundred dollars for a computer, plus Internet service of several dollars per month.

Policy Costs and/or Revenues

Year	Author	Type	Evidence
			No specific evidence found.

Business and Consumer Costs

Year	Author	Type	Evidence
2008	VTPI/TDM (ref 11487)	C	Teleworking is relatively affordable compared with other transportation modes, typically costing individuals a few hundred dollars for a computer, plus Internet service of several dollars per month, though this may be unaffordable to some potential users.
2008	EEA (ref 11538)	Q	A 2006 BT case study found that avoided travel/subsistence costs and freed up management time equated to a benefit of £238m (€35m) for BT as a whole — £35m (€200m) in avoided travel and subsistence, and the equivalent of £103m (€152m) in time saved. Savings to BT were at least 10–15 times greater than the costs of providing teleconferencing services. In 2007 BT saved travel and subsistence costs of £109m (€161m) and £103m (€152m) of time equivalent.
2005	Matthews and Williams (ref 4368) citing Roitz et al., 2003	Q	AT&T notes that 17% of its managers work full time from home with an estimated annual benefit of $150 million (citing Roitz et al., 2003).
2001	IEA (ref 11354)	C	Even if half the energy savings from telework is lost to rebound effects, it would represent a very low cost, or negative cost, way to reduce CO2 emissions. Telework is usually agreed on voluntarily by the employer and employee with the understanding that they provide net benefits to both. Thus they can be seen as having negative cost, or net benefit, to society.

Unintended Consequences

Year	Author	Type	Evidence
			General
2008	VTPI/TDM (ref 11487)	C	Although it tends to reduce peak-period trips, telework does not necessarily reduce total vehicle travel unless implemented in conjunction with other travel reduction strategies. Vehicle travel reductions and energy savings

Year	Author	Type	Evidence
			may be partly offset in the following ways: • additional vehicle trips to run errands that would otherwise have been made during a commute. • relocation further from worksite which increases travel distance and possibly urban sprawl. • Vehicles not used for commuting may be driven by other household members. • additional energy use for home heating and cooling, and to power electronic equipment.
2002	Wiegmans (ref 2273)	C	In the Netherlands experiment, although it would seem that teleworking could help reduce CO2-emissions through direct effects, due to subsequent indirect effects the preliminary result is that CO2-emission will increase (in the medium and long term) because of it.
2002	Wiegmans (ref 2273) citing Van Reisen, 1997	Q	Time not used for travelling might be used for working and this also requires the use of energy (e.g. computers). These are the direct effects to be expected from teleworking. Indirectly, extra car traffic for other purposes than working and traffic over longer distances might be generated. Research in California showed that within two years, 15 percent of teleworkers had moved to a greater distance from work (citing Van Reisen, 1997).
2002	Wiegmans (ref 2273)	C	The reduction potential from ICT in terms of energy, CO2 emissions, and km savings seems limited. A distinction must be made between short- and long-term effects. In the short-term, the direct effects are leading, which means that a reduction in mobility is possible. But, in the long-term, indirect effects reduce the savings realised in the short-term.
			Travel consumption-related
2008	VTPI/TDM (ref 11487)	C	Consumers use the Internet to find lower-cost airfares so they can travel more. It is inappropriate to assume electronic communications always substitutes for physical travel.
2008	EEA (ref 11538); and citing James, 2007	Q	In assessing the BT case study EEA (2008) notes that teleconferencing is not completely carbon neutral. EEA (2008) cites the James (2007) study which calculates that emissions caused by electricity use could offset the benefits. See Table 17 & 18. Note that full life-cycle emissions have not been taken into consideration in this calculation (for example, the manufacture and disposal of required equipment). Overall, conferencing calls replacing face to face meetings are creating a net saving of at least 97,628 tonnes of CO2.
2005	Wolfram (ref 11380) citing Cairns et al, 2004	Q	There were offset effects identified in the BT survey (814 BT staff, response rate of 24%): • some people (20% of the sample) said they now used the car more for other trips. For these, the increase in car use was 77 miles per week. • some people (47% of the sample) made replacement journeys for tasks that would previously have been part of a chained commute

Year	Author	Type	Evidence
			(for example to go shopping, or to escort children). For these, the increase in car use was 34 miles per week. • business travel also increased for some staff, although this was balanced by other staff who said it had decreased (citing Cairns et al, 2004).
2005	Wolfram (ref 11380)	C	Energy savings from telecommuting is not as simple as it may seem, since overall increases in activity levels and shifts between travel motives can well overcompensate for the obtained substitution effects. The actual capacity of ICT to substitute transport can be seriously doubted regarding the diversity of rebound effects such as changing location choices, mobility patterns and activity levels.
2001	IEA (ref 11354) citing DOE, 1993	C	One study by the United States Department of Energy on the effect of telework on travel accounted for all three types of rebound effect (increased non-commute travel; increased sprawl from household relocation; and increased travel by others on roadways vacated by telecommuters). It found that, in the long term, around half of the travel-related energy savings of telework might be lost to the rebound effects (citing DOE, 1993).
			Home energy-related
2007	Shaheen (ref 11192)	C	While telecommuting may potentially reduce CO2 emissions, reduction may be offset by greater home energy use and or commercial electricity use at the business office.

Reasons/Arguments for Carbon Reduction Achievement and/or Failure

Year	Author	Type	Evidence
2008	VTPI/TDM (ref 11487) citing Nilles, 1996	Q	An estimated 50% of all jobs produce information-related goods suitable for Telework, but the actual portion of employees who can telecommute is much lower. Many jobs require access to special materials and equipment, or frequent face-to-face meetings, even if the main output is information that can be transmitted electronically (citing Nilles, 1996).
2008	VTPI/TDM (ref 11487) citing Henderson and Mokhtarian 1996	Q	Telework tends to be particularly attractive to longer-distance commuters, so VMT reductions tend to be relatively high. For example, a telework program that reduces 10% of vehicle trips may reduce 15% of vehicle mileage if participants have longer than average commutes. One study found that neighborhood telework centers reduce commute VMT by about 50%, but provide smaller emission reductions since even short automobile trips produce heavy pollution due to cold starts (citing Henderson and Mokhtarian, 1996).
2008	DfT (ref 11597)	Q	The National Travel Survey measures home-working and shows that there is little sign that the uptake of broadband has resulted in an increase in the number of people working from home. The latest results (11597

Year	Author	Type	Evidence
			DfT 2008) show that around 3.5% of people always work from home and this number has remained essentially unchanged since the question was first asked in 2002. The number having worked at home at least once in the previous week has been rising, but very slowly (from around 5% to 6%). The proportion who say they haven't worked from home but that it would be possible for them to do so stands at around 10%.
2007	Nelson et al (ref 11500)	C	The US Federal Government and some states and local governments have tried promoting teleworking in recent years using statutes and regulations to encourage telework. Some of these promote only teleworking and others promote it as part of a broader set of initiatives to influence single occupancy vehicle travel to work. For instance, in 1999, the National Air Quality and Telecommuting Act established pilot telecommuting programmes in five major US metropolitan areas to offer organizations credits for avoiding nitrogen oxides emitted from vehicles if they let their employees telework or participate in other pollution-reducing initiatives. The credits could be traded with firms that needed emissions reductions for purposes of compliance with the US Clean Air Act. However, Nelson et al (2007) conclude that this programme suffered from the difficulties of accurately measuring emissions reductions and in determining whether they are 'surplus, permanent, quantifiable, and enforceable'.
2005	Matthews and Williams (ref 4368)	C	Matthews and Williams (2005) list the following considerations and issues: • Teleworking implies increased energy use in the residential buildings sector. • The main power uses to consider are climate control, lighting, and equipment use. It is assumed the difference between power consumption of using IT equipment at home or at the office is negligible compared to climate control and lighting factors. • Reducing office space does not automatically lead to big energy savings. Around two-thirds of office area and energy use is not office space, but hallways, meeting rooms, etc. E.g. IBM-Japan reports a 25% reduction in desk space with a 4 day/week telecommuting program. If "supporting area" is similarly reduced, energy use should also fall c. 25%, but if only office space is reduced, these savings are cut to 6%. • For frequent telecommuting, the potential savings in office energy is similar in magnitude to transport reduction, thus this in particular deserves increased attention. • In particular cases the energy balance can be negative. For office workers who commute via public transport, infrequent telecommuting can

Year	Author	Type	Evidence
			lead to a rise in residential energy use larger than savings in commuting energy.
2005	Matthews and Williams (ref 4368)	C	Matthews and Williams (2005) suggest that: • reaping net energy benefits first and foremost requires that it be widely adopted. • environmental considerations are not key drivers in adoption of telework. Primary motives are desires to cut costs and improve productivity wasted in long commutes. • Energy benefits can be enhanced when indirect factors such as reduced congestion and construction of infrastructure are considered. In areas with congested traffic, energy saving is a nonlinear function of the number of cars taken off the road. • Best when offices plan it in from the start and reduce office space accordingly • Inefficient energy management, i.e., spaces heated/cooled regardless of occupancy, implies less potential benefit from telecommuting.
2001	IEA (ref 11354)	C	Governments can encourage growth in telework by providing incentives to businesses such as tax reductions to pay for equipment for home-based telecommuting, or even directly related it, such as based on person-days of telecommuting. Since large numbers of individuals already telework in most IEA countries, care must be taken to avoid a large free rider problem, i.e., providing monetary benefits for telecommuting that would occur anyway.
1991	Hamer et al (ref 11534)	C	A variety of empirical surveys characterising changes in the travel behaviour of telecommuters have been undertaken. The consensus seems to be that for the commuters/organisations affected overall vehicle use reduces substantially as a result of telecommuting /working.

Policy suitability for UK

Year	Author	Type	Evidence
2005	Matthews and Williams (ref 4368)	C	To put the potential 1-2% energy saving from teleworking in the US in context, compare it with increasing the fuel efficiency of the vehicle fleet by 20% (assuming no rebound effects) which would would save 5.4% of national energy use. Or alternatively, Americans switching to Japanese style homes (heating per room) would save around 15% of national energy consumption. While increased telecommuting and fuel efficiency are not mutually exclusive goals, it appears that the potential direct benefits of telecommuting are relatively small given the large degree of behavioral and structural change needed

Year	Author	Type	Evidence
			to achieve large benefits.
2005	Matthews and Williams (ref 4368)	C	The starting point is estimating how many workers can in principle telecommute. Next is how to interpret macrostatistics on the structure of employment so as to distinguish the possible telecommuting subset of the force, Given increasing servicisation including rising importance of e-commerce and other Internet-related work, it is likely that the fraction of the labor force suitable for telecommuting will increase in the future.

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