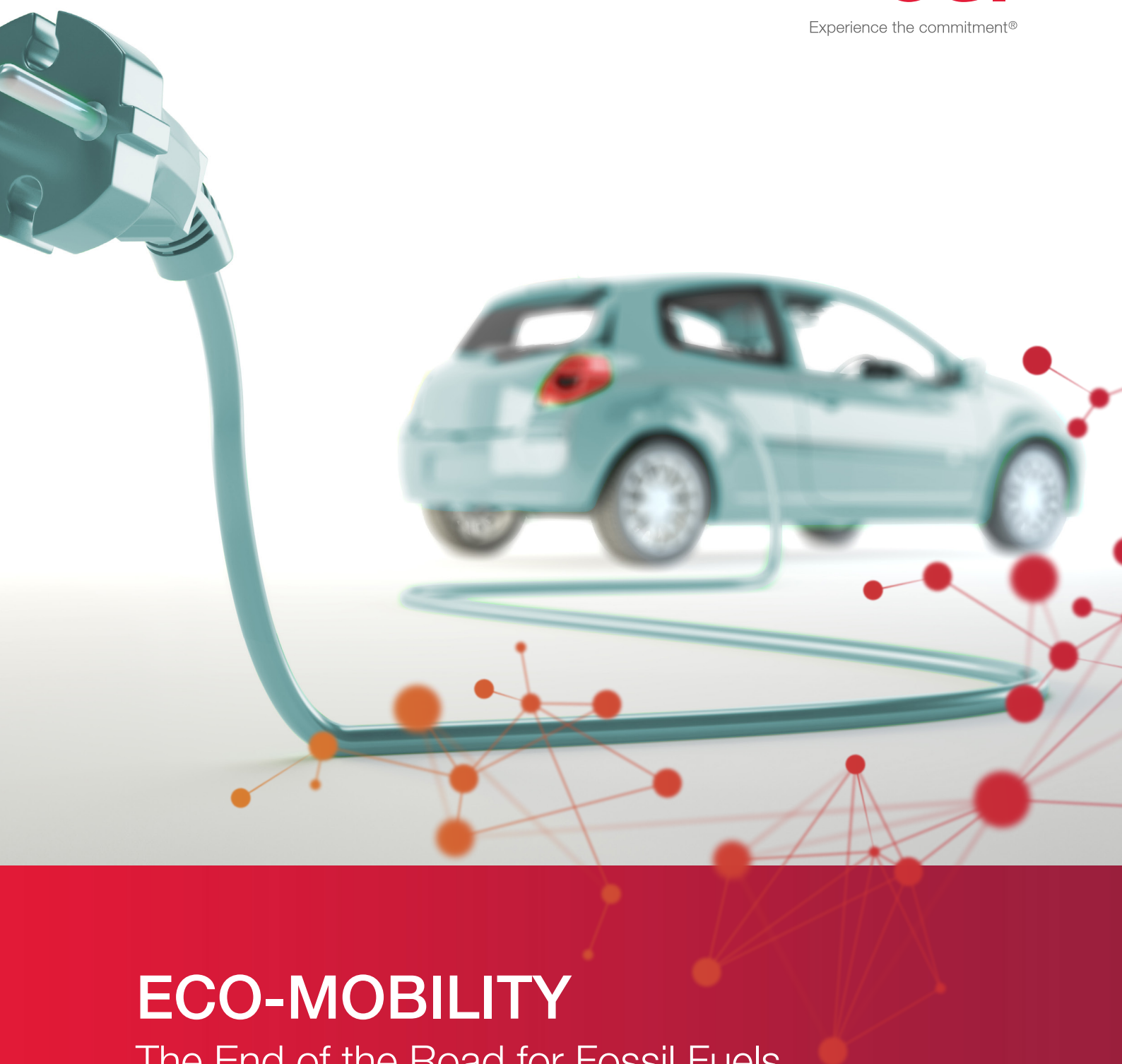


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ECO-MOBILITY

The End of the Road for Fossil Fuels

A view from 2030

If we couldn't travel by road, the impact on our lives would be detrimental. We couldn't deliver goods, get to work, see friends, or carry out a countless number of other essential activities. And, road transport depends on oil—more than 99 percent of vehicles are powered by petrol or diesel.

One way or another, that's about to change.

Some people believe that we have about 50 years of oil left. Others think that oil production has peaked, and we're already on the fast track to empty. As Saudi Arabia's then regent and now king, Abdullah bin Aziz Al Saud, told his subjects in 1998, "The oil boom is over and will not return... All of us must get used to a different lifestyle."¹

Sadad Al Hussein, the former head of Saudi Aramco's production and exploration, expressed the same view 10 years later. He thinks it likely that oil production reached its peak in 2006.²

Fatih Birol, chief economist of the International Energy Agency, believes that, based on current trends, oil will peak in 2020. "One day, if not 2020, 2030, 2040, one day we will run out of oil...we have to leave oil before oil leaves us,"³ he said.

We had similar fears about energy in general in 2005, with the prediction that the UK could face an energy gap of 16 percent with average demand in 2020 and a 31.5 percent gap at peak. And, that was on a conservative analysis.⁴ We have seen no evidence that changes that prediction.

If this is the case, we need to ask some hard questions.

1 "Peak oil could trigger meltdown of society," Energy Watch Group, 2007.

2 "The perfect storm," Dave Cohen, *ASPO-USA/Energy Bulletin*, October 31, 2007.

3 Interview with Fatih Birol, Bigthink.com, March 22, 2010.

4 "Mind the Gap: The Black Hole at the Heart of the UK's Energy Supply," white paper, LogicaCMG (now CGI), 2006.



Some business models for 2030

But not everyone agrees—even within the same company. Abdullah Jum'ah, president and CEO of Saudi Aramco, said in 2008, "We have grossly underestimated mankind's ability to find new reserves of petroleum, as well as our capacity to raise recovery rates and tap fields once thought inaccessible or impossible to produce."⁵

A five percent increase in extraction from current proven fields would maintain world oil supplies for decades. If we managed to improve extraction techniques by around 30 percent, we would have another 300 years of oil. Dr. Christoph Rühl, BP's chief economist, thinks this is more than possible. "Peak oil has been predicted for 150 years. It has never happened."

But he adds a rider, "[Global warming] is likely to be more of a natural limit than all these peak oil theories combined."⁶

So, perhaps we need to ask some different, but equally hard, questions.

What if in 2030:

- Oil does run out?
- We need to find new ways of getting around?
- We need to transition transport from oil to other forms of fuel?



⁵ "CEO Offers Positive, Realistic Energy View," *Saudi Aramco News*, 2007.

⁶ "BP: 'We should see volatility increase,'" *EurActiv.com*, 2008.





Fatih Birol, chief economist of the International Energy Agency, who even refuses to buy a car because they pollute, points out that nearly 95 percent of growth in oil demand comes from transport and that business as usual is not an option. “Industry has to find a way together with the governments to find new modes, new modalities for transportation.”⁷

Both the end of oil and the effects of global warming point to the same conclusion; we need to move to alternatively powered vehicles that have little or no dependence on oil and very low or zero emissions. These include electric vehicles, hybrids (powered by a mix of fossil fuel and electricity), fuel cell vehicles (for example, cars powered by hydrogen), and cars using alternative fuels, such as bio-fuels.

Together, we refer to these as ultra-low carbon vehicles. In the foreseeable future, electric vehicles (EVs) are likely to dominate the landscape. They are practical for short journeys—80 percent of all UK journeys by distance are by car, half of all car journeys cover less than three miles, and a quarter are less than two miles. Around 20 percent last for a mile or less. Electric vehicles also have an edge because more research and development work has gone into them.

Electric cars will make up 20 percent of UK auto sales by 2016 as drivers take advantage of government subsidies and lower fuel costs, according to Steve Holiday, CEO of National Grid Plc.⁸

OTHER FACTORS DRIVING THE EV REVOLUTION

As oil supplies in the developed world become scarcer, its countries will become more reliant on oil from less stable regions, with the risk that supplies will be withheld or prices will skyrocket. The West will therefore push to develop low carbon technologies and to retain control over their production.

There is also a need to protect our auto industry. In the UK alone, the auto sector accounts for more than three percent of GDP, employs 820,000 people directly and indirectly, and generates exports worth £20 billion a year. A move to EVs will safeguard the industry and should boost exports. Additional employment and growth will come from installing new infrastructure.

Congestion is another factor—one which, according to UK government estimates, will cost England alone £22 billion a year by 2025. EVs with intelligent vehicle systems that anticipate traffic conditions would mean that more cars can safely use the roads and traffic flow will improve. Intelligent transport systems, or intelligent mobility as the UK government is starting to call it, will connect private and public transport to move more people faster—and, again, safely. Overall, there should be a reduction in serious road accidents, which currently cost Europe two percent of its GDP.

What if in 2030:

- Oil isn't the issue but CO₂ and other global warming gasses are?
- We have to change road transport to save the planet?

⁷ Interview with Fatih Birol, Bigthink.com, March 22, 2010.

⁸ “Electric Cars to Reach 20% of UK Vehicle Sales,” Kari Lundgren, *Bloomberg News*, November 29, 2010.

Health will improve, too, because of the reduction in pollutants. Road vehicles currently account for 46 percent of nitrogen oxides (NOx).

If climate change is the main reason for switching to EVs, we will also have to ensure that the electricity powering them is not generated from fossil fuel. Today, fossil fuel power stations account for another 21 percent of NOx.

Instead, we will need a network of renewables, such as wind farms, tidal and wave barrages, solar and heat exchangers, and nuclear power stations.

The move to EVs will be part of an overall, fundamental restructuring of our economies. As Sir David King, former UK chief government scientific adviser and currently director of the Oxford University Smith School of Enterprise and the Environment, puts it, "I think we need a 21st Century renaissance—and by that I mean a transformation at least equivalent to the Renaissance or the Industrial Revolution—if we are going to manage this in a way that doesn't lead to massive breakdowns of our global economies."⁹



⁹ "Wanted, a 21st century renaissance," *Oxford Today*, Volume 22, No. 2, Hilary 2010.

Factors affecting the future of EVs

TAXATION

Already, more than 75 percent of a vehicle is recycled at the end of its life. Renault, for example, saved €400 million through recycling in 2007 alone and has now set up a joint venture with waste specialist SITA to recycle cars. Renault's recycling rate will rise to around 95 percent by 2015, partly prompted by EU legislation to make manufacturers responsible for car disposal and partly by rising raw material prices.

New types of vehicle design, manufacture and ownership, perhaps encouraged by waste taxes, should lead to universal recycling. Vehicles may be designed to be reconfigured for individual users as personal needs change or to be broken up, with individual parts reused in new vehicles. Environmentally damaging practices, such as paint spraying, will disappear because of new techniques, such as embedding color in body parts. Oil lubrication may be replaced by nanotechnology.

The excise duty and value-added tax (VAT) on fuel raises upwards of £25 billion a year for the UK government. As oil use diminishes, so will the tax take. This will certainly have consequences. One is that governments will find ways of making up the difference. Another is that they could also see this as an opportunity to change public behaviour to make the most of diminishing resources.

What if in 2030:

- Your car is partly taxed on its recyclability?
- The excise duty and VAT on fuel falls?
- Fuel taxation is based on driving style?

THE BUSINESS CONSEQUENCES

- Businesses are under legal duties both to comply with legislation and to do what is best for their shareholders. Recyclability taxes will therefore prompt manufacturers to increase their recycling rates and clever design may well enable them to reuse parts and save money. But, if the penalties for failing to reach recycling targets are low, businesses might well take the view that the cost of compliance exceeds the benefits.
- Road pricing is also likely, along with new taxes on whatever powers fuel cell vehicles. The UK coalition government has already said that it will focus on introducing a new HG V road user charging system and the Department of Transport has said this will be put into place during the current Parliamentary term. This may well be the precursor to road charging for all users. Government will probably try to keep taxes on EVs low to begin with to encourage mass take-up, then increase taxes once most drivers are using the new vehicles.

Dentist



- It is certainly possible that personal carbon allowances will be in place by 2030. These will have the effect of penalising people whose lifestyles involve above average carbon use. Choice will still be important, and we shouldn't lose sight of the fact that a vast amount of travel will still be completed by private car, therefore emphasising the need to decarbonise private transport, as well as providing energy efficient or even completely de-carbonised public transport networks.
- You can also expect green behaviour among drivers of petrol and diesel powered vehicles to be rewarded through innovations such as CGI EMO. EMO measures a vehicle's emissions as it is driven, sending data back to a collection point. It has been named by The Economist as one of 10 global green game changers. Those whose driving creates minimal emissions could be rewarded by lower fuel prices and excise duty, as well as insurance discounts (because greener drivers tend to have fewer accidents).





Energy infrastructure

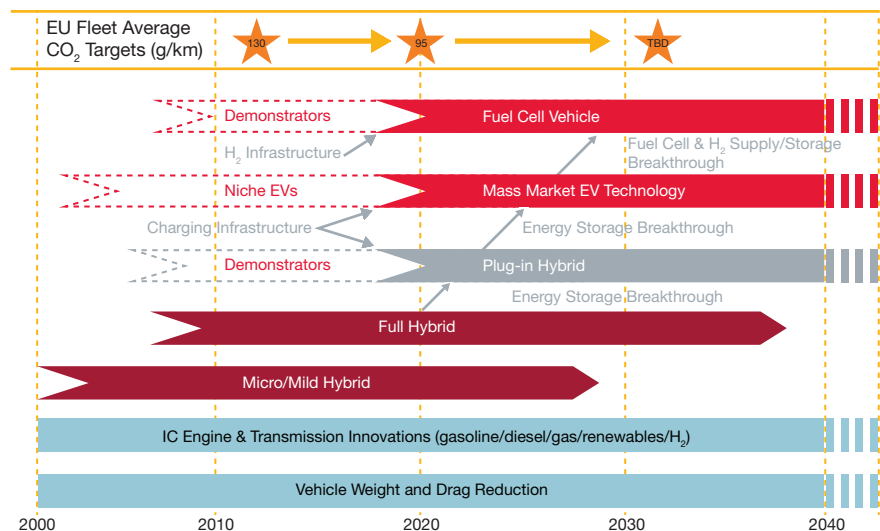
Pure EVs and hybrids, including LPG/electric and very low emission/electric vehicles are being developed in parallel. This will require developing parallel infrastructures to support them. Hydrogen and other fuel cell technologies are still in their infancy. It will be 15 to 20 years before these systems are ready for mass manufacture. A new fuelling infrastructure will be needed to supply fuel cell vehicles.

The UK currently has around 9,000 petrol stations, many of which could become battery exchange or fast charge centres. Many may also become fuel-cell recharge centres and LPG providers. Alternatively, petrol station sites could disappear in the longer term and exchange/recharge centres could be situated in entirely new locations.

The UK's New Automotive Innovation and Growth Team (NAIGT), an industry-led study into the future of vehicle manufacturing, sees this timeline for different types of EV:

What if in 2030:

- Different types of alternate fuel vehicles develop at the same time?
- We have to invest in multiple infrastructures?



This implies that there will be a period measured in decades where multiple infrastructures have to be supported.

THE BUSINESS CONSEQUENCES

- The current electricity infrastructure could not cope with EVs—the load would be too great. We will therefore need smart grids that balance local and national supply and demand. Micro-generation from solar panels and other sustainable sources will feed into the local grid to help power EVs. This is unlikely to be enough, and we will need to encourage people to recharge EVs at times of lowest demand, probably through pricing. It is also possible that EVs will power homes during high-cost hours and will recharge during low-cost hours, which will change business models for electricity provision.
- An alternative is developing superconductors to reduce cable energy loss, along with substituting aluminum for copper cables, but this would be expensive and very disruptive.

- Tens of thousands of charging points must be installed and, because it will take hours to recharge batteries using current technologies, their location will be critical. One obvious option is to install recharging points outside homes but that won't be enough. Car parks at public transport interchanges could provide services, as could parking meters. Who provides this infrastructure and controls pricing is a moot point. A CGI FutureScope survey shows that 87 percent of businesses expect utility companies to be responsible, 63 percent expect oil companies to offer recharging at petrol stations, and 58 percent expect telecommunications companies to provide charging points because of their cabling and billing experience.
- Manufacturers will need to work with power companies to estimate the optimum number of public recharging points—not every parking space will need access to power, particularly if swap-out batteries are developed.
- The public sector will address how new EV infrastructures will be installed and how EVs will be promoted. One approach will be to lead by example, progressively upgrading public sector vehicle fleets to EV and persuading private sector providers of public transport to move to EVs. Expect legislation to encourage a faster migration than some providers would like.
- Local authorities will work with the private sector to encourage EV investment, providing policies and incentives that encourage adoption of the new vehicles. They will not invest much in the infrastructure itself; that will be left to the profit-making private sector. Again, expect legislation that will ensure profitability. Varying road tolls based on vehicle type may be one consequence.
- By 2030, all road-based public transport will use energy-efficient technologies.
- There will be techniques that fast-feed batteries, with recharges measured in minutes rather than hours, but these will also increase local load. It's highly likely that new types of battery will give EVs a much longer range. An alternative is swap-out batteries. These will need to be controlled and owned by suppliers, or owners will complain that new batteries in a new car are being replaced by batteries that have been used many times before. Battery suppliers will want to reuse vehicle batteries once their retention capacity falls too low for transport but is still good enough for energy storage.

What if in 2030:

- EVs are much more expensive in relative terms than current vehicles?
- Ownership patterns change to reflect the higher cost of transport?



Intelligent mobility

It may be counterintuitive but experts expect no increase in traffic congestion and a 50 percent increase in journey arrival time accuracy by 2030. This means that not only will pinch points in the travel infrastructure effectively disappear while the number of vehicles on our roads increases, but we'll also be able to predict our arrival times much more accurately. "I got stuck in traffic" will no longer be a valid excuse.

By 2030, emissions are expected to be reduced to 20 percent of the level achieved by all engines in 1998. The emission of gases such as NOx and CO₂ will be half the current Euro 4 level for fossil fuel-powered vehicles.

THE BUSINESS CONSEQUENCES

- Congestion targets will depend on in-car technology that will allow more vehicles on the road—effectively, the driverless car—and on congestion and road use charging.
- Vehicles will be remotely controlled to meet variable speed limits, and there will be a significant reduction in accidents caused by driver tiredness.
- Remote controls will also eliminate vehicle theft.
- The reduction in accidents and vehicle thefts should result in lower insurance premiums. Insurance companies and health authorities may pressure manufacturers to roll out advanced vehicles with crash and congestion avoidance technologies as standard features. If you think it unlikely that these technologies will extend beyond luxury cars, remember that air bags and assisted braking systems were uncommon just a few years ago. Now, they are standard.
- Expect engines that can run on any fuel by 2030. Waste heat will be recovered and will contribute to power. Remaining fossil fuel vehicles, meanwhile, will offer much better fuel economy and much lower pollution. Engines will double their power-to-weight ratio. The International Energy Agency is aiming for half of all light vehicles to be EVs by 2050. By then, it is possible that hydrogen-powered vehicles will be common, in which case electrically powered vehicles will be an intermediate technology. Some experts expect fuel cells to power half of all vehicles by 2030 and bio-fuelled vehicles to account for 20 percent of new registrations.

What if in 2030:

- Congestion ceases to be a problem, but rising insurance costs are?
- Pollution, as well as fuel shortages and CO₂, become an issue?



Ownership

Today, the average cost of running a petrol or diesel-driven car is around £22,300 over four years, taking into account depreciation, fuel and other costs. The cost of running an electric car is around £32,600 over four years.

By 2025 or thereabouts, the depreciation cost of a conventional car will still be less than an electric car over four years (£14,200 against £16,200) but the running costs for conventional cars will have increased so much that overall, electric vehicles become cheaper, at £28,300 against £31,300, over four years.

Overall, even running a “cheap” electric vehicle will be considerably more expensive than running a conventional car in 2010, which will have an effect on their ownership.

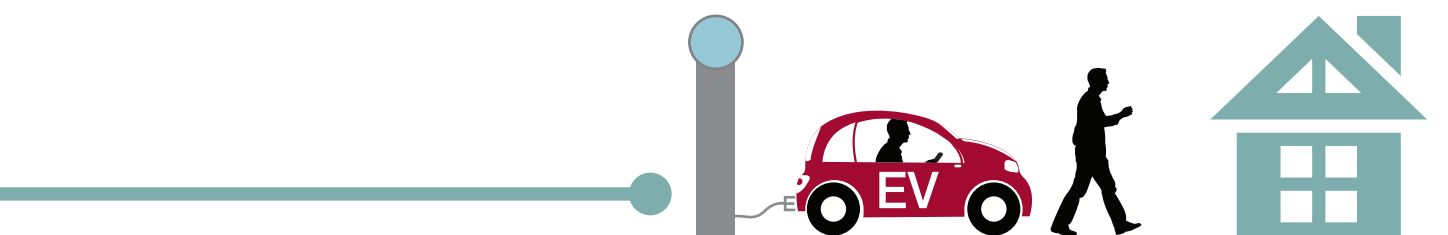
THE BUSINESS CONSEQUENCES

- Leasing could become the standard, with manufacturers taking back vehicles for reprocessing after an agreed age or mileage. To reduce costs, vehicles may be jointly leased by neighbours or be owned by a car club. Journey sharing, organised and booked online, is likely to be commonplace. Vehicles will be seen less as status symbols and more as utilitarian ways to get from A to B.
- Expect new value-added services, such as in-built internet, online entertainment services and automatic location and booking of charging points. These developments will necessitate greater cooperation between vehicle and telecommunications companies. Manufacturers will have to design in value-added services.
- For companies, timing the move to EVs will be crucial. A first mover advantage exists in £400 million of grants. Companies will have to weigh the gains from a grant against the speed of technological change. Currently, the UK has earmarked £100 million for sustainable mobility trials and is installing 11,000 charging points. People using EVs will be eligible for grants of up to £5,000 per vehicle. While those grants will be phased out, the price of EVs will fall substantially.
- There will be a rise in mobility based web sites that help people plan long journeys involving multiple modes of transport. Again, the public sector will take the lead, but the sites themselves may be integrated into much larger, more useful social networks that provide many services beyond person-to-person communication.

We hope this paper has provided you with interesting insight into eco-mobility. The opportunities for organisations are clear, as are the challenges. This is the start. And, we believe that success will only be achieved through sharing ideas, collaboration and innovative ways of working—some of which we have covered in the paper.

If you agree, share this paper with your colleagues and community. If you disagree, tell us why.

One last thought; imagine your business model without fossil fuels. If the well runs dry, will your business engine keep running or will it splutter to a halt?





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