AMBITION, VISION & ROADMAP
SMART PUBLIC TRANSPORT ISTANBUL

D6.4 Final city report
The R4E project received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 649397.

Disclaimer: This report presents the views of the authors, and do not necessarily reflect the official European Commission’s view on the subject.

Abstract
This report (D6.4) is the final deliverable of the R4E project and contains all relevant project results for smart mobility / smart public transport in the city of Istanbul.
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WP7. Project management

WP1. Ambition setting
- Ambition workshops: 3-day workshop in each city to define specific ambitions per focus area

WP2. Vision development
- Scenario workshops: 3-day workshop in each city to develop specific desired future scenarios per focus area

WP3, 4, 5. Roadmapping
- Roadmapping interviews: 2-day training session for expert partners on methodology and way of working
- Desk study: analysis of the available information on the selected topics for the roadmaps and to identify relevant experts

WP6. Project portfolio
- Current projects: each city identifies projects that have running that will contribute to the realization of the roadmaps, as well as the topics for cross-city learning
- New projects: each city identifies the desired new projects to ensure the timely realization of the roadmap ambition
- Organizing for learning: current projects, costs, identifying learning objectives

WP8. Communication & dissemination

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 649397.
**R4E - ROADMAPS FOR ENERGY**

**Introduction**

In the Roadmaps for Energy (R4E) project, the partners work together to develop a new energy strategy, their Energy Roadmap. The difference between the regular energy strategies and action plans and these new Energy Roadmaps is the much earlier and more developed involvement of local stakeholders. These include not only those who benefit from the new strategy, such as the citizens themselves, but also relevant research and industry partners. They offer a much clearer view of the future potential of the city in terms of measures and technologies, as well as of the challenges presented by today’s situations in the cities. The result is a shared vision, containing the desired, city-specific scenarios and the dedicated roadmaps embedded in each city’s specific context. These roadmaps take into account the diversity in the geographies, ecologies, climates, societies and cultures of the eight partner cities in the project: Eindhoven, Forlì, Istanbul, Newcastle, Murcia, Palermo, Sant Cugat and Tallinn.

The R4E project focuses on the vision creation and roadmapping capabilities of the individual municipalities. This includes initiating joint activities to drive the development and implementation of innovative energy solutions in cities. In this way, the R4E partners learn the process and the roadmap structure. At the same time they gain the skills they need to work independently on their future roadmaps.

The ultimate result is a process that allows the partners to work together in developing the Energy Roadmap to achieve their ‘Smart Cities’ ambition. Since energy and Smart Cities are too broad to cover in a single project, R4E focuses on three key areas of sustainable energy.

These are closely linked to the main responsibilities of the municipalities:

- **Smart Buildings**
- **Smart Mobility**
- **Smart Urban Spaces**

The three focus areas of R4E

**Approach**

The R4E project follows a 4-step approach:

1. The FIRST step sets the ambitions for the project. The ambitions of the participating cities on sustainable energy and Smart Cities in general are set, as well as the partner cities’ choice of two (out of three) focus areas within Smart Energy Savings: Smart Buildings, Smart Mobility or Smart Urban Spaces.

2. The SECOND step is to develop desired city scenarios for the selected focus areas.

3. In the THIRD step, the roadmap is created. This involves identifying existing and future technologies and other developments that will enable the desired future scenarios. The opportunities and developments are plotted on a timeline to show the route and milestones towards the favoured scenarios. The roadmaps contain common parts for all the partner cities, as well as specific parts for the individual cities.

4. In the FOURTH and final step, a project portfolio is generated with new projects and initiatives to reach the ambitions, visions and roadmaps of the cities. This portfolio provides an overview of individual and joint projects, and includes cross-city learning and financial plans.

The approach is characterised by four main elements:

- Backwards planning – the project starts with the development of a shared vision as a starting point for the creation of a well developed path to achieve it.
- Inclusive workshops in the cities – a cooperative process to engage key stakeholders (companies, citizens, public and private organisations and knowledge institutes) within the region in co-creating a clear and well designed implementation plan with a stronger commitment to the joint effort in the realisation phase.
- Expert knowledge is sourced in a practical and usable form during the vision development and roadmapping.
- A visual language is used to easily connect people and share main insights.

**The R4E partner cities**

**Eindhoven**
- Gemeente Eindhoven, the Netherlands
- Population: 220,000
- Area: 90 km²

**Forlì**
- Comune di Forlì, Italy
- Population: 120,000
- Area: 228 km²

**Istanbul**
- Istanbul Metropolitan Municipality, Turkey
- Population: 14,100,000
- Area: 1,830 km²

**Newcastle**
- Newcastle City Council, United Kingdom
- Population: 282,000
- Area: 114 km²

**Murcia**
- Ayuntamiento de Murcia, Spain
- Population: 885,000
- Area: 160 km²

**Palermo**
- Comune di Palermo, Italy
- Population: 86,000
- Area: 50 km²

**Sant Cugat**
- Ajuntament de Sant Cugat del Vallès, Spain
- Population: 885,000
- Area: 114 km²

**Tallinn**
- Tallinna Keskkonnaamet, Estonia
- Population: 430,000
- Area: 160 km²

**Four step approach of R4E**

**The eight partner cities of R4E**
Ambition Setting

The aim of Step 1 is to set the ambitions for the project. An ambition expresses what a city wants to achieve in the future. For this purpose the ambitions of the participating cities on sustainable energy in general are defined and refined in a process of co-creation, using existing policy documents as a basis for workshops with the individual cities. Each city selects two focus areas for which specific city ambitions are defined.

Today’s reality

During the kick-off meeting the cities present the current status of their energy policy in general and their selected focus areas in particular. This chapter starts with a summary of this information.

Ambition Workshops

The strategic ambitions for energy-related themes in general and for the selected focus areas in particular are assessed in a series of workshops in each of the partner cities. The Ambition Workshops consists of 3-day visits to the individual cities, during which several workshops with policy-makers and stakeholders are held to gain a deep understanding of the ambitions and specific contexts of the cities. Through the networks in the cities the local stakeholders (companies, citizens, public and private organisations and knowledge institutes) are invited to participate in the workshops. Together, the participants interactively contribute to the strategic ambitions. See also the pictures of the workshops on the previous page. The results of the Ambition Workshops are reported in similar formats for each of the cities to enable cross learning between the cities.

Joint Ambition Workshop

In a joint meeting in Palermo, the cities shared their ambitions and held in-depth discussions to understand the common and specific aspects of their ambitions. The main aim of the Joint Ambition Workshop is to enable cross-city learning. In this way, the cities gain a deeper understanding of the Ambition Setting process, and can improve their own ambition with inspiration from others.

The Joint Ambition Workshop is a 1-day workshop that finalises the activities of Step 1 and prepares for Step 2.

Programme of the Ambition Workshops in the cities

Day 1
- Interview with policy makers
- Workshop with strategy department

Day 2
- Workshop with stakeholders focus area 1
- Workshop with stakeholders focus area 2

Day 3
- Project team working session to establish scope
- Preparing main content of concept report

Programme of the Joint Ambition Workshop

Morning
- Presentation of the cities ambitions
  - Each city presents their ambition for the focus areas

Afternoon
- Understanding the Drivers for Change
  - Exploring the relevance of the focus area and selection of drivers for scenario workshops

Finalising Step 1
- Learning from each other’s ambitions
  - In-depth discussion on common and specific ambitions

Preparing for Step 2
- Presentation of the Drivers for Change
  - Sharing of results of Future Telling research
Introduction to Istanbul

Introduction to the city

Istanbul is like a state on its own. With a population of almost 14 million, it is larger than 23 European countries. The metropolitan area falling under the responsibility of the Metropolitan Municipality is 5,389 km², extending for 165 km from east to west, with a north–south distance of 45 km.

For centuries, Istanbul has always had a very strategic position along the historical Silk Road and naval routes between the Mediterranean and the Black Sea. This strategic location has helped the city to develop a cosmopolitan population.

Istanbul is the largest city in Turkey. The officially registered population is 13.8 million as of 2014, which is about 18% of Turkey’s population. This means one in five Turkish citizens live in Istanbul. Istanbul is also the third-largest metropolitan area in Europe, after London and Moscow.

Istanbul Metropolitan Municipality has a massive budget, which is larger than those of 18 of the 29 Turkish ministries. The consolidated budget generally increases by 7.7% each year, and for 2013 it was around USD 12 billion. Of this figure, USD 8 billion is the investment budget, and around half of this budget is dedicated to transport.

So far, the municipality has succeeded in solving all its problems for the foreseeable future. Thanks to the recent excavations in Marmaray which had repercussions in many circles, we now know that the city’s history goes back to the Neolithic Age. It has a history of eight thousand five hundred years.

There are 2.5 million vehicles throughout the metropolitan area and 1.8 million of these circulate on the roads every day.

The transportation network length has witnessed a sharp increase since 2004, and the transport sector looks likely to dominate the city’s budget, and around half of this budget is dedicated to transport.

A car ownership per 1,000 residents is 133 automobiles, which is growing as more and more people are better off in Turkey. This figure is a bit higher than Turkey’s average (which is 96/1,000) but still quite low when compared to other OECD countries such as USA (812/1,000), Italy (656/1,000), Japan (599/1,000) France (576/1,000), Spain (564/1,000) Germany (548/1,000), UK (515/1,000) figures for the year 2002. But here we should note that the figure was only 67 in the year 2000, so it is almost doubled in every decade.

So, this is the time to solve this traffic problem, and past experience as well as the case of huge metropolitan cities show that, no matter how large and long are the roads you build, you’ll not be able to solve the traffic congestion problem, unless you create a backbone transport network which is based on railways. That’s why the Municipality’s strategy is to build high-capacity lines throughout the city and promise people guaranteed trip durations from one location to another.

Istanbul is the city of massive projects: The most famous one is probably Marmaray, known as the «project of the century».

This high-capacity rail transport project consists of the construction of an underwater rail tunnel under the Bosphorus strait as well as the modernization of suburban rail lines along the Sea of Marmara and the modernization of the suburban rail lines along the Sea of Marmara from Halkali to Golyazi on the Asian side. The procurement of new rolling stock for suburban passenger traffic is also part of the project.

Construction started in 2004, with an initial target opening date of April 2009. After multiple delays, the projected starting revenue services in October 2013, and so far it’s doing quite well, carrying about 150 thousand riders per day. However, Marmaray will have its real meaning when its overground section is opened in late 2015.

The Eurasia Tunnel Project, The Istanbul Strait Road Crossing Project will be constructed between Kazlicesme and Goztepe districts along a 14.6-km route including a 5.4-km twin-deck tunnel that will cross the Bosphorus beneath the seabed, with the aim to ease the city’s traffic pressure.

The Third Bosphorus Bridge is a planned suspension bridge located at the northern end of the Bosphorus, north of the other two bridges, in Istanbul. The tender was held in May 2013, and the bridge will be completed by the summer of 2015. It will have a total of 8 motor lanes, plus 2 tracks for high speed rail.

The 3rd Airport: The new airport will be built in a build-operate-transfer model and the winning bidder would have operating rights of the airport for 25 years. The new airport would have a total passenger capacity of 150 million per year. Once completed in 2017, it’s going to be the biggest on earth with 6 runways.

Istanbul Canal is the name of the artificial sea-level waterway, which is proposed to be built by the government on the European side of the city. The new waterway would bypass the current Bosphorus. Istanbul Canal aims to minimise vessel traffic in the Istanbul Strait.
Statistical figures about transportation in Istanbul in general are as follows: The road system currently accounts for about 84 percent of overall transport in Istanbul. This includes the elements of private cars, IETT public buses, privately-owned public buses, the BRT system, minibuses, taxis and company buses.

The share of rail-based transportation is about 13 percent, which was only 8 percent just a few years ago. All urban rail operators in Istanbul are public, and are performed by TCDD (i.e. the state railways) as the suburban commuter line, IETT (predominantly the bus operator but also provides railway transport in two historical, short-distance lines) and Istanbul Ulaşım, which is affiliate company of Istanbul Metropolitan Municipality. Last but not least, Istanbul has also waterborne transport mode by almost 3.3 percent, which comprises the private operators IDO and private boats, and the public operator Sehir Hatları (i.e. City Lines).

In line with Istanbul’s Transport Master Plan designed in 2007, the future vision of the Municipality consists in changing the balance in favor of the second one—increasing the share of rail-based modes up to more than 50 percent, in order to have a sustainable, liveable city.

Under normal circumstances, we have a 10 percent increase in the ridership every year. However, in extraordinary years when we open a new line, this figure could be higher, which was the case in 2013 with the opening of M3 and M4 lines.

Throughout the year 2013, we carried a total of more than 402 million passengers.

For the entire transport system of Istanbul, we have an integrated smart ticket called IstanbulCard. The card was developed and put into practice by Belbim which is the information technology company of the Istanbul Metropolitan Municipality. This is the last-generation ticketing system based on RFID technology. It’s valid for all transport modes within the city and allows you transfer opportunity of five consecutive times within two hours. Plus, for the second, third, fourth and fifth validations you have discount, i.e. pay more or less half of the original price.

IstanbulCard was introduced on March 2009 and since then it has been doing quite well, even winning the most prestigious European award in the field.

Currently, our IstanbulCard usage ratio is about 92 percent, while the remaining 8 percent represents the token usage—for single journeys within our network we use plastic RFID tokens.
Istanbul Metropolitan Municipality (IMM)

Istanbul is one of the world’s fastest-growing megacities, both with 14 million population and its strategic location. 27% of national GDP, 60% of Turkish trade and 40% of national tax revenues come from Istanbul. Besides being at the heart of the Turkish economy, Istanbul has many universities which make the city attractive for thousands of students from all over Turkey. Istanbul is located at the intersection of Asia, Europe and Africa, which makes it an international trade hub. In addition, thanks to its good accessibility from countries all over the world countries, many international organizations and exhibitions take place each year in Istanbul. As a result, there is a growing demand for all types of facilities in Istanbul especially for transportation.

The Istanbul Metropolitan Municipality:
- Serves as the municipal government centre for Turkey’s thriving transcontinental hub
- Carries out local administrative tasks in Istanbul
- Provides public services for a population of around 14 million

Has 25 municipal enterprises, 2 subsidiary public utility corporations and a total of 43,500 employees.

Mobility and Transportation

Istanbul Metropolitan Municipality (IMM) allocates considerable amount of budget for transportation and effective traffic management projects every year. Even if new transportation facilities and projects are introduced, it doesn’t satisfy the mobility needs of inhabitants. For this reason, IMM supports the projects which will help manage traffic effectively and optimize the use of transport network and deliver a sustainable environment for next generations. Within the scope of IMM’s strategic plans, IMM gives importance to smart management and energy efficiency topics for its new projects and deployments in Istanbul.

Goals by near future

Istanbul has defined a number of goals, as shown in the images to the right.

Istanbul has selected two focus areas for the R4E project:

- Smart public transport
- Smart traffic management
Demographical aspects

Number of inhabitants
Total: 14,377,018
Men: 7,221,158
Women: 7,155,860

Graph: Age structure of the population
Source: Turkish Statistical Institute

Graph: Population trends
Source: Turkish Statistical Institute

Social aspects

Table: Level of education of citizens

<table>
<thead>
<tr>
<th>Educational Year</th>
<th>Primary Education</th>
<th>Secondary Education</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Not schooling (%)</td>
<td>Not schooling (%)</td>
</tr>
<tr>
<td>2007-2008</td>
<td>9.14</td>
<td>11.87</td>
</tr>
<tr>
<td>2008-2009</td>
<td>9.26</td>
<td>12.87</td>
</tr>
<tr>
<td>2009-2010</td>
<td>9.34</td>
<td>12.18</td>
</tr>
<tr>
<td>2010-2011</td>
<td>9.28</td>
<td>12.93</td>
</tr>
<tr>
<td>2011-2012</td>
<td>9.40</td>
<td>12.11</td>
</tr>
<tr>
<td>2012-2013</td>
<td>9.36</td>
<td>12.77</td>
</tr>
<tr>
<td>2013-2014</td>
<td>9.37</td>
<td>13.54</td>
</tr>
<tr>
<td>2014-2015</td>
<td>9.40</td>
<td>13.52</td>
</tr>
<tr>
<td>2015-2016</td>
<td>9.17</td>
<td>13.95</td>
</tr>
<tr>
<td>2016-2017</td>
<td>9.41</td>
<td>13.07</td>
</tr>
<tr>
<td>2017-2018</td>
<td>9.80</td>
<td>13.01</td>
</tr>
<tr>
<td>2018-2019</td>
<td>9.87</td>
<td>13.87</td>
</tr>
</tbody>
</table>

Table: Connectivity level: penetration grade of smart phones, percentage of houses with broadband 1
Source: Turkish Statistical Institute

Table: Unemployment rate

Year | Province Name | Unemployment rate (%) |
-----|---------------|-----------------------|
2013 | Istanbul      | 11.2                  |
2012 | Istanbul      | 11.3                  |
2011 | Istanbul      | 11.8                  |

There are 670,756 disabled people in Istanbul which means around 3% of population.

Table: Percentage of people that require special care/needs
Source: Istanbul Family and Social Policies Provincial Directorate

Economical aspects

Income per head in comparison to the national average income: Average yearly income per family in Turkey in 2013: 29,479 TL
Source: Turkish Statistical Institute

The most strong industry, business, transportation, advertisement and financial entities are located in Istanbul. 40% of national income is obtained from industry, 30% of it is obtained from business and the rest of it is available from other sectors. The part of agriculture is only 1%. Istanbul composes the main source of Turkish budget. Approximately 37% of total taxes are collected from Istanbul. Other sectors are agriculture and stockbreeding, fishery industry, forestry, mining, transportation, highway, railway, seaway, airline and Bosphorus.
Source: IME

Business sector has 27% share, transport and communication sector has 15% share and industry employment has 20% share in local economy.
Factors Affecting Climate

- Mathematical position
- Geographical Formations (Level, direction of mountains, aspects)
- Position according to sea
- Direction of wind
- Centre pressure

Climate conditions

Projects implemented by the Istanbul Metropolitan Municipality (IMM) to improve air quality and to reduce GHG emissions:

1) To minimize the rate of solid waste going to landfill providing maximum material recovery by mechanical and biological treatment of municipal solid waste with high organic content and to reduce 171,000 tons of CO2-e/year GHG emissions generating alternative fuel (solid recovered fuel - SRF).
2) To reduce GHG emissions through waste transfer stations used for transfer of waste from garbage trucks into silos and semi-trailers of bigger volume for onward transportation to landfill. Usage of transfer stations lowers amount of GHG emissions by reducing traffic towards landfill.
3) CO2 reduction from heat and power (CHP) generation in wastewater treatment and sludge dewatering units of Istanbul Water and Sewage Administration (ISKI).
4) The efforts on increasing green areas and reforestation.
5) The use of energy efficient equipments (thermostatic valve, solar collectors, lighting sensor etc.) in the houses produced by KIPTAS municipal company of IMM.
6) The establishment of 274 solar collectors in the facilities of IMM.
7) The establishment of healthy charging infrastructure for electric vehicles.
8) The efforts of IMM Art and Vocational Training Courses (ISMEK) to raise awareness of housewives about efficient consumption of energy in daily life.
9) The project of ISKI on the effects of climate change on some important water resources in Turkey including Istanbul as a pilot region.
10) The efforts on increasing the rail system.
11) The use of LED and solar energy for traffic signalization.
12) The use of online crossroad system in traffic signalization.
13) The efforts on intelligent transportation systems (ITS).
14) The efforts on promoting public transport.
15) Renewal of the bus fleet of IMM (buses working with compressed natural gas (CNG), buses with Euro 5 standards).
16) The efforts on changing transportation modes (increasing marine transportation, extending bike lanes).
17) The project “Development of a GIS-Based Decision Support System for Urban Air Quality Management in the City of Istanbul” was performed within the frame of the LIFE Third Countries Programme for the term February 1, 2007- January 31, 2009. A decision support system for urban air quality management was developed for the first time for a metropolitan city in Turkey within the scope of this study. According to the results of the study, Istanbul Metropolitan Municipality has prepared an action plan titled “Istanbul Air Quality Strategy.”
18) In an effort to identify the largest sources of GHG in Istanbul and to determine targeted initiatives that will achieve the greatest economic and carbon savings, the IMM inventory report, the first publicly available report for Istanbul, was prepared.

The reporting year selected for the inventory is 2010 as the data for this year is the most complete at the time of developing the inventory. The inventory includes emissions from carbon dioxide (CO2), methane (CH4) and nitrous oxide (N2O).
According to Istanbul Transportation Master Plan Households Research Report, 50.72% of travels are performed with motor vehicles and 49.28% are performed on foot. It is necessary not to rule out pedestrian travels due to it has a huge ratio as 49.28%. The main sources of environmental and transportation problems are motor vehicles. Traffic problems can be solved if bicycle and pedestrian transport are supported in short distance travel. By this way, traffic congestion will decrease and at the same time people will have a chance to do sport. To extend and make it attractive this environment friendly system, IMM Transportation Planning Directorate has carried out a planning and designing project for bicycle and pedestrian roads in Istanbul.

“Rider and Pedestrian Transportation System” has created in Istanbul for 630 km long road. To provide route continuance, approach roads are added to 630 km and total road network will extend to 1004km. Within the scope of “Rider and Pedestrian Transportation System” routes are divided into 4 group as first, second, third and fourth priority bicycle roads as 2023 objectives. The concept projects of first and second priority roads are ready for implementation.

Rider and Pedestrian Transportation System Priority Table

<table>
<thead>
<tr>
<th>Priority</th>
<th>2013</th>
<th>2014</th>
</tr>
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<tbody>
<tr>
<td>1.</td>
<td>3</td>
<td>56</td>
</tr>
<tr>
<td>2.</td>
<td>51</td>
<td>56</td>
</tr>
<tr>
<td>3.</td>
<td>58</td>
<td>-</td>
</tr>
<tr>
<td>4.</td>
<td>-</td>
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</tr>
</tbody>
</table>

Noise data

IMM Directorate of Environmental Protection has prepared road-related draft noise maps along routes used by more than 6 million vehicles per year in Istanbul since 2010. Road-related draft noise maps of Büyükçekmece, Esenler, Gaziosmanpaşa, Sultangazi, Eskişehir, Kasımpaşa, Beşiktaş, Sariyer, Fatih, Zeytinburnu, Bahçeköy, Üsküdar, Ataşehir were completed. The noise maps for the remaining districts are being prepared. According to the data of prepared maps:

378,800 of 5,224,554 people are exposed to total noise values of above 55 and 90,400 people are exposed to total noise values of above 65 dBA.

246,600 of 5,224,554 people are exposed to total noise values of above 50 dBA and 119,400 people are exposed to total noise values of above 55 dBA.

CO2 emission per capita in 2010 has been estimated as 3.31 tCO2e.

Air quality data

Way of working

Departments in the municipality

Recent projects

1. Pedestrian roads
   (To extend Carbon free zone) Pedestrianization projects are increased. Bicycle paths has been planned and put into practice.
   - Total Current Bicycle Roads in Istanbul: 88.3 km
   - Completed Construction Project / Planned to Construct: 106.1 km
   - Ongoing Construction Project: 67.7 km

2. SARIYER HACIOSMAN – BELGRAD FOREST BICYCLE ROAD
   This road has been planned to construct in 2015 and is 6.5 km long. It reaches out from Sarıyer Haciosman Metro Station and follows Büyükçekmece – Maresal Fevzi Çakmak Street–Valide Sultan Street–Bahçeköy Forest Faculty route to Belgrad Forest entrance. It is planned to connect this new road to current bicycle path which is located in the forest. This integrated project is important for sustainable and uninterrupted transportation. By this way, comfortable travel for riders is aimed. They may use their own bicycles or may rent from ISPARK- Bicycle Rent System.
   - Increasing low commissioned public transport vehicles
   - Extending rail system network
   - Decreasing private cars by supporting public transportation
   - Supporting the use of electric vehicles

24 km long road From Bakırköy İDO to Alibeyköy, 4.5km long road from Eminönü to Besiktas Square and 32.5km long road from Üsküdar to Kartal are decided to construct as first priority. UTK2008/24-23 (UTK: Transportation and Traffic Circulation Committee) numbered decision for aforementioned routes has been taken and transferred to put into practise to General Directorate of Public Works and Engineering.

Source: www.ibb.gov.tr
Today’s reality: smart public transport

IETT, a general directorate of IMM, is in charge of delivering public transport services in Istanbul. IETT provides only public transportation by bus, Bus Rapid Transit (Metrobus) and Tunnel Operations and is also responsible for management and inspection of Private Bus Transit Services.

IETT equipped all its buses and Metrobuses with a smart payment system, which is the quickest and most preferred way of payment system for all public transport modes in Istanbul. IETT’s buses and Metrobuses are equipped with smart monitoring and surveillance systems, which gives confidence to the public in terms of security. IETT buses continuously transfer their GPS coordinates to IETT’s data centre which helps to monitor the buses and provides estimated arrival times to passengers at bus stops to avoid long waiting times. To provide the best-quality, high-tech solutions to its passengers, IETT has changed and renewed its bus fleet, which is now environment-friendly with lower gas emissions. IETT also takes advantage of hybrid systems in its buses, which use both oil and electrical energy.

Table: Mobility modal share: % use of different modes of transportation (bicycle, car, taxi, bus, train, trolley, …)

<table>
<thead>
<tr>
<th>Source: IETT</th>
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14 December 2015

Ugur KIZILOK
Ambition: Fully integrated, accessible & sustainable mobility in Istanbul 2050

1. Clean, green and healthy mobility

In 2050, a clean, green and healthy environment is valued by the citizens of Istanbul. Travellers appreciate the wide range of alternative routes and forms of transport. Travellers choose sustainable options: they use fewer cars and more public transport, and they frequently choose to travel by bike or to walk.

Public transport systems use renewable energy resources.

Strategic ambitions
- In 2050 we have energy-efficient, sustainable and green transport.
- In 2050 we use less cars and more public transport and bikes.
- In 2050 we have increased the share of rail systems to beyond 50%.
- In 2050 we have attractive pedestrian and bicycle areas.
- In 2050 we use renewable resources for energy in public transport.

2. Fully accessible, seamless transport

In 2050, public transport benefits everyone by providing good accessibility of all modes of transport. These are seamlessly integrated, providing a finely meshed network that reaches every part of the city, while respecting its historical heritage. Public transport provides a single route to people’s destinations, without disruptions caused by changes between modes.

Strategic ambitions
- In 2050 we have accessibility of all modes of transportation through integration.
- In 2050 we achieved a 100% social inclusion in terms of mobility.

3. Well-informed travellers

In 2050, travellers value the availability of accurate, up-to-date and cross-modal information. This enables them to choose from the best option as and when they need them, taking into account changing situations and transport availability.

The information provided includes available routes, fares and car parking facilities.

Strategic ambitions
- In 2050 all mobility elements will be smart, using all effective Intelligent Transportation Systems (ITS) solutions.
- In 2050 we have better information in information systems.
VISION DEVELOPMENT

Vision development
The aim of Step 2 is to develop visions for the cities on the selected focus areas. A vision is based on a long-term perspective on the world — in this case we are focusing on 2050. Two main activities take place in this step: Future Telling research and the development of the desired future scenarios in the cities.

Future Telling
The first part of the vision development activity is to identify Drivers for Change that influence the future of Smart Cities in general, as well as of Smart Buildings, Smart Mobility and Smart Urban Spaces in particular. The Future Telling research method develops context-related possible future scenarios in a creative and imaginative way and leads to Drivers for Change for liveable Smart Cities in 2050.

The method is briefly described on the following pages and more elaborate in the Future Telling 2050 D2.1 Report — Drivers for Change.

Developing desired future scenario’s
Of the 18 Drivers for Change for Smart and Sustainable Cities, the cities chose four Drivers for Change for each focus area that relate best to their specific contexts and ambitions. Together with the ambitions of step 1, these are used to develop the desired future scenarios for the focus areas.

Scenario Workshops
The desired future scenarios for the selected focus areas of the cities are created in a series of workshops held in each of the partner cities. These Scenario Workshops consist of a 3-day programme in each city, and include sessions with policy-makers and stakeholders to develop a rich, contextual scenario for the city. Local stakeholders (companies, citizens, public and private organisations and knowledge institutes) are invited to take part in the workshops through the networks in the cities. The results of the Scenario Workshops are reported in the same format for each city to facilitate cross-learning between the cities.

Two sessions are held for each focus area. In the morning session the outline for the vision and the desired future scenario is developed. The main stakeholders work with the set ambition for the focus area and the selected Drivers for Change to understand their impact on the city in 2050. Together, the participants define the main elements of the vision. Then, in the afternoon session, a broad spectrum of stakeholders are invited to enrich the desired future scenario by making specific additions. Based on the outlined vision, they carry out a further in-depth exploration of the main elements of the vision. In all the sessions, the participants interactively build a visualisation of the desired future scenario. See also the pictures of the workshops on the previous page.

The result of the vision development step is a visualisation of the desired future scenario in an A0-format poster. The poster shows the visual together with a brief explanatory text. A common visual language is used to make sharing easier and to facilitate discussion among the cities on common and specific aspects of the visions.

Joint Vision Workshop
In a joint meeting in Istanbul the cities presented their desired future scenarios to each other, and held in-depth discussions to understand the common and specific needs in their visions.

This Joint Vision Workshop served two purposes:
• To enable cross-city learning. The cities gain a deeper understanding of the vision development process, enabling them to improve their own vision with inspiration from others.
• To describe the needs as input for the roadmapping step.

The Joint Vision Workshop finalised the activities of Step 2 and prepared for Step 3.
Future Telling & selection drivers for change

Future Telling research

The future is unpredictable and elusive. Recent changes in technology, ecology, economics and society have already led to significant changes.

The expectation is that the complexity that people and organisations experience will only increase further in the years ahead. A number of current Drivers for Change will lead to radical changes in the future. For example, new developments in information technology will create opportunities that we cannot imagine today. These will undoubtedly change our lives significantly, including the way we shop, travel, move, communicate and work.

Another example is the increasing level of social connectivity, which will drastically affect the relationships between organisations and their strategies. Even today, disruptive developments in many areas are challenging us to redesign our world.

This constant process of change has also become more complex: developments are so rapid that the future is unpredictable, based on our knowledge and models of the past and present. Predictions based on analysis appear pointless. The new complexity is characterised by simultaneous developments with far-reaching effects. We need a new way to visualise the future, with all the opportunities and challenges that it will bring – an approach that is creative, imaginative and research-oriented. Even though we can’t predict the future, we can create a range of possible context-related future scenarios. These desired scenarios will direct our decision-making, from short-term actions to long-term consequences.

In the R4E project, the Future Telling research method is used to develop possible, context-related future scenarios in a creative, imaginative way. This implies a structured method to map the expertise and ideas of the thought leaders. The process focuses on Smart Cities, in particular using analysis to gain insight into the Drivers for Change for cities in 2050.

Thought leaders

Finding suitable Drivers for Change requires both broad and specialist views. The research involves 25 interviews with thought leaders holding different views on smart and sustainable energy in cities. A broad spectrum of experts with a visionary scope was chosen from knowledge institutes, companies, consultancies and profit or non-profit organisations. Their expertise was both general on (smart) cities, and specific on mobility, buildings and urban spaces.

To overcome possible cultural bias, the experts were drawn from all over Europe, and even included thought leaders from the USA. These thought leaders are introduced on the following pages. For the interviews, the requested expertise of the thought leaders was not specifically their future vision, but their knowledge of important influences in their own fields. The Future Telling method inspired them to use their knowledge to visualise future trends and to describe possible future scenarios in rich stories. In fact, the richness of those stories makes them fertile input for the R4E project.

Future Telling card set

The Future Telling research method uses a set of 52 cards showing general future trends derived from an extensive research project by The Hague University of Applied Sciences. The cards are shown on the previous page. They are used to trigger ideas by the research participants, and to inspire them to tell rich stories about how they think these trends will influence the future.

The Future Telling card set is used in the interview. The interviewees are asked to identify relevant future trends and to tell stories about how they imagine these trends could develop.

The card set with a broad collection of general trends helps in the interviews with specialists by making them consider all the relevant directions (social, technological, economic, ecological, political and demographic), and at the same time to consider more distant future scenarios. The trends that are presented on the cards trigger their thinking, and inspires them to give rich descriptions of how they see the future developing in relation to energy in cities in 2050.

The interviews contain three main questions:

1. Sort the 52 trends on the cards into three categories:
   - Not relevant in the context of smart and sustainable energy in cities
   - Already relevant now
   - Relevant in the future

2. Take the selected cards in the category ‘relevant in the future’ and pick the 10 cards that in your opinion will have the greatest impact on quality of life (or lack of it) in cities in the context of smart and sustainable energy. (The interviewees can also add missing trends which they regard as important.)

3. Tell stories about how you imagine these 10 trends will develop and what the future in cities will look like.

Drivers for Change

A limited yet representative number of Drivers for Change are distilled from the large volume of expert material. In this phase, the data from the interviews is analysed by means of clustering, selecting and comparing the quotes by the thought leaders. The clustering is based on both commonalities and contradictions in the statements by the experts on the specific topics.

A Driver for Change needs to address the topic of a cluster, as well as to point in the directions that the future might take. So for each cluster, a short title and a description are given to capture the richness of that cluster. The quotes by the thought leaders serve as an inspiration to paint richer stories of the possible new future scenarios.

The analysis led to 18 Drivers for Change for the future of sustainable and liveable cities in 2050. We identified Drivers for Change at the general and smart city levels, as well as more specific Drivers for Change for the future of buildings, mobility and urban spaces.

Selection of Drivers for Change

For an complete description, please refer to the complete report on Future Telling 2050 - D21 report Drivers for Change.

For the focus area Smart Public Transport the city of Istanbul selected four Drivers for Change:

1. Valuing public transport
2. Experience, experience, experience
3. Connecting to ‘green’ and ‘nature’
4. Democratised systems based on open data

The following pages give brief descriptions of the chosen Drivers for Change, stating the essence of the changes. These are supported by a few quotes from the experts.
Valuing public transport

In 2050, cities offer attractive, seamless mobility options: these give everyone access to everywhere. New investment structures and revenue models ensure that the city values (such as inclusiveness) are ingrained in system design. Cities actively influence operators to ensure high levels of customer satisfaction and service quality.

This Driver for Change represents the following cluster of quotes of the thought leaders:

a. Affordable, accessible, seamless and attractive

FT13.30. One other thought line we are starting to explore is the impact of door to door services, the concept of collaborative or shared mobility. ... If you believe in this scenario to happen of the fully connected traveller, then probably the urbanite may opt out of the mass transport systems. He may no longer choose the bus or the metro. If you believe systems like Uber for instance, who promise door to door transport, and shared mobility services are more and more organised in a way that you do not have to bring back the car to where you got it and you can leave the bicycle close to your door, then you will be tempted away from mass transport. And if you look at the impact of such a scenario then that will be very big. ... And would you then care about spatial structure when transport becomes available at all places at all times.

FT19.05. ... the way we look at it now with each city having its own public transport corporation for trains, trams, buses, subways. But in a few years all this can be replaced by self-driving cars. There is a new technology coming up, and it is going to change the way of thinking. Suppose we stop this large scale, mass public transport or we limit it to heavy trafficked areas only, and self-driving cars are just open for use by everybody who want to use them. ... If we do that, what would be the problem? What is the kind of issue that might be coming up? These questions hook up to the question to what kind of values do we want to design our cities in the future. That is the most relevant question: what values do we have? One of the important values in Europe is inclusiveness. Public transport is now enabling people who do not have a lot of money to take part. It is these values that are important. It is the same for energy. Inclusiveness is important to prevent energy poverty.

FT20.06 One thing that pops into my mind now is also in this inequality is public transport and the affordability of public transport. ... Transport needs to be affordable for people, they need to be able to travel easily from A to B. It is already now not affordable anymore, and I cannot see how that can be sustainable for the future. ... we have to rethink buses, trams, trains. Make sure people can move around in your city.

FT24.08 The hope is that in future that big cities that really want to improve quality of life that they have the right influence on the operator to ensure that they invest in customer satisfaction, and not only in earning money.
Experience, experience, experience

In 2050, city residents travel because they like the experience. For short (hyper-local) distances by walking or cycling, to reach places on a daily human scale. And for longer (hyper global) distances, the whole planet can be reached within a few hours. Even space travel could be an option! There’s a range of convenient, clean mobility options, making use of abundant renewable energy. Travel has never been easier – it provides seamless connections from where you are to where you want to go. Services focus on what people need, and not on the available systems.

FT11.07. It will be nice to see if that will increase mobility. If we get back to that: if this is all much easier, how much more will we move? Will we be on and off everywhere in the world? Or will we stay more in one place and are connected? So far it seems that we are much more ‘out’. Even though we are connected, we still want to be somewhere else connected. I kind of think that it is human nature not to just want to sit around the house. More of us want to be somewhere else. It is about experience, experience, and experience. The virtual experience is not replacing that. We still want the real thing. People still go to concerts, although CD’s are there, even in better sound quality, but there are more concerts than ever. There is not going to be a big change in that. They are all more accessible in that sense.

FT13.21. If energy is cheap and available, that also means that you can travel far and long. So you need alternative mechanisms to reduce traffic volumes. Because the space is limited factor then. ...

FT13.22. How do you manage mobility? Space is an element to make people understand what traffic can and will do in the city. For instance when Groningen (in the Netherlands) started to plan its urban space, already in the 70’s or begin 80’s, when they started, it took them at least 25 years to become a very cycling oriented city. So 2050 is now 35 years ahead as well, if you want to accomplish something by now, you now have to start with urban space management. You can accomplish a lot, but it takes a lot of time and digital policies and modelling to support it. It is not that simple.

FT25.04. … That is a kind of habit that we have: we accept certain travel times. Commuting will be more like buildings. Mobility is already a commodity, but will be more of a commodity, in the sense that stepping into your mode of transport will be an extension of your living room. You will not drive yourself, but basically it will be like entering another room in your home. Mobility will be a stepping-stone it will not be an activity, so as a cost on life it will disappear – other than separating us from the ones we care about.

FT3.25. For cities there is also a question in public transport. Do you just want a high speed train to bring you in two hours over a long distance to central hubs, and then just a local network to connect the centre of the city to the surrounding areas? Or do you want local networks between cities? Or will it be local sharing services, with e.g. local cars and e-bikes, but not necessarily public transportation like tram or metro. The focus on more local communities means that we need less travelling on national scale. We may have international and local transportation needs, but much less in between.

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Connecting to ‘green’ and ‘nature’

In 2050, people’s need for ‘green’ and ‘nature’ is met by well-connected green spaces and landscapes all over the city. Soft birdsong and other nature sounds add an intangible quality and sense of well-being. Urban farming increases regeneration of resources, creating fresh, healthy foods, reconnecting with nature and mobilising local communities. People are aware of the effect of their living environment on health and well-being, and push for cleaner technologies. Advanced systems allow control of micro-climates, contributing to more resilient cities.

This Driver for Change represents the following clusters of quotes of the thought leaders:

- Caring for nature
- Urban farming to enable healthy and happy living
- Improving the environment

FT18.10. ... I do think that regardless about how we think about national boundaries or local boundaries, regardless about how technology is improving our day to day life and the access to energy and food and et cetera, I think that at the end of the day humans are animals. That there is something that we deeply need, that is met by green space, that is met by quiet sound and birds drizzling, there is this very intangible effect that that kind of peacefulness has on peoples well being, physical and mental.

FT23.16. ... if you read Pope Francis papal encyclical, it starts with “the global eco reconciliation”. It is fantastic. Because the ecology has a big consequence in social impact in agricultures and politics. And it is said by the Pope, who would have thought about this? ... Now is the time of reconciliation, because people want to live in cities together with nature, and not just buildings. So maybe smaller cities have now a great opportunity, because agriculture is inside the cities. So there lies an opportunity to optimise the relation between buildings and nature, and that may help with our energy problems and social problems. Maybe it is as simple as that. We should not make it more complicated. It can be this simple.

FT15.07. The other big change we will see is around the urban farming concepts. By 2020 80% of the world population lives in an urban environment. It will become more and more important to grow the food close to where it is going to be consumed ...

FT15.18. It will increasingly become very important for people that live in an urban environment to feel that they are actually consuming a freshly produced food. The urban farming concept with the growing vegetables and the fish is almost circular, since the fish help grow the vegetables and they can eat the waste vegetable products again. So you grow fish to feed them, to grow the vegetables, and you feed the waste vegetable back in to the fish. And then you sell the fish with the vegetables. You capture the CO2 in the building and feed that into the greenhouse because it needs CO2 to grow ...

FT6.02. For example if you look at a healthy city, from e.g. minimising the risk of industrial and traffic emissions, better technology will lead to clean vehicles, clean industry. With respect to air pollution, noise pollution, et cetera, emissions will greatly decrease and therefore increase the quality of living in an urban area. That will not happen automatically, we have a quite strong technocratic steering principle in that classical environmental hygiene type of policy. So there is quite a lot of technology in that area.

FT5.09. Maybe the government will manage all the things from the space. For example right now the US implemented a laser gun and in my imagination after a while they will control everything from the space. We are able to control the weather and the rains. And this will be together with the global water supply.
Democratised energy systems based on open data

In 2050, energy systems are open, bidirectional, multi-purpose platforms on which (renewable) energy and energy management services are open to all. Entrepreneurs have developed business models that provide value for them, for their users and for society at large. Citizens can choose freely from a range of available options. The system ensures privacy and security of users, who are always in control. Ambient energy networks provide connectivity for (wireless) access to data and energy. Increased computing power and artificial intelligence make system resilient: self-organising, self-sustaining and self-learning.

This Driver for Change represents the following clusters of quotes of the thought leaders:
a. Open infrastructures to bring together supply and demand of energy in decentralised systems
b. Privacy and security in systems and services build on open data
c. Being in control with or being controlled by intelligent systems
d. Merging brain power and computer power to make smarter decisions
e. Integrating (wireless) data and ambient energy networks

FT3.10. There may be a competition of energy networks. Also there will be an integration of data and energy networks. But it could also be a completely new energy internet that is competing with the existing systems.

FT3.09. In cities you will need some sort of layered structure, in which you have a grid that provides stability and interconnectivity, and on top of that you will have more freedom and less restrictions to design your own thing. It will affect the city as it will no longer be needed to have global or national grid that is build by a government. But there will be local grids that provide enough stability by sharing resources so that you have a guaranteed stable energy production in the way you want it. You need to ensure that everybody can connect to such a grid, but it will be more local grids, that do not necessary need interaction...

FT19.04. One of the other things in district heating now is that the one who owns the network is also the one who provides the service. It is like a monopoly. You cannot choose. We need a new type of district heating - open. Not only to increase the investment capacity, but also for everybody to be able to put heat on the network. So that you have a distinction between the network infrastructure and the heat generation capacity. Because in the city there are a lot of heat sources, e.g. industries, data centres. They produce a lot of heat, and this can be used to heat buildings. So you need this openness, like for electricity.

FT19.06. The other important value is openness. The way I described it, the way we organise it has to be open. Technology is available, but what kind of openness do we want? By getting this openness you get a new form democracy ...

FT13.35. Data is the fuel of the 21st century. ...

FT16.03. ... the fact that people do not need energy, but they need to wash, to cook, to be warm. The fact that they will be able to produce energy directly, or coming from their neighbour. And the fact that digital technology will allow to combine this supply and demand, I will guarantee that all activity will move from energy producer and energy distributor towards energy manager. ...

FT1.06. Analysing and monitoring our human systems on the social level, in public spaces or in social contexts, we will have a lot of new conditions which we do not know up till now. Next to an impact on humanity, it means that we have to redefine what is life and what is public and what are our civil rights ...

FT10.14. ... I think in 35 years, when we really get this wisdom of the crowd, and let the crowd of humans, robots or together decide. You cannot really draw a line between humans and robots and you can actually soon draw a line between a human and a computer ...

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Creating the visual of the desired future scenarios
In 2050, a clean, green and healthy environment is valued by the citizens of Istanbul. Travellers appreciate the wide range of alternative routes and forms of transport. Public transport benefits everyone by providing good accessibility to all modes of transport. These are seamlessly integrated, providing a closely-knit network that reaches every part of the city while respecting its historical heritage.

Travellers choose sustainable and healthy options. Public transport provides a single route to people’s destinations, without disruptions caused by changes between modes. Travellers value the availability of accurate, up-to-date and cross-modal information. This enables them to choose the best options as and when they need them, taking into account changing situations and transport availability.

The public transport systems use renewable energy resources.

Elements of the desired future scenario are:

### A clean and green city

In 2050, Istanbul is a clean and green city. A whole new city concept has been created around emission-free and ecological buildings with green roofs and waste recycling. In green areas all over the city residents enjoy walking, cycling and (hobby and urban) gardening. Pedestrian tunnels and floating gardens connect the areas. Citizens are energy-aware; a tree is planted for each child’s birthday. Energy efficiency and sustainability are monitored for continuous improvement.

### Seamless transport and pleasurable travel experience

Istanbul has an integrated transport system that provides door-to-door service. Buses, trams, automated vehicles, taxis, shared cars and bikes are all integrated into one, easily accessible service. New modes of transport and innovative vehicles are also integrated, like autonomous vehicles in the air and on water. The integration of smaller units (personal or larger) into larger ones (ferries or trains) avoids transfers. Management is by an autonomous system.

‘Public’ transport provides a pleasurable and comfortable travel experience. The PRT (personal rapid transit) system allows people to travel in their own units, which are transformed into DRTs (demand response transit) with VIP services. People can easily transfer between all vehicles at hubs. These are real experience centres, with shopping, cinemas, and theatres.

### Personal travel assistant

Everyone has a virtual ‘guardian angel’ for personal travel advice wherever they are, free of charge. All the ‘angels’ are connected to the cloud for accurate, up-to-date, cross-modal information. They give warnings of storms or snowfall, help to cancel or postpone trips when needed, help in case of emergencies or prevent accidents by warnings. They balance capacity in the system, important city parameters (energy, air quality, etc.) and personal health parameters.

### Privacy & security

People feel comfortable and safe, because only the ‘angels’ have access to personal data. In 2050, the transport systems in Istanbul are also perceived as secure. For example, the biometric information used to identify people at entry points is also used to identify suspicious persons and activities. Personal data banks have a virtual shield to ensure confidentiality and privacy, and guard against hacking.
Roadmapping

The aim of Step 3 is to develop specific roadmaps for the cities in the selected focus areas. A roadmap shows all existing and future technologies and other relevant developments that enable the achievement of the desired future scenarios by 2050. Two main activities take place in this step. Firstly, the roadmapping research to define the general roadmaps. Secondly, the definition of milestones for the years 2020 and 2030, and local solutions and research projects to create city-specific roadmaps.

General roadmaps

Desk studies and expert interviews are conducted to collect input for the roadmaps. The roadmaps explore the options to achieve the cities’ desired future scenarios. The resulting General Roadmaps for Smart Buildings, Smart Mobility and Smart Urban Spaces provide input for the city-specific roadmaps.

Roadmap Workshops

The city-specific roadmaps are created in a series of workshops held in each of the partner cities. These Roadmap Workshops consist of programmes with three sessions in each city.

In the first session, the policy-makers and city representatives select the topics from the general roadmaps as focus for the city-specific roadmap. This choice is based on their specific ambitions and context. They also define intermediate milestones for 2020 and 2030 on the path to their desired future scenarios.

Then, for each of the focus areas, local stakeholders (companies, citizens, public and private organisations and knowledge institutes) are invited to take part in the roadmapping sessions. With all the available knowledge of potential developments and the given focus of the city, the local stakeholders generate project proposals for (local) solutions and research proposals, as a first step towards the project portfolio. See also the pictures of the workshops on the previous page.

The results of the Roadmap Workshops are reported in the same format for each of the cities, facilitating cross-learning between the cities.

Joint Roadmap Workshop

In a joint meeting in Newcastle, the cities presented their city-specific roadmap enriched with current projects and proposals for new projects, and held in-depth discussions to understand the common and specific learning objectives and opportunities for joint projects. The Joint Roadmap Workshop served two purposes:

- To enable cross-city learning. The cities gain a deeper understanding of the roadmapping process, and can improve their own roadmaps with inspiration from others.
- To describe the common learning ambitions as input for the Project Portfolio step.

The Joint Roadmap Workshop finalised the activities of Step 3 and prepared for Step 4, in which the project portfolio will be further developed.
How to read the general roadmap

The resulting General Roadmap contains four important elements:

- The timeline from now (2016) to the visions for 2050 as described in the desired future scenarios of the cities (see D2.2 — Report Vision Development for the full set of desired future scenarios).
- The eight common needs in the desired future scenarios as described by the cities in the Joint Vision Workshop (see also D2.2) are indicated at the end of the timeline in 2050 as the goal of the roadmap.
- The relevant topics for the focus area on which developments are required to achieve the desired future scenarios. These topics cover sustainable technologies, sustainable behaviour and sustainable organisations.
- The options that will become available in the short or longer term for each of the topics.

Each topic has a timeline showing the developments that are relevant to that topic. The image shows the elements of the General Roadmap.
Relevant topics for Smart Mobility

In the general roadmap, timelines are created for the topics that require developments to achieve the desired future scenarios in 2050. The topics selected for the Roadmap Smart Mobility are described briefly here.

Sustainable technologies
The first element needed to achieve the sustainable energy ambitions is the availability of sustainable technologies. A wide range of sustainable technologies is already available, and new technologies are constantly being developed. But unfortunately there is not always a consensus on the best option for the future. The Roadmap Smart Mobility includes the following technology developments:

**SMART INFRASTRUCTURE**
Smart Infrastructure is about the physical infrastructure and energy systems relating to mobility. Specifically, this topic includes the engineering, (re-)design, maintenance and role of the physical infrastructure in terms of roads, city squares, urban areas, bridges and tunnels. The topic also applies to energy systems in terms of charging infrastructure and (connected) energy systems. It therefore has close links to Smart Buildings and Smart Urban Spaces.

**SMART MOBILITY MODES**
Smart Mobility Modes is about the different types of (sustainable) mobility, including the development of the required technologies. More specifically, this topic applies to the development, implementation and use of sustainable and smart mobility modes such as cars, trucks, bikes and drones.

**CONNECTIVITY & ROBOTISING**
Connectivity & Robotising describes developments in ICT infrastructure, communication technologies and autonomous driving. Connectivity & Robotising applies to all forms of intelligent in-vehicle solutions that allow vehicle-to-vehicle, vehicle-to-infrastructure, vehicle-to-person and vehicle-to-grid communication. The topic also includes (semi-)autonomous vehicles and ICT-related developments such as 5G, since these contribute to a connected and automated mobility system.

**DATA & TRAFFIC MANAGEMENT SYSTEMS**
Data and Traffic Management Systems includes developments relating to transport systems and the increasing use of different types of data, including those relating to the shift towards Mobility as a Service. Data can and will be generated and communicated by the digital infrastructure and communication technologies as described by the Connectivity and Robotising topic. This data topic also applies to the management of transport systems, the developments relating to data interoperability between service providers, data protocols, and personal data and privacy issues.

**PERSONALISED SERVICES**
Personalised Services include the availability of mobility services, developments in public transport and those relating to applications allowing for mobility à la carte and Mobility as a Service. The Personalised Services topic is also about the development of specific (personalised) services. These are based on different types of data such as open, personal and real-time traffic data, and are aimed at matching supply and demand. As such, this topic also includes the blend of public and private mobility services and personalised travel advice.

**URBAN LOGISTICS**
In general, Urban Logistics is about logistics solutions and developments that affect the logistics flows in cities. More specifically, it includes aspects relating to the (integrated) transport of goods across the whole urban logistics system, integrating multiple urban logistics flows, and the development of new solutions for urban logistics.

Sustainable behaviour
One of the crucial elements of a sustainable city is the behaviour of citizens. Making a collective shift to more sustainable solutions and energy-saving alternatives requires awareness. In many cases, the available technologies are not sufficiently attractive to gain acceptance in mass markets. The Roadmap Smart Mobility includes the following behavioural developments:

**VALUES, MOTIVES & BEHAVIOURAL CHANGE**
Values, Motives and Behavioural Change includes the way citizens can play an active role in behavioural change, driven by different values and reasoning over time. Small-scale initiatives, the role of the media and healthy behaviour are some of the aspects covered.

Sustainable organisation
Last but not least, the element of sustainable organisation is addressed. How can we organise the collaboration between relevant parties (public, private, citizens) to achieve the desired future scenarios? Because the technology is not yet mature, new business models are needed to enable learning processes, and these can be modified and updated as necessary. The Roadmap Smart Mobility includes the following organisational developments:

**COOPERATION & INNOVATION NETWORKS**
Cooperation and Innovation Networks describes how forms of cooperation between different types of organisations (public and private) will evolve over time to speed innovation and new mobility solutions. Among the aspects covered are active roles of multiple stakeholders, and sharing of assets.

**POLICIES & LEGISLATION**
Legislative changes and the right policies are important factors in the developments relating to Smart Mobility. This topic includes the developments in this field. More specifically, it applies to developments relating to legislative aspects, and frameworks and measures to enable the creation of Smart Mobility systems.

The city specific roadmap
The general roadmap describes the developments on a timeline, indicating when experts estimate that those development will be broadly available. For the cities to create their specific roadmaps, they were asked to focus on the topics that are most relevant for them to reach their own desired future scenarios. The cities create milestones for 2020 and 2030, describing what they will look like when their own developments and city projects have evolved. In this way each city can indicate the focus and pace that it will need to achieve. Projects can then be proposed on this basis to define (local) solutions or research leading to further realisation of the roadmap.
**Smart Mobility General Roadmap**

**Sustainable Technology**

**Smart Infrastructure**

**Smart Mobility Modes**

- Expanding and exploiting use of existing infrastructure and construction of new physical infrastructure (roads, hubs etc.) to accommodate growing mobility demand.
- Physical separation of flows (e.g. separation of lanes and re-design of infrastructure for flexible use over time, aligned with growing diversity of sustainable mobility modes).
- Smart solutions (e.g. increased intelligence in vehicles, e.g. sensors, cameras, RFID tags and inductive loops for detection and energy generating constructions, e.g. ‘solar roads’).
- (Re-)designing dedicated areas. Creating areas for e.g. intermodal hubs, green corridors for cycling and walking, e-bike highways, e-vehicle charging systems and areas for autonomous vehicles.
- Energy-efficient solutions (e.g. increased availability of new solutions for fast charging of (mainly) electric vehicles, e.g. charging systems and areas for autonomous vehicles).
- Proactive infrastructure (e.g. increasing the intelligence of physical infrastructure to proactively adapt to guide sustainability, e.g. smart charging and adaptive road markings).

**Connectivity & Robotising**

- New incentives and measures. How efficient use of existing infrastructure and construction of new physical infrastructure (roads, hubs etc.) to accommodate growing mobility demand.
- Optimising mobility modes. Increasing efficiency, e.g. drive trains (e.g. plug-in hybrid electric vehicles), comfort and safety of mobility modes.
- New mobility modes. New solutions for specific mobility demands, e.g. e-bikes, hover boards, e-airports.
- Sustainable technologies for lightweight vehicles. Sustainable technologies for a range of lightweight vehicles, e.g. lightweight vehicles.
- Enhanced connectivity. Small, autonomous, efficient and affordable sensors in infrastructure and mobile devices enable the shift to bidirectional communication.
- Fast, reliable and secure communication network. Roll-out of 5G and fibre networks.
- Cooperative driving technology. Technologies to communicate, react and respond between new vehicles, enabling efficient (high) occupancy in all areas.

**Data & Traffic Management Systems**

- Occasional interoperability of data sources. Different data sources (open, private, traffic) are occasionally combined by means of open protocols.
- New mobility services and sharing initiatives. Based on (open) data and matching of supply and demand, enabling new, disruptive mobility services, e.g. Uber, mytaxi, car2go.
- Booking and billing services. Integrated booking and billing services across multiple public transport solutions (e.g. one city card for all public transport services).
- Hybrid mobility solutions. Separation between public and private transport flows due to the change in ownership (first sign of Mobility as a Service).
- Integration of resources for city logistics. Sharing of resources to integrate city logistics flows by sharing hubs, storage, data and transport.
- Connected urban logistics. Internet of Things allows real-time monitoring of locations and status of goods, and connectivity between urban logistics among different (urban) logistics service providers.

**Personalised Services**

- Efficiency improvement of urban logistics. Efficiency improvement by means of e.g. matching between different logistic service providers.
- Lightweight logistic solutions. New technological solutions for lightweight logistics (e.g. drones and robot delivery of small packages).
- Individual services. Merger of diverse data sources (e.g. weather forecast and diary) enables more reliable user information and customised services.
- Optimising logistics flows. Optimising logistics flows by using time slots (e.g. night deliveries) and usage role of infrastructure (e.g. urban spaces).
- Encouraging green behaviour. Encouraging people to choose more active mobility options by (re-)designing the urban space with more attractive green areas.
- Conscious decisions. People's travel reasons and purposes will change, reducing the urge to travel and increasing the choice to use alternative forms of travel.
- Responsible sharing of assets. Public parties ensure access by other (private) parties to public assets, e.g. public transport data and infrastructure.
- Openness. New features for accessibility and openness of data sources and mobility systems, including coverage of national priority areas.
- Scalability. EU legislation to ensure scalability of innovative mobility solutions, e.g. scalable legislation for Uber.
Sustainable organisation

- Sustainable technology

- House management systems
- Values, motives & infrastructure
- Urban logistics & legislations

- Cooperation & services

- 2016

- Smart mobility general roadmap

- New incentives and measures
- Based on (open) data and matching
- Supporting sustainable and comfort and safety of mobility
- Economy, e.g. by sensors and (e.g. in tendering procedures).

- Transition towards smart and more efficient use of existing sharing initiatives

- Sustainable mobility

- Public parties take the lead in an
- New forms of cooperation for all public transport services.
- (including all parties necessary for sharing of assets (e.g. 'who is responsible?') to promote the
- Autonomy of driving in

- (Re-)designing dedicated areas
- Connecting vehicles for more critical
- Enable active response to suitable
- Sharing of private data for
- Smart solutions
- New protocols to connect systems and enable roaming of services (e.g. Integrated system using different
- Solutions in circular economy
- New solutions, e.g. up-cycling, aimed
- Physical internet
- Open logistics system based on
- Solutions for limited range
- Open and connected platform
- Diverse, high-quality total system with sufficient suitability of transport of people and goods for all needs, distances and lifestyles

- Self-organising transport system
- Integrated system using different data sources to dynamically respond to supply and demand

- Self-organising communities
- Communities create value by

- New value systems
- Attractive economic systems to enhance the creation of integrated mobility services and products.

- Self-learning traffic management system
- One integrated smart system for intermodality transport (private and public, passengers and goods) based on different data sources.

- Demand-driven services
- Flexible choice of transport and services (e.g. based on widespread use of dynamic pricing) matching diversity in needs and lifestyles.

- Personal influence
- Social mechanisms, incentives and measures provide evidence of the consequences of people’s choices and influences.

- Public living area
- Redesign of urban areas to release infrastructure for other purposes.

- Globalisation
- Data privacy and legislation at a global level.

- Total value
- Data is valued based on value for society, instead of purely by economic value – this creates a level playing field for sustainable solutions.

- The 'next economy'
- The 'next economy' based on value models and integrated value for society at large.

- Sustainable solutions and lifestyles
- All systems use energy from renewable sources
- All modes of transport are sustainable (material, zero-emission)
- Systems support users in making optimal choices (e.g. balancing costs, emissions, time and social aspects)
- Sharing of (autonomous) vehicles and rides
- Sustainable acceptability (e.g. for the elderly and disabled)

- Health and lifestyle
- Comfortable, accessible, high-quality living environment that encourages outdoor activities
- Green urban areas, safe areas and clean air
- Inviting people to spend time outdoors
- Healthy, flexible, and efficient activity levels

- Reducing the need for travel
- Human scale urban planning, all daily needs are nearby
- Remote services (health, education, public services, working)
- Poly-centric cities with decentralized service hubs
- Local production (food, 3D-printed goods)
- Smaller scale ecological solutions (e.g. goods delivery)

- Seamlessly connected networks
- Networks for quick, easy travel
- Smoother, seamless transport (e.g. through integrated system to provide 'door-to-door' service
- Integration of new modes of transport and innovative vehicles
- Smoother, seamless transition between (regional) networks

- Mobility à la carte
- A wide range of interconnected alternative routes and modes of transport to suit different lifestyles
- Flexibility and freedom of choice
- An enjoyable and convenient travel experience
- Demand-driven diversification (blending public and private)

- Accessible, affordable and convenient mobility
- All modes of (public) transport are safe, convenient, accessible, fast, flexible and affordable for all
- Convenient and easy-to-use (zero-click) reservation, flexible payment, pick-up/drop-off at any point
- Easier transport at intermodal/transport hubs

- Personalised advice
- Personalised travel advice based on factual, up-to-date information and personal needs at that moment
- Smart adjustments based on people’s preferences and needs
- Accessible, up-to-date, real-time, cross-modal information
- Personalised advice accessible through multiple applications and devices

- Smart management
- Smart traffic management based on real-time, cross-modal information, analysis and prediction
- Automated systems for smooth (public) traffic flows
- Communication between vehicles, infrastructure and public
- Safe and secure, in both the physical and virtual worlds

- Desired future scenario

The Smart Mobility theme focuses on sustainable energy solutions for public and private transport and logistics. The ambition of the cities is to create attractive and clean public spaces and healthy, sustainable green environments that invite residents and visitors to walk or go by bike. Open data platforms, integrated systems and accurate multi-modal transport information provide personalized advice for seamless journeys, integrating sharing of sustainable vehicles and green public transport.

2030

2040

2050
## Smart Infrastructure

### Short-term developments
- In the short term, new infrastructure continues to be constructed (mainly outside the city centres), and current infrastructure is used more efficiently to accommodate the growing demand for mobility.
- Separation of lanes and (re-)design of infrastructure allows flexible use of infrastructure over time, aligned with growing diversity of mobility modes. In addition, the creation of new areas or the re-creation of existing areas allows for dedicated areas such as green corridors, e-bike highways and e-vehicle charging systems.
- More (fast) charging solutions and solutions for local energy storage are in place.
- The increase in intelligent assets allows for a more intelligent (proactive) infrastructure. Intelligent infrastructure could, for example, proactively drive sustainability in cities by guiding users of electric vehicles to charging stations or by automatically banning vehicles with high emission levels from city centres.

### Mid-term developments
- Connected energy systems allow for the generation, storage, use and exchange of energy between infrastructure, buildings and other assets.
- New engineering technologies are in place to make lightweight infrastructure (e.g. unfoldable bike paths and footpaths). Sustainable energy is largely available in the medium term as a result of large-scale solutions such as wind and solar parks. The resulting abundant sustainable energy is affordable for all.

### Long-term developments
- In the long term, new engineering technologies are in place to build heavy infrastructure. This results in cheaper, faster and more sustainable ways to build and maintain heavy infrastructure such as roads, railways and constructions such as tunnels and bridges.
- Finally, a wide range of sustainable mobility solutions, less physical infrastructure and an integrated energy system enable a greener living environment in which sustainable energy supply and demand can be organised efficiently.

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### ROADMAPS FOR ENERGY - D6.4 Final city report Smart Mobility / Smart Public Transport Istanbul

**Innovation Networks**

Guiding users of electric vehicles to charging stations or by automatically banning vehicles.

The increase in intelligent assets allows for a more intelligent (proactive) infrastructure.

**Behavioural Change**

Promoting bottom-up movements.

Supporting sustainable and logistic streams more efficient, e.g. optimising mobility modes.

New mobility services and transitions towards smart and sustainable mobility.

**Legislations & Robotising**

Public parties take the lead to ensure on-board automation.

Mid-term developments

- New mobility modes
  - Increasing efficiency, drive trains (e.g. plug-in hybrid electrical vehicles), comfort and safety of mobility modes.
- Sustainable technologies for lightweight vehicles
  - Sustainable technologies for a range of lightweight vehicles, e.g. electric and hydrogen powered.
- Full-electric lightweight vehicles
  - A wide range of models of full-electric vehicles provide freedom of choice for users.
- New frameworks for accessibility and mobility solutions.

**2016**

Optimising mobility modes

- Increasing efficiency, drive trains (e.g. plug-in hybrid electrical vehicles), comfort and safety of mobility modes.

New mobility modes

- New solutions for specific mobility demands, e.g. e-bikes, hoverboards, e-scooters.

Sustainable technologies for lightweight vehicles

- Sustainable technologies for a range of lightweight vehicles, e.g. electric and hydrogen powered.

Energy-efficient solutions

- Increased availability of new solutions for fast charging of (mainly electric) vehicles (e.g. inductive charging) and increased local storage of energy.

Proactive infrastructure

- Increasing the intelligence of physical infrastructure to proactively adapt to guide sustainability, e.g. smart charging and adaptive road marks.

**2020**

Electric heavy-duty vehicle solutions for limited range

- Extension of available heavy-duty vehicle that provide clean and silent solutions for in-city transport (last mile).
### Smart Mobility Modes

**Short-term developments**
- In the short term there are incremental improvements in vehicle drivetrains, comfort and safety. As well as optimising current mobility modes, new mobility modes are also emerging as solutions for specific mobility demands, such as e-bikes, hoverboards and e-scooters.
- Over time, but still in the short term, sustainable technologies enable a wide range of lightweight (electric or hydrogen-powered) vehicles. The range of lightweight vehicles is accompanied by increasing availability of full-electric vehicles, giving users freedom of choice.

**Mid-term developments**
- In the mid-term, a limited range of heavy-duty vehicles is available. More specifically, the available range of heavy-duty vehicles increases, providing clean and silent solutions for in-city transport.
- In addition to the developments in heavy-duty vehicles, all kinds of sustainable (mainly electric) vehicles are more affordable for the mass market than conventional, polluting vehicles. From this point on, the numbers of sustainable vehicles grow faster than the traditional, polluting vehicles.

**Long-term developments**
- In the long term, all available vehicles and mobility modes are clean, zero-emission and fit for their intended purposes. But it will still take a very long time before all vehicles on the road are clean and non-polluting.
Connectivity & Robotising

Short-term developments
- Short-term developments in connectivity and robotising can first of all be relate mainly to in-vehicle automation and autonomous driving in controlled areas. This means that the development of in-vehicle solutions enhances safety, comfort and fuel economy, e.g. by means of sensors and monitoring. In addition, autonomous driving is possible in separate controlled zones.
- Secondly, short-term developments in connectivity and robotising are related to one-directional communication. Later in this period, enhanced connectivity enables a shift to bidirectional communication. More specifically, one-directional communication between vehicles and their environment shifts over time towards bidirectional communication. This will be enabled by efficient, affordable sensors in infrastructure and mobile devices.

Mid-term developments
- In the mid-term, the experts predict developments relating to the creation of a fast, reliable and secure communication network, enabled by the roll-out of high-speed 5G and fibre networks. In addition, cooperative driving technologies to communicate, react and respond between new vehicles enable forms of “platooning” of vehicles in almost all areas. Autonomous buses and autonomous driving outside cities are expected to be possible (on a larger scale) by the end of the mid-term period.

Long-term developments
- Long-term developments in connectivity and robotising relate mainly to adaptive vehicles, full cooperative driving technology and finally autonomous urban driving. Artificial intelligence, fully interconnected and communicating vehicles (both old and new) and full integration of autonomous vehicles with other modes of traffic and urban infrastructure are some of the core aspects of these long-term developments.
Sustainable technology

HOUS E

VALUES, MOTIVES &

PERSONALISED & ROBOTISING

SMART MOBILITY

2016 2030 2040 2050

Increasing efficiency, drive trains (e.g. new, disruptive mobility services, e.g. to enhance safety, comfort and fuel awareness, e.g. through education of supply and demand, enabling More efficient use of existing services.

means of open protocols.

demands, e.g. e-bikes, hover boards, of infrastructure for flexible use over different parties (public - private -

New forms of cooperation infrastructure, people and grids.

mediate in the transition towards a and social media are used to (real-time) information management Sustainable technologies for a range energy generating constructions e.g. ‘solar roads’.

Merging of diverse data sources (e.g. enable active response to suitable charging systems and areas for small-scale initiatives autonomous vehicles.

modes.

towards Mobility as a Service (MaaS).

Energy-efficient solutions Increased availability of new Sharing of personal data is urban spaces).

Small, autonomous, efficient and high-emission (private) cars and unsustainable solutions, e.g. by security issues and enable roaming of services (e.g. New protocols to connect systems Integration of resources for integrated billing, booking and intermodal logistics solutions more affordable for the mass market

Connected urban logistics Lightweight vehicles

Openness to communicate, react goods, and connectivity between and influences.

Scalability

Intermodal logistics solutions

Data & Traffic Management Systems

Short-term developments

• In the short term, several main developments can be identified. The first developments relate to the interoperability of different data sources. The creation of a fully interoperable platform is perhaps the main challenge in creating complete, sophisticated data & traffic management systems. Currently open protocols allow different data sources to be combined and integrated on an occasional basis. This kind of occasional interoperability of multiple data sources continues to increase over time.

• Recognition of the value of data drives the market uptake of sharing initiatives towards Mobility as a Service. This valuing of data is already visible, but this development is likely to increase over time. In addition, the development of new protocols enables the interconnection of systems and roaming of services across multiple mobility modes. However, this requires new solutions to address privacy and security issues.

• Enhanced traffic management is already happening. The increasing amount of smart infrastructure speeds the potential of enhanced traffic management. Smart infrastructure also enables fast (real-time) information management and control of traffic flows and crowds.

Mid-term developments

• The development of new protocols is likely to increase over time, and this development also continues to intensify in the mid-term period, allowing an increase in the interconnection of systems and roaming of services across multiple mobility modes. Self-learning traffic management systems begin to emerge as a result of the enhanced traffic management system and the increase in connectivity. These integrated smart systems allow the management of intermodal transport of passengers and goods, using different (secure) data sources.

Long-term developments

• The creation and use of a self-organising transport system is already possible and applicable within a (secure) small-scale environment. However, an integrated system that uses different data sources to dynamically respond to supply and demand of goods, services and passengers on a large scale is still some years away.
### Personalised Services

**Short-term developments**

- In the short term, the number of new mobility services and sharing initiatives is likely to increase. This is mainly due to the increase in (open) data and matching of supply and demand, enabling new, disruptive mobility services, e.g. Uber, Lyft, car2go.
- By the end of the short term, at around the beginning of 2020, there is a shift from hybrid mobility solutions towards more integrated services. The separation of public and private also blurs over time, due to the change in ownership. In addition, connected and integrated mobility services in an open information system will offer a range of mobility options.

**Mid-term developments**

- New protocols to connect systems and enable roaming services allow better connected and more integrated services. Factual, up to date advice across different modalities and based on shared services creates a more efficient mobility system that combines services and the transport of goods and peoples. In the long term, this development results in demand-driven services.

**Long-term developments**

- In the long term, demand-driven services allow for flexible choices of modalities and services matching a wide range of needs and lifestyles. These demand-driven services are enabled by a fully open and connected platform. The result is a diverse and high-quality total system that offers sufficient capacity for all transport needs – for people and goods, for all distances and for all lifestyles. However, it will still take a couple of years and some conditions need to be met before all these services are available on a large scale.
Urban Logistics

Short-term developments
- In the short term, small-scale logistics solutions are further developed making city logistics flows more efficient, for example by using pick-up and drop-off points, and these solutions become more widely available. Efficiency improvements by means of cargo ‘hitching’ between logistics service providers and the development of new technological solutions for lightweight goods logistics are two developments that reach maturity and are ready for market uptake in the short term.
- Optimising physical logistics flows by exploiting time slots, for example night deliveries and higher usage of infrastructure such as urban spaces, have already been implemented on a local scale. By the end of the short term, these developments are widespread.

Mid-term developments
- The integration of resources for city logistics is a development that occurs by the end of the short term and in the beginning of the mid-term period. Sharing of resources is more common and allows the integration of city logistics flows. The sharing of hubs, storage facilities, data and transport solutions is seen as a straightforward solution for urban logistics.
- In the mid-term the Internet of Things (IoT) allows extensive real-time monitoring of the locations and status of goods. In addition to real-time monitoring, IoT will allow increased connectivity of urban logistics among different service providers. The connectivity of urban logistics and the market uptake of Mobility as a Service allow intermodal logistics solutions, combining goods transport with all mobility modes (cargo ‘hitching’).
- Small-scale solutions (home and neighbourhood) for resources and waste resulting from developments in 3D printing, retail, urban farming and local goods storage allow logistics flows in urban areas to be reduced by the end of the mid-term period.

Long-term developments
- Hybrid logistics solutions are widely available, using all mobility modes to transport goods and people. These developments emerge in line with those already referred to in connectivity, personal services and data & traffic systems. Overall, the result is an open logistics system based on physical, digital and operational interconnectivity through embedded interfaces and protocols. These long-term developments are also known as the physical internet.
- Solutions in circular have the potential to disrupt urban logistics flows. New solutions, products, components and materials are designed to constantly maintain the highest value and efficiency.
Values, Motives & Behavioural Change

Short-term developments
- Values, motives and behavioural change are about the way citizens can play an active role in their own and others’ change, driven by different values and reasoning over time. In the short term, this is made possible by promoting bottom-up movements towards healthy behaviour and awareness, for example with education and incentives. The role of the media is crucial for people’s values, motives and behavioural change relating to the use of smart, sustainable mobility solutions. Both traditional (critical) journalism and new (social) media are used in the short term to support and facilitate the transition towards a sustainable society.
- Small-scale initiatives for sustainable and cooperative solutions by individuals, communities and local business are more widespread in the short term. This develops in line with the encouragement of green behaviour so people choose more active mobility options (e.g. bikes or walking). For this purpose, the urban space is redesigned with more green, liveable and attractive areas.

Mid-term developments
- Mid-term developments show that people’s thinking and reasons for traveling will change due to technological developments and Mobility as a Service (MaaS), which reduces the urge to travel and increases the choice of alternative ways of travel. The shift in people’s thinking and reasons for travelling enables demand-driven solutions, in which engaged citizens increasingly demand sustainable and flexible solutions.

Long-term developments
- Social mechanisms, incentives and measures provide help to show people the consequences of their choices by the end of the mid-term and the beginning of the long term. By the end of the long-term period self-improving communities emerge. More specifically, in the long term these communities create value through local and personal initiatives to share and exchange energy and mobility solutions.
Sustainable technologies for a range of applications and industries require integration of smart solutions. Implementation of policies and frameworks aims to promote the uptake of sustainable mobility solutions. Demand-driven solutions encourage engaged citizens to choose more sustainable transport options. Personal influence plays a key role in shaping societal norms around sustainability. Self-improving communities foster local innovation and collaboration for sustainable development.}

**Smart Mobility General Roadmap**

- **2030**: Demand-driven solutions
- **2040**: Personal influence
- **2050**: Self-improving communities

**Key Developments**

- **Demand-driven solutions**
  - Engaged citizens increasingly demand sustainable, flexible solutions.

- **Personal influence**
  - Social mechanisms, incentives and measures provide evidence of the consequences of people’s choices and influences.

- **Self-improving communities**
  - Communities create value by realizing local and personal initiatives in which energy and mobility solutions are shared and exchanged.

**Smart Mobility in 2040**

- **Solutions in circular economy**
  - Encouraging people to choose more sustainable transport options.

**Smart Mobility in 2050**

- **Urban autonomous driving**
  - Cheaper, faster and sustainable transport options for all.

**The R4E project received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No 649397.**
Cooperation & Innovation Networks

Short-term developments
- Cooperation and innovation networks describe how new forms of cooperation between different types of organisations (public-private) evolve over time, speeding innovation and the roll-out of new mobility solutions. In the short term, public parties take active roles in ensuring cooperation between all those involved in the transition towards smart mobility, this is a trend that is already taking place. New forms of cooperation between the different parties – public, private and citizens – are established to speed innovation and the roll-out of new mobility solutions.
- Dynamic innovation networks, including all parties needed for smart mobility solutions, enable an active response to new mobility systems in the short term. Public parties play a leading role in this process by ensuring that other (private) parties have access to public asset such as data, transport data and infrastructure.

Mid-term developments
- As a result of the sharing of assets and other developments, a new value system emerges in the mid-term. This is based on attractive economic systems that enhance the creation of integrated mobility services and solutions.

Long-term developments
- In the long term, expected developments relate to the ‘next economy’, based on value models and overall value for society at large. Finally in the long term, redesigned urban areas release infrastructure for other purposes.
Policies & Legislation

Short-term developments
- Legislative changes and the right policies are important factors in the developments relating to Smart Mobility. In the short term, the implementation of new incentives and measures is stimulated and new mobility solutions and services are scaled-up. In this phase, public parties play an important leadership role in the ethical discussion of privacy and security to safeguard public interest. Technological developments in data security are an important factor in allowing and enabling the discussion of ethical recallibration.
- Frameworks for liability continue to develop in the short term. The availability of insurance for new asset ownerships and sharing models drives the penetration of sustainable mobility modes and the shift towards Mobility as a Service. Proactive local regulation encourages the adoption of smart, sustainable mobility solutions. At the same time it discourages the use of polluting vehicles, for example by regulating time slots or flexible use of infrastructure.

Mid-term developments
- In the mid-term, there is more openness in terms of new frameworks for accessibility of data systems and mobility systems. The openness of these data and mobility systems takes into account national privacy issues. The way national privacy is handled, together with EU legislation, also enables the scaling-up of innovative mobility solutions, for example with scalable legislation for taxi services such as Uber.

Long-term developments
- Frameworks and long-term legislation at both national and EU level ensure global data privacy. In the long term, experts expect to see a total value system in which data is value for its societal benefits instead of purely in terms of economic value. This creates a level playing field for sustainable solutions.

New value systems
Attractive economic systems to enhance the creation of integrated mobility services and products.

Globalisation
Data privacy and legislation at a global level.

The ‘next economy’
The ‘next economy’ based on value models and integrated value for society at large.

Total value
Data is valued based on ‘value for society,’ instead of purely by economic value — this creates a level playing field for sustainable solutions.

Public living area
Redesign of urban areas to release infrastructure for other purposes.

2030
2040
2050
SMART MOBILITY ROADMAP ISTANBUL – PUBLIC TRANSPORT

**SMART INFRASTRUCTURE**
- Expanding and exploiting more efficient use of existing infrastructure and construction of new physical infrastructure (braces, hubs etc.) to accommodate growing mobility demand.
- Physical separation of flows: Separation of lanes and the design of infrastructure for flexible use over time, aligned with growing diversity of (sustainable) mobility modes.
- Smart solutions: Increase intelligent assets, e.g. sensors, cameras, RFID tags and inducive loops for detection and energy generating constructions e.g. solar roads.
- Re-designing dedicated areas: Creating areas for e.g. intermodal hubs, green corridors for cycling and walking, e-bike highways, e-vehicle charging systems and areas for autonomous vehicles.
- Energy-efficient solutions: Increased availability of new solutions for fast charging of (many, electric) vehicles e.g. inductive charging and increased local storage of energy.
- Proactive infrastructure: Increasing the intelligence of physical infrastructure to proactively adapt to changing demand, e.g. smart charging and adaptive road marks.

**SMART MOBILITY MODES**
- Optimising mobility modes: Increasing efficiency, drive trains (e.g. plug-in hybrid electrical vehicles), comfort and safety of mobility modes.
- New mobility modes: New solutions for specific mobility demands, e.g. e-bikes, hover boards, e-scooters.
- Sustainable technologies for lightweight vehicles: Sustainable technologies for a range of light vehicles, e.g. electric and hydrogen powered.
- Full-electric lightweight vehicles: A wide range of models of full-electric vehicles provide freedom of choice for users.

**CONNECTIVITY & ROBOTISING**
- On-board automation: Development of on-board solutions to enhance safety, comfort and fuel economy, e.g. by sensors and monitoring.
- Communication with environment: One-directional communication from vehicles to the environment for less critical purposes, e.g. with infrastructure, people and goods.
- Enhanced traffic management: Smart infrastructure enables fast real-time information management, and control of traffic flows and crowds.

**DATA & TRAFFIC MANAGEMENT SYSTEMS**
- Occasional interoperability of data sources: Different data sources (open, private) are occasionally combined by means of open protocols.
- Enhanced traffic management: Smart infrastructure enables fast real-time information management, and control of traffic flows and crowds.

**PERSONALISED SERVICES**
- New mobility services and sharing initiatives: Based on (open) data and matching of supply and demand, enabling new, disruptive mobility services, e.g. Uber, mytaxi, car2go.
- Booking and billing services: Integrated booking and billing services across multiple public transport solutions (e.g. one city card for public transport services).
- Individual services: Merging of shared data sources (e.g. weather forecast and demand) enables more relevant information and customized services.

**URBAN LOGISTICS**
- Small-scale logistics solutions: Small scale solutions to make city logistics streams more efficient, e.g. pick-up points.
- Efficiency improvement of urban logistics: Efficiency improvement by means of cargo ‘hitching’ between different logistic service providers.
- Lightweight logistic solutions: New technological solutions for lightweight logistic (e.g. drones and robot delivery of small packages).
- Optimising logistics flows: Optimising physical logistic flows by using time slots (e.g. night deliveries) and usage rate of infrastructure (e.g. urban spaces).

**SUSTAINABLE TECHNOLOGY**
- Supporting sustainable and healthy choices: Promoting bottom-up movements towards healthier behaviour and awareness, e.g. through education and incentives.
- Deployment through media: Traditional media (critical journalism) mediate in the transition towards a more responsible urban transport system.
- Supporting sustainable and healthy choices: Promoting bottom-up movements towards healthier behaviour and awareness, e.g. through education and incentives.
- Small-scale initiatives: Supporting initiatives by individuals, communities and local businesses to implement and support sustainable, cooperative solutions.
- Dynamic innovation networks: Dynamic innovation networks (including all parties necessary for smart and sustainable mobility) to enable active response to sustainable new mobility systems.

**VALUES, MOTIVES & BEHAVIOURAL CHANGE**
- Active role of government: Public parties take the lead to ensure cooperation among all parties in the transition towards smart and sustainable mobility, e.g. in tendering procedures.
- New forms of cooperation: New forms of cooperation between different parties (public – private – citizen) to speed innovations in mobility solutions.
- Dynamic innovation networks: Dynamic innovation networks (including all parties necessary for smart and sustainable mobility) to enable active response to sustainable new mobility systems.
- Framework for liability: Insurance for new conveniently and sharing of assets (e.g. who is responsible?) to promote the adoption of sustainable mobility modes.

**SUSTAINABLE ORGANISATION**
- New incentives and measures: Implementation of new incentives and measures to promote and scale-up new mobility solutions and services.
- Ethical recalibration: Public parties take the lead in an ethical discussion of privacy and security to safeguard public interest.
- Ethical recalibration: Public parties take the lead in an ethical discussion of privacy and security to safeguard public interest.
- Framework for liability: Insurance for new conveniently and sharing of assets (e.g. who is responsible?) to promote the adoption of sustainable mobility modes.

**Cooperative driving technology**
- Technologies to communicate, react and respond between new vehicles, enabling e.g. (truck) platooning in all areas.
- MILESTONE 2020
- Electric heavy-duty vehicle solutions for limited range: Extension of available heavy-duty vehicle that provide clean and silent solutions for in-city transport (fast role).
- Cooperative driving technology: Technologies to communicate, react and respond between new vehicles, enabling e.g. (truck) platooning in all areas.
- MILESTONE 2020
- Electric heavy-duty vehicle solutions for limited range: Extension of available heavy-duty vehicle that provide clean and silent solutions for in-city transport (fast role).
- Integration of cities: Sharing of resources to integrate city logistics flows by sharing hubs, storage, data and transport.
- Connected urban logistics: Internet of Things allows real-time monitoring of locations and status of goods, and connecting between urban logistics among different (urban) logistics service providers.
- Conscious decisions: People’s travel reasons and purpose specific, reducing the urge to travel and increasing the choice to use alternative forms of travel.
- Responsible sharing of assets: Public parties ensure access by other parties to public assets, e.g. public transport data and infrastructure.
- Openness: New frameworks for accessibility and openness of data streams and mobility systems, including coverage of national pricing revenues.
- Scalability: EU legislation to ensure scalability of innovative mobility solutions, e.g. scalable legislation for Uber.
Elements of the desired future scenario are:

- Self-organising energy system
  - Integrated system that matches supply and demand for sustainable energy.
- Sustainable technologies for a range of applications, such as lightweight vehicles
  - 'Solar roads'.
- Sustainable energy is widely available and affordable as a result of large-scale solutions, e.g. wind and solar parks and alternatives.
- Less physical urban infrastructure
  - Less physical infrastructure for mobility in cities due to sustainable mobility solutions, enabling a green living environment.
- Innovative heavy infrastructure
  - Cheaper, faster and sustainable technologies for heavy infrastructure (e.g. roads, railway) and constructions (e.g. tunnels and bridges).
- Abundant renewable energy
  - New engineering technologies to make infrastructure for light weight vehicles e.g. unfolding bike paths.
- Connected energy systems
  - Biocatalytic grids and systems to generate, store, use and exchange of energy between infrastructure, buildings, vehicles etc.
- Affordable full-electric lightweight vehicles
  - All kinds of full-electric vehicles are more affordable for the mass market than conventional polluting (combustion) engines.
- Autonomous buses
  - Connected, automated buses can drive autonomous outside controlled areas on dedicated routes with dedicated bus stops.
- Self-learning traffic
  - One integrated smart system for intermodal transport (private and public, passengers and goods) based on different data sources.
- Intermodal logistics solutions
  - Combining transport of goods with all mobility modes (cargo hitching).
- Reduced logistics flows
  - Small-scale solutions (house and neighborhood) for resources and waste, due to developments in 3D-printing, retail, urban farming and waste treatment.
- Hybrid logistics solutions
  - Combining transport of goods and people with all modes (hitching), e.g. by using multifunctional drains, smaller (shared) vehicles or pipelines.
- Personalised travel advice
  - (Personal) advice across different modality platforms based on shared services creates a more efficient system (combining people and goods).
- Demand-driven services
  - Sustainable energy is widely available and affordable as a result of large-scale solutions, e.g. wind and solar parks and alternatives.
- Adaptive vehicles
  - Artificial intelligence within the vehicle for user comfort, adaptation based on user profile and personal preferences.
- Full cooperative driving technology
  - All vehicles (fast, reliable and secure) are monitored for continuous improvement.
- Open and connected platform
  - Flexible choices, affordability and services (e.g. based on widespread data sharing of traffic information).
- Solutions in circular economy
  - New solutions, e.g. up-cycling, aimed at ensuring constant high usability and value of products, components and materials.
- Physical internet
  - Open logistic system based on digital, physical and operational interconnectivity, through encapsulation, interfaces and protocols.
- Self-improving communities
  - Communities create value by realizing local and personal initiatives in which energy and mobility solutions are shared and exchanged.
- Public living area
  - Redesign of urban areas to release infrastructure for other purposes.
- The ‘next economy’
  - The ‘next economy’ based on value models and integrated value for society at-large.
- Total value
  - Data is valued based on value for society instead of purely for economic value – this creates a level playing field for sustainable solutions.

Desired future scenario:

In 2050, a clean and green healthy environment is valued by the citizens of Istanbul. Travellers appreciate the wide range of alternative routes and forms of transport. Public transport benefits everyone by providing good accessibility to all modes of transport. These are seamlessly integrated, providing a closely-knit network that reaches every part of the city while respecting its historical heritage.

- Travelers choose sustainable and healthy options. Public transport provides a single route to people’s destinations, without delays caused by changes between modes. Travelers value the availability of accurate, up-to-date and cross-modal information. This enables them to choose the best options as and when they need them, taking into account changing situations and travel availability.
- The public transport systems use renewable energy resources.
- Elements of the desired future scenario are: A clean and green city.

In 2050, Istanbul is a clean and green city. A whole new city concept has been created around emission-free and ecological buildings with green roofs and waste recycling. In green areas all over the city residents enjoy walking, cycling and fridays and urban gardening. Pedestrian routes and floating gardens connect the areas. Citizens are energy-aware, a tree is planted for each child’s birthday. Energy efficiency and sustainability are monitored for continuous improvement.

Seamless transport and pleasurable travel experience

Istanbul has an integrated transport system that provides door-to-door service. Buses, trams, automated vehicles, trains, shared cars and shuttles are all integrated into one, easily accessible system. New modes of transport and innovative vehicles are also integrated, like autonomous vehicles in the city air and on water. The integration of smaller units (personal or larger) into larger ones (buses or trains) allows transportation management by an autonomous system.

Public transport provides a pleasurable and comfortable travel experience. The BRT (bus rapid transit) system allows people to travel in their own units, which are transformed into DRTs (demand responsive transit) with VIP services. People can easily travel between all vehicles at hubs. These are real experience centers, with shopping, cinemas, and theaters.

Personal travel assistant

Everyone has a virtual ‘angel’-guide for personal travel advice whenever they are, free of charge. All the ‘angels’ are connected to the cloud for accurate, up-to-date, cross-modal information. They give warnings of storms or traffic, help get to care of emergencies or prevent accidents by warnings. They balance capacity in the system, important city parameters (energy, air quality, etc.) and personal health parameters.

Privacy & Security

People feel comfortable and safe, because only the ‘angels’ have access to personal data. In 2050, the transport systems in Istanbul are also personalized as well. For example, the biometric information used to identify people at entry points is also used to identify suspicious persons and activities. Personal data banks have a virtual shield to ensure confidentiality and privacy, and guard against hacking.

MILESTONE 2030

A clean and green city.

In 2030, Istanbul is a clean and green city. A whole new city concept has been created around emission-free and ecological buildings with green roofs and waste recycling. In green areas all over the city residents enjoy walking, cycling and fridays and urban gardening. Pedestrian routes and floating gardens connect the areas. Citizens are energy-aware, a tree is planted for each child’s birthday. Energy efficiency and sustainability are monitored for continuous improvement.

Lightweight logistic solutions

Sustainable energy is widely available and affordable as a result of large-scale solutions, e.g. wind and solar parks and alternatives.

Innovation infrastructure for lightweight vehicles

New engineering technologies to make infrastructure for light weight vehicles e.g. unfolding bike paths.

Connected energy systems

Biocatalytic grids and systems to generate, store, use and exchange of energy between infrastructure, buildings, vehicles etc.

Affordable full-electric lightweight vehicles

All kinds of full-electric vehicles are more affordable for the mass market than conventional polluting (combustion) engines.

Autonomous buses

Connected, automated buses can drive autonomous outside controlled areas on dedicated routes with dedicated bus stops.

Self-learning traffic

One integrated smart system for intermodal transport (private and public, passengers and goods) based on different data sources.

Personalised travel advice

(Factual) advice across different modality platforms based on shared services creates a more efficient system (combining people and goods).

Demand-driven services

Flexible choices, affordability and services (e.g. based on widespread use of dynamic personal matching diversity in needs and lifestyles.

Hybrid logistics solutions

Combining transport of goods and people with all modes (hitching), e.g. by using multifunctional drains, smaller (shared) vehicles or pipelines.

Open and connected platform

Flexible choices, affordability and services (e.g. based on widespread data sharing of traffic information).

Solutions in circular economy

New solutions, e.g. up-cycling, aimed at ensuring constant high usability and value of products, components and materials.

Physical internet

Open logistic system based on digital, physical and operational interconnectivity, through encapsulation, interfaces and protocols.

Self-improving communities

Communities create value by realizing local and personal initiatives in which energy and mobility solutions are shared and exchanged.

Public living area

Redesign of urban areas to release infrastructure for other purposes.

The ‘next economy’

The ‘next economy’ based on value models and integrated value for society at-large.

Total value

Data is valued based on value for society instead of purely for economic value – this creates a level playing field for sustainable solutions.

2030

2040

2050
The cities plotted the presented current and future projects on a matrix, indicating when the result of the project would be visible in the city (horizontally) and the expected impact on the city, in terms of energy or emission (vertically).
Project portfolio
The aim of Step 4 is to develop a portfolio of projects that the cities can work on – individually or jointly – and that help them to reach their desired future scenarios. The cities created an overview of running projects, and in a joint meeting they selected common ambitions that they all want to pursue. The new projects have to explore many new ways forward. This means that new project proposals are worked out in specific project plans, all relating to the learning opportunities between cities. The financial opportunities are also explored in this step.

Joint workshop
In a joint meeting in Newcastle the cities presented current projects and proposals for new projects based on their city-specific roadmaps. They held in-depth discussions to understand their shared and specific learning objectives and opportunities for joint projects. First, the cities presented their projects and plotted them on a poster to show when the results will be visible in the city and how they will impact energy and emissions in the city. The picture at the left on the previous page shows the result of this first part of the workshop.

Secondly, a marketplace was held in which city representatives could put forward themes for further development into project portfolios. A theme is a challenge to become a smart city with the ability to grow into a project programme. The themes build on the running and new projects presented by the cities. In the marketplace, each city took on the role of ‘seller’ of a theme and proposed it to ‘buyers’. The buyers supported the themes, and were able to enrich them by ‘negotiation’ to include objectives which they considered important. If three cities ‘bought’ a theme, it was accepted. The marketplace resulted in 14 themes. Together it was decided to merge some of these themes. This left 10 themes for further elaboration in groups.

Thirdly, the cities worked in groups to elaborate the themes by describing their objectives, relevant projects and innovation opportunities. The resulting rich discussion combined the insights of all the experts, and built on the visions and roadmaps. The groups then presented their proposals in a plenary session, after which all the cities described their learning objectives related to the themes.

Towards a project portfolio
The themes defined in the joint workshop will be further developed into project portfolios that contain local projects in the cities, but also joint projects, all forming part of the project portfolio. The project portfolios are not included in this report as they will not be made public.
Running Projects Smart Mobility Istanbul - Public transport

1 BLACK BOX FOR SUSTAINABLE PUBLIC TRANSPORT

This system analyses location, temperature, route and distance information and reports vehicle and driving data such as speed, fault information, fuel pressure and oil pressure. These notifications are monitored by Public Transport Monitoring Centre which intervenes immediately in the event of an incident. The black boxes have the capacity to save six months of information.

2 REMOTE MONITORING OF PUBLIC TRANSPORT VEHICLES

In order to keep track of all public transport vehicles in Istanbul, IMM started to install surveillance cameras in minibuses, taxis, and shared cars. All those vehicles are remotely monitored from Transportation Management Centre of IMM and Police Department to avoid any negative/social events which may happen and affect people in Istanbul.
New Project Ambitions Smart Mobility Istanbul

1. **CycleST**
   - Istanbul Metropolitan Municipality gives importance to expand the bicycle roads within its road network. For this reason, IMM will soon create its Bicycle Master Plan and based on this master plan, Istanbul will have 500km bicycle roads along with 3000 shared bikes which will facilitate transportation for short distances and access to public transport. At the end of 2023, Istanbul will have 1050km bicycle roads.

2. **SMART TRANSFER HUBS**
   - IMM plans to build smart transfer hubs in Istanbul so that the city’s public transport network becomes fully integrated with each other. These transfer hubs will not only be integrated with existing public transport options, but they will also be locations full of social facilities such as malls, information desks, ATMs, rest areas, etc. Those hubs will include parking lots for buses, minibuses, bicycles, too.

3. **iTAXI**
   - Taxi application to utilize taxis efficiently and effectively which have a considerable share in transport. It will help taxis avoid wasting time and fuel consumption while looking for passengers in streets. It will enable passengers to find closest taxi and help save energy. Taxis will be managed remotely by a centre and the communication between taxi driver and passengers will be recorded to improve service quality and passenger satisfaction.

4. **MONORAIL OF ISTANBUL**
   - Istanbul (and Turkey) will have its first monorail between Küçükçekmece - Sevakay and Basaksehir which will be integrated with Istanbul’s public transport network. The tender process has been completed and the contract phase is in progress. The construction of monorail is scheduled to begin in April 2017 and it is planned to service in the first quarter of 2019.
CONTRIBUTIONS

The results in this project are co-created with many stakeholders in the cities. We would like to thank all participants for their valuable contributions.

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SMART MOBILITY
Ambition, Vision & Roadmap

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This report contains the results of the ambition setting, vision development and roadmapping activities for smart mobility / smart public transport in the city of Istanbul. Workshops were conducted with policy makers, strategy departments, integral project managers, department managers and external stakeholders and strategic partners to define a shared ambition, create a desired future scenario, develop a city specific roadmap and identify initial (local) solutions and research projects to achieve the desired future in the specific context of the city. The participants will continue working on the project portfolio.

This report is the final public deliverable of the Roadmaps for Energy (R4E) project. The R4E partners work together to develop a new type of energy strategy through visions and roadmaps for the 8 partners cities, in co-creation with local stakeholders. The project supports the development of envisioning and roadmapping capacities within the municipalities to spur future development and implementation of innovative energy solutions.