Sven Alsheimer, Uta Burghard and Markus Fritz
LESSONS FROM MUNICIPAL NETWORKS FOR MUTUAL SUPPORT: EMPOWERING MUNICIPALITIES TO LEAD THE TRANSITION TOWARDS A LOW-CARBON SOCIETY

Sven Alsheimer: Fraunhofer Institute for Systems and Innovation Research ISI,
Breslauer Str. 48, 76139 Karlsruhe, Germany,
Phone: +49 721 6809-565; sven.alsheimer@isi.fraunhofer.de
Uta Burghard: Fraunhofer Institute for Systems and Innovation Research ISI,
Breslauer Str. 48, 76139 Karlsruhe, Germany,
Phone: +49 721 6809-433; uta.burghard@isi.fraunhofer.de
Markus Fritz: Fraunhofer Institute for Systems and Innovation Research ISI,
Breslauer Str. 48, 76139 Karlsruhe, Germany,
Phone: +49 721 6809-249; markus.fritz@isi.fraunhofer.de

Abstract
Municipalities play a crucial role in the transition to a low-carbon society. The EU introduced the instrument of Sustainable Energy (and Climate) Action Plans (SE(C)APs) to foster the transition process at local level, but many municipalities have only just started the process of setting up such a plan and thus have little experience with implementation of the defined measures. To empower municipalities and to fully utilise their potential in the transition to a low-carbon society, the PATH2LC project brings together European municipalities on a regional and international level. The core of the project is the 'Learning Municipality Network' (LMN) approach, which promotes close cooperation between municipalities through regular, organised, and moderated meetings that include expert input and peer-to-peer learning. The approach is being implemented in municipalities in five established networks in five countries (France, Greece, Italy, the Netherlands and Portugal). The aim of this paper is to evaluate the process and outcomes of the LMN approach and provide recommendations for its broader diffusion. We evaluated the effectiveness of the LMN approach in the five networks using two types of monitoring: socio-scientific and technical. The socio-scientific monitoring was aimed at determining how the participating municipalities and the local partners moderating the network perceived the LMN approach. We conducted five guideline-based online-interviews with the network moderators and another 20 interviews with stakeholders from the municipalities who were actively involved in the network process. The technical monitoring was aimed at assessing the progress of each network in terms of the implementation status of measures defined in the SE(C)APs. This involved an annual survey of representatives from each municipality on the implementation status of energy efficiency measures. Our results indicate that the LMN approach implemented in the five networks has facilitated the municipalities' pursuit of emission reduction targets. It has contributed to the implementation of energy efficiency and sustainability measures; most of the measures implemented belong to the category of energy efficiency or renewable energy. In particular, measures in the area of efficiency, renewables and heating and cooling have helped to generate large energy savings for the municipalities concerned. Moving forward, any potential future implementation of an organised networking approach for municipal networks requires careful planning and consideration of the unique characteristics and needs of the participating municipalities to overcome potential barriers. Furthermore, enhancing networking opportunities between municipalities across Europe could further support peer-to-peer learning and best practice sharing, and foster greater success in transitioning towards a low-carbon society.

1. Introduction
Municipalities play a crucial role in the transition from a fossil-based to a low-carbon society. This is not only because they are a major emitter of greenhouse gases due to the energy consumption of buildings and transport (Strasser et al. 2018). In recent years, climate and energy topics increasingly found their way onto municipal political agendas. To foster the transition process at local level, the EU introduced the instrument of Sustainable Energy (and Climate) Action Plans (SE(C)APs) as part of the voluntary Covenant of Mayors (CoM) initiative (Andreanidou et al. 2018). However, many municipalities in Europe have only just started the process of setting up such a plan and thus have little experience with the implementation of the defined measures. Furthermore, there are challenges due to the complexity of the transition process that are related to the involvement of multiple stakeholder groups, a wide range of

topics, differing targets, long project durations, and market dynamics (Strasser et al. 2018). In light of these challenges, greater efforts are required to support municipalities in drafting SE(C)APs and implementing the respective measures required to achieve the climate and energy targets in the EU.

To empower municipalities and to fully utilise their potential in the transition to a low-carbon society, several municipal networks have been established across Europe that aim to achieve their climate goals with mutual support, such as the CoM, the Climate Alliance, the ICLEI network or Eurocities.

This is the starting point for the project 'Public Authorities Together with a Holistic network approach on the way to Low-Carbon Municipalities' (PATH2LC), which supports existing municipal networks in Europe with implementing and further developing their SE(C)APs. The core of the project is the 'Learning Municipality Network' (LMN) approach, which differs from most other network approaches to date by strongly emphasising the close cooperation between municipalities through regular, organised, and moderated meetings that include expert input and peer-to-peer learning. LMN is an adaptation of the 'Learning Energy Efficiency Networks (LEEN)' approach, which was originally designed for companies supporting each other in implementing energy efficiency measures (Dütschke et al. 2018). The PATH2LC project applies the approach for the first time to five established municipal networks in five countries (France, Greece, Italy, the Netherlands and Portugal). Its aim is to enable municipal decision-makers and administrative staff, both individually and as a group, to obtain the competencies and skills they need to implement energy-saving or climate action measures.

The objective of this study is to evaluate the process and outcomes of the LMN approach and provide recommendations for future projects employing a similar approach. We used two types of monitoring to evaluate the effectiveness of the LMN approach in the five networks: socio-scientific and technical. The socio-scientific monitoring was aimed at determining how the participating municipalities and the local partners moderating the network perceived the LMN approach. We conducted guideline-based interviews with the moderators of the networks and stakeholders from the municipalities. The technical monitoring was aimed at assessing the progress of each network in terms of the implementation status of measures defined in the SE(C)APs and involved an annual online survey of representatives from each municipality on the implementation status of energy efficiency measures.

Section 2 of this paper presents background information on the LMN approach. Section 3 reports the results of a literature review on the effects of networking on the implementation of climate action measures. In Section 4, we describe the methods used in the socio-scientific and technical monitoring. In Section 5 and 6, we report and discuss the corresponding results. Finally, in Section 7, we draw conclusions and provide an outlook.

2. Background: PATH2LCs Learning Municipality Network approach
2.1. Description of the Learning Municipality Network approach
The overarching objective of the LMN approach in PATH2LC is to support policymakers and public authorities at local level in the transition to a low-carbon society. Stakeholders in public authorities are brought together in a holistic network, which enables peer-to-peer learning and increases their engagement in the energy and climate transition. To do so, several municipalities within a specific region form a network and collaborate and exchange information and experiences on shared topics. In our case, these topics included heating and cooling planning, energy in buildings, renewable energy, stakeholder engagement and financing. This approach is intended to facilitate meetings, target setting and commitment, and mutual motivation. Close cooperation in the form of regular, organised and moderated meetings is at the heart of these networks. The aim is for the participating municipalities to meet twice a year to report on their activities in the chosen fields, and exchange information about their experiences and plans. A facilitator fosters the exchange at these network meetings, which are usually one-day events. In addition, experts are invited to provide information on specific topics related to energy.

The Learning Municipality Networks approach is designed to follow a predefined process: (1) initiation of the network, (2) identification of climate- and energy-related measures, (3) setting a common target in the networks, (4) regular network meetings on predefined topics with relevant municipal stakeholders, (5) monitoring the progress and success of the network, (6) dissemination of results and experiences, (7) trans-regional and international exchange with other municipalities.

2.2. Networks participating in the Learning Municipality Network approach
The following table gives an overview of the networks, municipalities and their action plans.

Table 1: The participating networks and municipalities (sources: Conforto 2021 and own research)

Network name and country	Local Administrations	Action plan format	Publication year
Rhône Network (ALTE69) - France	CCMDL - Communauté de Communes (CdC) des Monts du Lyonnais (32 municipalities)	SECAP	2018
	CCSB - CdC Saône-Beaujolais (35 municipalities)	SECAP	2020
	COR - Communauté d'agglomération de l'Ouest Rhodanien (31 municipalities)	SECAP	2019
	SOL - Syndicat de l'Ouest Lyonnais (41 municipalities)[1]	SECAP	2020
SCN - Greece	Oichalia	SEAP	2017 (1st monitoring 2019)
	Ierapetra (Crete)	SEAP	2015
	Korinth	SEAP	2014
	Vari-Voula-Vouliagmeni	Decarbonisation Plan (C-TRACK 50)	2021
	Messini	SEAP	2013
	Dodoni	-	-
	Pella (Edessa)	-	-
	Xylokastro	SECAP	2021
UCSA - Italy	Palma Campania	SECAP	2020
	Striano		
	San Giuseppe Vesuviano		
	San Gennaro Vesuviano	-	-
CNNL - Netherlands	Achtkarspelen	SECAP	2020
	Ameland	SEAP	2019
	Dantumadeel / Dantumadiel	SECAP	2012-2016
	De Friese Meren / De Fryske Marren	SECAP	2019
	Harlingen	SEAP	2022
	Heerenveen	SECAP	2019
	Leeuwarden	SEAP	2016
	Noardeast-Fryslân	SEAP	2017
	Ooststellingwerf	SECAP	2021
	Opsterland	SEAP	2019
	Schiermonnikoog	SECAP	2019
	Smallingerland	SECAP	2016
	Súdwest-Fryslân	SECAP	2022
	Terschelling	SECAP	2018
	Tietjerksteradeel / Tytsjerksteradiel	SECAP	2020
	Vlieland	SECAP	2017
	Waadhoeke	-	-
	Weststellingwerf	SECAP	2021
	Provincie Fryslan	SEAP	2019
Oeste Sustentável - Portugal	Alcobaça	SEAP	2014
	Alenquer	SEAP	2014
	Arruda dos Vinhos	SEAP	2014
	Bombarral	SEAP	2014
	Caldas de Rainha	SEAP	2014
	Nazaré	SEAP	2014
	Óbidos	-	-
	Peniche	SEAP	2014
	Torres Vedras	SEAP	2013

See Burghard and Alsheimer (2023) for an overview of the most outstanding characteristics of the networks that were collected at internal workshops, during bilateral talks with network operators and by analysing documents (e.g. SE(C)APs).

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[1] The Syndicat de l'Ouest Lyonnais is composed of four inter-municipalities: Communauté de Communes de la Vallée du Garon (five municipalities), Communauté de Communes du Pays Mornantais (eleven municipalities), Communauté de Communes du Pays de l'Arbresle (17 municipalities), Communauté de Communes des Vallons du Lyonnais (eight municipalities).

3. Effects of municipal and corporate network approaches on the implementation of climate action measures

3.1. Insights from corporate energy efficiency networks

Network approaches focusing on energy efficiency in companies are well established and have been applied for many decades. These projects have been evaluated by research institutes in extensive evaluation processes (Dütschke et al. 2018). Networking has proven to be an effective instrument for the implementation of energy-efficient measures in companies. Research has shown that companies participating in such an efficiency network doubled their progress in the respective field compared to those not participating (Bradke et al. 2015). An interview study by Paramonova and Thollander (2016) indicates that participation in such networks helps to reduce companies' energy costs. According to the majority of participants in a survey study by Wohlfarth et al. (2017), it also leads to the implementation of measures that would not have been realised otherwise. It has also been shown that the network approach helps to overcome barriers to the implementation of energy efficiency measures, such as information deficits and financial barriers. However, the effect of the network approach on implementing measures is related to the size of the company involved - with smaller companies typically realising fewer measures (Wohlfarth et al. 2016).

The success of the network approach in a corporate setting can be traced back to the standardised process involved (Dütschke et al. 2018). This finding is echoed by other authors (e.g. Köwener et al. or Jochem and Gruber 2007), who identified similar mechanisms. One relevant driver for the success of corporate energy-efficiency networks is related to the use of audits that make profitable potentials visible (Dütschke et al. 2018). Furthermore, network participation leads to enhanced employee motivation regarding energy issues and knowledge gains through mutual learning and the exchange of experiences during meetings and site visits. Finally, although network participation reduces transaction costs, the difficulties associated with providing the resources needed for network activities over a longer period, e.g. time, staff and money, are perceived as hampering its effectiveness (Dütschke et al. 2018; Paramonova and Thollander 2016).

3.2. Insights from municipal climate and energy networks

Similar to the LMN approach implemented in the PATH2LC project, other projects are also seeking to strengthen the exchange between municipalities using a network approach. Projects at EU level that also focus on climate and energy topics and involve networking and peer-to-peer learning between municipalities include the following: ENERgeewatch (https://energee-watch.eu/), CEESEN (https://ceesen.org/en/), ePLANET (https://www.eplaneth2020.eu/) and OwnYourSECAP (https://www.ownyoursecap.eu/). EU projects that also aim at capacity building among municipal actors within these fields but without a pronounced networking component are Prospect+ (https://h2020prospect.eu/), IN-PLAN (https://fedarene.org/project/in-plan/) and C-Track 50 (https://www.c-track50.eu/).

Overall, municipal networks are thought to play an important role in fostering climate planning at the local level as well as influencing higher levels of government (Gore 2010; Pietrapertosa et al. 2021). In the field of climate change adaptation, Heikkinen et al. (2020) found that network membership is correlated with higher levels of activity. One characteristic of (transnational) municipal networks is that they tend to focus on soft mitigation measures (such as fostering knowledge exchange or capacity building) rather than on quantified mitigation targets (Bansard et al. 2017; Kern and Bulkeley 2009). The networks also function as facilitators of personal networking among local policymakers (Haupt 2019) and enable benchmarking, which has been shown to contribute to knowledge generation within municipal administrations (Askim et al. 2007).

In terms of knowledge exchange, study visits allow policymakers to learn from the experiences of authorities in other municipalities. In this regard, a study by Haupt (2021) indicates that such visits are more successful if the municipalities are quite similar, e.g. of comparable size and with a similar institutional context. In fact, the study argues that learning from exchanges among municipalities with similar conditions is more suitable for a large-scale implementation of peer-to-peer learning approaches than learning from frontrunners only. However, in many municipal networks there is a clear split between a core group of the most active municipalities and the other, more passive municipalities (Kern and Bulkeley 2009). To facilitate learning processes, informal personal connections have been shown to be important, as these are one of the main channels of peer-to-peer exchange (Ansell et al. 2017).

4. Methods

We evaluated the effectiveness of the LMN approach in the five PATH2LC networks using two types of monitoring: socio-scientific and technical.

4.1. Socio-scientific evaluation

The socio-scientific monitoring analysed the perception of the LMN approach by the participating municipalities and the local partners moderating the network. We conducted five guideline-based online interviews with the moderators of each network in December 2022. These interviews lasted between 51 and 71 minutes, and were 59 minutes on average. In addition, we provided adapted interview guidelines to the local partners, who conducted a total of 20 interviews with stakeholders from the municipalities that were actively involved in the network process. Eight interviews were conducted in Greece, four in France[2], one in Portugal, three in Italy and four in the Netherlands. The interviews with the municipalities were held between December 2022 and April 2023, the majority online (14) and four face-to-face.[3] These interviews took between 12 and 90 minutes, and lasted 46 minutes on average. The following table gives an overview of the interview database.

Table 2: Interview database

Network	ID	No. of interviews	
		... with network operators	... with municipalities
Greece	GR	1	8
France	FR	1	4
Portugal	PT	1	1
Italy	IT	1	3
Netherlands	NL	1	4[4]

For an overview of the guidelines for the interviews with network operators and with the municipalities, see Burghard and Alsheimer (2023). The interviews with the network operators were conducted in English via MS Teams, while the interviews with the municipalities were conducted by the local partners in the respective national language. For data protection purposes, an informed consent form was developed, which gave the interview partners information about the study (e.g. aim of the project, contribution of the interview partners, risks of participation etc.) so that they could make an informed decision about their participation in this research. The form had to be signed by the participants.

All interviews - with the network operators as well as with the (inter-)municipalities - were recorded. Interview summaries were made based on these recordings. A template was provided for the interview summaries, which was structured according to the interview guideline. The local partners who interviewed the municipalities provided a summary of each interview in English to the researchers responsible for analysing the interviews. The interviews were analysed with the help of MaxQDA. First of all, a code system was created based on the interview guidelines. During the subsequent coding, new codes and sub-codes were added if topics arose that had not been mapped in the code system. For an overview of the code system, see Burghard and Alsheimer (2023).

4.2. Technical evaluation

The technical monitoring aimed at assessing the progress of each network in terms of the implementation status of measures defined in the SE(C)APs. All measures not included in the SE(C)AP were also collected by carrying out an annual monitoring in the form of a questionnaire. This questionnaire should be completed by the responsible person from the respective municipalities and was structured so that each measure could be entered individually. The following information was recorded for each measure: Short name, implementation status, brief description, whether the measure was part of the SE(C)AP, condition before the measure, category, date of implementation, energy carrier before implementation, energy carrier after implementation, energy consumption before implementation, energy consumption after implementation, and investments and funding. For the variables 'category', 'type of measure' and 'energy carrier' a pre-selection was provided as shown in Table 3.

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[2] In France, the network consists of so-called inter-municipalities instead of municipalities.

[3] For two interviews in Italy, information on the type of interview (online vs. face-to-face) is missing.

[4] Including one interview with a province and one interview with two municipalities.

Table 3: Pre-selection for the variables 'category', 'type of measure' and 'energy carrier'

Category		Type of measure	Energy carrier	
Efficiency - Building retrofitting	Training, information campaigns	Replacement	Electricity	Fuel oil (heavy)
Efficiency - Lighting	Energy saving	Extension	District heating (CHP)	Lignite
Efficiency - Transport	Sustainability and liveability	Optimisation	District heating (biomass)	Hard coal
Efficiency - Heating, Cooling, DHC	Adaptation of operational processes	New installation	District heating (other)	Gasoline
Efficiency - Electricity	Behavioural change	Training	Natural gas	Diesel
Renewables	Stakeholder engagement	Other, namely:	Other gases (liquid gas, biogas, bottled gas)	Biomass
Financing; Funding	Other, namely:		Fuel oil (light)	Other, namely:

The entries were carefully examined and, if necessary, any missing information was supplemented over the course of a manual review. For instance, the category could often be inferred from the concise descriptions provided for many measures. Measures were evaluated collectively for all LMNs, as conducting a comprehensive assessment at the level of individual municipalities was impractical due to the low response rate during the monitoring.

All the monitoring rounds achieved a commendable response rate of 92%, with measures submitted by 23 out of 25 municipalities. A total of 407 measures were reported in the survey for the time period 2009-2023, showcasing a diverse range of initiatives aimed at promoting sustainable development. In the specific context of the project period (2020-2023), 75 new measures were introduced, highlighting the continued dedication of the participating municipalities. Among the reported measures, 264 (65%) were presented without additional information on savings, while 143 (35%) included supplementary data on savings. This information provided insights into the overall savings and also the cost-effectiveness of the implemented measures. 299 measures (73%) lacked information regarding the energy carrier employed, while 108 measures (27%) provided explicit details on the energy source used. This information plays a pivotal role in understanding the environmental implications and efficiency of the implemented measures. Regarding the timeline of implementation, 179 measures (44%) did not include any information on the year they were executed, while 228 measures (56%) clearly indicated the year of implementation. This temporal context helped us to track the progress made over time and analyse the impact during the project period.

The data provided by the participating municipalities enabled us to develop a deeper understanding of the various measures implemented across the board. Additionally, the monitoring provided evidence of the effects achieved by the measures.

5. Results
This section presents the results of both the socio-scientific and the technical monitoring.

5.1. Results of the socio-scientific evaluation of the LMN approach
The evaluation of the LMN approach is described to start with. After that, the perceived effects of the approach in terms of the development or updating of SE(C)APs and the implementation of the respective measures are presented, followed by a description of the interview partners' expectations regarding a further roll-out of the LMN approach.

5.1.1. Overall evaluation of the LMN approach
Overall, the LMN approach was evaluated positively - by the interviewed network operators as well as by the interviewed (inter)municipalities: "The network approach offers real added value," as a French interview partner stated. The approach was perceived as useful and beneficial by all network operators as well as by the majority of the (inter)municipalities.

5.1.2. Perceived benefits, shortcomings, drivers of and barriers to the LMN approach
The interview partners gave insights into their perceptions of the benefits, shortcomings, drivers of and barriers to the LMN approach, which are summarised in the following table.

Table 4: Overview of the perceived benefits, shortcomings, drivers of and barriers to the LMN approach

Benefits	Shortcomings	Drivers	Barriers
Knowledge gains (energy, funding, SE(C)APs)	Time-consuming	Experience of the network operators	Lack of time and resources
Exchange between municipalities	Mixed relevance of contents	Mutual motivation	Administrative issues of municipalities
Peer-to-peer learning	Difficulties in translating methodology to local context	Willingness to collaborate	Difficulties in involving external stakeholders
Benchmarking	Short project duration	Commitment of the mayors and the municipal administrations	Limited language skills
Strengthened institutionalisation of the networking	Lack of examples from concrete projects	Clear communication of goals	Differences in size between municipalities
			Reluctance to share information between municipalities
			Covid restrictions

In line with their overall positive evaluation of the LMN approach, the interviewees mentioned many perceived **benefits** including knowledge gains, which were perceived as an important advantage of participation. Ultimately, this knowledge was not only of benefit to the participating municipal representatives, it was also transferred to others within the municipality. Another benefit from the viewpoint of the majority of interview partners was the exchange with other municipalities, as this can lead to new ideas and increase their inspiration and motivation, as well as the perceived importance of energy issues. Additionally, it enables joint problem solving and peer-to-peer learning. The project also makes benchmarking possible, i.e. to compare one municipality's progress with that of others. As far as the exchange with other municipalities was concerned, there was a mixed response to whether the exchange with the municipality's own network members or the exchange with other European municipalities was more useful. Finally, the LMN approach also facilitates the institutionalisation of the previously rather informal networking. However, according to other interview partners, it was sometimes hard to identify the direct benefits of the PATH2LC project against the background of changing context factors, e.g. the energy crisis that had focused attention on the importance of energy topics.
Only a few overall **shortcomings** of the LMN approach were mentioned. In some networks, participating in the project was perceived as time-consuming. However, the benefits gained outweighed the time invested from the perspective of the interviewed actors. Furthermore, some interviewees stated that there was a good match between the contents presented and the specific needs of their municipalities, while others did not. For those municipalities that are already far advanced in terms of sustainable energy and climate action and have had a SE(C)AP in place for some time, some of the topics in the project were of little interest. This heterogeneity, however, e.g. in terms of the size of municipalities in a network, can also be seen as an advantage, as it facilitates learning from different projects of bigger cities.

"I liked the heterogeneity that existed in the Greek network. If our municipality was talking to the municipality of [name of municipality], for example, we would exchange the same views and ideas. A big urban municipality with more experience offers us more experiences." (GR)

The project methodology was perceived as rather abstract and therefore sometimes difficult to adapt to local needs and circumstances. Additionally, it was pointed out that some of the topics presented over the course of the LMN approach are rather complex and thus might be discouraging. Several interview partners also mentioned that the duration of the project was too short to make a real difference. One municipality mentioned the lack of examples from concrete projects. These would have provided inspiration and ideas for others to implement projects themselves.

Various **drivers** of the network approach were mentioned. One important driver was the experience of the network operators. The motivation from participating in a network with like-minded people was also mentioned as another driving factor. It was further stated that the representatives had to be willing to collaborate and share their knowledge with others instead of expecting to only receive support. This was also valid for the commitment of the mayors and the municipal administrations to the project. Furthermore, clear goals were important according to one municipality. This means that the participants in the network must be clear about what they want to achieve.

Barriers that can hinder the implementation of the network approach included a lack of time and resources. This challenge applies to small municipalities in particular. In the Netherlands, it was added that municipalities there were being assigned an increasing number of tasks by the state, which makes participation in projects like PATH2LC even more difficult. In addition, Dutch municipalities receive funding according to their size; i.e. the burden of participation is higher for smaller municipalities with fewer staff. At the same time, it is precisely these smaller municipalities that might be able to benefit more from PATH2LC. One consequence of the lack of human resources was that only half of the registered participants were present at many meetings. One way of dealing with this was to distribute people between meetings. The often vertically organised administrative structure in municipalities and the changing contact persons due to municipal elections can be another challenge. The same goes for getting stakeholders on board who were not directly involved in the project (such as political representatives and local enterprises). Possible reasons given by interviewees for this included scepticism about working with municipalities, a lack of information and communication targeted at other relevant stakeholders, frequent changes of contact persons, and maintaining the level of enthusiasm of these stakeholders about the project across its entire duration. Another important barrier for the implementation of the LMN approach was language. Many people were not familiar with important terms from the field of energy or energy policy. As a consequence, in many cases, the material provided in English was not read by the representatives. Differences in size between municipalities in the network were also identified as barrier, as these face different challenges and have different issues on their agendas. Finally, reluctance of some municipalities to share information with others and the Covid restrictions were perceived as a difficulty, and some interviewees felt that cooperation between municipalities would have been easier if there had been more physical meetings.

5.1.3. Evaluation of elements of the LMN approach

The **network meetings** were evaluated positively by the interviewees, who stated that the time spent on the project was well invested and that the meetings gave them the feeling they were not facing their respective challenges alone. The exchange with the other municipalities, sharing best practice examples, receiving feedback from network operators, and the material provided were appreciated. Some interviewees felt that meetings became more practice-oriented over the project's lifetime. Additionally, participants got to know each other better, which further increased the value of the meetings. However, some interviewees stated that the meetings should focus more on the needs of the specific regions and municipalities and provide more practical content and examples. Certain contents were difficult to understand for people dealing with these issues for the first time, but the translations offered helped to clarify them. There were mixed views concerning the number of participants in the network meetings. Some municipalities considered this too high, and others considered it appropriate, because diverse perspectives could be integrated and considered. Some interview partners voiced a desire for strengthened cooperation between the participating municipalities across the different networks. The efforts of the network operators were evaluated positively. Differences between municipalities, such as size, hindered comparability, especially in the earlier stages of the project. The frequency of two to three network meetings per year was considered sufficient by most, although some wished for more meetings to strengthen participant involvement. Several network operators opted for half-day instead of full-day meetings. Most of the network meetings were held online due to Covid restrictions. However, several municipalities were critical of these online meetings because they were seen as hindering the exchange of information and the process of getting to know each other. In addition, face-to-face meetings could have

been valuable in terms of best practices, e.g. physical visits to municipalities that had implemented an innovative project. The lack of human resources came up again when discussing the network meetings in the interviews. This can complicate the project work, because many participants were missing or there was a change of people between meetings. Some also reported that the municipalities hardly continued working after the network meetings or hardly read the material provided.

The **trainings and capacity building measures** (for network operators) were evaluated positively in some networks, as they are designed in such a way that even newcomers can understand them. Interviewees also regarded the trainings and capacity building measures designed for municipalities as useful. The trainings and good practices helped the municipalities to assess the feasibility of a particular project. The different tools provided, e.g. the webinar and dialogue tool, were evaluated as helpful by some interviewees. However, it was noted that the training sessions were hard to follow, sometimes due to too many participants, too much information and too few interactions due to the digital format. Furthermore, some of the input was not tailored enough to the specific needs of the municipalities, although this improved over the course of the project. Some of the examples given targeted bigger cities and examples for smaller communities were needed as well. Some of the technical assistance provided was too similar to that used for companies and municipalities follow a different logic. For example, they need more time to identify their requirements and processes may also take longer.

The **peer-to-peer learning workshops** were evaluated positively, especially the presentations held by small municipalities from other countries. On the other hand, some meetings at EU level were assessed as rather advanced and thus less applicable. It was valued that peer-to-peer learning made projects really visible and tangible.

In some networks, the **common target setting** was perceived positively. A common goal was seen as strengthening the commitment, promoting a more target-oriented exchange, and leading to greater motivation and a stronger sense of belonging on the part of the participating municipalities. Even if the goal was more abstract, so that all municipalities could identify with it, it was perceived as important to have a common goal.

> "In addition, setting a common goal is important and useful. The degree of abstraction is important here. In a network, you have different people connected to each other. It is an illusion that everyone has the same goal, even if this has been agreed beforehand. In a network, you need to know what the underlying goals of partners are. Partners may have different goals but all within the same topic. The goals are then an extension of each other. Then working together within a network approach is very valuable." (NL)

5.1.4. Effects of the LMN approach on the development or update of SE(C)APs

In several networks, not all the municipalities already had a SE(C)AP. Network operators and municipalities perceived PATH2LC as an important booster for developing or updating the SE(C)APs. It contributed to reviewing the measures planned in the present SE(C)APs to see whether they were a good fit for the characteristics of the municipalities, and to updating existing SE(C)APs with current data. In addition, the project helped to raise awareness of existing SE(C)APs. Furthermore, the support with drafting the SE(C)AP monitoring report for the CoM was mentioned positively.

> "The training on the SECAPs has helped us to understand that it is now necessary and that there is no more room for postponement. When you go through the process of comparing yourself to someone else, listening to someone who is involved in the subject, you understand that it is a necessity and it is definitely a positive boost." (GR)

Several municipalities without a SE(C)AP started to elaborate one. In this context, it was emphasised how important PATH2LC was to motivate municipalities to create a SE(C)AP. One municipality highlighted the support of PATH2LC in developing their own SEAP:

> "Currently we have started to do the SEAP, and I think within a few, also because of the information we have received through these meetings and this project, I think we will shortly complete it. We are half, or more than half way through and obviously without these meetings it would have been much more difficult, almost impossible." (IT)

According to some municipalities, PATH2LC made it possible to compare one municipality's SE(C)AP and its implementation status with other municipalities. PATH2LC can be helpful to increase knowledge and awareness of climate plans in the municipality. However, more trainings and information could have helped municipalities to develop a SE(C)AP on their own, instead of outsourcing it. Barriers to developing a SE(C)AP include the lack of specially trained staff.

5.1.5. Effects of the LMN approach on the implementation of SE(C)AP measures

PATH2LC helped to highlight the SE(C)AP measures already in place as well as others not currently playing a role. One municipality emphasised the positive effect of being able to compare performance in terms of implemented measures:

> "I feel that PATH2LC has helped in accelerating the implementation of heat visions. Municipalities learn from each other and share best practices. Colleagues from other municipalities then know what works well so they can also try to apply that in their context. We also learn by sharing negative experiences, which other municipalities can then avoid." (NL)

Some interviewees were positive about the monitoring of SE(C)APs as part of PATH2LC. They evaluated the monitoring tool as useful for tracking the implementation status of measures in the climate action plans. Even if a municipality is already quite advanced in terms of the implementation of measures, participating in the projects was still helpful:

> "When we joined the network, we were too far along with the implementation of the SECAP, but it helped to some extent, because we came into contact with new information and examples from other cities." (GR)

Some interviewees, however, did not notice any direct influence of PATH2LC on the implementation of SE(C)AP measures. This was also due to the rather short duration of the PATH2LC project. According to the municipal representatives, the project was more helpful for reviewing and, if necessary, correcting the plans than for the concrete implementation of individual measures. However, this was seen differently by some of the network operators, who noted a positive influence of PATH2LC on the implementation of measures. The network approach leads to greater involvement with the topic of energy and one's own municipal goals in this regard. The continuous comparison with other municipalities regarding the implementation of measures increased the pressure to push this forward. But in this group too, it was also noted that a direct influence of the project was difficult to assess.

> "It was a mechanism that pushed things to happen. The fact that you meet regularly, that you report, or face the others, or you discuss the issue. And also the fact that you have training on some issues. Then even in that situation you have to face what you are doing. And again you are forced to stay on the spot and not lose the focus on these activities." (IT)

Barriers to the implementation of SE(C)AP measures are, according to several networks, a lack of human and financial resources. Optimally, one person in the municipality should be responsible for the SE(C)APs and their implementation. In addition, tools and information are lacking, but PATH2LC has helped to mitigate this. Furthermore, old data and outdated measures in the SE(C)APs can act as a barrier. Also, the (un)availability of data makes developing and implementing SE(C)APs measures more difficult. Very broad and unspecific SE(C)APs are further barriers to implementing the measures. In addition, the SE(C)AP may not be known in the municipality: "But if [...] you don´t have a general idea, you don´t implement the measures that are in the SE(C)AP" (GR). One municipality cited the difficulty of obtaining EU funding as a barrier for municipalities. A barrier specifically applicable to Italy is the recovery fund. The mechanism leads to municipalities competing for funds and consequently wanting to collaborate less. On the other hand, one intermunicipality cited strong political will as a driver of measure implementation.

5.1.6. Look into the future: What are the expectations for the networks?

Some interviewees hoped that the feeling of trust and sense of belonging created under PATH2LC would last beyond the official end of the project. One way to achieve this could be further meetings on a regular basis.

> "We have created a fairly strong local network. We will continue at the local level on all the joints projects/actions that have been highlighted thanks to the European project. This is the beginning and not the end. And there are so many other joint projects/actions to tackle …" (FR)

Some interviewees stated that they would continue working on their SE(C)APs as well as on achieving the common goals set as part of PATH2LC. One network operator considered using the approach of PATH2LC for similar projects in the future. The approach could be applied to projects at local or national level. The municipalities themselves would like to continue further cooperation. Some are very committed to keep working on the decarbonisation of their municipality and on developing their SE(C)APs.

> "Let's say that we consider projects that may also seem ambitious, but we would like our own country to become eco-sustainable, in the sense that we would like to, I don't know, to be able to [...] make all the cars electric, make the buses that move around electric. I don't know, maybe

make our offices and all our municipal buildings, even our private ones, make them efficient [...]."
(IT)

The hope is that the success achieved by the municipalities in PATH2LC will also motivate other municipalities to become more involved in the topic of energy and climate action and the participating municipalities themselves were willing to participate in a similar project in the future.

"For me, it was a very interesting experience and I hope it will continue because I believe that such networks help, especially the smaller municipalities." (GR)

Furthermore, some municipalities considered using tools presented in PATH2LC in the future. A challenge to this might be changing municipal representatives due to elections, possibly leading to other priorities and a lack of continuity in previously established priorities or projects. In some networks, the heterogeneity of the municipalities in terms of size and cultural differences remained a challenge for continuing the collaboration. In some networks, it was expected that the commitment of municipalities would decline after the end of the project. Especially with regard to the motivation to develop the SE(C)APs, the end of the project was expected to have a negative impact.

5.2. Results of the technical evaluation of the LMN approach

407 measures were reported in the survey, of which 274 measures were part of a SE(C)AP and 86 measures were not part of a SE(C)AP. 47 measures could not be assigned to either category. This reveals that in addition to the measures in the SE(C)APs, other measures have also been implemented. Out of the 407 measures reported, 135 measures have been successfully implemented and 191 measures have been partially implemented or are still in the process of being implemented. This shows that work is ongoing, and efforts are still being made to fully realise these measures. Unfortunately, no implementation status information was available for 81 measures. While it is regrettable that details are lacking for these particular measures, this does emphasise the importance of improved data collection and reporting mechanisms to ensure comprehensive and accurate monitoring.

The results show a consistent and continuous implementation of measures over the past years. Of particular note is the significant increase in the number of measures implemented each year, especially from 2018 onwards. This upward trend reflects the growing commitment and proactive efforts of the participating municipalities to advance sustainable initiatives. However, it is also apparent that the total number of measures implemented has plateaued since 2019.

Figure 1 illustrates the number and respective savings of the measures in the different categories. The most prominent areas include efficiency measures and initiatives related to efficiency, renewable energy and sustainability. Within the efficiency measures, there is a notable focus on improving transport systems, promoting renewable energy sources and improving lighting infrastructure. It is important to note, however, that sustainability and quality of life have not been overlooked. Several measures aimed at improving the overall quality of life and promoting sustainability. These measures cover a range of initiatives, including new or improved cycle paths, the creation of new green spaces and waste management measures. These actions reflect a comprehensive approach to creating sustainable communities that prioritise the well-being of residents while minimising their impact on the environment. It can be seen that certain measures, particularly those related to building retrofitting and heating and cooling, have resulted in significant annual savings. These measures have contributed to a total savings estimate of more than 135 GWh/yr. It is important to note that this value represents cumulative savings from 2009 onwards and that not all measures provided information on savings.

Figure 1: Number and savings of implemented measures
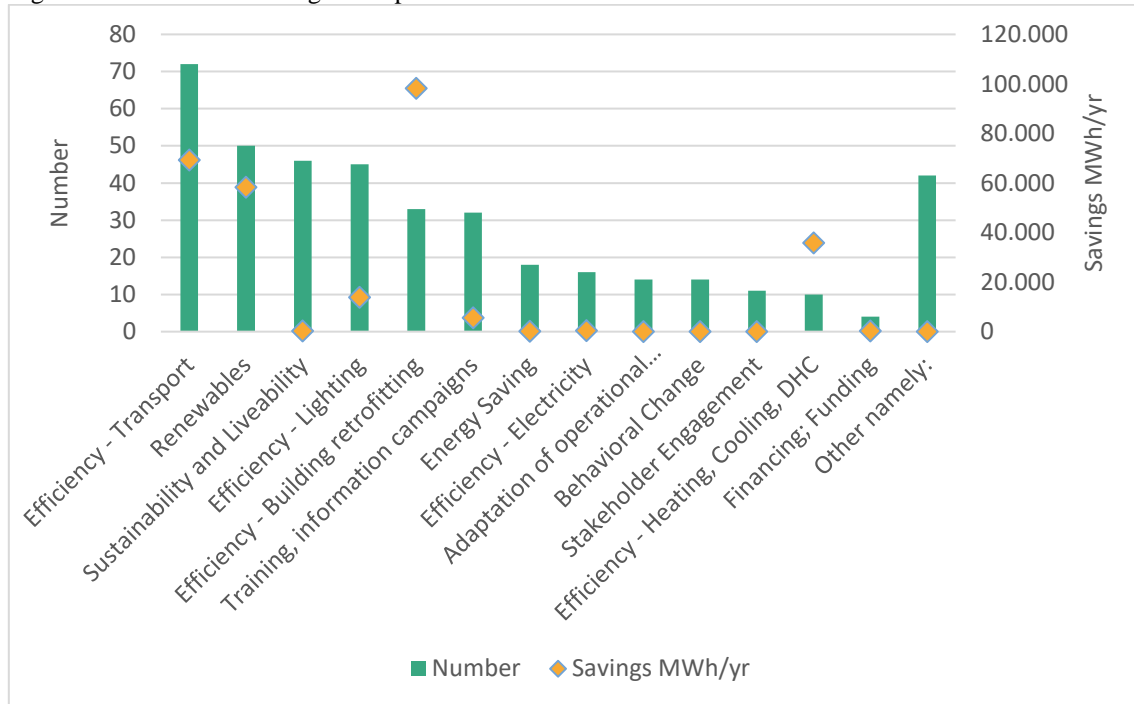
The results of the analyses show that the electricity and transport sectors have implemented the highest number of measures and achieved the greatest savings. This highlights the strong focus on energy efficiency and sustainability in these sectors and demonstrates a proactive approach to reducing energy consumption, promoting renewable energy sources and improving transport efficiency. However, the results also suggest that there is untapped potential for further savings, particularly in the heating and cooling sector. Despite notable achievements in the electricity and transport sectors, the relative paucity of measures implemented in the heating and cooling sector indicates an opportunity for future initiatives. This area is a promising avenue for implementing energy-efficient technologies, optimising heating and cooling systems and exploring renewable energy alternatives. Of the measures reported, only 39 provided information on both savings and investments. These measures were used as a sub-set for further analysis to gain insights into the financial aspects of the implemented initiatives. In this sample, the median savings were 239 MWh/yr and the median investment was 87,500 euros. When analysing the financial efficiency of these measures, the median abatement cost was 0.58 EUR/kWh. It is important to note that this median financial efficiency is relatively high compared to the average abatement costs in buildings or industry, which typically range from 0.01 to 0.03 EUR/kWh.

Throughout the project period, a total of 75 measures were recorded between 2021, 2022 and 2023. Of these measures, only 8 reported savings during the project period, resulting in total energy savings of 7.7 MWh/yr. The median savings of these reported measures were 239 MWh/yr. For the remaining 67 measures, the median savings were used to estimate the total savings of 16 GWh/yr over the project period.

Taking into account the primary energy factor of 1.1 for fuel and 2.4 for electricity, the total primary energy savings achieved by these measures amounted to 30 GWh/yr. When assessing the financial efficiency of the measures, the median efficiency was 0.58 EUR/kWh. Based on this median financial efficiency, the total investment for the project measures was 13.7 million euros.

6. Discussion

Overall, the results of the socio-scientific evaluation show that the learning network approach was perceived as useful and beneficial for the municipalities. Perceived benefits included the exchange and collaboration with other European municipalities and with the municipalities in their own network. This is in line with findings by Haupt (2019), who identified networks as facilitators of personal networking among local policymakers. Knowledge gains were also mentioned by several interview partners, which was also in line with our initial expectations based on the existing literature (Bansard et al. 2017; Kern and Bulkeley 2009). With regard to the evaluation of specific elements of the LMN approach, municipalities in particular were very positive about capacity-building elements such as training. General shortcomings of the LMN approach were also mentioned: Some interviewees reported that the project's

contents were not tailored enough to the needs of municipalities, and that the approach was partly perceived as too abstract. Frequently mentioned barriers to participating in the LMN approach were a lack of time and resources, in particular in small municipalities. Further barriers were the administrative structure in municipalities and changing contact persons due to municipal elections. This is a particularly relevant issue, as the success of the LMN approach was reported to often depend on individual persons in the municipalities. In addition, language can act as a barrier as some materials were only provided in English. Finally, the Covid restrictions that started in 2020 were identified as a challenge in some networks, e.g. digital meetings made collaboration between municipalities more difficult.

Concerning the perceived effects of the LMN approach, the interviews showed that PATH2LC had positive effects on developing or updating SE(C)APs, as well as on implementing the measures defined in those SE(C)APs. This indicates that the positive effects on measure implementation observed in company settings were also found here (cf. Bradke et al. 2015). Some barriers to measure implementation were identified, such as a lack of human and financial resources, a lack of awareness of the SE(C)APs in the municipalities, old or missing data, as well as outdated measures in the SE(C)APs. In addition, PATH2LC's project lifetime of three years was rather short - processes often take a long time, especially in municipalities. On the positive side, the LMN approach further featured some overarching effects that exceeded the specific objectives of the PATH2LC project. The main effect in this regard was that it strengthened networking among the municipalities within the networks, which was perceived as an improvement compared to the previous rather informal structure. As a consequence, expectations about the future development of the network were mainly positive, in particular from the perspective of the municipalities. However, a major shortcoming of the LMN approach is its limited contribution to strengthening the information and knowledge exchange with local actors outside municipal administrations. Here, approaches that specifically aim at fostering these exchanges might be more appropriate, such as those implemented in the projects TOMORROW (https://www.citiesoftomorrow.eu/) and "Improving Municipal Government Services Through Innovation and Local Networks" (The trust for the Americas 2021).

The technical monitoring showed that measures have been implemented evenly and continuously over the last few years (2009-2022). In 2021, a total of 33 measures were implemented, followed by 29 measures in 2022 and 13 measures in 2023, indicating that the participating municipalities show an ongoing commitment to sustainable initiatives and positive change. However, it is notable that many of these measures lack key information on savings, energy sources, and financing. This underscores the need for improved data collection and reporting mechanisms to ensure comprehensive monitoring and evaluation of implemented measures. By addressing these gaps, communities can gain a more holistic understanding of the impact and effectiveness of their sustainability efforts. Of the measures implemented, a significant portion fall into the efficiency or renewable energy category. This indicates that there is a clear focus on promoting energy efficiency and the use of renewable resources to drive sustainable development. By prioritising these areas, participating municipalities are taking meaningful steps to reduce energy consumption and transition to more sustainable energy systems. In addition, it is evident that certain measures in the areas of building retrofits and heating and cooling have the potential to generate significant savings. These specific areas have proven effective in achieving energy efficiency improvements and cost reductions, underscoring the importance of targeting these sectors in other sustainable initiatives. In terms of funding, only 22% of the implemented actions received financial support. This highlights the need for greater emphasis on funding within municipalities. By actively addressing the issue of funding, municipalities can better utilise the available resources and secure additional financial support to implement a greater number of sustainable measures. This finding underlines the importance of fostering collaboration, exploring funding opportunities, and advocating sustainable investments to achieve future progress.

In summary, while measures have been steadily implemented, data reporting must be improved, particularly in terms of savings, energy sources, and financing information. The focus on efficiency and renewable energy is encouraging, but more attention should be paid to building retrofits and heating and cooling measures. In addition, more emphasis on financing is needed to ensure successful implementation of sustainable initiatives in the future.

Our study has several limitations. First, when asked about the perceived effects of the LMN approach on climate action in the municipalities, a positive influence was frequently reported in the interviews. However, some interviewees reported that it is difficult to distinguish between the direct benefits of the approach and the changing context factors (e.g. the energy crisis against the background of the Ukraine war) that raised the importance of energy topics in general. Due to the so-called social desirability bias, the interview partners might also have had a tendency to answer questions in such a way as to present themselves in socially acceptable terms. Thus, they might have been inclined to give more positive than negative feedback. It is also difficult to pinpoint the effect of cultural differences. Interviewees from

different cultural backgrounds might have been more or less inclined to voice positive or negative aspects in their evaluation. In addition, the effects of the network approach were only assessed qualitatively. Further research could also investigate the effects quantitatively using a longitudinal design or control groups.

Finally, methodological points need to be taken into account when interpreting the results: The interviews with the network operators were conducted by two members of the scientific project team, while the interviews with the municipalities were conducted by the network operators themselves. Interviewers can influence interviewees, i.e. how an interviewer behaves in the interview and how they organise the interview can influence the responses. Moreover, outsourcing the interviews with the municipalities to the network operators made it impossible to assure the quality of the interviews, because network operators may have different levels of experience in conducting interviews. Another limitation is that the data collection for this analysis was finalised in April 2023, four months before the end of the project. Consequently, in some networks, not all capacity-building measures had already been carried out at the time of the interviews. This was further exacerbated by schedule shifts in the project resulting from the effects of the Covid pandemic. Finally, there were personnel changes to the network operators and the municipal representatives involved in the LMN approach throughout the project period. As a result, some interview partners lacked in-depth insights into certain time segments of the project.

With regard to the technical monitoring, it can be said that the data quality is insufficient in some places. In future analyses, more data should be collected and solutions should be developed together with the municipalities to enable them to monitor the implemented measures more easily and comprehensively. Additionally, of the 407 measures reported, it is worth noting that only 89 measures received funding, indicating that no information was available for the significant majority of measures, specifically 230, on whether a grant had been obtained or not. This highlights the need for a more robust and focused approach addressing the topic of funding within the municipalities.

7. Conclusion and outlook

This study shows that the LMN approach is viewed very positively and is perceived to bring multiple benefits to municipalities. In addition, many municipalities and network operators stated that they would like to see the cooperation in the network continue. The increasing pressure to tackle climate change at local level may also lead to further municipal activities in the future. Not only the increasingly noticeable effects of climate change, but also the energy crisis may have led to climate and energy becoming more important at local level. The results obtained in this study can be used for a better alignment of the networks' activities to the needs of municipalities. The findings also make it possible to tailor future projects using a similar approach to the specific network participants. However, when doing so, it is important to take into account existing barriers and challenges at the municipal level.

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