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FP7-ENERGY-SMARTCITIES-2012

INSMART

Integrative Smart City Planning

Mid-Term Implementation Action Plan – Cesena

D-WP 6 – Deliverable D.6.2

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Executive Summary
An application of the innovative city planning method, developed within the EU FP7 project INSMART, is applied to the municipality of Cesena (Italy). A multi-model approach is used to explore and rank alternative plans (combinations of actions and measures) towards the sustainable development of the municipality, with a particular focus on the residential and transport sectors.

Keywords	Mid-term implementation plan, techno-economic viability analysis of interventions, funding schemes and monitoring KPIs.

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Acronyms and Definitions

BaU	Business as Usual
EEC	Energy Efficiency Certificates
ERDF	European Regional Development Fund
ESCO	Energy Service Company
ESM	Energy System Model
KPI	Key Performance Indicator
MCDA	Multi-Criteria Decision Analysis
ROP	Regional Operative Programme
SEAP	Sustainable Energy Action Plan
TJ	Terajoule (= 0.277 GWh)
UIA	Urban Innovative Actions

1. Introduction

An application of the innovative city planning method, developed within the EU FP7 project INSMART, is applied to the municipality of Cesena (Italy). A multi-model approach is used to explore and rank alternative plans (combinations of actions and measures) towards the sustainable development of the municipality, with a particular focus on the residential and transport sectors.

Compared to the existing city Strategic Energy Action Plans of Cesena (mainly based on the downscaling of the national/regional planning approaches), the INSMART method allows to explore multiple future planning hypotheses of the "integrated" energy-urban system (explicitly modelled and simulated) and to engage the local stakeholders in all the steps of the decision problem. Table below summarizes the key differences and highlights the novelty of the approach proposed to the municipality of Cesena. Results and findings presented in this Mid-Term Implementation Action Plan should be looked at based on the following important characteristics.

	Existing SEAP approach (Cesena)	**InSmart approach (Cesena)**
Approach	Top-down. Downscaling of national targets, policies and measures.	Bottom-up. Driven by urban specific needs and integrated with the urban planning.
Sectors (coverage)	Residential, Commercial, Public Administration (very limited analysis of agriculture and industry). Transport is not included.	Residential, Transport, Public Administration.
Emissions (location)	Direct (within the urban area) and indirect (e.g. due to the generation of electricity consumed in the urban area).	Direct (within the urban area). All the emissions "directly" generated by the players of the system (e.g. households) are taken into consideration.
Emissions (type)	Carbon dioxide (CO_2), Methane (CH_4), Nitrous Oxide (N_2O)	Carbon dioxide (CO_2), particulate (PM10, PM2.5)
Measures	Simulation. Cost-benefit analysis of individual stand-alone measures.	Optimisation/Simulation (what-if analysis). Integrated system approach.

Table 1. Qualitative comparison between SEAP and InSmart approaches in Cesena

1.1. Interventions promoted through the MCDA process

The modelling analysis developed within the INSMART project, supported by a multi-criteria decision analysis (MCDA)[1], has identified combinations of measures (planning hypotheses) that are ranked "high" according to the preferences of city stakeholders (see Box 1 for details). Among six alternative planning hypotheses[2] the modelling analysis has identified the two planning hypotheses which perform best, to be further analysed in this report: namely the **Alternative "F"** (ranked first), and the **Alternative "A"** (ranked second).

Ranking	Alternative planning hypotheses	Phi	Phi+	Phi-
1	**Alternative F**	**0.2871**	0.4777	0.1906
2	**Alternative A**	**0.1986**	0.381	0.1824
3	Alternative C	0.0455	0.3863	0.3408
4	Alternative B	-0.0338	0.2729	0.3066
5	Alternative E	-0.1552	0.3121	0.4674
6	Alternative D	-0.3421	0.1986	0.5407

Ranking	Alternative planning hypotheses	Results / Decisions
1	**Alternative F**	**Shortlisted**
2	**Alternative A**	**Shortlisted**
3	Alternative C	Below the threshold
4	Alternative B	Likely not of interest
5	Alternative E	Likely not of interest
6	Alternative D	Discarded

Table 2. Generation of "flows of preference" (Phi) and key findings about the alternatives

These alternatives have been composed combining sets of measures in different sectors into "comprehensive" plans. In particular Alternative "A" includes measures on the existing building stock and on transport (speed reduction and modal shift from private car transport to cycling), whereas Alternative "F" simulates more moderate measures on the existing building stock and on renewable energy.

Box 1. Stakeholder engagement in the INSMART project

Due to the complexity of the decision planning process for the city, the wide diversity of impacts of the projects, and the multiple stakeholders involved or impacted by the projects, a participatory multi-criteria approach has been used to identify relevant measures (planning hypotheses) for the city. Local stakeholders have been engaged in all the key stages of the development of the analysis: from the design of the planning options (stakeholders have been asked to imagine and suggest actions and measures to simulate in a time horizon of around 20 years); to the definition of the criteria against which the alternatives are evaluated; and to the selection of their preferences (weights) on these criteria.

[1] Deliverable D.5.8 - Report on the multicriteria methodology, the process and the results of the decision making – Cesena, R. De Miglio, A.Chiodi, S. Burioli (eds.). Available from: <http://www.insmartenergy.com/wp-content/uploads/2014/12/D5.8-Report-on-the-Multi-criteria-methodology-Cesena.pdf>

[2] Deliverable D.5.4 - Report on optimum sustainability pathways – Cesena, R. De Miglio, A. Chiodi, M. Gargiulo (eds.). Available from: <http://www.insmartenergy.com/wp-content/uploads/2014/12/D5.4-Optimum-Sustainable-Pathways-Cesena.pdf>

The first step for stakeholder engagement was the formal establishment of an interdisciplinary working group composed by technicians of the municipality of Cesena from the Environmental, Mobility, Urban planning, Public and Private buildings and GIS departments; and representatives of "Energie per la città Ltd". The group has actively participated in the data collection and in the definition of the first list of planning scenarios.

The second step was the enlargement of the stakeholder group to involve others local actors to the decision making process. This stakeholder group included:

- Universities (Architecture and Engineering faculties);
- CEAS (Municipal environmental and sustainability education centre, composed by different associations involved in urban sustainability projects);
- Professional orders (Ordine degli Architetti, Ordine degli Ingegneri);
- Professional associations (CNA Confesercenti, Confartigianato, Confcommercio)
- Consumers associations (Federconsumatori, Adoc Adiconsum)

This group has been involved in the definition of the final list of planning scenarios, the identification of relevant evaluation criteria; and in their preferences based on priorities and perceptions between criteria. The engagement consisted in a number of workshops, organized within the Municipality of Cesena with the collaboration of E4SMA:

- March, 14th 2016 - I workshop

  Presentation of the MCDA method and first draft of the scenarios
- June 2016 - On-line survey for the evaluation of the KPI indicators
- July, 5th 2016 - II workshop

  Presentation of the second draft of the scenarios.
- November, 29th - III workshop

  Presentation of key results from the cost-optimal scenario analysis and the MCDA ranking analysis.

In parallel three meetings with the political parties of the municipality of Cesena were organized:

- January, 28th 2016 - Presentation of the first draft of the scenarios to the Councillor of Urban Planning, Councillor of Sustainable Development and Europe, Councillor of Mobility;
- March, 13th 2016 – Special workshop dedicated to the City Council to present the MCDA method and a first draft of the scenarios;
- May, 10th 2016 - Presentation of the scenarios Council Committee Environment and Energy

2. Economic Viability Analysis

2.1. Methodology

This implementation plan focuses on the two best-performing alternative planning hypotheses (i.e. “F” and “A”), rather than to the best one only, as it aims to provide detailed information to the stakeholders and clarify pros and cons of such complex decision problem. For each key action of the planning hypotheses particular emphasis is given to *costs* – the economic effort – and *location* of the investments, as relevant for the implementation of a realistic and applicable mid-term implementation plan. The breakdown of each key indicator is provided on a zonal basis, as shown in Figure 1.

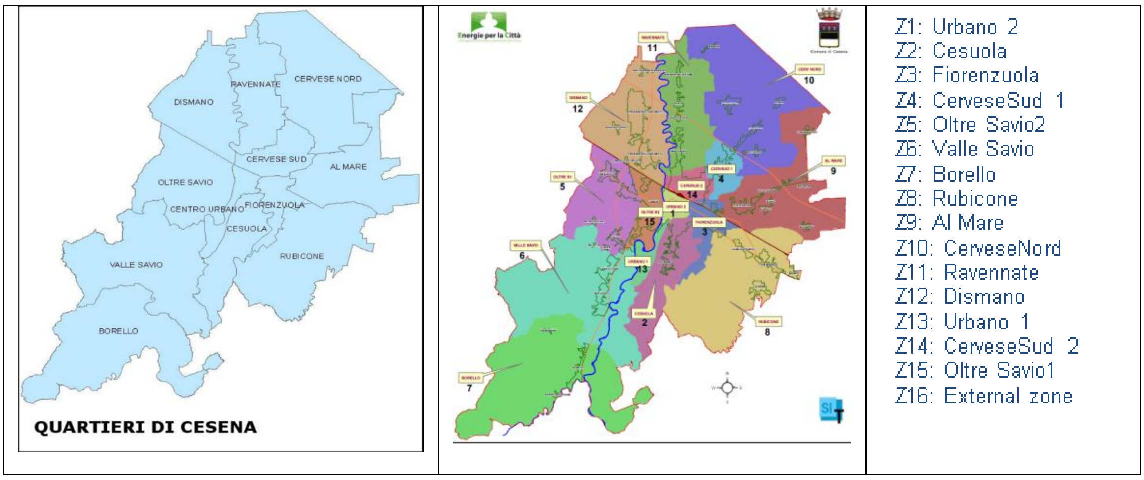

Figure 1. Administrative disaggregation by zone of the city (left), and disaggregation by zone of the model (right)

2.2. Economic Viability Analysis

This section provides a detailed techno-economic viability analysis on the key components (specific actions) which underpin the two shortlisted strategies for the Municipality of Cesena. The key element of novelty of such approach to the energy planning is that different actions (e.g. “retrofit-oriented”, “renewables-oriented” and “transport-oriented”) can be designed as separate actions and analysed in detail, but are *de facto* interdependent in an integrated system, like an urban-energy system. For example, these are subject to the same budget constraints (e.g. the available budget at family level for investing in more efficient technologies), and technical constraints (e.g. the available roof area which can be allocated either to solar photovoltaic or to solar water heaters). Integrated analysis can both provide detailed overview of implications of specific planning hypotheses, and, at the same time, useful insights about integrated city level dynamics.

The key components (specific actions) which underpin the two shortlisted planning hypotheses (alternatives) are the following:

1. Alternative A:

- Strong urban regeneration of the existing building stock;
- Simple measures on transport;

2. Alternative F:
    - Moderate urban regeneration of the existing building stock;
    - Expansion of renewable energy (decentralized production);

For both the alternatives, strong information campaigns are also part of the strategy.
The following sections provide a description of specific assumptions of these alternative strategies and the key findings. A reference case considering all the current key policy developments is also used as basis against which to compare the alternative city planning hypotheses.

Alternative A

This Alternative A ranked "second" in the multi-criteria stage of the work, thus representing the second "most-balanced" option among the available alternative sustainable-oriented plans. This alternative was meant to simulate the impacts of a deep urban "regeneration" of the existing building stock, in combination with few simple measures on transport system which favour a shift from private transport to *soft* transport modes (e.g. bikes).

Action A1: Urban regeneration

The first action was meant to simulate the impact of the refurbishment of a large share of the most energy-greedy (existing) building stock of the city. This alternative simulates the impacts of refurbishing 40% of the current building stock with an energy rating equal or lower than class-E (above 130 kWh/m^2 year). Of this 40%, 10% will be brought to class-A (< 40 kWh/m^2 year), while the remaining 30% to class-C (below 90 kWh/m^2 year). Such a "simple and city-wide" statement and target has been translated into a specific constraint of the city energy system model (City-ESM) of Cesena. Model has returned a set of quantitative information by zone, by building type and by time-slice which are here used to evaluate the specific benefits of the action with respect to the key objectives of the city.
Figure 2 shows the projected energy savings (in terms of useful energy) in 2020 and 2030 in the residential building stock due to the implementation of the action. Around 51 TJ (in 2020) and 144 TJ (in 2030) are expected to be saved at city level. The distribution at zonal level of savings reflects the actual location of the existing class-E (or lower) building stock in the city, and the cost-effective potential of the refurbishment options. A large share of the retrofit interventions will be located in the central part of the city: namely Zone 1 (Urbano 2), 3 (Fiorenzuola) and 15 (Oltre Savio 1).

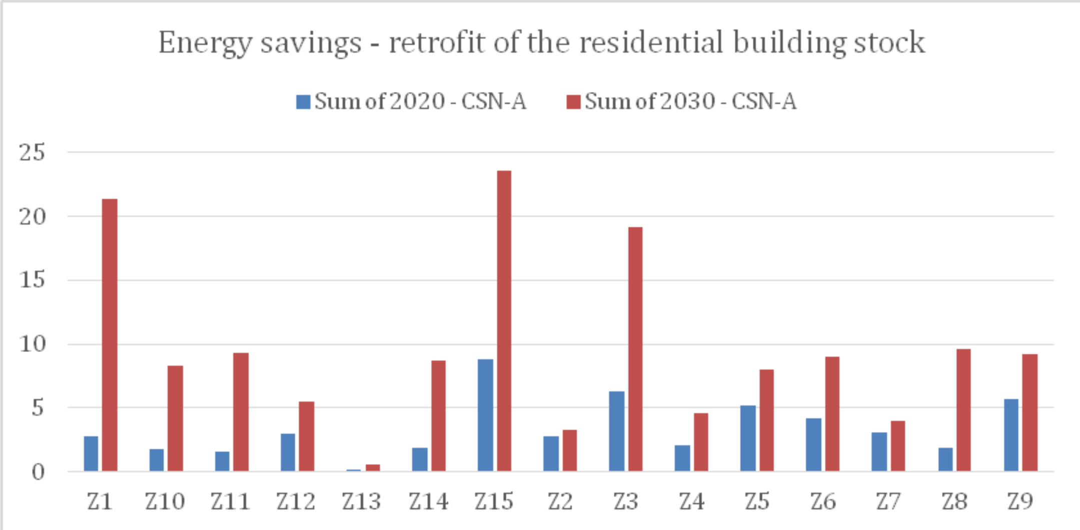

Figure 2. Energy savings (useful energy, TJ) in the residential building stock by zone in 2020 – 2030

Additional insights, about the most rationale way to implement the action, can be obtained by Figure 3. The results indicate that interventions on semidetached and terraced buildings – in particular for dwellings built before 1980 – should be prioritized among the other building typologies. Of these, the cost-optimal analysis suggests for semidetached dwellings the insulation of about 7000 roofs (measure “R2"), and the replacement of windows with high efficiency ones in about 6000 dwellings (measure “R3”)[3]; while for terraced dwellings the insulation of about 4500 external walls. Other typologies, like flats – which are the most common building typologies in Cesena – or detached houses (high costs of retrofit), contribute to the target with a smaller proportion of retrofit investments.

This type of results is an example of unique insights that can be gained from an integrated analysis, which in this case identifies – under a certain policy or planning strategy – the least-cost combination of retrofit options, building typology and location.

Appendix 1 reports an overview of the saving potentials, by type of retrofit and building typologies, as calculated in WP2, used in the model.

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[3] Due the additive nature of the savings generated by the three retrofit options (assumptions based on the work of WP2), it is like to say that 6000 out of 7000 are expected to be refurbished with both R2 and R3.

R1 - Walls: Installation of external insulation on the walls for typologies without insulation or insufficient insulation, according to the thermal properties defined by the Italian Regulation for the specific climate zone.

R2 - Roof: Installation of external insulation on the roof for typologies without insulation or insufficient insulation, according to the thermal properties defined by the Italian Regulation for the specific climate zone.

R3 - Windows: Replacement of existing windows, according to the thermal properties defined by the Italian Regulation for the specific climate zone.

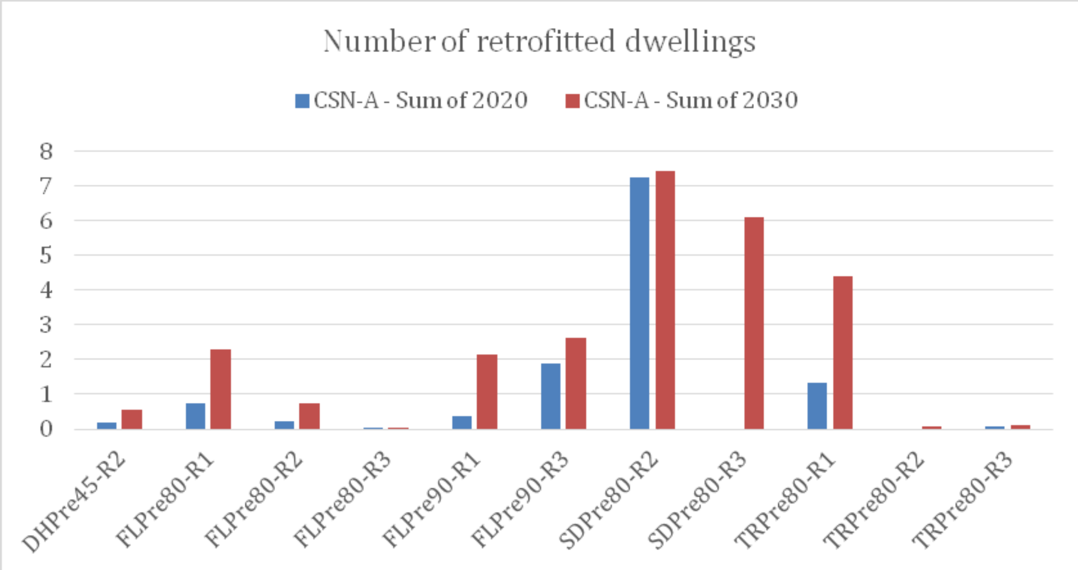

Figure 3. Number of retrofitted dwellings (thousands of dwellings) by type in 2020 – 2030.

In the city of Cesena, residential consumption is currently dominated by natural gas, which is also foreseen to be the key energy commodity used in the sector by 2030, as shown in the chart below.

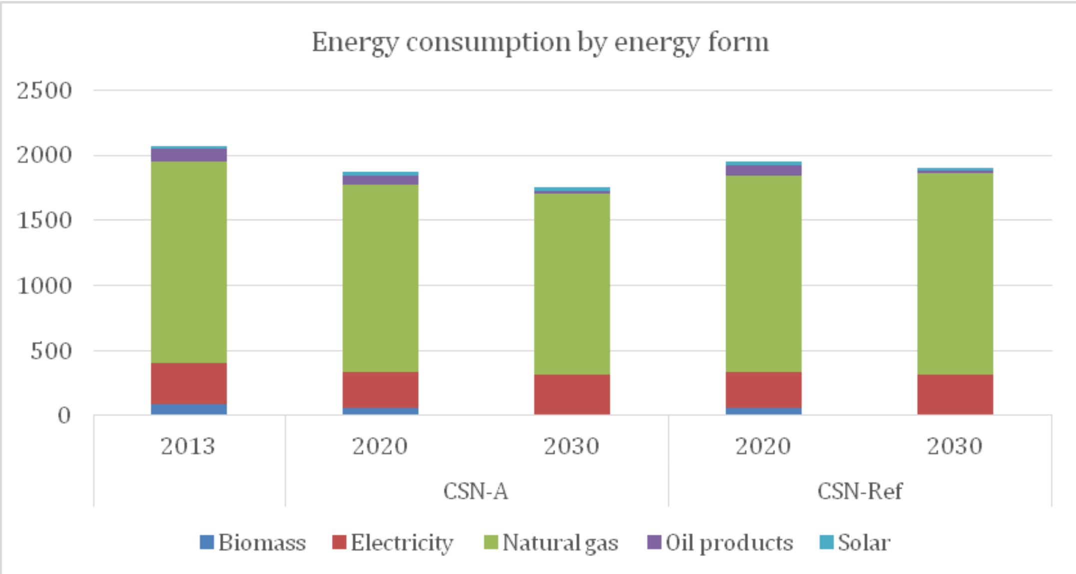

Figure 4. Energy consumption in the residential sector (TJ)[4] – Comparison between Alternative A and Reference

An interesting impact of this action is the reduction of the gas consumption in the high heating demand periods. Figure 5 shows (in relative terms), the yearly gas consumption profile across 24 time slots[5] in three cases: in the base year of the analysis (2013), in 2030 under the reference development of the system, and in 2030 after the implementation of the action. The benefit of an action which boosts the

[4] Solar includes the energy for water heating only. Generation of PV technologies is part of the item "electricity".

[5] See Appendix 2 for details about the inter-annual periods.

building stock retrofit, can be measured in 2030 as a 10% of reduction of gas consumption in the peak season (S1 = January), and in about 8%-10% in the intermediate seasons (S2, S6).

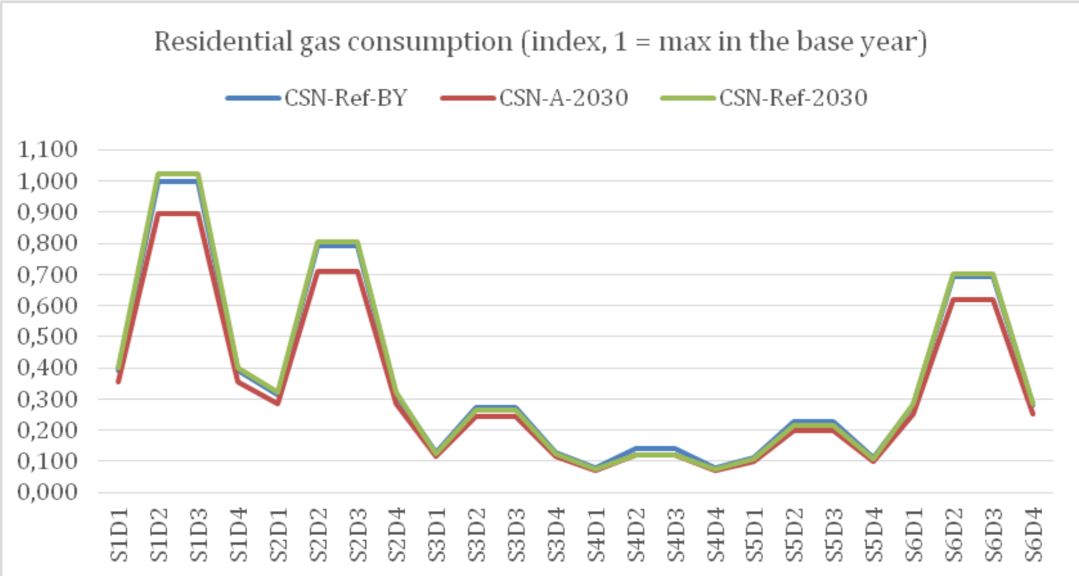

Figure 5. Gas consumption profile in the residential sector (index)

The "overnight" cost of the action, estimated on the basis of the model response, is about 108.7 Euro millions (equivalent to approximately 1120 Euro/inhabitant to retrofit a fraction of the existing building stock with the above mentioned standards, at the costs-per-retrofit reported in Appendix 3). For a more detailed analysis, this total cost can be further broken down by retrofit measure (40.6% for R1, 13.2% for R2, 46.2% for R3), by building typology (1.3% for detached, 50.6% for semi-detached, 23.4% for flat, 24.8% for terrace), and by zone (13.6% in Z1, 14.4% in Z3, 18.8 in Z15, etc.[6]).
Assuming an average domestic gas price of 27 Euro/GJ, the overall "payback period" of the action is not lower than about 25 years.

Action A2: Transport measures

The second important action of the integrated planning hypothesis "A", focuses on the transport sector. In particular this action foresees two main interventions:

1) The completion of cycle paths (for a total of 16 km) along the main road network and within the so-called "areas 30", to favour the use of the bicycles in daily home-school and home-work trips.
2) The realization of "environmental" bike paths along the river Savio for cycling tourism (for a total of 87 km) and to connect the low population density areas (in particular between zones 11, 10, 4 and 9).

[6] A complete set of results has been shared with the experts of Cesena

The results of the analysis performed with a transport-specific model [7], reported in the table below, shows the impact of the actions on the transport demand per each transport mode in terms of "number of total movements" per day (daily vehicle demands) and the equivalent vehicle-kilometres (including the average distances per movement) at the end of the horizon (2030). Table 3 reports a reduction of private demands of around 11500 movements per day, while the vehicle demands of public and freights are equivalent to the reference case and not affected by the action. The indicator of *private vehicles dependency* (movements of cars and moto over the total) is then reduced of around 4% with respect to the reference case.

	Alternative A – 2030				**Reference – 2030**		
Description	Daily Vehicle Demand	Daily Vehicle Kms	Annual Vehicle Kms		Daily Vehicle Demand	Daily Vehicle Kms	Annual Vehicle Kms
All Cars	233578	2147353	723659289		243458	2234571	753050787
Buses	2069	22129	7457939		2069	22129	7457939
Freight	9775	104417	35189858		9775	104417	35189858
Moto	39971	368447	124167703		41559	382498	128903388
Total	285393	2642346	890474789		296861	2743615	924601972

Table 3. Impact of the action on the transport demand

The action cost (overnight investment) is expected to be of about 450000 Euro per km of cycle lane, for a total investment of 7.2 Euro million. The private contribution is supposed to be negligible, as the cost is almost entirely supposed to be covered by the Municipality.

The total energy consumption of the transport sector, as calculated by the integrated model[8], is reported in Figure 6. Chart shows a decrease of energy consumption in the reference case mainly driven by two elements: demands in 2030 (movements) are expected to be lower than in the base year[9], and technology substitution. The penetration of more efficient and hybrid-engine vehicles due to national regulation/standards and to the cost-effectiveness of more efficient vehicles is expected to be an important factor of the coming 15 years, no matter which local-specific sustainable-oriented actions is applied.

Based on these results, chart also shows the relatively small, but still important, effect of the transport-specific action (included in the integrated alternative "A") on the consumption of the sector in 2030. When compared to the reference profile, energy

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[7] Deliverable 3.8 (2015), Transport Scenarios Results Report Cesena, Available from: <http://www.insmartenergy.com/wp-content/uploads/2015/10/D.3.8.v2-Transport-Scenarios-Cesena.pdf>

[8] As reported in the specific project deliverable, values must be interpreted as follows: the consumption for private, public, freights movements the origin of which is in the geographical area of analysis.

[9] Movements by transport mode are projected making use of the transport specific model.

use drops of additional 140 TJ. At an average price of gasoline of 45 Euro/GJ, the overall "saving" (due to the modal shift "from car to bicycle") is expected to be about 6.3 Euro millions (approximately 65 Euro per person) in the final year.

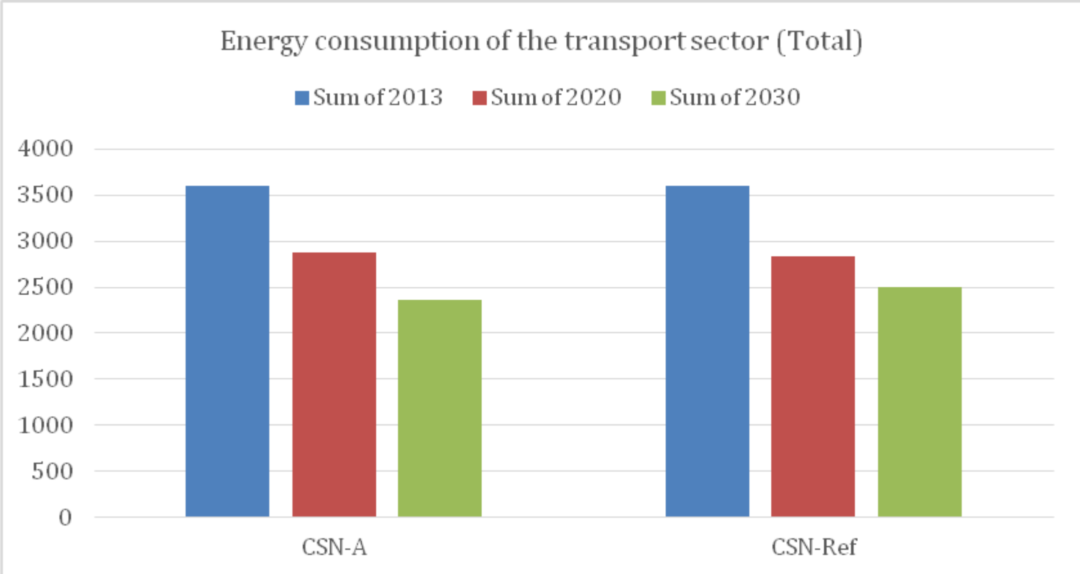


Figure 6. Energy consumption in the transport sector (TJ)

A more conservative projection of consumption for the transport sector, is provided by the transport-specific model (making use of different methodologies and assumption) which calculates a reduction of consumption, from the base year to 2030, of about 15% in the reference case.
But even according to this analysis, the impact of the realisation of cycle routes is relatively small with respect to the total consumption of fuels in 2030.

Alternative F

This planning hypothesis ranked "first" in the multi-criteria stage of the work, thus representing the "*most-balanced*" option among the available alternative sustainable-oriented plans. The Alternative F was meant to simulate the impact of an increase of 30% (relative to 2013) in the use of renewables [10] in the local energy system (residential + tertiary + supply, transport is excluded) by 2030, in combination with the refurbishment of a medium-to-small share of the most energy-greedy buildings. As for the Alternative A, such a "simple and city-wide" combination of measures has been translated into constraints for the energy-system-model of Cesena, in order to control the two specific targets. The quantitative information "by zone", "by building type" and "by timeslice" returned by the integrated model are used below to evaluate the specific benefits of the actions with respect to the key objectives of the city.

[10] Mainly solar and biomass/biogas. Potential of wind at urban level was not considered.

Action F1: Urban regeneration

This action was meant to simulate the impact of bringing 25% of buildings currently with an energy rating equal or lower than class-E (over 130 kWh/m^2 year), to class-B (below 60 kWh/m^2 year).

Figure 7 shows the expected energy savings (in terms of useful energy) in 2020 and 2030 in the residential building stock, due to the implementation of this retrofit plan. Around 39 TJ (in 2020) and 100 TJ (in 2030) are expected to be saved at city level, well below the values reported for the urban regeneration action of Alternative A.

The distribution at zonal level of such savings largely reflects the actual location of the existing class-E building stock in the city, and the cost-effective potential of the refurbishment options. However, given the limited family budget available for investments, this distribution is in part also affected by the simultaneous target on renewables (Action F2), which leads to a different location of intervention. The largest share of retrofits would be still needed in the central part of the city – Oltre Savio 1 (Z15) and Fiorenzuola (Z3) – but energy savings are now more evenly distributed across the zones, as shown in Figure 7.

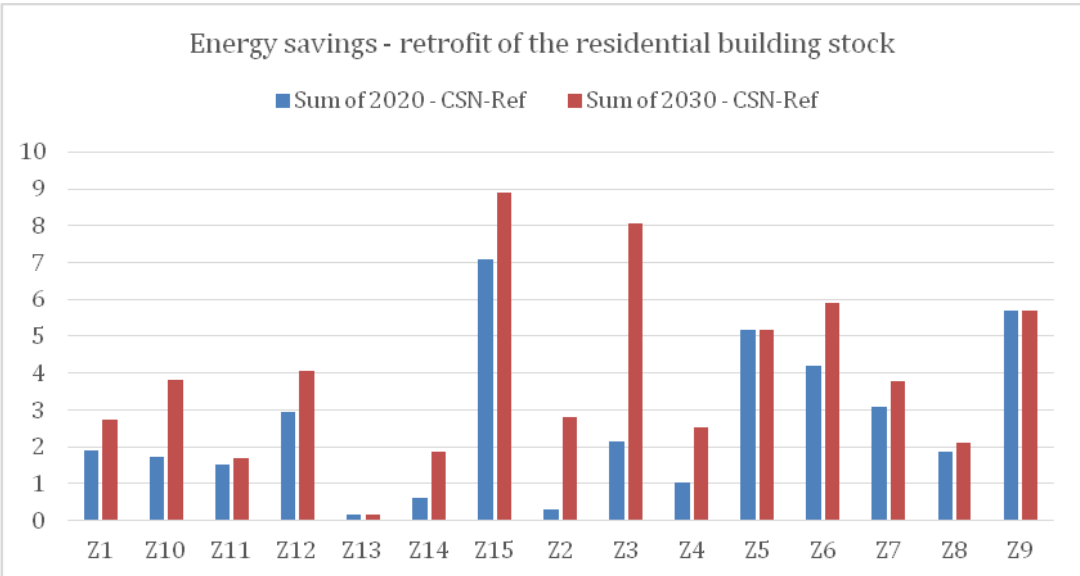


Figure 7. Energy savings (useful energy, TJ) in the residential building stock by zone in 2020 – 2030

Figure 8 provides a detailed overview of the type of dwellings subject to retrofit and the type of measures, as allocated by the model. The main building typology which should be focused on are, as for the Alternative A, semidetached dwellings. To fully implement the action in the cost-effective way, up to 7000 semidetached dwellings – built before 1980 – are required to be retrofitted with the measure “R2” (roof insulation) and up to 3000 with the measure “R3” (windows replacement)[11].

[11] Due the additive nature of the savings generated by the three retrofit options (assumptions based on the work of WP2), it is like to say that 6000 out of 7000 are expected to be refurbished with both R2 and R3.

The numbers of retrofitted dwellings is lower than in the alternative A, however in general this planning hypothesis performs well against many criteria.
Based on model results, we can conclude that the most cost-effective way to reach the target designed by this action is to orient most of the efforts to the semidetached, retrofitting windows and roofs, and terrace, for which the installation of external insulation of walls (for the equivalent of around 2000 dwellings) is fruitful.

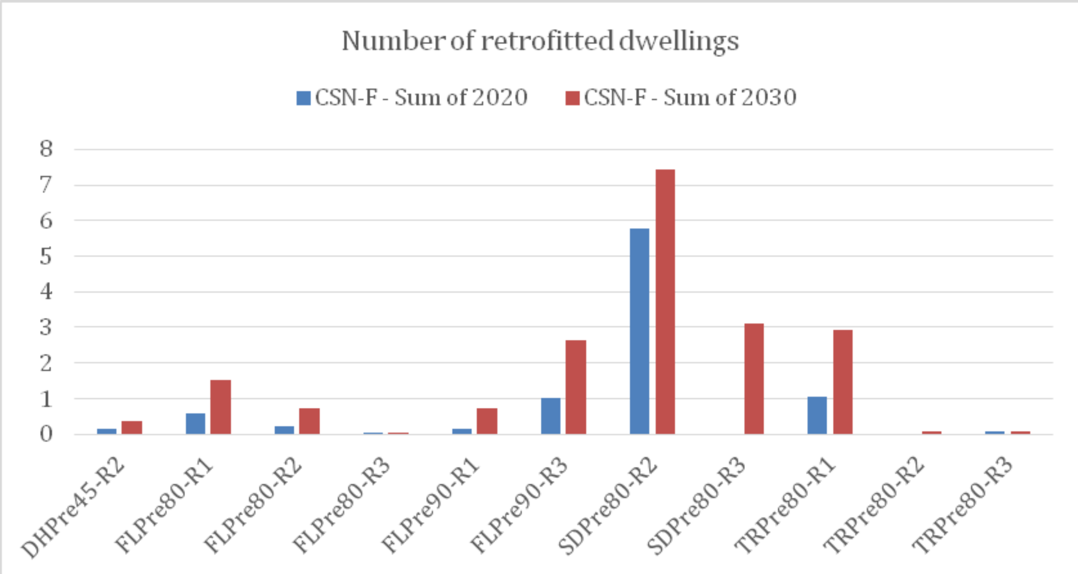


Figure 8. Number of retrofitted dwellings (000dwellings) by type in 2020 – 2030.

Residential consumption is dominated by natural gas which is also projected to be the key energy commodity used in the sector by 2030, as reported in the chart below (Figure 9). However, driven by the renewable target, solar energy takes a non-negligible share in the mix.

R1 - Walls: Installation of external insulation on the walls for typologies without insulation or insufficient insulation, according to the thermal properties defined by the Italian Regulation for the specific climate zone.
R2 - Roof: Installation of external insulation on the roof for typologies without insulation or insufficient insulation, according to the thermal properties defined by the Italian Regulation for the specific climate zone.

R3 - Windows: Replacement of existing windows, according to the thermal properties defined by the Italian Regulation for the specific climate zone.

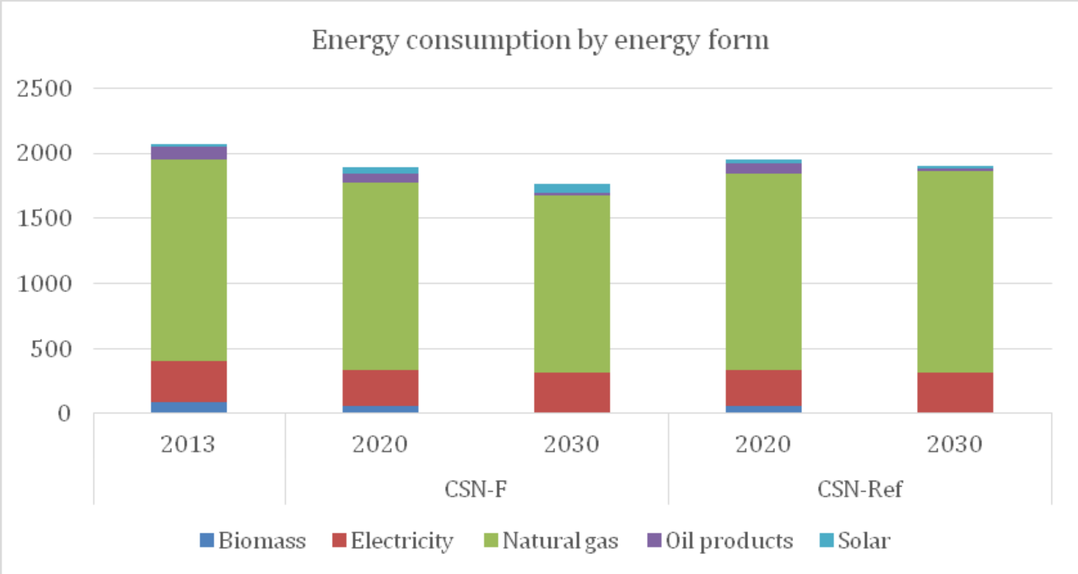


Figure 9. Energy consumption in the residential sector (TJ)[12] – Comparison between Alternative F and Reference

The "overnight" cost of this urban regeneration action, based on the response of the model in terms of type and number of retrofit and building involved, is about 69.654 Euro millions (approximately corresponding to 715 Euro/inhabitant to retrofit a fraction of the existing building stock with the above mentioned standards, at the costs reported in Appendix 3).

For a more detailed analysis, this total cost can be further broken down by retrofit measure (38% for R1, 20% for R2, 42% for R3), by building typology (1.4% for detached, 49.1% for semi-detached, 23.9% for flat, 25.6% for terrace), and by zone (12.4% in Z1, 12.1% in Z3, 9.2% in Z15, 10% in Z10, etc.).

Assuming an average domestic gas price of 27 Euro/GJ, the overall "payback period" of the action is not lower than 23 years, slightly lower than the Alternative "A", but with also less savings.

Action F2: Increase of renewables

But the "key" action of such planning hypothesis is on renewable energy. It has been specifically designed with the aim of increasing the overall use of renewable energy for the production of decentralised heat and electricity (transport is excluded from the action) in the city-system of (at least) 30% by 2030.

The contribution of the household sector to this integrated planning hypothesis is shown in the following figures and charts. Around 5.3 MW of solar PV roof technologies (amorphous silicon) are suggested to be installed in the buildings by 2030, together with around 10 MW of solar water heaters in addition to the existing installed capacity. The total overnight cost for the household sector (compatible with the budget constraint) of the action is 34.115 Euro millions (approximately

[12] Solar includes the energy for water heating only. Generation of PV technologies is part of the item "electricity".

corresponding to 350 Euro/inhabitant), of which 40% for investments in PV-roof technologies and the remaining for solar water heaters, according to the optimal configuration of the system.
Total cost can be also broken down by dwelling type: namely 21% of the investments would be assigned to the detached, 47% to the flat, 13% to the semidetached and the remaining to the terraced. By comparing these figures with the distribution of investments for building retrofits, it results evident that for some building typologies (semidetached) the most cost-effective allocation of the available (household) budget is for the reduction of the heating needs, while for other dwellings (flat) there seems to exist a larger cost-effective room for the boosting the use of solar technologies.
Such a finding can be obtained only when an integrated system-oriented analysis is undertaken, and different policies and measures are tested "simultaneously"[13].

Figure 10 shows the production of renewable electricity (from solar PV technologies) in the residential sector by timeslice in the base year (2013), and in 2030 under both the Reference and the Alternative F scenarios. Around 69 TJ of electricity are projected to be generated in 2030 when the action is implemented, 12 TJ more than in the base year. At an average electricity price of 65 Euro/GJ in the medium term, the overall "payback period" of the action is expected to be around 15 years.

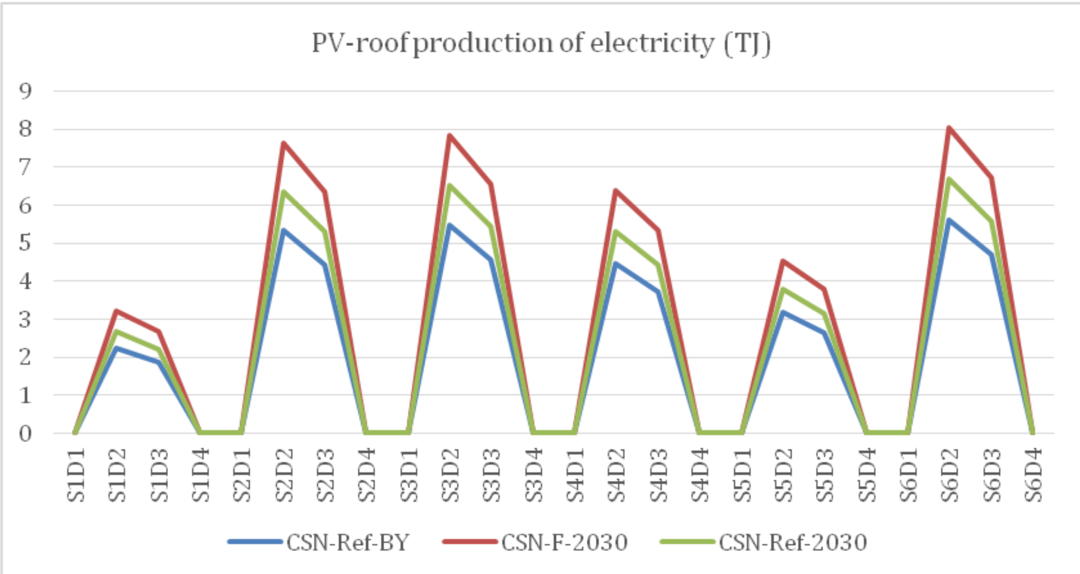


Figure 10. PV-roof production of electricity by time slice and scenario.

The combined effect of building retrofits, penetration of renewables (both explicitly included in alternative "F"), and energy efficiency improvements of the electric appliances (based on cost-effectiveness in all the scenarios) in the households sector, can be also analysed by time slot as shown in the following chart (Figure 11).

[13] Each alternative planning hypothesis is designed by combining different actions in a "single" plan. Synergies and redundancies can be found by analysing the results of the integrated simulation.

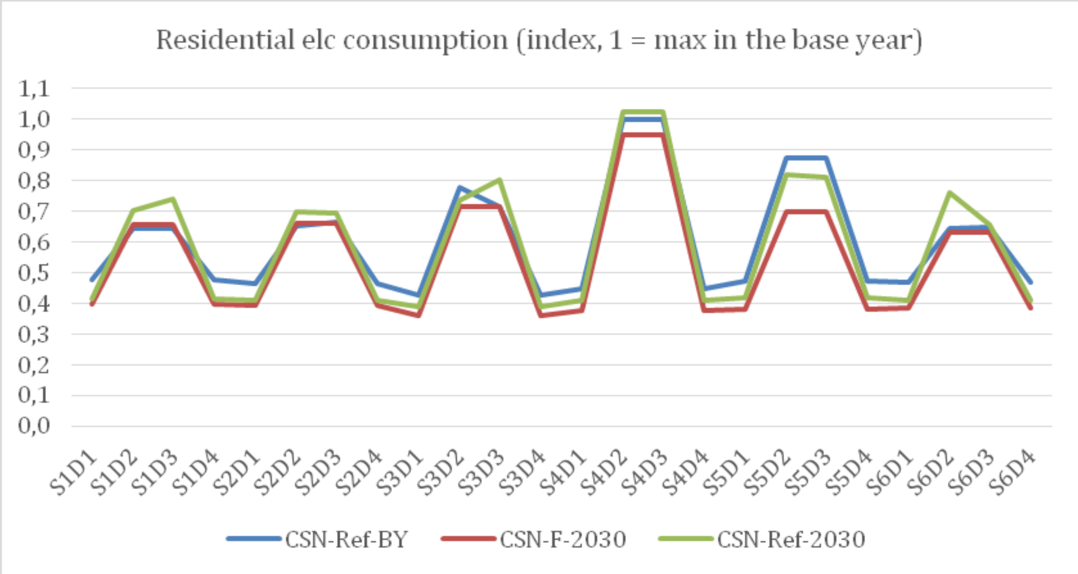


Figure 11. Electricity consumption in the residential sector (index)

Results show a reduction of electricity demand of around 5% in the peak slices (S4D2, S4D3) with respect to the base year, and a consumption curve (red line) which is generally placed "below" the reference load shape (green line).

The above-mentioned results must be interpreted on the basis of the storyline of alternative F and of the integrated response of the city-model. Reduction of electricity demand due to energy efficiency, in particular in the summer time[14] (S4), coupled with budget constraints of the households, discourages extra investments in PV technologies (which mainly operate in the summer time). That is why 60% of the investments in solar technologies are allocated to the water heaters.

Moreover, biomass technologies in the residential sector are replaced by other heating options in the medium-term, improving the indicator of PM emission but reducing at the same time the share of "renewables" in the energy mix of the city. This makes the target on renewables even more challenging as only solar technologies (no utility scale plants are allowed) and biogas can play a role.

Hence, the only way to meet the target set by the action – i.e. a 30% increase of renewables at city-wide level – is to call for investments in the "local" supply sector, for example with new biogas micro-cogeneration plants able to produce about 15 TJ of additional "CO_2-free" electricity within the borders of the city, and consuming an equivalent of 45 TJ of biogas.

It's also worth noting the response of this comprehensive planning hypothesis (Alternative "F") with respect to the gas consumption across the slices of the year. The simultaneous application of a "soft" retrofit strategy and the boost of renewable energy (solar) depicts a slightly different consumption curve (Figure 12).

[14] No significant increase in cooling demand was assumed.

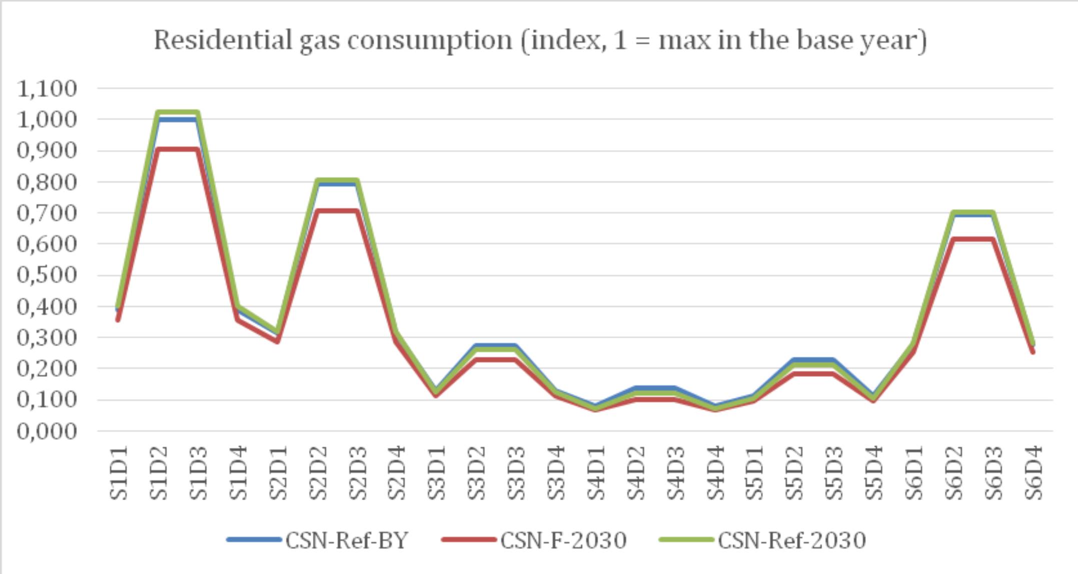


Figure 12. Gas consumption profile in the residential sector (index)

The benefits during the heating seasons are still evident (although lower than for the Alternative A), but a reduction of gas consumption also occurs in the intermediate year-slots. This is mainly due to an extra penetration of solar water heaters in the residential technology mix, as the larger part of the family's budget can be allocated to the renewables and efficient boilers rather than to heavy building retrofits.
Overall, in 2030 the expected consumption of gas in the sector is around 25 TJ lower than in the case "A". This result points out that the combination of actions designed in the alternative "F" is more effective on average among different criteria, even if under the indicator "gas consumption in the residential sector" it performs (slightly) worse.
Assuming the INSMART approach to the strategic planning, the penetration of solar PV technologies does not impact (reduce) the "direct" CO_2 emissions of the city-system, as all the centralised generation of electricity is placed out of the borders of analysis (the municipality of Cesena). On the other hand, the penetration of solar water heaters does impact on the direct emissions, as some gas-fired boilers are replaced by solar technologies.
A consistent definition of the space of analysis is of extreme importance when policies and measures are designed and monitored. This latter comment, which is of particular importance for plan "F" (the "best" planning hypothesis, according to this analysis) when the indicator on CO_2 emissions is analysed, introduces a final comparison between the out-of-the model goals and the response of the present modelling exercise.

Information campaigns (and other legislative and regulatory measures)

Without adequate information on the benefits of some choices, inhabitants have no possibility of understanding the dynamics, the objectives and the possible opportunities of a "rational" (energy-related) behaviour.

Strong "information campaigns" are assumed as being part in both the "most effective" plans for the municipality of Cesena. Information campaigns are twofold important: they are expected to act in such a way that the explicit actions designed for the integrated strategies (retrofit of the building, penetration of renewables) can be actually met by due time, and they have to "impact" on the rationale of the private investment decisions which are not explicitly mentioned in the policy and planning actions (e.g. replacement of the heating systems, reduction of overheating, substitution of the electrical appliances in the residential sector, or efficiency improvement in the tertiary sector, etc.)[15]. In other words, info campaigns are needed to enable decision-makers to contribute in the realisation of the designed measures, and to allow them to take smart investments decisions for everything is "not directly/explicitly" included in the planning hypotheses. The benefits on the energy-environmental system can be measured in terms of rate of energy efficiency improvements and, consequently, in terms of corresponding consumption and emission level.

Information campaigns play in an environment which is already "regulated" by supranational, national and local measures, so that the benefits for the city of such an action is "incremental" to the effects of the existing regulations (taken into consideration by default in the analysis):

- the Directive 2009/125 / EC was introduced with the aim of reducing energy consumption under the Kyoto Protocol. It made mandatory the production and commercialization of condensing boilers (high efficiency) only, starting from September 2015. Information campaigns can explain / make clear / suggest the benefits of the new options (compared to the existing) to the consumers, thus boosting the substitution of old technologies with the new (condensing) ones, *even before the end of the technical lifetime* when, and if, the replacement is "cost-effective" for the city-system.
- the Directive 2010/30/EU on the indication by labelling and standard product information of the consumption of energy and other resources by energy-related products[16]. The directive itself aims to improve the efficiency of products related to energy consumption through an *informed choice* of the consumer. But, again, a full recognition of the (economic) benefits of replacing inefficient appliances with efficient appliances can be supported by the action of the campaigns. Awareness campaigns may turn the resistance of change, cope the lack of information of consumers, and help them in making rational decisions (which may result in the allocation of more money for the "investment" in order to save money during the operation of the device).

[15] Simulations run with a (constrained) optimisation approach meaning that investment decisions are based on rational behaviour of the agents and on a cost-effective allocation of resources/costs/budget.

[16] The new labelling code provides additional three classes of greater energy efficiency (A +, A ++ and A +++), which are in addition to traditional classes A, B, C and D, and must be applied by manufacturers to refrigerators, freezers, washers, dryers, dishwashers, TVs and to air conditioners.

Costs for information campaigns vary depending on the mean and the level of the awareness message. An open web-page with a free energy savings calculator may cost from 10 to 15 Euro per household (per each "home appliance" decision), a doorstep campaign up to 40-60 Euro per household (per each "home-appliance" decision), while a more targeted, strong and permanent info-point may result even more expensive for the municipality. A cost of 75 Euro per household (per each "home-appliance" decision) has been assumed to simulate the effort needed to enable decision-makers to contribute in the realisation of the designed actions (e.g. retrofit of the building stock), and to support them to behave in a smarter way with respect to the energy-related decisions (investments and utilization of energy technologies). The total investment cost of such an action would be about 16 Euro millions (approximately corresponding to 165 Euro/inhabitant) distributed across the time periods.
Schools and associations can also promote initiatives and contribute to make people more aware of the implication of the energy consumption on the environment. Although their impacts is hardly "quantifiable", the direct involvement of such actors in education and information is expected to lower the burden (cost) for the Municipality.

Short-medium term sustainable goals

This section briefly compares some key results from the analysis of the best performing option (Alternative "F"), with the objectives of the existing Sustainable Energy Action Plan (SEAP).
The three key objectives of the SEAP were:

- A reduction of 20% of the emissions (based on values in 1995).
- A reduction of emissions per capita to 2.9 tons of CO_2.
- A reduction of 133000 tons of CO_2 with respect to the BaU scenario.

As mentioned in section 1, a direct comparison between these policy targets and the INSMART results is not straightforward, due to the several differences in the approach and in the sectoral coverage of the analysis.
Although these differences, this section provides a first-order "*rough*" comparison. The total CO_2 emissions calculated by the integrated model for the base year (2013) has been moved backward (to 1995) by applying a correction factor of 1.22 to lower the emissions to the reference point in the time. Emissions covered by the present analysis are assumed to be scaled down with the same factor used to calculate the emission in 1995 and 2007 in the existing/available Action Plan.
Table 4 summarises the key data used to calculate and benchmark the indicators.

Scenario / Period	**1995**	**2013**	**2020**	**2030**
Population	88000	97000	97000	97000
Reference (kt CO_2)	297000	359450	301828	273869

Alternative "F" (kt CO_2)	297000	359450	312379	246819

Table 4 Short-medium term sustainable goals - "key" data

The key findings are:

- In 2030, emissions covered by the INSMART analysis reduce to about 17% relative to 1995 levels. However, when the results of the model are adjusted – with an out-of-the-model calculation of the indirect emissions[17] – to include indirect emissions from centralised electricity generation, the emissions achieve a 23.5% reduction. This proves that the inclusion or exclusion of the indirect emission is a very important assumption in the design of sustainable implementation plans at local level.
- Emission per capita covered by the present analysis reduces to 3.2 in 2020 and to 2.5 in 2030 (t/capita).
- A BaU scenario, assuming a direct correlation between CO_2 emissions and population, would project a value of 359450 kt CO_2 in 2030. A reduction of around 113000 tons of CO_2 with respect to the BaU is then obtained.

Other designs for a comprehensive energy plan

The inclusion of additional "explicit measures" in the planning hypothesis, as well as the selection of a different combination of the actions already identified, may lead to a different development of the system and of the corresponding energy-environmental performances.

Based on the proposed approach to the "integrated" analysis of the local system, it is not possible to estimate "ex-ante" the "exact" impact of such new designs, because of the important "feedback and interdependencies" that some actions may have. In other words, *the response of the "integrated simulation" is different from the algebraic sum of the stand-alone actions which are part of the planning hypothesis*.

In spite of that, it is still possible to capture some more qualitative trends resulting from the implementation of differently designed alternatives. For example, the planning hypothesis "F" (the best ranked) can be further extended by including the realisation of "new cycle routes".

Enhanced strategy (F+)			
Extra intervention	Emissions	Energy Efficiency / penetration of renewables	Costs covered by the Municipality
New cycle routes			

[17] Assuming the carbon intensity indicators (from the PRIMES model – reference scenario) for electricity and steam production equal to 0.345 t of CO2/MWh (in 2013), and to 0.24 t of CO2/MWh (in 2030).

The expected response of a so-defined new integrated strategy (compared to the standard option "F") would result in a further reduction of the emissions (due to the reduction of the private demand), a simultaneous increase of energy efficiency and/or penetration of renewable energy in the household sector, a different distribution of the refurbishment at zonal level, but a higher cost covered by the Municipality.
The enhancement of strategy "F" with an extra measure (on transport) is likely to lower the emissions covered by the present analysis of around 20%[18] (based on values in 1995), so that the objective of the existing Action Plan can be met even without any assumption about the indirect emissions.

3. Proposed funding schemes

3.1. Available and proposed funding schemes

National and regional instruments (e.g. incentive schemes) are currently available to support investments in efficient and renewable technologies. Some of the most interesting options which may enable the proposed actions (as designed in the mid-term plan described in the above sections) are reported below.

Retrofits and renewables in the households sector
An important part of the investment is expected to be paid by the families. Tax reliefs are the most common instruments to enhance energy savings in the residential sector.

- Tax relief for energy-efficiency measures: for costs incurred from 6 June 2013 to 31 December 2016 it was possible to take advantage of a tax relief (from the national systems) of 65%, for the interventions to improve energy efficiency, respectively for individuals (Irpef) and companies (Ires). This tax relief is recognized for the costs incurred, for example, for the reduction of energy requirements for heating, thermal upgrading and retrofit of the building (insulation, windows frames, etc.), the installation of solar thermal collectors, etc.
- Tax relief for interventions of building renovation: the costs sustained for building renovations determine an advantage in terms tax relief (on individual income tax deduction) of 36%; for expenditure that have been incurred from 26 June 2012 to 31 December 2016, the income tax relief is equal to 50%. This fiscal instrument is applicable to energy efficiency measures, as well.
- Energy Efficiency Certificates (hereinafter E.E.C.): these are the so called "White Certificates" (market-oriented instrument), put in place by the ministerial decree of 20 July 2004 and subsequent amendments. Energy Markets Manager (hereinafter EMM) certify the achievements in terms of energy savings among end-users through energy efficiency interventions and

[18] Compared to the 17% of the default Alternative F.

upgrading projects. According to the legislative decree 20/2007, also high-efficiency cogeneration units can access the E.E.C. mechanism.

This scheme can be used to fund the extra investments needed to meet the renewable target (+30%) which cannot be covered by the household sector.

- Thermal Account (so called 'Conto Termico'): foreseen by M.D. 28 December 2012, amended by M.D. 16 February 2016, it promotes actions to increase energy efficiency and generate thermal energy from renewable sources. Incentives may be accessed by public administrations, private individuals, and companies. Incentives will be available and reserved to the public administrations for interventions improving efficiency of buildings' envelope (insulation of walls and roofs, replacement of doors and windows, etc.), the replacement of existing boilers with condensing boilers, interior lighting, building automation technologies. Incentives are available both for public administrations and private individuals, with regards to small interventions for the production of thermal energy from renewable sources (heat pumps, solar thermal plants, etc.).

Assuming that these incentive mechanisms are reconfirmed by local governments, they are considered to continue to positively influencing private decisions about upgrading interventions on buildings and to represent a useful funding source for citizens.

The Emilia-Romagna Regional Operational Programme is the programming document that defines the strategy and operations of use of EU resources allocated to the Region by the European Regional Development Fund within the framework of cohesion policy, for economic growth and the attractiveness of the territory. The 2014-2020 program focuses on six priority actions - axes. Axis 4 of ROP-ERDF (2014-2020), in particular, promotes the reduction of energy consumption in buildings and public facilities and the introduction of systems for the production of renewable energy. Other objectives of Axis 4 are explained in the following paragraphs, as they are more specific for renewables and transport.

<u>Renewables</u>

- Ministerial decrees of 6 July 2012 and 23 June 2016: they provide incentive schemes for plants using renewable sources other than photovoltaic solar energy, with power equal to or greater than 1 kW, having become operational from 1 January 2013. Terms and payments are defined in the Decrees. With the entry into force of the Ministerial Decree of 23 June 2016, defining new incentive arrangements, some plants (as defined in the Decree) can continue to apply for incentives under the previous Decree of 6 July 2012.

  This scheme can be used to fund the extra investments needed to meet the renewable target (+30%) which cannot be covered by the household sector.
- The development of projects addressing renewable energy sources could also be financed through the involvement of Energy Services Companies (ESCOs).

These companies can provide all the technical, commercial and financial services to carry out energy efficiency interventions, by bearing investment costs and the risk of lost savings, in front of the signature of a contract where profits are established.

European Funds are also available in the sector of renewables, in the form of structural funds managed by national and regional institutions, as well as direct funds, managed directly by the European Commission. The following are the ones that Cesena Municipality used the most in order to finance or co-finance its interventions:

- ERDF

The ERDF-Emilia Romagna ROP (2014-2020 program), as stated above, foresee in the Axis 4, along with sustainable mobility and transports, the objective of encouraging efficiency and energy saving and the development of renewable sources by both public entities and businesses with a view to sustainable development in the region both in terms of environmental protection and energy cost savings.

The results to be pursued are: reducing the energy consumption of production processes of industrial enterprises and public buildings by 20% and raise the production of energy from renewable sources in enterprises and 20% for self-consumption by 25%.

Axis 4 objectives for renewables are: promoting the reduction of energy consumption of enterprises and the production of energy from renewable sources for own consumption also through the creation of ecologically equipped productive areas.

Cesena Municipality is working on ERDF Axis 4 in order to support some key interventions on its area (requalification of public buildings and renewable energy production installations). These interventions require a quote of Municipal co-funding, alongside the Regional funding.

- Horizon 2020

The EU's Research and Innovation Programme Horizon 2020 provides €5.931 billion in funding towards energy projects between 2014 and 2020. These projects aid in the creation and improvement of clean energy technologies such as smart energy networks, tidal power, and energy storage. Cesena Municipality is submitting some project ideas under this funding stream.

In the previous programming period, energy projects were funded by the 7th Framework Programme for Research and Technological Development (FP7), then included into Horizon2020, which ran from 2007 to 2013. In the past, Cesena Municipality took part to a pilot action for the retrofit of a school building inside the successful project School of the Future, funded under the FP7.

Intelligent Energy Europe (IEE) Programme was another previous funding scheme that came to an end in 2013 and then included into Horizon 2020, where Cesena Municipality acted as partner in PassREg project (Passive House Regions with Renewable Energies), aimed at the empowerment of local and regional authorities and involvement of local politician for the introduction of Passive House in construction practices.

- Territorial cooperation

Other EU funding schemes supporting innovation and energy efficiency can be found in the territorial cooperation programmes. European Territorial Cooperation is central to the construction of a common European space, and a cornerstone of European integration. It has clear European added value: helping to ensure that borders are not barriers, bringing Europeans closer together, helping to solve common problems, facilitating the sharing of ideas and assets, and encouraging strategic work towards common goals.

Under one of these programmes (e.g. Interreg Central Europe) Cesena Municipality is running a project coordinated by Wismar University (Germany) for energy savings in planning public lighting, called Dynamic Light.

- UIA

Urban Innovative Actions (UIA) is an Initiative of the European Commission that provides urban areas throughout Europe with resources to test new and unproven solutions to address urban challenges. Based on article 8 of ERDF, the Initiative has a total ERDF budget of EUR 372 million for 2014-2020.

Among other topics, UIA supports projects dealing with "circular economy", energy transition (in particular energy efficiency and local renewable energy systems) and sustainable urban mobility.

<u>Transport</u>

- With the aim to finance the extension of the cycle path network, the municipality of Cesena is trying to access to Regional, National and European funding schemes. In particular city has already applied at the call for tender "Collegato ambientale" from the national Ministry of Environment (Ministero dell'Ambiente e della tutela del territorio e del mare). The tender includes the financing mechanism for implementing actions which promote green economy mechanisms and rational use of natural resources. The scheme co-finances the 60% of the awarded projects, up to a maximum of 1 million of Euro. No direct participation of the private sector is considered (expected) for this action.

European Fuds are available for sustainable mobility and intelligent transport systems:

- ERDF

Axis 4 of ROP-ERDF (2014-2020) plans to allocate 27 million Euros for urban areas in the following themes:

  - Action 1: implementation of the existing Regional Travel Planner - Integrated timetable information service of public transport in Emilia-Romagna with the aim of creating a dynamic Travel Planner covering all the possibilities for modal mobility;

- Action 2: development in urban areas of a system of tickets purchase on board of the local public transport (LPT) in contactless mode through the use of the credit card;
- Action 3: upgrading of the regional public transport stops on iron, in interchanges with the network by road, through the installation of monitors and video surveillance systems;
- Action 4: implementation of measures to encourage modal interchange at stops and vehicles of LPT;
- Upgrading the buses and trolley fleet with environmentally friendly vehicles;
- Bike paths, 30 km/h zones, traffic lowering, redevelopment of the LPT stops.

- CEF

The Connecting Europe Facility (CEF) supports trans-European networks and infrastructures in the sectors of transport, telecommunications and energy.

The CEF benefits people across all Member States, as it makes travel easier and more sustainable, it enhances Europe's energy security while enabling wider use of renewables, and it facilitates cross-border interaction between public administrations, businesses and citizens.

In addition to grants, the CEF offers financial support to projects through innovative financial instruments such as guarantees and project bonds. These instruments create significant leverage in their use of EU budget and act as a catalyst to attract further funding from the private sector and other public sector actors. Since January 2014, INEA is the gateway to funding under the CEF, it implements most of the CEF programme budget, in total €27.4 billion out of €30.4 billion (€22.4 billion for Transport, €4.7 billion for Energy, and €0.3 billion for Telecom).

- UIA

As stated in the previous paragraph, the UIA tool supports projects addressing sustainable mobility in urban areas.

Alongside the incentives, legislation on energy has been evolving as well, introducing new requirements or changing some provisions. Main changes regarding buildings and energy production are, for example:

- Legislative decree 102/2014: it establishes the duty for large companies to perform an energy audit by 5 December 2015 and every four years. Then, starting from July 2016 those auditing can be performed only by Energy service companies that are certified according to UNI CEI 11352 or by energy auditor, certified according to UNI CEI 11339. It also imposes the duty, by 31/12/2016, to install in apartment dwellings and in multi-purpose buildings with central heating, direct heat accounting and temperature control systems for single housing unit, or, if not technically or economically feasible, on each radiator of housing units.
- European Directive 2009/125/EC: aimed at reducing energy consumptions in the framework of the Kyoto Protocol, it provides, among other measures, that from September 26, 2015 only condensing boilers can be produced and supplied.
- Emilia-Romagna Region Council Resolution no. 967/2015: it approves the "regional technical coordination Act for the definition of minimum requirements of buildings energy performance ". The Act establishes minimum energy performance requirements to be met for the design and construction in the regional area of new buildings and for equipment installed on them, new systems which are going to be installed in existing buildings, interventions on existing buildings and plants. It then defines that, with effect from 1 January 2017, new public buildings should be "nearly to zero energy buildings", and with effect from 1 January 2019 this will be applied to all the other buildings. The regional timeline is earlier than expected by national legislation.
- Emilia Romagna Region Council Resolution no. 1715/2016: (in force since 11 March 2016) containing amendments to the Regional Council Resolution no. 967/2015. The resolution makes some changes to the previous legislation regarding minimum energy requirements on buildings performance.

4. Ten years implementation plan steps

The key characteristics of the actions included in the mid-term implementation energy plan for Cesena, fully described in the project deliverable 5.4 as part of an integrated sustainable strategy, are summarised in the following tables. Additional details on timing, resources and monitoring are also reported to make the plan as much detailed and applicable as possible.

ACTION.1.B – URBAN REGENERATION

General description:

Refurbishment of a medium-to-small share of the most energy-greedy existing building stock of the city with the following standards: 25% from class E to class B

To fully implement the actions in the cost-effective way, up to 7000 semidetached dwellings (built before 1980) are required to be retrofitted with external insulation on the roof and up to 3000 (built before 1980) replacing existing windows.

The municipality covers only the costs regarding urban regeneration projects on public buildings

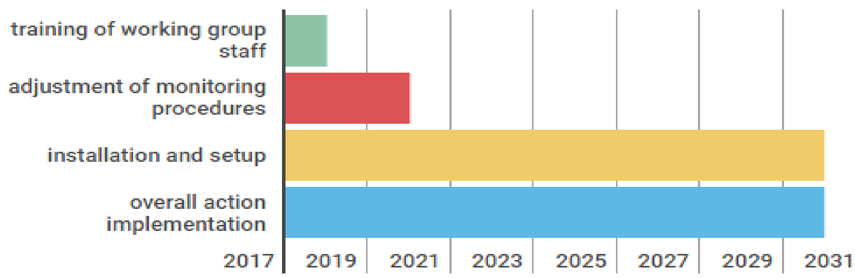
Energy savings in 2020:
39 TJ (useful energy)

Energy savings in 2030:
110 TJ (useful energy)

Overnight cost:
715 €/inhabitant

Reduced emission sources	
☐	Electricity (indirect)
☑	Methane
☑	Fuel oil
☑	Gasoline/DieselOil/Lpg

Incentive mechanisms	
☑	Retrofit tax relief
☑	Energy renovation tax relief
☑	Thermal Account
☑	Energy Efficiency Certificates



Responsible organisation/department:
Urban Planning and Private

Monitoring:
KPI: Variation of GHG emissions in residential buildings; Average household carbon intensity; Investment in Residential buildings measures; Zero Energy

Housing Department	Buildings **Monitoring frequency**: yearly **Data sources**: Urban Planning and Private Housing Department, Territorial Information System, Emilia Romagna Region. **Time schedule**: intermediate / further ahead

ACTION.5.A – INCREASE OF RENEWABLES (IN 2030)

General description:

Refurbishment of a medium-to-small share of the most energy-greedy existing building stock of the city with the following standards: 25% from class E to class B.

Around 5.3 MW of solar PV roof technologies (amorphous silicon) are suggested to be installed in the buildings by 2030, together with around 10 MW of solar water heaters in addition to the existing installed capacity.

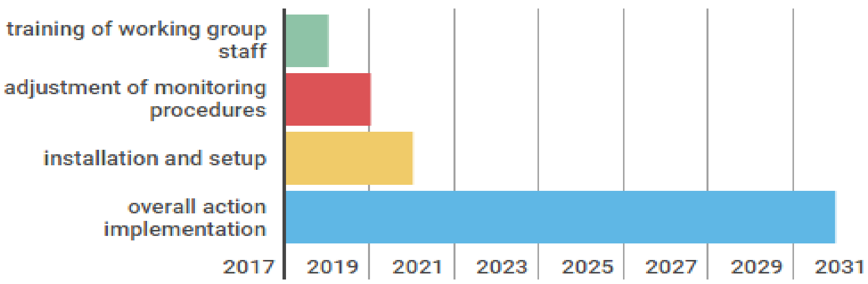
Investments in supply sector (e.g. biogas micro-cogeneration) are also needed to fully meet the designed target. This cost will be covered by investments of the services sector and, in part, by Municipality projects

Generation in 2030 (household sector):
69 TJ

Overnight cost (household sector):
350 €/inhabitant

Extra investments are needed to supply CO_2-free energy into the system

Reduced emission sources		Incentive mechanisms	
☑	Electricity (indirect)	☑	Retrofit tax relief
☑	Methane	☐	Energy renovation tax relief.
☐	Fuel oil	☐	Thermal Account
☐	Gasoline/DieselOil/Lpg	☑	Energy Efficiency Certificates



Responsible organisation/department: Energie per la Città Spa	**Monitoring:** **KPI**: Variation of FEC; FEC per capita; Share of green electricity in FEC; New PV Installed Capacity in roof tops; New Installed Capacity Other RES; New businesses related with energy services; New jobs created; **Monitoring frequency**: yearly

Data sources: TIS; Energy Service Manager; Environment Department; Energie per la Città Spa.
Time schedule: intermediate

ACTION.4.C – INFORMATION CAMPAIGN

General description:

Awareness raising campaign addressed to the citizenship, in order to promote information about further efforts on energy to be implemented, the viable incentive mechanisms and the development of new energy technologies. (Opening of an "Energy info point" where citizens can have information, educational labs on energy culture in schools and implementation of good energy-saving habits in public buildings).

Dissemination of the principles and duties at the base of the campaign "Clean Heat", relating to thermal plants in the Emilia-Romagna Region and that includes the analysis, at rates established according to the type of generator, of combustion products and of generator efficiency.

Cost is totally covered by the Municipality.

Investments in 2030:
To enable the rational behaviour of consumers and meet the goals (of scenario F)

Energy savings in 2030:
To enable the rational behaviour of consumers and meet the goals (of scenario F)

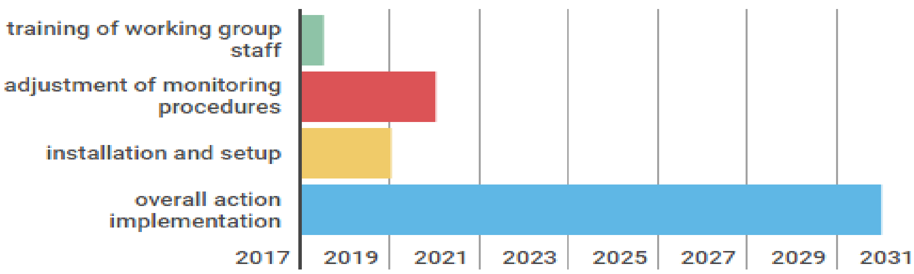
Overnight cost:
165 Euro/inhabitant

Reduced emission sources

☑	**Electricity (indirect)**
☑	**Methane**
☑	**Fuel oil**
☑	**Gasoline/DieselOil/Lpg**

Incentive mechanisms

☐	**Retrofit tax relief**
☐	**Energy renovation tax relief**
☐	**Thermal Account**
☐	**Energy Efficiency Certificates**



Responsible organisation/department:
Energie per la Città Spa

Monitoring:
KPI: Number of admission to the front office, satisfaction, distribution of questionnaires to monitor different aspects of energy (if needed).

Monitoring frequency: quarterly and yearly
Data sources: Energie per la Città Spa
Time schedule: immediate

ACTION.3.B – CYCLE PATHS

General description:

Completion of cycle paths (tot of 16 km) along the main road network and within the so-called "areas 30", to implement the use of the bicycle in the home-school and home-work trips.

Realization of "environmental" bicycle paths along the Savio river for cycling tourism and within the low population density areas (in particular zones 11-10-4-9).

Municipality is expected to cover 100% of the cost which will be possibly co-financed by the Ministry of Environment.

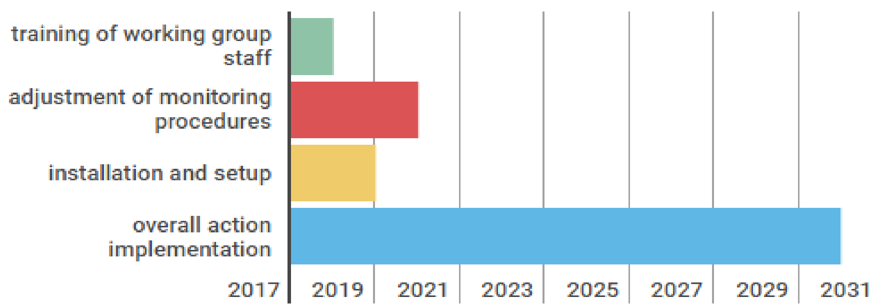
Private dependency in 2003:
-4%

Energy savings in 2030:
140 TJ

Overnight cost:
75 €/inhabitant

Reduced emission sources	
☐	Electricity (indirect)
☐	Methane
☐	Fuel oil
☑	Gasoline/DieselOil/Lpg

Incentive mechanisms	
☐	Retrofit tax relief
☐	Energy renovation tax relief.
☐	Thermal account
☐	Energy Efficiency Certificates



Responsible organisation/department:
Mobility and Transports Department

Monitoring:
KPI: Variation of FEC; Share of mobility in public transportation; Share of electricity in FEC; FEC per capita; Variation of GHG emissions in transport; Average vehicles carbon intensity; Investment in Transport measures; Extension of bike lanes; Public bikes; EV charging points
Monitoring frequency: yearly

Data sources: Mobility and Transport Department
Time schedule: intermediate

Conclusions / Acknowledgement

This document demonstrates the applicability (and strength) of the INSMART methodology for an integrated and participatory sustainable energy planning at city level, and in particular in accompanying the City of Cesena on a path towards a smart future to 2030.

Turning a regular city into an INSMART city is not simple. There are a lot of challenges and issues to be tackled: detecting reliable data sources, identifying the funding sources; defining the strategic plan; knowing the right benefits to the citizen and so on. Government entities are complex 'companies' – that is, a lot of people with different rules and responsibilities and with their own focus and problems. In order not to fall into the same old patterns of redundant initiatives and stand-alone or disconnected solutions, it is very important to have someone in the government responsible for the "whole" initiative who can use the City Vision as the City Roadmap.

The core of the INSMART multi-criteria approach is first of all, the municipality and the interdisciplinary working municipal group, who have interacted with other stakeholders, and experienced a new way of planning in an integrated manner to set smart energy solutions and policies.

The results contained in this Plan are just the starting point of a complex planning process that is expected to last long and evolve over time: the results of the analysis presented above depend on several factors such as the type of policies and measures included, the (quantitative) input parameters, the modelling details, and the level of participation of the stakeholders. Other assumptions and specifications may lead to different responses of the models.

The real challenge now is to try to create a dialogue on INSMART method with other sustainable planning tools at local level, strengthening data collection modes and the interaction between sectors of the territorial government.

In the case of the municipality of Cesena, the starting point will be sharing the INSMART method with the others five municipalities, which are part of the Union of Municipalities of Savio Valley since January 2015, as a concrete example of how to approach the concept of energy smart cities in the near future.

Furthermore, on 16 June 2016, the municipality of Cesena has signed the "Mayors Adapt" the new initiative promoted by the Covenant of Mayors to support local authorities in defining adaptation strategies to climate change at local level to 2030, in particular through improved energy efficiency and increased use of renewable energy sources. By signing the Mayors Adapt the Municipality of Cesena is committed to draw up within two years, the new Sustainable Energy and Climate Action Plan (SECAP), to design a set of policies and interventions that will integrate energy policies and adaptation to increase the resilience of the territory. Within this framework, the INSMART method, is a unique opportunity to continue an integrated and participatory sustainable energy planning process at local level.

5. References

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Appendices

Appendix 1 – Reduction of heating needs by retrofit measure (R) and building typology (T)

	T1	T2	T3	T4	T5	T6	T7	T8	T9	T10	T11	T12	T13	T14	T15	T16	T17
	Reduction of heating needs (%)																
R1	10%	17%	15%	1%	0%	9%	16%	1%	0%	24%	15%	0%	1%	29%	14%	0%	0%
R2	28%	3%	2%	2%	0%	8%	1%	1%	1%	2%	2%	1%	1%	4%	1%	1%	0%
R3	25%	26%	13%	15%	0%	18%	9%	12%	4%	12%	10%	14%	4%	12%	12%	16%	4%

Key: T1: Detached (Pre1945), T2: Detached (1946-1980), T3: Detached (1981-1990), T4: Detached (1991-2005), T5: Detached (2005-2011), T6: Semidetached (1946-1980), T7: Semidetached (1981-1990), T8: Semidetached (1991-2005), T9: Semidetached (2006-2011), T10: Terraced (1946-1980), T11: Terraced (1981-1990), T12: Terraced (1991-2005), T13: Terraced (2006-2011), T14: Apartment (1946-1980), T15: Apartment (1981-1990), T16: Apartment (1991-2005), T17: Apartment (2006-2011)

Appendix 2 – Time granularity of the energy system model of the city of Cesena

Time of day	**D1**	**D2**	**D3**	**D4**	**Year**	
Season	N. hours	N. hours	N. hours	N. hours	N. days	Start - End
S1	7	6	5	6	31	1 Jan - 31 Jan
S2	7	6	5	6	74	1 Feb - 15 Apr
S3	7	6	5	6	76	16 Apr–30Jun
S4	7	6	5	6	62	1 Jul - 31 Aug
S5	7	6	5	6	44	1 Sept - 14 Oct
S6	7	6	5	6	78	15 Oct - 31 Dec

Appendix 3 – Investment costs per dwelling (assumptions) by building typology and retrofit measure

Dwelling type / Retrofit type	Cost	Unit
Flats-R1	4000	Euro/dwellings
Flats-R2	600	Euro/dwellings
Flats-R3	2800	Euro/dwellings
Detached-R1	9000	Euro/dwellings
Detached-R2	2500	Euro/dwellings
Detached-R3	10500	Euro/dwellings
SemiDetached-R1	6000	Euro/dwellings

SemiDetached-R2	1700	Euro/dwellings
SemiDetached-R3	7000	Euro/dwellings
Terrace-R1	6000	Euro/dwellings
Terrace-R2	900	Euro/dwellings
Terrace-R3	4100	Euro/dwellings

Appendix 4 – Transport specific actions

Transport Action 1 (T1) – Two new tram routes

This scenario foresees a decrease in traffic of 15% in 2030 compared to the reference scenario in the areas adjacent to the Via Emilia street (zones 12, 14, 9, 5, 15, 1, 3) and Cervese street (Cesena's main streets), through the following actions:

1) the construction of 2 tram routes:

-> Along the Via Emilia street (zones 5, 15, 1, 3)

-> Along the Cervese street (zones 4, 14, 1, 15)

Each tramway provides 150 seats per trip with a frequency of 4-5 minutes and should move at least 10,000 people / day.

2) the creation of 3 new park and ride with a capacity of about 300-400 (free parking spaces).

The 3 new park will be built at the terminus of the new tram routes (in particular the zones 5, 3, 4).

	T1 – 2030				**Reference - 2030**		
Description	Daily Vehicle Demand	Daily Vehicle Kms	Annual Vehicle Kms		Daily Vehicle Demand	Daily Vehicle Kms	Annual Vehicle Kms
All Cars	241421	2147100	723571842		243458	2234571	753050787
Buses	2069	22129	7457939		2069	22129	7457939
Freight	9903	104583	35247530		9775	104417	35189858
Moto	41438	369756	124606085		41559	382498	128903388
Total	294831	2643568	890883396		296861	2743615	924601972

Transport Action 2 (T2) – New cycle routes

This measure, as part of the Alternative "A", is described in the corresponding section.

Transport Action 3 (T3) – Car share and electric vehicles

This measure foresees the construction of 15 new stations electric car-sharing for a tot. of 500 electric vehicles. The new stations will be built within each INSMART zone. Below is the number of vehicles per INSMART zone: Zona1 (50), Zona 2 (50), Zona 3 (50), Zona 4 (30), Zona 5 (40), Zona 6 (10), Zona 7 (10), Zona 8 (30), Zona

9 (30), Zona 10 (30), Zona 11 (30), Zona 12 (30), Zona 13 (20), Zona 14 (50), Zona 15 (40).

The car-sharing system will be structured in such a way that users can choose not to use the car ownership. In addition, the electric vehicles will have access to the limited traffic zone and free parking.

	T3 - 2030				**Reference - 2030**		
Description	Daily Vehicle Demand	Daily Vehicle Kms	Annual Vehicle Kms		Daily Vehicle Demand	Daily Vehicle Kms	Annual Vehicle Kms
All Cars	243959	2238066	754228068		243458	2234571	753050787
Buses	2069	22129	7457939		2069	22129	7457939
Freight	9775	104417	35189858		9775	104417	35189858
Moto	40971	378401	127518345		41559	382498	128903388
Total	296774	2743013	924394210		296861	2743615	924601972

Transport Action 4 (T4) – Transport changes in the Northern sectors

This measure provides the reorganization of the road system in centuriation Cesena (zone 11-10-4-9), in particular through the reduction of speed to 30km / h from the current 50km / h of the following streets:
Via s.orsola, Via culverts, Via redichiaro, Via Marian, Via melona, Via parataglio, Via Montaletto, Via masiera, Via circle of s.martino, Via backhand, Via Targhini, Via border s.giorgio
Within the individual areas it is expected to create special one-way and the ban in driving except for residents and cycles.

	T4 – 2030				**Reference - 2030**		
Description	Daily Vehicle Demand	Daily Vehicle Kms	Annual Vehicle Kms		Daily Vehicle Demand	Daily Vehicle Kms	Annual Vehicle Kms
All Cars	221409	2228846	751120697		243458	2234571	753050787
Buses	2069	22129	7457939		2069	22129	7457939
Freight	9517	104596	35250639		9775	104417	35189858
Moto	37847	381984	128732707		41559	382498	128903388
Total	270842	2737555	922561982		296861	2743615	924601972

Transport ALL Actions (TS1+TS2+TS3+TS4) – All changes

This integrated measure aim to simulate all the above mentioned actions, together in the same scenario.

	TS1+TS2+TS3+TS4 - 2030				**Reference - 2030**		
Description	Daily Vehicle Demand	Daily Vehicle Kms	Annual Vehicle Kms		Daily Vehicle Demand	Daily Vehicle Kms	Annual Vehicle Kms
All Cars	205800	2059191	693947622		243458	2234571	753050787
Buses	2069	22129	7457939		2069	22129	7457939
Freight	10208	104778	35310309		9775	104417	35189858
Moto	34849	351702	118525062		41559	382498	128903388
Total	252926	2537800	855240932		296861	2743615	924601972