



BEST PRACTICES BOOK



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Introduction

Through the R2CITIES project (funded by European Commission under FP7 programme and coordinated by CARTIF Technology Centre), we have had the opportunity to expand our knowledge and expertise in the energy renovation of residential urban spaces.

With the further objective of having nearly zero energy cities, our project has implemented a set of technological solutions across its three demo sites (VALLADOLID in Spain, GENOA in Italy and KARTAL in Turkey) to reduce energy demand and increase the use of renewable energies. This has allowed us to address technical problems and overcome socio-economic barriers, and has provided us with an expertise of large-scale residential district renovation strategies that we would like to share with all the professionals in the building sector.

As our project comes to an end, we have compiled our five years' experience into this Best Practices Book to help guide future city renovations. The best practices draw on the development of the R2CITIES methodology, its implementation over almost 50,000m² in three demo sites, and the assessment of the energy really saved in the process.



Best practices

Design

		INDUSTRIAL PLAYERS	SMALL AND MEDIUM ENTERPRISES	RESEARCH ORGANISATIONS	PUBLIC INSTITUTIONS	LOCAL ADMINISTRATIONS
BP 01	Retrofitting conducted at district-level positively affects the city	●			●	●
BP 02	Get citizens on board	●	●	●	●	●
BP 03	Select retrofitting measures based on the district's features	●			●	●
BP 04	Link energy with intangibles as comfort and health				●	●

Retrofitting

BP 05	PV-parking lot for e-car charging				●	●
BP 06	Use tailored financing schemes to mobilise energy efficiency investments	●	●		●	●
BP 07	Involving private owners in the retrofitting financing				●	●

Operation and maintenance

BP 08	Comfort improvement is another benefit of energy retrofitting	●	●		●	●
BP 09	Maintaining for the future	●		●		
BP 10	Low cost monitoring	●	●		●	●
BP 11	Define a monitoring strategy before installing efficient measures	●	●			●

Exploitation

BP 12	How SMEs learn through EU projects		●		●	●
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All stages

BP 13	Using BIM from design to maintenance					●
BP 14	Social involvement	●		●	●	●
BP 15	Affecting the environment				●	●






R2CITIES has developed a methodological approach to the energy retrofitting of city districts where various stakeholders identify and work towards shared goals from an early stage. As a result, an optimised design and efficient execution of the renovation is obtained with the selection of the most appropriate and cost-effective technologies and close collaboration among policy makers and stakeholders. Key performance indicators and energy performance monitoring facilitate decision making and economic analysis. Risks and personnel costs are reduced through better design and decision making.




Retrofitting conducted at district-level positively affects the city

Buildings in our cities are not always as new and energy efficient as they could be. The poor quality of these buildings spoils districts and one of the main challenges for a city is minimise this. Such an ambitious goal requires of an integrated and systemic renovation strategy.

Impact

- | | |
|---|-------|
|  Comfort | ★★★★☆ |
|  Energy efficiency | ★★★★★ |
|  Environment | ★★★★★ |

Factors of success

- | | |
|---|-------|
|  Social acceptance | ★★★★☆ |
|  Technical aspects | ★★★★★ |
|  Planning | ★★★★★ |

Replicability ↑↑↑↑

Target stakeholders

- Industrial players
- Public institutions
- Local administrations

ADVICE

- Study in detail the possible districts for retrofitting to identify the best strategy for them.

CAUTION




- Involve citizens from each district in the decision making process.

Practice 2




Get citizens on board

Apart from considering social aspects in possible retrofitting scenarios, fluent communication channels have been established with the different citizens involved in our project. This is especially important where building owners contribute to funding the interventions. Information points were set up in municipalities to answer any queries and to obtain feedback on social acceptance of the interventions. This was the main way to get and keep citizens on board.

Impact

	Comfort	★★★★☆
	Energy efficiency	★★★★☆
	Environment	★★★★☆

Factors of success

	Social acceptance	★★★★★
	Technical aspects	★★★★☆
	Planning	★★★★☆

Replicability ↑↑↑↑↑

Target stakeholders

Industrial players
SMEs
Research Organisations
Public institutions
Local administrations

ADVICE

- Involve citizens when technical discussions are still ongoing.

CAUTION

- Don't assume users will necessarily accept a technology even if it is perfect from a technical point of view.




Practice 3

Select retrofitting measures based on the district's features




Our district retrofitting methodology can be used for systematically designing renovation projects. It integrates District Sustainability Indicators (DSI), Building Information Modelling (BIM), Integrated Project Delivery (IPD) as well as energy and life cycle simulation tools for selecting the most suitable combination of energy conservation measures. District sustainability indexes (DSI) are based on energy, environmental, economic, comfort, social and urban parameters for each scenario to allow the right energy conservation measures to be selected.

Many technologies can reduce the overall conventional energy demand in buildings. However, they are not often used across districts in an integrated manner. It is crucial to understand how these technologies may influence one another in order to select the most appropriate ones for specific interventions.

Impact

	Comfort	★★★★★
	Energy efficiency	★★★★★
	Environment	★★★★★

Factors of success

	Social acceptance	★★★☆☆
	Technical aspects	★★★★★
	Planning	★★★★★

Replicability ↑↑↑↑↑

Target stakeholders

Industrial players
Public institutions
Local administrations

ADVICE

- Customise the DSI according to your priorities in the six pillars that conforms it.

CAUTION

- Be careful with the rating procedure.




Practice 4

Link energy with intangibles as comfort and health




R2CITIES designed a comprehensive framework for residential building renovation which takes into account not only the technical aspects related to greater energy efficiency and the use of renewable energy sources, but it also improved the indoor comfort conditions, air quality and well-being of tenants. The improved wall and roof insulation has almost eliminated all thermal oscillations, the condensation and mould that worsen respiratory diseases.

R2CITIES established a tight relationship between energy efficiency and tenants' well-being.

Impact

	Comfort	★★★★★
	Energy efficiency	★★★★☆
	Environment	★★★★☆

Factors of success

	Social acceptance	★★★★★
	Technical aspects	★★★★☆
	Planning	★★★☆☆

Replicability ↑↑↑↑

Target stakeholders

Public institutions
Local administrations
Tenants

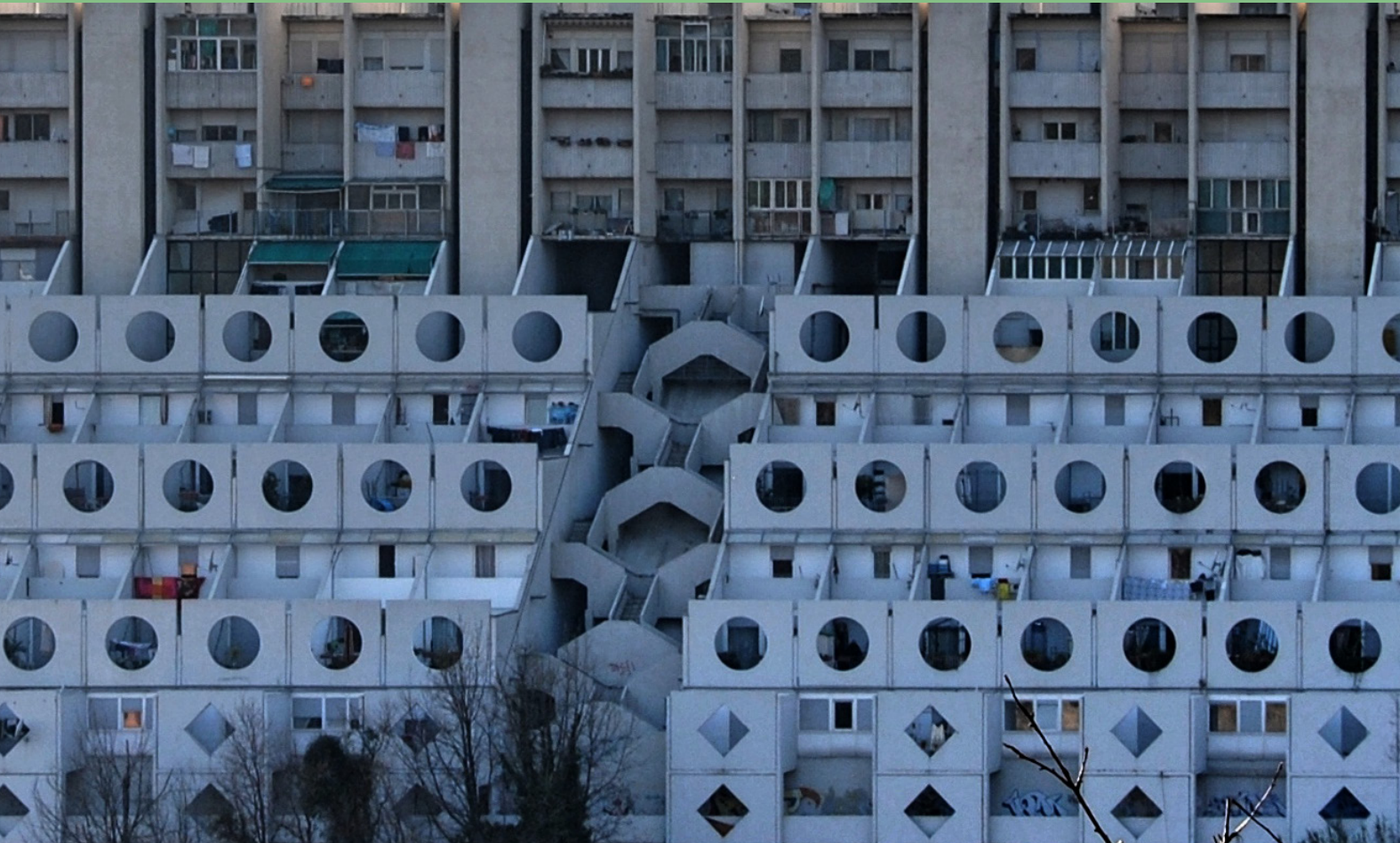
ADVICE

- Intangibles can make an intervention profitable. Attention should be brought to these aspects.

CAUTION

- It can be difficult to measure these aspects.








The canopy is integrated by mono-crystalline glasses, achieving an installed power of 4 kW. The installation of a battery system is required to accumulate the energy when there is production but not consumption. It is also important to connect the system to the utility grid to guarantee the charging point service.




The PV parking lot for e-car charging offers two great advantages for citizens: Firstly, it encourages the use of electric vehicles in the city, as a clean and sustainable mode of transportation. Secondly, this system reduces the footprint of the transportation, as the energy used to charge the vehicles comes from a renewable source.

The system is composed by a photovoltaic canopy and a charging point for electric vehicles. The energy generated by the photovoltaic glass installed in the canopy is used to satisfy the needs of the charging point.

Impact

	Comfort	★★★★☆
	Energy efficiency	★★★★★
	Environment	★★★★★

Factors of success

	Social acceptance	★★★★★
	Technical aspects	★★★★★
	Planning	★★★★★

Replicability ↑↑↑↑

Target stakeholders

Public institutions
Local administrations
Electricity companies, Energy providers

ADVICE

- Check local regulations to elaborate the design.
- Estimate the needs of the electric vehicles and users.
- Check the compatibility of the charging point technology with other components.

CAUTION




- Don't carry out the installation without consulting first the Electricity Company that it will be connected to.

Practice 6




Use tailored financing schemes to mobilise energy efficiency investments

Different business models have been implemented in the three demo sites according to their financing characteristics. For private buildings, owners received grants from municipal partners to help fund the interventions. For council houses, costs are partially covered by the energy savings. Economic indicators were considered for the retrofitting scenarios and different financing schemes were analysed in each.

Impact

	Comfort	★★★★★
	Energy efficiency	★★★★★
	Environment	★★★★★

Factors of success

	Social acceptance	★★★★★
	Technical aspects	★★★★☆
	Planning	★★★★☆

Replicability ↑↑↑↑↑

Target stakeholders

Industrial players
SMEs
Public institutions
Local administrations

ADVICE

- Adapt funding schemes to the different objectives. Many citizen behaviours should be considered.

CAUTION




- Try to align demo interventions with public funding timescales.
- Tax schemes should be considered in a grant analysis procedure.

Practice 7




Involving private owners in the retrofitting financing

Where the energy retrofitting of the district is not totally covered by grants or EC funding, building owners must cover part of the intervention funding. Private tenure increases the complexity of the process, not only in financial terms but also with regard to procurement procedures and management.

Impact

	Comfort	★★★★★
	Energy efficiency	★★★★☆
	Environment	★★★★☆

Factors of success

	Social acceptance	★★★★★
	Technical aspects	★★★★★
	Planning	★★★★☆

Replicability ↑↑↑↑↑

Target stakeholders

Public institutions
Local administrations
Private building owners

ADVICE

- The municipality can help promoting the intervention and guaranteeing the project success.
- Consider alternative business models as ESCo




CAUTION

- Managing a project to retrofit a privately-owned district demands a lot of effort. Consider involving the municipality.
- Inform the owners about the benefits of the project and how these are evaluated.




Comfort improvement is another benefit of energy retrofitting

The prime objective of district energy retrofitting is to reduce energy consumption and the impact of CO2 emissions on the environment. This has an effect on comfort within dwellings, which is not always taken into account.

Impact

	Comfort	★★★★★
	Energy efficiency	★★★★☆
	Environment	★★☆☆☆

Factors of success

	Social acceptance	★★★★★
	Technical aspect	★★★★★
	Planning	★★★★☆

Replicability ↑↑↑↑

Target stakeholders

Industrial players
SMEs
Public institutions
Local administrations

ADVICE

- Consider improved comfort as a prime objective.
- Quantifying comfort levels helps to involve citizens.

CAUTION

- Take care to use different approaches for winter and summer.



Practice 9

Maintaining for the future




The population of the Genoa demo-site was mainly composed of senior citizens without technological and digital skills. The domotic units were very difficult for them and other users to operate despite the user handbook.

The solution was twofold: firstly, the project produced a simplified summary of the user handbook with many pictures. Secondly, some of the neighbours were trained to act as technological advisers to the others.




This part of the solution was in line with the project's social objectives and increased the citizen involvement and acceptance.

One of the main problems of the R2CITIES Project was dealing with the user-unfriendliness of the domotic units and the related user handbook for an aging and technologically challenged resident population.

Impact

	Comfort	★★★★☆
	Energy efficiency	★★★★☆
	Environment	★★★★☆

Factors of success

	Social acceptance	★★★★★
	Technical aspects	★★★☆☆
	Planning	★★★★☆

Replicability ↑↑↑↑↑

Target stakeholders

Industrial players
Research Organisations

ADVICE

- Train some residents to act as advisers to the others.
- Urge companies to design more user-friendly domotic units for senior citizens.

CAUTION

- Don't assume people have the same technological skills as yourself.

Practice 10

Low cost monitoring




Monitoring equipment can be expensive and should therefore be selected carefully.

However, public bodies may still not be able to afford all the equipment required for a set of buildings.




Data mining can select the most representative dwellings and thus reduce the amount of equipment needed, which works out cheaper. There remain software costs relating to sampling, clustering and aggregation, but this is still less expensive.

Monitoring energy consumption in buildings is pivotal for the assessment of the energy performance. However, this works out costlier when dealing with districts. For this reason, data mining is used to select sets of representative examples.

Impact

	Comfort	★★★★☆
	Energy efficiency	★★★★★
	Environment	★★☆☆☆

Factors of success

	Social acceptance	★★★☆☆
	Technical aspects	★★★★★
	Planning	★★★☆☆

Replicability ↑↑↑↑↑

Target stakeholders

Industrial players
SMEs
Public institutions
Local administrations

ADVICE

- Select the number of clusters according to the best "score".
- Select the data-mining techniques according to the monitoring requirements.

CAUTION

- Sampling should be carefully defined to identify dwelling typologies.
- Clustering parameters must be properly determined to create suitable clusters.

Practice 11

Define a monitoring strategy before installing efficient measures

Real information according to the monitoring schema supports the energy management based on real-data.




The monitoring schema provides for sound energy management based on real-data and thus allows any malfunctioning or under-performance to be detected. To this end, the monitoring strategy must ensure data quality to avoid data loss and wrong data.

To ensure data continuity, contingency plans for recovering data, intermediate buffering and other software techniques need to be created.




Additionally, during installation and commissioning, checks are critical to avoid monitoring mistakes in advance.

Energy efficiency assessment relies on real data, which come from monitoring systems. A monitoring strategy then helps to ensure the application of the evaluation procedures with a high-level of confidence. Quality data is indeed needed to ensure reality is accurately represented.

Impact

	Comfort	★★★★☆
	Energy efficiency	★★★★★
	Environment	★★☆☆☆

Factors of success

	Social acceptance	★★☆☆☆
	Technical aspects	★★★★★
	Planning	★★☆☆☆

Replicability ↑↑↑↑↑

Target stakeholders

Industrial players
SMEs
Local administrations
ESCOs

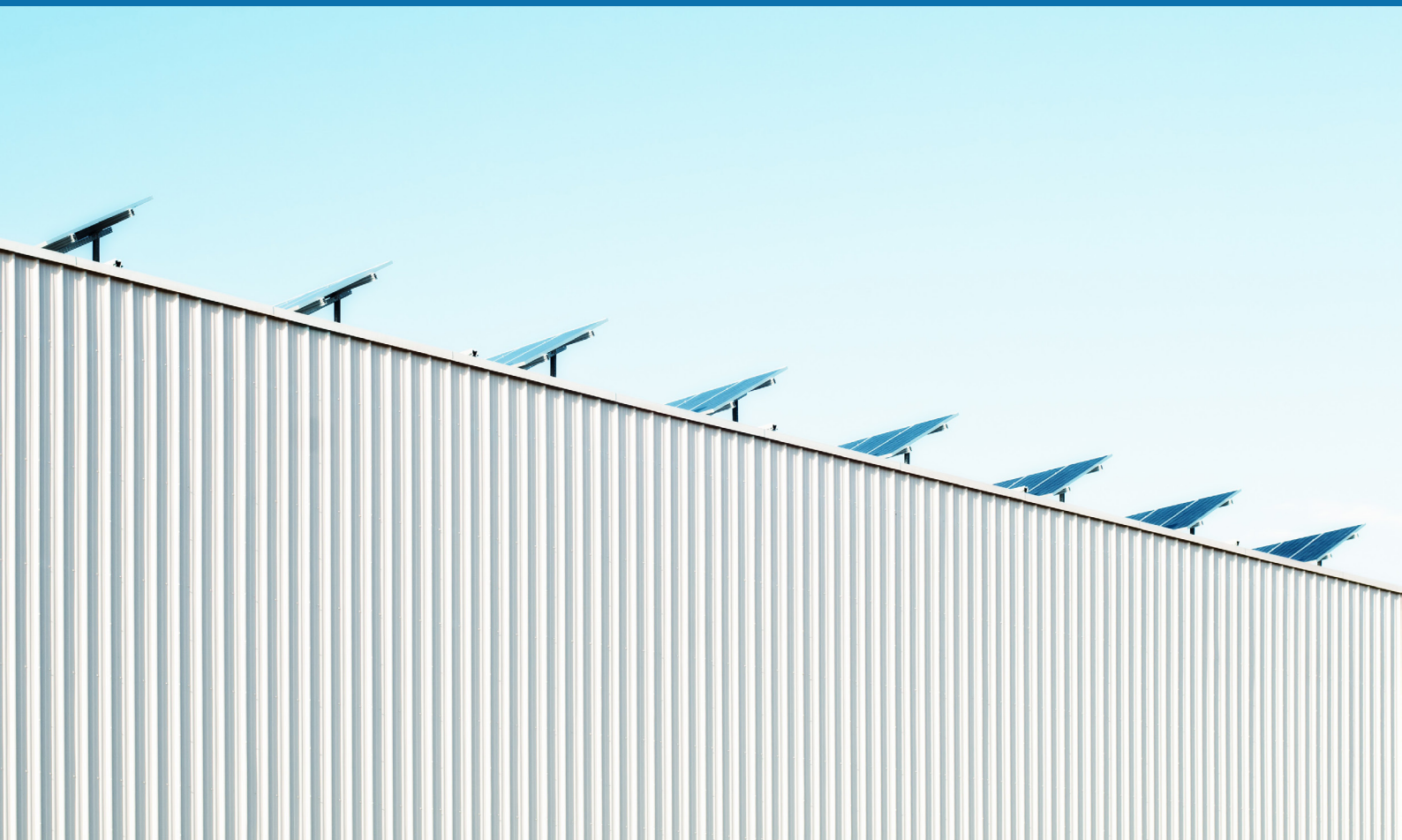
ADVICE

- Periodically check data collection to ensure data are being properly gathered.
- Validate and verify the monitoring equipment during installation and commissioning.

CAUTION

- Take time in defining a proper monitoring strategy.
- Remember to create data logs.
- Remember to create contingency plans for data recovery.








To increase the local impact of the R2CITIES retrofitting strategy, an open tendering procedure to select construction companies was launched at the Valladolid demo site.

Five local SMEs were in charge of the execution of the construction works, which allowed them to be familiarised with BIM, insulation techniques or control and monitoring strategies.




They have increased their market profile and their economic activity by upscaling the R2CITIES solutions in the same district and other areas of the city (as a first step towards a real market uptake).

Although for local SMEs it is difficult to participate in EU projects, they can learn and implement high level technical solutions collaborating in local demonstration activities

Impact

 Comfort	★☆☆☆
 Energy efficiency	★★★★☆
 Environment	★★★★☆

Factors of success

 Social acceptance	★★★★★
 Technical aspects	★★★★★
 Planning	★★★★★

Replicability ↑↑↑↑

Target stakeholders

SMEs
Public institutions
Local administrations

ADVICE

- Carefully set out the open public tendering procedures to help local SMEs to get involved.

CAUTION




- Deadlines should be more flexible due to the lack of knowledge by local SMEs.






Building Information Modelling (BIM) is a method designed to optimise the planning and construction of buildings using 3D images. It could be applied from the very beginning of the retrofitting works through all their phases, such as: Diagnosis, Design, Execution & Evaluation, Operation. Most importantly, BIM can support the actions related to quality control and construction management, getting better results. All the possible uses of BIM are listed in the "BIM Execution Plan Guide". In R2CITIES, using Building Information Modelling while drafting the Implementation Plan eliminated higher risks during the construction works by providing the team with predictions of the overlaps that could occur. This prevented major delays in the work.

The Building Information Modelling process is a valuable ally of the design and construction teams as it can support all the phases of the retrofitting works and improve the results while preventing delays.

Impact

- | | |
|---|-------|
|  Comfort | ★★★★★ |
|  Energy efficiency | ★★★★★ |
|  Environment | ★★★★☆ |

Factors of success

- | | |
|---|-------|
|  Social acceptance | ★★★☆☆ |
|  Technical aspects | ★★★★☆ |
|  Planning | ★★★★★ |

Replicability ↑↑↑↑↑

Target stakeholders

Local administrations: Kartal Municipality
Subcontractor-ATR

ADVICE

- Use BIM from the beginning of the project to the final phase.
- Provide a proper training for your technical team.

CAUTION

- Although in the future BIM will be an extended standard, not all stakeholders are currently familiarized with it (mainly SMEs or public authorities).

Practice 14

Social involvement

The project developed a methodology to engage tenants and assess their acceptance independently of the ECMs applied. The social research focused on the **three stages of the retrofitting process:**

Stage 1: Planning phase and research activities **BEFORE** the beginning of building works;




Stage 2: Research activities **DURING** the construction stage;

Stage 3: Research activities **AFTER** the completion of construction works or after the completion of the new buildings or energy systems.




In particular, attitudes and concerns of occupants were detected in all these stages in order to identify potential problems, offer suitable information and assistance and maximise the advantages of the selected technical measures.

The R2CITIES Project saw the involvement of all the stakeholders relevant to the building renovation process. The inhabitants of the three demo sites were also involved in order to stimulate their commitment and raise their awareness of the importance of saving energy and reducing emissions.

Impact

	Comfort	★★★★☆
	Energy efficiency	★★★★☆
	Environment	★★★★☆

Factors of success

	Social acceptance	★★★★☆
	Technical aspects	★★★★☆
	Planning	★★★★☆

Replicability ↑↑↑↑

Target stakeholders

Industrial players
Research Organisations
Public institutions
Local administrations

ADVICE

- Always provide clear and simple information about the project objectives and benefits to enable tenants to understand and accept.

CAUTION

- Avoid technical jargon and use words and images in your information.

Practice 15




Affecting the environment

Life Cycle Analysis methodology (LCA) translates design and management choices into meaningful statements about the impacts on the environment. The construction and maintenance of a building, as well as the processes which consume energy (either from external sources or from internal generation) produce atmospheric emissions, wastewater, industrial wastes etc.




All these are calculated through LCA using standard methods. In line with this approach, R2CITIES carried a two-step LCA during the design process and after the retrofitting activities were completed. This was to evaluate how beneficial the refurbishment on the three case studies of Valladolid, Genoa and Kartal were.

Life Cycle Analysis can help assess the impact on the environment and evaluate the benefits of the retrofitting activities.

Impact

	Comfort	★★★★★
	Energy efficiency	★★★★★
	Environment	★★★★☆

Factors of success

	Social acceptance	★★★★☆
	Technical aspects	★★★★★
	Planning	★★★★★

Replicability ↑↑↑↑

Target stakeholders

Public institutions
Local administrations
Residential building owners

ADVICE

- Consider the construction phases while performing environmental studies.
- Consider other environmental impact categories like impact on ecosystem health.

CAUTION

- Don't only take into account the energy use phase in environmental studies.
- Don't only consider the greenhouse gas emission reductions.

LESSONS LEARNT

1

Outcome of the district audit and establishment of methods, tools, targets and goals

During its first phase, the R2Cities Project validated a diagnosis methodology suitable for different urban, climatic, social or economic environments. The tests that were carried out to evaluate the districts showed how BIM functionalities can help improve the renovation process, while providing all the information needed for the development of EP simulation models. The tests also revealed the gap between existing standards such as IFC or gbXML with regard to data interoperability. These results are included in the Methodology Implementation Guidelines, which depict the most suitable tools and working methods.

BP 1

BP 2

BP 3

2

Intervention concept design

The concept design phase proved that by scaling up the strategy from buildings to district it is possible to implement a wider range of combined measures while reducing the costs of the interventions at all the demo sites. The interventions can improve both the passive behaviour of the buildings and the active systems producing energy while integrating RES and ICT solutions for a better control. The R2CITIES Project developed an overall evaluation method based on District Sustainability Indicators to identify inefficiencies, barriers, targets and goals. It is integrated into the R2CITIES systemic and holistic methodology, which ensures the most cost-effective combination of ECMs at district level and is supported by a variety of software tools.

BP 1

BP 2

BP 3

BP 5

3

Barriers when implementing the methodology

The Methodology Implementation Guideline developed from R2CITIES experience contains valuable advice for dealing with both technical issues and those related to processes and methods. It was designed to help municipalities establish the proper legal mechanisms to ensure the interventions could be performed. This is undertaken through a Collaborative Agreement between the Promoter Support Team and the Design and Execution Team providing a smooth design process in compliance with tender/public grants requirements. In R2CITIES, the three demo sites presented different legal and management barriers which were solved by identifying specific roles, i.e. the BIM Manager, the Energy Specialist and Quality Control Plan Supervisor. This led to an open methodology applicable to different scenarios.

BP 1

BP 2

BP 3

4

Measurement of energy savings through the extension of existing protocols to tackle the district concept

To evaluate the impact of an intervention it is necessary to build a performance model able to quantify the savings from the Energy Conservation Measures (ECMs) implemented. Established protocols used to evaluate energy or cost savings, such as IPMVP, cannot be applied at district scale as they work only at building level. For this reason, R2CITIES developed an extension of the protocol using sampling and aggregation techniques. However, this extension can only be implemented in districts where buildings present similar energy types.

BP 11

5

R2CITIES and end users

End users are a key stakeholder group. Therefore, their involvement is essential for the success of the retrofitting process. The differences between the R2CITIES demo sites led to different strategies. End users were involved in the diagnosis and design phases, as well as in the definition of the investment plan when they were also owners and promoters of the intervention. At the Genoa and Kartal demo sites, the buildings are owned by the municipality, which also acted as a promoter of the interventions. In contrast, the buildings in Valladolid are owned by multiple people.

The interventions were promoted directly by the owners of the dwellings, while the municipality acted as coordinator and supervisor. At all the demo sites,

users were asked to fill in questionnaires to gauge their behaviour and expectations. In Genoa and Kartal, financial investments were covered by public funds, while in Valladolid the owners had to bear some of the costs. The Municipality of Valladolid evaluated various business models to ensure the feasibility of the district retrofitting. We found out that the level of involvement depends on the users' social profiles. End users usually do not perceive energy efficiency as a fundamental aspect but focus primarily on the economic benefits. For this reason, it is very important to raise their awareness through communication campaigns.

BP 2

BP 7

BP 14

6

Financial plan and business models

It is essential to identify the beneficiaries of the interventions and the investors upfront and to analyse the return of investment carefully. The time needed to recoup the investment is considerably reduced when facing holistic interventions through the combination of passive and active ECMs. In the cases of Genova and Kartal, the overall investment was covered by public funds, while for Valladolid part of the intervention was paid directly by the owners through a direct contracting of a private construction company. These models must be analysed to establish the basis for improved scenarios in which the combination of public and private funds can make the intervention affordable.

BP 7

7

From district audits to detailed design

After completing the district audits, the project moved on towards the finalisation of the design phase. In parallel with RTD activities, a reduced set of DSIs was selected to evaluate the feasible scenarios for each demo site and calculate their possible performance according to the technical studies carried out by R2CITIES Partners. We took into account several elements, such as basic execution projects, budgeting and energy efficiency certifications, as well as the results of the audits, the project scope and targets. This allowed us to progress with the tender and public grant procedures in the three demo sites and start the interventions.

BP 1

BP 3

8

Decision Support tool based on a consensus approach

During the second year, the R2CITIES Project designed a Multi-Criteria Decision Analysis (MCDA) method based on a set of District Sustainability Indicators tested at the three demo sites. A panel of experts gave its opinion on different scenarios (defined as a combination of potential technologies) through questionnaires built by means of fuzzy logic techniques to handle uncertainty. The results of this analysis were used to formulate a weighting scheme and to solve the method's evaluation matrix. The formulation of the MCDA method was only made possible by the complementary skills of R2CITIES consortium. It served not only as a tool in the decision-making process, but was also applied during the construction and operation phase to evaluate the overall progress of the intervention.

BP 2

BP 3

9

Implementing R2CITIES methodology

Following the main pillars of the R2CITIES methodology, IPD concepts, DSIs and BIM technology were applied at the three demo sites during the phases of design, execution and assessment of the retrofitting. The roles outlined during the first year (BIM Manager, Energy Specialist and Quality Plan Supervisor) were deployed with the help of a Task Management Tool. This enabled a collaborative framework to be set up where roles and permissions were allocated, thus establishing a hierarchy between task administrators and users. Since the demo sites presented different district conditions, the R2CITIES methodology was developed to be as flexible as possible for replication in different circumstances.

BP 1

BP 2

BP 3

10

Monitoring and controlling specifications

To deal with the gap in monitoring systems for quantifying energy savings related to ECMs in districts, R2CITIES implemented a new approach to the IPMPV protocol. First, the partners identified the monitoring and metering requirements. Through measurement and verification plans at the demo sites, they defined the protocols and the mechanisms for collecting and communicating data in view to ensuring adequate information. The resulting descriptions of the equipment needed at each demo site served as a basis for the development of monitoring and controlling solutions during the third year of the project.

BP 8

BP 10

BP 11

11

Financial plans and associated business models

Clear financial models are essential for the success of district renovations to improve energy efficiency in a cost-effective way. The purpose of a financial or business plan is to reflect in a document the business idea to ensure (with a low level of uncertainty) its feasibility. In R2CITIES, the financial plans of the three demo sites were finalised in the second year. Each of them identified the available financial resources, the beneficiaries and the investors needed as well as the facilitators (ESCO, Banks, etc.) who could play a key role in releasing the initial investments for the interventions. In addition to this feasibility study, several financial indexes were calculated under different financial scenarios to evaluate the economic performance of the ECMs.

BP 7

12

End users' acceptance of R2CITIES

The involvement of end users is one of the requirements of R2CITIES methodology. Therefore, tenants and flat-owners were involved throughout the retrofitting process at the demo sites. They were surveyed in order to understand their expectations and experience, and several meetings were held to present and discuss R2CITIES concept and interventions. In addition, the project provided three mini websites in local languages to provide official information and serve as a contact point between all those involved locally. All these activities ensured citizens accepted and adopted the sustainability concepts.

BP 2

BP 5

BP 7

BP 14

13

Main barriers in Valladolid not appropriately identified

The R2CITIES Methodology can deal with a wide range of scenarios, provided that all its steps are correctly applied. In the case of the Valladolid demo site, decision makers failed to identify the barriers and consequently, they didn't define the existing boundaries and targets. It was estimated that a sufficient number of communities would apply for a grant to implement a biomass district heating solution. Nineteen buildings expressed an interest, but it was not possible to proceed as they were too distant from each other. From this experience the project learnt that all variables should be considered and analysed when studying the scenarios and that ESCOs facilitation can boost energy efficiency projects, but it is not the only way of empowering citizens.

BP 2

14

Municipalities as a guarantee for the citizens

Municipalities play a key role for the successful implementation of the retrofitting process, not only by providing funds, but also by acting as a guarantee figure. Indeed, they can actively assist the citizens in negotiating with private companies and can support them in assessing the quality of the interventions and in defining maintenance plans. In R2CITIES, municipalities were involved as stakeholders in the definition of the measures, as well as in the monitoring of the execution of the activities. In Valladolid, the Deputy Mayor led a communication campaign to convince citizens to get involved in the retrofitting project. The involvement of the municipality proved to be essential to ensure the success of the third call for grants after two failed calls.

BP 7

BP 14

15

High acceptance of R2CITIES results once completed the interventions

After the interventions have been completed, users can see first-hand the benefits such as lower the energy bills and also improved comfort. At the Genoa demo site, the tenants were completely satisfied with the results of the renovations. The interventions were implemented according to the initial schedule and as the final costs were lower than expected, the municipality and the demo team were able to carry out additional interventions like insulating the main heating pipes. The tenants were so happy with the new comfort levels in terms of internal temperature, sun radiation and air quality that they encouraged the tenants who did not benefit from R2CITIES retrofitting to ask for the same renovation of their apartments.

BP 7

BP 15

16

BIM use beyond current market standards

R2CITIES is supported by two main pillars: Integrated Project Delivery (IPD) and Building Information Modelling (BIM). The first is aimed at organising the project, while the latter is a 3D visual concept used to support the execution and monitoring of the interventions. The BIM procedure integrates architects, engineers and construction professionals in the same team, thus ensuring an appropriate application of IPD principles. It allows mechanical and electrical systems to be designed on-site, thus reducing errors, costs and the time needed for installation. Furthermore, inspection tasks are performed more efficiently when using BIM. In general, BIM proved to be an extremely useful tool for implementing the R2CITIES Methodology during the whole retrofitting process.

BP 13

17

Construction companies are crucial for the successful implementation of R2CITIES methodology

Construction companies have a big impact on the outcome of retrofitting projects. In R2CITIES, they were not part of the consortium but were external players selected by the municipalities or, in the case of Valladolid, by the communities of owners. As each community hired its own construction company, architects and builders, the homogenisation of the retrofitting works was complex. It was not always possible to apply the BIM methodology because the construction companies had no experience in managing this technology.

Despite these issues, the R2CITIES interventions in the district "Cuatro de Marzo" obtained good results. They improved thermal and acoustic insulation while reducing humidity. To minimise the aesthetic impact of the renovated blocks, architects and municipal technicians agreed on a common solution for their external appearance.

BP 12

18

Wireless monitoring: not always possible, not always better

Monitoring devices can be divided into metering systems and communication systems. At the Valladolid demo site it was not always possible to install wireless sensors inside the dwellings due to their need for a continuous power supply. As a result, more invasive solutions were installed, sometimes with a low visual impact, other times more visible. In addition to these devices, R2CITIES installed monitoring cabinets in the halls of the buildings connecting all of them through a local 3G network. As some cabinets were not covered by the 3G network, the project installed 4G antennas and cabling to the building façades. R2CITIES experience proves that although wireless is the future, it is not always a possible option.

BP 11

19

Citizen engagement is easier after seeing construction results

The Valladolid demo site residents are mainly elderly people, who are more reluctant to adopt new solutions and therefore to invest in retrofitting works. However, once the renovation was completed, the tenants who joined the project appreciated the aesthetic aspects, the temperature in summer and the impact on their energy consumption, while the neighbours who were not involved regretted not having participated. In R2CITIES, the budget allowed more buildings to be retrofitted. Other building owners did express their interest but only after the retrofitting has started, and there was no possibility of launching another call for grants due to the project's timescale. Therefore, more success could be achieved if the works are carried out in two stages. This shows that the impact of this kind of project could be increased by having more rounds of interventions to give more people the possibility to see the actual benefits of the retrofitting.

BP 7

BP 14

20

Monitoring commissioning procedures and data quality

Monitoring data is pivotal for properly evaluating the performance of energy facilities. Therefore, data quality is crucial. However, data errors or gaps happen due to malfunctioning, wrong installation or communication cuts. This must therefore be addressed during the commissioning and warm-up stages. In the latter stage, the data set-up and validation need to be double-checked in order to ensure correct data flows. During warm-up, data need to be carefully observed so that continuity and measurements within the range are ensured. Periodical checks of the measurements are also necessary during the entire data collection stage. To conclude, it is a matter of taking time in order to save time overall.

BP 10

BP 11

21

Common understanding of KPIs and EMP-DMP communication procedures

The development of tools for KPI calculation and data visualisation involves multidisciplinary stakeholders with different perspectives and understanding of the concepts. In R2CITIES, a good practice was to work hard at reaching a common understanding among, and alignment of the demo site teams during the design phase. Throughout the iterations for the KPI definition, EMP calculation methodology and EMP-DMP communication procedure, the success of the final implementation was quicker and better. In summary, design stages are crucial for success.

BP 11

22

Functionalities of DMP and their usability by building owners or energy companies

Complementary to the previous lesson learnt, it is important to keep in mind the final user of any application. Within R2CITIES, the DMP was developed to visualise data and KPIs and then provide end users with useful information. Nevertheless, it became clear that owners do not easily understand the information provided due to its complexity. It is therefore important to classify the end users and thus create interfaces according to the expected expertise. In contrast to the aforementioned, the functionalities and usability of the visualisation tools were not addressed enough in the design stage, and the end-user perspective was not really considered. These tools have become a very powerful tool for energy companies but are confusing for building owners.

BP 2

BP 11

BP 12

Methodology

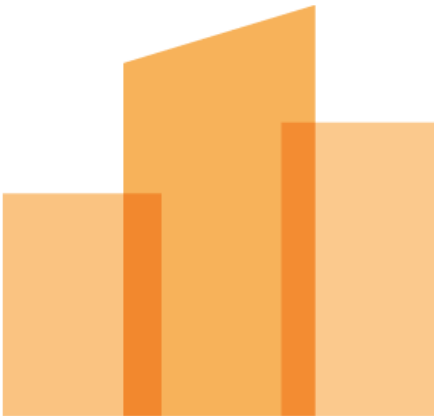
This Best Practices Book summarises the key findings from the R2CITIES Project and provides recommendations to all the stakeholders who may be involved in a retrofitting process such as architects, engineers, research centres, developers, contractors, public bodies, investors, as well as owners and tenants.

The Best Practices featured in this publication have been developed and drafted by the R2CITIES team based on the experience gained at the three demo sites: Yakacik (Kartal, Turkey), Cuatro de Marzo (Valladolid, Spain), and Lavatrici (Genoa, Italy).

The Best Practices cover all the phases of district renovation and are divided as follows:

- Best Practices on design
- Best Practices on retrofitting
- Best Practices on operation and maintenance
- Best Practices on exploitation
- Best Practices applicable to all stages

The backbone of each Best Practice is a combination of descriptive content, recommendations and assessment. To better understand the level of complexity of each best practice, the partners involved in its implementation have rated its replicability potential, impact and factors of success on a 4-point scale. At the end of this book you can also find a section on the lessons learnt during the five years of the project and a glossary of acronyms and abbreviations.



Design

		IMPACT ON...			FACTORS OF SUCCESS		
		COMFORT	ENERGY CONSUMPTION	ENVIRONMENT	SOCIAL ACCEPTANCE	TECHNICAL ASPECTS	PLANNING
BP 01	Retrofitting conducted at district-level positively affects the city	★★★☆☆	★★★★★	★★★★★	★★★★☆	★★★★★	★★★★★
BP 02	Get citizens on board	★★★☆☆	★★★★☆	★★★★★	★★★★★	★★★★★	★★★★☆
BP 03	Select retrofitting measures based on the district's features	★★★★★	★★★★★	★★★★★	★★★☆☆	★★★★★	★★★★★
BP 04	Link energy with intangibles as comfort and health	★★★★★	★★★★☆	★★★★★	★★★★★	★★★★★	★★★☆☆

Retrofitting

BP 05	PV-parking lot for e-car charging	★★★☆☆	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★
BP 06	Use tailored financing schemes to mobilise energy efficiency investments	★★★★★	★★★★★	★★★★★	★★★★★	★★★★☆	★★★☆☆
BP 07	Involving private owners in the retrofitting financing	★★★★★	★★★★☆	★★★★★	★★★★★	★★★★★	★★★☆☆

Operation and maintenance

BP 08	Comfort improvement is another benefit of energy retrofitting	★★★★★	★★★☆☆	★★★☆☆	★★★★★	★★★★★	★★★☆☆
BP 09	Maintaining for the future	★★★☆☆	★★★☆☆	★★★☆☆	★★★★★	★★★☆☆	★★★☆☆
BP 10	Low cost monitoring	★★★☆☆	★★★★★	★★★☆☆	★★★☆☆	★★★★★	★★★☆☆
BP 11	Define a monitoring strategy before installing efficient measures	★★★☆☆	★★★★★	★★★☆☆	★★★☆☆	★★★★★	★★★☆☆

Exploitation

BP 12	How SMEs learn through EU projects	★★★☆☆	★★★★☆	★★★★★	★★★★★	★★★★★	★★★★★
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All stages

BP 13	Using BIM from design to maintenance	★★★☆☆	★★★★★	★★★★★	★★★☆☆	★★★★☆	★★★★★
BP 14	Social involvement	★★★☆☆	★★★★☆	★★★★★	★★★☆☆	★★★★☆	★★★☆☆
BP 15	Affecting the environment	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★	★★★★★

Replicability

The following table summarises the replicability of the best practices identified during the R2CITIES project.

Most R2CITIES best practices are easy to replicate. The implementation of R2CITIES Methodology might be more complex, but it can be achieved with the support of the partners involved in its development. It may also be challenging to set out a low-cost approach to monitor entire districts. Data-mining techniques represent feasible solutions but require adjustments depending on the characteristics of dwellings and existing cost limits.

On the other hand, it is straightforward to adopt best practices such as the use of BIM in all stages of a retrofitting project, the definition of a monitoring strategy, and the selection of the most appropriate retrofitting measures based on the characteristics of a district. In addition, tailored financing schemes significantly help mobilise energy efficient investments and build investors' trust. Equally important is the involvement of building owners and tenants. The presence of an intermediate body between the residents and the municipality was identified as a main factor influencing the replicability of this kind of project.

Taking such practices on board increases the chances of success of retrofitting projects on district scale.

Design

REPLICABILITY

BP 01	Retrofitting conducted at district-level positively affects the city	↑ ↑ ↑ ↑
BP 02	Get citizens on board	↑ ↑ ↑ ↑
BP 03	Select retrofitting measures based on the district's features	↑ ↑ ↑ ↑
BP 04	Link energy with intangibles as comfort and health	↑ ↑ ↑ ↑

Retrofitting

BP 05	PV-parking lot fr e-car charging	↑ ↑ ↑ ↑
BP 06	Use tailored financing schemes to mobilise energy efficiency investments	↑ ↑ ↑ ↑
BP 07	Involving private owners in the retrofitting financing	↑ ↑ ↑ ↑

Operation and mantainance

BP 08	Comfort improvement is another benefit of energy retrofitting	↑ ↑ ↑ ↑
BP 09	Maintaining for the future	↑ ↑ ↑ ↑
BP 10	Low cost monitoring	↑ ↑ ↑ ↑
BP 11	Define a monitoring strategy before installing efficient measures	↑ ↑ ↑ ↑

Exploitation

BP 12	How SMEs learn through EU projects	↑ ↑ ↑ ↑
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All stages

BP 13	Using BIM from design to maintenance	↑ ↑ ↑ ↑
BP 14	Social involvement	↑ ↑ ↑ ↑
BP 15	Affecting the environment	↑ ↑ ↑ ↑

Glossary of acronyms

BEP	BIM Execution Plan
BIM	Building Information Modelling
CIP	Construction and Implementation Plan
DMP	District Monitoring Platform
DSI	District Sustainability Indicators
ECM	Energy Conservation Measure
EM	Energy Management
EMP	Energy Management Platform
EP	Energy Performance
ESCO	Energy Services Company
ICP	Integrated Control Plan
ICT	Information and Communication Technology
IPD	Integrated Project Delivery

IPMVP	International Performance Measurement and Verification Protocol
IT	Information and Technology
KPI	Key Performance Indicator
LCA	Life Cycle Analysis
LCC	Life Cycle Cost
LOD	Level of Development
MCDA	Multi-Criteria Decision Analysis
RES	Renewable Energy Source
RTD	Research & Technical Development
SME	Small and Medium Enterprise
SWOT	Strengths, Weakness, Opportunities and Threats



THE CONSORTIUM



Contact

Coordinator:

Cecilia Sanz Montalillo

Fundación CARTIF

cecsan@cartif.es

R2CITIES Communication Secretariat

secretariat@r2cities.eu

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