Guide to energy and publicly-accessible transport in rural areas
REPUTE Introduction

REPUTE (Renewable Energy in Public Transport Enterprise) was created as a response to the EU Atlantic Area priorities that encourage trans-national cooperation. The REPUTE project was one of six transport projects funded by the programme 2007–13. All six projects shared themes of inter-modality and inter-operability, smart ticketing and journey planning, and cooperation in public/private partnerships.

REPUTE was an 18-month project, established in January 2014, with the aim of developing and promoting the use of renewable energy in public transport in a rural or semi-rural context.

REPUTE aimed to be the catalyst for a dynamic and innovative application of renewable energy to the public transport sector. The partners explored the benefits of previous transport projects for their application to public transport, particularly in rural areas.

The REPUTE project involved seven full partners and two associate partners in the Atlantic Area Region - the UK, Ireland, Scotland, France, Spain and Portugal.

The objectives of REPUTE were to:

- Publish a guide on challenges facing publicly-accessible transport in the Partner regions, and provide a focused analysis of existing and renewable energy technologies that could be deployed
- Hold a workshop in each participating region to engage with local and regional Government departments responsible for public transport, public transport operators, the academic sector, the training sector, private enterprise and the energy sector
- Undertake pilot tests on the integration of renewable technologies and personal travel planning
- Provide an analysis of potential CO₂ savings
- Hold a final conference tour travelling to each of the Partners’ regions, to engage policy change discussion and to disseminate the REPUTE approach.
Participants in the REPUTE project

FULL PARTNERS
Action Renewables Ltd, Northern Ireland, UK
South West College, Northern Ireland, UK
Ecole d’Ingenieurs (EIGSI), La Rochelle, France
Fundacion Asturiana de la Energia (FAEN), Spain
Limerick Institute of Technology, Ireland
Comunidade Intermunicipal do Oeste (Oeste CIM), Portugal
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FOR MORE INFORMATION, PLEASE VISIT OUR WEBSITE:
www.reputeproject.eu
Executive Summary

The transport sector is the fastest growing source of greenhouse gas (GHG) emissions. European transport-related GHG emissions account currently for 25% of all European emissions and are expected to continue to rise at about 6% per year. Sustainable transport requires a radical shift in investment towards providing fast and efficient public transport systems. However people in rural areas typically travel 50% further than their counterparts in urban areas and most of these journeys are undertaken by bus or car. It is not economically viable to serve diffuse rural communities with a regular public transport network. New business models are therefore required to provide total transport solutions. A number of imaginative schemes exist that connect to rural public transport hubs through community-run schemes, shared ownership of transport resources and bespoke on-demand services.

The context and motivation for catalyzing transport changes are outlined in this Guide. The regions associated with the project partners are described, and analyzed in terms of energy and transport. We show that the key drivers for change include community engagement, fund-raising at a local level, local energy initiatives and policies. The introduction of cost-effective, energy-saving, technologies is also significant. The final part of the Guide provides a set of case studies that describe activities and solutions to particular challenges.

Summary points

- Many rural public transport services generate a lot of greenhouse gas emissions when under-utilized
- Electrically-powered vehicles can provide a compelling way of reducing emissions, provided that they use low-carbon electricity
- Future transport will have to use more energy derived from natural resources – solar, wind, tidal, hydro, biomass, etc.
- There is a compelling case for rural transport to use biofuels derived from waste biomass resources such as spent oils, food waste and farm residues
- Renewable energy sources can be owned, operated and controlled in rural areas through community actions and local partnerships. The energy generated can be used directly or indirectly in local transport
- Financing mechanisms such as crowd-funding and local share schemes can integrate community energy initiatives with transport solutions, providing a strong sense of local involvement
- Community actions in rural areas have the potential to provide local total transport solutions through a combination of public and private transport enterprises
- Pilot schemes and trials can be an effective means of bringing about behaviour shifts, and hence introducing new technologies and new modes of transport.

Rural public transport hubs need to be built and connected by express services to major destinations

Total transport solutions are required for rural communities where pooling of resources and voluntary actions can provide a service

Total transport hubs could be accessed by, and could provide shared transport means for, users of shared transport options (minibuses, e-bikes, etc) including community-run schemes
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Glossary

ACEA: European automobile manufacturers association
AD: Anaerobic digestion
CO₂: Carbon dioxide
EV: Electric vehicle
GDP: Gross domestic product
GHG: Greenhouse gas
GTL: Gas to liquid
GVA: Gross value added
Ha: Hectare
ICE: Internal combustion engine
NMHC: Non-methane hydrocarbons
NOₓ: Nitrogen oxides formed during combustion
PEDELEC: Electrically-assisted bicycles that require the user to turn the pedals with their legs
PT: Public transport
PTP: Personal travel planning
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June 2015
1. Introduction

The aim of this report is to provide a single point of reference for public transport challenges in rural areas. It should provide valuable information for policy makers, transport operators and communities. We have put into context the transport and energy challenges in rural areas, and we have evaluated the best practice to inform future activities.

1.1 Sustainability in transport

Today's society relies heavily on transport to access everyday necessities and employment, to enhance recreation, facilitate learning and mobilize emergency services. However, our current transportation system is placing unsustainable demands on finite resources of fossil fuels, minerals and materials. It is also evident that individual mobility is leading to congestion, air quality issues and particular pressures on urban environments. Countries with a higher share of trips by public transport, walking and cycling have much lower levels of CO\textsubscript{2} emissions from road and rail energy consumption (Buehler and Pucher (2011), Figure 1.1).

The transport sector is the fastest growing source of greenhouse gas (GHG) emissions. European transport-related GHG emissions already account for about 25% of all emissions in Europe and this proportion is set to rise to 30% by 2050, despite all of the mitigation measures introduced so far (Figs 1.2 and 1.3). European GHG transport emissions increased by 35% between 1990 and 2007 because of increased mobility and freight transport, and could increase by 75% by 2050 unless radical policy...
measures are introduced. Significant emissions increases between 2010 and 2050 are projected for road freight (for which an increase of more than 45% is projected), aviation (more than 50%) and maritime (more than 65%) without additional policy instruments. Whilst GHG emissions from cars are still projected to contribute the most to the sector’s GHG emissions in absolute terms in 2050, their emissions are projected to have declined slightly from 2010 levels, as anticipated improvements in the energy efficiency of vehicles negate projected increases in demand. In the UK, travelling by road (cars, vans, lorries and buses) accounts for 90% of the transport sector’s greenhouse gases, of which more than half is accounted for by cars.

World energy demand is forecast to increase by 37% between 2015 and 2040. Solutions to transport issues facing highly populated, rapidly-developing, economies such as China and India are likely to be developed in those countries where the local conditions and culture can be put into the context of local and national needs. However, inspiration for low carbon, low energy, transport solutions may well be found in Europe. Ahuja (2015) observes that about 70% of power generation in India is derived from coal, a similar proportion to that of China. It is significant that the per capita electricity consumption in China rose ten-fold in the period 1980-2010, whereas it was five-fold in India in the same period. It should be noted that global energy consumption roughly doubled in that time (IEA, 2014).

These factors now threaten the availability and affordability of transportation which has facilitated the expansion of our mobility network in the last 100 years. They indicate that the world’s current network will not be able to meet future demands in a safe and sustainable manner unless changes are made very soon. The key elements of future plans include modal shift, more and improved public transport, energy derived from renewable and sustainable sources, and the use of information technology to better plan and optimize individual journeys.

Eltis is the urban mobility observatory for Europe¹. This on-line resource offers a wealth of information and case studies to help in the planning of sustainable urban mobility. The European Platform on Sustainable Urban Mobility Plans (SUMPs) supports the transition towards competitive and resource-efficient mobility systems in European cities through a range of measures². These include the SUMP concept and supporting tools, a Mobility Plans portal, a co-ordinating group, an annual conference and events. The first annual conference took place in Poland in June 2014. The SUMP concept also extends to regions where several centres and municipalities may be involved. There are a number of poly-SUMPs (polycentric regions) in Europe where methodologies for planning sustainable urban mobility have been developed³.

We are now entering what has been termed the fourth industrial revolution whereby industry and technology have converged to provide business opportunities in transport that unite low energy mobility with intelligent transport solutions.

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¹ www.eltis.org/  
² www.eltis.org/mobility-plans/european-platform  
³ www.poly-sump.eu/home
Greenhouse gas emissions from transport rose 250% (>6% pa) between 1970 and 2010

Figure 1.3 Transport GHG emissions 1970 - 2010

1.2 Policy content

The EU TEN-T Public Portal provides a comprehensive overview on the European Commission’s work in relation to the Trans-European Transport Network (TEN-T) and aims to raise citizens’ awareness of the benefits of the TEN-T policy development. The EU Air Quality Directive provides the overall framework for reporting emissions. Related to this are EN 13816:2002 Public Transport and CEN/TR 14310:2002 Freight Transport.

Motor vehicles and light commercial vehicles

Historically, the EU and Japan have led the way on reducing emissions from motor vehicles. The use of regulatory standards to control CO₂ emissions from motor vehicles has been proven to be a cost-effective measure, and is likely to continue to other modes of transport in the future. Understanding the wider potential impact of such future standards on the European economy is therefore of particular interest.

“At the highest level, the creation of a level playing field [CO₂ target] by the EU was extremely helpful. A clear long-term target is what the industry needs - it will find a way to respond”

Automotive Manufacturer

Hyperlinks:

1 www.mitigation2014.org/report/summary-for-policy-makers

CO₂ emission targets for light-duty vehicles in the EU were first introduced in 1998 under the voluntary ACEA Agreement. The goal of this voluntary agreement was to reduce CO₂ from passenger cars to 25 per cent below 1995 levels (to 140 g/km) by 2008/9. Progress made against this target is shown in Fig 1.4.

Following under-performance of the voluntary agreement, the EU moved to mandatory standards for light-duty vehicles. In 2009, the EU formally adopted Regulation 443/2009, which sets an average CO₂ target for new cars sold in the EU of 130 g/km by 2015 (according to the NEDC Test Cycle), backed up by penalties for non-compliance. For 2020, Regulation 443/2009 set a target of 95 g/km, with an obligation for the Commission to review this target and define the specific modalities for implementation. This regulation was proposed by the Commission in July 2012 and is now under political review by the European Parliament and Council. The target for new cars in 2025 is likely to be around 73 g/km and the EU will further stretch the target for 2030.

The Renewable Energy and Fuel Quality Directives in the EU set out policies and minimum sustainability standards. However, different EU member states have their own policies and incentives to promote the use of alternatively-fuelled vehicles. At national level, several states have encouraged the uptake of electric vehicles (EVs) through subsidy while others have promoted the use of biofuels and gases such as hydrogen, methane and natural gas. At local level, reduced or zero emission vehicles are attractive in urban environments so that usage is encouraged by differential taxation and incentives. It must be noted that developments in infrastructure must be provided alongside changes in alternatively-fuelled vehicles, such as charging stations for EVs.

Similar regulations exist for light commercial vehicles (Regulation No 510/2011), which aim to cut CO₂ emissions from vans to an average of 175 g/km by 2017 and to 147 g/km by 2020. Again, these targets will be further stretched for 2025 and 2030.

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**Figure 1.4 Reductions in new car CO₂ in EU15 Member states 2007-2012**

The Renewable Energy and Fuel Quality Directives in the EU set out policies and minimum sustainability standards. However, different EU member states have their own policies and incentives to promote the use of alternatively-fuelled vehicles. At national level, several states have encouraged the uptake of electric vehicles (EVs) through subsidy while others have promoted the use of biofuels and gases such as hydrogen, methane and natural gas. At local level, reduced or zero emission vehicles are attractive in urban environments so that usage is encouraged by differential taxation and incentives. It must be noted that developments in infrastructure must be provided alongside changes in alternatively-fuelled vehicles, such as charging stations for EVs.
**Buses**

Buses account for 50-60% of the total public transport offer in Europe and 95% use diesel fuels (UITP, 2011). In England, between 2000 and 2010, bus use grew by more than 17% and investment in bus services doubled. Lower emission buses must play a growing role in the transport system and a wide range of alternative fuels and technologies, at different levels of technical and market maturity, are available to bus operators.

When purchasing buses, public authorities and operators are obliged to follow the conditions laid down in the Clean Vehicles Directive (2009/33/EC) by considering energy consumption and harmful emissions (CO$_2$, NO$_x$, NMHC and particulates). All new bus models sold since January 2014 must meet Euro VI standards. Further detail is provided on the Clean Fleets website. The UK government provides financial support to incentivize technological change through the Bus Service Operators Grant (BSOG), and through the Green Bus Fund to subsidize the uptake of hybrid and electric buses. The German government provides financial support for hybrid and electric vehicles through their Ministry for Environment. Many individual cities have followed their own particular paths for evaluating different technologies. An excellent overview of fuel and technology options is provided in a report from Clean Fleets (2014).

**Cycling**

Cycling represents one of the most cost-effective ways to increase urban mobility and reduce emissions from transport. Cycling is a viable alternative to car journeys for many short trips. In addition to reducing emissions, cycling can bring additional benefits for health, reduced road congestion and improved local air quality. Many cycle schemes exist where ‘docking stations’ are located in strategic places such as outside railway stations, and at park and ride facilities. For slightly longer trips, electric bicycles (pedelecs) offer a superb opportunity as an environmentally friendly way of moving around. The case for pedelecs is even more compelling if the energy is derived from renewable energy sources, eg solar canopies. An increasing number of short-term pedelec hire schemes exist, such as in Copenhagen, La Rochelle and Madrid.

**Integration of transport modes**

The attractiveness and convenience of public transport can be improved significantly by better coordination and integration of different services. Smart ticketing allows passengers to move seamlessly between different modes, which is even more effective when combined with improved information and travel planning tools. Improving the interchange between cycling and other forms of transport is also important. Many EU states have improved cycle storage at key railway stations to enhance the appeal of this option whilst local schemes often include bike rental services at key locations.

**1.3 Renewable energy in transport**

Renewable energy is the term used to describe energy that occurs naturally and continuously in the environment, such as energy from the sun, wind, river flows, waves and tides. That means that these sources are essentially inexhaustible, albeit intermittent in nature. There is a growing demand for renewables to be a larger part of the energy mix. For example, the UK may need to generate 40% of its electricity from this source by 2020 to meet its international commitments.

Hyperlinks:

1. www.clean-fleets.eu

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**Rail**

Most EU states have invested in gradually electrifying their rail networks. Electric trains offer better environmental performance than diesel equivalents, and can also increase capacity and reliability, as well as being cheaper to buy, maintain and operate.
By 2050, the radical decarbonization of transport will be characterized by cleaner fuels, greener technology and a shift towards renewable sources of energy. Road vehicles will be far more efficient through advances in powertrain technologies, light-weighting, aerodynamics and whole-life thinking. Telematics will also play an important role in journey planning and avoidance of congestion. The energy efficiency of public transport will be improved through powertrain improvements, hybrids and fully electric variants, energy storage devices that capitalize on stop-start driving patterns, route optimization, electrification of the railways and subsidies for buses to enable operating companies to invest in low carbon technologies.

The EU TEN-T Directive 2014/94/EU outlines the strategy for the deployment of alternative fuels in the transport infrastructure.

In terms of alternative fuels, the two main gaseous fuels derived from fossil sources are CNG (compressed natural gas) and LPG (liquefied petroleum gas). CNG has a much lower energy density than LPG and is generally stored at high pressures. They provide less harmful emissions than conventional fuels and zero particulate emissions. In Europe, CNG is typically used in heavy duty vehicles (where the size and robust storage tanks can be accommodated) while LPG is more commonly used in cars and vans. A significant switch from conventional diesel to gas refuelling would require the development of national gas refuelling networks which would have to be led by national governments.

Some commercial operators have experimented with biofuels, ie renewable transport fuels derived from organic materials. There remains much debate on the merits of biofuels. However, there is an important distinction between first generation biofuels (derived from crops grown for that purpose) and second generation biofuels (derived from waste products). There are many different types of biofuels including biogas (biomethane) and liquids such as biodiesel and bioethanol.

The European Renewable Energy Directive (RED) 2009/28/EC and the Fuel Quality Directive contain binding mandatory sustainability standards for biofuels. In effect, these require fossil fuel suppliers to demonstrate that a certain percentage of their fuel comes from renewable sources. The RED transport target is to ensure a 10% contribution of renewable energy by 2020. It is anticipated that this will be achieved by blending conventional fossil fuels with ethanol (eg E10).

Decarbonization pathways for electricity and hydrogen will require considerable additional investment in new technologies and upgrading infrastructure. The UK government projects a baseline reduction of grid carbon intensity from c. 500gCO\(_2\)/kWh today to 100gCO\(_2\)/kWh in 2030; the Intergovernmental Panel on Climate Change (IPCC) recommends a target of 50gCO\(_2\)/kWh by 2030 for all countries. Both cases imply the integration of far more renewable generation (wind, solar, hydro, tidal, biogas, etc).

A detailed commentary on alternative fuels, including electricity, is available from http://batterie.eu.com.

1.4 Intelligent transport systems

The need to combine energy efficiency with an enhanced user experience, including multi-modal transport solutions, requires new technologies for controlling and monitoring transport networks. Intelligent Transport Systems are defined as information and communication technologies applied to vehicles and transport infrastructures, allowing both operators and users to manage their travel. Examples of benefits include optimization of travel networks, reduced congestion, improved safety and real-time information. For users the key benefits of journey planning, efficient journeys, on-line booking and payment, and single-ticketing are compelling. Most of the ‘smart technologies’ are available in cities with limited applicability to rural regions.

1.5  Behaviour change and modal shift

The Policy Framework developed at EU and national levels has been crucial to the progress made so far on low carbon transport. The importance of consistency in approach and long-term commitments by government cannot be over-emphasized because, without these, commercial investment will not happen. To build a greener future means that low carbon transport must be a genuine, viable and attractive option for businesses and ordinary citizens. EU member states have generally had the benefit of their governments supporting key strategies like greater electrification of transport, improvements to infrastructure, providing grants that lead to decarbonization measures, supporting cycling schemes and encouraging cleaner energy generation technologies.

At a more local level, ordinary citizens have many choices but these can be informed by local actions. To date, cities have been at the forefront of improving air quality, reducing congestion and leading on climate change issues. City Councils and their mayors have emerged, in some cases, as genuine world leaders in focusing on solutions. City leaders often have powers over key assets such as road and rail systems, and over functions such as land use planning, and many have worked out how to take actions to promote the long-term sustainability of their communities. The world’s population is increasingly city-based; 53% of the population currently lives in urban areas and this number is expected to reach 67% by 2050. Urban mobility therefore represents a significant challenge as the number of urban journeys increase. Many actions have already taken place in the world’s 40 Megacities (the C40 Climate Leadership Group) and there has been much sharing of good practice. Some of the projects, and lessons learnt, arising from these have been replicated in much smaller conurbations. It is evident that many smaller towns and cities share good practice on smaller schemes such as bus park and ride, city bus gates, prioritization through bus lanes, congestion charging, smart ticketing, development of cycle paths, cycle rental, car sharing, car clubs, and so on. There is an increasing number of ‘smart’ cities that are exploiting the use of information technology to increase the efficiency and effectiveness of urban transport systems.

For ordinary citizens, local incentives and convenience tend to drive a modal shift (the change of mode of travel selected by individuals). There has to be some sort of incentive, be it a cost saving, time saving, information provision, convenience, reliability of journey time, guaranteed parking, etc in order to encourage a change in behavior. Every citizen needs to recognize that the status quo must change and that being environmentally responsible is simply normal. The overall challenge here is one of communication.

1.6  Approach and scope of report

The REPUTE approach is to consider the particular transport challenges in the Partner regions and to focus on possible solutions that meet viable implementation criteria. The Partner regions are primarily on the Atlantic seaboard. They are not heavily populated but significant distances often separate townships and access to public transport hubs may be limited. Thus typical journey distances may be long, the journeys may be multi-modal and the cost quite substantial. There may also be a significant input of renewable energy into the local electricity grid or available as biofuel. In assembling this report we have considered this balance of challenges, demographics and geography, against best practice that is relevant to appropriate publicly-accessible* transport solutions. Frequent journeys by rail for day-to-day mobility are limited in rural and semi-rural areas, and are not therefore considered in detail in this report.

- Section 2 contains a summary and analysis of the Partners’ regions. This takes the form of a general overview, followed by a detailed breakdown of the regional characteristics obtained through questionnaire responses. The study of social mobility in the Atlantic Arc area, commissioned in 2015, is also introduced.

* Publicly-accessible transport solutions include buses, taxis, cars in car-share schemes, bicycles and pedelecs in bike-share schemes, trams and trains.
• Section 3 focuses on regional transport mobility challenges and the concept of ‘total transport’. Possible solutions to some of these challenges are presented with reference to community engagement in both transport provision and localized energy generation. Localised funding mechanisms for the development of new community-based transport and energy schemes are presented.

• Section 4 introduces the notion of revolutionary change in publicly-accessible transport. The theoretical concept of socio-economic transitions is placed in the context of community-led and regionally-led mobility schemes. Energy and transport are then considered in detail with reference to experience, good practice, project activity and examples of commercial implementation.

• Section 5 contains case studies of relevant good practice found in the Partners’ regions and internationally. We have given particular consideration to schemes that exploit renewable energy sources and sustainable technologies. The pilot schemes that were initiated during the REPUTE project are also introduced; these were in progress at the time of publication of this report.
2. Current Situation in the Partners’ Regions

A general description of each of the Partners’ regions is provided with an emphasis on general economic activity, energy and transport. This is followed by a summary of the analysis undertaken in each region, where detailed information was obtained on energy, urban density, roads and cycleways, public transport, air quality and social factors.

Table 2.1 Statistical overview for the Atlantic Area regions in the REPUTE project

<table>
<thead>
<tr>
<th>EA REGIONS</th>
<th>POPULATION</th>
<th>AREA [km2]</th>
<th>DENSITY Inhab/km² 2011</th>
<th>GDP M/Euro 2009</th>
<th>GDPPC IN PPC EU27=100 2007</th>
<th>GDPPC IN PPC EU27=100 2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>10,744,534</td>
<td>94,724.9</td>
<td>113.4</td>
<td>236,119</td>
<td>101</td>
<td>99.8</td>
</tr>
<tr>
<td>France</td>
<td>15,185,843</td>
<td>156,314.3</td>
<td>97.1</td>
<td>375,150</td>
<td>92.5</td>
<td>92.4</td>
</tr>
<tr>
<td>Ireland</td>
<td>4,480,858</td>
<td>69,797.0</td>
<td>64.2</td>
<td>160,596</td>
<td>149.2</td>
<td>127.9</td>
</tr>
<tr>
<td>Portugal</td>
<td>10,143,600</td>
<td>89,088.8</td>
<td>113.9</td>
<td>159,517</td>
<td>78.2</td>
<td>79.4</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>19,818,007</td>
<td>128,165.3</td>
<td>154.6</td>
<td>413,145</td>
<td>97.0</td>
<td>91.9</td>
</tr>
<tr>
<td>Atlantic Area</td>
<td>60,372,842</td>
<td>538,090.3</td>
<td>112.2</td>
<td>1,344,527</td>
<td>97.2</td>
<td>94.0</td>
</tr>
</tbody>
</table>

Source | Fuente | Source | Fonte: EUROSTAT

Table 2.1 refers to the most recent figures available at Eurostat concerning population, area, demographic density, gross domestic product and gross domestic product per capita in the AA regions of Spain, France, Ireland, Portugal and the United Kingdom.
2.1 Regional descriptions

2.1.1 France: Poitou-Charentes

Poitou-Charentes is an administrative region in south-western France comprising four departments: Charente, Charente-Maritime, Deux-Sèvres and Vienne. The region covers a 25,809 km² area with a population of 1.78 million in 2011\(^1\), set to expand to 2.06 million inhabitants by 2040\(^2\). The population density is lower than the national average outside Paris. 39% of the population live in rural areas. With no metropolitan area, the Region has 4 urban areas: Poitiers (the regional capital), La Rochelle, Niort and Angoulême.

Agriculture is twice as important to the economy than the national average. Agriculture provides 4.5% of the region’s GDP and includes mainly cattle, wine and cognac production. Industry accounts for 14% of GDP in the region. This sector specializes in wood, eco-industry, packaging and food processing. Like the other parts of France, the service sector is the largest and accounts for about three-quarters of GDP.

Poitou-Charentes will be merged with Aquitaine and Limousin in January 2016, to create a much larger region with a population of 5.7 millions and 84,000 km². This territorial reform will align with French policy which aims to create larger economically active areas of a ‘European size’, reducing the total number of French regions from 22 to 13.

\(^1\) Schéma Régional Climat Air Energie Poitou-Charentes – Etat des lieux – Mars 2013
\(^2\) Insee Poitou-Charentes Decimal N° 308 - Décembre 2010
Figure 2.2 Energy consumption in Poitou-Charentes

The final energy consumption of the Region in 2011 was about 4623 ktoe\(^1\). Almost 50% of the consumption is for transport. In terms of energy, fossil fuel use is decreasing but was 57% in 2011, and electricity and natural gas are on the increase (Fig. 2.3). The proportions of energy consumption using energy generated from renewable sources are shown in green in Figs 2.3 and 2.4.

A nuclear power plant in Civaux produced 86% of power generated in Poitou-Charentes in 2012\(^2\). The remaining electric power was produced by hydro, wind and solar generation.

Figure 2.3 Sources of energy production in Poitou-Charentes

Renewable energy production represented 13% of the regional final energy consumption in 2012\(^3\). 77% of the production was from biomass - wood combustion. The relative share of production by use (Fig. 2.4) shows significant disparities and strong dependence on fossil fuels. Renewable energy provided 26.2\% of thermal energy consumption, 8.9\% of the electricity consumption and 3.3\% of fuel consumption is from biofuel. The Poitou-Charentes region has a high potential for development of solar energy with an average annual sunshine figure of 1270 kWh / m\(^2\).

Figure 2.4 Sources of renewable energy in Poitou-Charentes

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1. Synthèse ARECPC, October 2012 « la consommation d’énergie finale en Poitou-Charentes
2. « Bilan électrique 2012 de la région Poitou-charentes » RTE
3. « Etat des lieux du développement des énergies renouvelables en Poitou-Charentes 2013 » AREC Poitou-charentes
Mobility

Poitou-Charentes is a region of transit for both North/South and East/West exchanges (with more than 6,000 trucks per day) and also a major tourist destination in France.

Three highways travel through the region: A10 (Paris-Bordeaux), A83 (Nantes-Niort) and A387 (Rochefort-Saintes). The region is well connected by rail with high speed service to Paris and regional trains to Bordeaux and Nantes. There are also two active regional airports in Poitiers and La Rochelle.

La Rochelle Port is the 6th biggest French port in terms of annual traffic and it has established a Railway Operator (OFP Atlantic) in order to boost the supply of rail freight to origin or to a destination port for any client throughout the French territory.

In terms of cycling policy, because of EV1 (the euro bike route from Norway to Portugal), a cycling infrastructure has been stimulated. 8% of day to day travel in the La Rochelle area is by bicycle, compared to 2% national average for equivalent territories (medium sized cities). Nearly all households have at least one car (86.9% vs 80% on national level) due to urban sprawl and low density. Thus, one priority is the deployment of 1,000 EV charging points by 2015 throughout the regional territory, with a focus on urban and suburban areas.

In France, public transport is overseen by Local Transport Authorities (LTA) and operated by either private companies or companies controlled by the LTA. Local government - through the LTAs – sets the parameters for transportation and provides subsidies while the operators run the service. A transport tax is levied on the total gross salary paid by each company with over nine employees within the LTA’s territory. The tax is paid by the employer.

The issue of increasing urban sprawl is creating challenges for public transport in France, so that over the last decade there are greater numbers of people travelling longer distances.

2.1.2 Ireland

The population of the Irish Republic at the 2011 census was 4.5 million. Approximately 1.8 million or 28% of these live in The Greater Dublin area, and projections to 2031 suggest that Dublin could account for two thirds of total population growth. The remainder of the population lives in the four small cities of Cork, Galway, Limerick and Waterford, in other small and medium sized rural towns and villages, and in the open countryside. A relatively high proportion (38%) of the population of Ireland are classified as living in rural areas.

Aside from the agri-food sector, which makes up 10% of GDP, most of Ireland’s economic activity takes place in the urban areas. Economic activity is comprised of a mixture of SME’s, Technology and Manufacturing companies, and service industries. Tourism is also a significant contributor with up to eight million people visiting annually.

Figure 2.5 Ireland

1 Schéma Régional Climat Air Energie Poitou-Charentes – Contexte, Orientations et objectifs – March 2013
2 CDA La Rochelle, Enquête déplacements villes moyennes (EDVM) 2011
3 Insee 2009
Public transport in Ireland is serviced by intercity rail services and buses. Dublin is linked to its commuter belt by commuter rail and bus services. Travel within the city is provided by Dublin Bus and the Luas light rail system. In the regional cities, the main mode of public transport within the cities is by bus.

There are three principal airports in Ireland: Dublin, Cork and Shannon. Major sea ports are located at Dublin and Rosslare on the East, Waterford and Cork on the south coast, and the Shannon Estuary and Galway on the Atlantic coast.

The transportation challenge presented by Ireland’s rural demography is reflected in the modal split statistics. Between 1981 and 2011 the proportion of commuters travelling to work by car increased from 45% to 65% - meaning that two out of every three working commuters drove to work. By contrast the proportion of people walking and cycling declined significantly over the period. Although the numbers of people cycling to work increased by 9% to 39,000 between 2006 and 2011, this number is 20,000 less than the 1986 figure for cyclists.

The use of public transport is much more prevalent in Dublin (21%) than in the other five cities (6.8% Cork, 6.4% Galway, and 4.4% Limerick). In the aggregate rural only 1.8% of people use public transport to get to work. In Cork, Limerick, Galway and Waterford over 70% of people commute by car vs 54% in Dublin. In rural areas, car usage is close to 90%.

2.1.3 Portugal: Oeste

Figure 2.6 Portugal - Oeste
The Oeste Region of Portugal includes a long coastline along the Atlantic Ocean and it’s located on the centre west part of Portugal. This region incorporates the northern part of the district of Lisbon and a part of the District of Leiria. With an area of 2,486 km² (<5% of the area of Portugal) and a population of 362,523 (census 2011), this region is a short distance from Lisbon which provides a good economic advantage. The Oeste Region incorporates a diverse, hilly, landscape with 120km of coastline, and provides its citizens with a high quality of rural life with the proximity of the Capital, Lisbon.

The Oeste Region comprises 12 municipalities: Alcobaça, Alenquer, Arruda dos Vinhos, Bombarral, Cadaval, Caldas da Rainha, Lourinhã, Nazaré, Óbidos, Peniche, Sobral de Monte Agraço and Torres Vedras with different but complementary attributes. The Oeste Region therefore represents a vibrant area for the development of an integrated travel network.

The majority of the local active population works essentially in industry and services; around 27% of the population working is in the secondary sector and the tertiary sector represents roughly 66% of the region’s active population (PORDATA, 2011). Agriculture is an important activity in the Oeste Region, where some wine-growing and fruit cultures are produced. Over 99% of world’s Rocha Pear production comes from Portugal. In summary, the Oeste Region’s economic activities are based on commerce, services, industry, agriculture and fishing, and tourism is also becoming significant.

The Oeste Region has an enormous potential for renewable energies because of the hilly terrain and sunny weather. Wind energy is currently responsible for generating around 10% of the total Portuguese installed capacity for wind energy. A lot of energy is also generated using solar PV sources. It can be said that parts of the region are already self-sufficient in energy generation.

In terms of transport, regional travel by bus is carried out by five companies which provide good geographical coverage of the entire Oeste Region territory. However, due to the low frequencies in certain routes and timetables that do not favor commuting, the perception by the population is that bus services do not meet commuters needs. The bus companies also offer connecting services to major cities surrounding the Oeste Region, with special attention given to connections to Lisbon. Rail travel serves the Oeste territory through the “West Line” in a north-south direction. This line, with a total length of around 200 km, connects Lisbon to Coimbra and Figueira da Foz. In the Oeste territory there are 24 stations and the main stations are Bombarral, Caldas da Rainha and Torres Vedras. The availability of rail transport is limited, compared to the services offered by the bus operators. Three cities have bus and rail stations located within the urban area, but with limited integration between the two types of transport. The remaining stations are located mostly outside the urban centers, without any linkage with public transport by bus. The increased length, capacity and levels of network security main road in the region of Lisbon and Tagus Valley (Lisboa e Vale do Tejo), has favored the growth of motorization and the use of personal transport, contributing to a significant reduction in the supply and use of collective public transport.
2.1.4 Spain: Asturias

Asturias, located in northern Spain, covers an area of 10,604 km², or 2.1% of the land area of Spain. The population of around 1.08 million is concentrated around Oviedo, Gijón and Avilés in the central region. It contains about 400 km of coastline. This is an industrial area, primarily coal mining and steel production. Also important is the energy production sector (mainly electricity using coal, natural gas or renewables energies). Tourism is another increasing activity in Asturias.

The central area is well connected by rail and road. There are around 5,000 km of different types of roads (400 km highways) and 670,000 vehicles in the region. The railway network sells more than 11 million tickets every year. In addition, the high speed train between Asturias and Madrid is under construction (expected in 2016). There is also an airport used by around 1.2 million passengers in 2013. The port of Musel connected Asturias to France (Saint Nazaire), England (Poole) and Ireland (Rosslare) until 2014. However, public funds are now required by private operators if the region wants to continue with these connections.

Outside the central area, the more rural areas are not served well by public transport. Private cars provide the dominant means of transport in these areas.
The population in 2011 was 1.8 million, having grown 7.5% from just under 1.7 million in 2001. This constitutes just under 3% of the population of the UK (62 million) and just over 28% of the population of the island of Ireland (6.3 million). In Northern Ireland, the capital city Belfast and the city of Londonderry/Derry are the two largest urban settlements respectively. Belfast has a population of 280,962, and 43.9% are aged 30 or younger. Londonderry/Derry has a population of 107,887.

The Northern Ireland economy is the smallest of the four economies making up the United Kingdom. Northern Ireland has traditionally had an industrial economy, most notably in shipbuilding, rope manufacture and textiles, but most heavy industry has since been replaced by services, primarily the public sector. Tourism also plays a big role in the local economy. There were over 13 million visits to Northern Ireland tourist attractions in 2013, with tourism contributing 5.2% of the Northern Ireland economy and supporting 43,000 jobs in 20131. More recently the economy has benefited from major investment by many large multi-national corporations into high tech industry. These large organisations are attracted by government subsidies and the skilled workforce in Northern Ireland.

Belfast is ranked as the UK’s second most attractive city (after London) for foreign direct investment, particularly in the technology and financial services sectors2.

Northern Ireland is served by three airports – Belfast International near Antrim, George Best Belfast City integrated into the railway network at Sydenham in East Belfast, and City of Derry in County Londonderry. Major sea ports at Larne and Belfast carry passengers and freight between Great Britain and Northern Ireland. The Belfast port is the second largest on the Island of Ireland and handles 60% of NI seaborne trade. Passenger railways are operated by Northern Ireland Railways. With Iarnród Éireann (Irish Rail), Northern Ireland Railways co-operates in providing the joint Enterprise service between Dublin Connolly and Belfast Central.

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1 www.visitbritain.org/insightsandstatistics/visitoreconomyfacts
2 Source: Belfast Telegraph, 1 February 2011
There is a high dependence on private vehicles in Northern Ireland, with 67% of people relying on their car or van to get to work (Table 2.2). This is partly due to the largely dispersed and rural population, but also an inconsistent improvement in public transport usage. There were 0.625 vehicles/person for NI as a whole in 2012. However, 23% of households in NI have no access to a car/van, compared with 40% for Belfast.

There were 0.22 million rail users in 2012, a 22% increase on 2008 levels. However, national bus usage has stagnated at around 1.3 million users since 2008. Whilst bus use may not have risen in most of the country, in parts of Belfast the numbers using public transport have increased, as have the numbers of people walking or cycling. This is due to the success of the ‘Belfast on the Move’ scheme (see Section 2.2.4) which has introduced a number of new bus and cycle routes around the city.

The Regional Strategic Transport Network Plan 2015 represents the skeletal framework of the regional connecting all the main centres of economic and social activity and the major transport hubs. The plan contained proposals including enhanced public transport infrastructure, improved rail and bus services, new improved park and share/ride facilities as well as enhanced walking and cycling provision, all of which would help reduce reliance on private cars.

Hyperlinks:
1 www.drdni.gov.uk/rstn_tp-2.pdf
The population of Scotland is 5.3 million. The capital, Edinburgh, has a population of just over 584,000. The Greater Glasgow conurbation, with a population of almost 1.2 million, represents nearly a quarter of Scotland’s population.

The Central Belt is the most populous part of the country, with Glasgow in the west and Edinburgh in the east. Perth, Dundee, Stirling, Inverness and Aberdeen are Scotland’s other cities. The Highland covers an area larger than Belgium but is mostly sparsely populated, although the City of Inverness has been one of the fastest growing cities in Scotland over recent decades.

Scotland has five main international airports (Glasgow, Edinburgh, Aberdeen, Prestwick and Inverness), which together serve 150 international destinations with a wide variety of scheduled and chartered flights. The Highland and Islands Airports operates 11 regional airports, including Inverness and Dundee. The Scottish Government own Glasgow Prestwick Airport.

The Scottish motorways and major trunk roads are managed by Transport Scotland. The remainder of the road network is managed by the Scottish local authorities in each of their areas. Regular ferry services operate between the Scottish mainland and many islands. The largest ferry operator is state owned Caledonian MacBrayne, but some are operated by local councils and private operators. Network Rail Infrastructure Limited owns and operates the fixed infrastructure assets of the railway system in Scotland, while the Scottish Government retains overall responsibility for rail strategy and funding in Scotland. Scotland’s rail network has around 340 railway stations and 3,000 km of track. Over 80 Million passenger journeys are made each year.

The ScotRail network is managed by Transport Scotland. The East Coast and West Coast main railway lines connect the major cities and towns of Scotland with each other and with the rail network in England. Domestic rail services within Scotland are operated by ScotRail. In addition, Glasgow has had a small integrated subway system since 1896. Completely modernised between 1977 and 1980, its 15 stations serve just under 35,000 passengers per day.
Oxfordshire has a population of over 650,000 people, which is set to expand to 740,000 by 2026. Nearly a quarter of the population live in Oxford, but over 30% live in towns and villages of less than 10,000 people.

Oxfordshire is home to nearly 30,000 businesses, providing over 380,000 jobs including a high proportion in research, science and technology, engineering, and high-tech manufacturing. Oxfordshire’s GDP was reported as being 32,100 Euro in 2014. The city of Oxford’s GVA per capita is estimated at 39,000 Euro, the fifth highest GVA per capita of any city in the UK, and significantly higher than the national average of 27,800 Euro.

35% of the county’s jobs are located within the city but over half of all jobs based in Oxford are held by commuters. Car ownership and car usage is high outside Oxford, with 87% of households owning a car – compared with only 67% in Oxford. This is reflected in the high proportion of journeys made by car across the county – 65% of residents outside Oxford travel by car to work each day. Although 50% of journeys to central Oxford are by bus, many of the City’s jobs are on the edge of the city.

Oxfordshire is very well connected by rail with frequent services to London and other parts of the UK. Rail services from the city of Oxford are subject to congestion and overcrowding, particularly on trains into London and between Oxford and cities to the north.

Oxford is a key hub for the national coach network. There are over 150 coach services each day between Oxford and London (the highest frequency coach service in the UK), as well as a frequent services to airports. Other coach services connect the county to major cities in the UK.

The local bus network across the county is well used, with high frequency routes connecting Oxford city centre with other parts of the city and other major towns. Oxfordshire has one of the highest levels of bus patronage outside London and a number of services into Oxford are operating at or beyond capacity each day.

There is a good walking and cycling network across Oxford, and over a third of workers living in the city of Oxford either walk or cycle to work. Whilst there are similar opportunities for walking and cycling in other towns, it is a less popular activity outside of Oxford.


2.2 **Overview of energy and transport**

We obtained our information by requesting information from key regional officials and stakeholders. These people were invited to complete detailed questionnaires that targeted specific relevant questions. The responses to these questionnaires are presented in tables 2.3-2.4, and Figs. 2.11-2.16. Further data are presented in the Appendix.

2.2.1 **Energy sources**

*Table 2.3 Energy sources making up energy mix in the grid for partner regions*¹

<table>
<thead>
<tr>
<th>Country</th>
<th>Energy Sources for Grid</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>Poitou-Charentes</td>
</tr>
<tr>
<td></td>
<td>Fossil fuel</td>
</tr>
<tr>
<td>Ireland</td>
<td>Whole Country</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>Oeste</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>Asturias</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>Northern Ireland</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td>UK</td>
<td>Scotland</td>
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<tr>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>Oxfordshire</td>
</tr>
</tbody>
</table>

¹ REPUTE Partner and Stakeholder questionnaire, April 2014.  
² [bit.ly/1NeRSSQ](http://bit.ly/1NeRSSQ)
2.2.2 Urban density, transport and emissions

(Population, urban density) Ratio between the population of the urban agglomeration and its urbanised surface area (person per sq km)

Figure 2.11 Ratio between population of urban agglomeration and urbanized surface area

(Ownership density) Ratio between the total number of passenger motorised vehicles (including cars, motorcycles, taxis) within the urban agglomeration and its population

Figure 2.12 Ratio between the total number of passenger motorized vehicles and population within the agglomeration

1 REPUTE Partner and Stakeholder questionnaire, April 2014.
2 REPUTE Partner and Stakeholder questionnaire, April 2014.
Figure 2.13 Ratio between the total length of cycle lanes and cycle paths and urbanized surface area in the urban agglomeration

Figure 2.14 Ratio between the total amount of carbon dioxide emitted per annum as a consequence of its transport activities and its population (tonnes CO$_2$ per person)

1 REPUTE Partner and Stakeholder questionnaire, April 2014.  
2 REPUTE Partner and Stakeholder questionnaire, April 2014.
(Air quality in the urban agglomeration) Average daily concentrations of NO\(_2\) (μg/m\(^3\))

*Figure 2.15 Average daily concentrations of NO\(_2\) (μg/m\(^3\)) in the agglomeration*\(^1\)

(Air quality in the urban agglomeration) Average daily concentrations of PM\(_{10}\) (μg/m\(^3\))

*Figure 2.16 Average daily concentrations of PM\(_{10}\) (μg/m\(^3\)) in the agglomeration*\(^2\)

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\(^1\) REPUTE Partner and Stakeholder questionnaire, April 2014.

\(^2\) REPUTE Partner and Stakeholder questionnaire, April 2014.
2.2.3 Publicly-available transport modes and incentives

The availability of various transport modes for day-to-day mobility in each of the Partners’ regions is summarized in Table 2.4.

<table>
<thead>
<tr>
<th>Transport modes</th>
<th>Conventional buses</th>
<th>Hybrid-electric buses</th>
<th>Trans</th>
<th>Bicycle hire</th>
<th>Pedelec hire</th>
<th>Car or taxi sharing</th>
<th>Car hire scheme</th>
<th>Park and ride</th>
<th>EV charging points</th>
<th>Buses</th>
<th>Other</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>La Rochelle</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Transport on demand (Yelo Taxi) + TRAIN (la rochelle/Rochefort)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>France</td>
<td>Poitiers</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Transport on demand (Yelo Taxi)</td>
<td></td>
<td></td>
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<tr>
<td>France</td>
<td>Niort</td>
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<td></td>
<td></td>
<td></td>
<td>Transport on demand</td>
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<tr>
<td>France</td>
<td>Angouleme</td>
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<td></td>
<td></td>
<td>Transport on demand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>Whole Country</td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Transport on demand</td>
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<tr>
<td>Portugal</td>
<td>Oeste</td>
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<td></td>
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<td></td>
<td></td>
<td></td>
<td>Transport on demand</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Spain</td>
<td>Asturias</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Train, cycle and walking</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>Northern Ireland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Electric buses</td>
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<td></td>
</tr>
<tr>
<td>UK</td>
<td>Scotland</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Electric buses</td>
<td></td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>Oxfordhire</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Electric buses</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Oxford has 5 Park and Ride termini, several bike and car sharing schemes. Congestion in the city has forced adoption of walking and cycling, and the use of public transport.

‘Belfast On The Move’, the Transport Masterplan for Belfast City Centre, has been very successful. By reorganising traffic management in Belfast city centre the project set out to facilitate a reduction in general traffic levels and encourage greater walking, cycling and public transport use in line with the aims of the Belfast Metropolitan Transport Plan. Post opening results (comparing 2011 to 2013) showed a 37% increase in the number of people entering the city centre by train and an 18% increase in the number of people entering the city centre by bus. Overall, public transport patronage is showing a year on year growth of around 2%. Park & Ride usage has shown a notable increase of over 40% in the last 2 years.

Hyperlinks:

2.3 Regional economics

<table>
<thead>
<tr>
<th>Country</th>
<th>Region</th>
<th>GDP (Euro)</th>
<th>GVA (Euro)</th>
</tr>
</thead>
<tbody>
<tr>
<td>France</td>
<td>Poitou-Charentes</td>
<td>26,660 (2011)</td>
<td></td>
</tr>
<tr>
<td>Ireland</td>
<td>Whole Country</td>
<td>35,500</td>
<td></td>
</tr>
<tr>
<td>Portugal</td>
<td>Oeste</td>
<td>21,000 (b,c)</td>
<td>21,035 (a)</td>
</tr>
<tr>
<td>Spain</td>
<td>Asturias</td>
<td>21,035 (a)</td>
<td></td>
</tr>
<tr>
<td>UK</td>
<td>Northern Ireland</td>
<td>19,700</td>
<td>20,464</td>
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<tr>
<td>UK</td>
<td>Scotland</td>
<td>31,100 (35,500 including geographical share of offshore activity)</td>
<td>25,500</td>
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<tr>
<td>UK</td>
<td>Oxfordshire</td>
<td>32,100</td>
<td>39,076 for City of Oxford</td>
</tr>
<tr>
<td>UK</td>
<td>Average</td>
<td>29,000</td>
<td>27,835</td>
</tr>
</tbody>
</table>

Table 2.5 Approximate GDP and GVA per capita (2014)

One of the considerations, in reviewing and comparing regional data on energy and transport, is the prosperity of each region. We used the indicators of Gross Domestic Product (GDP) and Gross Value Added (GVA) (Table 2.5). GDP represents the total economic activity and is a key indicator of the state of the whole economy. Three theoretical approaches are used to estimate GDP: ‘production’, ‘income’ and ‘expenditure’. GVA measures the contribution to the economy of each individual producer, industry or sector. It is used in the estimation of Gross Domestic Product (GDP). When using the production or income approaches, the contribution to the economy of each industry or sector is measured using GVA.

2.4 Social mobility in the Atlantic Arc area

The School of Engineering in La Rochelle (EIGSI) commissioned a detailed study of the mobility patterns and potential for modal shift in 5 countries that line the Atlantic Arc (Ireland, Portugal, and the Atlantic coast of France, Spain and the UK). The overall purpose was to understand travel patterns, types of transport used and social attitudes towards using different, and new, forms of transport. The study was undertaken by the Bureau de Recherche during the period March - June 2015, using detailed questionnaires returned from 400 respondents in each country. The surveys examined demographic information using 8 profiles of social mobility relevant to non-urban zones, attitudes to transport and publicly-accessible transport in the respective regions. The survey focused on rural and semi-rural areas, deliberately excluding cities.

The final report was published in May 2015 (Godillon et al., 2015) which confirms that people living in rural areas cover significantly longer distances than their counterparts who live in urban areas. This has implications for the provision of public transport services and highlights the significance of the additional energy used by people in rural areas to satisfy their mobility needs. For instance in Poitou-Charentes, 50% of all energy consumed is for transport (Figure 2.2).

A more detailed commentary of the aim, methodology and results of the study is provided in Appendix 2.

Hyperlinks:

(a) http://knoema.com/atlas/Spain/Principado-de-Asturias/GDP-per-capita-Euros
(b) http://en.wikipedia.org/wiki/List_of_OECD_regions_by_GDP_(PPP)_per_capita
(c) www.pordata.pt
3. Regional mobility challenges and initiatives

3.1 Rural issues, community engagement and financial considerations

The REPUTE project was one of six transport projects funded by the Atlantic Area Programme 2007–13. All six projects shared themes of inter-modality and interoperability, smart ticketing and journey planning, and cooperation in public/private partnerships. We focus here on rural public transport and regional energy generation schemes. There are some general factors which affect all regions such as:

- People living in rural areas may travel up to 50% further than their city counterparts and a large proportion of their total mileage is made by car or bus
- Lack of integration of different modes of transport
- Lack of access to public transport hubs
- Lack of coherence of policy
- Lack of real-time information.

These similarities are the key issues in REPUTE. How can each of the regions in Atlantic Area learn from each other and keep up with the pace of development within larger, more populated regions? In Paris for example, while the ‘Autolib’ project will work in a large populace, it would struggle to work in one of the AA regions. How can the Atlantic Area regions develop their transport networks to keep pace, or even gain advantage with the larger more populated regions? Can such a project be emulated in the regions? We have piloted a smaller version in REPUTE, to see if it might work.

INTERREG projects like REPUTE are about territorial cohesion; innovation and partnership. INTERREG projects help to develop a critical mass to achieve objectives, which would otherwise be unachievable. That critical mass, together with the ‘triple helix’ approach of Academia, Public Sector and Private Sector capabilities also bring credibility to the outputs, and a voice which can be heard within local, regional and national policy-making bodies. REPUTE has been very fortunate to have a dynamic mix of triple helix organisations who will maintain an enduring partnership beyond the lifetime of the project.

Weighed against these challenges is the positive engagement and actions of local community schemes, together with innovative methods of funding new initiatives. A major piece of legislation that was enacted in the UK was the 2011 Localism Act. This Act provides more freedoms and flexibilities for local government, allowing decisions to be made that reflect local circumstances, and it gives more rights and powers for communities and individuals. Importantly, it diverts some of the central government funding into local funding schemes that can be accessed by established community groups. Community groups can work with their local authorities to provide new services such as access to publicly-accessible transport services.

Hyperlinks:

1 www.autolib.eu
2 http://services.parliament.uk/bills/2010-11/localism.html
3.2 Transport context

3.2.1 Overview

People who live in rural or isolated communities require a means of transport to access employment, education, training and healthcare. However, commercial operators often struggle to run passenger transport services in rural communities where demand is limited or diffuse. A UK Government report (HCC288, 2014) stated that in 2009 just 42% of households in the most rural areas had an accessible regular bus service, compared to 96% of urban households. Older people, younger people, unemployed people, people on low incomes and disabled people who live in rural communities rely on passenger transport and are disproportionately affected by inadequate or reduced services. Local authorities therefore subsidize passenger transport in rural communities according to local circumstances and priorities.

The UK Government regards the provision of transport in isolated and rural areas as a major concern that affects several Departments, because it affects the ability of individuals to access services such as education, training and healthcare (HCC288, 2014). The Government obtained evidence from many organizations, trade associations and government departments; these included Action with Communities in Rural England (ACRE). In Northern Ireland, Wales and Scotland, the respective devolved Administrations are primarily responsible for policy and funding decisions in relation to passenger transport. There are 38 rural Community Councils covering England and Wales which are registered charities and work closely with ACRE. The Wheels to Work scheme provides an affordable means of transport, such as mopeds, to enable young people to travel to work or college. The Wheels to Work schemes have also trialled electric mopeds and pedal-assisted electric bicycles (pedelecs) (Fig 3.1).

Figure 3.1 Wheels to work – pedelecs in action
3.2.2 Bus services

The bus is the only mode of passenger transport in many rural communities. In the UK the bus market outside London is deregulated, meaning that many different operators can apply to their local authority to provide a service. Whilst generally beneficial, this presents challenges in terms of seeking agreements to operate on a single ticket or smart mobility card.

The most beneficial outcome of new integrated transport schemes in rural areas would be the development of public transport hubs that are served by ‘local’ methods of getting to those hubs. This is outlined in Figure 3.2.

![Figure 3.2 Schematic of public transport hubs](image)

3.2.3 Community rail partnerships

Community Rail Partnerships (CRPs) are a cost-effective way to facilitate passenger transport in isolated communities, but their future viability may be threatened by a funding shortage. In the UK, the Association of Community Rail Partnerships works with the Association of Train Operating Companies to access local funding initiatives to develop and market niche services, and to disseminate best practice through the Department of Transport.

3.2.4 Community transport

‘Community transport’ describes passenger transport schemes owned and operated by local community groups. Some of these link with schemes run by local authorities where resources, such as minibuses, are not required all of the time. Community transport is provided on a not-for-profit basis and is run by volunteers. Community transport schemes serve people who do not have access to conventional public transport or who are unable to use it. Particular schemes may set their own conditions for who can be carried, according to local priorities.

The UK Department for Transport allocated 30 million Euro to a new fund in January 2015 to provide hundreds of new minibuses to community transport operators in rural areas. This new fund is to enable organizations, who already provide a service to the local community, to bid for new minibuses.
Community transport encompasses a range of transport services:

- Voluntary car schemes. An organised form of lift giving where volunteer drivers use their own cars to provide door to door journeys for people without transport. Passengers are charged a rate per mile for their journeys to cover drivers’ costs.

- Community bus services. Minibuses operated by volunteers serve regular routes to a published timetable. They are available to all members of the general public.

- Minibus hire. Vehicles owned by community groups are made available to other local organisations for low-cost hire. This service can be useful for a number of different purposes, including leisure, education and sport. Some vehicles are wheelchair accessible.

- Dial a ride. This service provides door-to-door journeys for people who are unable to use conventional public transport. Potential passengers need to register as members to use the service. Journey bookings are usually made in advance.
3.3 Examples of Rural Transport schemes and projects

3.3.1 Total transport

The UK Department for Transport (DfT) is currently recommending the concept of total transport, which has the potential to revolutionise transport provision in rural and isolated communities by making more efficient use of existing resources. Total transport involves integrating transport services that are currently commissioned by different central and local government agencies and provided by different operators. Such integrated services might deliver improved passenger transport in isolated communities by allocating existing resources more efficiently. That might entail, for example, combining conventional bus services with hospital transport. The DfT must work with local government to co-ordinate large-scale total transport pilot schemes in a range of urban and rural communities.

3.3.2 Ireland

An example of a rural transport scheme in Ireland is the Rural Transport Network\(^1\). The Rural Transport Network is a group of 35 Companies which together delivers the Rural Transport Programme (RTP) in Ireland. The aim of the Rural Transport Programme is to provide a nationwide community based public transport system in rural Ireland which responds to local needs. The Rural Transport companies delivered over 1.7 million passenger journeys in rural Ireland in 2012.

3.3.3 Northern Ireland

In Northern Ireland, the Rural Transport Fund (RTF)\(^2\) has funded the provision of Information on bus Services through this scheme\(^3\). Its primary objective is to support transport services designed to give people in rural areas improved access to work, education, healthcare, shopping and recreational activities and by so doing assists in reducing their social isolation.

The RTF offers support through two primary means of assistance: subsidy for new rural services provided by Translink which are economically unviable but socially necessary, and revenue and capital funding for Rural Community Transport Partnerships that offer a range of complementary services to the public transport network for their members.

The rural Department of Regional Development in Northern Ireland used to run a Rural Transport Fund Voucher Scheme\(^4\). Supported by the Rural Transport Fund, the scheme worked in partnership with private transport operators who will deliver the actual transport. This scheme was aimed at rural community groups and organisations wishing to transport 17 or more passengers. The scheme provided a 130 Euro voucher towards the cost of transport for successful applicants.

A Dial a lift scheme is available in Northern Ireland\(^5\), with a particular example\(^6\).

There are 11 rural community transport partnerships in Northern Ireland and there is an on-line tool, CT online, which allows the user to search for community transport providers in their area.

Hyperlinks:

1. http://ruraltransportnetwork.ie/
3. www.translink.co.uk/Services/Other-Translink-Services/The-Rural-Transport-Fund/
5. www.nidirect.gov.uk/dial-a-lift
6. www.laganvalleyruraltransport.co.uk/services
3.3.4 Spain

In Asturias the Transport Consortium of Asturias (CTA) and the city of Villaviciosa are developing the first generalized experience of using school transport services by users in general use, with the aim of providing personalized transport for neighbours of many areas that had previously lacked a suitable daily schedules with the capital of the municipality.

Travellers may use school buses with some restrictions:

- The students will always have their place reserved in the front area of the vehicle
- Other passengers will be accommodated in the free remaining seats.

3.3.5 England and Wales

Several small-scale total transport projects have been implemented in England. For example, Norfolk County Council and the East of England Ambulance Service have piloted an integrated transport project, a taxi-bus service has been trialed in Devon, and National Health Service transport has been integrated with local transport authority services in Greater Manchester. It is reported that a large-scale total transport scheme has been successfully implemented in the Netherlands (HC288, 2014).

Three Case Studies of community-run transport, in Wales, are described in Section 5.2.
3.4 Car clubs

Car clubs offer a number of benefits to local authorities including providing access to flexible transport for residents and reducing business travel costs for the organisation. They can offer mobility in areas served poorly by public transport.

A car club is a membership-based organisation that provides access to pay-as-you-drive cars and vans parked in clearly marked spaces in publicly-accessible locations. Members book by telephone or online in advance, and access the vehicles via a smartcard. The club covers all the costs of owning the vehicles, including insurance, tax, fuel, cleaning and maintenance. Members usually pay a small annual fee and an hourly, or daily, charge for hires plus a mileage charge to cover fuel and consumables.

The most common model of car club has vehicles owned by the club which are returned to their dedicated parking spot after the hire period has finished. The viability of a car club in small towns and cities can be underpinned by a major employer such as a local authority making use of the vehicles during the working day when the demand from private users is at its lowest. This can be achieved either by the local authority making its vehicles available for club members’ use in evenings and at weekends, and benefiting from a share of the income generated, or by a car club offering exclusive use of some vehicles to the local authority during the working day, potentially at a favourable hire rate.

3.4.1 Car clubs in Scottish towns and cities

Car clubs are now established in a range of Scottish towns and cities including Glasgow, Edinburgh, Aberdeen, Dundee and Dumfries. City Car Club has fleets in Edinburgh and Glasgow, and Common-wheels (Co-wheels) covers Aberdeen, Dundee, Dumfries and several smaller towns. There is also a range of community-led car clubs operating between 2 and 10 vehicles in range of rural and urban locations. In all cases, the strong support of the local authority was essential to giving the operator the confidence to invest in the town. The subsequent success, however, is due to the latent market demand that emerged once the car club was in operation. The cars are generally parked in town centres or at railway stations.

Independent support for help in developing car clubs in the UK is available from Car Plus. The City Car Club in Edinburgh has over 5,000 members and 143 cars, including 13 EVs.

Some case studies of community-run car clubs in Scotland are described in Section 5.2.

Hyperlinks:

3.5 Energy context

3.5.1. Overview

The Trans-European Network for Transport (TEN-T) guidelines recognise that alternative fuels serve, at least partly, as a substitute for fossil oil sources in the energy supply to transport, contribute to its decarbonisation and enhance the environmental performance of the transport sector (Directive 2014/94/EU on the deployment of alternative fuels infrastructure).

In 2008, renewable resources accounted for 11.9% and 3.6% of Ireland’s gross electrical and thermal energy production, respectively. Ireland is over 99% dependent on imported oil products to provide energy in the transportation sector. In 2010, the Irish government delivered the National Renewable Energy Action Plan (NREAP) to the EU which set indicative targets of 40%, 12% and 10% renewable energy share in gross energy production for electrical (RES-E), thermal (RES-H) and transport (RES-T) energy in Ireland by 2020, respectively. Goulding and Power (2013) undertook a study to demonstrate that full scale national development of 5% of the area under grass in Ireland could contribute 11.4% of renewable energy to the total final transport energy demand by 2020. Murphy et al (2013) argue that biomethane is a valuable potential transport fuel with an excellent resource. Typically it allows for conversion of waste to transport fuel (or transport heat or electricity), allows for storage of night time produced electricity and can be produced from soft or hard feed stocks. The resource can fuel 30% of the private transport fleet and allow Ireland to meet 40% RES-T. The target for 2020 is 10% RES-T.

Micro-hydro electricity generation is a fast growing industry with a variety of different turbines used for different flow conditions. Across Europe there are thousands of locks and weirs on rivers and canals where there are one or more areas of highly concentrated, fast flowing water; either through lock gates or channeled over weirs. The kinetic energy of this resource is, in nearly all cases, uncaptured as it continues to flow downstream afterwards. Therefore a potential opportunity for capturing this energy is presented.

3.5.2. Financing mechanisms and community renewable energy generation schemes

Crowd-funding

CITIZENERGY is the European crowd-funding platform for renewable energy. It is an online marketplace that brings together energy-aware citizens with renewable energy projects across Europe. CITIZENERGY lets individuals support and invest in renewable energy projects and share in the benefits of producing clean energy. CITIZENERGY projects function on a peer-to-peer basis, with investors browsing the available projects and choosing projects to invest and support. CITIZENERGY aims to give more people across Europe the opportunity to participate in the decentralised network of renewable energy and help shape Europe’s energy future. In its current and first version, CITIZENERGY directs citizens towards the three first crowdfunding platforms which exists in Europe: Lumo (France), Abundance (United-Kingdom), and Greencrowding (Germany). In its second and complete version (May 2015), the CITIZENERGY investment platform will directly match EU citizens with investment opportunities in renewable energy projects across Europe. The CITIZENERGY platform is expected to raise 14.6 million euros by 2017, representing 6,000 citizen investments from 10 European Member States.

CITIZENERGY is a joint project of ATEKNEA SOLUTIONS (ES, coordinator), BOA ENERGIA (PT), LUMO (FR), ABUNDANCE GENERATION (UK), GREEN CROWDING (DE), SOM ENERGIA (ES), WINDVOGEL (NL), EUROPEAN CROWDFUNDING NETWORK (BE), ACTIVE CITIZENSHIP NETWORK (IT), EURADA (BE), CLIMATE ALLIANCE (DE), UNITED NATIONS DEVELOPMENT PROGRAM (HR), EUPPORTUNITY (PT), UNIVERSIDADE DE SANTIAGO DE COMPOSTELA (ES). It is co-funded by the European Union and builds on know-how developed within the consortium to implement citizen renewable energy projects – from cooperatives to investment intermediaries – and provides them with a European dimension.
Local funding

Based in La Rochelle, Lumo is a French crowdfunding website which enables citizens to invest directly in renewable energy projects (wind, solar, hydro). Lumo is part of the 2015 new European website CITIZENERGY. On www.lumo-france.com, citizens can invest as little as €25 in a civic and sustainable project through bond purchase.

Lumo’s vision is that civic crowdinvesting has the potential to contribute to the energy transition financing while providing citizens with a new saving product which is both sustainable and low-risk. The low-risk of this investment is based on the feed-in-tariff guaranteed by EDF (the French Electricity Company) for 20 years.

Therefore, citizens can invest in a chosen renewable energy project alongside the bank and benefit from the same features as the bank loan (10 to 20 years maturity and a gross interest rate of 2 to 5% per annum). Once the installation generates clean electricity, it is sold to EDF through a long term contract. This revenue it produces pays back the citizen investor, with interests, over every year of its investment horizon. In France, Lumo is pioneer in offering RES crowdfunding through bond purchase.

Low Carbon Hub\(^1\) is an umbrella scheme for Oxfordshire that provides coordination for energy projects, and funding through public shares and income derived from the feed-in tariff raised through electricity generation from solar and hydro schemes.

Three Archimedes screw turbines will be installed on the river Thames at Sandford near Oxford at a cost of €650,000 in 2015. The turbines will produce 1,600 MWh of electricity per year, sufficient to meet the needs of 385 average houses whilst generating a monetary return of 200,000 €/year\(^2\). The return on investment would therefore be 3-4 years. Several other schemes for micro turbines have already been built or are planned for the River Thames, each of which include a fish pass.

Figure 3.3 Community hydro-electric energy generation in Oxfordshire

Hyperlinks:

1. [www.lowcarbonhub.org](http://www.lowcarbonhub.org)
2. [www.westernrenew.co.uk/wre/hydro_basics/financial](http://www.westernrenew.co.uk/wre/hydro_basics/financial)
Smart Hydro in Nigeria, a German company, introduced their flagship product to a community in Nigeria as part of a charity scheme. The SMART Monofloat is a hydrokinetic system that is designed to float in water and harvest energy using a spinning rotor within an outer shell, which channels water over the blades. The weight of one fully operational unit is 380kg and the turbine can produce up to 5kW depending on water speed. The design of the turbine makes it ideal for waters with heavy debris and the system is expandable so that multiple turbines can be fitted. The turbine is normally suspended using wires so that it can be raised or lowered as the water levels dictate. This turbine could easily be utilised at the areas of fast flowing water at weirs.

The Oxford Bus Company is the first Oxfordshire business to develop a renewables scheme with community benefit in partnership with the Low Carbon Hub. The 140kW solar PV scheme on the Bus Company roof generates 122,000kWh/year. It provides the company with low cost electricity, a fair return for investors and an income stream for the Low Carbon Hub to support and fund community energy projects across the City and County.

Integrated strategies for solar energy generation and car parking

PCER Poitou-Charentes Energies Renouvelables (PCER) is a cooperative for the development of renewable energy in Poitou-Charentes. PCER aims to accelerate the development of the regional production of renewable energy in communities, companies and associations, by bearing the development, funding, realisation and operation of projects. The collective interest enables the support of all stakeholders to collectively contribute to the sustainable development of the territory and promote a social and inclusive economy, in accordance with the priorities of the region.

PCER currently has 5 installations on roofs and 11 installations on parking canopy structures in service or under construction (Fig 3.5). A charging point for electric vehicles is built on each side of the canopy, managed by the owner of the site according to the characteristics of its users and its electro-mobility policy. Initial installations include car parks at sports centres, universities, businesses, retail, community technology centres and rural villages are listed.

Hyperlinks:

1 www.smart-hydro.de/en/
REGIONLIB is a local public company to promote and deploy car-sharing with electric vehicles in Poitou-Charentes (Fig 3.6). ‘Régionlib’ was created in 2012 and is now implemented in the agglomerations of Saintes, Niort and Châtellerault, in rural municipalities such as Sauzé Vaussais, in commercial areas, private companies and communities. Members also have access to a driverless vehicle for the journey of their choice and for a limited time period.

All electricity is derived from renewable energy: the certificates are called EQUILIBRE. The French low carbon rate per kWh permits an estimated tailpipe emission CO\textsubscript{2} rate of 20 to 25 g/km for an electric car with an average power, excluding the impact of manufacturing/end of life. This French performance is obviously due to its nuclear power plants. ‘Régionlib’ has mutually committed to EDF for an approach called ‘EQUILIBRE’ for 100 MWh whose certificates represent a warranty delivered by the third party organisation responsible for supplying electricity produced from plants using renewable non-fossil energy located in mainland France: wind energy, solar energy, aero-thermal, geothermal, hydrothermal, hydropower and ocean energy, biomass, landfill gas, gas from sewage treatment plants and biogas. (Article 2a, Directive 2009/28/EC and the Council of 23 April 2009).
4. Suggestions and directions

4.1 Modal shift

There are two fundamental kinds of change in human mobility: incremental change and revolutionary change. Throughout history, people made incremental improvements to their inherited technology and practices for moving people and goods. These improvements in land transport largely revolved around improving comfort, safety and efficiency. Revolutionary change means the more dramatic shift from prevailing to new mobility patterns. Transport revolutions can shape the whole of society. However, a new technology is not revolutionary until it results in a significant shift in the way people travel. Modal shift therefore implies that a large number of new trips are undertaken using a new mode of transport, such as an electric scooter, or there is a significant shift to a new mode (e.g. pedelecs) by a large number of people from an existing mode such as a car. Revolutions essentially cause a change in behaviour in response to many complex and inter-related factors.

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Table 4.1 Passenger travel by main mode in the UK in 2012 (Bayliss, 2014)

This modal shift is also demonstrated by the split shown in Table 4.2 for the EU.
### Modal Split of passenger Transport on land and by country 2010

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**Notes:** If powered two-wheelers are included, they account for 2.0% of the total in EU-27 (2.1% in EU-15, 2.0% in EU-12), while the share of the other modes becomes:

<table>
<thead>
<tr>
<th>Country</th>
<th>EU-27</th>
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<tr>
<td>BE</td>
<td>82.8</td>
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**Table 4.2 Modal split of land transport for the EU (Source: EU Transport in figures 2012. © European Union, 2012)**
4.2 Socio-technical transitions

Attitudes to transport and changes in behavior can take a very long time to develop. When such changes happen, many other processes are set in motion as well. There are cultural, social and political influences, in addition to mere technological changes. The theory of socio-technical transitions was first developed by Rip and Kemp (1998). Geels (2002) showed how changes can be promoted through the strategic management of different niches (see Figure 4.2). The basic framework in which the socio-technical transition theory operates for transport was applied in the EU Enevate Project¹.

The top, or landscape, level contains all of the overriding economic, ecological and cultural conditions; these include fuel sources, existing transport infrastructure and a desire to reduce carbon emissions. The middle, or existing regime, level represents how the landscape level is translated into transport systems. It includes the dominant transport providers, assumed practices, shared assumptions and rules within which transport is provided. It could, for example include choices over types of bus, powertrain, operational factors such as timetabling, and methods of ticketing. The bottom, or niche, level represents the small-scale local deployment of new technologies or business models. Many will fail and disappear, but some will prosper and develop. Niches may be specific technologies (eg improved energy storage systems), new energy sources (eg biogas), a new on-demand service for transport, different methods of purchasing mobility, and so on.

Innovation in publicly-accessible transport was at the core of the REPUTE project. We tried to identify niches in technology and business opportunities that could become part of the accepted regime, in response to changes in the overall landscape. In rural and semi-rural areas, many such niches are led by individuals and community groups. We have therefore separated many of our examples and suggestions into ‘community-led’ and ‘regionally-led’ schemes.

Figure 4.2 Multi level perspective for socio-technical transitions (Geels, 2002)

Hyperlinks:

¹ www.enevate.eu
4.3 Alternative and renewable energy

Renewable energy provided an estimated 19% of global final energy consumption in 2012, and continued to grow in 2013. Of this total share in 2012, modern renewables accounted for approximately 10%, with the remaining 9% coming from traditional biomass. Heat energy from modern renewable sources accounted for an estimated 4.2% of total final energy use; hydropower made up about 3.8%, and an estimated 2% was provided by power from wind, solar, geothermal, and biomass, as well as by biofuels (REN21, 2014).

The BATTERIE project has produced two briefing notes on ‘Alternative Fuels in the Transport Sector’ which are available to download from the website. The purpose of the BATTERIE project was to improve cooperation and links between various transport services with the Atlantic Area region and to promote the application of smart technologies and usage of alternative fuels. The briefing notes provide some background and update on the various fuels, along with safety and environmental aspects, and recommendations for policy makers.

4.3.1 Biofuels

The general term ‘biofuels’ is used to refer to those fuels that are produced out of ‘fresh’ biomass resources. The use of biofuels is generally regarded as resulting in lower net GHG emissions than conventional fuels, since at least part of the associated emissions are compensated for by the CO₂ that was previously absorbed during the biomass’ growth phase. Such offsetting is never total, though, since GHG are emitted throughout the so-called ‘life cycle’ of a biofuel, i.e. not only at its point of use (when it is burnt), but also when the energy crops are planted, irrigated, fertilized, harvested, transported, and processed. Additionally, there may be indirect GHG emissions arising from land use change (e.g. converting abandoned or unproductive land to arable land, etc.); the latter are difficult to quantify, but it has been argued that in some cases at least they may end up being quite large (Nature, 446 (2007), pp. 727-728).

A distinction is also to be made between ‘first generation’ and ‘second generation’ biofuels; the latter are also referred to as ‘advanced’ biofuels.

First generation biofuels are made from the sugars and vegetable oils found in arable crops, which can be easily extracted using conventional technology. Specifically, bioethanol is produced from plants such as maize, wheat, sugar beet and sugar cane, through a process of fermentation, distillation and dehydration. It can be used as a 5% blend with petrol in unmodified engines. Through the Fuel Quality Directive, EU regulations now permit blends of up to 10% bioethanol. Biodiesel is instead produced through a process known as transesterification, which separates glycerine from vegetable oil, leaving biodiesel as a product. Biodiesel can be used as a straight fuel, or blended with mineral diesel to create a diesel blend.

Despite having been initially touted as a quintessentially ‘green’ solution, and also having been given ample support by the EU, first-generation biofuels have since been shown to be affected by a number of serious issues, and the rationale behind their promotion has been seriously questioned (Critical Reviews in Plant Sciences, 20:1 (2001), pp. 71-106; Critical Reviews in Plant Sciences, 24:5 (2005), pp. 365-384; Energy Policy 36 (2008), pp. 1169–1180). Among the main drawbacks are:

1. Intrinsically low energy return on energy investment (EROI), meaning that when all direct and indirect energy demands for the cultivation, harvesting and processing of the fuel crops are considered, each unit of biofuel only provides marginally more energy to the end user than the energy that was required to produce it (Environment, Development and Sustainability, 13:1 (2011), pp. 179-202)

2. Huge land demand – it has been calculated, for instance, that just trying to reach the original target set by European Directive 2003/30/EC (i.e. 5.75% of the energy used for transport by 2010) in Italy would have required devoting the equivalent of about one third of the entire Italian agricultural land to earmarked fuel crops (Energy Policy 36 (2008), pp. 1169–1180)

3. Competition for land and resources with food crops production, with ensuing higher market prices for the latter


Hyperlinks:

1 http://batterie.eu.com
Second generation biofuels are currently being developed in an attempt to address at least some of the issues listed above. Second generation biofuels may be produced using a range of technologies such as via the ‘cellulosic ethanol’ route (converting lignocellulosic biomass to ethanol), the biomass-to-diesel route, the bio-synthetic gas route (whereby a syngas composed of CO, H₂ and CH₄ is produced by thermochemical gasification), and a range of advanced technologies still in the R&D phase, using algae and other microorganisms as biological precursors.

The second generation biofuel industry is still in its infancy, but it is rapidly expanding. Figure 4.3 highlights the main existing pilot production plants worldwide.²

All such ‘advanced’ biofuel production methods promise high land-use efficiency, avoided competition with food crops, and reduced fertilizer demand (thus reducing the associated life-cycle GHG emissions), and in this way provide an improvement vs. first generation biofuels as far as issues (2), (3) and (4) above are concerned. Their production chains are however invariably longer and more complex, which ultimately makes it harder to extract the required fuel. It therefore remains to be ascertained the extent to which their EROI may end up being high enough for them to be a viable alternative (issue (1) above).

4.3.2 Biofuels derived from waste

One particular class of second generation biofuels that appears to be promising, in terms of its benefits and comparative lack of drawbacks, is that of biofuels derived from waste biomass resources (such as spent oils, food waste, farm residues, etc.). If not converted into biofuels, such waste flows would in fact remain a missed opportunity, and instead represent a problem requiring appropriate treatment. CEWEP (Confederation of European Waste-to-Energy Plants) is the umbrella association of the owners and operators of Waste-to-Energy plants across Europe. Waste-to-Energy Plants (waste incineration with energy recovery) thermally treat household and similar waste that remains after waste prevention, reuse and recycling by generating energy from it¹. A key issue is the development of a refuelling infrastructure for transport applications.

Renewable energy in the transport sector is used in the form of liquid and gaseous biofuels, mainly for road vehicles, and in the form of electricity for trains, light railways, trams and EVs. Liquid biofuels, primarily ethanol and biodiesel, meet about 3% of global road transport demand. Gaseous biofuels (biomethane or biogas) meet

Hyperlinks:

¹ http://demoplants.bioenergy2020.eu
² www.cewep.eu
a much smaller demand for use in road transport, with significant uptake in Germany and Sweden. Electricity is commonly used for trains and city transit systems, and for buses, EVs, scooters and bicycles. Several German cities including Frankfurt and Nuremberg rely upon renewable electricity to light their railway and subway systems. Sweden is aiming for a fossil fuel-free vehicle fleet by 2030, with road vehicles powered by biofuels or electricity and a further promotion of walking and cycling.

Scottish company Celtic Renewables, a spin-out company from the Biofuel Research Centre (BfRC) at Edinburgh Napier University, introduced sustainable bio-butanol in February 2015. It has commercialized the production of bio-butanol from the production residues of the whisky industry in Scotland. The samples of bio-butanol are produced using a process called Acetone-Butanol-Ethanol (ABE) fermentation in partnership with Bio Base Europe Pilot Plant (BBEPP) in Belgium. It now hopes to reintroduce the process to Europe for the first time since the 1960s. The biofuel is produced from draff - the sugar-rich kernels of barley which are soaked in water to facilitate the fermentation process necessary for whisky production - and pot ale, the copper-containing yeasty liquid that is left over following distillation. Bio-butanol has 25% more energy per unit volume than bioethanol and it can be blended easily with conventional liquid fuels for use in vehicles. Celtic Renewables claim that the bio-butanol could replace 16% of all the fuel used on European roads.

The International Council on Clean Transportation (ICCT) claims that fuel made from waste from farms, forests, households, and industry could replace 16% of all the fuel used on European roads by 2030 (Malins et al, 2014). It is calculated that Europeans generate 900 million tonnes of waste paper, food, wood and plant material each year, about a quarter of which - about 220 million tonnes - is available for energy use. This would provide enough feedstock to produce fuel to displace 37 million tonnes of oil imports each year by 2030, creating an industry at full capacity could support up to 300,000 jobs and make significant greenhouse gas savings. Welfle et al (2014) argue that the UK could provide up to 44% of its energy needs from biomass sources including household waste, agricultural residues and home-grown biofuels, by 2050, without impacting food sources.

43% of all UK Methane emissions came from waste management in 2007. One tonne of bio-degradable waste releases between 200 m$^3$ – 400 m$^3$, which goes straight into the atmosphere and the UK produces 300 million/tonnes per year of waste. Anaerobic Digestion (AD) represents a technology for generating methane from household food waste. AD is the process of breaking down organic material in the absence of oxygen using micro–organisms. There are several commercial operations in the UK, including those run by Agrivert. Food waste, collected from houses and businesses, is transported to the AD plant. It is sorted, separated from all packaging materials and then fed into large digestors that are kept at temperatures normally around 60°C. The methane is drawn off and typically used to power electric turbines. The electricity is then fed into the grid, with up to 10% being used to power the anaerobic digestion facility. This concept reduces landfill significantly, it captures the greenhouse gases that would otherwise be emitted, and it provides energy.

A large new recycling, biogas and waste-to-energy plant will be built at Allerton in North Yorkshire, UK, in 2015 by AmeyCespa. It is scheduled to handle 320,000 tonnes of waste per year. In addition to materials recovery and recycling, it is scheduled to generate 203 GWh of electricity per year; this is sufficient to power over 40,000 households.

Organic Power Ltd., a UK company based in Somerset, has developed an energy production system that uses agricultural and food waste sources to generate biomethane. The technology transforms organic materials by combining aerobic and anaerobic digestion to create biogas which, in turn, can be compressed to provide CNG for use in transport. Organic Power has a CNG filling station next to their headquarters where vehicles, suitably converted, can run on this renewable biogas. A number of articles covering the use of biomethane in transport across many countries have been published in Fleets and Fuels.

Hyperlinks:

1. www.celtic-renewables.com
2. www.agrivert.co.uk/products-and-services/waste-solutions
4. www.organic-power.co.uk
5. www.fleetsandfuels.com
There is a clear opportunity for rural and agricultural regions to generate their own biomethane gas supplies using local energy production systems, located in agricultural regions or near food processing plant. The gas could be compressed, stored and used directly in transport applications. This provides fuel security, as well as indigenous sustainable renewable transport fuel production, associated employment and opportunities for innovative research and development.

Greenwatt\(^1\) is a low carbon UK consultancy encouraging and supporting renewable energy technologies, bio-energy, low carbon transport, and efficient waste and resource management. Greenwatt worked with the Royal Agricultural Society of England to produce a report in 2014 on the potential for farms to become engaged in the production and use of innovative low carbon transport technologies and fuels\(^2\), in addition to food production. The farm of the future could become the centre of the local community, supplying energy sourced from solar photovoltaic, wind or bioenergy produced on the farm. The ‘energy farm’ could also serve as a local rural vehicle refuelling station providing renewable fuels.

A commercial, and very public, demonstration of using biogas in transport can be found in the UK. The GENeco bio bus (Figure 4.4) runs between Bristol Airport and the City of Bath. This airport commuter route, uses human waste and food scraps. It fills up with biomethane which is produced at the Bristol Sewage Works at Avonmouth, which converts food waste and human sewage into biomethane by the anaerobic digestion route. The 40-seater bus has a range of 300 km (186 miles) on a full tank which is equivalent to the waste per year from five people. These buses produce approximately 30% less greenhouse gases than their diesel equivalents and improve the air quality in city centres. The biomethane is also purified to ensure there is no smell from any emissions. Similar pilots have been investigated in Norway, Sweden, Denmark and Canada. A case study is incorporated in Section 5.2.

Hyperlinks:

1. www.greenwatt.co.uk
2. www.greenwatt.co.uk/RefuellingtheCountryside-opportunitiesfor sustainableruraltransport.htm
3 current and 2 previous projects in the EU 7th Framework Programme address the use of biofuels in transport:

- **ALL-GAS (May 2011 – April 2016)**
  
  This project intends to demonstrate on large scale the sustainable production of bio-fuels based on low-cost microalgae cultures. The full chain of processes from algal ponds to biomass separation, processing for oil and other chemicals extraction, and downstream biofuel production, as well as the use in vehicles, will be implemented on a 10 ha site.

- **BIOFAT (May 2011 – April 2016)**
  
  BIOFAT is a microalgae-to-biofuel demonstration project with a farming area of 10-ha for microalgae cultivation and a target annual productivity of 100 tonnes per ha.

- **INTESUSAL (May 2011 – April 2015)**
  
  This project intends to demonstrate an optimised approach to generate biofuels from algae in a sustainable manner on an industrial scale. It will integrate prior high quality research which has been undertaken at national and international levels; both with public support and with private finance. The demonstration and associated dissemination activities undertaken in this work will help to enable increased security of energy supply for European transport needs and greater penetration of Renewable Energy Sources as part of the drive to meet the European Commission's 20:20:20 objectives.

- **OPTFUEL - Optimized fuels for sustainable transport in Europe (January 2009 – June 2012)**

  OPTFUEL undertook a first large scale demonstration of the Biomass to Liquid (BtL) production chain from biomass via gasification and fuel synthesis to the final fuel in the consumer car. The project was coordinated by Volkswagen with Renault, Ford and the Indian Institute of Technology, Delhi, among others.

- **BIODME - Production of dimethylether from biomass and utilisation as fuel for transport and for industrial use (September 2008 – August 2012)**

  The aim of the project was to demonstrate production of environmentally optimised synthetic biofuel from lignocellulosic biomass at industrial scale. The final output of this demonstration was dimethylether (DME), produced from black liquor through the production of clean synthesis gas and a final fuel synthesis step. In order to check technical standards, commercial possibilities and engine compatibilities, the bio-DME was tested in a fleet consisting of 14 Volvo trucks.

  Coordinated by VOLVO POWERTRAIN AB, Sweden.

The city of Lille has over 10 years’ commercial and technical experience of using biofuels in buses. By December 2014 there were 428 biogas buses fuelled by natural and/or purified biogas, produced from the fermentation of sludge from a local sewage treatment plant. The activity has included the provision of filling stations and modified bus depots. This represents a remarkable achievement that has demonstrated economic, environmental and technical feasibility on a large scale.

Hyperlinks:

4.3.3 Hydro-electric power

On a global basis, hydroelectric power delivers the largest proportion of truly renewable energy. The proportion is very significant in countries such as Canada, China, New Zealand and Norway. However in most countries it is generated in a national context as a supplement to the electricity grid to satisfy peaks in demand. Pumped storage systems use excess electricity to pump water up to a reservoir, then regenerate electricity when it’s required using turbines. Small-scale hydro generation was reviewed in Section 3.5 for the purpose of transport applications. A community scheme is also presented as a case study in Section 5.2.

4.3.4 Wind power

The Atlantic Area has the best wind resources in Europe, and offshore wind farms produce a higher power per unit area than onshore wind farms. However, offshore wind generation is undertaken only at large scale and requires significant investment. The electricity generated can provide a reasonable, albeit fluctuating, contribution to grid electricity that may then be used in electric transport applications.

4.3.5 Solar energy

Solar energy represents a market share of renewable energy of less than 5% currently, on a global basis, but it is rapidly-growing market. Solar energy has the potential to satisfy a large proportion of the world’s power requirements, particularly when concentrated using mirrors or lenses to focus sunlight. Photovoltaic (PV) systems can be contrived to maximise sunlight collection through mirrors and lenses, but PV systems exist mostly as flat panels. These panels can be integrated with the roofs and sides of buildings and structures. On a global basis, PV generation is growing very fast indeed. Energy may be used instantly but it is more common to store it until required. A direct link with transport is made when solar canopies are used to cover parking bays for pedelecs, scooters and electric cars (Figure 4.5). Example applications are reviewed in Section 3.5.

Figure 4.5 Solar canopy installation by Louritex, near Torres Vedras, Portugal
In order to directly supply EVs with low-carbon electricity to recharge their batteries, Princeton Satellite Systems in the USA has introduced the SunStation – a compact solar powered electric vehicle recharging station that can be set up at any location¹. The SunStation comes in two models, Single and Double, for single- and dual-vehicle charging. The Single model has eight 240W panels and 14 kWh of battery storage. The Double has fourteen 240 W panels and 28 kWh of battery storage. The station provides a steady stream of 240V of electric power, which can fully charge a Nissan Leaf in 8 hours, a Chevrolet Volt in four hours, and a Prius in just 1.5 hours. Unlike other solar powered recharging stations already developed, the SunStation does not have a connection with the electric grid, but it stores renewable energy in an underground high capacity Li-Ion battery, which helps recharge electric vehicles 24 hours a day.

A similar system is offered by Younicos AG in Germany, based on a biaxial photovoltaic generator with 12 large modules and a long-life vanadium redox flow battery serving as storage unit². One such unit is already in place in Berlin-Adlershof.

The shift from conventional mobility to electric mobility need not be restricted to cars, vans and other comparatively large and heavy vehicles (Figure 4.6). In fact, even larger benefits may be obtained if such shift is compounded by a gradual transition to lighter and more efficient means of transport, such as scooters and mopeds. For example, the number of electric scooters in China has grown exponentially over the last decade, and has now nearly matched that of conventional petrol units.

Figure 4.6 Shift in energy used in transport

Hyperlinks:

¹ [www.psatellite.com/SunStation/ev.php](http://www.psatellite.com/SunStation/ev.php)
² [www.younicos.com/download/Yana/solar_charging_mobility_Mobility_Adlershof_en.pdf](http://www.younicos.com/download/Yana/solar_charging_mobility_Mobility_Adlershof_en.pdf)
4.3.6 Hydrogen

The use of hydrogen gas as an alternative ‘clean’ transport fuel has been proposed as a way to drastically reduce local contamination as well as life-cycle GHG emissions. In vehicles, H\textsubscript{2} may either be used as direct fuel in ICEs or as one of the main reactants to produce electricity in on-board low-temperature Fuel Cells. However, in spite of having been on the horizon for almost two decades, and notwithstanding several proofs-of-concept (e.g. the ICE-powered BMW Hydrogen-7 in 1997, and the FC-powered Mercedes Benz B-class F-cell in 2009), the wide-spread adoption of H\textsubscript{2} as an automotive fuel has so far remained elusive. Among the main problems impeding its success are: how to efficiently produce the H\textsubscript{2} with low-carbon technologies (again, requiring ad-hoc renewable electricity for water electrolysis), and how to safely and mass-effectively store the H\textsubscript{2} on board.

A commercial-scale hydrogen refuelling station was launched at Honda’s manufacturing plant in Swindon in the UK. Solar energy is used to drive electrolysis, to produce hydrogen for fuel cell vehicles (Engineering & Technology, December 2014, p20). It is claimed that hydrogen fuel-cell cars can be refuelled in less than 5 minutes.

Two examples of Hydrogen Powered bus demonstrator projects have taken place in Northern Ireland \(^1\) \& \(^2\).

4.3.7 Energy-saving devices

There is a compelling requirement to reduce the amount of energy used in transport, irrespective of the type of energy used and its source. In addition to efficiency improvements in general engine and drivetrain components, a cost-effective solution using a kinetic energy recovery system (KERS) for buses was introduced in Oxford in 2014. KERS technology was developed originally for the Formula 1 industry. The energy usually lost to heat through braking is used to spin a flywheel. This short-term energy store is released directly into the drivetrain when the buses start off. This is the subject of a further case study in Section 5.1.

4.4 Accessible and intelligent transport of people and goods

The UK Department for Transport has introduced a range of transport initiatives. At a National level the Government Door-to-Door strategy (2013) presents a vision of an integrated, innovative and inclusive transport system. In essence, by improving the whole journey experience (information, ticketing, connectivity and facilities) more people will be able to use greener transport options. The organization, set up with a mixture of public/private funding to help realize this vision, is the UK Transport Systems Catapult. At a regional level, local authorities can access the Local Growth Fund and the Local Sustainable Transport Fund (LSTF) (2011-2015). LSTF has funded a variety of projects to address particular local transport problems. Information on these funds and initiatives is summarized in a two-weekly publication called Local Transport Today. This provides an overview of the total urban and regional UK transport scene for planners, policy-makers, traffic engineers, analysts, investors and managers. There is also a very useful linked website that hosts publications and resources\(^3\).


NISTO is a trans-national cooperation project from five countries funded by the EU in Interreg IVB NWE Programme. The object is to develop a ‘smart’ toolkit to evaluate mobility and transport concepts that include initiatives to enhance traffic flow, integration of different transport modes, improved environmental quality and reduced travel time.

Hyperlinks:

1 http://ec.europa.eu/research/environment/newsanddoc\_article\_3894\_en.htm
2 www.global-hydrogen-bus-platform.com/Home
3 www.transportXtra.com
By the year 2020, 80% of the French population will live in urban areas i.e. in an environment more and more complex, noisy and polluted. Partly funded by ADEME, the COLIS URBAINS project in La Rochelle aims to identify new urban logistics plans to tackle these issues. These improvements are focused on three main aims that underpin a Total Transport solution:

- **Organizational** - the project targets the exploitation of different transportation modes and to base this exploitation on a pooling strategy (goods / commodities) and on a mixing strategy (goods / passengers)

- **Technological** - the project gives priority to electric transport mode for access in the city centre

- **Informational** – the project proposes to develop a decision support tool dedicated to transport operators in order to help them to reduce negative impact on air quality.

In different projects dealing with urban freight transport, a single solution is defined and implemented. This cannot take into account the complexity of the urban environment and previous dimensions. COLIS URBAINS proposes a systematic framework to provide more solutions chosen for their sustainability. One example is that of the transport of freight in buses without affecting the users’ experience. These experiments will test new solutions and innovative solutions developed by Renault for buses. Redesign of bus interiors for different forms of occupation (passengers, bikes, freight) will enable better use of scheduled services.

There is a significant opportunity to employ buses to move freight around urban and suburban areas at off-peak times (Figure 4.7). The bus operating companies are obliged to provide scheduled services, whatever the passenger demand, so they could become delivery vehicles. This would require some interior re-design to provide flexible spaces for seats or cargo. The opportunity may be largest in urban areas, in conjunction with bus services connecting park and ride locations with city centres, allowing deliveries of purchased goods to pick-up points.

*Figure 4.7 Freight transport by bus*
4.4.1 Journey Planning and integrated ticketing

Many European projects have addressed smart ticketing, smart cards, journey planning and information displays.

The BATTERIE project\(^1\) developed a briefing note on ‘Smart technologies in the Transport Sector’ which is available to download from the website. The purpose of the BATTERIE project was to improve cooperation and links between various transport services with the Atlantic Area region and to promote the application of smart technologies and usage of alternative fuels. The briefing note focuses on technologies such as Intelligent Transportation Systems (ITS), and strategies for implementation of smart technologies, as well as making recommendations for policy makers.

A unique web-based journey planning tool\(^2\) for electric car journeys was developed in the BATTERIE project. The tool has been optimised for mobile use and it is being piloted in Ireland. Users can enter start point and destination information, and then receive suggested routes that account for charging points, charging time, energy cost, CO\(_2\) emissions and savings.

Pro.Motion Plus was a project funded under the Smarter Travel Projects Fund, and its partners were Tipperary Institute, Tipperary Energy Agency and Mendes Limited, assisted by North Tipperary LEADER Partnership\(^3\). The two main applications associated with Pro.Motion Plus were provision of local travel information and personal travel planning. The projects were undertaken and evaluated in the rural region of North Tipperary, and those who did participate in the process and activities implemented reported satisfaction with the services and found the information provided to be very interesting and useful. The project involved the development of an electronic and online cost and carbon calculator, and local area and personal travel planning in Cloughjordan, and training and local area and personal travel planning in selected communities in North Tipperary.

In France, there is no national journey planner for public transport, but 14 public transport authorities in Poitou-Charentes are partners of CommentJV, a regional journey planner which provides accurate data from all regional public transports operators. The system was launched in April 2013, and has been developed by Canal TP. The system provides information on all modes of transport and traffic disruptions, and works on a common platform, “Comment JV”\(^4\).

SYMOD is an example of a mobility policy coordinated between several transport authorities in Charente-Maritime, running for 14 years. The aims of SYMOD are: the establishment of a single ticket (Pass’Partout 17), the establishment of an intermodal SIV-traveller information system (route search engine, dynamic display), and coordination of transportation services (supply).

Hyperlinks:

1. http://batterie.eu.com
2. www.egomap.eu
3. www.mendes.ie/proj01.html
4. www.commentjv.poitou-charentes.fr site (or www.commentjv.mobi from a mobile device)
The unifying role of SYMOD allows the development of shared tools and ensures interoperability for public transport in Charente Maritime. An example is the successful ecotourism approach with “Pass’touristiques”, in partnership with Charente-Maritime Tourism and the Tourist Offices which gives daily or weekly transport for tourists, along with discounted entry to a tourist attraction. There have also been discussions initiated around tariff harmonization, passenger information and coordination of transport supply.

La Rochelle has developed a large range of public transport modes in its territory over the years. It has now launched Yélo, a network offer and pricing system which gives access to all modes of transport easier with one single smart card: buses/coaches, bike sharing, park-and-rides, boats, electric.
4.4.2 Cycling

The European Cycling Federation provides a platform for many organisations that aim to promote cycling and electric bikes as a means of transportation and leisure.1

Cycling accounts for 2% of all journeys in the UK, although there have been significant increases in trips by bicycle where local areas have invested in the provision of cycle routes and general promotion. This is most obvious in cities such as London. The UK Government’s Cycling Delivery Plan provides funding and sets out ambitious targets for improving cycling in selected major cities and national parks (DfT 2013). The Plan includes aspects of improvements to infrastructure and safety provision.

Cycle BOOM2 is a UK study to understand cycling among the older population and how this affects independence, health and wellbeing. The ultimate aim is to advise policy makers and practitioners how our environment and technologies can be designed to help people to continue to cycle in older age or to reconnect with cycling. The study focuses on four cities and their surrounding areas in the UK: Oxford, Reading, Bristol and Cardiff.

Many towns and cities across the world have cycle hire schemes, both public and private. Within the REPUTE project Belfast, La Rochelle, Oxford, and Torres Vedras have at least one major scheme. Vienna has a housing estate equipped with extra-large lifts to accommodate bicycles and deliberately limited space for car parking. New housing developments in Freiburg were constructed as virtually car-free zones; cycling and walking complete dominate transport (Buehler and Pucher (2011)). Indeed, residents who own a vehicle are required to pay a large annual charge to park it in a designated community car park. Zurich and La Rochelle have lent bicycles free of charge to residents and visitors since the early 1990’s.

Copenhagen in Denmark is developing a network of 28 super cycle highways to encourage a modal shift in the period 2012-2020. A large part of the initiative is to increase the capacity of the cycle routes to the city centre and to build dedicated bridges and subways for bicycles to allow an uninterrupted journey for riders (eg Fig 4.8). Similar schemes exist in The Netherlands where impressive bridge structures have been built (Figs 4.9 & 4.10).

Figure 4.8 Bicycle snake bridge in Copenhagen

Lille and Paris (Velib service) and Brussels (Villo service) involves flexible bicycle renting (bike sharing) through an electronic network. London’s self-service, bike-sharing scheme is primarily for short journeys.3 There are more than 10,000 bikes at over 700 docking stations situated every 300 to 500 metres in London.

Figure 4.9 Green connection bridge, Rotterdam, created for cyclists

Hyperlinks:
1 www.ecf.com
2 www.cycleboom.org
3 www.tfl.gov.uk/modes/cycling/barclays-cycle-hire
Gothenburg promoted cycle by doubling the number of cycle parking spaces from 7,000 to 14,000.

Lyon introduced a bike-sharing system and improved the infrastructure. Leipzig has a “Bike and Ride” system, in which bikes are used to connect to the public transport network and access for free is offered to the cyclist if the bicycle is parked in a bicycle parking space.

In Grand Poitiers, 600 pedelecs are available for long-term use and multiple-user sharing. A viaduct was constructed for buses, cyclists and pedestrians to enhance the use of public transport (Fig 4.11).

In La Rochelle, a separate bridge for pedestrians and cyclists has been constructed along the edge of an existing road bridge.
• **CIVITAS MIMOSA (2009-2013) Making Innovation in MObility and Sustainable Actions**

This project brought 5 cities together to develop sustainable mobility: Bologna (Italy), Funchal (Portugal), Gdansk (Poland), Tallinn (Estonia), and Utrecht (Netherlands). Cycle promotion saw a number of innovative aspects from cycling skills through bus&bike, cycle and accessory design and cycle loan schemes. Enabling Cycling Cities: Ingredients for Success contributes to the body of knowledge in cycling planning, providing a number of no-frills and evidence-based facts, inviting cities to take cycling even more seriously\(^1\&2\).

• **BiConde** is the bike hire scheme in Vila do Conde, Portugal. It started in June 2014 and is part of public policies of sustainable planning and includes promoting cycle lanes.

• **VELO-CITY Conferences (2013, 2015)**

A major, two-yearly, conference called VELO-CITY has now built up momentum. The first one was in Vienna, in June 2013, at which there were 250+ presentations. The second one took place in Nantes, in June 2015. Nantes lies at the crossroads of two EuroVelo routes, numbers 1 and 6. Nantes has pioneered many sustainable mobility schemes for over 10 years. These conferences capture all aspects of cycling and infrastructure, policy, commercial hire schemes and psychological aspects. The conferences include conventional cycling and motor-assisted cycling (using pedelecs).

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Hyperlinks:

1. [www.pas-port.info/cycling](http://www.pas-port.info/cycling)
2. [www.civitas-mimosa.eu](http://www.civitas-mimosa.eu)
4.4.3 Electric 2-wheel bicycles (pedelecs), 3 and 4 wheeled vehicles and scooters

An interesting range and variety of motorised 2-, 3- and 4-wheel small vehicles exist for business, commuting and leisure purposes (Figure 4.12). Most of these are powered by electric motors and may be ‘sit-in’ or sit-on’. These are defined as L-category vehicles in Europe. Within this category there are numerous sub-classifications. In the USA the electric 2- and 3-wheelers are also known as velomobiles (www.velomobiles.net). A detailed overview is provided by www.electric-bikes.com.

The main motivation for replacing larger vehicles with smaller vehicles, and electrically-assisted bicycles, is the reduced energy consumption in use. This is important even if a renewable energy source is used to power the vehicle because of the knock-on advantages of less energy storage, and so on. A simple comparison of the energy-in-use associated with different types of vehicle is shown in Table 4.3.

Includes commercial vehicles
m.i.r.o. ≤ 600Kg for L7e-CU

Figure 4.12 Examples of L-category vehicles (www.lowcvp.org.uk)
A pedelec is a bicycle with an electric motor that assists the rider once she/he pedals. The motor assistance has to stop at 25km/h and the power of the motor must not exceed 250 W. These vehicle types and their components, such as battery and power management, are defined in the European EPAC Standard EN 15194 (Comite Europeen de Normalisation (CEN) 2008).

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Pedelec</th>
<th>Scooter</th>
<th>Twike</th>
<th>Renault Twizy</th>
<th>Mitsubishi iMiEV</th>
<th>Nissan Leaf</th>
<th>Tesla S</th>
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<tr>
<td>Energy used (kWh/100 km)</td>
<td>0.5</td>
<td>3</td>
<td>5</td>
<td>8</td>
<td>20</td>
<td>25</td>
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Realistic in-use energy consumption measured on the vehicle. It excludes electricity grid generation.

Table 4.3 Energy consumption for different types of electric transport

A municipal pedelec scheme called BiciMAD is run by the City of Madrid. The scheme operates in 5 districts of Madrid (www.bicimad.com) and it comprises 1560 pedelecs and 123 charging/parking stations. Users are required to pay a registration fee (refundable) of 150 Euro by credit card and then top up their usage rates in steps of 10 Euro minimum, always by credit card. There are plans to run a club for BiciMAD members in the future.
GoBike was established in 2008 in Barcelona, motivated by the desire to provide a personal mobility solution suitable for travelling up hills\(^1\). The company aspires to be the leading provider of digital bike-sharing solutions. The GoBike operating system is fully integrated with GoBike bicycles, docking points, the Gobike Tablet PC interface, and the End-User Website & Mobile Web interface. Some of the city systems themselves seem to be distributed and operated by Yellowbike who offer a turnkey contract service\(^2\). GoBike has established substantial pedelec schemes in Barcelona, Spain, Copenhagen (Figure 4.13) and Fredericksberg, both in Denmark, Stavanger in Norway and Rotterdam in the Netherlands. By spring 2015 the system in Copenhagen was expected to reach 1,860 bikes, 100 docking stations, and 2,790 docking points.

MacBike is a pedelec scheme in Amsterdam that is operated through a network of seven shops, where hire is arranged on a spontaneous basis. There is no scheme membership fee but the correspondingly high daily fees (around 25 Euro for 24 hours) suggest that the scheme is not appropriate to regular users. Common Wheels is a company that specializes in hiring cars rather than bicycles (see Section 3.4.1). However, they operate a hire scheme in Inverness comprising 12 pedelecs. The hire charge for residents, of about 13 Euro for 24 hours, is half that for non-residents in order to encourage use by local people. There is no annual membership fee.

Hyperlinks:

1. [www.gobike.com](http://www.gobike.com)
2. [www.yellowbike.biz](http://www.yellowbike.biz)
„Go Pedelec!“ (2009-13) was an EU co-financed project within the Intelligent Energy Programme, carried out by four municipalities, three non-profit-organizations and three private companies. The common goal of these ten partners from Austria, Czech Republic, Germany, Hungary, Italy and the Netherlands was to raise awareness about pedelecs among citizens as well as among municipal decision makers. It was acknowledged that the intermodal usage of pedelecs, in particular in combination with public transport, was both the most immediate future challenge as well as the most promising opportunity in sustainable urban mobility. A wealth of experience and information is available in the final report.

PRO-E-BIKE (Promoting electrical bicycles and scooters for delivery of goods and passenger transport in urban areas) (June 2013 on). This project promotes clean and energy efficient vehicles, electric bicycles and electric scooters (E-bikes), for delivery of goods and passenger transport among private and public bodies such as delivery companies, public administration and citizens in European urban areas as an alternative to conventional fossil fuelled vehicles. PRO-E-BIKE aims for a change in behaviour of target groups in urban areas manifested in their decision to replace their conventionally fuelled vehicles with E-bikes. Pilots among target groups will not only help the project to achieve its objectives, but also to enable the demonstration of measurable effects in terms of CO₂ emission reduction and energy savings by inclusion of E-bikes in urban transport.

Overall PRO-E-BIKE hopes to shift urban delivery transport from fossil fuel delivery vehicles toward E-bike vehicles, both to reduce noise and pollution in urban areas and to reduce congestion, save energy and to create new market opportunities for local economy.

Pilot cities include Valencia (Spain), Genova (Italy), Heerhugowaard (Netherlands), Lisboa (Portugal), Moravske Toplice (Slovenia), Motala (Sweden), Torres Vedras (Portugal), Zadar (Croatia).

Hyperlinks:
1. www.gopedelec.eu/finalpublishablierreport
2. www.pro-e-bike.org/
3. www.pro-e-bike.org/v...
• **Inmod – electric mobility in the countryside**

(2012-14)

This innovative scheme was pioneered in Northern Germany. The concept was to link people who live in rural areas with a fast bus service to go between major centres of population. Individuals rode a pedelec, for a maximum of 15 minutes, from where they lived to bus pick-up points. The pick-up points were equipped with bike boxes where the bikes were stored securely. A single (express) electric bus travelled along main routes, picking up passengers at the limited number of bespoke pick-up points. 200 bike boxes were provided by the scheme. There was an Inmod smart card to provide the booking, management and back-office. The scheme was aimed at (i) residents in rural areas with occasional need for transport (ii) commuters (iii) tourists. A paper was presented at the VELO-CITY 2013 conference by the Hochschule, Wismar.

• **ELE.C.TRA (Electric City Transport)** (December 2013 to May 2016)

This project aims to promote a new urban mobility model by increasing the use of electric scooters in urban areas, through hiring for short durations (e.g. for one day) or rent (e.g. for six months). The objective is to achieve a modal share of 1% of daily trips (house-work/school) by 2020, equal to about 4,700 daily trips in urban areas with 1 million inhabitants. Electric scooter sharing will be piloted in 3 big cities (Genoa, Florence and Barcelona) where travel by scooter already accounts for 15% to 20% of the modal share. The pilot actions include a supply of about 100 electric scooters in each city with full infrastructure provision (signs, parking system, users services and facilities).

Solar parking canopies for pedelecs exist in several countries. Figs 4.15a and b show small installations in France.

Sanyo market and install solar-powered e-bike sheds, or solar parking lots. It is reported that these have been installed in Tokyo for Sanyo’s own Eneloop bicycles. The bikes can be charged directly or else the electricity generated is diverted to battery systems for power storage attached to these solar-powered sheds.

Hyperlinks:

1 www.inmod.de
2 www.electraproject.eu
3 www.cyclez.fr
4 www.fastcompany.com/1585081
Figure 4.15 Solar canopy charging for pedelecs (www.cyclez.fr)
4.4.4 Ticketing

Public transport in Switzerland is often held up as an example for others to follow. Factors for success include a truly nationwide coverage by public transport, punctuality, through-ticketing, a public mind-set geared towards public transport, value for money and customer-oriented offers. The transport system is partially subsidized by the government. Three types of travel card exist for users: a full-fare travelcard that entitles users to ‘free’ travel on the entire public transport network, a half-fare travelcard and a local network card. A unique operating system called Travel Direct entitles the user of a travelcard to use numerous transport companies in the course of a single journey.

Mobility Mixx is an all-in-one mobility card scheme in The Netherlands that is operated by a leasing firm called Leaseplan\(^1\). The scheme includes options to travel by train, bus, tram, metro, and car. Currently there are over 120,000 registered business users and the programme processes over 2 million trips per month. The concept could also be rolled out to include the general public.

In Belfast, Translink\(^2\) offers the following types of ticketing: daylink card provides unlimited travel on Metro network, MultiJourney Cards for Metro network, yLink 16-23 year olds get 1/3rd off, iLink for travel by both bus and train to destinations on a regular basis, Annual Commuter Travelcards for Ulsterbus and NI Railways, and TaxSmart scheme. Smartlink and iLink cards can be topped-up at Translink sales outlets and all 900 PayPoint outlets across Northern Ireland.

In Derry/Londonderry, Translink offers the following types of ticketing: mLink to purchase and display Rail tickets on mobile phone, iLink for travel by both bus and train to destinations on a regular basis, Annual Commuter Travelcards for Ulsterbus and NI Railways. iLink cards can be topped-up at Translink sales outlets and all 900 PayPoint outlets across Northern Ireland.

- **PLUSBUS (UK operators)**\(^3\)

This is a bus pass that is bought in conjunction with a train ticket, allowing unlimited bus and tram travel (on participating operators’ services) around the whole urban area of a town served by a railway. PLUSBUS can save time and money, simply making the whole series of journeys more convenient.

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4.4.5 Electric vehicles

The use of electric vehicles (EVs), both of the hybrid type and of the fully battery-electric type, offers potential benefits in terms of both reduced GHGs emissions, and reduced tailpipe emissions of a range of hazardous compounds such as NOx, VOC, PM, etc. The EVs’ advantage in terms of GHG emissions depends entirely on the mix of technologies used to produce the electricity that is fed to recharge the vehicles’ batteries. In simple terms, the key requirement for achieving the desired GHG emission reductions is the supply of low-carbon electricity (i.e. electricity largely produced by renewable technologies such as wind, PV, geothermal, tidal, etc., and/or by nuclear power plants). Failing this, the replacement of conventional internal combustion engine (ICE) vehicles with EVs often results in little more that impact shifting (i.e. the same, or sometimes even higher GHG emissions are produced, but the emissions happen upstream along the electricity supply chain, rather than at the vehicle’s tailpipe).

Electric buses feature in many towns and cities across Europe, generally as small-scale pilots. Battery electric buses are best suited to relatively low duty cycles and short distances because of the mass of the battery energy store, and the charging times. This pattern typically lends itself to urban use. There are two interesting variations on this concept that reduce the size of the on-board battery energy store, and therefore lower the investment cost for each bus, increase the passenger payload and reduce the charging times. Both single-decker and double-decker buses may be considered. One case, known as opportunity charging, involves conductive charging using a roof-mounted pick-up system for DC-fast charging. A charger, conductor pole and pantograph are required (Fig.4.16).

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Hyperlinks:

1. [www.mobilitymixx.nl](http://www.mobilitymixx.nl)
2. [www.translink.co.uk](http://www.translink.co.uk)
3. [www.plusbus.info](http://www.plusbus.info)
4. [www.fastcompany.com/1585081](http://www.fastcompany.com/1585081)
The high level energy transfer, of up to 500kW, minimises both charging time and charging stop frequency. The Clean City Alliance website (www.cleancityalliance.com) provides case study information on demonstrations in Europe that began in 2014 for Helmond (the Netherlands), Munster (Germany) and Gothenburg (Sweden) (Fig. 4.17).
The second case for opportunity charging arises with electric buses that can be charged wirelessly (by magnetic induction), either when stopped for short periods at bus stops or when on the move (dynamic induction charging). In the latter case, the bus would need to travel over coils buried in the road surface. A case study is provided in Section 5.2.

A further opportunity arises with hybrid diesel-electric buses because their batteries could be charged when on the move, allowing greater use of electric-only power. This could then allow hybrid buses to serve more rural areas, provided that the route included areas where induction was available.


This EU FP7 project aims to be “the main EU activity to extend the fully-electric solution to the core part of the urban bus network”. It has a budget of 22.5m Euro and has 40 partners, coordinated by UITP. The project includes trials of plug-in and wirelessly-charged buses in 9 different cities (Barcelona, Bonn, Cagliari, Munster, Paris, Plzen, Ranstadt, Stockholm and Varsovie).

The commonly-held view that electric cars are better suited to towns and cities is challenged by Newman et al (2014). The clear benefits for town/city use of course include zero tailpipe emissions, quietness and access to charging points. However, the authors hold that EVs are expensive to buy and are therefore maximized when large distances are travelled. They make the economic case that EVs are, in fact, better suited to rural use because greater distances are generally covered. (In the UK, the RAC Foundation report that rural drivers cover 50% more distance than urban drivers). It is also more likely that suburban and rural households will have parking areas and garages where domestic recharging can be undertaken routinely. This economic maxim holds true for almost any new technology where there is a price premium at introduction.

The EU ENEVATE project explored the potential of e-mobility in rural areas by conducting social research and gathering information from various studies. The pilot schemes confirmed that e-mobility could be used to meet local demands and achieve sustainable mobility (ENEVATE2.0 Final Report, 2014).

Electric freight highways have been introduced in the USA and in Holland. The trial at Carson near the port of Los Angeles involves trucks powered by overhead cables, over a 3km-long e-highway. The trial around Rotterdam in Holland uses battery-electric trucks to transport market vegetables, from large-scale commercial greenhouses to the port for onward shipping, around a 25km loop. Grid energy is used at the moment with an input of renewables.

### 4.5 Financial considerations

The introduction of any new scheme or new technology comes with a cost. The payback period for new technologies such as more efficient internal combustion engines, EVs, Kinetic Energy Recovery Systems, and so on depends upon the use pattern. In simple terms, the payback is faster if larger distances are covered – and this suits the rural transport context.

One possible area of focus that would assist in changing hearts and minds would be an exposition of the economic and financial case for investments. These decisions, as noted by Wrightbus (REPUTE workshop, Cookstown, October 2014), are made on financial grounds (for commercial PT operations), and also on economic grounds (for subvented PT operations). At a European level, where projects are supported by European grant funding or EIB loans, decisions are informed by the outputs of cost benefit analyses (as set out in the EU’s Guide to Cost Benefit Analysis of Investment Projects2.

Educating decision makers on the benefits of such investments (i.e. that such investments are worthwhile), and providing sector specific guidance to practitioners on the approach to be pursued in undertaking such appraisals (including a quantification of the benefits by renewable / sustainable investment type would be valuable.

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1. [http://zeeus.eu/](http://zeeus.eu/)
5. Case studies of good practice

A great deal of information exists globally about sustainable urban mobility. This is because the majority of transport problems appear in centres of population where there is a large movement of people and goods. Congestion and air quality are the key issues for which many solutions have been identified and, to varying degrees, implemented. One of the most valuable reports to catalogue the challenges and solutions, The Future of Urban Mobility 2.0, was published by the consultancy Arthur D Little in 2014 (Little (2014)).

Challenges in more rural communities tend to be associated with remoteness, distances to be travelled, limited access to public transport hubs, and the cost of travel. Funding for public transport is far more limited than in urban areas on a per capita basis. Integration of transport modes and access to real-time information represent significant issues. However, there are valuable lessons to be learnt from the experiences of urban communities where regional strategies and intelligent transport systems have been developed. The European Sustainable Urban Mobility Plans (SUMPs) and polycentric plans (poly-SUMPs) provide useful methodologies for planning (see Section 1.1). European poly-SUMP pilot regions currently include: Alentejo, Portugal; March, Italy; Central Macedonia, Greece; Parkstad Limburg, The Netherlands; the Heart of Slovenia, Slovenia, and; Rhine Alp, Austria.

Most pilots and schemes have been set up with some finance from public bodies (central government, regional government, national parks, etc) but some have been initiated by local communities with no or limited help. This latter category is interesting because it demonstrates how the niche level of socio-technical transition can happen (Section 4.2).

5.1 Within the partners’ regions

<table>
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<tr>
<th>Case study</th>
<th>City or niche/community</th>
<th>Intermodal mobility</th>
<th>Intelligent transport systems</th>
<th>Buses</th>
<th>Bicycles and pedelecs</th>
<th>Taxis</th>
<th>Local delivery</th>
<th>Autonomous vehicles</th>
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Agostinhas bike sharing scheme, Torres Vedras, Portugal

This scheme has been in operation since June 2013. 290 public bicycles, 30 of which are electric, and 11 bike stations are distributed throughout the city of Torres Vedras. Additionally, parking is available in another 27 locations distributed among the most frequented locations, near the main areas of commerce and services in the city.

“Agostinhas” are available every day of the week between 8h and 20h to anyone 14 years or older and for a maximum time of 4 hours of continuous use; after these four hours, the bicycle must be returned to any bike station. The use of the bicycle depends on prior registration for membership that is carried out by filling in an appropriate form. Additionally, a payment of 10 € / year for insurance is required. Currently the total number of registered users is 1231. The system averages 1300 uses per month.

The system is unique and innovative in Portugal. With a charge time of 3 to 4 hours, the electric bikes are charged directly when placed in the docking station. The electric bicycles are powered by renewable energy. In case of grid power failure, photovoltaic cells supply energy to the system.

The initiative’s main benefits are: a significant reduction of pollutant gases in urban areas, reduction in noise levels in the city, the freeing up of public space for other uses, as well as the promotion of intermodality between various urban transport modes.

Hyperlinks:

1 [www.agostinhas-tvedras.pt/](http://www.agostinhas-tvedras.pt/)
Smart card ticketing for bus journeys, Asturias region, Spain

A smart card/ticket was introduced for journeys made within the Asturias region. This is an integrated single ticket service. However, there is only one commercial operator which makes it very efficient.

Smart card ticketing for bus and rail travel in Belfast, Northern Ireland

iLink is an integrated smartcard which provides unlimited day, weekly or monthly bus and rail travel within 5 specified zones across Northern Ireland. Zones 1 and 2 comprise inner and outer Belfast. If travel is made by bus and train within specified zones, using iLink could be better value for money than buying separate bus and train tickets.

CityMobil2: Autonomous electric vehicle demonstration in La Rochelle, France

CityMobil2 is co-funded by the European Union in the Seventh Framework Programme for Research (FP7)1. CityMobil2 represents a new step towards collective, clean and integrated transport in a fully urban context.

A large-scale demonstration of automated collective transport with fleet of driverless electric shuttles started in autumn 2014. The innovative vehicle is called Eleonora, from Robosoft.

La Rochelle has already held automated vehicle demonstrations in 2008 and 2011. Building on these demonstrations, the town wished to have a more ambitious trial. To set up a truly automated transport system, running from the train station to the university passing by the Old Harbour, which is a substantially longer route than the one demonstrated in 2011.

La Rochelle has always been a laboratory and has shown itself capable of adapting to environmental changes. Public acceptability of electric delivery vehicles in the town centre as well as electric car-sharing schemes have helped bring down barriers and opened up new ways of moving around the town.

EIGSI, the Engineering School in La Rochelle, is responsible for implementation of the demonstration and the evaluation of the project.

Hyperlinks:

1 www.citymobil2.eu/en/
Oxford: Integrated transport solutions

Congestion and air quality represent the chief concerns for the city of Oxford. The deregulation of buses allowed several operators to flourish, resulting in congestion and poor air quality.

Oxford City Council plans to spend €450,000 on the maintenance and expansion of cycleways 2012-2016, together with bicycles available at Park and Ride locations (Fig 5.3).

The closure of the central Westgate car park, with the loss of 800 out of 2,000 existing car parking spaces, has prompted a UK Government-funded collaborative project with the 2 universities (Oxford University and Oxford Brookes University), Oxfordshire County Council, and a number of SMEs in a partnership called MobOx1 (Mobility Oxford). This has analysed data from park and rides and travel patterns, and has proposed a number of solutions, which are summarised in Fig. 5.4:

- Creation of retail hubs at park and rides
- Park and rides to become multi-modal hubs where commuters can change transport modes
- Integrated ticketing to encourage use of alternative modes of transport
- Dynamic signage and information with journey planning and pricing
- More flexible bus interiors to accommodate push chairs and wheel chairs
- Shopping delivery to park and rides
- Electric bike and trike schemes for personal transport and last-mile delivery

Hyperlinks:

1 www.mobilityoxford.com
To reduce emissions, and improve bus fuel efficiency, a number of KERS buses are now operating in the City.

Figure 5.4 MobOx solutions proposed in response to closure of the city centre Westgate car park

Figure 5.5 Bus fitted with a Kinetic Energy Recovery System in Oxford
5.2 Outside the partners’ regions

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<th>Case study</th>
<th>City or niche/community</th>
<th>Intermodal mobility</th>
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Table 5.2 Overview of case studies – outside partners’ regions
Talybont Energy Zero Carbon Car Share Scheme, South Wales

Talybont Energy has run a community zero carbon car share scheme since 2011 (www.talybontenergy.co.uk). It serves Talybont, a small village in rural Powys, with less than 300 households and a population of 743, for whom personal transport was said to account for 40% of their carbon footprint.

Talybont on Usk Energy Ltd owns and manages a community hydro scheme in the Brecon Beacons National Park. The revenue of about 30,000 Euros / year, which is sold to a ‘green’ energy company, is used to pay for the vehicles. The project has the two environmental aims of replacing fossil fuel miles with zero carbon miles, and encouraging less cars on the road through car sharing.

Talybont Energy runs two vehicles, one electric van using electricity generated by solar panels (attached to a community building roof), and one car powered by bio-diesel (recycled vegetable oil). The vehicles have names, thus giving them a personality which is said to have encouraged locals to embrace the idea and accept the automobiles as part of their community. There are currently about 12 members using the vehicles.

Cilgwyn Community Group EV Club, South West Wales

This became the first electric car club in Wales in early 2013. The project is centred around a small rural community in Pembrokeshire. The Group leases 2 EVs (Nissan Leaf). They currently have around 15 members and receive over 50 bookings per month.

Project start-up was funded by 30,000 Euros awarded from the Big Lottery Fund’s Village SOS programme. Income is generated from membership fees and mileage charges which are re-invested in the scheme.

The Group works with the St David’s Eco City Group to promote the installation of charge points in the region.

Hyperlinks:

1 http://bigblogwales.org.uk/2013/03/19/all-systems-go-for-first-electric-car-club-in-wales/
Eco Travel Network EV Rental, Brecon Beacons National Park, South Wales

Introduced in 2012, the Eco Travel Network\(^1\) runs an electric vehicle rental and charging network for tourists to the Brecon Beacons national park. In addition to reducing the carbon footprint of visitors, the project seeks to promote the environmental and social benefits of electric vehicles. They are attempting to position the Brecon Beacons as an eco-tourism destination.

The scheme uses seven electric vehicles (Renault Twizys), with 40 charging points installed throughout the national park. These have been introduced in partnership with local tourism businesses with charge points located at establishments such as B&Bs, pubs and shops. The Renault Twizys (Quadricyles) were selected over cars to be more fun for the holiday experience and as a conscious choice to represent a non-car experience.

The Eco Travel Network is run as a not-for-profit organization. They obtained a 30,000 Euro Start up Grant from the Brecon Beacons National Park Sustainable Development Fund. This was used to cover set up costs and to subsidize the first set of vehicles. All further costs were covered by members such as hotels in the scheme.

---

Hyperlinks:

\(^1\) [www.ecotravelnetwork.co.uk](http://www.ecotravelnetwork.co.uk)
GENeco bio bus, Bristol-Bath, UK

This bus, introduced into the Bath-Bristol Airport commuter route, uses human waste and food scraps. The bus, dubbed the ‘poo bus’ or ‘the number 2’, is the first of its kind in the UK and it fills up with biomethane which is produced at the Bristol Sewage Works at Avonmouth, which converts food waste and human sewage into biomethane by the anaerobic digestion route.\(^1\)

The 40-seater bus has a range of 300 km (186 miles) on a full tank which is equivalent to the waste per year from five people. These buses produce approximately 30% less greenhouse gases than their diesel equivalents and improve the air quality in city centres. The biomethane is also purified to ensure there is no smell from any emissions. Similar pilots have been investigated in Norway, Sweden, Denmark and Canada.

Figure 5.9 GENeco biobus, Bath to Bristol

Bristol’s sewage treatment works handles around 75 million cubic metres of sewage and 35,000 tonnes of food waste every year, and is capable of producing 17 million cubic meters of gas a year, enough to power 8,300 homes.

Wirelessly-charged electric buses in Milton Keynes, UK

Milton Keynes was created as a ‘new town’ in the 1960s. The population of the town is growing fast because of its excellent connections by rail and road to London, and to many other UK towns. The head-quarters of many large organizations are based in Milton Keynes, including the UK Transport Systems Catapult. The roads were built on an American-style grid system. It is not therefore typical of many European towns and cities but it does provide a useful proving ground for innovations in low carbon transport, such as trials of autonomous vehicles (The Lutz Project).

A fleet of eight, single-decker, wirelessly-charged electric buses was introduced in January 2014 for a 5-year pilot. The purpose of the project is to compare the performance of these electric buses with their diesel counterparts in a real operational environment. The trial is a free market collaboration led by eFleet Integrated Services, an enabling company set up by Mitsui & Co Europe and Arup, an engineering design and consultancy company. The unique feature of this trial is that the buses are able to recharge their batteries wirelessly.

Figure 5.10 Wirelessly-charged electric bus in Milton Keynes

Hyperlinks:

1. [www.geneco.uk.com](http://www.geneco.uk.com)
wirelessly during the day, known as opportunity charging, allowing the buses to operate continuously and carry the equivalent passenger loading of a diesel bus. The batteries are charged when power is transferred from primary coils buried in the road surface, picked up by secondary coils underneath the buses. It is claimed that ten minutes parked over a coil will provide enough energy for two thirds of the bus’s route. The induction power technology supplier is Conductix-Wampfler and the buses were manufactured by Wrightbus Ltd.

The Number 7 bus route chosen for the trial is relatively flat. It currently transports 775,000 passengers per year over a total of 720,000km. This initiative aims to remove 500 tonnes of tailpipe CO₂ emissions per year, plus 45 tonnes of other emissions, and could reduce operational costs by about 15,000 Euro per year.

**Case Study 6**

**Community-led car share in Scotland: Common-Wheels**

Dumfries is the southern gateway to the Dumfries and Galloway area in the south west of Scotland. The town itself has a population of around 32,000 and is the administrative, commercial and shopping centre for a large hinterland. The Common-wheels car club based there has 6 vehicles provided by Dumfries and Galloway Council and an EV funded by the Developing Car Clubs in Scotland (DCCS) Programme in 2014. A part-time Development Officer focuses on marketing the club and ensuring that the cars are kept in good order. Since the launch of the Common-wheels car club in 2013, the club has 80 individual and 110 corporate members.

Common-wheels East Lothian is established in the towns of Dunbar, an historic fishing town now with a considerable working population commuting to Edinburgh via train, and the country market town of Haddington which has no rail link. Both towns have a population of around 8,000. The club expanded to the neighbouring town of North Berwick at the end of 2014. A board of volunteer directors opted to run the club as a franchise of the national Co-wheels car club with a supporters group for each location. There are 125 members and 9 cars including 3 EVs.

Many other projects and pilots exist that span small-scale specific initiatives, such as:

- the Lutz Project: Autonomous electric vehicle demonstration in Milton Keynes, UK
- activities in Baden-Wuerttemberg, southern Germany, and in the state capital Stuttgart
- bus, cycle hire, car-sharing, driver information and journey planning in London
- public transport initiatives in Cork, Ireland (www.drive4zero.ie).
5.3 Introduction to REPUTE pilot projects

5.3.1 Portuguese Pilot - renewable energy for publicly-available electric cars

This pilot made small electric vehicles available for public use in each of the twelve municipalities of Portugal’s Oeste region. The pilot began in March 2015 in the town of Arruda dos Vinhos, in the hills north of Lisbon. The electric cars, Renault Twizys, are located in specially designated parking spots close to the bus stations in each of the towns, and they are available for public use (Figure 5.13). The key to this demonstration is that the electric vehicle charging stations are powered by solar panels, from Bright Solar, thereby exploiting renewable energy in transport. Tourists coming in to the towns for short visits or locals in need of a car can reserve the vehicles online\(^1\) and pick up a key at the local tourist office. The online registration system was designed by ZEEV, a local leader in electric vehicles, who also provide the rented electric cars. It represents a true collaboration between private enterprise and publicly funded organisations. Over 800 users had covered 5000 km by mid-June 2015.

![Figure 5.13 Renault Twizy in pilot project](image)

Hyperlinks:

\(^1\) [www.mobilidadeoeste.pt](http://www.mobilidadeoeste.pt)
5.3.2 Scottish Pilot (1) - information signs powered by renewable energy

REPUTE has rolled out two pilot tests of market stimulation in Scotland, in partnership with HITRANS\(^1\), the regional transport agency for the Highlands and Islands of Scotland.

The first of these is a test of two transport information signs, powered by renewable energy, to be located on poles at existing bus stops; one in Aviemore, Burnside Bus Stop, and one in Carrbridge, Bus Turning Circle. The signs will be installed by Nexus Alpha\(^2\).

5.3.2 Scottish Pilot (2) - personal travel planning (PTP)

The second pilot is a personal travel planning project being run by JMP in association with HITRANS. The project will see PTP take place in key locations within Fort William and the surrounding communities of Caol, Corpach and Banavie, including schools and workplaces. An important element will be selected PTP taking place on a ‘door to door’ basis within key sections community which are likely to achieve the best change in modal share for active travel.

One key element of this project will be to develop a toolkit for the PTP exercise, so that it can be delivered in other project areas within the REPUTE project, and also within other locations in the HITRANS region.

Hyperlinks:
\(^1\) www.hitrans.org.uk
\(^2\) www.nexusalpha.co.uk
Sustainable transport requires a radical shift in investment towards providing fast and efficient public transport systems. However people in rural areas typically travel 50% further than their counterparts in urban areas and most of these journeys are undertaken by bus or car.

It is not economically viable to serve diffuse rural communities with a regular public transport network. New business models are therefore required to provide total transport solutions. A number of imaginative schemes exist that connect to rural public transport hubs through community-run schemes, shared ownership of transport resources and bespoke on-demand services. It has been shown that the key drivers for change include community engagement, fund-raising at a local level, local energy initiatives and policies. The introduction of cost-effective, energy-saving, technologies is also significant.

The main conclusions are that:

- Rural public transport hubs need to be built and connected by express services to major destinations
- Total transport solutions are required for rural communities where pooling of resources and voluntary actions can provide a service
- Total transport hubs could be accessed by, and could provide shared transport means for, users of shared transport options (minibuses, e-bikes, etc) including community-run schemes
- Many rural public transport services generate a lot of greenhouse gas emissions when under-utilized
- Electrically-powered vehicles can provide a compelling way of reducing emissions, provided that they use low-carbon electricity
- Future transport will have to use more energy derived from natural resources – solar, wind, tidal, hydro, biomass, etc.
- There is a compelling case for rural transport to use biofuels derived from waste biomass resources such as spent oils, food waste and farm residues
- Renewable energy sources can be owned, operated and controlled in rural areas through community actions and local partnerships. The energy generated can be used directly or indirectly in local transport
- Financing mechanisms such as crowd-funding and local share schemes can integrate community energy initiatives with transport solutions, providing a strong sense of local involvement
- Community actions in rural areas have the potential to provide local total transport solutions through a combination of public and private transport enterprises
- Pilot schemes and trials can be an effective means of bringing about behaviour shifts, and hence introducing new technologies and new modes of transport.
REFERENCES


BIBLIOGRAPHY


### Appendix 1 Regional information

Data for primary urban agglomerations

#### Table A1.1 General data

<table>
<thead>
<tr>
<th>Primary urban Agglomeration</th>
<th>Population density (citizens/km²)</th>
<th>Vehicle ownership density</th>
<th>Road density (km/km²)</th>
<th>Cycle lane density (km/km²)</th>
</tr>
</thead>
<tbody>
<tr>
<td>France Poitou-Charentes</td>
<td>La Rochelle 2390</td>
<td>0.50</td>
<td>30.6</td>
<td>3.6</td>
</tr>
<tr>
<td>Ireland Whole Country</td>
<td>Limerick 1608</td>
<td>0.46</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Portugal Oeste</td>
<td>Lisbon 1457</td>
<td>0.58</td>
<td>0.3</td>
<td>0.9</td>
</tr>
<tr>
<td>Spain Asturias</td>
<td>Oviedo 1206</td>
<td>0.55</td>
<td>0.4</td>
<td>-</td>
</tr>
<tr>
<td>UK Northern Ireland</td>
<td>Belfast 3425</td>
<td>0.50</td>
<td>10.7</td>
<td>1.0</td>
</tr>
<tr>
<td>UK Scotland - Highlands</td>
<td>Inverness 2820</td>
<td>0.60</td>
<td>13.5</td>
<td>1.1</td>
</tr>
<tr>
<td>UK Oxfordshire</td>
<td>Oxford 3290</td>
<td>0.57</td>
<td>1.8</td>
<td>-</td>
</tr>
</tbody>
</table>

1 REPUTE Partner and Stakeholder questionnaire, April 2014.
### Table A.2 Air Quality

<table>
<thead>
<tr>
<th>Primary urban Agglomeration</th>
<th>CO₂ (tonnes/person)</th>
<th>NO₂ (μg/m³)</th>
<th>PM10 (μg/m³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Poitou-Charentes</td>
<td>La Rochelle</td>
<td>-</td>
<td>21</td>
</tr>
<tr>
<td>Whole Country</td>
<td>Limerick</td>
<td>-</td>
<td>22</td>
</tr>
<tr>
<td>Oeste</td>
<td>Lisbon</td>
<td>3.6</td>
<td>35</td>
</tr>
<tr>
<td>Asturias</td>
<td>Oviedo</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Northern Ireland</td>
<td>Belfast</td>
<td>1.2</td>
<td>41</td>
</tr>
<tr>
<td>Scotland - Highlands</td>
<td>Inverness</td>
<td>2.6</td>
<td>12</td>
</tr>
<tr>
<td>Oxfordshire</td>
<td>Oxford</td>
<td>2.8</td>
<td>45</td>
</tr>
</tbody>
</table>
Appendix 2 Atlantic Arc mobility study

Over 60 million people live in the Atlantic area, defined in Figure A2.1, with a third of that number in the UK. The results of the study of the travel patterns of people living in this area are based upon an on-line survey conducted by the Bureau de Recherché (6t) for the School of Engineering in La Rochelle (Godillon et al, 2015). The purpose was to construct socio-mobility types in order to understand the travel patterns of the inhabitants of the Atlantic Area regions, excluding the large towns. The study sought to understand how these inhabitants currently travel, how they view the travel options available in these sparsely populated areas, and to better understand how the provision of transport and the actual demand interact.

The infographic presented in Figure A2.2 provides a powerful overview of the results of the entire study.

Figure A2.1 The Atlantic Arc area (http://atlanticarea.ccdr-n.pt/)
What modes of transportation do households in each country* have access to?

What are the most commonly used modes of transportation?

Are users multi-modal?

How do people get to work or school?

What do people think about public transport vs. cars?

Is the quality of public transport equal for all territories?
Overview

The socio-travel types were identified from an on-line survey of 2,016 people, aged over 18 years, in 5 countries. The methodology for classifying a typology of regions included a detailed consideration of population density. The report sets out the results of the analysis of this database and is structured in 3 sections:

- Household transport equipment and provision of transport in the territories studied (privately owned car(s), own bicycles(s), public transport subscription, proximity to the provision of public transport, etc)
- Modes of transport habits and practices
- Presentation of the different socio-mobility types and comparison according to individual and socio-demographic characteristics and to residential location.

Socio-mobility types

8 characteristic types of people were identified from the results of the survey, as shown in Table A2.1. The research adopted a novel approach that looked at times, prices, use preferences and travel habits in relation to the different modes of transport. In simple terms, the socio-types distinguish between inhabitants according to:

- Modal habits, by drawing a distinction between inhabitants who are mono-modal, using one mode of transport only, and multi-modal, using several modes (even sporadically)
- Values towards travel, depending on whether they view modes of transport collectively or individually
- Attitudes, such as whether they view the various modes of transport favourably, unfavourably, or are neutral.

<table>
<thead>
<tr>
<th>Socio-travel types</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convinced exclusive car users</td>
<td>They only use cars in their daily lives; their activities are structured around the accessibility offered by this transportation mode.</td>
</tr>
<tr>
<td>Open-minded exclusive car users</td>
<td>The only difference with <strong>convinced exclusive car users</strong> is that they have a positive image of public transport and are open to its use.</td>
</tr>
<tr>
<td>Exclusive users of alternative modes</td>
<td>They never use the car. Their mobility is structured around the accessibility offered by public transport, cycling and / or walking.</td>
</tr>
<tr>
<td>Civic ecologists</td>
<td>They prefer the use of environmentally friendly transportation to be consistent with their beliefs.</td>
</tr>
<tr>
<td>Time comparators</td>
<td>They use the fastest transportation mode; they know the possibilities of both public transport and cars, and they choose on a case-by-case basis.</td>
</tr>
<tr>
<td>Car drivers who have to use public transport</td>
<td>They prefer to use the car rather than public transport but, mainly because of parking or congestion, they are sometimes forced to use public transport.</td>
</tr>
<tr>
<td>Predisposed towards alternative modes</td>
<td>They prefer to use public transport, cycling or walking instead of driving, given the possibilities offered by these transportation modes.</td>
</tr>
<tr>
<td>Stay close to home</td>
<td>They do not like to move by means of motorised transport and stay (or would like to stay) close to home.</td>
</tr>
</tbody>
</table>

Table A2.1 Socio-travel types
Main findings

The results show that households are highly motorised, and they travel predominantly by private car. The majority of working people use their car every day. Having a garage at home, and parking facilities at work, increases the high use of private cars. Access to public transport is highly dependent on the type of region inhabited: the urban regions of the UK, Portugal and Spain have the best provision of public transport. The bus network is the service used in three-quarters of cases, and is used daily. Public transport services are used by students in particular.

- A high proportion of open-minded exclusive car users in France linked to a strong attachment to cars
- Predisposed towards alternative modes among Irish people, linked to an average age that is lower than in other countries
- Time comparators among Spanish people, who seek to travel using the mode of transport that is the most suited to their needs in terms of costs, comfort and travel time
- Exclusive users of alternative modes and those who stay close to home (10%) in the UK, which is explained by a lower rate of motorisation and more expensive travel costs.

The distribution of eight socio-types for the inhabitants of the regions of the Atlantic Area shows that there is a strong predisposition towards using modes of transport other than the car even if the use of public transport remains sporadic in territorial contexts where public transport provision is poor. The youngest are more favourably inclined towards alternative modes of transport. The strong attachment to cars in France reinforces the representation of open-minded exclusive car users while the lower rate of motorisation in the UK explains the greater proportion of exclusive users of alternative modes.
Participants in the REPUTE project

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