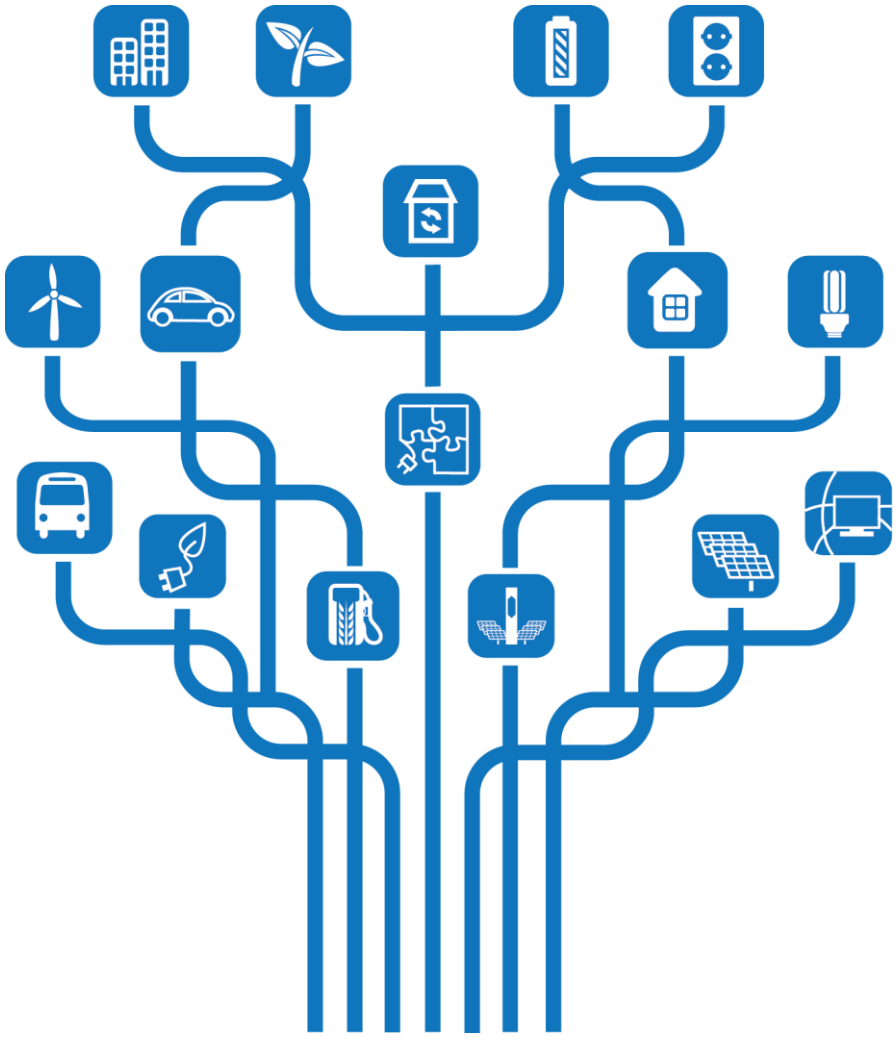
Strategic Energy Technology (SET) Plan

Towards an Integrated Roadmap: Research & Innovation Challenges and Needs of the EU Energy System

ANNEX I: Research and innovation actions

Part III – Fostering Innovation in Real Environments and Through a Market – Driven Framework



Acknowledgements to Drafters and Contributors

in alphabetical order

Climate Alliance of European Cities with Indigenous Rainforest Peoples (Climate Alliance)

European Industrial Initiative on the Electricity Grids (EEGI)

European Innovation Partnership on Smart Cities and Communities (SCC EIP)

European Platform of Universities Engaged in Energy Research (EPUE)

European University Association (EUA)

International Association representing the District Heating and Cooling and Combined Heat and Power sector (Euroheat&Power)

Multinational Company Air Liquide (Air Liquide)

The European Innovation Partnership on Smart Cities and Communities (EIP-SCC)

The Union of the Electricity Industry (Eurelectric)

		Number	Investments (M Euro) (when available)
Headings		4	1 818
Challenges		7	
Proposed R&I Actions/Programmes	**ARP**	0	0
	IRDP	26	1 102
	IMUP	19	716

TABLE OF CONTENTS

INTRODUCTION:

Part III focuses entirely on smart cities and communities. This reflects the belief that cities, with their high densities of both population and infrastructures, are the hotspots where energy innovations will be first implemented – and will have the most direct impact. This does not mean that cities are the only environments in which the innovations highlighted in parts I and II will grow to fruition and be introduced to the market. While being complex entities that present a high diversity of stakeholders all looking for appropriate energy solutions, local authorities (i.e. city councils) can steer the development of the city as a whole. As such they are the ideal breeding ground for realistic pilots and first-of-a-kind actions that move solutions out of the laboratory and into real life.

Smart cities and communities play a key role in the energy transition, because of their importance in both economic and ecological impacts. Ecologically speaking the emission of cities, caused by its residents and businesses, its energy infrastructure and its mobility system, represent a major part of the overall emissions of the EU. Reducing them will therefore have a major impact. Economically speaking there is a huge opportunity for Europe in deploying the integrated systems and solutions that are needed to reach the climate and energy goals. The sheer size of this challenge, combined with its highly complex nature and strong local embeddedness of the solutions, means turning cities into smart ones will provide a lasting impetus to the European economy as a whole.

Part III will first look into the challenges linked to each of the sectors mentioned before (buildings and districts, energy infrastructure, mobility) and highlight the actions that are needed – both technologically and non-technologically – to address them. The focus is entirely on combining solutions and successfully putting them into practice in complex city environments. Therefore, part III focuses on the actions related to planning, support to decision-making and exchange of information and best practices that will enable the deployment of the technologies and the innovative solutions developed under the actions in parts I and II -links should be ensured in particular with the actions on energy efficiency, development of renewable technologies and the System Integration heading in part II- and there are no advanced research programmes in this part. The industrial research and the market uptake programmes, however, are substantial and strongly interlocked. This must support the work that is needed on integration and the creation of system-level solutions that provide answers to the needs of cities and their stakeholders. This combination of technology push and especially support to innovation and market uptake is crucial for smart cities to live up to their full potential.

HEADING 1: Promoting Sustainable Districts and Built Environment

Challenge 1: Low Energy/Climate Neutral Districts

KEY ISSUES

- Enabling the reduction of energy use, environmental impact and carbon footprint at district level:
  - Scale up significantly the upgrading of existing buildings with sustainable and affordable retrofitting solutions.
  - Low carbon solutions for new buildings and districts through the use of local RES, smart energy networks.
- Introducing and spreading new technological solutions at district level:
  - Replication and scaling up of solutions, technology and materials.
- Integration and streamlining of energy systems:
  - Optimal management of energy demand, supply, storage.
  - Introduction of user-friendly multi-utility solutions.
- Mobilizing sufficient resources including private ones:
  - Enable public-private partnerships between industries and cities.

INDUSTRIAL RESEARCH AND DEMONSTRATION PROGRAMME

Action 1: New integrated decision tools for refurbishment of districts

Scope: The building stock representing 40% of EU final energy demand, there is a need for a broader uptake of the existing and the upcoming affordable and sustainable retrofit solutions at a large scale in order to make districts and cities sustainable. In the last decades industry has developed a wide range of solutions for renovation and energy efficient/positive buildings based on innovative and existing materials and products (including green solutions), new lighting, heating and cooling systems and combinations of these.

The uptake by citizens and cities of the renovation solutions developed in the last decades does not only require advances in performance and reduction of costs but also a sound basis for cities to take decisions on the investments to be carried out. Therefore, it is necessary to assess the retrofitting potential in cities and districts and to analyse the optimal mix of measures. To do so it is necessary to create new integrated decision tools (simulation, diagnosis and modelling instruments, visualization/virtualization, open data/information platforms) for the various stakeholders (citizens, operators, industries and in particular local authorities). A first step is to collect and review the existing decision tools for near zero buildings and districts, selecting the most commonly used ones and analysing the user target groups and the main input and output values. By assessing the existing gaps it will be possible to collect new data (on materials, technologies, etc.) that allow the improvement of existing decision tools and the creation of new and more comprehensive ones, adapted to various stakeholders' needs.

Deliverables:

- Frameworks for understanding cities' and stakeholders' needs/drivers in district-level renovation
- Set of new multi-stakeholder decision tools developed.

Expected impact:

- Significant increase in the number of near-zero-energy district development projects.

KPIs:

- Amount of new investments decided upon by using the above decision systems.
- 50% of EIP cities' administrations implementing the new tools in their workflow.

Costs: EUR 10 - 15 million.

Timeline: 1 - 3 years.

Modality of Implementation: European level.

Action 2: Integration of decision tools for existing and near zero buildings and districts

Scope: On the basis of the upgraded and new decision tools resulting from the Advanced Research programme, a more holistic view will be developed by integrating those tools in the different perspectives for city and district design. To enable the use of the knowledge on decision-taking processes of the different stakeholders in urban planning, it is necessary to review the interfaces of different tools and identify and implement the possibilities to connect or integrate the various tools. New or upgraded interfaces will be developed and tested.

Based on the selection of the most promising sets of tools, their integration will be carried out with the aim of providing a toolkit that enables multi-stakeholder analyses of different spatial and domain perspectives as integrated ecosystems.

Deliverables:

- Integrated multi-criteria toolkits for existing and new near-zero buildings and districts.

Expected impact:

- Significant increase in the number of near-zero-energy district development projects.

KPIs:

- Number of decision tools and interfaces integrated.

Costs: EUR 6 - 8 million.

Timeline: 1 - 3 years.

Modality of implementation: European level.

Action 3: New auditing, monitoring and data quality criteria for the renovation of districts.

Scope: Local strategies for renovation aiming at bringing the districts to nearly zero-energy building levels vary from city to city. It is essential to assess and measure the performance of cities and districts and the impacts of the decisions adopted so as to progressively improve the definition and implementation of local policies in this field.

In order to improve the evaluation tools at the disposal of local authorities it is also necessary to access quality and quantity of existing data for auditing and monitoring for existing and new buildings and districts and to identify possible gaps. On this basis, new criteria for data and information on issues such as CO2, the use of energy, gas, water, etc. and the need for additional data on technologies, materials and other solutions needed to enable the improvement of the auditing tools will be defined –taking into account privacy aspects-.

Deliverables:

- Assessment (quality and quantity) of existing data for policy evaluation.
- Definition of new criteria and scoping of additional data needed for auditing local policies.

Expected impact:

- More systematic and more cost-efficient audits of existing city districts.

KPIs:

- 80 of data needed that is (already) available.
- 25 of new criteria integrated in assessment tools.

Costs: EUR 2-4 million.

Timeline: 1 - 2 years.

Modality of Implementation: European and national.

Action 4: Definition of auditing tools and systems for the renovation of districts

Scope: Based on the data collected in the advanced research programme and the new criteria defined for auditing of the performance of buildings and districts, it is necessary to develop auditing methods adapted to the needs of local authorities for the evaluation of districts' energy performance and local policies in this area.

This action would focus on the integration of new data and criteria and existing auditing methods (and data) to develop comprehensive auditing tools and systems for the renovation of districts. These tools should be developed in close collaboration with end-users, not only local authorities but other stakeholders such as energy utilities, to ensure the adaptation to their needs and capabilities.

Deliverables:

- Auditing methods tools and systems developed.

Expected impact:

- More systematic and more cost-efficient audits of existing city districts.

KPIs:

- Number of auditing tools and systems applied.
- Number of stakeholders involved in the development of auditing methods.

Costs: EUR 10 - 15 million.

Timeline: 2 - 3 years.

Modality of implementation: European and local.

Action 5: Solutions linking networks and storage at district level to automated buildings

Scope: A number of technologies, materials and products for refurbishment have been developed and its combination enables the advancement of energy efficient/positive buildings and solutions have been developed.

However, some of these solutions might need to be deployed outside of the building as such (e.g. storage solutions serving several buildings, energy generation from renewables at district level) and the interconnections and interplay of the solutions in automated buildings with the distribution grids at local level needs to be assessed and ensured. An example would be the development of technologies to store and release energy from electric vehicles, the deployment of solar charged lampposts or the solutions and infrastructure required to share energy with other buildings in the districts.

This action focuses on the development of solutions at district level linking smart energy (district/city) networks and energy storages to zero energy buildings and building automation tools in order to enable the large scale deployment of zero energy new districts.

Deliverables:

- Comprehensive solutions at district level linking smart energy (district/city) networks and energy storages to buildings.

Expected impact: Increased efficiency of the local energy system because of tighter integration between networks and buildings.

KPIs:

- Number of solutions developed and commercially deployed.

Costs: EUR 100 million.

Timeline: 3 – 6 years.

Modality of Implementation: European.

Action 6: Integration of storage and grid applications adapted to districts

Scope: The generation, storing and grid applications at district/city level developed in action 3 of the Advanced Research Programme need to be integrated and demonstrated in real environments. The combination of the various solutions will improve district level energy efficiency. The links with technical building solutions and building automation systems will improve the performance of zero energy buildings.

Due to the scope beyond single buildings, the demonstration of these solutions will require the cooperation not only with district/local authorities but also the involvement of other stakeholders, such as energy cooperatives, aggregators, neighbourhood associations, etc. Financial models need to be identified and tested.

Deliverables:

- Pilot projects integrating storage and grid applications adapted to districts.

Expected impact:

- Increased efficiency of the local energy system because of tighter integration between networks and buildings.

KPIs:

- Number of actors/districts/cities involved in the piloting actions.

Costs: EUR 100 million.

Timeline: 4 - 8 years.

Modality of implementation: European, local.

INNOVATION AND MARKET-UPTAKE PROGRAMME

Action 1: Piloting of digital platforms for integrated multidisciplinary collaborative design and planning

Scope: In order to allow the integration of scalable design and multi-criteria across cities, the integrated toolkit for multidisciplinary collaborative design and planning needs to be piloted in real environments.

The pilot projects would be done through the establishment of digital platforms which include user-friendly tools for co-simulation and optimization of complex interactions in different domains, virtual environments for viewing and commenting designs, and tools for assessment of multiple solutions and materials. The use of this toolkit should allow participatory planning of districts and /or cities.

Furthermore, the dissemination activities following the pilot projects and the development of e-learning applications and user-oriented cognitive data visualizations are necessary to foster wide scale implementation in Member States.

The final aim is the development of national frameworks for continuous work to implement integrated tools for district and city planning and operation.

Deliverables:

- Digital platforms for integrated multidisciplinary collaborative design and planning.
- National frameworks for continuous work to implement integrated tools for district and city participatory planning.

Expected impact:

- Significant increase in the number of near-zero-energy district development projects.

KPIs:

- Number of pilot projects.

- Number of cities and stakeholders using the digital platforms.
- Number of national frameworks for district and city participatory planning.
- Money saved as compared to BAU.

Costs: EUR 30 million.

Timeline: 2 - 5 years.

Modality of implementation: European and national level.

Action 2: Piloting of auditing frameworks to enable their roll-out on a large-scale

Scope: Comprehensive auditing frameworks based on the tools developed under the industrial research programme should be tested and piloted in real environments. Pilot projects in different cities should be monitored and criteria for the evaluation of the audited districts and cities should be defined. Evaluation should comprise the auditing tools as such as well as the actual performance of districts and cities and the impact in the renovation policies at local level, not only on the definition but also in the implementation and results. This evaluation should include feedback gathered from local authorities and other stakeholders and would allow an improvement and further development of auditing and monitoring methods.

Deliverables:

- Number of pilot projects.
- Evaluation and improvement of monitoring frameworks.

Expected impact:

- More, more systematic and more cost-efficient audits of existing city districts.

KPIs:

- Number and size of audited districts/Cities.

Costs: EUR 30 million.

Timeline: 3 - 4 years.

Modality of implementation: European and local.

Action 3: Integration of holistic zero energy district solutions in city design/perspectives

Scope: Once demonstrated, the upscaling of holistic zero energy district solutions linking district supply, storage and networks will require substantial efforts to be replicated across Europe. Results of the pilot projects and best practices will have to be disseminated to other cities and the potential to adapt them to different urban environments needs to be assessed. Financial models and collaboration mechanisms between public and private actors need to be further developed. Capacity building activities for local authorities will be carried out.

The ultimate goal of this action is to promote the inclusion of holistic zero energy solutions adapted to districts in planning policies.

Deliverables:

- Framework for the integration of holistic zero energy district solutions in city design.

Expected impact:

- Improved efficiency of local energy systems.

KPIs:

- Number of cities adopting policies for deploying holistic zero energy district solutions.

Costs: EUR 10 - 15 million.

Timeline: 2 - 3 years.

Modality of implementation: European and local.

Action 4: Replication of (proven) refurbishment solutions to cities and districts with specific typologies and characteristics

Scope: Renovation materials and solutions need to be adapted to the geographical, demographic and climate conditions of the cities. While local industries develop technologies and materials taking into account these factors, some solutions developed in one region would need to be adapted to be equally effective and replicable in other regions.

Adapting to the typology and specific characteristics of districts makes optimization of the energy efficiency solutions at district level possible, and it could lead to better, combined solutions in the public and private space.

It is necessary to develop collaboration mechanisms between cities and companies throughout Europe to promote the replication of solutions by adapting technologies and materials to different environments.

The focus of this action should be the adaptation of solutions which have been tested or deployed in a specific environment to local circumstances of other cities and regions and to enable the dissemination of adapted solutions to cities of similar characteristics. A first step should be the collection of data and the development of a database with solutions specific to a certain environment or which have been deployed/tested only for certain regions and not throughout Europe, followed by an analysis of the potential for adaptation. Adaptation of solutions should be tested and validated in real environments. Furthermore, to enable replication of these solutions, specific dissemination actions should be undertaken to raise awareness of local authorities and to integrate new approaches in urban planning and energy planning.

Deliverables:

- Solutions adapted to and tested in relevant environments.

Expected impact:

- Greater uptake of energy efficiency solutions at district level.

KPIs:

- Number of pilot projects carried out and number of cities/regions involved.

Costs: EUR 100 million.

Timeline: 2 - 3 years.

Level of implementation: European and regional (supra-national).

Action 5: Promotion of the integration of renovation projects in overall urban planning and energy planning through the development of training schemes for local employees, including civil servants, and urban planners

Scope: The tools, solutions and approaches developed throughout the actions of these industrial research and market uptake programs, need to be understood and mastered by the local authorities that will work with them. Therefore the standard training schemes for all public sector employees involved will have to deal with the conception, development and management of integrated refurbishment projects.

Integrated projects with different (public and private) stakeholders pose particular legal issues. Special attention will therefore have to be paid to questions of PPP, procurement of innovation and state-aid for renovation.

Deliverables:

- Full training package on integrated city refurbishment.
- 25 cities piloting the training package with their employees.

Expected impact:

- Sharp increase in the uptake of innovative integrated refurbishment methods by European cities.

KPIs:

- Number of cities piloting/deploying the training packages.

Costs: EUR 2 - 4 million.

Timeline: 3 – 6 years.

Modality of implementation: European and local.

HEADING 2: Developing Integrated Infrastructures and Processes

This heading focuses on integrating innovative energy infrastructures in the physical and social fabric of city districts. The objective is to transform cities into smart environments with the aim to improve the citizens' daily lives. Innovative city solutions have to be triggered and to be replicated in particular in those places where synergies between energy facilities of different kinds (production, distribution) and ICT can be exploited, facilitating their evolution towards advanced and innovative services and functionalities.

The idea behind the interaction of different facilities is to optimize their presence and use, saving asset' and operational' costs and providing innovative products and services. Nowadays, cities are composed of a number of networks – ICT, electricity, gas, heat, cooling, transport, water, wastewater, street lighting etc. – which are developed in parallel, with no real interaction sometimes even on a competitive basis. In order to reach the common goals of decarbonizing the economy and securing the energy supply without negative influence on comfort level and growth, a new approach is needed.

Challenge 1: Networks of infrastructures

This challenge aims at the development of the next generation of urban network infrastructures (gas, water, heat/cooling, electricity, street lighting, transport, etc.). The goal is to increase efficiency and improve their functionality by exploiting synergies among existing infrastructures. Telecommunication networks integrating new ICT solutions should provide new services and capabilities to operate different networks. The use of new cross-network equipment would allow efficient collection, analysis and interpretation of data as well as control and operation of integrated networks. The development of new, innovative solutions will decrease investment costs and operating costs on the existing infrastructure through a new way of exploiting and operating them. To adapt all these solutions to the network infrastructures, standardisation and interoperability compatible for all networks are necessary.

KEY ISSUES

- Design of next generation of urban network infrastructures:
  - Upgrade existing urban network infrastructures in an integrated way where existing and new infrastructures must cooperate while cities are in operation.
  - Optimize capital and operational costs of the resulting infrastructures through cooperation amongst cities.
  - Develop ICT solutions and networks which involve the extensive use of real-time data collection.
- Building links between crucial network infrastructures.
- Integration of electrical and transport infrastructures.
- Quantify and demonstrate the value of integrating across different types of infrastructure promoting large scale demonstration projects:
  - Test within real local scale environments how far the integration of infrastructures can be achieved taking into account different climate and regulatory environments.

Action 1: Optimization of urban space devoted to networks

Scope: The existing network infrastructures have been deployed in the past following independent programs and separated ownership of the urban or rural spaces employed. A different approach is needed in which the planning of spaces devoted to the different networks (water, waste water, electricity, gas, heating/cooling…) should be studied since a common vision of the spaces is missing.

Deploy networks in urban areas saving common spaces in order to optimize as much as possible urban architectural space, to facilitate access to critical places and to optimise operations on this networks, always considering security issues.

Deliverables:

- Architectural designs of common spaces for network infrastructures.

Expected impact:

- Optimize urban architectural space.
- Transforming cities into attractive, competitive and sustainable cities.

KPIs:

- Reduction of urban spaces devoted to infrastructures.
- Improved operation of different networks.

Costs: EUR 10 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 2: Optimising the synergies between electricity and other networks (e.g. heating/cooling, waste processing, transport, etc.) where electricity is needed

Scope: Existing network infrastructures can be used to enable various and new applications with improved use of energy. For example, heating networks could be used as energy storage for electricity, or hydrogen generation could create value from electricity surplus. Hydrogen can be 'stored' in the gas grid or can be used as transport fuel. Other possible ways for optimising energy use are the waste processing and major ICT installations which may become a source for heating/cooling buildings with heat pumps.

Optimisation of the flows of energy, communication, transport, water, etc., to detect system bottlenecks, places where inefficiencies may be corrected or energy losses may be reduced. For the identified bottlenecks, other sources have to be considered (e.g. use of heat pumps for excess electricity).

To articulate business cases to develop new services and to move from reactive to predictive operation.

Deliverables:

- Solutions to increase the efficiency of the use of different networks through exploiting synergies among infrastructures.
- Evaluation of the economic feasibility of the different solutions.
- Tools to analyse understand and solve problems related in particular to urban areas.

Expected impact:

- Significant improvements in energy efficiency.
- Modernized and better integrated EU energy grids.
- Reduced city services costs.

KPIs:

- Efficiency improvements within individual energy networks by 8-10%; overall net efficiency gain >10%.

- Reduced CO2 emissions commensurate with efficiency gains.

Costs: EUR 100 million.

Timeline: 2015 - 2030.

Modality of implementation: Member State, EU level.

Action 3: Using existing infrastructures to support the development of new communication networks

Scope: Analysing possible scenarios and study the optimal implementation of new communication networks based on existing infrastructures. Making pilots of the models and comparing them with the baseline situation to verify the potential benefits. Conducting replication and scalability analysis for future solutions.

Information should flow from one network to another in order to allow them to adapt themselves and to collaborate if necessary for the benefit of each network and of the energy system as a whole.

Deliverables:

- Analysis, requirements specification, and implementation of new communication solutions.
- Studies for replication and scalability on communication solutions.

Expected impact:

- New solutions to improve ICT network.
- Improved communication networks.

KPIs:

- Percentage of networks that share existing infrastructures.

Costs: EUR 10 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 4: Developing ICT solutions and networks based on real-time information

Scope: In some cases, network infrastructures (water, gas, or electricity metering...) present specific communication problems which are not well solved by the standard existing solutions and require specific ICT solutions.

Telecommunication networks should provide new services and capabilities to make accessible their own internal management layer to other networks. The equipment spread along the different city infrastructures should be adapted to operate the telecommunication management layer.

To adapt all these solutions to the network infrastructures, standardization and interoperability compatible for all networks is needed. It is necessary to specify requirements, clarifying the capabilities to enable industry to innovate on interoperability of systems, future proof solutions, etc.

Deliverables:

- Requirement specifications and implementation of solutions for standardization and interoperability of real time ICT systems.
- Demonstration of specific ICT real time solutions.

Expected impact:

- Improving data management systems.
- Improving ICT network systems to facilitate networks integration.
- Standardization and interoperability of real ICT solutions.

KPIs:

- Percentage of ICT solutions providing real-time information.
- Degree of interoperability between network infrastructures.

Costs: EUR 30 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 5: Converging ICT infrastructure and/or solutions for metering (water, electricity, gas, heating/cooling) exploiting the infrastructures and solutions already deployed

Scope: Developing ICT and integrated metering solutions that unify different urban measurement networks such as gas, water, electricity, street lighting. Exploiting the already deployed infrastructure, reducing the operation time and optimizing the use of spaces in buildings and cities.

To develop new cross-network equipment allowing efficient collection, analysis and interpretation of data: retrofitting strategies/priorities; city planning.

Deliverables:

- Specify requirements and solutions for the implementation of the integrated metering infrastructure.
- New cross-network equipment allowing efficient collection, analysis and interpretation of collected data.
- Demonstration of the solutions.

Expected impact:

- Expansion of shared use of the infrastructures in the cities.
- Advanced ICT and integrated metering solutions.
- Improving ICT cross-network equipment.

KPIs:

- Percentage of networks using common ICT infrastructure for metering with respect to the whole amount of infrastructure networks.

Costs: EUR 30 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 6: Integration of electrical installations for different public transport networks (underground, tramway, electrical bus)

Scope: Public transport networks (underground, tramway, electrical bus, etc.) are often replicating auxiliary infrastructures (such as electrical grids) in urban areas. The objective is to reduce and optimize the infrastructure investments thanks to synergies between auxiliary solutions. The use of common secondary substations and the reduction of the amount of cabling are solutions for the optimization of the electrical network infrastructure devoted to transport.

Reducing the energy dependency and energy consumption during peak loads requires that the use of storage systems in transport becomes crucial. Deploy storage technologies such as ultra-capacitors, fast charging points or hydrogen as energy storage solutions, etc. may facilitate such improved peak load management.

Deliverables:

- Solutions for integrated infrastructures for transport and demonstration.
- Demonstrations of deployment of storage systems for transport.

Expected impact:

- Introducing efficient public transport solutions.

KPIs:

- Percentage of new infrastructure deployment using common infrastructures already installed.

- Percentage of new networks that combine and share infrastructures with different networks.
- Percentage of energy consumption reduced from the peak periods in the load curve.

Costs: EUR 100 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

INNOVATION AND MARKET-UPTAKE PROGRAMME

Action 1: Optimizing costs (capital and operational) by exploiting existing infrastructures and related operation across cities (A2)

Scope: Proposing and finding innovative solutions to improve CAPEX and OPEX on the existing infrastructure through a new way of exploiting and operating them.

Reducing the amount of operations in the cities through common actions for different network infrastructures.

Deliverables:

- Solutions to improve CAPEX and OPEX on the existing infrastructure.

Expected impact:

- Advance the shared use of the infrastructures in the cities.
- Improved costs of existing infrastructures and related operation.

KPIs:

- Reduction of operational costs and implementation costs.

Costs: EUR 20 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 2: Determine and demonstrate where integration creates value

Scope: To quantify and demonstrate the value of integrating across different types of infrastructure promoting large scale demonstration projects. Determining within the different network layers (physical, communications, information management and analytics, applications, etc.) the value of integration.

Deliverables:

- Study and analysis of integrated solutions within different network layers.
- Large scale demonstration projects of the solutions.

Expected impact:

- Modernizing and developing the EU energy grids.

KPIs:

- Reduction in installation or operation costs.

Costs: EUR 100 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Challenge 2: Integrated infrastructures-based services

This Challenge will assist the design and development of new successful models for integrated planning of new-built infrastructures, building on synergies between different infrastructures. The new solutions and planning tools may trigger the redesigning future integrated urban infrastructures, as well as integrated planning and governance. New tools for integrated urban network infrastructure would allow a common and simplified maintenance service for different network infrastructures and help urban planners to evaluate and choose the most cost-efficient and environmentally friendly solutions.

New architectural structures are needed to be deployed to host renewable systems, and electricity networks in an efficient, safe and a comfortable way in cities to couple local supply with various energy demands or to integrate charging infrastructures for electric vehicles.

New Integrated infrastructures-based services would enable individual citizens and Public Administrations to interact with the network infrastructures. New ICT solutions for different network services (using standardized open data formats), encouraging multimodality in different platform tools, would allow citizen interactions with network services. Operational centres could be informed through sensors, remote indicators, etc., or triggered by users that have detected any kind of incongruence, anomaly or incidences in the networks. Integrating payment solutions (through ICT systems) can be developed for public transport networks and other grids (gas, electricity, water, etc.). The use of smart home devices and single control devices could contribute to optimization of integrated grid services and increase the efficiency of buildings. New business models for cooperation between different networks should exploit synergies in infrastructures and reveal new solutions to optimize costs.

KEY ISSUES

- Proactive redesigning of operations allowing cities leverages the basic infrastructure.
- Enabling individual citizens and Public Administrations to interact with the network infrastructures.
- Integration of Distributed Energy Resources (DER) in the urban into the existing networks (Electricity, ICT, heating/cooling), including charging infrastructures for electric vehicles.
- Smart Homes/Smart District devices or systems for optimization of integrated grid services and energy efficiency.
- Developing viable business cases for services built on the infrastructure.

INDUSTRIAL RESEARCH AND DEMONSTRATION PROGRAMME

Action 1: Integrated infrastructure planning to overcome sector specific boundaries (integrating domains such as electricity, heating/cooling, transport structures, ICT, lighting etc.)

Scope: Design and develop new successful models for integrated planning of new-built infrastructures, allowing the reuse of the existing ones and synergies between different infrastructures. The new solutions and planning tools may trigger the redesigning of future integrated urban infrastructures, as well as integrated planning and governance.

Not only when planning a new area, but also when changing the (local) energy system (e.g. installing new energy generation units or refurbishing buildings), an integrated approach should be applied that allows for the best solutions and allocation of resources.

Deliverables:

- Tools for integrated urban network infrastructure (Hardware and Software) to help urban planners to evaluate and choose the most cost-efficient and environmentally friendly solutions.
- Achieving integrated solutions for the urban energy supply through the assessment of the systemic interrelations within urban energy structures and energy components.

Expected impact:

- Transforming cities into attractive, competitive and sustainable cities.
- Increase the shared use of the infrastructures in the cities.
- Increase the integrated planning of new-built infrastructures.

KPIs:

- Percentage of integrated network infrastructures planned, considering the whole existing networks.

Costs: EUR 20 million.

Timeline: 2014 - 2020.

Modality of implementation: Member State, EU level.

Action 2: Solutions to fully involve citizens in the proper operation of integrated city infrastructures

Scope: Cities are moving forward to environments where citizen participation becomes more important. To enable feedback from citizens may be a solution to detect anomalies, damages and malfunctions. Operational centres could be informed through sensors, remote indicators, etc., or triggered by users that have detected any kind of incongruence, anomaly or incidences in the networks (water scape, traffic accidents, stole, visible electricity conductor anomaly, damaged infrastructures, etc.).

Utilizing cell phone locations, the system may detect citizen movements enabling solutions to predict traffic jams or congestions and also to inform citizens about traffic, utilities, emergency response etc.

This information availability is useful to city networks by showing where people are clustering or how they are moving, to give a fast response in emergency case. Having information regarding routines allows the utilities to determine forecasting near-term demand.

Deliverables:

- Demonstrations of the introduction of sensors and indicator systems in the city for citizen cooperation.
- Demonstrations of infrastructure solutions (electricity, ICT, etc.) for citizen cooperation.

KPIs:

- Reduction of time for resolution of faults through citizen participation.

Expected impact:

- Fostering and activating participation of citizens in smart cities.
- Improved operation of networks.

Costs: EUR 25 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 3: Architecture designs to accommodate Distributed Renewable Energy Resources (DRES) and integrated networks in urban areas (C1)

Scope: The need to reduce the carbon dependency makes crucial increasing the amount of DRES specially in the cities, on the other hand the increase of charging points for electric vehicle makes necessary to study, analyse and deploy new architectural structures to host renewable systems, and electricity networks in an efficient, safe and comfortable way in cities.

To develop integrated energy networks to couple local supply with various energy demands, i.e. to achieve self-sufficient communities by coupling local energy sources (electricity, heat, cold, etc.) with the various energy demands.

Deliverables:

- New architectural structures to host renewable systems.

KPIs:

- Level of integration of DRES in urban areas.

Expected impact:

- Enabling and accommodating an increasing share of renewables energies.
- Enabling a more efficient decentralization of energy supply.

Costs: EUR 50 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 4: Integrated information service about customer consumptions (electricity, water, heating/cooling, gas)

Scope: Distribution Energy companies may have servers that collect, store, organize and merge all data from smart meters and provide it to the final user (independently of the retailer) through the platforms already indicated.

Deliverables:

- Integrated networks information services oriented to customers.

Expected impact:

- Improving ICT network systems to facilitate the citizen's daily life.
- Improved information services about customer consumptions.

KPIs:

- Percentage of customers with access to consumption information.
- Amount of networks with the integrated information service.

Costs: EUR 50 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 5: District/urban information points about different services to citizens

Scope: Providing Information about mobile clean points (batteries, white line, and wasted oil), touristic information, transport maps, routes of combined public transport, etc. to citizens, in order to facilitate their daily life and make available that information in different smart devices such as mobile phones or tablets with common interfaces for different European cities, so adaption of citizens to another European city should be easier.

Coordination between networks is required in order to combine all data and to be available through servers.

Deliverables:

- Integrated networks information services oriented to cities.

Expected impact:

- Improving ICT network systems to facilitate the citizen's daily life.
- Enabling a more active participation of citizens in the smart cities.

KPIs:

- Numbers of cities with at least 'X' information points per habitant.
- Amount of networks integrated in the service.

Costs: EUR 50 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 6: Common interfaces to access different public networks

Scope: Achieving real integration of networks at European level. To reach real citizen mobility throughout Europe and to facilitate the interaction with different services independent of the EU country, common interfaces for the different services (same payment methods for public transport, subscription to water/telecommunication/power services in different EU countries, etc.) are necessary.

Integrating payment solutions (through ICT systems) for public transport networks with parallel infrastructures (bus, underground, tramway…) facilitate citizen mobility. The same idea should be extended to other grids (gas, electricity, water, etc.).

Designing apps for different network services, encouraging multimodality in different platform tools (tablet, smart phone…) allowing consultation on tariffs, time-schedules and operations or interactions with network services. This might include standardizing the open data format to be used in all cities.

Deliverables:

- Design of IT solutions for public network services (transport, electricity, telecommunications, etc.).
- Development of payment systems for various network services at national and pan European level.
- Comprehensive management of integrated services of public networks (contracts, temporary suspension of the service, cancellation of the service, etc.).

Expected impact:

- Introducing new ICT solutions to modernize cities to improve lives of millions of European citizens.
- Achieving real integration of networks at European level.

KPIs:

- Number of cities using the same interface or service.

Costs: EUR 50 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

INNOVATION AND MARKET-UPTAKE PROGRAMME

Action 1: Common Maintenance Services of integrated infrastructures to organize urban network infrastructure public works

Scope: Allowing a common and simplified maintenance service for different network infrastructures (water, electricity, heating/cooling, etc.) needing public works. Integrating parallel works in a single common work, may avoid disturbances and reduce operational costs. All aspects involved in the common operation like compatibility, necessities, ownership should be considered.

A possible example is closing of a street in order to carry out maintenance services. Taking advantage of this situation, proceed to install all network infrastructures at same time without the need to close the street again in a long term period. Reducing the amount of actions and the operational costs.

Deliverables:

- Solutions to reduce parallel works and operational works in the urban area.
- Planning tools to be used in coordination centres for public works.

Expected impact:

- Reducing parallel works in the cities and facilitating citizens' daily life.
- Fewer disturbances for citizens and increased public acceptance of large infrastructures.
- Decrease of maintenance costs.

KPIs:

- Reduction of maintenance operations due to common maintenance of a single infrastructure.
- Amount of integrated networks.

Costs: EUR 50 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 2: Solutions and functionalities to enable new services for citizens and Public Administrations

Scope: The integration of the different networks of infrastructures that co-exist in a populated area may help to develop new services for citizens or even for Public administrations. This should be studied considering the value provided by the solutions presented and the business case analysis that proves its feasibility.

Deliverables:

- New services based on common infrastructures for sustainable mobility (environment monitoring and control, energy efficiency services...) including economic feasibility studies.

Expected impact:

- Improving ICT network systems to facilitate citizen daily life.

KPIs:

- Reduction of city services cost (without reducing the quality or level of services).

Costs: EUR 10 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 3: Methodologies for citizen awareness raising and training (B3)

Scope: To teach and to sensitize the citizen about the possibilities of integration of technologies, as well as foster the citizen participation through programs to use properly the available technologies.

Deliverables:

- Solution to incentivise the proper use of technologies.

Expected impact:

- Enabling a more active participation of citizens in the smart cities.

KPIs:

- Increase of citizens' awareness and of interaction of citizens.

Costs: EUR 5 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 4: Addressing new regulation and market strategies to optimize the use of urban network infrastructure

Scope: Determine possible business models for cooperation between distributors of water, electricity, heating/cooling, gas, etc. to exploit synergies in infrastructures and solutions to optimize costs.

Regulation of public works would facilitate cooperation between different networks, optimizing costs by the reduction of the number of actions in the city and sharing the costs of them. This would improve the citizen's quality of life that will have to attend a lower number of disturbing actions in the city.

Deliverables:

- Propose business models for cooperation.
- Proposals to offer new services to customers or other third parties.
- Studies to propose recommendations to regulators related to urban network infrastructure.

Expected impact:

- Reducing the number of disturbing actions in the city.
- Improving solutions to facilitate citizen daily life.

KPIs:

- Improved competitiveness of the energy market.

Costs: EUR 5 million.

Timeline: 2015 - 2020.

Modality of implementation: Member State, EU level.

Action 5: Large-scale pilot on the interconnection, joint usage and management of urban infrastructures

Scope: Integration of energy carriers (electricity, heat, etc. – including storage) on the one hand and of energy infrastructure with ICT on the other need to be put in practice on a realistic scale.

The integrated infrastructure serves as the basis for innovative services to be offered within the context of the pilot.

End users and stakeholders should be actively and meaningfully involved in the deployment and the design & use of the services.

The pilots on urban infrastructures can be made to interact with the action from Heading 1 on linking grids and storage to buildings.

Deliverables:

- Five integrated pilots, two of which are linked to the pilot actions on the integration of storage and buildings.

Expected impact:

- Significant increase in the uptake of integrated city solutions.

KPIs:

- Number of validated, replicable integrated concepts that link heterogeneous network infrastructures, storage, ICT and refurbishment at a realistic scale, with consent/involvement of end users and stakeholders.

Costs: EUR 250 million.

Timeline: 2015 – 2020.

Modality of implementation: European and local.

HEADING 3: Fostering Sustainable Transportation

EU policy goals and targets aimed at achieving sustainability in the transportation sector require an integrated approach of research and innovation programming and prioritisation, including transportation means, fuels and the energy system. Integration is equally geared towards achieving a balanced mix of increasingly diversified fuels and powertrain options.

Challenge 1: Fuel and fleet diversification

KEY ISSUES

- Provision of an integrated offer of less carbon/energy-intensive transport solutions:
  - Addressing standardisation needs and ensure innovative business models do not lead to market fragmentation.
  - Devising efficient transport around smart integrated infrastructure and mobility planning.
- Support and foster demand for less carbon-intensive transport solutions:
  - Involve local and regional authorities in pilot actions aimed at achieving a structural shift to less emission/energy-intensive transport solutions.
  - Disseminate good practices on relevant incentive structures and public procedures, including tendering.

INDUSTRIAL RESEARCH AND DEMONSTRATION PROGRAMME

Action 1: Demonstrate the usage of waste brake energy through batteries in buses (B1)

Scope: Hybrid configurations, combining internal combustion engines and electric motors, can save oil and reduce CO2 emissions by improving the overall energy efficiency of propulsion (up to 20%) but are, without external recharging possibilities, not an alternative fuel technology. Foster the use of this technology in buses.

Deliverables:

- Marketable final product (2 years).

Expected impact:

- Greater uptake of hybrid configurations in bus fleets and other vehicles.
- Reduced CO2 emissions from public transport modes.

KPIs:

- Energy efficiency of propulsion.
- Reduced emissions (gCO2/MJ).
- Yearly number of public tenders comprising this option.
- Yearly sales rates (vehicle replacement).

Costs: EUR 100 million.

Timeline: 2 - 5 years.

Modality of implementation: European / Global.

Action 2: Electrification of buses and captive fleets in urban areas (B4)

Scope: Fostering the electrification of buses and captive fleets in urban areas is a means to establishing the critical mass required for electromobility to change the road transportation market while contributing to solving local air quality issues at least. Technological solutions such as inductive charging are not yet technically or economically mature.

Deliverables:

- Large-scale demonstration projects in urban/metropolitan areas in all Member States (2-4 years).
- Assessment of technical and economic viability of demonstrators (4-6 years).

Expected impact:

- Increased electrification of buses and captive fleets in cities.

KPIs:

- Performance (i.e. fast charge, ability to maintain sustained power and acceleration in different operating conditions etc.).
- Energy efficiency.
- Yearly number of vehicles sold per vehicle category.
- Number of patents over 5 years.

Costs: EUR 100 million.

Timeline: 5 - 10 years.

Modality of implementation: EU-28/ market outlook: global.

Action 3: Enabling bio-based fuel components in urban transportation (road, rail and water)

Scope: Today, biofuels are the readily available alternative to fossil fuels contributing to reduced CO2 emissions. Standard fuel quality and availability of protection grades are required across Europe. Standardised information to users on vehicle/fuel compatibility, fuel performance (energy and emissions), and fuel supply network is required.

Deliverables:

- Publicly available calculator of energy efficiency and regulated emissions' profile for the average road vehicle fleet with bio-based fuel alternatives using different feedstocks (1 year).
- Publicly available calculator of energy efficiency and regulated emissions' profile allowing comparisons across transportation modes (MJ and gCO2 eq respectively for passenger/km and tonne/km, as relevant) (3 years).

Expected impact:

- Increased share of bio-based fuel urban transportation.

KPIs:

- Number of refuelling points/stations selling labelled biodiesel.

Costs: EUR 5 million.

Timeline: 1 - 5 years.

Modality of implementation: EU-28/ ideally Europe (continental scale).

Action 4: Implementing zero emission harbours and airports (B3)

Scope: Refuelling infrastructure in harbours and airports.

- Energy efficient/ low-carbon docking, port operations and on-ground operations in airports.

Deliverables:

- Conversion to green solutions in inland harbours and airports, including renewable on-shore electricity for ships/barges and green taxiing at airports (3-5 years).
- Dissemination of good practices (1-5 years).

Expected impact:

- Reduced emissions from activities in airports and harbours.

KPIs:

- Number of inland harbours equipped with innovative solutions for energy saving, including volumes of green electricity provision and number of access points (yearly).
- Number of aircrafts serviced by green taxiing (yearly per Member State).

Costs: EUR 50 million.

Timeline: 5 - 7 years.

Modality of implementation: inland waterways: EU-28 and relevant river/canal basins beyond its borders; aviation: EU airports / global traffic.

INNOVATION AND MARKET-UPTAKE PROGRAMME

Action 1: Accelerating the electro-mobility deployment for passenger cars (A1)

Scope: By implementing electro mobility in concert with intelligent energy and transportation concepts, it is urgently necessary to exploit the diverse benefits of the technology and make it accessible to a broader public thus increasing acceptance and demand. Demonstration projects of electric cars are important to test customer acceptance and market readiness. There are a number of challenges for the large scale deployment of electro mobility at European level. These, in particular, are:

- The high cost of the battery.
- Relatively low driving range of battery electric vehicles (BEV).
- Limited consumers' interest.

Moreover, electromobility requires interaction of market actors, including niche producers, supply chain (i.e. battery, power electronics and electric motor producers), charging service providers, network operators, energy utilities and e-mobility service providers with new business models or innovative Vehicle-To-Grid solutions.

A massive and efficient use of EV by final customers will therefore result from the development of competitive and cost transparent services, which will be possible through interoperability of data exchange between the operators. Therefore, interoperability and standardization of data models and protocols is as essential as development and deployment of the technology itself.

Deliverables:

- Electrification roadmap to 2050.
- Large-scale risk sharing initiatives for manufacturing batteries in Europe.

Expected impact:

- Increased share of electric vehicles in cities.

KPIs:

- New vehicle sales of EVs in Europe by 2020.
- Cost per Kwh of battery storage capacity below EUR 75/Kwh.
- Efficiency (passenger and tonne km).
- CO2 emissions (Well-to-Wheels).
- Average battery range per vehicle segment.
- Number of interoperable charging stations available in European cities.

Costs: EUR 50 million.

Timeline: 1 - 4 years for roadmap.

Modality of implementation: European.

Action 2: Accelerating the H2-mobility deployment (A2)

Scope: Hydrogen is a clean energy carrier and when used as a transport fuel has the potential to significantly contribute to Europe's transport sector related emissions reduction, sustainability and fuel security targets to 2030 and beyond. Hydrogen powered fuel cell electric vehicles (FCEVs) could be competitive with conventional passenger and light-medium duty cargo vehicles on total cost of ownership basis already in the early 2020's[1]. However, the high early cost of deploying a hydrogen refuelling infrastructure and the higher cost of the vehicle itself are a barrier to H2-mobility roll-out and it is still necessary to improve FCEV technology and to strengthen customer acceptance, a pre-requisite for full commercialisation.

Demonstration of H2-mobility is essential to gain live operational experience, test the attractiveness of FCEVs for customers, and show that vehicle reliability, durability and availability can be achieved in long distance and local passenger and (light-medium) cargo fleet operation, in conjunction with safe use of an emerging network / clusters of hydrogen refuelling station facilities. These will validate and benchmark customer acceptance, business and market readiness levels and set the final stage, pre-commercial, challenges for the large scale deployment of H2-mobility on a pan European level. Such challenges would cover:

- Iterations on FCEV component design and production concepts to reduce full vehicle costs (passenger and light-medium duty cargo versions).
- Validation of business models and infrastructure requirements for return-to-base fleets.
- Network optimisation for hydrogen refuelling infrastructure.

As with electro-mobility, the H2- mobility solution to zero emission transport requires the interconnection of multiple market segments including vehicle OEMs, component supply chains, repair and maintenance service providers, private and public fleet operators, hydrogen refuelling facility operators and service providers together with on-site H2 generation and trucked-in H2 supply (which can be aligned with grid level renewable H2 supply) arrangements. Such services will need to be competitive and cost transparent so data exchange (based on standardization of data models and protocols) between the different operators will be essential.

Deliverables:

- Alignment of national and regional H2Mobility programmes to be consistent with the creation of a real European network with HRS demonstration sites located at, or close to, the network of the Trans-European Transport Network (TENT-T), as laid out in Regulation 1315/2013, along with clustered HRS coverage in at least one or two large densely populated regions in order to test the willingness of customers to switch to FC vehicles.
- Validation of customer acceptance and business models, specifically for return-to-base captive fleets.

Expected impact: - Increased deployment of FCEV and HRS infrastructure.

- Overall decrease in carbon emissions related to transportation.

KPIs:

- FCEV deployment in Europe at 100,000 vehicles by 2020 and 3 million vehicles by 2030.
- Parity of FCEV total cost of ownership (TCO) by 2025.

[1]New IG: "Fuel Cell and Hydrogen technologies in Europe 2014-2020" (25 November 2011), Fuel Cells and Hydrogen Joint Undertaking: "Revised Multi-Annual Implementation Plan" (22 November 2011),

- Substantive air quality improvement with sustained reductions achieved in CO2 and other local (NO2, PM2.5 and PM10) emissions.
- H2 metering and fuel quality issues resolved by 2020.
- Installed HRS infrastructure in line with levels indicated in the Clean Power for Transport Directive by 2023.

Costs: EUR 10 million.

Timeline: 2015 - 2025.

Modality of implementation: European and national participation.

Action 3: Accelerating the adoption of non-carbon mobility options

Scope: Cities, with their relatively compact areas and the proximity of services, are well-suited to non-carbon mobility like walking or (electric) bicycles. Nonetheless much of the mobility systems remain centred around fuel-powered mobility, even for situations and places where it is suboptimal. Schemes and infrastructure works to facilitate other means of transportation are highly needed to accelerate the uptake of non-externally powered mobility wherever appropriate.

Deliverables:

- Overview of best practices on sustainable urban mobility from commitment signatories.
- Integrated handbook/guidelines for cities willing to facilitate more sustainable mobility.

Expected impact:

- Overall decrease in carbon emissions related to transportation.
- Overall reported increase in quality of living environment by inhabitants.

KPIs:

- 10% increase of kilometres/movements using non-carbon mobility options (walking, cycling).

Costs: EUR 3 million.

Timeline: 2015 – 2016.

Modality of implementation: European, national and local.

Challenge 2: Energy performance of transportation systems

KEY ISSUES

- Promote integrated operations of a truly intermodal transport system.
- Favour behavioural shifts of people and businesses on mobility decisions.
- Induce technological shifts towards less polluting, energy efficient, better integrated and more efficient transport solutions by providing enablers for deployment (e.g. non-motorized; grid connected e-vehicles for inner city logistics).
- Promote accessible mobility and non-motorised transport through appropriate urban planning and form, e.g.:
  - Need for further studies on the relationship between urban form's (included street network layouts') influence on amount and kinds of transport.
  - How to create cities with robustness for changes regarding transport modes, kind of energy supply).

Action 1: Increase Information Data Management for Electric Transport Infrastructure to enable smart services and improve logistics (C1)

Scope: Transport networks for electrical mobility have to face challenges such as affordable costs, increasing environmental requirements and high-level service expectations. This requires innovative solutions, partly relying on information systems and ICT. The main goal is to develop concepts, methods and tools to create and manage product information associated to High-Level Services Transport Infrastructure (HLSTI) during the whole life cycle of infrastructure. These can include access to the charging services of any electrical grid operator through a single contract with one e-mobility service provider.

Deliverables:

- Demonstrators for data architecture solutions integrating soft and hard infrastructure requirements, including data management and data protection issues.
- Interoperable solutions for data management and data protection issues, including access and payment options.

Expected impact:

- Increased presence and efficiency of electric transport infrastructure.

KPIs:

- Number of active users of the ICT services.
- Cost of service per use.

Costs: EUR 10 million.

Timeline: 2-5 years.

Modality of implementation:

- Demonstrator: sufficient scale to establish a network.
- Interoperability: EU-28 (ideally, Europe at continental scale).

Action 2: Develop smart charging as a way to better integrate electric vehicles into the grid and promote renewables i.e. real time control of charging power of an electric vehicle according to the user needs, the availability of network capacity, the cost of energy and its sourcing (A3)

Scope: Smart charging technologies and simulations to define and study solutions enabling a reduction of loading during peak hours of consumption. Proposing market solutions that enable users to sell energy stored in the battery of the electric vehicle. Integration with current EU initiatives e.g. European Green Vehicles Initiative etc.

Deliverables:

- New market solutions for electric vehicles, including selling electricity stored in EVs.
- Solutions to incentivise consumption during off-peak time.

Expected impact: - Integration solutions for electrical vehicles and renewables

KPIs:

- Number of active users of new services.
- Cost of service per use (projected and actual trends per quarter).

Costs: - EUR 50 million.

Timeline: 2 - 4 years.

Level of implementation: not relevant at this stage.

INNOVATION AND MARKET-UPTAKE PROGRAMME

Action 1: Promote the "Human Factor" (B2); Promote more sustainable mobility choices

Scope: To promote sustainable transport and the use of the new technological options available, it is essential to have a firm grasp of how to effectively encourage individuals and businesses to adopt behaviours that are resource efficient. Most initiatives to foster sustainable transport rely upon large-scale information campaigns that utilize education and/or advertising to encourage behaviours change.

While education and advertising can be effective in creating public awareness and in changing attitudes, numerous studies show that behaviour change rarely occurs as a result of simply providing information. Community-based social marketing targeted towards sustainable mobility is an attractive alternative to information-based campaigns.

Deliverables:

- Public-private forum: design strategy at European scale to foster consumer acceptance of new mobility patterns.
- Deploy the strategy upon its adaptation to local specificities.

KPIs:

- Pace of market introduction of alternative-fuelled vehicles.
- Pace of uptake of more sustainable mobility alternatives by citizens/users.
- Passinger km/year Tonne km/yr (Eurostat).
- Level of interaction of citizens.

Costs: EUR 5 million.

Timeline: 5-7 years.

Modality of implementation: European.

HEADING 4: Enabling a City to become a Smart City

Challenge 1: Governance

The key to a smart city is integration. The basis is a sound vision of the city as a highly complex system of interdependent actors working towards sustainability. This needs to be translated into a common approach to all sectors involved, held constant over a longer period of time, enabling the different departments of the local administration as well as the stakeholders to buy into it and adjust their actions. It is clear that the leadership and governance models of cities need to be adapted to deal with the challenge of working on the long-term within a complex environment that is defined by shorter-term electoral cycles.

Effective and efficient multi-level governance is crucial for the design and implementation of energy and climate policies. Most evaluation efforts at present (if any) are concentrated at and focus on the national level, which overlook considerable heterogeneity across cities/regions. In fact, energy and climate policies are commonly viewed as just one level of governance and/or as a top-down policy approach. Policy interactions between different levels of governance are often very complex and can lead to high inefficiencies.

Although integration and integral approaches have been put forward under previous headings, this challenge specifically looks into building capacity at the level of a city – and sharing best practices and lessons learned with other cities and local authorities. The competences and skills needed for such capacity building are crucial, but they will be covered in Part IV of this integrated roadmap as an element of the educational agenda.

KEY ISSUES

- City councils/leadership should be motivated to base their policy and decision making on integrated roadmaps and long-term visions. The visions and integrated roadmaps cover more than a single thematic area of the city environment and therefore required active participation of all relevant departments within the local authority. Longer term means ambitious time spans of up to thirty years (if we talk about visions) or ten/fifteen years (if we talk about roadmaps). This should be part of a deeply embedded process, leading to regular updates and revisions.
- Citizens – and stakeholders in general – need to get the means to engage in an appropriate way in this process of visioning and roadmapping. The goal is both to leverage the common insight and to attain a far higher level of acceptance of/commitment to the resulting policies and actions.
- The sharing of knowledge and best practices in and among cities has to be stimulated. Active networks and mentoring relationships are crucial to support the development of smart cities throughout Europe.
- Well-selected and ambitious priority projects will translate the vision of ambitious cities into action in the field. Any such project obviously consists of a mix of top-down (vision-based planning) and bottom-up (stakeholder engagement and initiative). Within this context bottom-up processes can be sustained, empowering different actors to participate and to engage. Furthermore a priority of a smart city should be the unceasing flow of information towards citizens so that the authority can be accountable for its actions and the top-down processes happens in a state of transparency.

INDUSTRIAL RESEARCH AND DEMONSTRATION PROGRAMME / INNOVATION AND MARKET-UPTAKE PROGRAMME

Action 1: Setup of transition platforms to support the development of visions and concrete action plans together with relevant departments of the local authority and in cooperation with stakeholders

Scope: Such platforms will be developed by and in collaboration with different local government departments, research centres, private sector, citizen groups and other key stakeholders. These platforms ensure the engagement with stakeholders (and creating ownership). Such platforms could help developing strategies and consequently action plans, but also implementing actions / measures with a variety of different stakeholders.

Deliverables:

- Guidelines for setting up transition platforms.
- Publicly accessible database of reference transition cases.

Expected impact:

- More widespread use by all stakeholders of transition/integrated approaches to overall city development.

KPIs:

- Number of transition platform(s).

Costs: EUR 10 million.

Timeline: 1 – 3 years.

Modality of implementation: European and local.

Action 2: Promotion of joint practices and innovative networking ways for learning and sharing at a larger scale

Scope: Integrated approaches and developments within one city (or even city district) should be systematically identified and shared with other cities to attain real impact. To ensure successful approaches are adopted sufficiently quickly and gain critical mass, it is necessary to spread them at the regional level (i.e. within a city's sphere of influence), nationally, Europe-wide and internationally. This will lead to a body of public sector employees and decision makers advocating and implementing smart city approaches as meant in this roadmap. Examples include regional or national networking around the pilot projects, peer to peer exchange, and ensuring replicability and comparability (e.g. via benchmarking).

Deliverables:

- Active learning/networking platforms implementing innovative/effective/forward looking learning schemes.
- Integrated city developments plans based on successful pilots.

Expected impact:

- Rapid spread of integrated city development practices after the initial pilot period.

KPIs:

- Five active learning /networking platforms.
- Number of cities adopting an integrated development approached.

Costs: EUR 10 million.

Timeline: 1 – 3 years (for the learning structures to get set up).

Modality of implementation: - European and local.

Challenge 2 – Funding and financing

Building a smart city requires investments in both infrastructure and capacities. The investments required are typically large, sustained and involve many different parties. This also means that the benefits accrue to different stakeholders – both public and private – and that the beneficiaries of one particular investment may not be those that invested in the first place.

The main challenge therefore is not just finding sufficient funds, but also finding models that correctly apportion efforts and returns. Financing related barriers are not always linked with investments or how to invest. There are several other barriers, such as the lack of know how to deal with contracting or an absence of well explained, analysed and transferable business cases or models. The gaps in financing needs, in support of more integrated and long term planning, should be analysed and then efforts directed accordingly.

Cities can actively promote alternative visions on the economic paradigm: one paradigm is a circular economy where the one's waste is the other's resource. The complete value chain can be re-evaluated when a city defines its economic priorities differently and basing these priorities on becoming highly resource efficient.

KEY ISSUES

- As evidenced under JESSICA Implementation, funding and financing models will not deliver wider value unless in the context of an adequate and focused city **strategy** which targets well designed projects that deliver both acceptable financial returns and non-financial returns in terms of city's development.
- There are different perceptions and positions about innovative approaches to financing and greater **understanding** is required of investor positions. For example, the availability of discretionary public investment which can act as a first loss piece in more innovative investments increasingly resides at the regional and city level through the availability of European Structural and Investment Funds. However, more ESIF Managing Authorities need to be convinced of the merits of implementing innovative Financial Instruments.
- Barriers also go beyond the availability of finance and include investment 'know-how'. Finding suitable **mechanisms** for investment and how to invest are significant barriers. The development of well explained, analysed and replicable financing models and business cases can address this.
- How to use **new financial models** is a challenge for cities and capacity needs to be developed. Cities are exploring the alternatives of the performance based economy and new product/service combinations. They are already buying services, instead of products (e.g. moving from lamps to lighting) and using for example energy service contracting. Quite some work is currently put to promote and support such models, but how to use them is still a challenge for cities. Training and increasing capacities on how to use new financing models such as the energy performance contracting can address this.
- Complex solutions require a **multi-stage and adaptable modular approach**. Given the size and complexity of such solutions (encompassing fundamental infrastructure, capacity building and the like), it is important to develop parts of them in a viable way and then tie them together at a later stage. Developing modular business models for smart city solutions allows for this and also offers attractive propositions to the different types of stakeholders involved.
- **Lifecycle financing models**, such as Public Private Partnership (PPP) that incorporate the total cost of implementation and operation have to be developed. Both the initial capital expenditure and the subsequent operational expenses have to be taken into account to build balanced and thoughtful models. This may require a novel and more encompassing vision than the one espoused by traditional financing mechanisms.
- Financing will necessarily have to be **market-based**, including 'alternative' sources. Both the size of the investments and the role various actors need to play mean financing should

primarily come from market-based – or at least market-compliant – mechanisms. The implication is that parties need to see a credible return within an acceptable time horizon to eventually provide financing. Possible approaches here are joint ventures/joint investments and pre-commercial procurement of innovation. Market based financing can also mean 'alternative' financing such as citizen based financing / cooperatives for example for energy projects.

INNOVATION AND MARKET-UPTAKE PROGRAMME

Action 1: Translating integrated city strategy into fundable projects

Scope: This action aims at emphasising the need to ensure that an adequate and focused city strategy is in place and that the effective use of Advisory/Technical Assistance services boosts the pipeline and design quality of potential projects for such instruments. It also aims at developing new and existing user friendly applications that can guide local authorities and stakeholders towards business models that build further on the failures and successes from predecessors. Some examples have been developed during JESSICA implementation in support of effective implementation of financial instruments and such existing tools/models may provide a starting point in this regard.

Deliverables:

- Tools for identifying individual projects and business models in overall city strategies.
- Publicly accessible section on the Smart Cities and Communities European Innovation Partnership (SCC EIP) website with references to available financing mechanisms, their modalities and supporting/advisory initiatives.
- On- and offline training modules on different financial instruments (e.g. MOOCs).

Expected impact:

- Higher execution rate of the actions and plans put forward in city strategy documents.

KPIs:

- Percentage of initiatives identified in plans (SEAPs or other) that actually get funded and implemented.

Costs: EUR 25 million.

Timeline: 1 - 4 years.

Implementation modalities: Pan-European.

Action 2: Further analyse and ensure practical applicability of new and innovative financial instruments, while maximising the use of existing and upcoming resources

Scope: : Develop platforms and frameworks, like the Technical Assistance Platform for Financial Instruments, to circulate solutions and improve the understanding between funding institutions, Managing Authorities, cities and other investors.

Deliverables:

- Network/platform connecting stakeholders on complex and multi-faceted city(-related) investments.

Expected impact:

- Deeper and more diversified pool of public and private investment tools and money available for city-related investments.

KPIs:

- Number and type of partners joining the platforms.
- Number of new financial tools to finance projects created and deployed through platforms.

Costs: EUR 2, 5 million.

Timeline: 3 years.

Implementation modalities: Pan-European, with openness to international participation.

Action 3: Support investment projects that combine different financing instruments and test business models and render them more reliable and transferable.

Scope: Real city developments will require a multitude of (public and private) investment funds, being accessed by different stakeholders and being used throughout interlocking development projects and city scale strategies. There is an urgent need to support such complex sets of development projects, with a specific focus on their setup and on how they are being made bankable. This provides a crucial complement to the 'content-centred' approach of the integrated pilots mentioned earlier in this part of the Integrated Roadmap. Again, existing JESSICA tools and models should provide a starting point in this regard.

Deliverables:

- One complex city development with workable business models, fully funded through appropriate means (can be combined with the integrated pilot actions).
- Casebook with practical cases, business models, recommendations (including special attention paid to circular economic models).

Expected impact:

- Increased ambition in city developments with reduced impact on public budgets.

KPIs:

- 10% increase in city development projects that tap several funding options, including the ones other than project subsidies

Costs: EUR 5 million (project support) + EUR 1 million (casebook development).

Timeline: 1 – 4 years (setup of the projects + casebook development two years later).

Modality of implementation: European and local.