This project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 649397

AMBITION, VISION & ROADMAP
SMART BUILDINGS MURCIA

D6.4 Final city report

18 August 2017

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R4E ROADMAPS FOR ENERGY®

AMBITION, VISION & ROADMAP SMART BUILDINGS MURCIA

D6.4 Final city report

Leader: TU/e LightHouse

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Abstract

This report (D6.4) is the final deliverable of the R4E project and contains all relevant project results for smart buildings in the city of Murcia.

The R4E project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 649397.

Versions of this report:

18 August 2017	Concept for internal check by R4E partners (limited distribution)
xx Month 2017	Final version for public distribution

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quality management, project coordination, financial & administrative activities

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2-day workshop in Eindhoven with all partners to sart project (WP7) and to prepare for ambition workshops and future telling interviews (WP1)

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EINDHOVEN
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Newcastle City Council — domestic, non-domestic
Ajuntament de SantCugat
Murcia

Ambition sharing & selecting drivers for change
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3-day workshop in each city to develop specific desired future scenario's per focus area

EINDHOVEN
Murcia
Newcastle City Council — domestic, non-domestic
Ajuntament de SantCugat
ISTANBUL METROPOLITAN MUNICIPALITY — public transport, traffic mgt

Scenario sharing & selecting topics for roadmaps
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collecting expert insights with 20 experts for each focus area

SMART BUILDINGS
- Sustainable technologies
- Sustainable behaviour
- Sustainable organisation

SMART MOBILITY
- Sustainable technologies
- Sustainable behaviour
- Sustainable organisation

SMART URBAN SPACES
- Sustainable technologies
- Sustainable behaviour
- Sustainable organisation

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Roadmap workshops
2-day workshops in each city to develop specific timelines for the realisation of the desired future scenario's

EINDHOVEN
Murcia
Newcastle City Council — domestic, non-domestic
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ISTANBUL METROPOLITAN MUNICIPALITY — public transport, traffic mgt

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EINDHOVEN
ISTANBUL METROPOLITAN MUNICIPALITY — public transport, traffic mgt
Newcastle City Council — domestic, non-domestic
Murcia
Ajuntament de SantCugat

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identifying different opportunities for financing of the city specific and the joint projects

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Strategy & visuals — developing a communication & dissemination strategy, logo's and graphic charter

Event — Palermo

Regular communication activities — electronic project newsletters, other newsletters and information services, project and partner websites, press releases and other media releases, social media

Event — Tallinn

Regular communication activities

Final event — conference in Murcia

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ROADMAPS FOR ENERGY®

Version 4 September 2015

R4E - ROADMAPS FOR ENERGY

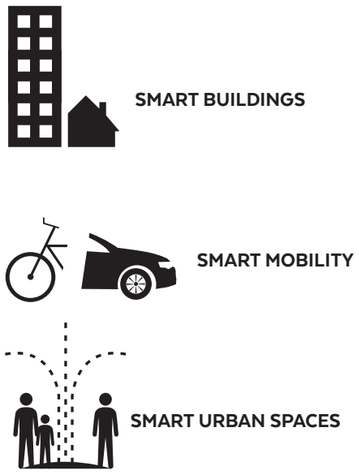
SMART BUILDINGS

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, Forli, 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:



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.

Four step approach of R4E

The R4E partner cities

EINDHOVEN

Gemeente Eindhoven, the Netherlands

- Population: 220,000
- Area: 90 km²

SMART MOBILITY
SMART URBAN SPACES

Newcastle City Council

Newcastle City Council, United Kingdom

- Population: 282,000
- Area: 114 km²

SMART BUILDINGS
- Domestic buildings
- Non-domestic buildings

Comune di Forlì, Italy

- Population: 120,000
- Area: 228 km²

SMART BUILDINGS
SMART URBAN SPACES

Comune di Palermo, Italy

- Population: 885,000
- Area: 160 km²

SMART BUILDINGS
SMART MOBILITY

ISTANBUL METROPOLITAN MUNICIPALITY

Istanbul Metropolitan Municipality, Turkey

- Population: 14,100,000
- Area: 1.830 km²

SMART MOBILITY
- Public transport
- Traffic management

Ajuntament de SantCugat

Ajuntamient de Sant Cugat del Vallès, Spain

- Population: 86,000
- Area: 50 km²

SMART BUILDINGS
SMART URBAN SPACES

Murcia

Ayuntamiento de Murcia, Spain

- Population: 440,000
- Area: 885 km²

SMART BUILDINGS
SMART MOBILITY

Tallinn

Tallinna Keskkonnaamet, Estonia

- Population: 430,000
- Area: 160 km²

SMART BUILDINGS
SMART MOBILITY

The eight partner cities of R4E


Roadmaps for Energy
a Horizon 2020 project


2050

AMBITION SETTING

SMART BUILDINGS

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.

Day 1	Day 2	Day 3
Interview with policy makers	Workshop with stakeholders focus area 1	Project team working session to establish scope
Workshop with strategy department	Workshop with stakeholders focus area 2	Preparing main content of concept report

Programme of the Ambition Workshops in 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.

Morning Finalising Step 1	Presentation of the cities ambitions · Each city presents their ambition for the focus areas
	Learning from each other's ambitions · In-depth discussion on common and specific ambitions
Afternoon Preparing for Step 2	Presentation of the Drivers for Change · Sharing of results of Future Telling research
	Understanding the Drivers for Change · Exploring the relevance for the focus area and selection of drivers for scenario workshops

Programme of the Joint Ambition Workshop

Introduction to Murcia

Introduction to the city

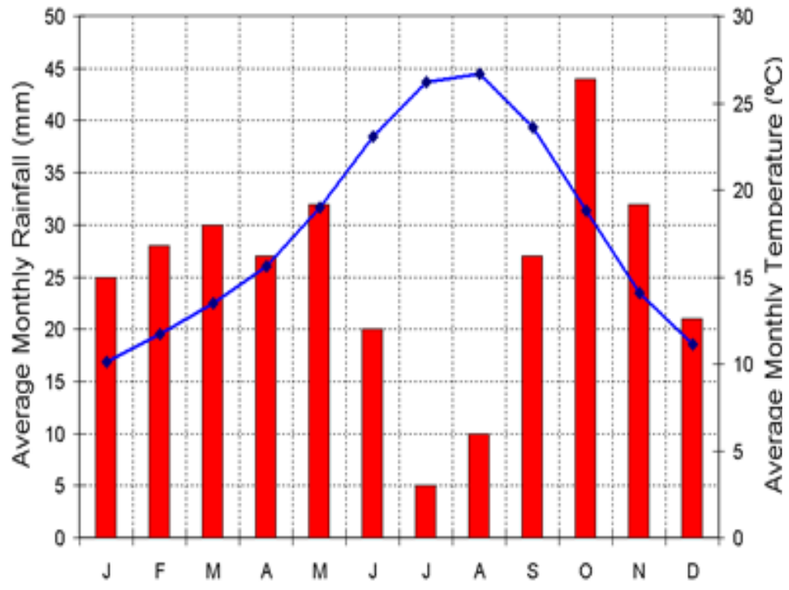
Murcia is the major city in south-eastern Spain, and the capital and most populous city of the autonomous community of the region (with the same name, Murcia). It is Spain's seventh-largest city, with a population of 439,712 inhabitants (about one-third of the total population of the region). Murcia has a mild climate with hot summers, mild winters and relatively low rainfall. In global terms, the region's climate can be described as 'an eternal spring'.

Murcia is a municipality of 890 km^2, at 43 metres above sea level, covering the city and 52 parishes in the surrounding 40 km. The region has 2,800 hours of sunshine each year, and the average rainfall in the Segura basin is one of the lowest in Spain (only 301 l/m^2).

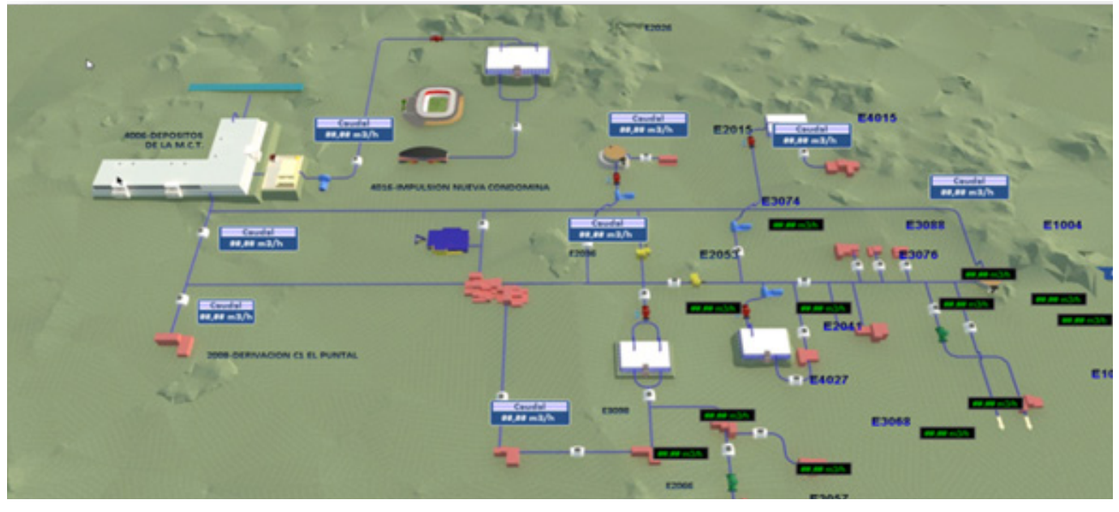
The average temperature is 17.8 ºC. Yearly average relative humidity is 59% Irrigation uses the 85% of the 240 Hm3 consumed in the basin, whilst domestic, industrial and other uses represent only the 15% of the water consumption, 50% of it will soon be supplied with desalinated water.

Due to its location, Murcia has high levels of solar radiation during the whole year. Specifically, it has a yearly average of 5 kWh/m^2/day, one of the highest in Spain. The Municipality of Murcia owns 27 roof-mounted PV installations on a number of buildings to generate electricity, producing 362 KWp. The income from the sale of this energy is used to improve the energy efficiency of the installations in these buildings.

On the other hand there is little rain, which is why Murcia has developed very advanced irrigation system to make efficient use of the available water. Traditionally Murcia has been known for its agriculture, and at present it exports fruits and vegetables to the whole of Europe. The shortage of water and its importance for crops has forced farmers to invest in high-tech systems to get the most out of the available water.

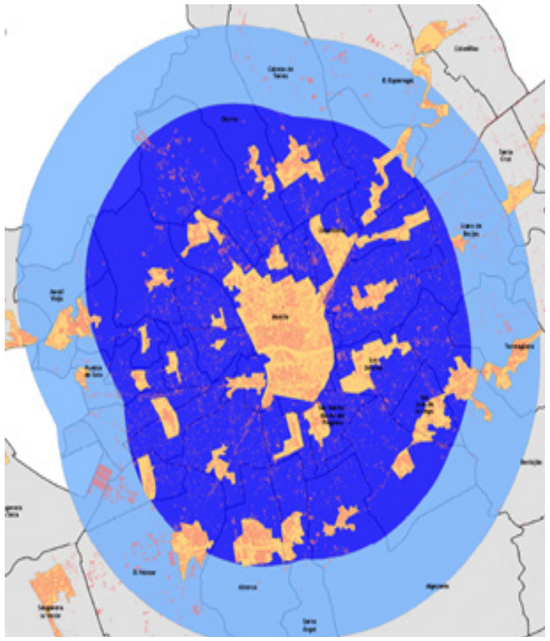


Murcia Drinking Water Network



SMART BUILDINGS

The Municipality of Murcia has a complex land planning system. 83% of the population live within a 5 km radius, and within a radius of 7 km the figure is 89%. The city centre attracts most commuters each day, and this is also the area with the most severe congestion problems.



Murcia has selected two focus areas for the R4E project:

SMART BUILDINGS

SMART MOBILITY

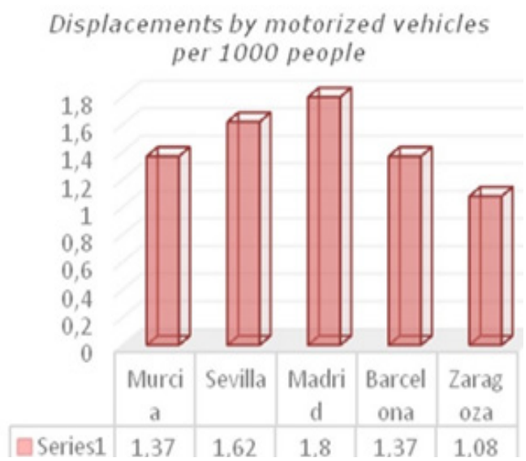
Murcia

Mobility and transport

MOBILITY KEY DATA OF MURCIA			
	TOTAL	%	Per person
Total moves	**915.770**	**100,00%**	**2,21**
Public transport	94.549	10,33%	0,23
Private trasnport	463.075	50,57%	1,12
Other	10.200	1,11%	0,02
By foot	337.786	36,89%	0,81
Bycicle	10.115	1,10%	0,02

To make a good diagnosis of Urban Mobility in Murcia, it is necessary to analyse the social and demographic situation in detail. Regarding mobility, the chart of "MOBILITY KEY DATA OF MURCIA" shows the essential mobility data of Murcia Municipality, based on our SUMP (Sept. 2009). This shows that the use of public transport remains relatively low compared to other large cities (10.33%).

In terms of comparativeness with the rest of Spain, the following chart shows that Murcia has similar levels to Barcelona regarding motorised travel:



Walking

The City of Murcia has over 252.000m2 of pedestrian zones - just in the city centre and 100.000m2 in the surroundings districts. Murcia City Council has built and marked an urban route, so-called "Walk 10.000steps", which covers a distance of 10.000 steps and connects 8 urban districts within the centre of Murcia. (See pedestrian areas in orange colour).

Our Council continues to highlight streets and pathways to further expand the pedestrian zones and enlarge the traffic-restricted areas in order to encourage people to walk on daily basis. So far, we do have in Murcia over 338,000 daily trips made by foot. This accounts for 37% of total daily trips, being equivalent to 0.87 trips per person per day.

The following graph shows the distribution of journeys by foot in Murcia:

Bicycle

The bicycle in Murcia is under a high process of transformation. The City has over 162 km of cycle paths, bike friendly routes and streets with limited speed. The City has 10,100 daily trips by bicycle, which represented 1.1% of total daily trips, (Sept, 2009), nevertheless we are updating the statistics, that are rather closed to 3% nowadays). Of all these trips, 66% may be considered "needed" trips due to different causes. In addition, 60% of bicycle users take the bike daily from Monday to Friday in their displacements.

Public transport

The use of Public transport represents the 10% of all journeys in Murcia, meaning the 17% of all motorised journeys. Regarding the City Bus System, the City has a good set of accessibility to travellers and several bus stops. It offers a good system of bus information and an adequate cover: 300 meters within the Murcia City Centre. The tram has very positively benefited public transport in Murcia. Over the last two years has improved the rate of use of public transport. Murcia's tram has served in those 2 years to 7,047,475 passengers.

Electric mobility

Murcia City has a considerable fleet of electric vehicles. Nevertheless, our public electric network of chargers must be expanded. This would Foster the demand of electric vehicles and would gradually grow the number of registered electric vehicles. Great efforts are being made by our Municipality in order to spread out the needs of changing mobility habits. We do incorporate electric vehicles to our usual means of transport, always in detriment of fossil fuels. Murcia City Council is currently looking for strong financing schemes in order to support the development of a proper e-mobility infrastructure, to better facilitate the introduction of electric mobility in Murcia.

Traffic and circulation

Traffic in Murcia indicates that there is a high use of private vehicles for commuting, which accounts for 51% of all trips and 81 % of all motorised trips, (Sept, 2009). Roundabouts are our main Traffic hotspots in the City, where there is the higher volume of traffic. In addition, also make it a place where unfortunately there is the higher level of conflicts, casuistic and accidents. The average speed is quite high in Murcia (22km/h) and there are no significant variations between peak and valley period. Furthermore we cannot address significant traffic congestion in Murcia, though it is a big city. From further analysis, it has been concluded that the global system used for traffic management in Murcia should give more priority to public transport rather than private one. Nevertheless, Murcia offers a massive use of private vehicles, which mainly causes heavy traffic in the roundabouts of the City (here below Murcia road´s distribution).

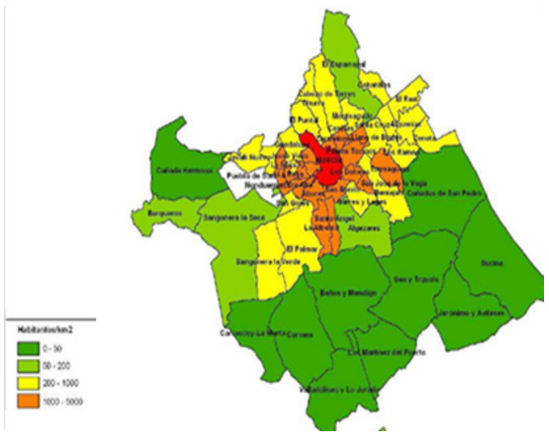
Existing studies and surveys show a great interest by citizens to change their usual means of transport, as for a more efficient one. Citizens in Murcia give great importance – as mainly everywhere else - to saving opportunities, towards mobility alternatives.

SMART BUILDINGS

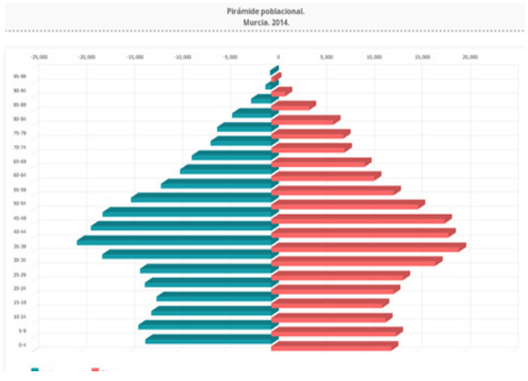
Demographical aspects

Number of inhabitants in 2014: 439.712

Population density 497 inhab./km². Due to the extension of Murcia Municipality, percentage of people living outside the city is bigger (61,33%) than percentage living in the urban centre (38,67%). The highest density of population (in red) occurs in the urban centre.



In Murcia the population increased to 50.000 people from 2003 to 2011. A soft decrease of population has been registered in the last years.



Social aspects

Percentage and evolution of people from foreign origin:

	Inhabitants (2014)	percentage
Spanish origin	388.510	88,36%
African origin	18.121	4,12%
American origin	17.420	3,96%
European origin	13.387	3,04%
Asian origin	2.258	0,51%
others	16	0,00%

Economical aspects

Income per head in comparison to the national average income in 2014: Murcia €18.529, Spain €22.780.

Due to financial and economic global crisis which extremely affected Spain and its regions, the number of unemployed in Murcia increased in 32.600 people since 2007 to 2013. In 2014 a downward evolution can be seen, and number of unemployed was reduced in 2600 people.

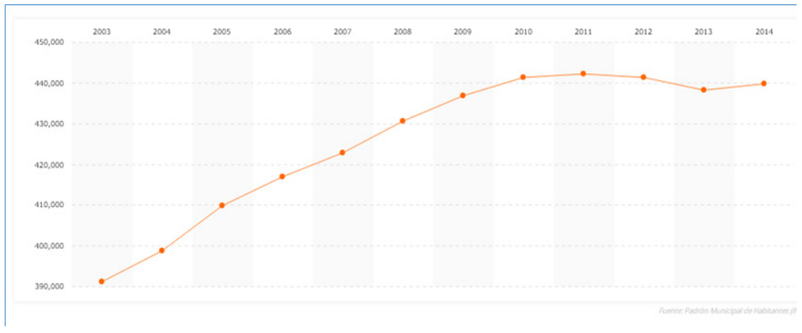
According to sector, unemployment in Murcia (2014) mainly affects Services.

Agricultural	1,117	Industry	4,286
Construction	5,694	Services	28,555
No activity	3,031		

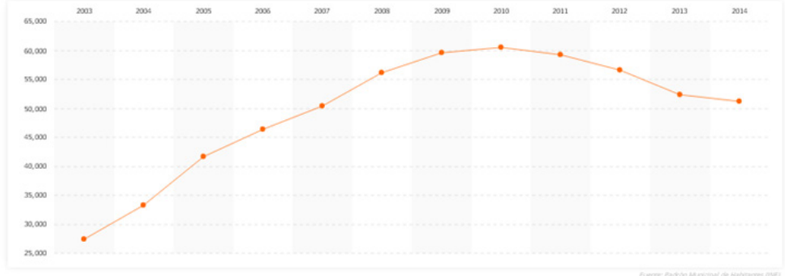
Numbers in percentages

http://www.murciaencifras.com/datos-basicos

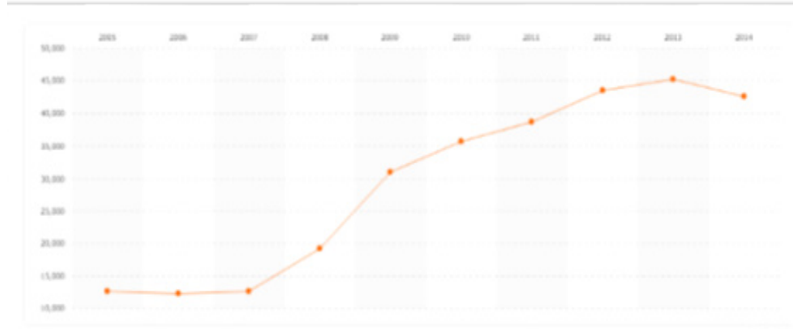
Evolution of the population in Murcia 2003-2014:



Murcia foreign population 2003-2014:



Registered unemployment. Murcia. 2005-2014:



Murcia

Environmental aspects

In 2008 Murcia was the first Spanish city to joint the Convenant of Mayors initiative, in order to take action to reduce 20% of CO2 emissions in 2020. Within this context, Murcia also launched in 2008 the 'Local Climate Change Strategy'. recently, in 2015, Murcia joined the European initiative to fight the climate change, Mayors Adapt.

The total area of the city is 890km2. The extension of with green space making up 67.72km, or 55%.

Total surface of public parks and gardens in the municipality: 4,2 km2

Water consumption per head 143 lit/day. Cost of water in Murcia is the higher in Spain 2,5 €/m3

SMART Real Time Water Management Center – smart meter infrastructure

Drinking Water Network is 2,187 km long. 164 km are main pipes of up to 1,000 mm diameter.

Biogas production in the Waste Water Treatment Processes (WWTP), which ensures a large part of its energy consumption of the by this renewable energy source.

Climate conditions: average temperature 18,4 ºC, rain¬fall 215 mm in 2013 .

Evolution of air quality (in number of days):

	2010	2011	2012	2013	2014
Good	172	123	84	111	92
Admisible	186	229	280	246	273
Bad	4	13	1	6	3
Very bad	3	1	0	0	0

Recent projects

1. MOBISEC - Mobilitity Initiatives for Sustainable European Communities

Grant DG MOVE (Transport and mobility) of the EU.

Current

Coordinator of the project.

Main topics: Promotion of the use of the bicycle as usual transport; Guarantee the safety of users of public roads and especially cyclists and pedestrians; strategies to promote the intermodality of bicycle with other transport and Citizen participation

2. MUTRANS (Murcia-Transport).

Grant DG MOVE (Transport and mobility) of the EU.

Current

Coordinator of the project.

Mutrans is the integrated urban mobility platform of the City of Murcia. The web and App include all the information needed to move around Murcia tram, bus and bicycle, and can set routes combined. Also available in English to encourage a sustainable tourism

3. R4E: Roadmaps for Energy

H2020-EE-2014-3-MarketUptake

Current

Topics:Enhancing the capacity of public authorities to plan and implement sustainable energy policies and measures

4. SMARTSPACES – Saving Energy in Europe's Public Buildings Using ICT

CIP ICT Policy Support Programme.

Current

The project started on 1 January 2012 and will last for three years. It will set up 11 pilot sites in 11 cities in 8 countries and be operated by 26 partners with an overall budget of almost 7 million Euros.

5. SMARTPA - Smarter Public Administrations in the EU

Life Long Learning Programme

Current

This project aims to improve the use of ICT, particularly cloud computing and required competences, in European public administrations

6. SURE. Sustainable Urban Energy in the ENPI Region.

Program CIUDAD of the EuropeAid Office of the European Commission.

The aim of the project is exchanging experiences in energy planing, promotion of the Covenant of Mayors and technical advice for achieving the targets of the Covenant (20-20-20), meaning: decrease of CO2 emissions 20%, increase of energy efficiency 20% and renewable share 20% for the year 2020.

7. « ENPCOM project- European network for the promotion of the Covenant of Mayors »

"Europe for Citizens". DG Culture

ENPCOM is a network of local governments, citizens, industry organizations and associations aimed at strengthening the involvement of European citizens in the fight against climate.

8.Creation of Local Energy Agencies in Bordeaux, Latina, Murcia, Riga and Porto

Intelligent Energy for Europe Programme

9. Partnership Energy Planning as a tool for realising European Sustainable Energy Communities (PEPESEC)

Intelligent Energy for Europe Programme

PEPESEC supports the development of sustainable energy communities by increasing the role of local community planning in developing a more efficient supply, distribution and use of renewal energy sources (RES) and conventional energy, demand-side management and associated mobility.

10. ProSto project

Intelligent Energy for Europe Programme

The overall objective of ProSTO is to support European local authorities in planning, developing, introducing and managing efficient solar thermal ordinances (STOs).

11. Pro-EE: improve energy efficiency through sustainable public procurement.

Intelligent Energy for Europe Programme

Pro-EE brought together producers and consumers, implemented energy-efficient green public procurement (GPP) procedures in local administrations, and organised training sessions for municipalities' procurement staff. At the same time, five pilot cities set up integrated energy efficiency action plans, which included the involvement of stakeholders and awareness-raising campaigns for citizens.

12. NICE Project (Networking Intelligent Cities for Energy Efficency)

FP7 funded project

The NiCE project aimed to support the fulfilment of the Green Digital Charter commitments.

13. Networks:

- Signature in 2008 of the Covenant of Mayors
- Member of Mayors Adapt, launched in the context of the EU Adaptation Strategy and is implemented within the Covenant of Mayors
- Vice president of the CIVITAS network in Spain and Portugal
- Member of Eurocities.
- Member of Eneragen, Spanish network of Energy Agencies
- Signature in 2009 of the Green Digital Charter. European Innovation Partnership on Smart Cities and Communities (EIP-SCC)
- Members of EnerAgen, the Spanish Association of Energy Agencies
- Members of RECI, the Spanish network of Smart cities
- Vice-Chair of the Technical Committee of Standardization AENOR CTN 178 on Energy in

SMART BUILDINGS

Smart Cities

- Presidents of the Spanish Network of Cities for the Bicycle (RCxB)
- Municipal Observatory of bicycle. It is a consultative body of the City of Murcia composed of representatives of all political groups of the municipal corporation, municipal technicians, representatives of associations of bicycle users, citizens' associations in defence of sustainable mobility and companies that regularly work with the City Council in advocacy and promotion of cycling.

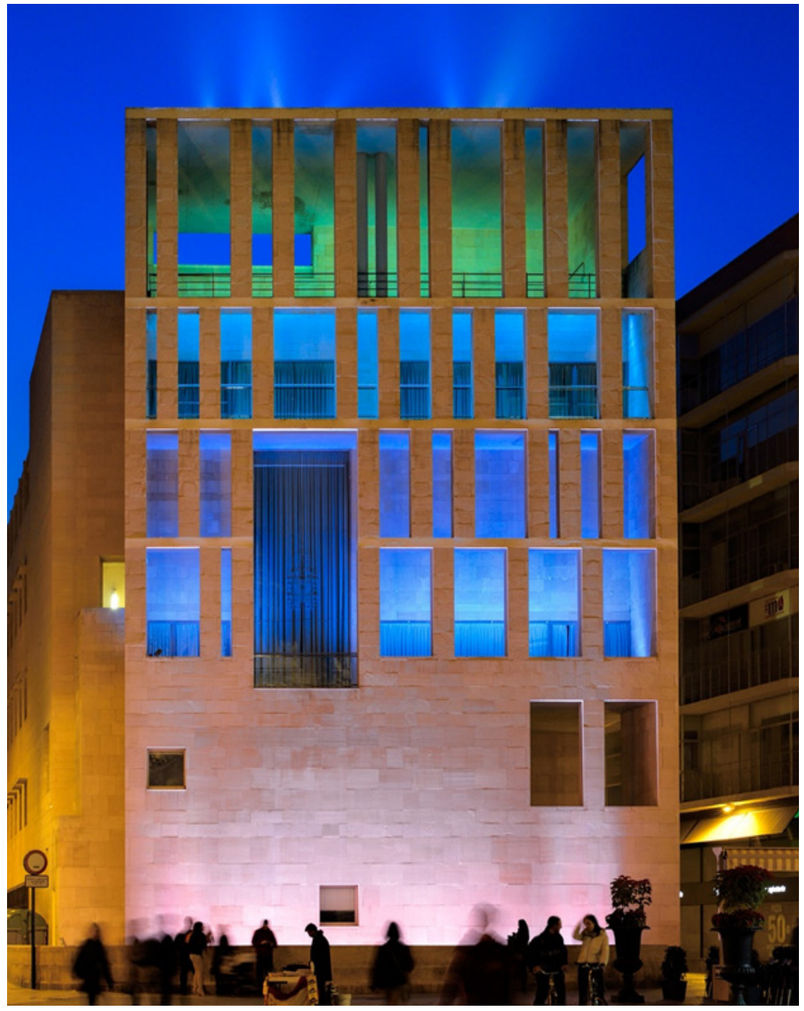
Today's reality: Smart buildings

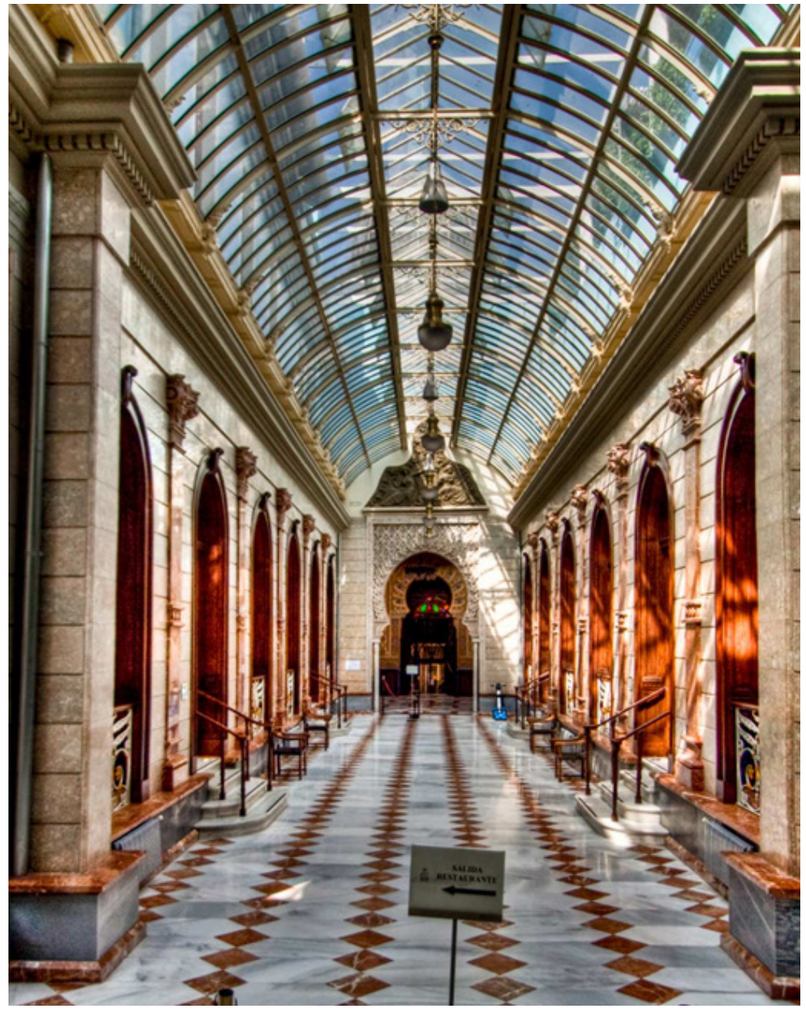
The city of Murcia has seen a strong construction sector during the period 2000 – 2007. From that time, the property bubble meant that the city has not had many examples of private smart building projects. With respect to Municipal Buildings, the Murcia City Council has built some remarkable buildings like the 'Edificio Municipal multiusos de Abenarabi', which is a good example of monitored and integrated systems. It uses the latest advances in communications, and can be considered as a reference in energy efficiency at regional level.

Apart from these examples, the Murcia City Council has been involved in the European 'Smart Spaces' project to reduce energy consumption in municipal buildings using ICT and by raising awareness. Murcia City Council achieved a reduction of the energy bill by 16% in five of its more representative buildings. The use of metering equipment in such buildings, combined with recruitment and dissemination activities, helped to make this possible.

Thanks to this project, the municipal staff can monitor the energy consumption of their building in real time with just a few clicks. This 'Free Access' to energy consumption data has been very helpful in raising staff awareness about energy saving. The online platform, allows them to view the specific energy consumption of each department and to check how the behaviour of people in the offices affect energy use.

There is a lot of work to be done yet in the field of monitoring and improving energy efficiency in Murcia's municipal buildings. There are a total of 500 buildings with different characteristics and uses, so the big challenge is how to install a precise and affordable monitoring system meets all the requirements and provide useful data to take decisions and act accordingly.





The pictures show the starting point in every building involved in the "Smart Spaces" project:

- Surface (m²): 5543
- Number of users: 223
- Visitors/month: 6000
- Electricity: 1,173,669 kWh
- Cost (€): 214,674
- Savings Planned: 20%

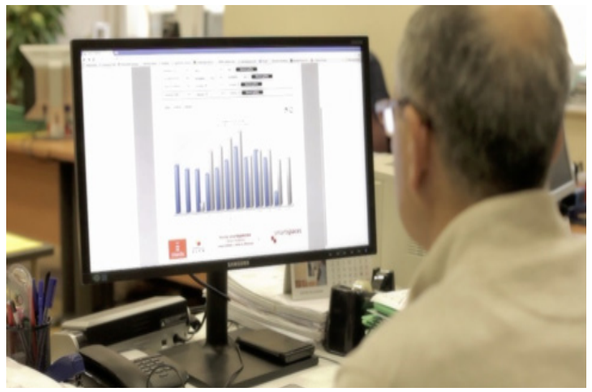
MURCIA CITY COUNCIL

- Surface (m²): 2000
- Number of users: 135
- Visitors/month: 6000
- Electricity: 431,665 kWh
- Cost (€) 82,525
- Savings Planned: 20%

ANNEXE BUILDING

- Surface (m²): 4399
- Number of users: 85
- Visitors/month: 6000
- Electricity: 1,265,436 kWh
- Cost (€) 221,007
- Savings Planned: 20%

POLICE STATION COMPLEX



15 December 2015

Jaime RUIZ HUESCAR & María Cruz FERREIRA COSTA, Ayuntamiento de Murcia

Ambition: Smart, interconnected green buildings maximise user comfort in Murcia 2050

SMART BUILDINGS

1

Interconnected buildings optimise comfort and use of resources

In 2050, the buildings in Murcia are interconnected by a tele-management system that enables sharing of energy and resources. This makes a big contribution to users' comfort and convenience, both inside and outside the buildings.

Strategic ambitions

- In 2050 buildings in Murcia inter-communicate, think and act in order to provide comfort and user-centered services with energetic autonomy.
- In 2050 in Murcia tele-management will allow buildings to inter-operate in order to optimise resources.

2

Buildings proactively adjusting to changing user needs

In 2050, people in Murcia value buildings that proactively adjust to their changing needs. Through profiles based on the expected use (presence and activity) and external factors (weather, season etc.), buildings actively choose the optimal energy settings to maximise comfort for users.

Strategic ambitions

- In 2050 the buildings in Murcia adjust themselves to the needs of their users and to external factors. The buildings being flexible and granted in terms of comfort by the use of centralised intelligent systems. The use is also optimised.
- In 2050 buildings in Murcia inter-communicate, think and act in order to provide comfort and user-centered services with energetic autonomy.

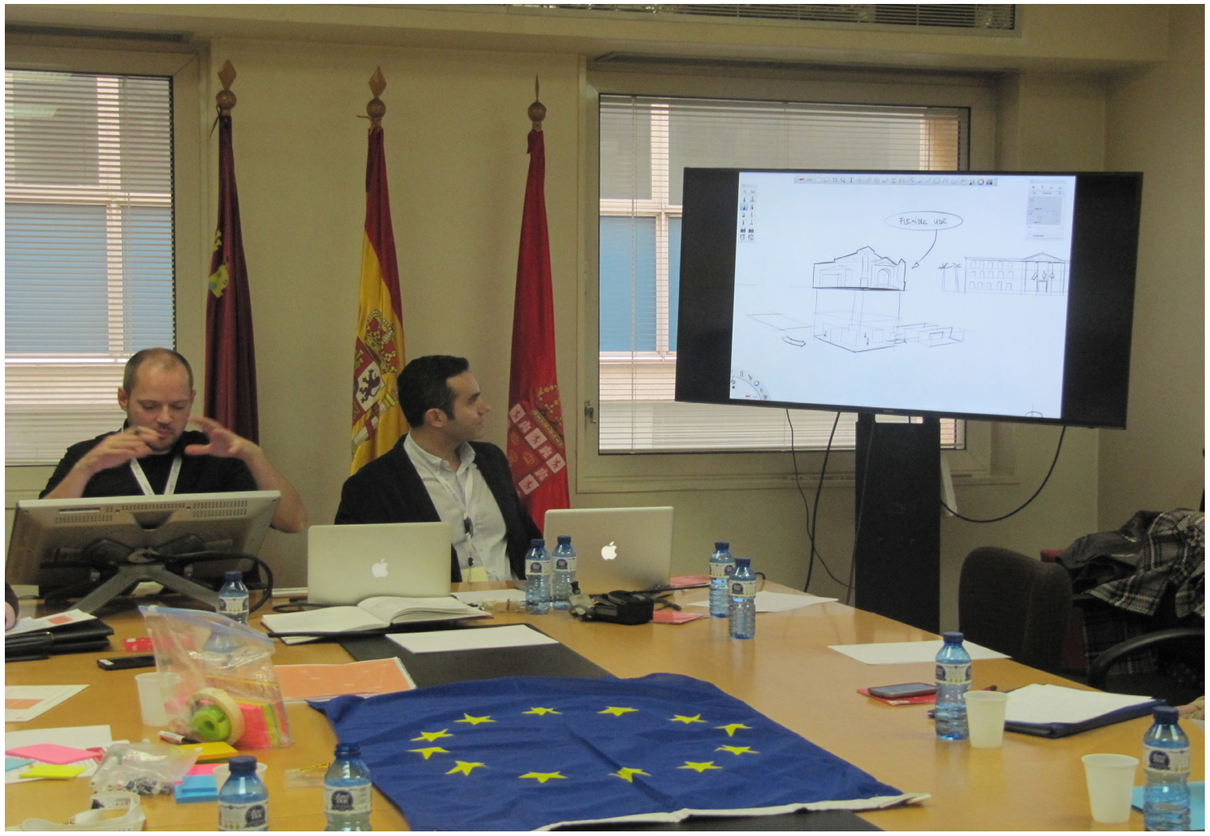
3

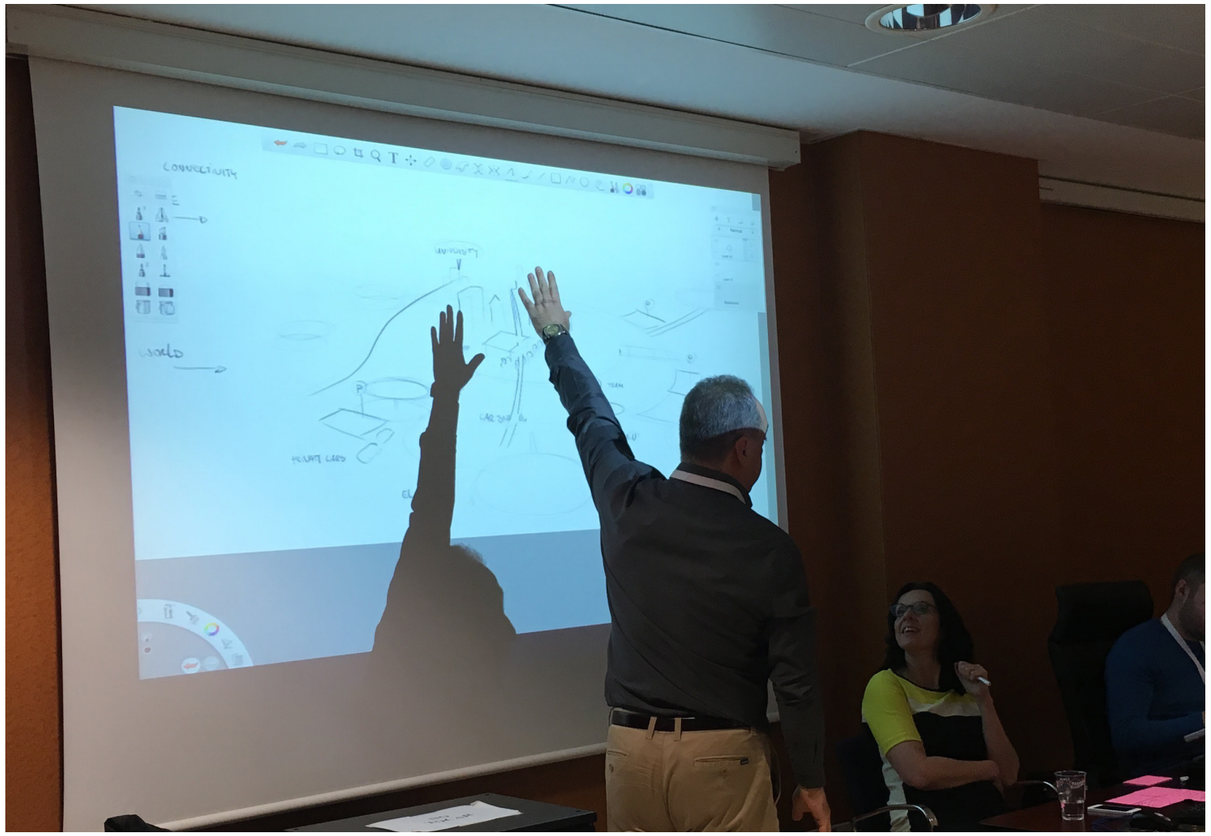
'Clean & green' buildings and city

In 2050, Murcia is among Europe's top 'clean & green' cities. This is achieved by green urban planning that values CO2-neutral, energy-producing buildings. These use renewable energy sources and have a low impact on nature, both during their construction and in daily use.

Strategic ambitions

- In 2050 all buildings in Murcia are zero-net balanced throughout the city. The buildings generate clean produced energy to fit their use. The capacity to store the energy is also realised. A greener Murcia is energy self-sufficient.
- In 2050 in Murcia the buildings will run on renewable energies, will be build with reusable materials and will not generate waste that may have a negative impact on nature.
- In 2050 Murcia is amongst the top 10 green, eco-friendly cities in Europe. Urban planing creates enough green to minimize local CO2-emission and local heat stress. The citizens are aware of their energy consumption and reduce their use.





Creating the visual of the desired future scenarios

VISION DEVELOPMENT

SMART BUILDINGS

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.

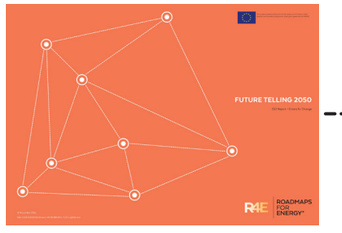
Joint Vision Workshop

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.

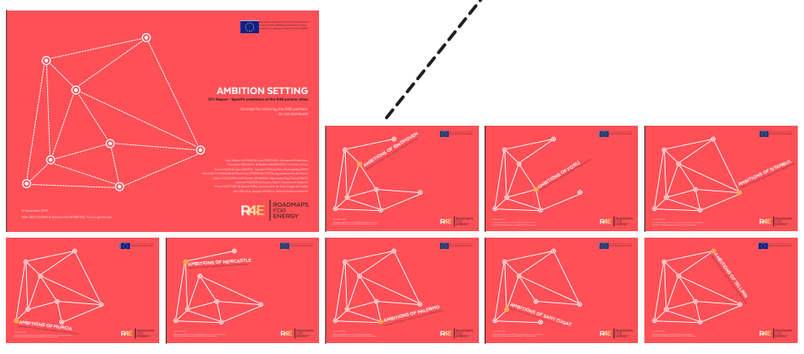
This Joint Vision Workshop served two purposes:

- 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 2050 - D2.1 report - Drivers for Change



Ambition Setting - D1.1 report - Specific ambitions of the R4E partner cities

City scenario workshops

Day 1 - Focus area 1	Day 2 - Focus area 2	Day 3 - Reporting
Outlining the vision · Exploring the drivers for change in relation to the future of the city · Selecting the main elements of the vision	**Outlining the vision** · Exploring the drivers for change in relation to the future of the city · Selecting the main elements of the vision	Project team working session to prepare the report of the Scenario Workshop
Enriching the desired future scenario · Exploring the future the city and the main elements of the vision · Enriching the vision with specific additions	**Enriching the desired future scenario** · Exploring the future of the city and the main elements of the vision · Enriching the vision with specific additions	

Programme of the scenario workshops in the cities

Day 1 Finalising Step 2	Poster exhibition of the city visions · The cities share their desired future scenarios for the focus areas
	Learning from each other's visions · In-depth discussion on common and specific needs described in the visions
Day 2 Preparing for Step 3	Presentation of the Roadmapping process · Sharing of interim results of the roadmapping desk study
	Identifying topics and experts for the roadmap interviews · Selecting topics for the roadmapping interviews and making a list of suggested experts using the networks of all partners

Programme of the Joint Vision Workshop

R4E ROADMAPS FOR ENERGY


TODAY'S
A new game-changing technology is again on the horizon. The question is which one?
There is more room for small-scale, local services specifically tailored in the field of education and in product personali-
Intensive replaced that produ used for fo
Compan and acr skills, p input.
Exploitin manufac meat o now p
In the care-sector as we in education, welfare of the individual is a core concern.
The merging of bra with digital systems has now led to a physically and mentally different kind of
Each individual is provided with personal space to develop uniquely and is suitably challenged in both their studi and professional lives.
32
33
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DO
Governments are increasingly withdrawing their control. Citizens are taking more responsibility and initiatives; both now innovate together.
People are living longer. learning, working, relaxing longer separated and ed: Learn-time, now span our d) active life.
In the expanding on and off-line social networks, people search for authenticity, economy of scale and a sense of security.
conditions for the empowering them.
by informed citizens on a global scale who advise each other about consequences and risks.
People are increas looking for a meanin contribution to societ heightening their sens well-being and happi
Our beh
Medical knowledge is a commodity where me professionals are los control over its use
Now that e design som have b
Soli People interest- money and together in, h rare disease res
People exclusiv reward b holistic vie spend their time.
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y and authentication vices for companies and individuals have become an increasingly important

Future Telling & selection drivers for change

SMART BUILDINGS

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 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.

Structured interviews

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.)

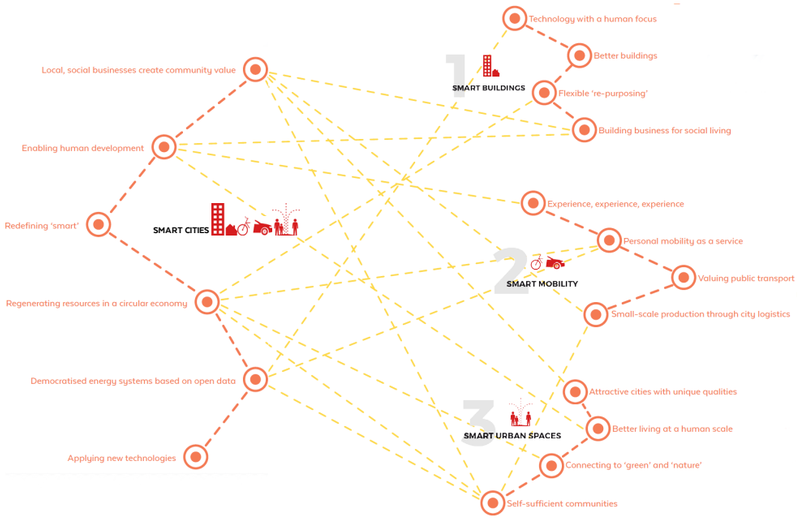
3. Tell stories about how you imagine these 10 trends will develop and what the future in cities will look like.

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 though 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.



18 Drivers for Change resulted from the Future Telling research

For an complete description, please refer to the complete report on Future Telling 2050 - D2.1 report Drivers for Change.

Selection of Drivers for Change

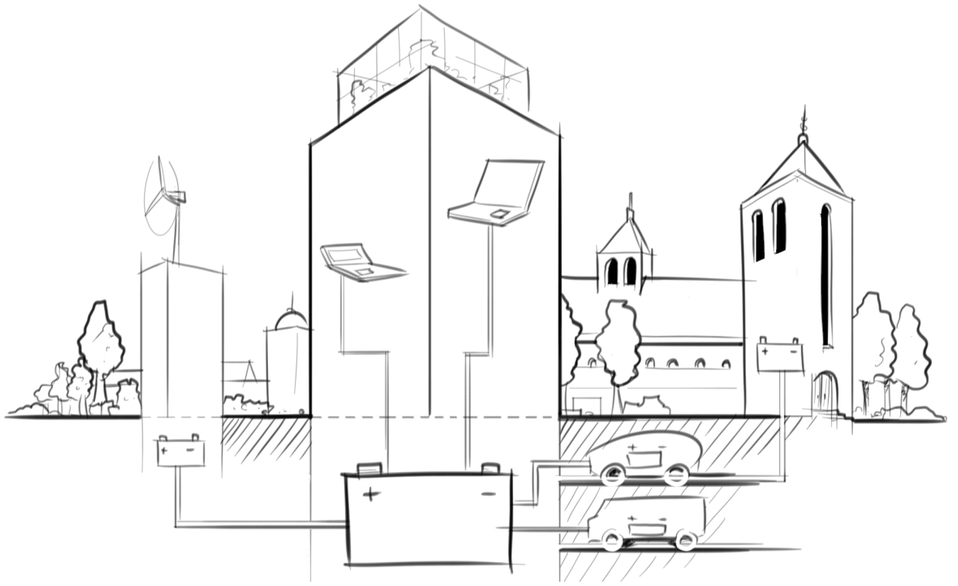
For the focus area Smart Buildings, the city of Murcia selected four Drivers for Change:

- Better buildings
- Technology with a human focus
- Democratised energy systems based on open data
- Applying new technologies

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.

Better buildings

In 2050, new buildings combine historical qualities and new technologies, creating maximum comfort and functionality for their users. Historical expertise in building for specific local climates is used to design solutions for new buildings, and for thoughtful upgrading of those already existing. The latest technologies and materials are applied to make buildings self-sufficient or even energy positive, contributing to abundant of renewable energies in cities. Policies aim at improving the quality of neighbourhoods and strengthening the sense of community, and not only at reducing energy consumption.



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

a. Blending the quality of our architectural past with the opportunities of new technologies

FT15.02. By 2050 we will be in a scenario where the building itself stores the energy that it needs. .... Today, even in this building, there is a lot of energy stored in every battery in every machine, but they are not connected to one another. There is a lot of cars parked underneath this building, and whether there will be cars in the future or cars will be slightly different, but there will be battery powered mobility. So all of that collective energy can plug into the building, to pair with the building. And buildings can then plug in into other buildings and share all this energy that is there.

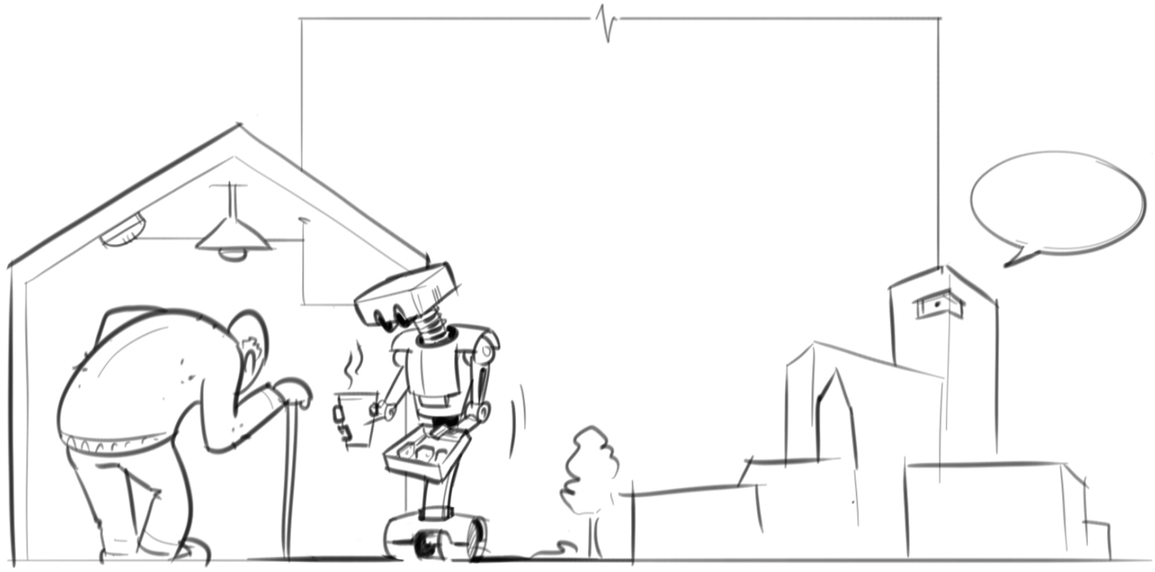
FT23.05. ... because the climate change is a reality, it will effect more the lower class people. Which is a big number of people in Europe these days. Last year, we had a big crisis and people did not use any gas and energy for cooking anymore. They were reducing the amount of energy because they were not able to pay the bills. We need to be very careful about these things. Energy savings in this way is easy, ... I believe we should make policy that is not aiming for reducing energy, but aim for increasing the quality of fabrics and buildings. But if you are not able to explain why this is necessary, then it will not work, because no one will invest money voluntarily to do that.

FT22.15. We also have the problem of social housing that were built in the last decades and all these houses are very bad. Poor constructions, poor systems. After the second World War the set-up, of cities of houses, has been forgotten. There is now no more money to change completely. The problem is that these neighbourhoods become the place where the new people will stay and that creates a lot of conflicts.

FT7.18. In 2050 you will get windows with electricity generating capacity in them. And smarter houses, and new infrastructure for electricity with IQ as we say. A lot will happen in new and refurbishing old buildings.

Technology with a human focus

In 2050, we've mastered the challenge of ever more complex, multifunctional systems and the need to make them easier to use. Those systems are user-focused: that means users can understand how the systems work, and how their own behaviour affects sustainability and energy use. Robotics and smart (home care) systems support living at home, helping people to live healthier lives and to stay in their homes longer as they get older. There's a range of available solutions that plug-in directly to the city's open energy platform.



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

a. Smart systems with a human touch
b. Improving quality of life with robotic support and home care systems

FT22.12. It is important to invest constantly. So people understand immediately the advantages of new technologies for sustainability in buildings and houses. Just to save electricity or for condition, because they immediately save money. That is very easy to understand. This requires a change for the experts to develop good scenario's. Not in the far future, or even the future, it starts right now. They have to present in a way that people easier understand.

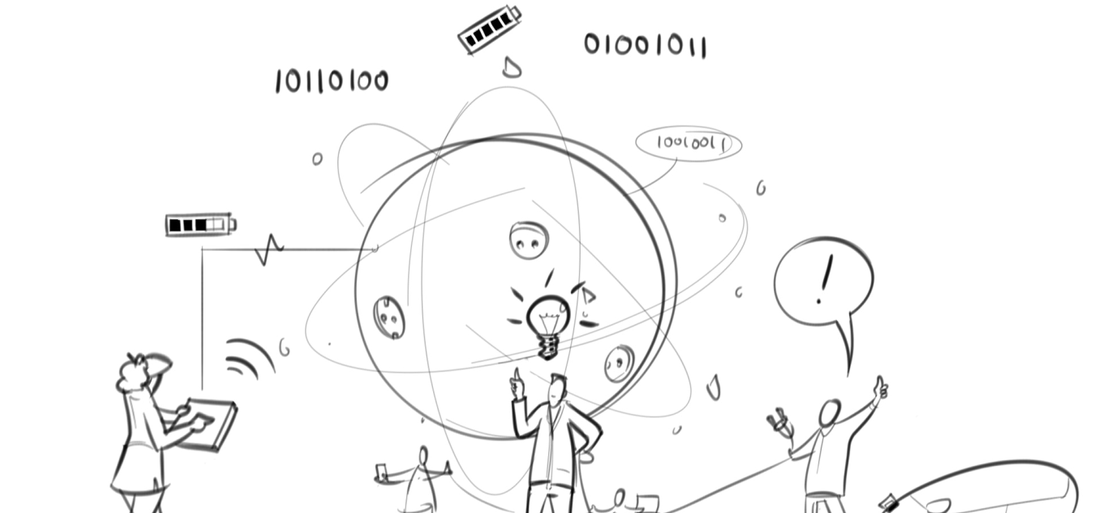
FT15.13. Now today there is things you can do in the home and around to save energy. … The value in Euros is not worth much. And I don't think honestly that most home owners want to reduce their energy bill either. They just don't want it to go up. … We have the technology to help you do that. Some of these technologies even mean that they can help to reduce your bill. So you could save 5 Euros a month. If you could translate that 5 Euros into something that is valuable. So if you say look, if you allow us to join you, or to involve you in this response-demand program, you will see no reduction in your home comfort, the heating will be on, etc. And we will take those credits and with those credits, we will give you another system in the elderly home where your mother lives, 300 miles away. It is very simple, you can set a scenario, that if the lights do not get on between 7-8 in the morning, or she doesn't put the kettle on between 7-8, then we will send you a text message and you can ring her up to see if she is alright. … So instead of the 2 or 3 Euros, translate that into a service that is very cheap to deliver but of a very high value to the individual. The challenge around utilities is to engage with the customers.

FT23.01. … This is the weak part of the story. If we do not speak about these weak elements of the society in the suburbia, then there is no way to talk about energy. Energy is invisible, people do not see it and do not understand it. They do not know where energy comes from and they do not connect the fact that you have energy and that creates problems in terms of emissions and pollution. So if you do not connect to that idea that energy has an impact on everybody, then you can never win.

FT 15.17. … Interesting will be the lighting. If you want more lighting, and you want to turn the switch, you are actually saying 'I want more light for reading'. Now the building can do anything to his ability to analyse and see if it does so by letting more lights in from using the blinded windows or change the transparency of the walls. It will do whatever the most efficient solution is to give you what you need. And then as a last resort, okay turn the light on. The switch of tomorrow is just a sensor and the robotic support mechanism will change walls, windows, blinds, everything to help you get what you need.

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. ...

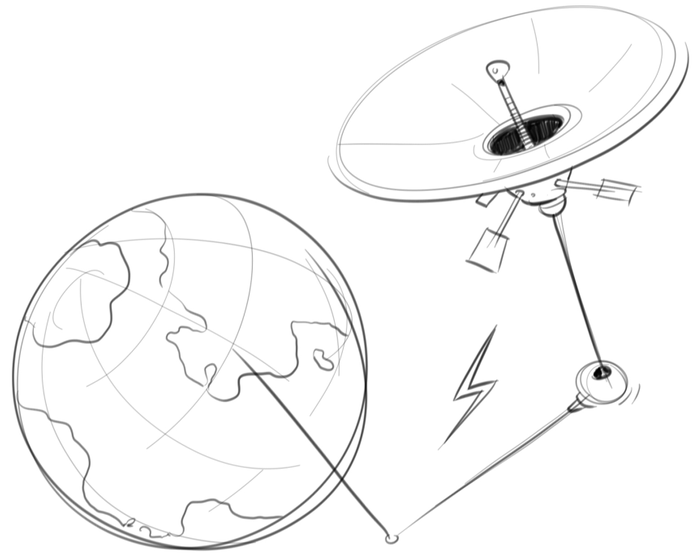
FT16.03. ... the fact that people do not need energy, but they need to wash, to cook, to be warm. The fact that they will be able to produce energy directly, or coming from their neighbour. And the fact that digital technology will allow to combine this supply and demand, I will guarantee that all activity 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't actually soon draw a line between a human and computer. ...

Applying new technologies

In 2050, a range of new technologies are available and affordable. Some of them are already in development, others are still unknown. Cities apply those technologies in new solutions that contribute to the quality of life, and in particular to the creation of smart buildings, smart mobility and smart urban spaces.



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

a. Applying new technological solutions to increase quality of life in cities

FT7.17. There is another trend that is now not included: in 2050 humanity has moved into space. We will have much more activity in space, on the moon, on asteroids. ... When we succeed to harvest energy in space and beam it to earth it will be a revolution.

FT2.15. We will have our first test satellite up with solar power in 2017. We might be able to have the worlds first beaming of solar energy from space.

FT5.01. In 2050 I imagine that they are looking for the new world in space, out of our world. ...and maybe, if we will create a much better world than this one, there will be no-one left on this planet.

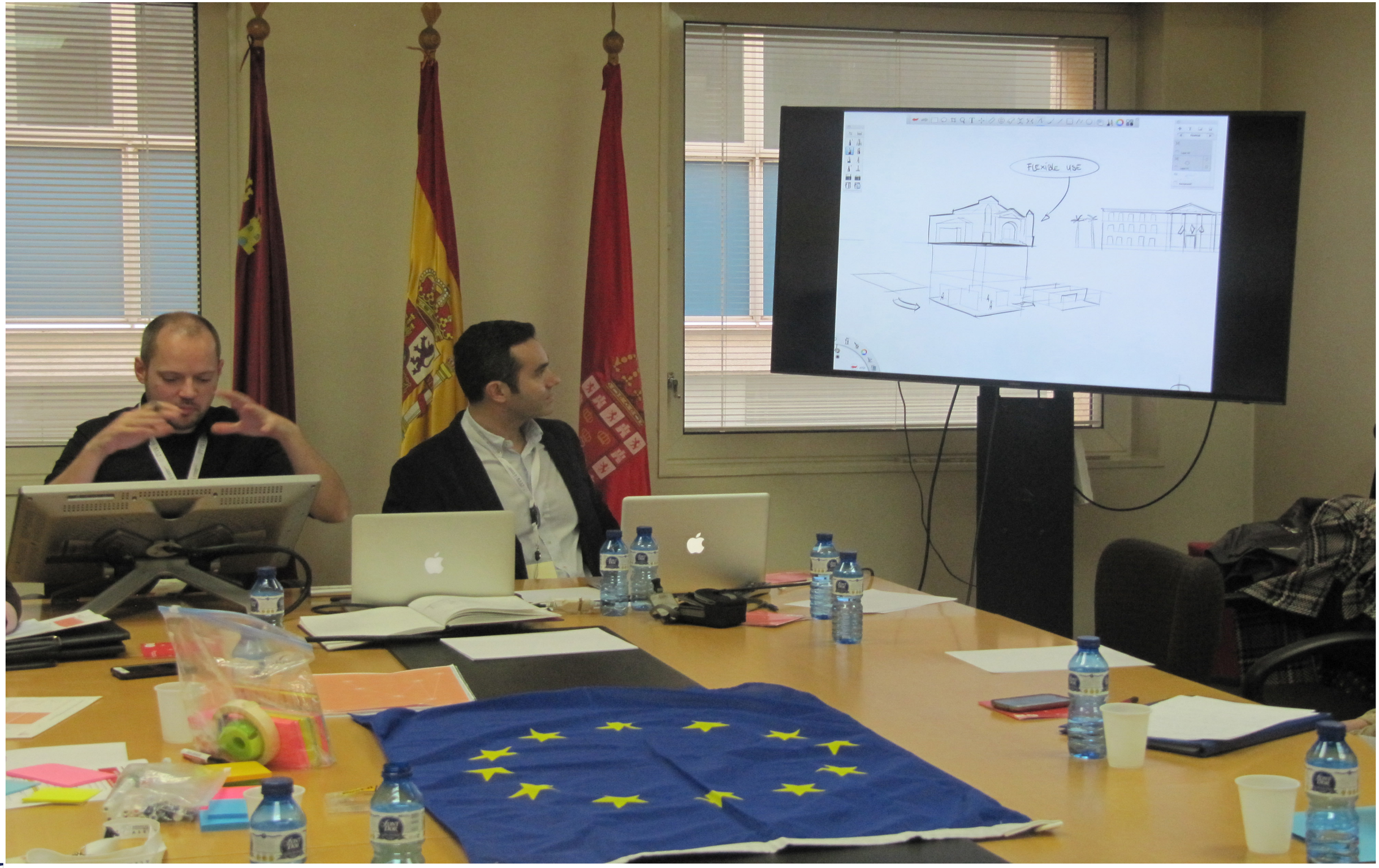
FT8.11. ...Technology will make diseases extinct. ... To be honest I do not know how feasible this is by 2050, surely aids, maybe not distinct, but under control. But if the key could be unlocked, for cancer for instance, I think this would have a huge impact on people's lives. Also because we will be getting older, so the more that you can cut out these kind of things would contribute to premature deaths, but also having an impact on the quality of live ...

FT10.13. ... I am not saying that by 2050 we will have an infinite amount of energy, but we will have so much that we can consider things like the 'beam-me-up-Scotty' type of stuff or space travelling.

FT5.07. ... Technology will enter all kinds of fields and disciplines, so this will happen everywhere.

FT2.12. Maybe the sweet spot is fabrication in the city, in vertical farms or whatever, 3D printing food. If I want a cup of coffee, I'll print the cup. The table will be a 3D printer, printing up my cup. One of the divisions in Carnegie University has a project on programmable matter. At the moment they are little units, but their idea is to have them at micrometre scale, where the particles are basically magnets, they change colour, they've got behavioural autonomy and swarm collective intelligence. It is basically very fine dust that can take form and shapes and lock into. It may sound as fantasy now, but this sort of thing will be there in 2050. ...

FT15.06. Today all buildings have an AC grid (alternating current), some today have a DC grid (direct current). By 2050 there will be DC grids. The majority of the assets in the buildings will be DC.



Creating the visual of the desired future scenarios

SMART BUILDINGS

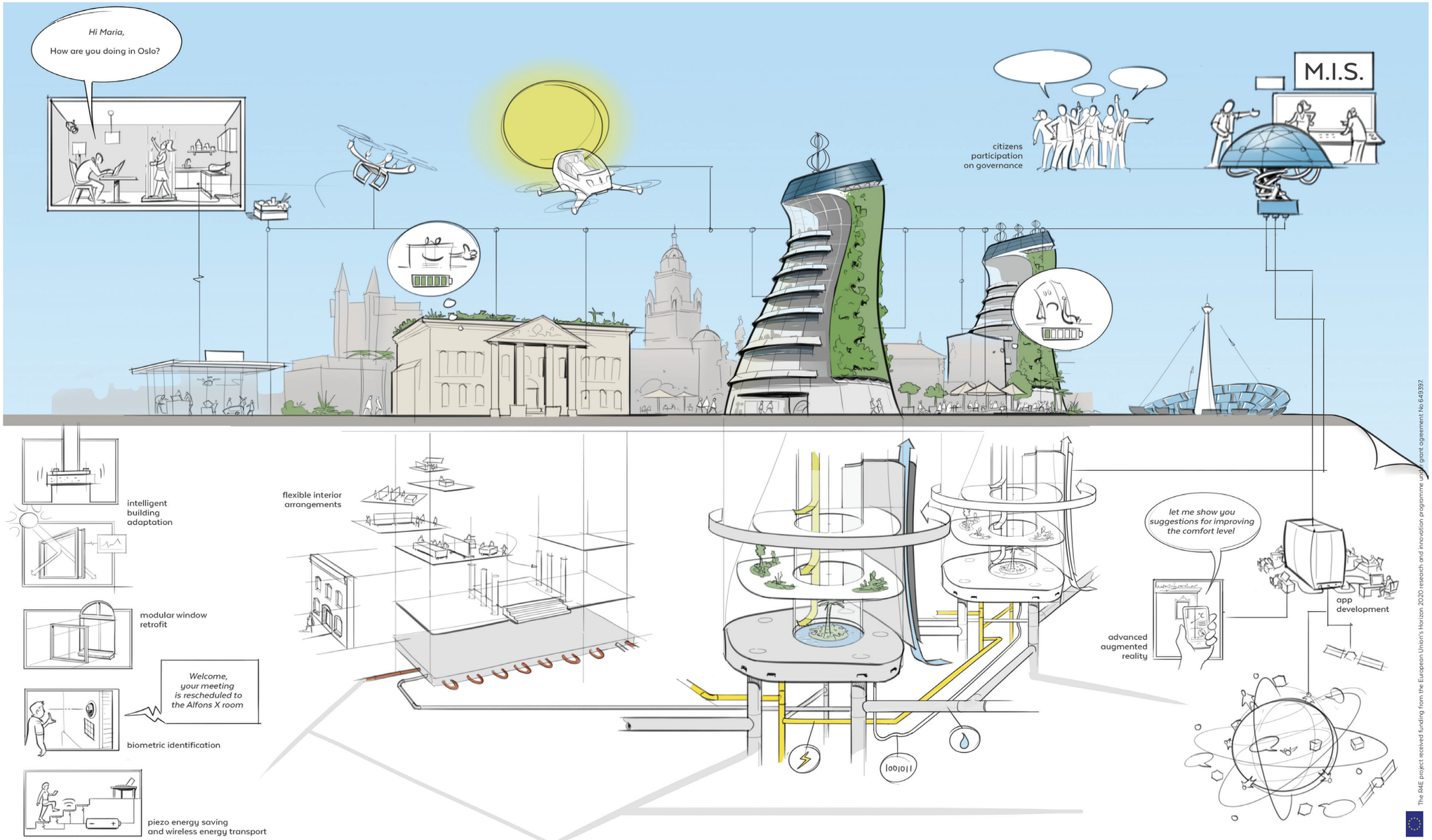
Murcia

SMART, INTERCONNECTED GREEN BUILDINGS MAXIMISE USER COMFORT IN MURCIA 2050

In 2050, the people of Murcia enjoy buildings that proactively adjust to their changing needs. Through profiles based on the expected use (presence and activities) and external factors (weather, season etc.), buildings actively choose the optimum energy settings to maximise comfort for users.

The buildings are interconnected by a telemanagement system that enables sharing of energy and resources. This makes a big contribution to users' comfort and convenience, both inside and outside the buildings.

Murcia achieved a position among Europe's top 'clean & green' cities by green urban planning that values CO_2-neutral energy-producing buildings. The buildings use renewable energy sources and have a low impact on nature, both during construction and in everyday use.



The R4E project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 649397

Elements of the desired future scenario are:

Flexible use of buildings

The buildings in Murcia facilitate highly flexible use, for different users, different activities and in different seasons. Walls, installations and furniture can be rearranged easily — for example using flexible partitioners, changeable windows or 'floating' desks. Standardised protocols enable roaming profiles for user settings in the virtual space. Smart management systems support effective and efficient use of the workspaces.

Enhancing working & family life

The buildings recognise people and can adapt to their personal preferences and habits by providing the desired atmosphere and climate settings. Homes cater for teleworking and remote healthcare through good connectivity and smart appliances. Use of the latest technologies facilitates a whole range of other activities — for example using augmented reality for easy enjoyable shopping, navigation and other everyday tasks.

'Green' buildings technologies

The latest technologies are used in the buildings for easy energy saving, generation and storage. Examples are the use of energy-absorbing materials, and light tubes to bring daylight into the heart of the building. The buildings are climate-proof, so they can absorb heavy rain showers. And they are resistant to earth-quakes through the use of innovative solutions like flexible materials and active bumpers. Wireless networks are used to charge energy-efficient appliances.

Learning buildings

The buildings are interconnected: not only do they learn during use, but they can also share their learnings. The use of all utilities (energy, water, waste and other resources) is monitored. Patterns of use are recognised so upcoming activities can be anticipated, providing maximum comfort for users. This active data sharing allows the buildings to learn from each other, providing maximum user comfort at the lowest energy consumption.

Master Intelligent System

Murcia's Master Intelligent System uses open data and standard protocols all over the city, providing new services on an open platform. People can easily access and connect to the platform, wherever they are. Energy supply and demand are matched — and legally embedded — in the central system. The focus is on the users' needs, with priority for emergency services when necessary. Energy can be exchanged freely between users, appliances, vehicles and buildings.

Version 15 June 2016

LIGHT HOUSE expertise in smart lighting & smart cities @ TU/e

R4E ROADMAPS FOR ENERGY®




SMART BUILDINGS GENERAL ROADMAP








ROADMAPPING

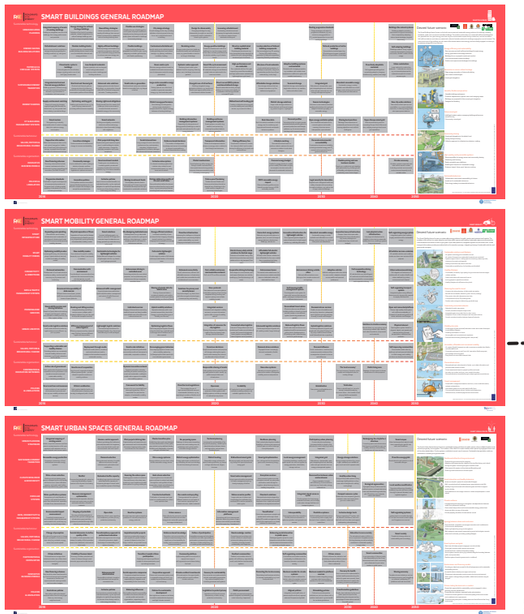
SMART BUILDINGS

Roadmapping

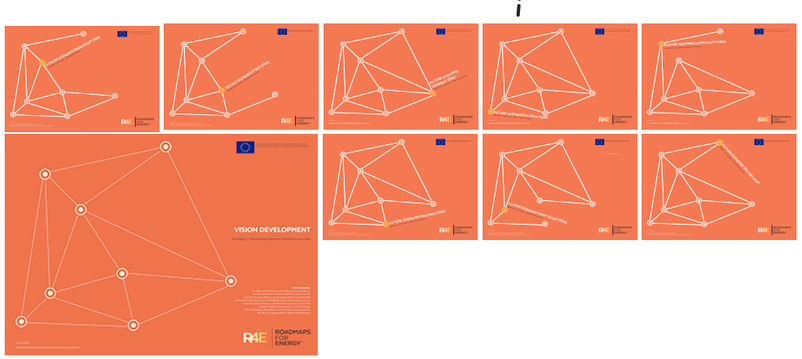
The aim of Step 3 is to develop specific roadmaps for the cities in the selected focus areas. A roadmap shows all existing and future technologies and other relevant developments that enable the achievement of the desired future scenarios by 2050. Two main activities take place in this step. Firstly, 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.



Smart Buildings General Roadmap - D3.2 report,
Smart Mobility General Roadmap - D4.2 report,
Smart Urban Spaces General Roadmap - D5.2 report



Vision Development - D2.2 report - Desired future scenarios of the R4E partner cities

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.

City roadmap workshops	Focus and milestones	Focus area 1	Focus area 2
	Making choices for the focus and intermediate milestones in the city specific roadmap to realise the Desired Future Scenarios for the two focus areas.	**Completing the roadmap** • Identifying (local) solutions and research projects needed to reach the city's desired future scenario • Reflecting on results and identifying missing solutions and research projects	**Completing the roadmap** • Identifying (local) solutions and research projects needed to reach the city's desired future scenario • Reflecting on results and identifying missing solutions and research projects

Programme of the roadmap workshops in 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.

Day 1 Finalising Step 3	Learning from each other • Presentation of current projects and proposals for new projects • Gaining understanding of the current strengths and challenges of the R4E partner cities
Day 2 Preparing for Step 4	Identifying cross-city learning objectives • Selecting common ambitions • Formulating cross-city learning objectives as input for the Project Portfolio step

Programme of the Joint Roadmap Workshop

R4E ROADMAPS FOR ENERGY

Murcia

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.

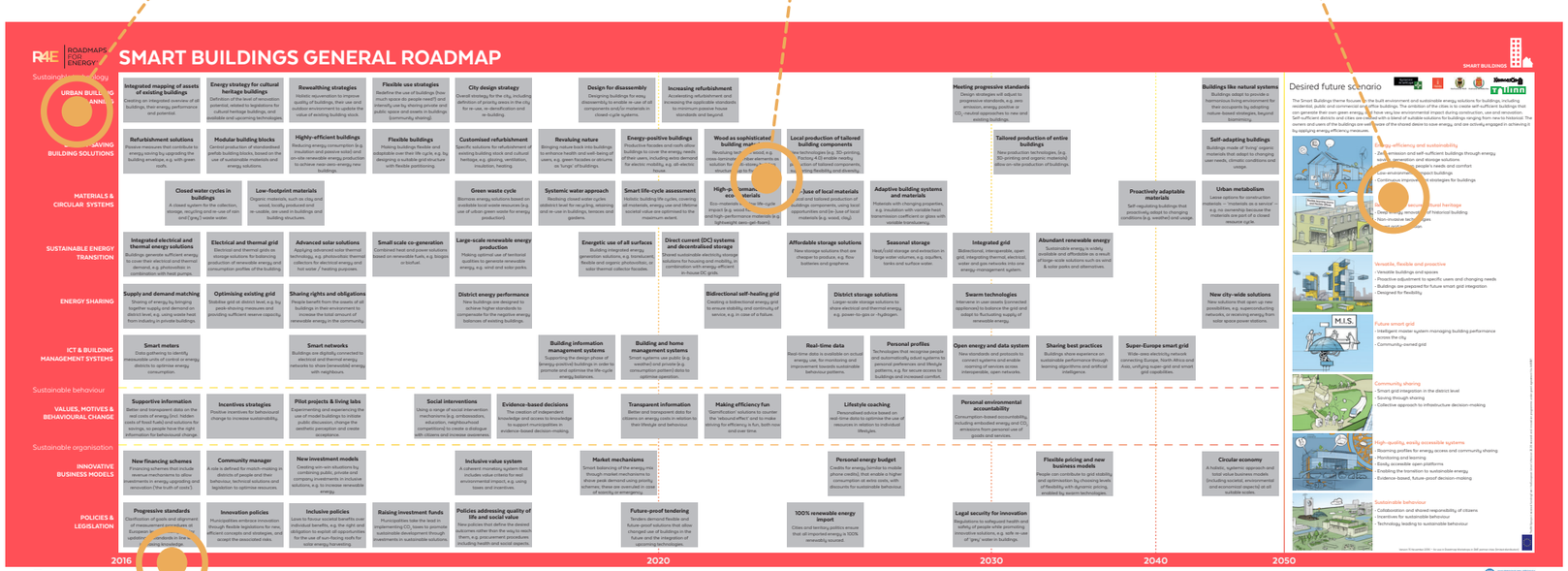
Each topic has a timeline showing the developments that are relevant to that topic.

The image shows the elements of the General Roadmap.

Relevant topics for the focus area

Future options on the timeline

Common needs in the desired future scenarios for 2050



Timeline from now (2016) to the vision (2050)

Elements of the Smart Buildings General Roadmap

Relevant topics Smart Buildings

SMART BUILDINGS

The generic roadmap shows timelines for the topics requiring developments to achieve the desired future scenario in 2050. The selected topics for the Roadmap Smart Buildings 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 Buildings includes the following technology developments:

URBAN BUILDING PLANNING

Urban Building Planning is about a structured approach to buildings within the overall city planning strategy. This topic refers to the need for integrated mapping of existing assets on a city-wide scale in developing holistic use and refurbishment strategies. This includes strategies for cultural heritage buildings and the introduction of progressive building standards, as well as developments towards the use of closed-cycle systems.

ENERGY-SAVING BUILDING SOLUTIONS

Energy-Saving Building Solutions refers to materials, systems and strategies to reduce the energy needed for the construction, operation and lifetime maintenance of the building. This includes strategies for building materials and systems, as well as flexible and adaptable energy-savings concepts. It also refers to the way buildings and their components will be constructed in the future.

MATERIALS & CIRCULAR SYSTEMS

Materials & Circular Systems is about material, water and waste cycles in buildings and their contribution to energy-efficiency and resource savings. The topic refers to the importance on closing material, water and waste cycles of buildings and the use of low-impact materials. This includes how buildings and their materials can be made increasingly adaptive, so they contribute to an urban metabolism based on closed resource cycles.

SUSTAINABLE ENERGY TRANSITION

Sustainable Energy Transition refers to the transformation of energy systems on the scale of building and grid towards integrated renewable-energy solutions. It is about the way current energy systems are becoming increasingly smart and integrated, shifting towards solar based, building-integrated renewable-energy solutions. The topic includes future grid developments for electricity and heat, including storage solutions and integrated management.

ENERGY SHARING

Energy Sharing refers to strategies that make individual buildings into contributors to efficient city-wide solutions. This topic deals with the active future role of buildings in the overall energy system, including supply and demand matching and contributions to improved grid stability. More specifically, this topic is about how to optimise overall district energy performance based on future energy grids.

ICT & BUILDING MANAGEMENT SYSTEMS

ICT & Building Management Systems is about the increasing generation and use of data to manage and optimise energy in buildings and grids. This refers to smart meters and their evolution towards smart networks supported by building information and home management systems. It also includes the increasing availability of real-time data and the interoperability of networks, resulting in improved performance through shared learning.

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 Buildings includes the following behavioural developments:

VALUES, MOTIVES & BEHAVIOURAL CHANGE

Values, Motives & Behavioural Change includes personal and institutional ways to drive transformations by new approaches to information, experience and personal accountability. This includes instruments like incentives, pilot projects and lifestyle coaching, all of which can contribute to evidence-based decision-making and lifestyle changes.

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 Buildings includes the following organisational developments:

INNOVATIVE BUSINESS MODELS

Innovative Business Models refers to new financial schemes, investment models and market mechanisms that accompany transition processes or arise as a result of those processes. This also includes new and inclusive value systems, coherent monetary systems and new ways of managing energy at personal and community levels, viewed from societal, environmental and economic perspectives.

POLICIES & LEGISLATION

Policies & Legislation refers to the role of municipalities and the changes in policies, with a holistic focus on improving the quality of life and societal value for the community as a whole. This includes policies and legislations on environmental and energy standards, as well as innovations, public tenders, public investments and taxation to reach the overall political goals.

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.

R4E ROADMAPS FOR ENERGY®

SMART BUILDINGS GENERAL ROADMAP

Sustainable technology

URBAN BUILDING PLANNING

Integrated mapping of assets of existing buildings
Creating an integrated overview of all buildings, their energy performance and potential.

Energy strategy for cultural heritage buildings
Definition of the level of renovation potential, related to legislations for cultural heritage buildings, and available and upcoming technologies.

Rewealthing strategies
Holistic rejuvenation to improve quality of buildings, their use and outdoor environment to update the value of existing building stock.

Flexible use strategies
Redefine the use of buildings (how much space do people need?) and intensify use by sharing private and public space and assets in buildings (community sharing).

City design strategy
Overall strategy for the city, including definition of priority areas in the city for re-use, re-densification and re-building.

Design for disassembly
Designing buildings for easy disassembly to enable re-use of all components and/or materials in closed-cycle systems.

Increasing refurbishment
Accelerating refurbishment and increasing the applicable standards to minimum passive house standards and beyond.

ENERGY-SAVING BUILDING SOLUTIONS

Refurbishment solutions
Passive measures that contribute to energy saving by upgrading the building envelope, e.g. with green roofs.

Modular building blocks
Central production of standardised prefab building blocks, based on the use of sustainable materials and energy solutions.

Highly-efficient buildings
Reducing energy consumption (e.g. insulation and passive solar) and on-site renewable energy production to achieve near-zero-energy new buildings.

Flexible buildings
Making buildings flexible and adaptable over their life cycle, e.g. by designing a suitable grid structure with flexible partitioning.

Customised refurbishment
Specific solutions for refurbishment of existing building stock and cultural heritage, e.g. glazing, ventilation, insulation, heating.

Revaluing nature
Bringing nature back into buildings to enhance health and well-being of users, e.g. green facades or atriums as 'lungs' of buildings.

Energy-positive buildings
Productive facades and roofs allow buildings to cover the energy needs of their users, including extra demand for electric mobility, e.g. all-electric house.

Wood as sophisticated building material
Revaluing technical wood, e.g. cross-laminated timber elements as solution for multi-storey building structures (up to five floors).

MATERIALS & CIRCULAR SYSTEMS

Closed water cycles in buildings
A closed system for the collection, storage, recycling and re-use of rain and ('grey') waste water.

Low-footprint materials
Organic materials, such as clay and wood, locally produced and re-usable, are used in buildings and building structures.

Green waste cycle
Biomass energy solutions based on available local waste resources (e.g. use of urban green waste for energy production).

Systemic water approach
Realising closed water cycles atdistrict level for recycling, retaining and re-use in buildings, terraces and gardens.

Smart life-cycle assessment
Holistic building life cycles, covering all materials, energy use and lifetime societal value are optimised to the maximum extent.

High-performance and eco-materials
Eco-materials with low life-cycle impact (e.g. wood fibre insulation) and high-performance materials (e.g. lightweight aero-gel-foam).

SUSTAINABLE ENERGY TRANSITION

Integrated electrical and thermal energy solutions
Buildings generate sufficient energy to cover their electrical and thermal demand, e.g. photovoltaic in combination with heat pumps.

Electrical and thermal grid
Electrical and thermal grids as storage solutions for balancing production of renewable energy and consumption profiles of the building.

Advanced solar solutions
Applying advanced solar thermal technology, e.g. photovoltaic thermal collectors for electrical energy and hot water / heating purposes.

Small scale co-generation
Combined heat and power solutions based on renewable fuels, e.g. biogas or biofuel.

Large-scale renewable energy production
Making optimal use of territorial qualities to generate renewable energy, e.g. wind and solar parks.

Energetic use of all surfaces
Building integrated energy generation solutions, e.g. translucent, flexible and organic photovoltaic, or solar thermal collector facades.

Direct current (DC) systems and decentralised storage
Shared sustainable electricity storage solutions for housing and mobility, in combination with energy-efficient in-house DC grids.

ENERGY SHARING

Supply and demand matching
Sharing of energy by bringing together supply and demand on district level, e.g. using waste heat from industry in private buildings.

Optimising existing grid
Stabilise grid at district level, e.g. by peak-shaving measures and providing sufficient reserve capacity.

Sharing rights and obligations
People benefit from the assets of all buildings in their environment to increase the total amount of renewable energy in the community.

District energy performance
New buildings are designed to achieve higher standards to compensate for the negative energy balances of existing buildings.

Bidirectional self-healing grid
Creating a bidirectional energy grid to ensure stability and continuity of service, e.g. in case of a failure.

ICT & BUILDING MANAGEMENT SYSTEMS

Smart meters
Data gathering to identify measurable units of control or energy districts to optimise energy consumption.

Smart networks
Buildings are digitally connected to electrical and thermal energy networks to share (renewable) energy with neighbours.

Building information management systems
Supporting the design phase of (energy-positive) buildings in order to promote and optimise the life-cycle energy balances.

Building and home management systems
Smart systems use public (e.g. weather) and private (e.g. consumption pattern) data to optimise operation.

Sustainable behaviour

VALUES, MOTIVES & BEHAVIOURAL CHANGE

Supportive information
Better and transparent data on the real costs of energy (incl. hidden costs of fossil fuels) and solutions for savings, so people have the right information for behavioural change.

Incentives strategies
Positive incentives for behavioural change to increase sustainability.

Pilot projects & living labs
Experimenting and experiencing the use of model buildings to initiate public discussion, change the aesthetic perception and create acceptance.

Social interventions
Using a range of social intervention mechanisms (e.g. ambassadors, education, neighbourhood competitions) to create a dialogue with citizens and increase awareness.

Evidence-based decisions
The creation of independent knowledge and access to knowledge to support municipalities in evidence-based decision-making.

Transparent information
Better and transparent data for citizens on energy costs in relation to their lifestyle and behaviour.

Making efficiency fun
'Gamification' solutions to counter the 'rebound effect' and to make striving for efficiency is fun, both now and over time.

Sustainable organisation

INNOVATIVE BUSINESS MODELS

New financing schemes
Financing schemes that include revenue mechanisms to allow investments in energy upgrading and renovation ('the truth of costs').

Community manager
A role is defined for match-making in districts of people and their behaviour, technical solutions and legislation to optimise resources.

New investment models
Creating win-win situations by combining public, private and company investments in inclusive solutions, e.g. to increase renewable energy.

Inclusive value system
A coherent monetary system that includes value criteria for real environmental impact, e.g. using taxes and incentives.

Market mechanisms
Smart balancing of the energy mix through market mechanisms to shave peak demand using priority schemes; these are overruled in case of scarcity or emergency.

POLICIES & LEGISLATION

Progressive standards
Clarification of goals and alignment of measurement procedures at European level, including regular updating of standards in line with increasing knowledge.

Innovation policies
Municipalities embrace innovation through flexible legislations for new, efficient concepts and strategies, and accept the associated risks.

Inclusive policies
Laws to favour societal benefits over individual benefits, e.g. the right and obligation to exploit all opportunities for the use of sun-facing roofs for solar energy harvesting.

Raising investment funds
Municipalities take the lead in implementing CO_2 taxes to promote sustainable development through investments in sustainable solutions.

Policies addressing quality of life and social value
New policies that define the desired outcomes rather than the way to reach them, e.g. procurement procedures including health and social aspects.

Future-proof tendering
Tenders demand flexible and future-proof solutions that allow changed use of buildings in the future and the integration of upcoming technologies.

2016 — 2020

LIGHT HOUSE

Meeting progressive standards
Design strategies will adjust to progressive standards, e.g. zero emission, energy positive or CO_2-neutral approaches to new and existing buildings.

Buildings like natural systems
Buildings adapt to provide a harmonious living environment for their occupants by adopting nature-based strategies, beyond biomimicry.

Local production of tailored building components
New technologies (e.g. 3D-printing, Factory 4.0) enable nearby production of tailored components, supporting flexibility and diversity.

Tailored production of entire buildings
New production technologies, (e.g. 3D-printing and organic materials) allow on-site production of buildings.

Self-adapting buildings
Buildings made of 'living' organic materials that adapt to changing user needs, climatic conditions and usage.

(Re-)use of local materials
Local and tailored production of buildings components, using local opportunities and (re-)use of local materials (e.g. wood, clay).

Adaptive building systems and materials
Materials with changing properties, e.g. insulation with variable heat transmission coefficient or glass with variable translucency.

Proactively adaptable materials
Self-regulating buildings that proactively adapt to changing conditions (e.g. weather) and usage.

Urban metabolism
Lease options for construction materials — 'materials as a service' — e.g. no ownership because the materials are part of a closed resource cycle.

Affordable storage solutions
New storage solutions that are cheaper to produce, e.g. flow batteries and graphene.

Seasonal storage
Heat/cold storage and extraction in large water volumes, e.g. aquifers, tanks and surface water.

Integrated grid
Bidirectional, interoperable, open grid, integrating thermal, electrical, water and gas networks into one energy-management system.

Abundant renewable energy
Sustainable energy is widely available and affordable as a result of large-scale solutions such as wind & solar parks and alternatives.

District storage solutions
Larger-scale storage solutions to share electrical and thermal energy, e.g. power-to-gas or -hydrogen.

Swarm technologies
Intervene in user assets (connected appliances) to balance the grid and adapt to fluctuating supply of renewable energy.

New city-wide solutions
New solutions that open up new possibilities, e.g. superconducting networks, or receiving energy from solar space power stations.

Real-time data
Real-time data is available on actual energy use, for monitoring and improvement towards sustainable behaviour patterns.

Personal profiles
Technologies that recognise people and automatically adust systems to personal preferences and lifestyle patterns, e.g. for secure access to buildings and increased comfort.

Open energy and data system
New standards and protocols to connect systems and enable roaming of services across interoperable, open networks.

Sharing best practices
Buildings share experience on sustainable performance through learning algorithms and artificial intelligence.

Super-Europe smart grid
Wide-area electricity network connecting Europe, North Africa and Asia, unifying super-grid and smart grid capabilities.

Lifestyle coaching
Personalised advice based on real-time data to optimise the use of resources in relation to individual lifestyles.

Personal environmental accountability
Consumption-based accountability, including embodied energy and CO_2 emissions from personal use of goods and services.

Personal energy budget
Credits for energy (similar to mobile phone credits), that enable a higher consumption at extra costs, with discounts for sustainable behaviour.

Flexible pricing and new business models
People can contribute to grid stability and optimisation by choosing levels of flexibility with dynamic pricing, enabled by swarm technologies.

Circular economy
A holistic, systemic approach and total value business models (including societal, environmental and economical aspects) at all suitable scales.

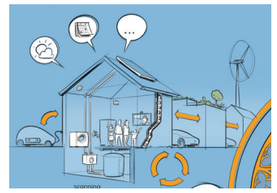
100% renewable energy import
Cities and territory politics ensure that all imported energy is 100% renewably sourced.

Legal security for innovation
Regulations to safeguard health and safety of people while promoting innovative solutions, e.g. safe re-use of 'grey' water in buildings.

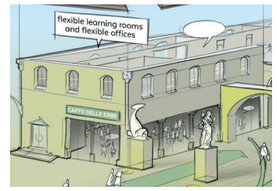
2030 2040 2050

Desired future scenario

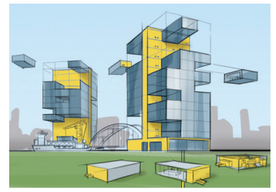
The Smart Buildings theme focuses on the built environment and sustainable energy solutions for buildings, including residential, public and commercial and office buildings. The ambition of the cities is to create self-sufficient buildings that can generate their own green energy, and have very low environmental impact during construction, use and renovation. Self-sufficient districts and cities are created with a blend of suitable solutions for buildings ranging from new to historical. The owners and users of the buildings are well-aware of the shared desire to save energy, and are actively engaged in achieving it by applying energy efficiency measures.



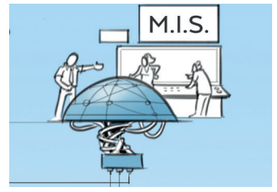
Energy-efficiency and sustainability
- Zero-emission and self-sufficient buildings through energy saving, generation and storage solutions
- Buildings focus on people's needs and comfort
- Low-environmental-impact buildings
- Continuous improvement strategies for buildings



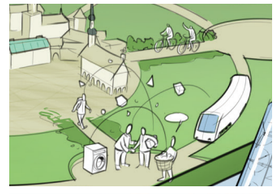
Renovation to secure cultural heritage
- Deep energy renovation of historical building
- Non-invasive technologies
- Smart grid integration



Versatile, flexible and proactive
- Versatile buildings and spaces
- Proactive adjustment to specific users and changing needs
- Buildings are prepared for future smart grid integration
- Designed for flexibility



Future smart grid
- Intelligent master system managing building performance across the city
- Community-owned grid



Community sharing
- Smart grid integration in the district level
- Saving through sharing
- Collective approach to infrastructure decision-making

High-quality, easily accessible systems
- Roaming profiles for energy access and community sharing
- Monitoring and learning
- Easily accessible open platforms
- Enabling the transition to sustainable energy
- Evidence-based, future-proof decision-making

Sustainable behaviour
- Collaboration and shared responsibility of citizens
- Incentives for sustainable behaviour
- Technology leading to sustainable behaviour

The R4E project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 649397

Urban building planning

Short term developments

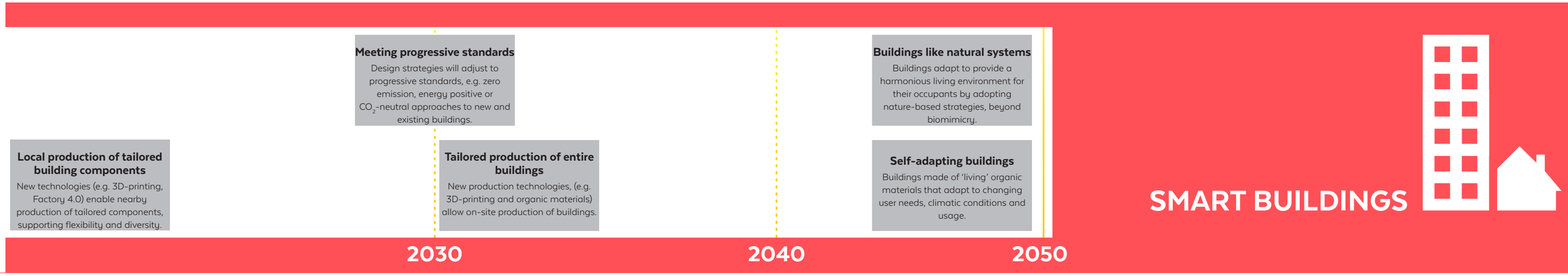
- In the short term, integrated mapping of the existing building stock, including its energy performance and the potential for improvement and use support integrated urban planning processes.
- Specific energy strategies for cultural heritage buildings are developed for the refurbishing of historical buildings, incorporating available and upcoming technologies.
- Rewealthing and rejuvenation strategies focus on the quality of internal and external spaces of the existing building stock. This includes the implementation of new and flexible forms of use, as well as sharing of spaces and infrastructure.
- General city design strategies focus on re-use, re-densification and re-building of the existing buildings and public spaces, defining priority areas for intervention.
- A life-cycle approach for buildings is considered, based on design for disassembly and re-use of materials, using closed cycle systems as far as possible.

Mid term developments

- Once experience has been gained and processes and strategies have been developed, the annual building refurbishment rate will be scaled up to 3 to 5% of the existing building stock, from today's typical rate of 1%. The minimum energy standard for refurbished buildings is the 'passive house' standard. However the standards will develop further, with increasing requirements for higher levels such as zero-emission, energy-positive or CO2-neutral performance over lifetime.

Long term developments

- In the long term buildings increasingly adopt nature-based strategies, and are integrated in and adapting to the surrounding natural systems. In this way they offer harmonious living environments for their occupants.



Energy-saving building solutions

Short term developments

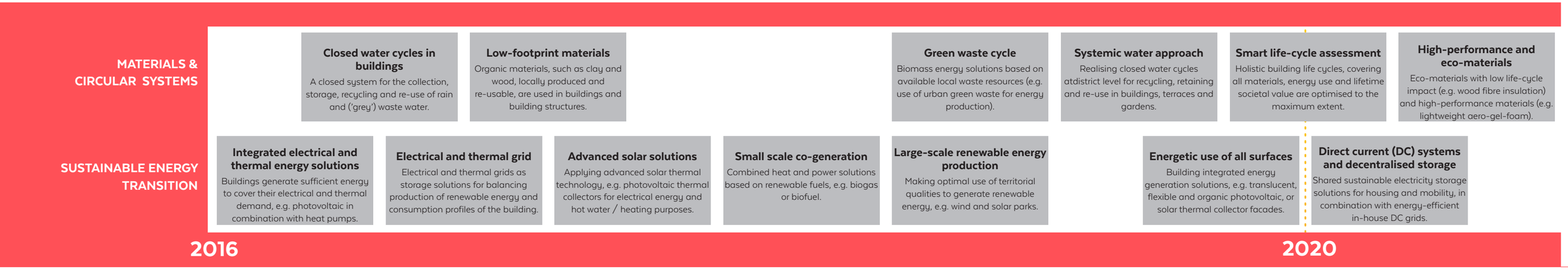
- Refurbishment plays a mayor role, and solutions for the upgrading of building envelopes and installations is gaining importance, including on-site renewable energy generation. The aim is to achieve nearly zero-energy standard in new buildings, and where possible also in existing buildings.
- Modular, prefabricated building blocks allow material and energy savings through centralised productions processes, with increasing flexibility and adaptability of buildings over their life-cycles.
- Customised refurbishment solutions for cultural heritage buildings allow improvement of energy performance while also meeting cultural protection standards. Increased energy performance is achieved through higher standards for both new buildings and those surrounding them.

Mid term developments

- Buildings are becoming increasingly energy-efficient and energy-producing, with a development towards energy-positive buildings as standard. Energy-producing facades and roofs cover all users' energy needs, including extra demand for electric mobility.
- Wood is increasingly used as a sophisticated building material, even for structural purposes in multi-storey buildings.
- Buildings are based on customised local building components, which are produced by new technologies such as 3D printing or Factory 4.0 solutions, enabling greater flexibility and diversity.

Long term developments

- Entire buildings are produced decentrally and on-site using new production technologies such as 3D printing and with local organic materials.
- Self-adapting buildings based on 'living' organic materials can adapt to changing user needs, climate conditions and usage.



Materials & circular systems

Short term developments

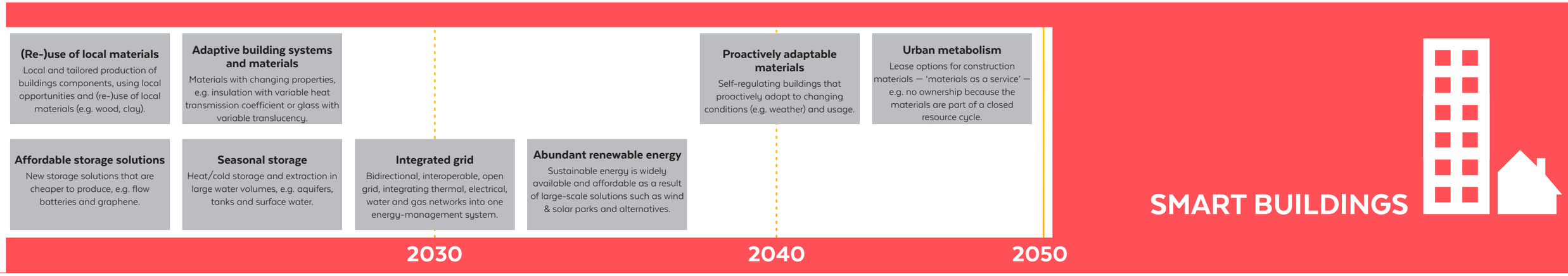
- In the short term water is considered as an increasingly valuable resource, and water cycles in buildings will be closed as far as possible.
- Closed water cycles at district level connect buildings, terraces and gardens to systems for water retention, storage and re-use.
- Building work increasingly uses organic materials such as clay and wood. These are locally produced and re-usable, reducing the overall carbon footprint of constructions.
- Biomass energy solutions use urban green waste for energy production, closing green waste cycles.

Mid term developments

- In the mid-term, smart life-cycle assessment allows calculation, tracking and optimising of material life cycles, energy use and even societal value of buildings over their lifetime.
- High-performance materials and eco-materials with a very low lifecycle impact are standard in buildings.
- Materials and components are locally produced through tailored production processes based on the (re-)use of locally available resources.
- Adaptive building systems and materials with changing properties are available, optimising the thermal performance of building envelopes.

Long term developments

- In the long term buildings are self-regulating, with materials and systems that proactively adapt to different climatic conditions or usage.
- Buildings contribute to an urban metabolism based on closed resource cycles, understanding materials as a service.



Sustainable energy transition

Short term developments

- In the short term, buildings generate enough energy to meet their own energy demand through integrated electrical and thermal energy solutions based on renewable energy.
- Electrical and thermal grids evolve, allowing storage of decentralised renewable energy produced by buildings, as well as balancing of supply and demand.
- Renewable energy technologies evolve towards more efficient and sophisticated integrated systems, e.g. advanced solar solutions such as photovoltaic thermal collectors for building integration or small-scale co-generation power solutions based on renewable fuels such as biogas or biofuel.
- Large-scale renewable energy installations such as wind and solar parks are used widely throughout the territory.
- All available exterior building surfaces are used to harvest solar energy through integrated energy solutions such as flexible and translucent photovoltaic or thermal collector facades.

Mid term developments

- In the mid-term, direct current (DC) systems allow the use of PV electricity through energy-efficient in-house grids, together with increasing amount of shared sustainable electricity storage solutions on all scales for buildings and mobility.
- Energy storage systems are increasingly affordable through the use of new materials and technologies such as flow batteries and graphene-based solutions.
- Affordable seasonal heat/cold storage is shifting the season-to-season availability of harvested thermal energy through large-scale natural or artificial storage options such as aquifers and water storage tanks.

Long term developments

In the long term, bidirectional integrated grids together with affordable storage solutions allow truly sustainable energy systems. Grids are interoperable, creating mixed thermal, electrical, water and gas networks within a single energy-management system.

The growing affordability and availability of sustainable energy solutions, based on a mix of decentralised small-scale and large-scale installations, lead to an abundance of renewable energy in the long term.

Energy sharing

Short term developments

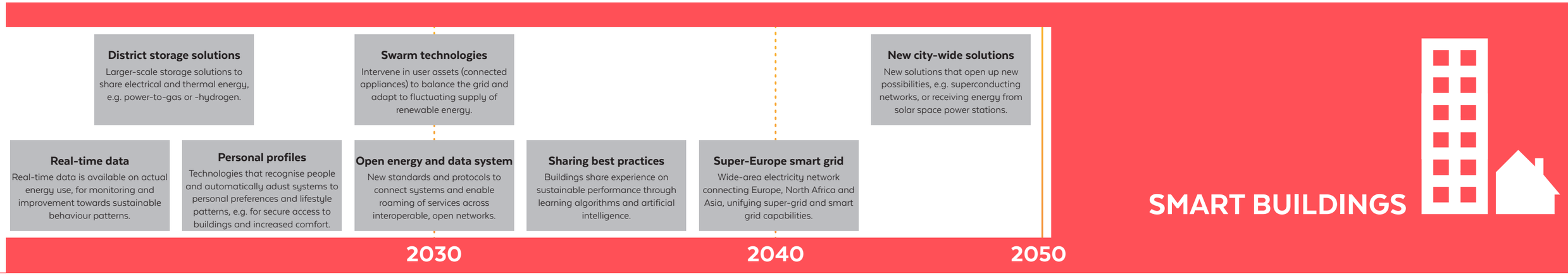
- In the short term, energy resources at city and district level are mapped and managed efficiently, allowing supply and demand matching between producers and consumers of electricity and heat, with individual buildings as contributors to efficient city-wide solutions.
- Existing energy grids with an increasing share of decentralised renewable energy generation are stabilised at district levels by peak shaving measures and by providing sufficient storage and generation capacity.
- Sustainable energy generation and consumption are regarded as community assets, through which people share corresponding rights and obligations, collectively increasing the total amount of renewable energy of a district.
- Energy performance is evaluated at district level. New buildings with higher energy standards and renewable energy production compensate for the older building stock with a negative energy balance.

Mid term developments

- Energy grids are self-healing and bidirectional, with a large number of interconnected decentralised production facilities for renewable energy, and mechanisms to ensure grid stability and continuity of service in case of failure.
- District storage systems are used to balance fluctuations in electrical and thermal energy supply and demand using efficient, large-scale storage solutions such as power to-gas and hydrogen.

Long term developments

- In the long term district energy performance is optimised through innovative approaches such as ‘swarm’ technologies, connecting appliances to self-learning and self-balancing networks and other city-wide solutions such as superconducting networks.



ICT & building management systems

Short term developments

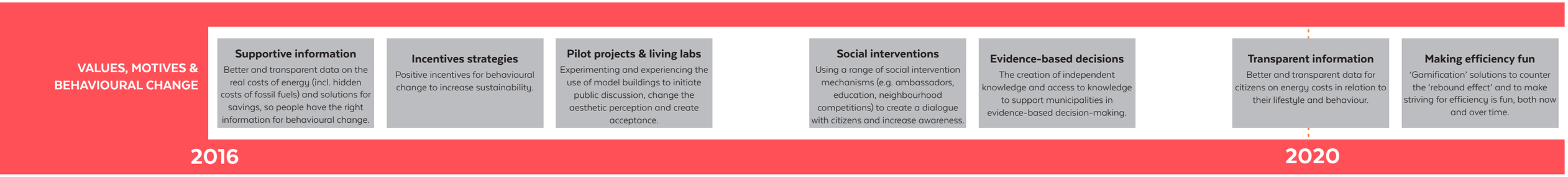
- In the short term ICT & Building Management Systems are evolving. This allows increasing generation and use of data for energy optimisation and management in buildings and grids, based on detailed control through smart meters.
- ICT technologies allow the creation and control of smart networks at local level to share electrical and thermal energy among neighbours.
- Right from the design phase, building information management systems allow simulation of building energy performance. This allows their life-cycle energy balances to be optimised and their contribution at district level to be determined.

Mid term developments

- In the mid-term, building and home management systems allow building energy performance and operation to be optimised using public (e.g. weather forecasts) and private (e.g. individual users consumption pattern) data.
- Detailed real-time data is available on energy use and building performance, as well as on user comfort and behaviour, to improve and optimise building operation. This allows the creation of users' personal profiles, with adaptive systems that can be adjusted to match users' personal preferences.

Long term developments

- In the long term, open energy and data systems allow interoperability of networks resulting in performance improvement through mutual learning. This is based on new standards and protocols to allow connection of systems.
- Buildings are active and self-learning, communicating and sharing experience on sustainable performance through learning algorithms and artificial intelligence.
- ICT contributes to the creation of extended smart grids, e.g. a super-Europe smart grid that connects Europe, North Africa and Asia, unifying super-grid and smart grid capabilities.



Values, motives & behavioural change

Short term developments

- Behavioural change depends greatly on the availability of reliable data. In the short term the transparency of data is increasing. This makes the real costs of energy visible, including externalised or hidden costs such as those relating to the environmental impact of fossil fuels. This supporting information helps to drive system transformation and behavioural change.
- Incentive strategies encourage people to change their behaviour towards more sustainable lifestyles, motivating through financial and non-financial rewards for individual or collective efforts towards overall societal sustainability.
- Experience and experimentation through pilot projects and living labs promote public discussion and awareness of new building methods and lifestyles. This helps to create acceptance for sustainable buildings, and positively influences the aesthetic perception of sustainable architecture.
- New social intervention mechanisms such as energy ambassadors, specific educational programmes and neighbourhood energy competitions promote dialogue with citizens and increase their awareness of and interest in sustainability.
- Cities can make evidence-based decisions as their access to knowledge increases and changes, with independent entities providing information and supporting municipalities.

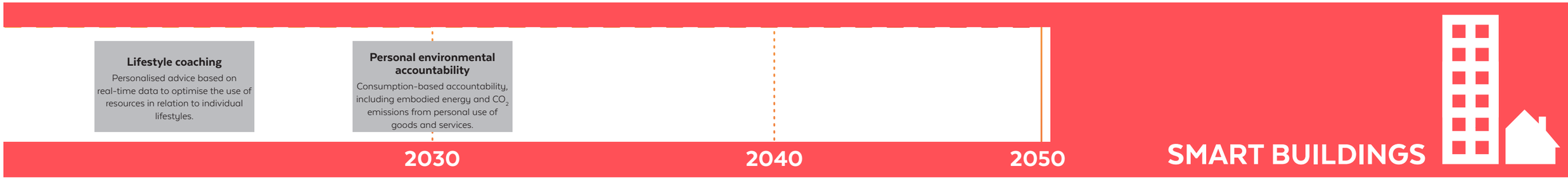
Mid term developments

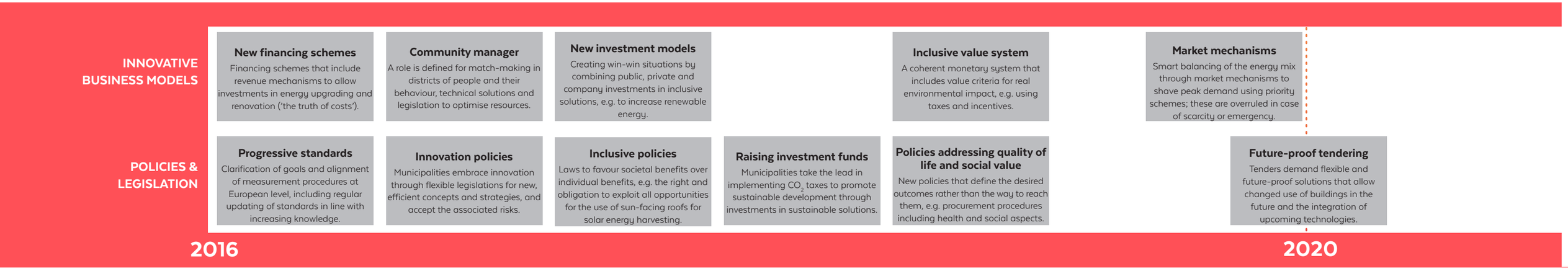
- In the mid-term information is increasingly transparent, ensuring that citizens have clear and transparent access to data on aspects like energy costs, individual lifestyle and behaviour, and the related environmental impact. This information allows individuals to take evidence-based decisions.
- Strategies like 'Gamification' solutions make energy efficiency and related lifestyle changes fun. For example these use personalised apps and competitions between citizens, allowing comparisons of personal performance and changes towards sustainability.
- Lifestyle coaching by experts helps citizens to optimising their personal use of resource relating to their individual lifestyles. This is based on personalised advice based on the available real-time data.

Long term developments

- In the long term personal environmental accountability drives individual behavioural change, avoiding 'rebound' effects. This personal accountability is based on citizens' individual use of goods and services, and takes into account embodied energy, CO_2 emissions and other indicators of environmental and social impact.

SMART BUILDINGS





Innovative business models

Short term developments

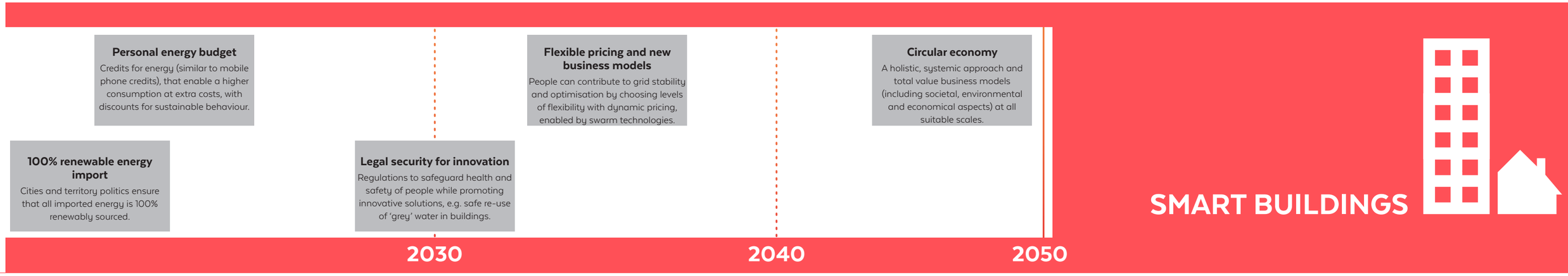
- In the short term new financing schemes promote investments, for example in energy upgrading and renovation of the existing building stock. This includes new revenue mechanisms based on 'truth of costs', a long-term holistic evaluation of costs and benefits for society.
- The 'community manager' emerges to deal with the complexity of communities. This role is defined for match-making in districts. To optimise the use of resources, the community manager matches the energy needs of people - taking into account their behaviour - with the available technical solutions in the district, and legislation.
- New investment models allow the creation of win-win situations based on combined public, private and company investments. These allow inclusive solutions, for example in the field of renewable energy installations.
- An inclusive value system makes existing monetary systems and mechanisms more coherent. Value criteria for the real environmental impact of products and services are included, for example through taxes and incentives.
- Market mechanisms contribute to balancing the energy system, allowing peak shaving and increasing overall energy efficiency.

Mid term developments

- In the mid-term, new mechanisms such as personal energy budgets allow personalised energy consumption. This could be based on energy credits (similar to mobile phone credits), enabling higher consumption at extra cost as well as discounts for sustainable behaviour.

Long term developments

- In the long term, new business models are based on flexible pricing schemes. This encourages people to contribute to overall grid stability and energy efficiency through flexibility in their use of energy in response to dynamic pricing.
- Contributing to the circular economy, business models are based on a holistic and systemic approach. This takes into account the total value of products and services, including their societal, environmental and economic value at different scales.



Policies & legislation

Short term developments

- In the short term, progressive standards are based on clear goals at European level and alignment of national measurement procedures, e.g. for nearly zero-energy buildings. These changes are the result of regular updating of standards based on increasing knowledge.
- Innovation policies of municipalities are based on flexible legislations for new, energy efficient and more sustainable building concepts and strategies. Municipalities accept the associated risks to promote innovation.
- Policies are increasingly inclusive, favouring clear societal benefits over individual benefits. For example this results from citizens' right and obligation to exploit all opportunities to use sun-facing roofs for solar-energy generation. In this was citizens contributing to the energy self-sufficiency of city districts.
- Municipalities use mechanisms like CO2 taxes to raise investment funds and to promote sustainable development by investing in sustainable solutions.
- Municipal policies address quality of life of citizens and social values for society as a whole. Desired outcomes rather than the way to reach them are defined, for example in public procurement procedures, including health and social aspects.

Mid term developments

- In the mid-term, tendering promotes future-proof solutions by including specific demands like flexibility and the ability to change the use of buildings, or easy future upgrading with new technologies.
- City and territory policies ensure 100% renewable energy imports as political and societal goal.

Long term developments

In the long term, the legal security of innovations is assured at different levels. Regulations safeguard the health and safety of people and promote innovative solutions. These contribute to sustainability and resource saving, for example by the safe re-use of grey water in buildings.

SMART BUILDINGS ROADMAP MURCIA

R4E ROADMAPS FOR ENERGY®

Sustainable technology

URBAN BUILDING PLANNING

Integrated mapping of assets of existing buildings
Creating an integrated overview of all buildings, their energy performance and potential.

Energy strategy for cultural heritage buildings
Definition of the level of renovation potential, related to legislations for cultural heritage buildings, and available and upcoming technologies.

Rewealthing strategies
Holistic rejuvenation to improve quality of buildings, their use and outdoor environment to update the value of existing building stock.

Flexible use strategies
Redefine the use of buildings (how much space do people need?) and intensify use by sharing private and public space and assets in buildings (community sharing).

City design strategy
Overall strategy for the city, including definition of priority areas in the city for re-use, re-densification and re-building.

Design for disassembly
Designing buildings for easy disassembly to enable re-use of all components and/or materials in closed-cycle systems.

Increasing refurbishment
Accelerating refurbishment and increasing the applicable standards to minimum passive house standards and beyond.

ENERGY-SAVING BUILDING SOLUTIONS

Refurbishment solutions
Passive measures that contribute to energy saving by upgrading the building envelope, e.g. with green roofs.

Modular building blocks
Central production of standardised prefab building blocks, based on the use of sustainable materials and energy solutions.

Highly-efficient buildings
Reducing energy consumption (e.g. insulation and passive solar) and on-site renewable energy production to achieve near-zero-energy new buildings.

Flexible buildings
Making buildings flexible and adaptable over their life cycle, e.g. by designing a suitable grid structure with flexible partitioning.

Customised refurbishment
Specific solutions for refurbishment of existing building stock and cultural heritage, e.g. glazing, ventilation, insulation, heating.

Revaluing nature
Bringing nature back into buildings to enhance health and well-being of users, e.g. green facades or atriums as 'lungs' of buildings.

Energy-positive buildings
Productive facades and roofs allow buildings to cover the energy needs of their users, including extra demand for electric mobility, e.g. all-electric house.

Wood as sophisticated building material
Revaluing technical wood, e.g. cross-laminated timber elements as solution for multi-storey building structures (up to five floors).

MATERIALS & CIRCULAR SYSTEMS

Closed water cycles in buildings
A closed system for the collection, storage, recycling and re-use of rain and ('grey') waste water.

Low-footprint materials
Organic materials, such as clay and wood, locally produced and re-usable, are used in buildings and building structures.

Green waste cycle
Biomass energy solutions based on available local waste resources (e.g. use of urban green waste for energy production).

Systemic water approach
Realising closed water cycles at district level for recycling, retaining and re-use in buildings, terraces and gardens.

Smart life-cycle assessment
Holistic building life cycles, covering all materials, energy use and lifetime societal value are optimised to the maximum extent.

High-performance and eco-materials
Eco-materials with low life-cycle impact (e.g. wood fibre insulation) and high-performance materials (e.g. lightweight aero-gel-foam).

SUSTAINABLE ENERGY TRANSITION

Integrated electrical and thermal energy solutions
Buildings generate sufficient energy to cover their electrical and thermal demand, e.g. photovoltaic in combination with heat pumps.

Electrical and thermal grid
Electrical and thermal grids as storage solutions for balancing production of renewable energy and consumption profiles of the building.

Advanced solar solutions
Applying advanced solar thermal technology, e.g. photovoltaic thermal collectors for electrical energy and hot water / heating purposes.

Small scale co-generation
Combined heat and power solutions based on renewable fuels, e.g. biogas or biofuel.

Large-scale renewable energy production
Making optimal use of territorial qualities to generate renewable energy, e.g. wind and solar parks.

Energetic use of all surfaces
Building integrated energy generation solutions, e.g. translucent, flexible and organic photovoltaic, or solar thermal collector facades.

Direct current (DC) systems and decentralised storage
Shared sustainable electricity storage solutions for housing and mobility, in combination with energy-efficient in-house DC grids.

ENERGY SHARING

Supply and demand matching
Sharing of energy by bringing together supply and demand on district level, e.g. using waste heat from industry in private buildings.

Optimising existing grid
Stabilise grid at district level, e.g. by peak-shaving measures and providing sufficient reserve capacity.

Sharing rights and obligations
People benefit from the assets of all buildings in their environment to increase the total amount of renewable energy in the community.

District energy performance
New buildings are designed to achieve higher standards to compensate for the negative energy balances of existing buildings.

MILESTONE 2020
Public decision-makers are aware of the need to optimise energy consumption in buildings. This is visible in more ambitious pilot projects – in terms of monitoring and telemanagement of buildings. People are adopting more sustainable behaviour, enabled by smart monitoring systems and visibility of energy-savings.

Bidirectional self-healing grid
Creating a bidirectional energy grid to ensure stability and continuity of service, e.g. in case of a failure.

ICT & BUILDING MANAGEMENT SYSTEMS

Smart meters
Data gathering to identify measurable units of control or energy districts to optimise energy consumption.

Smart networks
Buildings are digitally connected to electrical and thermal energy networks to share (renewable) energy with neighbours.

Building information management systems
Supporting the design phase of (energy-positive) buildings in order to promote and optimise the life-cycle energy balances.

Building and home management systems
Smart systems use public (e.g. weather) and private (e.g. consumption pattern) data to optimise operation.

Sustainable behaviour

VALUES, MOTIVES & BEHAVIOURAL CHANGE

Supportive information
Better and transparent data on the real costs of energy (incl. hidden costs of fossil fuels) and solutions for savings, so people have the right information for behavioural change.

Incentives strategies
Positive incentives for behavioural change to increase sustainability.

Pilot projects & living labs
Experimenting and experiencing the use of model buildings to initiate public discussion, change the aesthetic perception and create acceptance.

Social interventions
Using a range of social intervention mechanisms (e.g. ambassadors, education, neighbourhood competitions) to create a dialogue with citizens and increase awareness.

Evidence-based decisions
The creation of independent knowledge and access to knowledge to support municipalities in evidence-based decision-making.

Transparent information
Better and transparent data for citizens on energy costs in relation to their lifestyle and behaviour.

Making efficiency fun
'Gamification' solutions to counter the 'rebound effect' and to make striving for efficiency is fun, both now and over time.

Sustainable organisation

INNOVATIVE BUSINESS MODELS

New financing schemes
Financing schemes that include revenue mechanisms to allow investments in energy upgrading and renovation ('the truth of costs').

Community manager
A role is defined for match-making in districts of people and their behaviour, technical solutions and legislation to optimise resources.

New investment models
Creating win-win situations by combining public, private and company investments in inclusive solutions, e.g. to increase renewable energy.

Inclusive value system
A coherent monetary system that includes value criteria for real environmental impact, e.g. using taxes and incentives.

Market mechanisms
Smart balancing of the energy mix through market mechanisms to shave peak demand using priority schemes; these are overruled in case of scarcity or emergency.

POLICIES & LEGISLATION

Progressive standards
Clarification of goals and alignment of measurement procedures at European level, including regular updating of standards in line with increasing knowledge.

Innovation policies
Municipalities embrace innovation through flexible legislations for new, efficient concepts and strategies, and accept the associated risks.

Inclusive policies
Laws to favour societal benefits over individual benefits, e.g. the right and obligation to exploit all opportunities for the use of sun-facing roofs for solar energy harvesting.

Raising investment funds
Municipalities take the lead in implementing CO_2 taxes to promote sustainable development through investments in sustainable solutions.

Policies addressing quality of life and social value
New policies that define the desired outcomes rather than the way to reach them, e.g. procurement procedures including health and social aspects.

Future-proof tendering
Tenders demand flexible and future-proof solutions that allow changed use of buildings in the future and the integration of upcoming technologies.

2016 — 2020

LIGHT HOUSE

Meeting progressive standards
Design strategies will adjust to progressive standards, e.g. zero emission, energy positive or CO_2-neutral approaches to new and existing buildings.

Buildings like natural systems
Buildings adapt to provide a harmonious living environment for their occupants by adopting nature-based strategies, beyond biomimicry.

Local production of tailored building components
New technologies (e.g. 3D-printing, Factory 4.0) enable nearby production of tailored components, supporting flexibility and diversity.

Tailored production of entire buildings
New production technologies, (e.g. 3D-printing and organic materials) allow on-site production of buildings.

Self-adapting buildings
Buildings made of 'living' organic materials that adapt to changing user needs, climatic conditions and usage.

(Re-)use of local materials
Local and tailored production of buildings components, using local opportunities and (re-)use of local materials (e.g. wood, clay).

Adaptive building systems and materials
Materials with changing properties, e.g. insulation with variable heat transmission coefficient or glass with variable translucency.

MILESTONE 2030
100% of the energy bought by the city council is renewable, and increasing numbers of buildings provide energy. Near-zero-energy buildings are present in the city. An open platform is accessible for all citizens and buildings, and provides transparency on renewable energy production and consumption through new services and apps. Citizens' energy bills are more affordable, with less impact on household finances.

Proactively adaptable materials
Self-regulating buildings that proactively adapt to changing conditions (e.g. weather) and usage.

Urban metabolism
Lease options for construction materials — 'materials as a service' — e.g. no ownership because the materials are part of a closed resource cycle.

Affordable storage solutions
New storage solutions that are cheaper to produce, e.g. flow batteries and graphene.

Seasonal storage
Heat/cold storage and extraction in large water volumes, e.g. aquifers, tanks and surface water.

Integrated grid
Bidirectional, interoperable, open grid, integrating thermal, electrical, water and gas networks into one energy-management system.

Abundant renewable energy
Sustainable energy is widely available and affordable as a result of large-scale solutions such as wind & solar parks and alternatives.

District storage solutions
Larger-scale storage solutions to share electrical and thermal energy, e.g. power-to-gas or -hydrogen.

Swarm technologies
Intervene in user assets (connected appliances) to balance the grid and adapt to fluctuating supply of renewable energy.

New city-wide solutions
New solutions that open up new possibilities, e.g. superconducting networks, or receiving energy from solar space power stations.

Real-time data
Real-time data is available on actual energy use, for monitoring and improvement towards sustainable behaviour patterns.

Personal profiles
Technologies that recognise people and automatically adust systems to personal preferences and lifestyle patterns, e.g. for secure access to buildings and increased comfort.

Open energy and data system
New standards and protocols to connect systems and enable roaming of services across interoperable, open networks.

Sharing best practices
Buildings share experience on sustainable performance through learning algorithms and artificial intelligence.

Super-Europe smart grid
Wide-area electricity network connecting Europe, North Africa and Asia, unifying super-grid and smart grid capabilities.

Lifestyle coaching
Personalised advice based on real-time data to optimise the use of resources in relation to individual lifestyles.

Personal environmental accountability
Consumption-based accountability, including embodied energy and CO_2 emissions from personal use of goods and services.

Personal energy budget
Credits for energy (similar to mobile phone credits), that enable a higher consumption at extra costs, with discounts for sustainable behaviour.

Flexible pricing and new business models
People can contribute to grid stability and optimisation by choosing levels of flexibility with dynamic pricing, enabled by swarm technologies.

Circular economy
A holistic, systemic approach and total value business models (including societal, environmental and economical aspects) at all suitable scales.

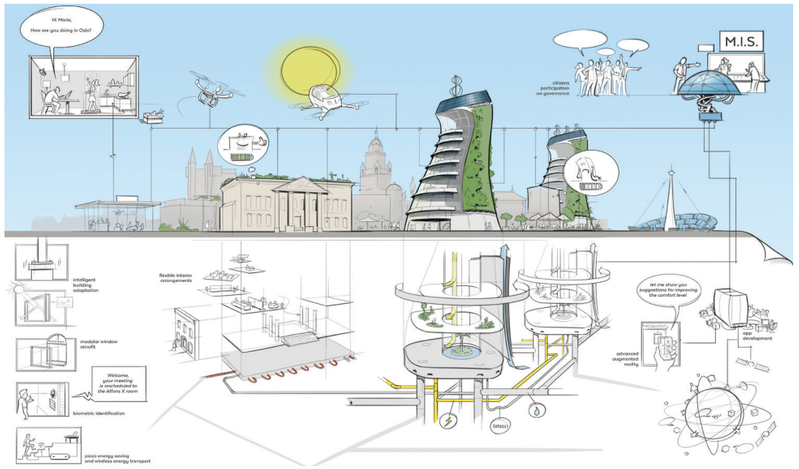
100% renewable energy import
Cities and territory politics ensure that all imported energy is 100% renewably sourced.

Legal security for innovation
Regulations to safeguard health and safety of people while promoting innovative solutions, e.g. safe re-use of 'grey' water in buildings.

2030 2040 2050

Desired future scenario

Murcia



SMART, INTERCONNECTED GREEN BUILDINGS MAXIMISE USER COMFORT IN MURCIA 2050

In 2050, the people of Murcia enjoy buildings that proactively adjust to their changing needs. Through profiles based on the expected use (presence and activities) and external factors (weather, season etc.), buildings actively choose the optimum energy settings to maximise comfort for users.

The buildings are interconnected by a telemanagement system that enables sharing of energy and resources. This makes a big contribution to users' comfort and convenience, both inside and outside the buildings.

Murcia achieved a position among Europe's top 'clean & green' cities by green urban planning that values CO_2-neutral energy-producing buildings. The buildings use renewable energy sources and have a low impact on nature, both during construction and in everyday use.

Elements of the desired future scenario are:

Flexible use of buildings

The buildings in Murcia facilitate highly flexible use, for different users, different activities and in different seasons. Walls, installations and furniture can be rearranged easily — for example using flexible partitioners, changeable windows or 'floating' desks. Standardised protocols enable roaming profiles for user settings in the virtual space. Smart management systems support effective and efficient use of the workspaces.

Enhancing working & family life

The buildings recognise people and can adapt to their personal preferences and habits by providing the desired atmosphere and climate settings. Homes cater for teleworking and remote healthcare through good connectivity and smart appliances. Use of the latest technologies facilitates a whole range of other activities — for example using augmented reality for easy enjoyable shopping, navigation and other everyday tasks.

'Green' buildings technologies

The latest technologies are used in the buildings for easy energy saving, generation and storage. Examples are the use of energy-absorbing materials, and light tubes to bring daylight into the heart of the building. The buildings are climate-proof, so they can absorb heavy rain showers. And they are resistant to earth-quakes through the use of innovative solutions like flexible materials and active bumpers. Wireless networks are used to charge energy-efficient appliances.

Learning buildings

The buildings are interconnected: not only do they learn during use, but they can also share their learnings. The use of all utilities (energy, water, waste and other resources) is monitored. Patterns of use are recognised so upcoming activities can be anticipated, providing maximum comfort for users. This active data sharing allows the buildings to learn from each other, providing maximum user comfort at the lowest energy consumption.

Master Intelligent System

Murcia's Master Intelligent System uses open data and standard protocols all over the city, providing new services on an open platform. People can easily access and connect to the platform, wherever they are. Energy supply and demand are matched — and legally embedded — in the central system. The focus is on the users' needs, with priority for emergency services when necessary. Energy can be exchanged freely between users, appliances, vehicles and buildings.

The R4E project received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 649397

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).

The cities worked together on themes with a potential to become a programme of projects.

PROJECT PORTFOLIO

SMART BUILDINGS

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 Buildings Murcia

1 PV INSTALLATION OF 20KWH ON MUNICIPAL BUILDING

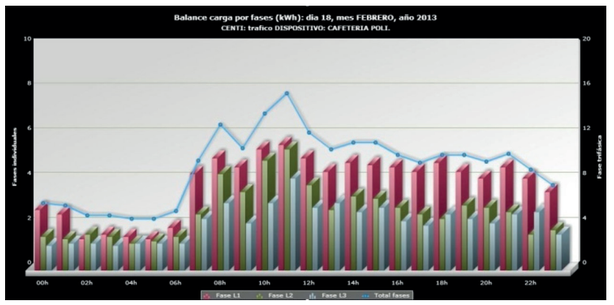
This is a recent project that we have been focused on during the last 4 months. We have had to deal with really annoying bureaucracy works because the electricity provider imposes a lot of red tape before they give you the license to produce electricity with PVs. We expect to use that electricity for lighting in the upper floors of the Municipal building where it is installed.

New Project Ambitions Smart Buildings Murcia

1 RENEWABLE ENERGY & SOLAR FURNITURE FOR EDUCATION

Schools will be provided with equipment and demonstrative material about renewable energy and sustainable behavior to teach children from a young age how important is to make use of resources properly when it comes to interact at home or at school with lighting, air conditioning and using the rest of the household appliances. It is also aimed to take renewables at schools so that kids can interact with them and learn the basics. E.g. lockers with mobile solar chargers .

2 ENERGY DEMAND MANAGEMENT SYSTEM ON BUILDINGS



Once monitored a group of specific public or residential buildings, the Project will evaluate and study the demand curve of these buildings and user in order to identify peaks of consumption. The goal is to prevent from these peaks and contribute to have a more flat demand curve by changing the consumption habbits and acting on main equipments.

3 THE MODULAR OFFICE SPACE

Murcia

The city council would offer their whole floor of one of their office buildings and it will be refurbished to make it fully modular. The refurbishment will consist of the creation of a comprehensive network for energy and services within the ceiling system; use the spaces of the lower ceilings for systems, like water and provide cooling and heating. In that case you can put walls where you want and be flexible in use of buildings.

5 ACCESS CONTROL AND LOCALISATION OF PEOPLE

Murcia

Provide buildings with specific control access technology able to identify users in all the spaces of a building so that we can act and adjust the lighting, HVAC and IT equipment depending on the occupancy level in order to remove the energy consumption of the equipment during unnecessary time. Also the localization of people with reduced movements (in wheelchairs. In emergency situations they can locate people that need help for evacuation.

4 THE CONTROL OF HVAC AND LIGHTING SYSTEMS

Murcia

Many current buildings are not ready for all these new technologies and not easy to convert to these new possibilities. However, it is feasible for a few of them and not too costly. Objective: to reduce energy consumption of the building, especially outside office hours with an integrated control system that, according to pre-established parameters (comfort, temperature, timetables, presence, etc.) allows remote operation and automation.


2050
Scope vision and roadmap smart mobility
Strategic values for smart mobility

CONTRIBUTIONS

SMART BUILDINGS

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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AMBITION, VISION & ROADMAP

SMART BUILDINGS MURCIA

D6.4 Final city report

This report contains the results of the ambition setting, vision development and roadmapping activities for smart buildings in the city of Murcia. 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 visioning and roadmapping capacities within the municipalities to spur future development and implementation of innovative energy solutions.

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