PATH2LC

LEARNING MUNICIPALITY NETWORKS

D4.3 Working paper on the analysis and assessment of SEAP/SECAPs measures

31/03/2021

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This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement N° 892560.

CONSORTIUM PARTNERS

LOGO	PARTICIPANT	COUNTRY	TYPE
IREES research for future.	Institute for Resource Efficiency and Energy Strategies (IREES)	Germany	Scientific
Fraunhofer ISI	Fraunhofer Institute for Systems and Innovation Research ISI (Fraunhofer)	Germany	Scientific
TU WIEN TECHNISCHE UNIVERSITÄT WIEN Vienna | Austria	Technische Universität Wien (TU Wien)	Austria	Scientific
e think ENERGY RESEARCH	Zentrum für Energiewirtschaft und Umwelt (e-think)	Austria	Scientific
ENERGYCITIES	Energy Cities (ENC)	France	Scientific
HESPUL	Hespul (HESP)	France	Communication
UCSA Ufficio Comune per la Sostenibilità Ambientale	Ufficio Comune per la Sostenibilità Ambientale (UCSA)	Italy	Local network
SUSTAINABLE CITY CITY NETWORK	Sustainable City Network (SCN)	Greece	Local network
OESTE SUSTENTÁVEL AGÊNCIA REGIONAL DE ENERGIA E AMBIENTE DO OESTE	Agência Regional de Energia e Ambiente do Oeste – OesteSustentável (Oeste)	Portugal	Local network
CITIES NORTHERN NETHERLANDS	City Northern Netherlands represented by City of Leeuwarden (CNNL)	Netherlands	Local network
ALTE69	Agence Locale de la Transition Énergétique du Rhône (ALTE69)	France	Local network

THE PATH2LC PROJECT

In the PATH2LC project public authorities are working together within the framework of a holistic network approach (so called learning municipality networks) with the aim to achieve low-carbon municipalities.

The core of the project activities are the SE(C)APs (Sustainable Energy (and Climate) Action Plans), or similar climate protection plans developed by the municipalities. The PATH2LC project will foster exchange of existing knowledge and experiences among municipalities, enhance coordination among different administrative bodies within the municipalities, improve cooperation with local stakeholders and civil society and will equip stakeholders in public authorities with required planning and monitoring tools to develop and implement transition roadmaps for achieving the targets set in the SE(C)APs.

The holistic network approach intends to link stakeholders in public authorities among municipalities enabling peer-to-peer learning and to increase the engagement for the energy and climate transition. Policy makers and public authorities at local level are supported with scientific analysis and expertise in order to understand and implement their SE(C)AP measures. Five existing networks of municipalities in Italy, Greece, Portugal, the Netherlands and France are participating in the project.

A special interest of the project is to invite other municipalities to replicate the learning municipality network approach and take advantage of the knowledge base collected in the project.

Further information on www.path2lc.eu

Project information

Proposal number: 892560

Acronym: PATH2LC

Title: Public Authorities together with a holistic network approach on the way to low-carbon municipalities

Years of implementation: September 2020 - August 2023

Client: EASME

Acknowledgement

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No. 892560.

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ABBREVIATIONS

CM	Calculation Module
CoM	Covenant of Mayors
EU	European Union
GHG	Greenhouse Gas(es)
H2020	Horizon 2020, the EU funding programme for research and innovation from 2014 to 2020.
JRC	Joint Research Centre, a European Commission's science, and knowledge service which carries out research to provide independent scientific advice and support to EU policy.
LAU2	Local Administrative Unit at level 2 (municipality), formerly NUTS5 a Eurostat territorial unit for statistics.
NUTS3	Nomenclature of Territorial Units for Statistics at level 3 (province/districts), a Eurostat territorial unit for statistics.
PATH2LC	Public Authorities together with a holistic network approach on the way to low-carbon municipalities, a H2020 program.
PV	Photovoltaic
RES	Renewable Energy Source(s)
SEAP	Sustainable Energy Action Plan
SECAP	Sustainable Energy and Climate Action Plan
ST	Solar Thermal

1. INTRODUCTION

The transition towards a new energy system has become an increasingly urgent matter, collectively endorsed at global scale, and addressed at multiple governance levels (Dobravec et al., 2021; Hoppe and Miedema, 2020; Jänicke, 2017; Jänicke et al., 2015). A good example of multilevel governance of the energy transition is the Covenant of Mayors (CoM) (Covenant of Mayors, 2021; Melica et al., 2018): an initiative launched in 2008 as a voluntary commitment by local authorities to implement climate change mitigation measures. When the EU Climate and Energy Package was approved, the CoM was created to bring together regions, cities and towns determined to meet the 2020 climate targets: 20% GHG emissions reduction, 20% renewable share, 20% energy efficiency improvements (European Commission, 2016a). To drive climate action, the CoM established that all its signatories should submit a Sustainable Energy Action Plan (SEAP) (EU Institute for Energy and Transport - JRC (Joint Research Centre), 2010) within two years from joining the initiative. A SEAP defines the local authority´s climate targets, provides an energy and emissions balance, and ideally the concrete actions, responsibilities, and timing to achieve said targets.

As we know, the EU climate ambitions have been raised multiple times after that (CABUZEL, 2019). First in 2014 with the 2030 Energy and Climate targets: 40% GHG emissions reduction, 32% share of renewable energy, 32.5% energy efficiency improvements (European Commission, 2016b). Then in 2015, with the signature of the Paris Agreement, keeping the global temperature increase well below 2 degrees Celsius compared to pre-industrial levels (UNFCCC, 2015). Most recently in 2019, with the European Green Deal (European Commission, 2019a) setting the far-reaching goal of seeing Europe become the first carbon-neutral continent by 2050, raising the 2030 targets, diversifying the instruments sustaining climate action, including adaptation alongside mitigation, in the effort to build a climate-resilient society. Consequently, the CoM updated in 2015 the SEAP requirement with a new format: the Sustainable Energy and Climate Action Plan (SECAP) (Bertoldi et al., 2018).

At country level, governments incorporate the EU climate strategy in the national legislation, and since 2018, they detail in the National Energy and Climate Plans (NECPs) how they plan to achieve the EU targets in the short and mid-term (European Commission, 2019b). Subnational entities, and particularly cities, also play a critical role in tackling climate change by enacting both EU and national climate policy in their municipal by-laws (Fuhr et al., 2018; Limongi, 2018). Being responsible for 75% of global carbon emissions and extremely vulnerable to climate change (Palermo 2020, IPCC 2014, The World Bank 2010), it is evident why cities, towns and local administrations engage in climate action. However, while local administrations are in a favoured position to leverage collective behaviours (Kona et al., 2018; Schoenberger, 2013), they face such limitations that the extent of their contribution to the fight against climate change (Messori et al., 2020; Salvia et al., 2021) remains open to debate. Cities often lack the resources to implement effective measures, have too little competences on key sectors, and the impact of their local climate policies is still unclear (Croci et al., 2017; Grafakos et al., 2020; Pablo-Romero et al., 2018; Palermo et al., 2020).

This study examines a selection of SEAPs and SECAPs of 25 local authorities across Europe belonging to 5 networks of municipalities actively engaged in the low-carbon energy transition, with the aim of answering the research questions: “Do SEAPs and SECAPs contain elements that can increase the chances of their successful implementation?”, “What room for improvement can be found in the SEAPs/SECAPs of municipalities actively engaged in the energy transition?” and “Are local energy and climate action plans aligned to national and European climate targets?”. Not only the action plans are assessed as part of this work, but also the municipalities´ specificities in terms of starting point, progress, barriers and needs. As a result, this work identifies where these cities could use support to advance in their energy transition. Given that the municipalities’ selection presents a significant diversity, the study also displays through concrete examples how a one-size-fits-all support would be inadequate.

The current literature offers assessments of SEAPs/SECAPs, climate action plans, and local climate mitigation policies either for large groups of cities across Europe, based on few indicators with a more statistical approach (Adami et al., 2020; Croci et al., 2017; Heikkinen et al., 2020; Palermo et al., 2020; Reckien et al., 2019; Salvia et al., 2021), or more in-depth analyses for small groups or single cities within

the same region or country (Balest et al., 2019; Boehnke et al., 2019; Coelho et al., 2018; Delponte et al., 2017; Exter et al., 2015; Jekabsone et al., 2019; Messori et al., 2020; Schoenberger, 2013). This study diverts from the literature covering a little investigated combination of a detailed analysis of SEAPs/SECAPs on a medium-sized group of authorities across multiple European countries (Rivas et al., 2015) with additional economic, demographic and energy data.

The selection of municipalities was provided by the municipal networks participating to the Horizon2020 project "Public Authorities together with a holistic network approach on the way to low-carbon municipalities" (PATH2LC): a project aimed at supporting local authorities in their low-carbon transition, by creating a network of stakeholders that fosters the transfer of expert knowledge and peer-to-peer learning, increasing the engagement and effectiveness of the participating municipalities climate action (CORDIS, EU Commission, 2020). Since these networks are already highly motivated to act upon climate change and their municipalities have already developed and implemented their action plans, this works investigates how local climate action of performing cities could go the extra mile.

The assessment described in this paper constitutes the Deliverable 4.3 "Working paper on the analysis and assessment of SEAP/SECAPs measures", which follows and supports a series of five presentations, one per network, which constitutes Deliverable 4.2 "PowerPoint presentations on the assessment of SEAP/SECAPs measures for each Learning Municipality Network". Both Deliverables are inscribed in the Work Package 4 "Outcome and process evaluation" whose aim is to evaluate and monitor the process and the outcomes of the 5 networks as well as to develop recommendations for further improvement of those networks and replication of this peer-to-peer learning approach.

2. METHODOLOGY AND INPUT DATA

The study proceeds in subsequent steps to identify the singularities of the selected municipalities, the strengths and weaknesses of their current energy and emission profiles, as well as of their action plans. Based on that, the study assesses the chances of the chosen municipalities to advance their energy transition and potential elements that could increase them.

First, participating municipalities are compared based on structural and energy parameters such as population, economy structure, employment, energy consumption and GHG emissions by sector and energy carrier to understand their distinctive features. Then, further insight is provided through additional data extracted from the Hotmaps Toolbox and default database, namely with regards to building heating and cooling demand and renewable energy potential. Climate and energy targets for GHG emissions, renewable energy share and energy efficiency, where defined at local level and written in the SEAP/SECAPs, are collected and shown together with the respective national and EU targets, with particular attention for any long-term and sector targets at local level. Eventually, foreseen mitigation and adaptation actions listed in the action plans are categorized by scope and sector, to provide an overview of the most significant measures.

In the second part of the assessment (cf. *D4.4 Working paper: Comparison of targets defined in local action plans and EU 2050 targets broken down to the local level*) the local targets are harmonized to the national and EU targets in order to make them readily comparable. National targets are also broken down to local level and, where local targets are not set or not sufficient to achieve national/EU targets, an indication of the desirable local target compatible with national and EU overall policy is provided.

The same methodology has been applied to all participating municipalities, but each network has been assessed as an independent subset. The list of networks, their municipalities, the type of assessed action plan and its publication year are provided in the results section in Table 1: The participating Networks and Municipalities. "Annex 1: Overview of collected data" lists all parameter that were collected with the relative source and calculations. Measures foreseen in the SEAPs and SECAPs have been categorized as shown in "Annex 2: Categorization of SEAP/SECAP Measures". Local climate targets included in the action plans are compared to national and EU targets and summarized in "Annex 3: Climate and Energy Targets compared at Local, National and EU Level".

2.1. Structure of the analysis: sections and data

The following data has been either collected from the action plans, provided by the network coordinators when included in confidential documentation, or calculated using such data. All data was compared wherever possible with averages at national, EU, and project level obtained through data exported from official statistical databases (e.g.: Eurostat, OECD, EEA, Hotmaps, EU Commission) and processed in own calculations. EU level data was taken for the most recent possible year calculated for EU-28, so still including the UK. Please refer to "Annex 1: Overview of collected data" for a detailed indication of each parameter considered, its measure units, and source. Instead, to access the actual data and its specific reference, please refer to SEAP-SECAP Assessment Data.xlsx.

- *Structural Data on demographics and economics*: population, area, density, percentage of employment and unemployment, average salary, share of economic sectors, administration budget, local tax revenue and climate budget and/or staff dedicated to climate. This data was collected to identify the size and density of municipalities, the urban or rural character, the level of wealth and availability of resources to be potentially engaged in climate action.

- *Energy consumption:* total energy consumption, per capita per economic sector and per energy carrier. This data was collected to obtain a measure of the average energy intensity of the municipality, of the major sectors for energy consumption, and of the diversification of the energy mix. For instance, any significant deviation in the energy consumption per economic sector compared to the shares of economic sectors, could indicate an exceptionally intensive industry or some other important feature of the territory, such as a stretch of highway crossing the municipality area.

- *GHG Emissions:* total GHG emissions, per capita, per economic sector and per energy carrier. Like for the energy consumption data, this data was collected to have a measure of the average emission intensity of the municipality, of the major sources of GHG emissions, both sectors and energy carries. In many cases, the emissions per sector and carrier published in the SEAPs/SECAPs are calculated based on the energy balance, so this set of data usually reflects the energy consumption set, however, any misalignment between these two sets can indicate other important features of the municipality.

- *Renewable energy:* total production per technology, production as share of final consumption and potential for solar, wind, biomass, and excess heat various sources. This data was collected to assess how much in detail the exploitation of renewable energy had been considered by the municipalities. Also, the Hotmaps default database was used to extract various renewable energy sources (RES) potentials. A scenario was run on Hotmaps to estimate the solar potential, both thermal (ST) and photovoltaic (PV), assuming 30% of available roof coverage to be used for solar energy, equally divided between PV and ST. The share of renewable energy was calculated over final energy consumption for municipalities and country average, but it was provided as share of gross final energy consumption at EU level. The gross final energy consumption is the energy used by end-consumers (final energy consumption) plus grid losses and self-consumption of power plants, therefore the share of RES over this value is expected to be smaller than over final energy consumption.

- *Local climate targets:* emissions reductions, share of renewable energy, and energy efficiency improvements, targets, with particular attention to sector and subsector targets as well as long-term targets (beyond 2030). Sector and long-term targets are particularly relevant in the process of setting EU/national compatible local targets.

- *Foreseen actions:* all foreseen actions were harvested from the SEAPs/SECAPs, categorized by field of action (efficiency, renewable energy, energy saving, transport, sustainability, stakeholder engagement) and economic sector of intervention (public administration, industry, agriculture, tertiary, private citizens).

All action plans were provided in original language and used as such or after a machine translation. Data provided directly by the municipalities was checked against the SEAPs/SECAPs and harmonized in terms of units of measure. Where inconsistencies were found and could not be solved, they have been brought to

the attention of the networks and more consistent, reliable or uniform data has been indicated as a potential improvement for future analyses. If the researched data was not available, and no other proxies could be identified, data was marked as missing, and this was taken into consideration.

2.2. Hotmaps

Further insight has been provided using the Hotmaps Toolbox and database. The Hotmaps project is a UE funded H2020 project in which data was collected at various levels (national, regional, and local), stored on over 70 repositories, concerning building stocks, population, industry, climate, renewable energy source potential and other topics.

For each municipality, Hotmaps was used to derive data on: Heating/Cooling demand, Gross Floor Area, Heating/Cooling Degree Days, as well as RES Potential for Solar Photovoltaic (PV), Solar Thermal (ST), Excess Heat and various Biomass sources.

Biomass Potential was calculated extracting NUTS3 level data from Hotmaps, where it is available up to this level, and weighting it per surface for agricultural residues, livestock effluents, and forest residues, and per population for municipal waste. Specific Heat Demand has been calculated as the ratio of Heat Demand over Gross Floor Area, declined for total, residential and non-residential heat demand, as well as for total cooling demand.

Hotmaps layers are described on this Wiki page , while the single layers used for this assessment are listed below with a link to the respective repository:

- Heat Density: Total and Residential
- Cooling Density Total
- Gross Floor Area: Total and Residential
- Heating and Cooling Degree Days
- Industrial Sites Excess Heat
- Wastewater Treatment Plants – Power and Capacity
- Agricultural Residues, Livestock Effluents, Forest Residues
- Municipal Solid Waste
- Wind Potential at 50 meters
- Solar Radiation on Building Footprint

The Calculation Module (CM) Solar Thermal and Photovoltaic Potential was used to calculate the PV and ST total energy production potential. This estimated potential depends on the parameters used in the calculation module. The default parameter used for this assessment was that 30% of potentially available roof area, calculated using the building stock, would be used for solar energy, of which 15% would be used for PV and 15% for ST. The complete set of default parameters for this CM can be found on the Hotmaps Wiki and on the Toolbox.

The territorial units at LAU2 (Local Administrative Unit) level indicating the area of the municipalities, used in the SEAPs/SECAPs and in Hotmaps were assumed to be identical, as Hotmaps uses the Eurostat database of statistical territorial units, but we cannot exclude that some discrepancies in the indication of the territorial units' boundaries might have occurred.

3. RESULTS - FINDINGS

The analysis shows a significantly diversified spectrum: municipalities stand out for heterogeneity of starting conditions, structure, progress in the transition, barriers and needs, depth and level of detail conveyed in the action plans, ambition of targets, type of measures, as well as capacity to advance effectively in the transition. Such diversity is addressed with progressive levels of investigation.

An indication of the network peculiarities, as provided in an introductory meeting with the network coordinators, is summarized below in Table 1: The participating Networks and Municipalities. The characteristics of the networks, their municipalities, and their action plans are detailed. Then the measures foreseen in the action plans are collected and categorized. Finally, some remarks are formulated, and where room for improvement is identified, some suggestions to move forward are provided.

Table 1: The participating Networks and Municipalities

Network Name and Country	Local Administrations	Action Plan Format	Publication Year	Network Description
Rhône Network (ALTE69) - France	CCMDL - Communauté de Communes (CdC) des Monts du Lyonnais (32 municipalities)	SECAP	October 2018	The Rhône network is managed by the recently founded organization ALTE69: Agence Locale de la Transition Énergétique du Rhône. The 9 members are communities gathering some 10 to 40 municipalities, in a rural area in the Rhône region, not far from Lyon, where funds for climate action are not so widely available and the use of biomass is the main measure foreseen to reduce carbon emissions. SECAPs are compulsory in France for all municipalities over 20.000 citizens, most often produced by external consultants. In fact, these administrations are not members of the CoM. They wish to receive an assessment of their SECAPs feasibility and effectivity, an overview of the other networks to learn from similar experiences, and training on how to tap funding. The Syndicat de l'Ouest Lyonnais comprises: CdC de la Vallée du Garon (5 municipalities), CdC du Pays Mornantais (11 municipalities), CdC Pays de l'Arbresle (17 municipalities), CdC Vallon du Lyonnais (8 municipalities).
	CCSB - CdC Saône-Beaujolais (42 municipalities)	SECAP	March 2020	
	COR - Communauté d'agglomération de l'Ouest Rhodanien (31 municipalities)	SECAP	June 2019	
	SOL - Syndicat de l'Ouest Lyonnais (41 municipalities)	SECAP	January 2020	
SCN - Greece	Oichalia	SEAP	September 2017	The network is managed by the organization Sustainable City Network (SCN) and counts 48 members. Few municipalities published a SEAP/SECAPs, some were updated, but not published nor shared on the CoM website. Lack of funding and human resources are behind the missing two -year monitoring. SECAPs have been mostly written by external consultants and municipalities do not have a deep understanding of their content, nor own their data. They wish to receive training to enable the network members to better understand the SECAPs' content, how to implement their measures, tap funding, and achieve their targets, as well as technical assistance on analysis and implementation.
	Ierapetra	SEAP	March 2015	
	Korinth	SEAP	March 2014	
	Vari-Voula-Vouliagmeni	SEAP	September 2016	
	Messinis	SEAP	October 2013	
UCSA - Italy	Palma Campania	SECAP	November 2020	The network is managed by the organization Ufficio Comune Sostenibilità Ambientale (UCSA), which has a good overview

	San Giuseppe Vesuviano			of the member municipalities. The previous SEAP has been updated by a SECAP covering 3 of its 4 municipalities, with individual detailed analysis, and currently. They wish to learn how to be more effective moving from the SECAP to concrete action, to tap funding, prioritize actions, involve and motivate institutional stakeholders and therefore set even more ambitious targets in the future.
	Striano			
CNNL - Netherlands	Groningen	SECAP	August 2018	The network is managed by a selection of the member municipalities' staff thus has a good overview of its members. The development of a SECAP and specific transition roadmap for phasing out natural gas are required by law for all municipalities by December 2020. Therefore, all members have a SECAP, some drafted by external consultants. They mainly wish to learn how other municipalities address climate issues across Europe, how to involve the local community of citizens and stakeholders, and how to motivate them and make them accept the change.
	Assen	SEAP	September 2016	
	Emmen	SEAP	June 2017	
	Leeuwarden	SEAP	February 2016	
Oeste Sustentável - Portugal	Alcobaça	SEAP	June 2014	The network is managed by the dedicated Regional Agency for Energy and Environment of the region Oeste: Oeste Sustentável. Their member municipalities developed a SEAP when joining the CoM several years ago. The analysis of the SEAPs remained with the consultants that developed them, so now the network and its municipalities do not always grasp fully the details of the analyses and the plans. The network wish to receive capacity building to pass it on to their member municipalities, to better support them in developing transition roadmaps and new SECAPs.
	Alenquer	SEAP	June 2014	
	Arruda dos Vinhos	SEAP	June 2014	
	Bombarral	SEAP	June 2014	
	Caldas de Rainha	SEAP	June 2014	
	Nazaré	SEAP	June 2014	
	Óbidos	SEAP	July 2013	
	Peniche	SEAP	June 2014	
	Torres Vedras	SEAP	July 2013	

3.1. Assessment of the Action Plans

The action plans are assessed for format, structure, date, completeness of data, level of detail, level of ambition of climate targets, targets time horizon, baseline year, presence of sector and subsector targets, adaptation besides mitigation measures, prioritization of measures, RES potential, explicit mention of relevant national climate regulation and interaction with local climate dispositions. Below, these parameters are addressed one by one.

The action plans show a **variety of structure and format**, first because some are older documents, modelled after the **SEAP** template (Greece, Portugal and most of Netherland), while others are more recent and structured according to the new **SECAP** template (France, Italy, and Groningen of the Dutch network). Second, because every municipality drafted its own analysis and plan. What can be noted, however, is that action plans of municipalities of the same network show many similarities, suggesting that they were drafted by the same authors.

The **level of detail** reported in the action plans is also considerably diversified: some present detailed, complete, and disaggregated data for all sections of the document (French, Italian, and some of the Dutch cities: Groningen and Assen), while others present mostly aggregated, partial data, with little level of detail, which hinders further considerations, and might be a signal that a less accurate analysis was done to draft the action plan. This can be observed for instance with regard to the energy balance and the emission inventory, showing data detailed per sector, per carrier, consistent with the structure of economic sectors, or more aggregated and inconsistent. In addition, the accounting of how the prospected emission reductions will be achieved through the planned actions can be a clear indication of the detail and accuracy of the analysis.

The **level of ambition** of the climate targets varies greatly following a trend already witnessed (Adami et

al., 2020; Messori et al., 2020; Palermo et al., 2020; Salvia et al., 2021): with higher targets in north-central Europe and in largest cities, decreasing the more the municipalities are located in southern-peripherical countries, and in smaller cities, with the due exceptions. It has been observed that municipalities in colder climates show a greater advancement in their action plans implementation compared to municipalities in warmer climates. This study cannot confirm or deny that trend as the indication of regular monitoring has been provided only by the Dutch and the Italian networks.

Concerning the **targets time horizon**, most assessed municipalities have 2020 emission targets (all except from Leeuwarden), partially in line with the EU target; more frequently showing less rather than more ambition compared to EU level. Some municipalities have also 2030 targets and targets for renewable energy share and energy efficiency improvements, but very few have 2050 targets and sector or subsector targets. This can be linked to the fact that the SEAP template had the inclusion of a 2020 emission reduction target as a minimum requirement, and the SECAP template included a 2030 emission reduction target, but none of the CoM formats explicitly requested any target beyond these dates, nor for parameters such as renewable energy, energy efficiency, and sector targets.

A more detailed overview of the respective energy targets at local, national and EU level is provided in "Annex 3: Climate and Energy Targets compared at Local, National and EU Level". However, local targets are not readily comparable among different municipalities, nor with national and EU level targets because they divert not only in terms of time horizon, but also of **baseline year**. In fact, the selected baseline year for the energy balance, the emission inventory, and the energy and climate targets varies across plans. A harmonization of both the target baseline year and time horizon, as previously mentioned, will be the object of a subsequent deliverable (*D4.4 Working paper: Comparison of targets defined in local action plans and EU 2050 targets broken down to the local level*).

Another level on unevenness is the presence and ambition of **sector and subsector targets** such as the use of biomass, the rate of building renovation, as well as the share of renewables and the efficiency in specific sectors. These are present only in the Dutch and French networks' action plans.

Keeping in mind these misalignments, it can be observed nonetheless that the Dutch network is the most ambitious one. It presents in fact three cities committed to carbon neutrality, Groningen by 2035, 15 years earlier than the overall EU target, and Assen and Emmen by 2050. Most cities set targets for the building footprint, energy consumption and renovation. However, each city shows a very specific pathway, where Assen and Leeuwarden's intermediate targets seem to indicate a slow start and a progressive increase of carbon cuts, while Leeuwarden has no overall emissions reduction target. The French network shows a long-term vision with targets that go as far as 2050, with intermediate 2025/2030 targets, and targets for renewables, efficiency, and sectors such as biomass, building renovation rate, electricity consumption. Some communities plan to become energy positive by 2050, and 2020 emissions targets are mostly aligned to EU policy, but other targets are not enough to achieve carbon neutrality by 2050 and the level of ambition progressively decreases with further and more specific targets. The Italian network commits to emissions reduction targets aligned to EU level for 20202 and as high as 60% for 2030, much more ambitious than EU targets. The plans are supported by a very thorough analysis, but set no targets for renewable energy, efficiency improvements or any sector targets. The Greek municipalities are broadly aligned to EU 2020 targets but have almost no targets after that year. The Portuguese municipalities show only 2020 emission reductions targets: one exceeding the EU 2020 targets, a few in line with it, and others committed to lower targets. The Italian, Greek and Portuguese networks foresee actions addressing specific sectors, but do not set any specific targets in this regard.

While all action plans foresee several **mitigation** measures, only some also include some **adaptation** measures, mainly because the SEAP template did not have them as a minimum requirement, while the more recent SECAP includes them. In particular, mitigation measures have both qualitative and sometimes quantitative targets, while adaptation measures have almost only qualitative targets.

Concerning the **prioritization** of actions, the French network is the only one where SECAPs foresee it explicitly. This might be read as a sign of a more programmatic and action-oriented analysis, missing in the action plans of the other networks.

The **available local potential for renewable energy sources** is indicated explicitly only in the action plans of the French network. Two action plans of the Dutch network mention that the RES potential has been estimated, while no reference is made in any other action plans. The estimation of the local RES potential and its inclusion in the action plan is not required by the CoM, but it is a sign of a thorough analysis oriented to increase the exploitation of such potential.

The **interaction between local and national targets/regulation** is mostly missing, being clearly defined only in the plans of the French network and in Groningen´s.

3.2. Categorization of Actions

The measures foreseen in the action plans have been categorized and mapped based on their main field of action: energy conservation, energy efficiency, renewable energy, financing tools, stakeholders' engagement, carbon sinks, sustainability, and adaptation. Energy efficiency and renewable energy measures have been further categorized. Energy efficiency measures were categorized based on the subfields: building retrofitting, LED lighting, transport, heating and cooling, and District heating and cooling. Renewable energy measures were categorized based on the technologies: biomass, biogas, solar, wind, geothermal, hydrogen, and other. Where measures addressed mainly one category and only indirectly other categories, they have been mapped once, unless they clearly addressed more than one category. Measures have been mapped also based on the target sectors: industry, tertiary, agriculture, public administration, residential, transport.

The "Annex 2: Categorization of SEAP/SECAP Measures" provides an overview of this categorization for field of action, target sector as well as an indication of the number of measures.

3.3. Remarks, room for improvement and suggestions to move forward

Action Plans are just a first step into the local energy transition and do not give any indication of the implementation progress that the municipalities have achieved since their publication. However, already in the action plan, elements can be found giving important indications of the thoroughness of the analysis supporting them and of how action-oriented the municipality approach is. Such elements are not mandatory for the CoM SEAP/SECAP template, but they are still desirable, as they can complete the picture of the available local climate actions, identify and anticipate potential barriers that otherwise could be faced later on, and overall, increase the chances of a successful implementation achieving the set targets. Where room for improvement emerged in this assessment, a few suggestions have been formulated to help the municipalities becoming more ambitious in their future commitments and more effective in the drafting and implementation of their plans.

Action plans that are **recent, regularly updated or accompanied by regular monitoring** show both a more accurate picture of the options for climate action, as well as more methodical follow up and implementation. Likewise, the **level of detail** portrayed in the plans can reflect the level of accuracy of the analysis behind them. Where older plans, less detailed and lacking regular monitoring were found, further research could identify whether some barriers prevented thorough implementation and a regular monitoring. A subsequent paper will elaborate on the barriers and success factors of the climate action at local level (D4.9 Working paper on barriers, success factors and decision process on local level).

The assessment over structural data shows that while **wealthier municipalities are more energy and emission intensive**, others show more sober energy and emission profiles often battle with the issue of **energy poverty**. **Modest energy mix diversification** as well as **limited renewable energy production** can be observed across the whole sample analysed. Also, an effective exploitation of the local renewable energy potential should be based on an accurate estimation, but the indication of the **RES potential** is predominantly absent in the action plans.

Carbon emissions reduction targets are set in all municipalities except one, and are mostly aligned with

national/EU targets, but **targets for renewable energy, energy efficiency and specific sectors** are less common, and they could be a step forward for those municipalities looking for improvements.

The **timespan** of most action plans follows the minimum requirements of the CoM, providing **no targets beyond 2020 for SEAPs and 2030 for SECAPs**. Those municipalities who have formulated a long-term strategy, could add mid- and long-term targets to their plans, adopting scenarios to gives consistency and depth to their analysis.

A **prioritization of foreseen actions** could be found only in very few plans. The municipalities who wish adopting a programmatic and action-oriented approach already from their plans, could include a priority order as well as a draft timeline with concrete implementation steps.

It can be observed that older action plans focus more on **measures addressing municipal premises** (buildings, equipment, vehicles, and staff). While this approach can increase the chances of an easier and more thorough implementation because less actors are involved, the impact of such measures is limited to energy consumption of the local administration which is usually a very small part of the whole municipality energy consumption. An improvement to this approach can be seen in more recent plans that foresee measures **involving private citizens and local businesses**. As already noted by some authors (Coelho et al., 2018; Palermo et al., 2020)), achieving a successful implementation without a full involvement of local stakeholders can prove very difficult.

The **interaction between local and national targets and regulation** is mainly missing in the local action plans. The measures that have proven achieving the greatest impact, such as regulation and financial tools, are adopted more rarely in the local action plans (Palermo et al., 2020) and they could be integrated in future plans as a step forward.

Adopting **financial tools** to make climate actions financially attractive for local stakeholders is a mean to overcome resistance to change as well as to motivate residents. Municipalities willing to adopt them could consider a mix of tax deductions for sustainable investments, facilitated financing, incentives for virtuous behaviours, and reduced energy bills. Other measures that can curb resistance to change are increasing comfort for users (e.g., ease to use of zero emission vehicles) and communicating what the community is already doing for the energy transition as well as highlighting sustainability as one of the local identity values.

One common issue observed is that municipalities often **lack the financial, technical, and human resources** that would allow them achieving an optimal level of accuracy and effectiveness both in the drafting and the implementation phase of their action plans. This issue is common especially among **small municipalities** which constitute the majority of EU municipalities. Therefore, **they could greatly benefit from receiving support** in drafting more accurate analyses, detailed energy balances and emission inventories, RES potential estimations, DH&C potential assessment, setting targets in line with national and EU policy, especially for RES, efficiency, and sectors, as well as developing regulation, policy and financing tools to encourage and support community participation. Such support could be found in a network, such as the learning network established in PATH2LC, but also in other network organizations.

4. DISCUSSION

While some action plans seem to be aligned to national and EU level targets for emission reductions in the short term, it is still unclear if they are as well in the long term. A harmonization process of the targets baseline and time horizon is needed to verify such alignment as well as the compatibility of local policies with national strategies e.g., with regards to the biomass local potential and foreseen increase in consumption and the national climate strategy. However, elements of uncertainty lay in the different implementation of local and national plans.

The assessment relied mostly on SEAP/SECAP data, but some data was missing, and some seemed inconsistent with the rest of the plan and other plans in the same network and in other networks. Given the local level, missing and inconstant data could not be retrieved by other sources such as national and EU

statistical institute databases. Therefore, a certain level of uncertainty of the data had to be assumed in the assessment.

The categorization and counting of measures hold an element of subjectivity, especially for transversal measures, and the number of measures might not be directly related to the impact of the same.

While it is quite tempting to assume that more detailed and accurate action plans, accompanied by regular monitoring, might lead to a more effective implementation, there is no mean to determine such correlation other than assessing the plans actual implementation. What some attentions and additional care can do, is to increase the chances that an effective and timely implementation will occur. Likewise, the presence of long-term targets and subsector targets cannot always predict a more effective implementation, but it can increase its chances and yet with some exceptions. This could be the case of municipalities having a long-term strategy, precisely structured over multiple sectors, that do not want to risk committing to targets that they might not achieve due to unforeseen circumstances and prefer to commit publicly only to part of their identified targets, which are those found on their action plans. Similarly, the absence of long-term and subsector targets cannot be read as a sign of a political commitment not supported by an action-oriented approach.

In fact, this assessment cannot prove that the presence of all above-mentioned SEAP/SECAP elements will determine an effective and timely implementation of the action plans, while their absence could prevent it, but it assumes that they can affect positively or negatively the chances of a successful implementation and are therefore desirable. As a matter of fact, signs of a programmatic approach such as prioritization of the measures, an implementation timeline with concrete steps, actions encouraging participation such as regulatory provisions and financial tools can be found in the action plans of more ambitious and successful energy transitions, but per-se cannot determine a successful transition.

5. CONCLUSIONS

This in-depth assessment on a medium-sized number of action plans provided enough elements to show the highly diversified landscape of local climate action. Not only the sample of municipalities showed very different starting point, possibilities, strategies and progress in their transition, but they also produced substantially different action plans, although mainly driven by the CoM templates. This alone confirms that no one-size-fits-all approach is possible in local climate action, and that each administration shows different needs. Concerning the action plans, not all desirable elements were found, and room for improvement could be identified even in the plans of also of ambitious and highly motivated municipalities. Local targets seemed only partly aligned with national and EU targets, but further analysis is needed to harmonize such targes and determine the measure of said misalignment. However, already the fact that the municipalities developed such plans show a great motivation to act at local level to advance in the sustainable energy transition. As many as possible of the elements that could increase the chances of an easier, more effective, and timelier implementation should be considered already at the action plan drafting stage. The assessed municipalities could include them in their future updates, and other municipalities could build on their experience and this assessment.

Ultimately, whether such elements and additions or improvements should be adopted in future action plans or not, is a decision that only the local administration drafting the plan can take, on the basis of their specific cost-benefit analysis: the effort to collect additional data, to draft more detailed analysis and to adopt a long term vision and a programmatic approach, assessing RES potentials, including measures that support private action such as regulation, standards and financial tools, setting sector targets, practical steps to move into the implementation phase and possibly a timeline. Such elements cannot determine the success of the implementation, but they can provide a clearer picture and anticipate elements of uncertainty and barriers that could otherwise be discovered only during the actual implementation. Also, the precise features captured in each action plan must be taken into consideration not only when drafting the action plans, but also during their implementation and especially in assisting the local administrations in their transition.

ACKNOWLEDGEMENT

This work has been performed in course of the Horizon 2020 project Path2LC (project number 892560) funded by the European Commission, to which I convey my deepest appreciation for providing the funding to carry out the present investigation. This work has greatly benefited from the discussions within the project consortium and mainly with the colleagues Marcus Hummel and Andreas Müller of e-think, Edith Chassein of IREES, Uta Burghard and Markus Fritz of Fraunhofer ISI, as well as with the local partners, Fréderic Bazzoli of ALTE69, Panayiotis Michael of SCN, Luigi Acquaviva and Michela Aufiero of UCSA, Michiel Deboer and Joep Poot of CNNL, and Filipa Carlos and Manuela Gervasi of Oeste Sustentável.

REFERENCES

Adami, L., Tubino, M., Ragazzi, M., Conti, F., Rada, E., 2020. Local Actions for Reducing Global Greenhouse Gas Footprint: 10 Years of Covenant of Mayors Initiative. Int. J. Sustain. Dev. Plan. 15, 247–252. https://doi.org/10.18280/ijsdp.150216

Balest, J., Secco, L., Pisani, E., Garegnani, G., 2019. Municipal transitions: The social, energy, and spatial dynamics of sociotechnical change in South Tyrol, Italy. Energy Res. Soc. Sci. 54, 211–223. https://doi.org/10.1016/j.erss.2019.04.015

Bertoldi, P., Lah, O., DALLEMAND, J.-F., Follador, M., GONZALEZ, Y., 2018. Guidebook "How to develop a Sustainable Energy and Climate Action Plan (SECAP)."

Boehnke, R.F., Hoppe, T., Brezet, H., Blok, K., 2019. Good practices in local climate mitigation action by small and medium-sized cities; exploring meaning, implementation and linkage to actual lowering of carbon emissions in thirteen municipalities in The Netherlands. J. Clean. Prod. 207, 630–644. https://doi.org/10.1016/j.jclepro.2018.09.264

CABUZEL, T., 2019. EU climate action and the European Green Deal [WWW Document]. Clim. Action - Eur. Comm. URL https://ec.europa.eu/clima/policies/eu-climate-action_en (accessed 3.5.21).

Cajot, S., Peter, M., Bahu, J.-M., Guignet, F., Koch, A., Maréchal, F., 2017. Obstacles in energy planning at the urban scale. Sustain. Cities Soc. 30, 223–236. https://doi.org/10.1016/j.scs.2017.02.003

Cinocca, A., Santini, F., Cipollone, R., 2018. Monitoring methodologies and tools for the Sustainable Energy Action Plans to support the Public Administration. Energy Procedia, ATI 2018 - 73rd Conference of the Italian Thermal Machines Engineering Association 148, 758–765. https://doi.org/10.1016/j.egypro.2018.08.135

Coelho, S., Russo, M., Oliveira, R., Monteiro, A., Lopes, M., Borrego, C., 2018. Sustainable energy action plans at city level: A Portuguese experience and perception. J. Clean. Prod. 176, 1223–1230. https://doi.org/10.1016/j.jclepro.2017.11.247

CORDIS, EU Commission, 2020. H2020 PATH2LC Porject: Public Authorities together with a holistic network approach on the way to low-carbon municipalities [WWW Document]. URL https://cordis.europa.eu/project/id/892560 (accessed 3.5.21).

Covenant of Mayors, 2021. About, Originis and Development [WWW Document]. URL https://www.covenantofmayors.eu/about/covenant-initiative/origins-and-development.html (accessed 3.5.21).

Croci, E., Lucchitta, B., Janssens-Maenhout, G., Martelli, S., Molteni, T., 2017. Urban CO2 mitigation strategies under the Covenant of Mayors: An assessment of 124 European cities. J. Clean. Prod., Experimentation for climate change solutions 169, 161–177. https://doi.org/10.1016/j.jclepro.2017.05.165

Delponte, I., Pittaluga, I., Schenone, C., 2017. Monitoring and evaluation of Sustainable Energy Action Plan: Practice and perspective. Energy Policy 100, 9–17. https://doi.org/10.1016/j.enpol.2016.10.003

Dobravec, V., Matak, N., Sakulin, C., Krajačić, G., 2021. Multilevel governance energy planning and policy: a view on local energy initiatives. Energy Sustain. Soc. 11, 2. https://doi.org/10.1186/s13705-020-00277-y

EU Institute for Energy and Transport - JRC (Joint Research Centre), 2010. Guidebook "How to Develop a Sustainable Energy Action Plan (SEAP)" [WWW Document]. EU Sci. Hub - Eur. Comm. URL https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/guidebook-how-develop-sustainable-energy-action-plan-seap (accessed 3.5.21).

European Commission, 2019a. A European Green Deal [WWW Document]. Eur. Comm. - Eur. Comm. URL https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en (accessed 3.5.21).

European Commission, 2019b. National energy and climate plans (NECPs) [WWW Document]. Energy - Eur. Comm. URL https://ec.europa.eu/energy/topics/energy-strategy/national-energy-climate-plans_en (accessed 3.5.21).

European Commission, 2016a. EU 2020 climate & energy package [WWW Document]. Clim. Action - Eur. Comm. URL https://ec.europa.eu/clima/policies/strategies/2020_en (accessed 3.5.21).

European Commission, 2016b. EU 2030 climate & energy framework [WWW Document]. Clim. Action - Eur. Comm. URL https://ec.europa.eu/clima/policies/strategies/2030_en (accessed 3.5.21).

Exter, R. den, Lenhart, J., Kern, K., 2015. Governing climate change in Dutch cities: anchoring local climate strategies in organisation, policy and practical implementation. Local Environ. 20, 1062–1080. https://doi.org/10.1080/13549839.2014.892919

Fuhr, H., Hickmann, T., Kern, K., 2018. The role of cities in multi-level climate governance: local climate policies and the 1.5 °C target. Curr. Opin. Environ. Sustain. 30, 1–6. https://doi.org/10.1016/j.cosust.2017.10.006

Grafakos, S., Viero, G., Reckien, D., Trigg, K., Viguie, V., Sudmant, A., Graves, C., Foley, A., Heidrich, O., Mirailles, J.M., Carter, J., Chang, L.H., Nador, C., Liseri, M., Chelleri, L., Orru, H., Orru, K., Aelenei, R., Bilska, A., Pfeiffer, B., Lepetit, Q., Church, J.M., Landauer, M., Gouldson, A., Dawson, R., 2020. Integration of mitigation and adaptation in urban climate change action plans in Europe: A systematic assessment. Renew. Sustain. Energy Rev. 121, 109623. https://doi.org/10.1016/j.rser.2019.109623

Heikkinen, M., Karimo, A., Klein, J., Juhola, S., Ylä-Anttila, T., 2020. Transnational municipal networks and climate change adaptation: A study of 377 cities. J. Clean. Prod. 257, 120474. https://doi.org/10.1016/j.jclepro.2020.120474

Hoppe, T., Miedema, M., 2020. A Governance Approach to Regional Energy Transition: Meaning, Conceptualization and Practice. Sustainability 12, 915. https://doi.org/10.3390/su12030915

Jänicke, M., 2017. The Multi-level System of Global Climate Governance – the Model and its Current State. Environ. Policy Gov. 27, 108–121. https://doi.org/10.1002/eet.1747

Jänicke, M., Schreurs, M., Töpfer, K., 2015. The Potential of Multi-Level Global Climate Governance 12.

Jekabsone, A., Kamenders, A., Rosa, M., Kaselofsky, J., Schule, R., 2019. Assessment of the Implementation of Sustainable Energy Action Plans at Local Level. Case Study of Latvia. Environ. Clim. Technol. 23, 36–46. https://doi.org/10.2478/rtuect-2019-0053

Kona, A., Bertoldi, P., Monforti-Ferrario, F., Rivas, S., Dallemand, J.F., 2018. Covenant of mayors signatories leading the way towards 1.5 degree global warming pathway. Sustain. Cities Soc. 41, 568–575. https://doi.org/10.1016/j.scs.2018.05.017

Limongi, G., 2018. Chapter 10 - European Cities Addressing Climate Change, in: Galderisi, A., Colucci, A. (Eds.), Smart, Resilient and Transition Cities. Elsevier, pp. 75–84. https://doi.org/10.1016/B978-0-12-811477-3.00010-9

Melica, G., Bertoldi, P., Kona, A., Iancu, A., Rivas, S., Zancanella, P., 2018. Multilevel governance of sustainable energy policies: The role of regions and provinces to support the participation of small local authorities in the Covenant of Mayors. Sustain. Cities Soc. 39, 729–739. https://doi.org/10.1016/j.scs.2018.01.013

Messori, G., Brocchieri, F., Morello, E., Ozgen, S., Caserini, S., 2020. A climate mitigation action index at the local scale: Methodology and case study. J. Environ. Manage. 260, 110024. https://doi.org/10.1016/j.jenvman.2019.110024

Pablo-Romero, M. del P., Pozo-Barajas, R., Sánchez-Braza, A., 2018. Analyzing the effects of the benchmark local initiatives of Covenant of Mayors signatories. J. Clean. Prod. 176, 159–174. https://doi.org/10.1016/j.jclepro.2017.12.124

Palermo, V., Bertoldi, P., Apostolou, M., Kona, A., Rivas, S., 2020. Assessment of climate change mitigation policies in 315 cities in the Covenant of Mayors initiative. Sustain. Cities Soc. 60, 102258. https://doi.org/10.1016/j.scs.2020.102258

Reckien, D., Salvia, M., Pietrapertosa, F., Simoes, S.G., Olazabal, M., De Gregorio Hurtado, S., Geneletti, D., Krkoška Lorencová, E., D'Alonzo, V., Krook-Riekkola, A., Fokaides, P.A., Ioannou, B.I., Foley, A., Orru, H., Orru, K., Wejs, A., Flacke, J., Church, J.M., Feliu, E., Vasilie, S., Nador, C., Matosović, M., Flamos, A., Spyridaki, N.-A., Balzan, M.V., Fülöp, O., Grafakos, S., Paspaldzhiev, I., Heidrich, O., 2019. Dedicated versus mainstreaming approaches in local climate plans in Europe. Renew. Sustain. Energy Rev. 112, 948–959. https://doi.org/10.1016/j.rser.2019.05.014

Rivas, S., Melica, G., Kona, A., Zancanella, P., Serrenho, T., Iancu, A., Koffi, B., Gabrielaitiene, I., Janssens-Maenhout, G., Bertoldi, P., 2015. The Covenant of Mayors: In-depth Analysis of Sustainable Energy Actions Plans.

Salvia, M., Reckien, D., Pietrapertosa, F., Eckersley, P., Spyridaki, N.-A., Krook-Riekkola, A., Olazabal, M., De Gregorio Hurtado, S., Simoes, S.G., Geneletti, D., Viguié, V., Fokaides, P.A., Ioannou, B.I., Flamos, A., Csete, M.S., Buzasi, A., Orru, H., de Boer, C., Foley, A., Rižnar, K., Matosović, M., Balzan, M.V., Smigaj, M., Baštáková, V., Streberova, E., Šel, N.B., Coste, L., Tardieu, L., Altenburg, C., Lorencová, E.K., Orru, K., Wejs, A., Feliu, E., Church, J.M., Grafakos, S., Vasilie, S., Paspaldzhiev, I., Heidrich, O., 2021. Will climate mitigation ambitions lead to carbon neutrality? An analysis of the local-level plans of 327 cities in the EU. Renew. Sustain. Energy Rev. 135, 110253. https://doi.org/10.1016/j.rser.2020.110253

Schoenberger, P., 2013. Municipalities as Key Actors of German Renewable Energy Governance: An Analysis of Opportunities, Obstacles, and Multi-Level Influences 39.

ANNEX 1: OVERVIEW OF COLLECTED DATA

Table 2: Overview of collected data.

Class of Data	Single Data/indicator Collected	Geographical Level	Source(s) (main source indicated first, followed by supplementary sources used when the first is not available)
Action Plans	Format: SEAP/SECAP	Municipality	Action Plans
	Date of publication	Municipality	Action Plans
	Link(s) to document(s)	Municipality	Covenant of Mayors website. Local Network/Municipality website when not CoM signatories or not available on CoM page. Provided by Local Network when not published.
	Baseline Year	Municipality	Action Plans
	Socio-Economic Background	Municipality	Action Plans
	Energy Balance	Municipality	Action Plans
	Baseline Emissions Inventory	Municipality	Action Plans
	Main Targets (emissions, renewables, efficiency)	Municipality	Action Plans
	Mitigation Actions	Municipality	Action Plans
	Adaptation Actions	Municipality	Action Plans
	Risk and Vulnerability Assessment	Municipality	Action Plans
	Monitoring	Municipality	Action Plans
	Implementation Roadmap	Municipality	Action Plans
Structural Data	Population [n of inhabitants]	Municipality	Action Plans. National Statistic Institutes when not indicated in the Action Plans.
		National Average per Municipality	National Statistics Institutes and own calculations: *National Population/N of municipalities in the Country*
		Project Average per Municipality	Own calculations: *Sum of population in participating municipalities/N of participating municipalities*
	Population age structure [% per age classes]	Municipality	Local Networks
	Area [km²]	Municipality	Action Plans. Provided by Local Networks when not indicated in the Action Plans.
		National Average per Municipality	National Statistics Institutes and own calculations: *Country Area/N of municipalities in the Country*
		Project average per Municipality	Own calculations: *Sum of municipality areas of participating municipalities/N of participating municipalities*
	Density [inhabitants/km²]	Municipality	Own calculations: *Municipality Population/Municipality Area*
		National Average	Own calculations: *Country Population/Country Area*

Class of Data	Single Data/indicator Collected	Geographical Level	Source(s) (main source indicated first, followed by supplementary sources used when the first is not available)
		Project Average	Own calculations: *Sum of municipality population of participating municipalities/Sum of municipality areas of participating municipalities*
	Employment/Unemployment rate [%]	Municipality	Provided by Local Networks, when available (harvested from National Statistics Institutes websites or confidential documents)
		National Average	National Statistics Institutes
		EU average	Eurostat
	Average gross yearly GDP/income per capita [€ PPP]	Municipality	Provided by Local Networks
		National Average	OECD Database
		EU average	OECD Database
	Gross value added at basic prices [yearly, € per capita]	Municipality	Own calculations: *NUT3 Gross value added (Eurostat)/NUTS3 Population * Municipality population*
		NUTS3 Region	Eurostat
		National	Eurostat
	Economy sectors' structure [%]: Agriculture, Industry, Tertiary, etc.	Municipality	Action Plans. Provided by Local Networks when not indicated on the Action Plans.
	PA Budget [€]	Municipality	Provided by Local Networks, when available
	Local Tax Revenue/ National contribution share [€ or %]	Municipality	Provided by Local Networks, when available
	Climate Action Budget [€]	Municipality	Provided by Local Networks, when available
	Climate/energy/ environment dedicated staff [n of employees]	Municipality	Provided by Local Networks, when available
Energy consumption	Final Energy consumption [GWh]	Municipality (Total and Per Capita)	Total: Action Plans Per capita: own calculations: *Municipality Total Final Energy Consumption/Municipality Population*
		National (Per Capita)	Own calculations: *National Total Final Energy consumption (Eurostat)/National Population*
		EU Average (Per Capita)	Own calculations: *EU Total Final Energy consumption (Eurostat)/EU Population (Eurostat)*
		Project Average (Per Capita)	Own calculations: *Sum of Municipality Total Final Energy consumption of participating municipalities/Sum of Municipalities Population*
	Energy consumption per Energy Carrier/Technology [%]	Municipality	Action Plans
		National	Absolute values in Country Energy Balance: Eurostat

Class of Data	Single Data/indicator Collected	Geographical Level	Source(s) (main source indicated first, followed by supplementary sources used when the first is not available)
			% share: own calculations
		EU average	Absolute values in EU Energy Balance: Eurostat % share: own calculations
	Energy consumption per Sector [%]	Municipality	Action Plans
		National	Absolute values in Country Energy Balance: Eurostat % share: own calculations
		EU average	Absolute values in EU Energy Balance: Eurostat % share: own calculations
	Primary Energy consumption	Municipality	Local Networks (when available)
		National	Eurostat and own calculations
Building Related Data	Heat demand Total [GWh/yr]	Municipality	Hotmaps
	Heat demand Residential [GWh/yr]	Municipality	Hotmaps
	Cooling demand Total [GWh/yr]	Municipality	Hotmaps
	Gross Floor Area Total [m²]	Municipality	Hotmaps
	Gross Floor Area Residential [m²]	Municipality	Hotmaps
	HDD [Kd]	Municipality	Hotmaps
	CDD [Kd]	Municipality	Hotmaps
	Specific Heat Demand Total [GWh/yr/m²]	Municipality	Hotmaps and own calculations: *Heat Demand Total / Gross Floor Area Total*
	Specific Heat Demand Residential [GWh/yr/m²]	Municipality	Hotmaps and own calculations: *Heat Demand Res. / Gross Floor Area Res.*
	Specific Heat Demand Non-Residential [GWh/yr/m²]	Municipality	Hotmaps and own calculations: *Heat Demand Non-Res./Gross Floor Area Non-Res*
GHG Emissions	GHG Emissions [tCO2e] total and per capita	Municipality (Total and Per Capita)	Total: Action Plans Per capita: own calculations: *Municipality Total GHG Emissions/Municipality Population*
		National (Per Capita)	Own calculations: *National Total GHG Emissions (European Environment Agency)/National Population*
		EU Average (Per Capita)	Own calculations: *EU Total GHG Emissions (European Environment Agency)/EU Population (Eurostat)*
		Project Average (Per Capita)	Own calculations: *Sum of Municipality Total GHG Emissions of participating municipalities/Sum of Municipalities Population*
	GHG Emissions per Energy Carrier/Technology [%]	Municipality	Action Plans
		National	Absolute values in Country GHG Emissions Inventory: European Environment Agency % share: own calculations

Class of Data	Single Data/indicator Collected	Geographical Level	Source(s) (main source indicated first, followed by supplementary sources used when the first is not available)
		EU average	Absolute values in EU GHG Emissions Inventory: European Environment Agency % share: own calculations
	GHG Emissions per Sector [%]	Municipality	Action Plans
		National	Absolute values in Country GHG Emissions Inventory: European Environment Agency % share: own calculations
		EU average	Absolute values in EU GHG Emissions Inventory: European Environment Agency % share: own calculations
Renewable Energy - Current Production	Renewable Energy production total [GWh]	Municipality	Action Plans
	Share of Renewable energy over final total consumption	Municipality	Own calculations: *Municipal Total Renewable Energy Production (Action Plans)/Municipal Total Final Energy consumption (Action Plans)*
		National	Own calculations: *National Total Renewable Energy Production (*Eurostat*)/National Total Final Energy consumption (*Eurostat*)*
		EU average	Own calculations: *EU Total Renewable Energy Production (*Eurostat*)/EU Total Final Energy consumption (*Eurostat*)*
Renewable Energy Potential	Solar Radiation on Building Footprint [kWh/m²*yr]	Municipality	Hotmaps
	PV total energy production [GWh/yr]	Municipality	Hotmaps
	ST total energy production [GWh/yr]	Municipality	Hotmaps
	Wind Potential at 50 meters	Municipality	Hotmaps
	Industrial Sites Excess Heat	Municipality	Hotmaps
	Wastewater Treatment Plants Excess Heat - Power [kW]	Municipality	Hotmaps
	Wastewater Treatment Plants Excess Heat - Capacity [person equivalent]	Municipality	Hotmaps
	Agricultural Residues [GWh/yr - NUTS3]	Municipality	Hotmaps and own calculations: *NUT3 value/NUTS3 area*Municipality area*
	Livestock Effluents [GWh/yr - NUTS3]	Municipality	Hotmaps and own calculations: *NUT3 value/NUTS3 area*Municipality area*
	Forest Residues [GWh/yr]	Municipality	Hotmaps and own calculations: *NUT3 value/NUTS3 area*Municipality area*
	Municipal Solid Waste [GWh/yr - NUTS3]	Municipality	Hotmaps and own calculations: *NUT3 value/NUTS3 population*Municipality population*
Climate and	Emissions reduction	Municipality	Actions Plans
		National	National Energy and Climate Plans
		EU	EU Commission website

Class of Data	Single Data/indicator Collected	Geographical Level	Source(s) (main source indicated first, followed by supplementary sources used when the first is not available)
Energy Targets	Renewable Energy share increase	Municipality	Actions Plans
		National	National Energy and Climate Plans
		EU	EU Commission website
	Energy efficiency increase	Municipality	Actions Plans
		National	National Energy and Climate Plans
		EU	EU Commission website
	Energy in Buildings	Municipality	Actions Plans
		National	National Energy and Climate Plans
	Biomass	Municipality	Actions Plans
		National	National Energy and Climate Plans
	Electricity	Municipality	Actions Plans
		National	National Energy and Climate Plans
	Heating, Cooling, DHC	Municipality	Actions Plans
		National	National Energy and Climate Plans
Actions	Energy Saving	Municipality	Actions Plans
	Efficiency (Building retrofitting, LED Lighting, Transport, Heating Cooling, DH&C, Network, Heat-pumps)	Municipality	Actions Plans
	Renewables (Biomass, Biogas, Solar, Wind, Geothermal, Hydrogen, Other)	Municipality	Actions Plans
	Financing (RES, Efficiency)	Municipality	Actions Plans
	Stakeholders and Community Engage-ment	Municipality	Actions Plans
	Carbon sinks	Municipality	Actions Plans
	Sustainability	Municipality	Actions Plans
	Adaptation	Municipality	Actions Plans
	Sectors: Industry, Tertiary, Agriculture, Public Admin., Residential	Municipality	Actions Plans

ANNEX 2: CATEGORIZATION OF SEAP/SECAP MEASURES

Table 3: Categorization of SEAP/SECAPs Measures

Network -Country	Local Administrations	Energy Efficiency						Renewable Energy							Financing Tools	Stakeholder Engagement	Carbon sinks	Sustainability	Adaptation	Target Sectors					
		Energy Conserva-tion	Building retrofitting	Lighting	Transport efficiency	Heating Cool-ing	DH&C	Biomass	Biogas	Solar	Wind	Geothermal	Hydrogen	Other						Industry	Tertiary	Agriculture	Public Administra-	Residential	Transport
Rhône Network (ALTE69) - France	CCMDL (Monts du Lyonnais)	+++	+++	+	+++	++		+++		++	+			+		++	++	+++	+++	✓	✓	✓	✓	✓	✓
	CCSB (Saône-Beaujolais)	+++	+++		+++	+++	+	++	+	+	+	+	+	+	++			++	+	✓	✓	✓	✓	✓	✓
	COR (Ouest Rhodanien)	+	+++		+++	+	+	+	++	+++	++	+		+	++	++		++		✓	·	✓	✓	✓	✓
	SOL - (Ouest Lyonnais)		+++	+	+++	+	+	+	++	+	+	+	+		+++	+	++	++	++	✓	✓	✓	✓	✓	✓
SCN - Greece	Oichalia	++	++	++	+++	++		+		++				+	+	+		+		·	·	✓	✓	·	·
	Ierapetra	++	++	+	++					+	+			+		++				·	·	✓	✓	·	✓
	Korinth	++	++	+	++											++				·	·	·	✓	✓	·
	Vari-Voula-Vouliagmeni	++	+++	+	++			+		+						++				·	✓	·	✓	✓	✓
	Messinis		++	++	+++	+++				+++				+	+	+				·	·	·	✓	·	·
UCSA - Italy	Palma Campania		+++	+	+++	+				+					+++			+		✓	✓	·	✓	✓	✓
	San Giuseppe Vesuviano		+++	+	+++	+				+					+++			+		✓	✓	·	✓	✓	✓
	Striano		+++	+	+++	+				+					+++			+		✓	✓	·	✓	✓	✓
CNNL - Nether-lands	Groningen		+++		+++	+++		++	+	+	+				+++					✓	✓	·	·	✓	✓
	Assen		++	+	+						+					+++		++		✓	·	·	·	✓	✓
	Emmen	+	+	+						+	+	+			++	+				·	·	·	✓	·	·
	Leeuwarden					+	+	+	+	+	+	+			+					✓	✓	·	✓	·	·
Oeste Sus-tentàvel - Portu-gal	Alcobaça	++	++	++	+++	+		+		++										✓	✓	·	✓	✓	✓
	Alenquer	++	++	++	+++	+		+		++										✓	✓	·	✓	✓	✓
	Arruda dos Vinhos	++	++	++	+++	+		+		++										✓	✓	·	✓	✓	✓
	Bombarral	++	++	++	+++	+		+		++										✓	✓	·	✓	✓	✓
	Nazaré	++	++	++	+++	+		+		++										✓	✓	·	✓	✓	✓
	Peniche	++	++	++	+++	+		+		++										✓	✓	·	✓	✓	✓
	Caldas de Rainha	+++	+++	++	+++	+		+		+	+			++				+++		✓	✓	·	✓	·	✓
	Torres Vedras	+++	+++	++	+++	+		+		+	+			++				+++		✓	✓	·	✓	·	✓
	Óbidos		+++	+++	+++			+		+++	+			+		++		+++		·	·	·	✓	✓	✓

+++	4 or more measures	++	2-3 measures	+	1 measure		no measures	✓	Targeted Sector	·	Not targeted Sector

ANNEX 3: CLIMATE AND ENERGY TARGETS COMPARED AT LOCAL, NATIONAL AND EU LEVEL

Table 4: Climate and Energy Targets at local, national and EU level

Net-work	Region	Emission Reduction	National	EU	Renewable Energy (RES)	National	EU	Energy Efficiency	National	EU
ALTE69 - France	**CCMDL**	By 2030: -18% CO2E Emission	By 2020: -20% GHG Emissions (non-ETS) By 2030: -37% GHG Emissions (vs 2005) By 2050: carbon neutral	By 2020: -20% GHG Emissions By 2030: -40% (-55%/-60%) GHG Emissions (vs 1990) By 2050: carbon neutral	By 2025: +21% RES (15,6% of final consumption) By 2030: 36% RES By 2050: 97% RES	By 2020: 20% RES in final energy consumption By 2030: 32% RES in final energy consumption (14% RE in transport and 1,3% in H&C) By 2050: more than >80% of electricity from RES	By 2020: +20% RES in final energy consumption By 2030: +32% RES in final energy consumption (14% in transport and 1,3% in H&C) By 2050: 80% electricity from RES	By 2030: -28% Energy consumption By 2050: -49% and Energy Positive	By 2020: 20% EE By 2030: 32,5% EE (-20% final energy consumption compared to 2012) By 2050: -50% Energy consumption (vs 2012)	By 2020: +20% EE By 2030: +32,5% EE
	CCSB	By 2020: -30% CO2E Emission By 2030: -39% CO2E Emission By 2050: -85% CO2E Emission			By 2020: 30% RES By 2030: 41% RES By 2050: 125% RES (energy positive)			By 2030: -31% Energy consumption By 2050: -55% Energy consumption		
	COR	By 2024: -9% CO2E Emissions By 2030: -22% CO2E Emissions By 2050: -50% CO2E emission			By 2024: 17% RES By 2030: 28% RES By 2050: 101% RES (energy positive)			By 2024: -10% Energy consumption By 2030: -20% Energy consumption By 2050: -52% Energy consumption		
	SOL	By 2024: -14% CO2E Emissions By 2030: -19% CO2E Emissions By 2050: -54% CO2E Emissions			By 2024: 13% RES By 2030: 15% RES By 2050: 46% RES			By 2024: -7% Energy consumption By 2030: -10% Energy consumption By 2050: -42% Energy consumption		
SCN - Greece	**Oichalia**	By 2020: -32,40% CO2e Emissions By 2030: -40% CO2E Emissions	By 2020: -20% CO2e Emissions By 2028: phase out lignite By 2050: -42% CO2e Emissions (compared to 1990, -56% to 2005)		By 2020: 18% RES final consumption (5% in 2011) from 7093 MWh/year to 25448 MWh/year	By 2020: +20% RES By 2030: 65% electricity from RES (wind, solar, geothermal, and others) By 2050: 80% of electricity from RES		By 2020: -4,9% (6836 MWh/y) energy consumption	By 2030: + 38% EE, buildings renovation program to be announced, circular economy and Green Financing Scheme	
	Ierapetra	By 2020: -22,4% CO2e Emissions			By 2020: 14% RES final consumption			By 2020: -8% Energy consumption		
	Korinthos	By 2020: -20% CO2e Emissions			Not clear, TBD			Not clear, TBD		
	Vari-Voula-Vouliagmeni	By 2020: -23,81% CO2e Emissions			By 2020: 449 MWh from PV on public buildings			By 2020: -17,23% Energy consumption		
	Messinis	By 2020: -20% CO2e Emissions			By 2020: +500 MWh from PV			By 2020: -16% (39553 MWh/y) energy consumption		

Network	Region	Emission Reduction	National	EU	Renewable Energy (RES)	National	EU	Energy Efficiency	National	EU
UCSA - Italy	Palma Campania	By 2020: -20% CO2E Emissions By 2030: -60% CO2E Emissions	By 2020: -13% GHG Emissions (non-ETS) By 2030: -33% GHG Emissions By 2050: carbon neutral	By 2020: -20% GHG Emissions By 2030: -40% (-55%/ -60%) GHG Emissions (vs 1990) By 2050: carbon neutral		By 2020: 17% RES (10% in transport) By 2030: 30% RES (22% in transport, +1,3% in H&C)	By 2020: +20% RES By 2030: +32% RES (14% in transport and 1,3% in H&C) By 2050: 80% electricity from RES		By 2020: -24% Energy consumption By 2030: -43% Energy consumption	By 2020: +20% EE By 2030: +32,5% EE
	San Giuseppe Vesuviano	By 2020: -26% CO2E Emissions By 2030: -61.7% CO2E Emissions								
	Striano	By 2020: - 41.9% CO2E Emissions By 2030: -61.1 % CO2E Emissions								
CNNL - The Netherlands	Groningen	By 2035: CO2E neutral (already set in 2011)	By 2020: -16% GHG Emissions (non-ETS) By 2030: -49% GHG Emissions By 2050: -95% GHG Emissions (vs 1990)		By2023: 150 MWp PV, 10.6 MWp wind, 5% biodiesel, bio-ethanol and bio-LNG in transport, 5% green gas, exploring geothermal options	By 2020: +14% RES By 2050: 100% renewable electricity generation		By 2035: -34% Energy consumption	Until 2020: -1,5%/ year energy consumption	
	Assen	By 2030: PA carbon neutral By 2040: all buildings carbon neutral By 2050: CO2E neutral			By 2020: 14% sustainable energy			By 2020: -10% Energy consumption		
	Emmen	By 2020: -23% Emissions (1990) By 2035: -30% Emissions By 2050: CO2E neutral								
	Leeuwarden				By 2020: 1.41PJ from sustainable energy (16% of 2013 energy consumption)			By 2020: -20% consumption in buildings (vs 2010)		
Oeste Sustentável - Portugal	Alcobaça	By 2020: -10% CO2E Emissions	By 2020: -18%/-23% GHG Emissions (vs. 2005) By 2030: -30%/-40% GHG Emissions (vs. 2005) then raised to -45%/-55% By 2050: carbon neutral			By 2020: 31% RES in final consumption By 2030: 47% RES in final consumption			By 2030: -35% Energy consumption	
	Alenquer	By 2020: -20% CO2E Emissions								
	Arruda dos Vinhos	By 2020: -20% CO2E Emissions								
	Bombarral	By 2020: -10% CO2E Emissions								
	Caldas da Rainha	By 2020: -20% CO2E Emissions								
	Nazaré	By 2020: -20% CO2E Emissions						By 2020: -20% CO2E energy consumption		
	Óbidos	By 2020: -34% CO2E Emissions								
	Peniche	By 2020: -10% CO2E Emissions								
	Torres Vedras	By 2020: -20% CO2E Emissions (at least)								