InventAir: Step-by-step development of Woodstove changeout roadmap

Consortium

Co-financed by:

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1. Welcome to InventAir

Although the energy poverty theme is rapidly spreading over the EU, it has distinct specificities in Eastern European Countries (EEC): low-income households cannot afford to change the old inefficient heating equipment or replace the poor-quality heating fuels. Thus, they become the primary cause of dramatic seasonal increases in air pollution in their communities. The lack of precise data on the quantities and quality of the fuels used makes estimation of environmental, climate and health impacts difficult.

The link between energy poverty and poor air quality has not gained EU-wide recognition in the current policies and measures: in the EEC existing energy efficiency programmes and schemes aimed at alleviating energy poverty allocate grants that allow vulnerable households to directly purchase and utilize humid wood and low-quality coal and burn them in highly inefficient stoves. A major obstacle to utilising these grants in an economically viable and environmentally and climate-friendly way is the lack of comprehensive energy poverty criteria and indicators that would facilitate the proper identification and precise segmentation of energy-poor households.

The undesired and negative effect of the low deployment of new and efficient heating technologies is the households' continuing use of inefficient heating equipment that produces excessive polluting emissions that threaten and deteriorate the population's health. It is necessary to carefully assess different woodstove changeout options towards cleaner heating for energy poor households that will both reduce air pollution and supress the GHG pollutants' increase. Major obstacles are the lack of a coherent methodology to identify and make an inventory of the energy-poor households, variety of facultative fuel-to-energy conversion methodologies and country-specific emissions factors. These are the basis for poor sustainable energy planning on local and national levels that hinders the rapid reduction of polluting emissions and reaching the EU-wide targets for low-carbon development.

The current document "InventAir: Methodological framework for mapping energy poverty and assessing its climate impacts" has been inspired by the specific demand to address the cross-cutting issue of poor heating practices and increased air pollution in urban and rural areas in the EEC. Its major aim is to support local policy makers in exploring the multiple environmental and climate impacts of energy poverty by focusing on the development and implementation of joint clean-air and energy-poverty policies. It has been primarily developed for energy and environmental experts, social experts, decision- and policy-makers, local authorities, national authorities and institutions.

Co-created by the EEC and German experts, the InventAir methodology supports the process of developing joint local, national and EU policies and actions for tackling energy poverty and air pollution by bringing forward and raising public awareness of the link between inefficient heating practices among energy poor households and the rapid air pollution in their communities. It facilitates long-term planning for woodstove changeout programmes to boost the sustainable, resilient and low-carbon development within local communities.

2. Step-by-step implementation of the InventAir Methodology

The InventAir Methodology takes into an account all aspects of energy poverty and all target groups affected. It provides a flexible approach towards identifying, segmenting and prioritising the households that need to be supported in changing their energy habits. It considers the whole chain *energy poverty – poor heating options – low energy efficiency – high environmental pollution* and provides the means to careful inspection of the current status and barriers and challenges.

The InventAir methodology supports the development of Woodstove exchange roadmaps as policy tools for medium- and long-term energy planning with the ultimate aim to alleviate energy poverty and reduce the harmful emissions produced by wood and coal burning. Such roadmaps may be the backbone of wood exchange programmes that will provide information and will encourage the citizens to replace the old and inefficient stoves with modern, clean heating equipment.

The InventAir Methodology considers a number of other strategic documents and engagements of the local communities towards energy, environmental and climate targets. Even though it focuses strictly on the poor heating practices of the energy poor households, it uses information and data concerning the global energy status of the local community. The proposed methodological framework by the InventAir project may be summarised in a number of simple steps:
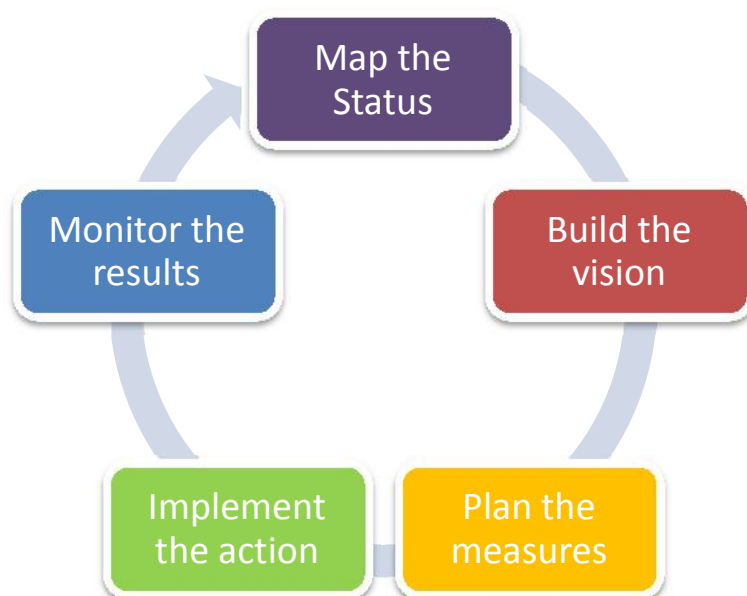

Figure 1 Step-by-step process

1. Map the status

The initial steps towards the roadmap development are pointed towards identifying the status and establishing a baseline. It is first necessary to get insight into the local

activities, technologies and fuels used that could be significant contributors to the air pollution observed. There are preparatory steps that would help narrow down the activities or target groups concerned and make the planned activities more specific and succinct. Also, the roadmap needs to be aligned with other strategic documents and respond clearly to the demands and challenges of the community concerned.

1.1. Define the scope

The scope of the woodstove exchange roadmap may be defined in terms of territorial, social, energy and climate aspects to be addressed.

In first place comes the community to be addressed – the bigger it is, the more varied the heating practices may be. It is not an unusual practice to split down a bigger city to small areas (districts, neighbourhoods, zones) that would better reflect the use of wood and coal. Moreover, spots in the city without other heating infrastructure or distant settlements have a greater potential to use wood and coal as primary energy source.

Second, the social scope must be defined as it directly correlates to the energy poverty aspect. It is good to remember that there are households who would use wood and coal not because of technical and financial constraints, but because of the sense of comfort and warmth. Even though they are a potential target group for an intervention, they are not with a high priority due to their rigid beliefs in heating changeout. More information on how to identify the potential households may be found in the methodology for multiple impacts assessment of the InventAir project.

The third aspect to consider is the energy and climate targets of the selected area. Through investigating strategic documents, programmes and action plans and reviewing the relevant analysis for the community, one can easily find out what the energy and climate targets are and extrapolate them. For example, even though the city has exceedances of PM and NO_x stated in its Air Quality documents, one can choose to target the PM and SO_2 pollution as most relevant to the use of wood and coal.

1.2. Gather information and data

Information and data collection has become notorious challenge when practitioners try to establish baseline and monitor progress. Some of the most common barriers are the lack or insufficient data, market-sensitive or protected data, unsuitable type or format of the data required.

The strategic documents of the community would contain sufficient information on the current status of the policies and activities implemented. They may be a good source of information what was done so far and what could be improved. Arranging meetings with experts who have contributed to their development may be helpful for

building a comprehensive image of what the intentions and vision of the policy makers had been when outlying the city strategic actions.

For the purpose of designing the roadmap, one would need quantitative data as well, which could be obtained through *top-down* or *bottom-up* techniques. The *top-down* approach is useful when general statistics for the chosen community are reliable, because this approach uses extrapolation based on the entire population and then scales it down based on a chose unit (for example, per capita) to the community. Top-down data may be national statistics, EU-wide data, energy provider or utility data, estimated social statistics, etc. It is easy and straightforward, but not very precise.
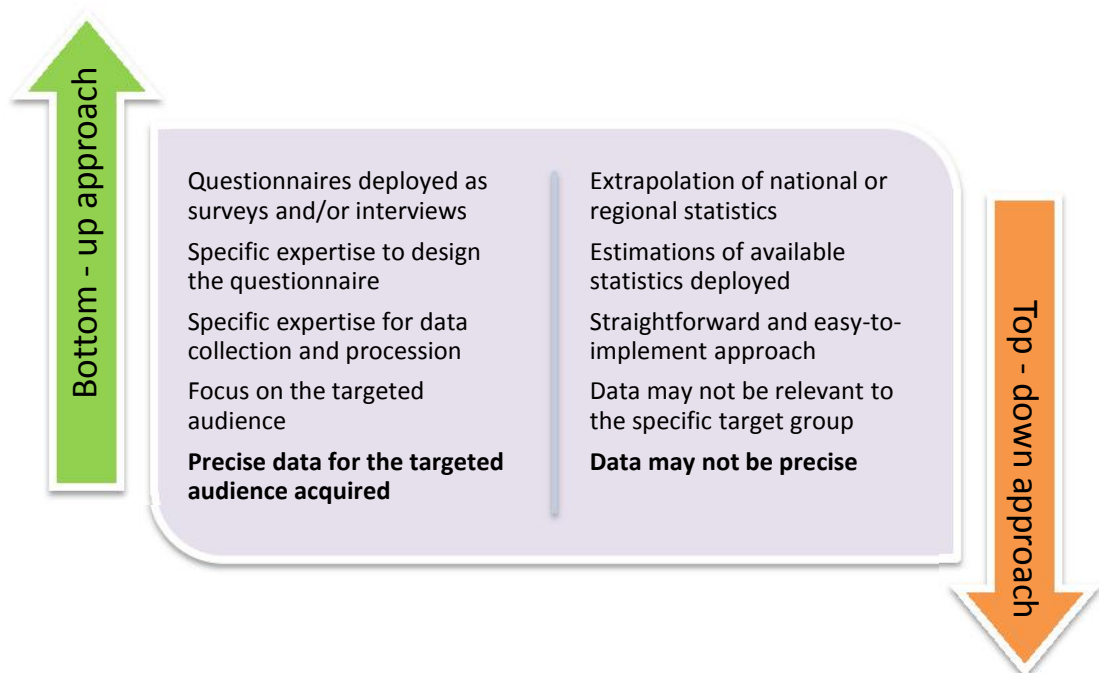
Bottom - up approach

Questionnaires deployed as surveys and/or interviews

Specific expertise to design the questionnaire

Specific expertise for data collection and procession

Focus on the targeted audience

Precise data for the targeted audience acquired

Top - down approach

Extrapolation of national or regional statistics

Estimations of available statistics deployed

Straightforward and easy-to-implement approach

Data may not be relevant to the specific target group

Data may not be precise

Figure 2 Comparison of top-down vs bottom-up approach

Still in the case of woodstove changeout, it is far more advisable to use *bottom-up* approach, i.e. gather data from the end-users. The data gathering may be conducted as live or online surveys and interviews. The composition of the questionnaires applied needs to encompass the matters relevant to the woodstove exchange activities combining energy and environmental aspects – type of stove, quantity of fuel, expenditures, heating practices, housing conditions, attitude towards the air pollution topic, etc. Bear in mind that energy-poor households may not be knowledgeable on the energy topics, so the questions need to be systematic, simple to understand, short and clear.

1.3. Set the baseline

Setting up a baseline for the current status is an important step of the process that will support the future monitoring of the progress. The baseline would be a fixed point back in time that serves as a reference value through which the change is defined. When it comes to woodstove changeout a baseline may refer to the both to the policies implemented or to the data available. Quite often in the strategic document, there is a defined baseline which could also be used for the woodstove changeout roadmap; still, it is possible to define a baseline of one's own that reflects better the situation. Also, if the baseline was defined long time ago, one may take the monitoring as a new baseline. For example, if the city has a SEAP that defines 2009 as its baseline year, it may seem that 10 years is a long period of time and many things have changed. Thus, one may take one of the monitoring years as their baseline – for example, the year 2013, and try to estimate the changes in the energy mix since then.

Choosing a baseline year is more or less a subjective process that is based on one's own demands for future energy and climate planning. However, it is good to note that aligning the baseline year of the woodstove changeout roadmap with other significant baselines may be extremely beneficial to applying integrated policies.

2. Build the vision

Once the initial status is clear, information and data are gathered and a baseline identified, one can start building the vision for the future which is the essence of the roadmap. The role of the roadmap is to match the policy processes with tangible actions and measures, including heating technology replacement, fuel improvement, change of energy habits, etc. Within the roadmap, one needs to couple policy with action and estimate its impact. It takes creativity as well as precise expertise to make the perfect matches between policy and actions and make estimations of the impact.

2.1. Analyse the needs and challenges

The first step of building the vision is to be aware of the needs and challenges of the chosen community. This builds up *Step 1 Map the status*, but also digs deeper into the barriers faced by the local community and aims to carve a niche for policy and action implementation. This analysis could be done from the perspective of the targeted households, local community, policy work, etc. A sample analysis is presented:

Table 1 Sample analysis of needs and challenges

Targeted area	Challenges	Needs
Energy poor households	- Inability to keep a home warm - Difficulty to paying energy bills - Low deployment of energy efficiency measures	- Improved heating options - Better heating fuels - Financial support/ incentives for introduction of energy efficiency measures

Local community	- Suffer significant PM exceedances and concentrations - Lack of energy poverty campaigns - Lack of heating infrastructure	- Significant reduction of PM emissions - Improved raising awareness and knowledge on the community issues
Policy work	- Non-ambitious targets for emission reduction - Lack of regulation over stove sales - Low control over the quality of the fuels sold	- Strict control over burning processes - Introduction of "burn ban" mechanisms - Quality assurance schemes for the heating fuels

The development of the needs and challenges analysis may be done in cooperation with the responsible experts or policy makers from the local community.

2.2. Outline the future

Based on the overview of the needs and challenges, one can outline the possible solutions and propose a general direction of the efforts in the roadmap. The vision encompasses the current needs and challenges with the desired future outcomes. It is meant to guide the efforts and capacities in a right direction towards achieving the desired results.

An example of a vision may be:

"**The community's 2030 vision for woodstove changeout among energy poor households is a constant, long-term alleviation of the energy poverty that would contribute to significant reduction of the PM emissions.**"

The vision needs to be realistic, but also futuristic; well-grounded, but also ambitious. It needs to propose an inspiring image of the future to fuel decisive actions on behalf of the policy makers and the citizens alike.

2.3. Set the overall objective and specific targets

Having in mind the status and the demands of the chosen community and the vision formulated, one can formulate overall objective of the roadmap and its feasible targets that will bring about the desired positive change.

One can deploy **SMART** objective to better illustrate the intended changes:

- **S**pecific: concise and detailed, narrowed down to a concrete topics
- **M**easurable: providing units to quantify the progress

- **A**ttainable: achievable and feasible actions
- **R**ealistic: aligned with the available resources
- **T**ime-bound: specific time frame/ schedule for achieving the desires results

An example of a SMART objective is:

"**Decrease of the PM emissions by 40% on average among energy poor households in the community by 2024 through replacement of old woodstoves**"

Or

"**Decrease of the final energy consumption and CO2 by 10% on average among the energy poor household heating on electricity in the community by 2030 through implementing energy poverty support campaigns**"

The specific targets to be defined may be again aligned with other targets in the strategic documents or be stand-alone targets that better reflect the need for change in the local community. In order to quantify the targets, the baseline values are needed (Step 1.3.) – for example, if the baseline PM emissions are 200 t/y and the intended reduction is 10% by 2030, then the specific target is 20 t PM reduction by 2030.

3. Plan the measures

The core of the roadmap is the definition of the specific needs of the target groups and assigning suitable measures to alleviating the energy poverty.

3.1. Analyse the status of the target group

The status of the target group will support better allocation of resources and measures. It may cover social and economic aspect as well as perception of the local environmental and climate issues and readiness to change.

Some examples of such aspects are features of the housing stock, average size of the dwellings, GDP per capita, unemployment and employment rate, income and energy expenditures, energy bills or consumed energy, heating and DHW infrastructure, recipients of social support (esp. for heating), poverty risk and number of households below the poverty line, etc. This information will help you determine the scope of the measures to be implemented and whether they need to be extended beyond the woodstove changeout.

3.2. Segment and prioritise the target groups

Most of the member states do not have a national definition for energy poverty, so one may need to come up with a suitable set of indicators and criteria to identify the households that may be at energy poverty risk. The more expanded criteria, the more households will be included in the segmentation. Segmentation is a slow process, so patience is crucial – it is an iterative and constant alignment between the target groups you feel need to be addressed and the once that fulfil the criteria set.

As energy poverty is a widely defined as the inability to afford good heating/cooling, the first step would be to define an economic threshold beyond which the households are not able to pay their bills. The second criteria may be related to the housing conditions – whether there is good wall insulation, change windows, new heating devices, etc. The third criteria would be related to their energy usage – electricity, central/district heating, natural gas, wood and coal only, etc. Mind that households on wood and coal may use a supplementary energy source.

Once one narrows down the households to be addressed, one may put specific social criteria to prioritise the households to be supported – for example, single-parent and multi-family households, old people living alone, households with members with disabilities, etc. Combined social criteria may be applied so that better prioritisation for intervention is made.
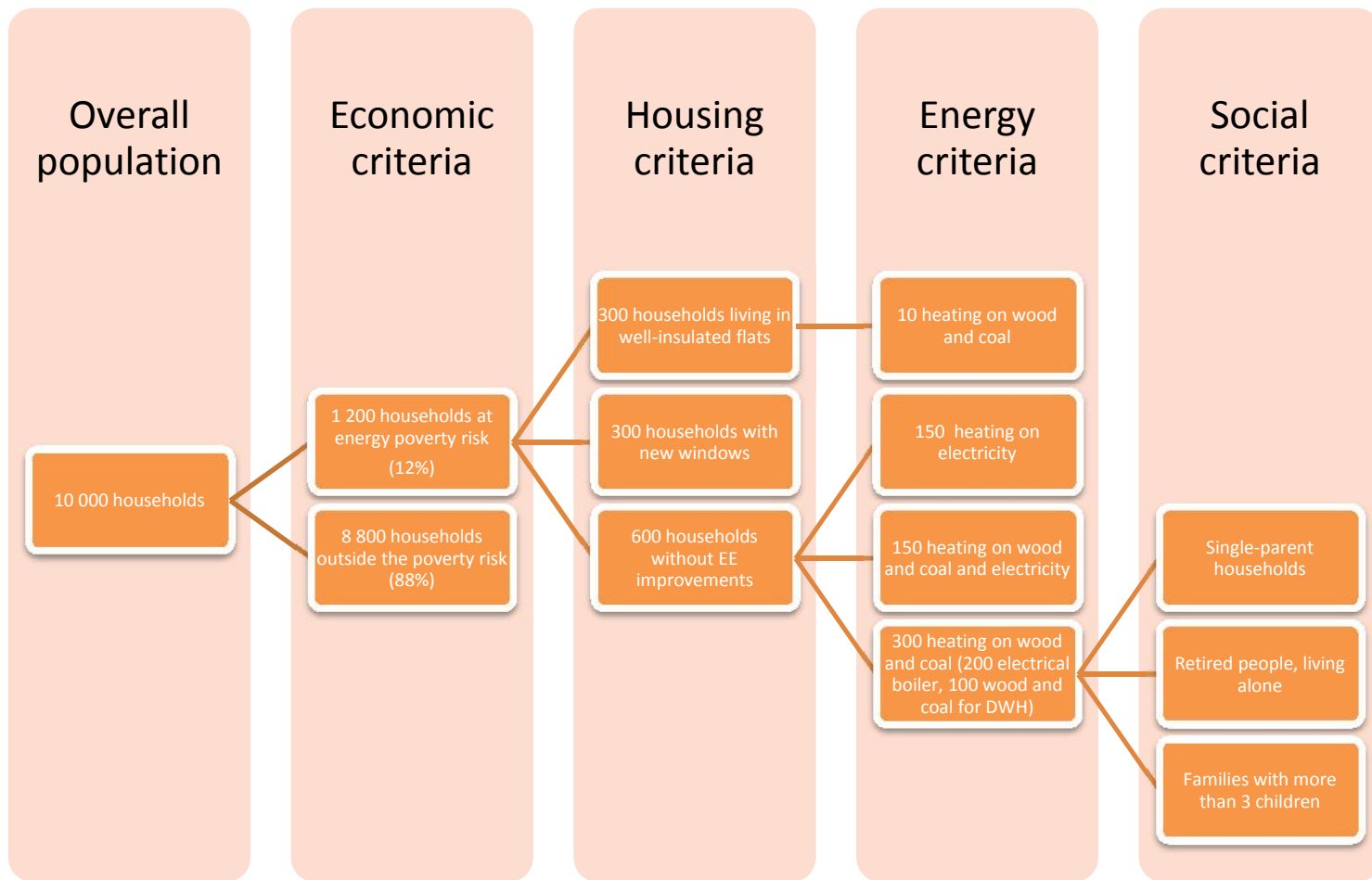
Figure 3 Sample segmentation matrix

Mind that there may be precise statistics on the households heating on wood and coal, so one may consider only them as a target group and skip the segmentation. Still, this is not a guarantee that some of these households use wood and coal, because they are energy poor. They may be able to freely afford a better energy source, but still use wood and coal, because they like the warmth and comfort of the fire or there may not be any other suitable infrastructure for them. Careful consideration of such circumstances may help the overall planning of the woodstove exchange.

More instructions on the approaches to conduct identification and segmentation may be found in the multiple impacts assessment of the InventAir project.

3.3. Assign measures and actions to specific target (sub)-groups

Once the segmentation and prioritisation is conducted, the measures and actions may be done. One may be inspired from best practices across th EU on the approaches to woodstove exchange, but only this may not be enough. In order to alleviate energy poverty additional measures may be needed – increasing the overall EE in the household, replacing old boilers with new and RES-based ones, introduction of RES, campaigns for support for the energy poverty, campaigns for changing the energy behaviour, raising awareness campaigns, etc. In case supplementary measures to the woodstove exchange are assigned, one needs to consider if they will have impact on the woodstove exchange as well – for example, "burn right" training does not have a direct impact on the woodstove exchange, but it will change the energy behaviour of the households and may reduce their energy use by 10%.

The adequate selection of measures will be crucial for achieving the objectives set. A sample of a table assigning measures and actions to the specific target groups is shown below:

Table 2 Sample table of measures and actions

Target group based on…		Number of households	Measures
Housing criteria	**Energy criteria**		
Energy-poor households with well-insulated flats	… heating on wood and coal only (incl. boiling water)	10 / 300	▪ woodstove exchange ▪ financial mechanism for RES boiler deployment
	… heating on wood and coal and having electrical boiler	290 / 300	▪ woodstove exchange ▪ financial mechanism for RES boiler deployment
Energy-poor households without any EE measures implemented	… heating on wood and coal and using electricity as supplementary energy source	130 / 150	▪ woodstove exchange ▪ energy poverty campaign for changing behaviour
	… heating on wood and coal and boiling water on electrical stove	160 / 200	▪ woodstove exchange ▪ financial mechanism for EE measures implementation ▪ financial incentives for electrical boiler exchange ▪ technical training on using

			new heating equipment ▪ energy poverty campaign for changing behaviour
	… heating on wood and coal only (incl. boiling water)	80 / 100	▪ woodstove exchange ▪ financial mechanism for EE measures implementation ▪ financial mechanism for RES boiler deployment ▪ technical training on using new heating equipment ▪ energy poverty campaign for changing behaviour
	Unaffected households from the upper three groups	80	▪ "burn right" workshops and training

More ideas on the measures and policies to be implemented may be found in the Fairmode catalogue[1].

3.4. Develop the roadmap

The roadmap development is the core of the methodological framework and combines all its elements discussed so far. It takes into an account the targeted and participating households, measures and actions implemented, energy and emission savings.

For each of the measures, there need to be calculations of the saved energy and emissions and investment needed and overall comparison with the specific targets. One may need to align the prescribed measures so that they cumulate as to achieve the specific and overall targets. As with the example of Step 2.3., the reduction by 2030 needs to be 20 t PM and by exchanging the stoves of 200 households only (Table 3), one would achieve only 6.1 t PM reduction, i.e. 30% of the target. Thus, there are two ways to proceed to achieve the rest of the target – to either increase the numbers of the exchanged stoves or provide additional measures that boost the reduction.

Table 3 Sample table of roadmap input*

Measures	Nm of households participating	Energy savings (MWh / household)	Total energy saving (MWh)	CO_2 emissions saved (kg/y)	PM emissions saved (kg/y)	Investment needed (Eur)
Woodstove exchange (wood to pellets)	200	6	1 200	-72**	6 183	200 000 EUR
Financial	50	0.8	40	-2.4**	206	25 000

						EUR
incentives for wood for pellet boiler exchange						
"Burn right" campaign	60	1	60	0	139	10 000 EUR

* Bulgarian emission coefficients used for illustration. Use emission coefficients suitable for your community.

** CO2 increases as pellets have small CO2 emissions.

The second step of the roadmap development is to split the number of households addressed according to the feasible efforts and investments to be made by years. Also, one can decide to visualize the roadmap from a number of perspectives – in terms of target achievement, savings achieved for energy and/or emissions, households addressed per measure, etc. This step requires creativity to display the data in the desired format so that it is clear and easy to understand.
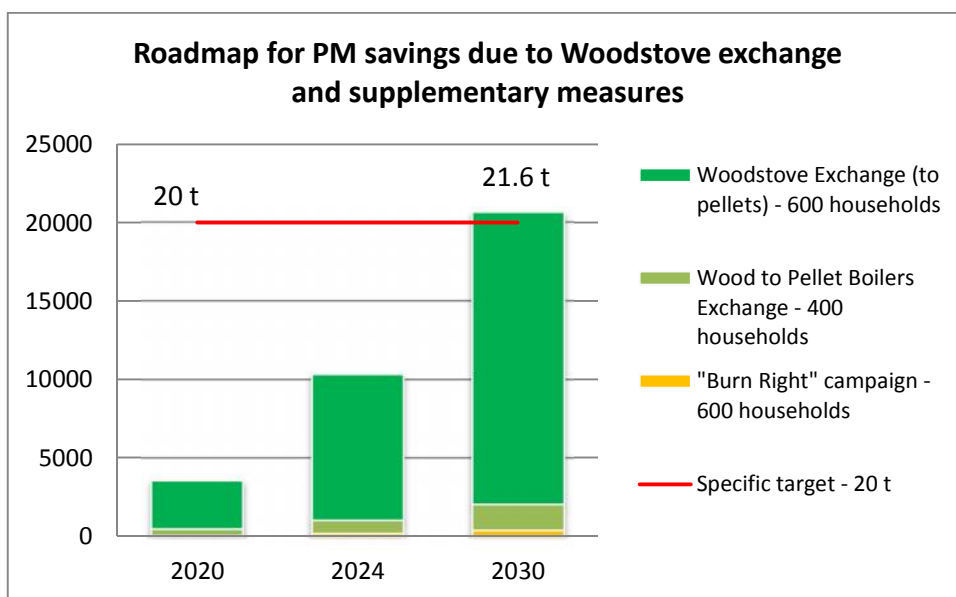

Figure 4 Sample roadmap for PM savings due to Woodstove exchange and supplementary measures

3.5. Develop an action plan

When all the measures and policies to be implemented are clearly quantified, they may be assigned to different departments and set in a time-frame and appointed funding source. It is advisable that more complex measures and actions are split down to specific activities. Thus, the implementation will be facilitated and easily monitored.

Table 4 Sample table of action plan (2020-2030)

Measures	Specific responsibilities	Deadline	Responsible authorities	Financing
Woodstove exchange (wood to pellets)	List of eligible heating equipment	2019-2020	Ecology department	Municipal budget
	List of eligible fuels		Ecology department	Municipal budget
	Information campaign	01.-06.2020	PR department	Project funding
	Implementation of woodstove exchange	2020-2030	Specialised municipal team	National funding
Financial incentives for wood for pellet boiler exchange	Development of feasible financial schemes	2019-2020	Financial and Ecology department	Municipal budget
	Information campaign	01.-06.2020	PR department	Project funding
	Implementation of boiler exchange	2020-2030	Specialised municipal team	National funding
"Burn right" campaign	Design of a campaign	2019-2020	Energy efficiency department	Municipal budget
	Preparation of training materials	2019-2020	Energy efficiency department	Municipal budget
	Recruitment campaign	2020	PR department	Project funding
	Implementation of the campaign	2021-2030	Energy efficiency, Ecology departments	National funding

The comprehensive development of an action will support the implementation and further monitoring of the roadmap. Also, if needed, the table may be split down to years and visualised as a Gantt chart.

4. Implement the action

The woodstove changeout roadmap is not exclusively a map for a woodstove exchange programme. It is more to it – it encompasses joint policies and measures in the field of sustainable energy and environmental planning and provides insight into cross-cutting issues. It relies on the extensive partnership between local and regional and national authorities and institutions, the NGOs and the citizens. In order for the roadmap to be achieved successfully the stakeholders need to harmonise their understanding and efforts on the actions.

4.1. Engage the key stakeholders

It is important to involve the key stakeholders, esp. policy makers, in the process and promote the "buy-in" of the woodstove exchange. Their recognition of the issue

as well as the proposed solutions will provide good grounds for the roadmap to develop and progress. Key stakeholders could be representatives of local authorities and institutions, national authorities and institutions, environmental protection agencies, etc.

The cooperation of key experts and practitioners from the local authorities and institutions will ensure the smooth run of the woodstove. In order to involve them one can organise regular working meetings and seminars, face-to-face interviews and discussions, etc. In the communication, one needs to explain the technical feasibility, the environmental and health benefits and align them with the strategic plans of the local community.

The communication with the key stakeholders needs to be continuous – from the very first day of the roadmap development throughout its implementation.

4.2. Activate the citizens

When developing the roadmap, do not forget that the major target group is the citizens. Even though the woodstove changeout measures do not target the entire community, its application will be visible to everyone.

For the direct participants in the woodstove changeout roadmap, it is good to envisage promotional and educational campaigns and engagement activities. These could be "burn right" workshops, specialised advice sessions on wood burning, retailers' fairs to showcase new heating technologies, etc. The campaigns may include personalised information in the mailbox in the addressed area or door-to-door communication and webpage and social media information.

For the indirect participants, it is important to show the progress of the roadmap and the woodstove campaign. Often people are conscious about the environmental problems, especially when they live in the "hot spots" of the pollution and could see and feel its impacts (bad odour, dirt, etc.). Such visible signs of pollution are great triggers of public disapproval and criticism and thus it is essential to show the end-results of the changeout. For example, regular information on the air quality status may be issued.

4.3. Promote feasible solutions

The development of the woodstove changeout roadmap focuses on the change of the old stoves with more efficient ones. This is a steady, straight-forward approach towards reducing harmful emissions and improving the air quality in a relatively short time. Also, there are important co-benefits associated with the exchange – reduction of the heating fuel consumption and increased energy efficiency, less heating and maintenance costs for the end-users, improved fire safety, reduced risk of energy poverty and social isolation, etc.

In order for the end-user to better perceive the benefits of the new heating option, it is good to present them with an infographic and comparable table of its features – for example, nominal capacity, heating volume, costs for reconstruction, installation and maintenance, etc. Additional information for the fuel consumed per ton or MWh needs also to be explained.

Table 5 Sample table for presenting the viable solutions

Heating equipment	Nominal capacity	Heating area/ volume	Device Price	Reconstruction of the heating infrastructure	Technical documentation	Installation materials costs	Maintenance/supervision costs per year	Total costs
	kW	m2 / m3	EUR	EUR	EUR	EUR	EUR	EUR
New heating device N1								
New heating device N2								

Still, it may be difficult to achieve sustainable change with only one action so supplementary activities may be promoted such as financial schemes for cleaner fuels, support for introduction of energy efficiency and RES measures in households, heating training and guidance and promotional materials, etc. The right mix of leading and supporting measures will boost the performance of the local woodstove changeout campaigns and will help transform the local community.

5. Monitor the results

The implementation of the woodstove roadmap is an effective policy approach, but also takes time and resources from all stakeholders. It may bring significant benefits to the local communities that need to be evaluated with the proper monitoring schemes and indicators.

5.1. Set up a monitoring scheme

The effective monitoring schemes include a variety of tools to follow-up on the activities implemented. They utilise both qualitative and quantitative data gathered from the various stakeholders – policy makers, experts and practitioners, fuel and technology providers, and end users.

Real-life measurements: The real-life measurements of energy consumption and air quality are related to communication with the data managing institutions. This approach requires careful planning of the type and format of the data needed for the monitoring scheme – it should be the same as the baseline data so that comparability is ensured. Usually, specific permissions need to be obtained from the data institutions.

Impacts calculation: The impact calculations are an on-paper method to estimate the impacts of the activities in terms of energy consumption and emission reduction. It requires specific or estimated data as well as expertise to perform the calculation. Compared to the measurements approach, this one may not provide the same level of exactness of the results.

Focus groups: The focus groups are a useful approach to acquire data from experts or users who have participated in a concise action from the roadmap. The focus group may freely discuss the progress or have a moderated discussion with semi-open questions.

Surveys: The surveys may be implemented before and after certain actions to better understand the users' perspective on the change, and alter the actions if needed. They are quick and easy way to acquire quantitative data that would need further procession and analysis.

Interviews: The interviews are suitable for specific communication with the target groups where precise information needs to be extracted. The questions asked may vary and the interview could wind ahead as the conversation goes. They may not be standardised.

5.2. Choose indicators

The indicators are the measurable aspect of the monitoring scheme. For each measure and action in the roadmap, there need to be indicators allocated. They need to be selected so that they fit the action and represent its progress in a satisfactory manner.

Table 6 Sample list of indicators per measure/action

Measures (based on Table 3)	Indicators
Woodstove exchange (wood to pellets) **Or** **Financial incentives for wood-for-pellet boiler exchange**	▪ Number of households interested in the programme (phone calls, email requests, etc.) ▪ Number of approved applications ▪ Number of households addressed within certain target sub-group ▪ Number of stoves exchanged ▪ Harmful emissions reduced (kg/household)

	▪ Final energy consumption reduced (kWh/household) ▪ Energy bill reduction (% per household) ▪ Investment per household
"Burn right" campaign	▪ Number of households interested in the campaign (phone calls, email requests, etc.) ▪ Number of participants per sessions ▪ Number of downloads of guidance/promotional materials

The indicators need to be quantifiable – they need to be expressed in numbers of percentages so that objective data on the progress are made. They could be allocated to preparatory actions (e.g. number of households interested in the programme, but not direct applicants), implementation actions (e.g. number of stoves exchanged) and monitoring actions (e.g. final energy consumption reduction, harmful emissions reduced, etc.). All of them may be place at various time-points during the implementation of the roadmap so that various aspects of it are monitored. Data needs to be precisely collected (see Step 5.1.) and stored for further investigation and procession.

5.3. Set milestones

The milestones are important "stops" in the design of the roadmap as they mark the critical points of the overall implementation of the action, especially when it is needed to manage numerous activities. The milestones could be set in the roadmap timeline to represent completion of specific measures and actions, point out the need for consolidation with the key stakeholders, delivery of a specific output that is crucial for the further run of the woodstove changeout. The milestones could be coupled with qualitative or quantitative monitoring. They are useful for the proper planning and implementation of the actions.

Reporting and documentation

The roadmap may have the same structure as the suggested steps above, but if there are themes more relevant for the local situation, they may be introduced as separate chapters.

The structure that may be deployed is:

I. **Introduction**
    Covers general information for the community addressed – geography, population, energy infrastructure and sources, energy and social policies, etc.

II. **Local background**

Covers information on strategic local planning concerning energy, environment and climate.

III.   Baseline status
Covers information extracted from the strategic documents, qualitative and quantitative data and statistics.
  a. Energy supply and demand
  b. Energy poverty
  c. Air quality

IV.   Exploring 2030 targets
Covers estimations and projections of the impacts of the 2030 energy, environmental and climate policies on the status. It needs to encompass the energy vs air quality targets and try to merge specific measures and actions to address the cross-cutting issues.
  a. Energy targets
  b. Air quality targets

V.   Woodstove Exchange Roadmap 2030
Covers the essence of the roadmap and presents the identification, segmentation and prioritisation of target groups and the respective measures and actions. It provides specific calculations and estimations of the current vs long-term status, assignment of measures and their respective impacts, cumulative estimation of the impacts, and visualisations of the progress of savings and alleviated impacts.
  a. Methodology
  b. Segmentation and prioritisation of interventions
  c. Scenario development
  d. Cumulative and multiple impacts by 2030
  e. Roadmap for achieving the energy and air quality targets

VI.   Conclusion
Covers summary of the findings and closing remarks to the overall implementation of the document.

For more clarity and inspiration on how to design and develop the Woodstove exchange roadmap, please refer to the Smolyan and Zagorije Roadmaps developed within the project.

3. Conclusions

The current document "InventAir: Step-by-step development of Woodstove changeout roadmap" presents the process of the development of Woodstove exchange roadmaps. They may become strong policy tools for medium- and long-term energy planning with the ultimate aim to alleviate energy poverty and reduce the harmful emissions produced by wood and coal burning. Such roadmaps may be the backbone of wood exchange programmes that will provide information and will encourage the citizens to replace the old and inefficient stoves with modern, clean heating equipment.

The Woodstove changeout roadmaps consider the whole chain *energy poverty – poor heating options – low energy efficiency – high environmental pollution* and provide the means to careful inspection of the current status and barriers and challenges. They may be a supplement to Covenant of Mayors SECAPs or other strategic municipal documents that explain the energy and environmental vision of the local communities.

The woodstove changeout roadmaps might be effective policy tools to achieve the positive change. They can support the local and national authorities in planning and designing effective join policies that address energy, environmental and social challenges and strive for achieving sustainable, resilient and low-carbon future for their communities.

The current document builds upon the multiple impacts methodology explained in "InventAir: Methodological framework for mapping energy poverty and assessing its climate impacts".

ANNEXES

Annex 1. Self-check list

	Map the status	If "No", then consider:

	1. Have you defined the status in terms of:
	   a. geographical coverage
	   b. energy infrastructure, energy demand and supply
	   c. social scope and energy-poverty target groups
		The scope may be defined to express better:
		(1) the hot stops of air pollution (exposition spots) where measurements show values above the limits, or
		(2) the energy poverty groups – e.g. poor neighbourhoods, spots with alarming signals to the local environmental institutions, etc.
		.

	2. Have you gathered enough information on:
	   a. final energy consumption
	      i. quantity of fuel used
	      ii. quality of fuels sold
	      iii. number of households at energy poverty risk
	      iv. energy and housing conditions for energy-poor households
	   b. air quality statistics
	      i. types of pollutants concerned
	      ii. quantities of pollutants based on the energy consumption
	      iii. daily exceedances
	      iv. annual averages
		Data collection is a notorious challenge. If you find difficulties to collect it consider addressing:
		(1) energy utilities and energy providers
		(2) local and national energy institutions, energy agencies and energy observatories
		(3) local and/or national environmental offices
		(4) statistical offices
		
		Specific calculations may be needed and if you think you cannot manage, then address energy and environmental experts to perform them for you. Some guidance is given in the multiple impacts assessment of the InventAir project.

	3. Have you set the baseline on:
	   a. energy poverty baseline
	      i. number of households considered energy poor
	      ii. energy and housing status of the energy-poor households
	   b. air pollution
	      i. quantities of pollutants
		If there are sufficient strategic documents (e.g. SEAP, action plan on energy poverty, or air quality action), then use the baseline defined in it. If there are no such documents, then define your baseline on the year for which you have the most reliable data. For calculation of emissions, please refer to the multiple impacts assessment of the InventAir project.

	Build the vision	**If "No", then consider:**

	1. Have you analysed the needs and challenges?	If you feel overwhelmed with the question of the needs and challenges in the community, then pay attention to the surveys among the population, the media stances or on the ongoing debates in the social media. Information on what worries the citizens will give you the best direction to what they "hot topics" for the community are.
	2. Have you made an outline of the future?	Envisioning the future is not easy. It takes creativity and courage to set the aim high. If you are in need of inspiration, then go to initiatives like the Covenant of Mayors, Eurocities, the EIP-SCC platform, to check out what the leading cities are implementing and thus form your vision.
	3. Did you put overall objective and specific targets?	The overall objective needs to correspond to the vision, but the specific targets are evidence-based – they are based on the data in the baseline year and the desired result to be achieved. The targets need to be quantifiable.
Plan the measures		**If "No", then consider:**
	1. Have you analysed the status of the target group?	When you are clear on whom you wish to address, then it is good to define their specific status. Data may not be available, but estimations are possible based on local and/or national data. The most reliable approach though is to go to the target group and make a small representative survey. Thus, data will be reliable and providing you all information needed.
	2. Did you perform segmentation of the target group?	The segmentation is always based on data. You need to choose adequate characteristics based on which you will split the target group in sub-groups. Such characteristics may be economic, energy and housing, and/or social.
	3. Did you prioritise specific sub-target groups?	Prioritisation is not a must, but gives good grounds to develop the action plan and has the potential to give you better insight into the

		groups you need to address and how to support them so that the targets and objectives are achieved. There is the Fairmode catalogue of measures and actions that may provide some inspiration.
	4. Did you assign measures and actions to specific target groups?	The allocation of specific measures to groups is adequate when there is segmentation and prioritisation. It is useful approaching to saving efforts, time and financial resource, and at the same time preserving the good quality work.
	5. Did you develop an action plan?	The development of an action plan is not a must. but it puts the roadmap into time perspective and pinpoints the responsible stakeholders. The suitable responsible bodies may be from the Energy or Environmental Department, the Social policies department, Infrastructure and Planning department. It if also good to consider the support of NGOs, charity organisations, local energy providers, etc.
Implement the action		**If "No", then consider:**
	1. What stakeholders did you involve in the development or implementation of the roadmap?	The roadmap needs to be presented to the local policy and decision makers so that they feel confident in its impact and support it. The potential support may come from the city council representatives, the mayor's office, the local NGOs and citizen initiatives, the energy and environmental experts, etc.
	2. What do you plan to do activate the citizens?	The citizens are a crucial element of the successful implementation of the roadmap, so any type of involvement will be beneficial – informational campaigns, regular meetings, engagement in the policy processes, information through the local media and the social media.
	3. How do you plan to promote the roadmap solutions?	The solutions offered by the roadmap need to be actively promoted among the community as the major beneficiary is the 'citizen'. Thus, it is essential to involve the energy providers, both fuel and

		technology retailers, to join a massive campaign that will support the replacement of the old stoves. They may distribute and publish information for the changeout options, or promote improved fuel and technologies to the end used.
	Monitor the results	**If "No", then consider:**
	1. Did you foresee a monitoring scheme?	The monitoring scheme is essential element of implementing and improving the roadmap. The data that will be required for the monitoring will be best acquired from the participants in the woodstove replacement through surveys, questionnaires, and/or interviews. The data acquisition may be supported by the local fuel and technology providers.
	2. Did you choose monitoring indicators?	The monitoring indicators should have quantitative and qualitative indicators. The data needs to be defined well from the start of the action so that good evaluation and assessment is ensured. They could be related to energy, environmental, economic, housing, social aspects and the proper combination of indicators will provide better evaluation routes.
	3. Did you set milestones?	The milestones are not obligatory, but help to define key moments of the implementation of the action and thus to better closely monitor the implementation. The milestones may be defined based on key activities, or key achievements.

REFERENCES

[1] http://fairmode.jrc.ec.europa.eu/measure-catalogue