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European Cities in the Energy Transition: A Preliminary Analysis of 27 Cities

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Abstract: Nowadays, there is a wide scientific consensus about the unsustainability of the current energy system and at the same time, social awareness about climate change and the IPCC's goals is increasing in Europe. Amongst the different pathways towards them, one alternative is the radical transition to a democratic low-carbon energy system where the local scale has a key leading role. Under this scope, this research is framed within the mPOWER project, financed by the European Commission's H2020 programme, which promotes collaboration among different European municipalities in order to boost the transition to a renewable-based participatory energy system. This paper presents the starting point of the mPOWER project, where the main energy features of 27 selected European municipalities are collected and analysed for the year 2016. An open public tender and selection process was carried out among European cities in order to choose the candidates to participate in mPOWER project. A view of this situation will be taken by the mPOWER project as a diagnostic baseline for the following steps: a peer-to-peer knowledge-sharing process among these European municipalities, and subsequently, among a more extensive group. The first finding of the paper is that, even if those municipalities are trying to reduce their greenhouse gas emissions, they are highly dependent on fossil fuels, even in cases where renewable energies have significant presence. Second, their energy consumption is logarithmically related to the human development index and gross domestic product but not to the size of the cities and their climate characteristics. Finally, despite the work that these cities are making towards energy transition in general and within the mPOWER project in particular, the paper shows a high difficulty mapping their energy systems. The lack of accurate and unified data by the municipalities is a sign of disempowerment at a local and public level in the energy sphere and makes difficult any strategy to advance towards a bottom-up energy transition. Among other goals, the mPOWER project aims to reveal these kinds of difficulties and help local authorities in managing their transition paths.

Keywords: energy transition; sustainable cities; transition roadmaps; renewable energies; policymaking; energy democracy; energy mapping

1. Introduction

The urgency for changing the current European energy model and transiting towards a more sustainable one is a well-accepted reality among European inhabitants, policy-makers and scientists. In line with this, it has been clearly detected that the elevated use of fossil fuels needs to be reduced in order to keep the temperature increase of the planet to under 2 degrees Celsius [1]. Furthermore, it has been accepted that the incoming transition will not be merely a technological transition towards renewable energy systems [2], but will require a change in our way of dealing with democracy, economy and social values [3,4]. Indeed, there is an on-going debate about how this multi-dimensional transition will take place [5]. The goals of energy democracy movements all over the world intend to resist the current energy agenda, and reclaim and restructure the energy sector [6], with desired outcomes such as shifting public resources away from fossil fuels, leaving fossil fuels on the ground and stopping extractivist infrastructures, ensuring public or social control of the energy sector, or not prioritising only the monetary benefit out of the energy system.

A number of different voices point to the need for a locally based energy transition, as the local scale is related to more participative, inclusive and socially accepted policies and actions. Van der Schoor et al. [7] argue that local communities should lead a bottom-up transition since they boost the use of local resources with democratic horizontal governance and own financial strength-based energy production and supply. Other similar studies maintain that the new energy system will be funded directly by citizens, since they are at the heart of this new transition based on decentralised renewable energy cooperatives [8]. In the same vein, Vita et el. [9] show that those individuals who are members of sustainability-oriented grassroots initiatives have a more sustainable lifestyle compared to their socio-demographic counterparts, which leads to a more satisfying life and lower carbon footprints in the analysed domains of housing, transport, clothing and food. Indeed, energy embedded in consumed products and services [10,11] is a major issue that goes beyond direct energy consumption and needs to be considered in local energy transitions in order to avoid global rebound effects. Beyond the influence of a single consumer [12], as Grabs et al. [13] point out, grassroots initiatives play a major role in this field. After analysing the nexus between individual motivation and collective action in the context of sustainable consumption, they concluded that individuals can be agents of societal change when they are organised in groups.

Furthermore, some authors attribute the progress of energy transitions in different countries to the presence of grassroots initiatives in such countries [14]. In the above-mentioned reference, Kooij et al. studied what the conditions are for grassroots initiatives to emerge, and how these initiatives create an impact upon these conditions. They observe that openness to alternative discourses and a shared knowledge are favourable conditions for the appearance of these kinds of initiatives. In turn, they argue that the influence they exert upon energy systems is low in the case of those systems with strong vested interests, and that the support by governments and institutions is crucial for those initiatives to make a change.

More specifically, in relation to local authorities, in the Sustainable Development Goals of 2015 [15], the United Nations clearly recognised the key role of local public institutions in the transition towards a more sustainable future. According to Sperling et al. [16], cities will be relevant in boosting locally produced and consumed energy systems based on renewables in different sectors. This change will occur by focusing our attention on underlying social drivers, and releasing the need for economic growth as a single scope [17]. However, they suggested that the role of municipalities needs to be outlined very clearly and that the state must provide municipalities with the necessary planning tools, establishing the required strategy, for the integration of a 100% renewable source-based decentralised system [16] or decarbonisation plans [18]. Comodi et al. [19] show that, even while the role of local authorities is relevant, the results of their actions can be merely partial within a multi-scalar energy transition. The support and energy policies of nations and states remain central in achieving decarbonisation goals under democratic principles [20].

This paper has been developed within the mPOWER project, which focuses on the strategies and actions that municipal authorities carry out towards a sustainable and democratic energy system [21]. Within the framework of the project and despite their limitations, municipalities are recognised as key political actors in the transformation of the energy system within the European context.

During the last decade, the EU has promoted a proactive climate policy, increasing renewables and improving energy efficiency [22]. Some of the leading EU countries, going beyond climate change on the direction of the conservation of the national and global environment, have also opted for nuclear phasing-out [23]. However, the results do not appear to be sufficient. In Europe (European Union 28, EU-28), non-renewable energy consumption (coal, oil, gas and nuclear energy) constitutes 85.3% of the total primary energy supply [24], consuming 23.18 MWh of non-renewable energy per inhabitant and year ($MWh \cdot cap^{-1} \cdot yr^{-1}$) out of the total of 27.16 $MWh \cdot cap^{-1} \cdot yr^{-1}$. Even though the consumed non-renewable energy in EU-28 is 26% less than the average for OECD countries, it is 68.7% greater than the world average value [24], which has already been considered 2–6 times above sustainable levels, making it beyond the planetary boundaries [25]. This underlines that there is an urgency to continue reducing the consumed non-renewable energy in EU-28.

According to Tagliapietra et al. [22], the cost of a fully-fledged energy transition in the EU would be similar to that of preserving the current non-renewable energy system, and adopting the right policies to mitigate the distributional effects of said transformation, could make it also socially desirable. Since the social and metabolic transformations required by a real decarbonisation process are to be so relevant [26], it will be determinant to control its distributional and democratic aspects. Nevertheless, concerning local experiences, there is a gap in the current energy system between the new theoretical sustainable energy systems and the reality that the cities are facing [8]. In order to build bridges among theoretical roadmaps and practical strategies, the active role of the municipalities is considered a key factor [9]. Furthermore, difficulties in modelling the impacts of citizens' behaviour on climate change have been detected [27], concluding that further collaboration between social scientists and economic developers are required.

Cities are said to be responsible for 70% of global emissions of CO_2eq [28], and different targets have been established in EU cities in order to face the energy transition towards a sustainable one. According to van den Dobbelsteen et al. [29], all targets at a municipal level should aim to research the current energy situation, reduce the total energy consumption, reuse energy (i.e., reuse flows, heat transfer) and produce renewable energy. To this effect, one of the first targets in the EU was established by the Swiss government, following the ETH researchers who estimate 17.5 MWh per capita per annum (equivalent of 2000 watt during 365 days and 24 h) as a sustainable amount [30]. This target is also aligned with the 1 $eqtCO_2$ emissions per person and year, which would allow us to avoid a climate change scenario [30]. The percentage of integration of renewable energy or electricity has also been established, and most European cities have the goal of integrating 20% of renewable energy into their electric mix by 2020 [29]. The European Commission goes beyond and targets a renewable energy share of 20% in the gross final energy demand [31,32]. It has also been common to use relative targets in percentages, such as reductions of CO_2eq emissions of 40% by 2030 [31,32] or 85–90% by 2050 [32] (compared to 1990). Another commonly used percentage target is a 27% increase in energy efficiency compared to a 'business-as-usual' projection of future energy demand [30,31]. The existence of different goals has generated a diversification of targets among different cities, with an absence of unified targets [33]. Nevertheless, despite the existence of targets, emission reductions in cities measured in consumption-based accounts do not always occur. In the study developed in six Japanese cities from 1980 to 2000, it was concluded that consumption-based emissions measured by carbon inventories have not been reduced, but rather increased from 8 to 9 $eqtCO_2$ per year and capita [28].

Furthermore, it has been also detected that the energy consumption and carbon emissions of cities are related to their economic performance, especially in developed countries such as China [34], thus a massive reduction of energy or emissions could happen to not be attractive or convenient for some cities, drawing us into a controversial panorama.

Despite these limitations, different initiatives are being developed on the roadmap to more sustainable cities. One such example is the European Energy Awards [35], given to municipalities for energy and climate protection activities at the European level. Those cities awarded can be considered exemplary in energy transition.

In this regard, different bottom-up movements have arisen in recent years to boost the necessary energy transition. The 'Covenant of Mayors' (CoM) [36] is one of the most relevant initiatives, a movement that involves more than 9000 cities in 131 countries, where local authorities voluntarily commit to meeting and exceeding the European goals for CO_2 emissions reductions [37]. In the same vein of work, 'Energy Cities', the European association of cities in energy transition, is a network of local authority representatives from 30 countries that gathers frontrunners and energy transition beginners, city officials and technical experts. Their principal goal is to support the creation of new policies through National Energy and Climate Plans (NECP) [38]. Similarly, Ursula von der Leyen presented the plan to make the EU the world's first 'climate-neutral' continent by 2050 [39].

Apart from the work that has been carried out on (and combined with) policy-making, from an academic perspective, several efforts to model a sustainable energy model have been made. The MEDEAS project [40] is one of the best examples, a tool to design the transition into a 100% renewable energy system (RES) in Europe. This initiative considers three different scenarios to model the energetic macro-economic system from 1995 to 2050: Business as Usual (BAU), Green Growth (GG) and the Post-Growth or degrowth approach (PG). Other tool to boost this transition in urban districts is the learning experience through the use of visualisation games, such as Go2Zero [41].

Within the framework of this European energy transition, the mPOWER project is funded by the European Commission Horizon 2020 Research and Innovation Framework Programme and aims to boost municipal actions, public engagement and the creation of routes towards the necessary Energy Transition [42]. The project is managed by seven partners (the University of Glasgow, Platform-London, the Stichting Transnational Institute, the Society for the Reduction of Carbon Limited, the Institute for Political Ecology, Energy Cities and the University of the Basque Country). Throughout the 48-month duration of the project, the partners will detect, through systematic peer review, the best replicable municipal practices in energy transitions and create a framework to share the different achievements in a peer-to-peer learning programme.

The central question of this paper is: What is the current situation, regarding energy, of the 27 municipalities that were selected for the initial stages of the learning programme? In addition, two sub-questions are defined, to be answered throughout the structure of the paper:

- What are the difficulties in describing the current situation?
- How can these difficulties help other authorities in their energy transition?

The analysis used in order to answer these questions is based on the statistical evaluation of various energy indicators and was carried out using the data provided by municipalities from an online survey related to energy consumption, renewable production and municipal policies and strategies of participatory energy transition. The data were collected in order to determine the baseline for year 2016 (in some cases, updated data of 2017 have been used), that is, the reference situation that will be compared with that of the end of the project. To this end, first, a description is given of the mPOWER project, as well as the methodology used in the research, which includes the baselining, standardisation and evaluation of the data. Following this, the results obtained from the 27 cities (i.e., municipalities) are presented and, finally, a summary provided of the conclusions drawn.

2. The mPOWER Project

The mPOWER project aims, by means of learning programmes participated in by more than 100 local public authorities, to replicate innovative best practices in municipal energy, and develop ambitious energy transition plans. The project relies on two learning programmes: first, a bespoke learning programme (referred to as mPOWER Exchange) in which 27 cities are participating and second, a peer-to-peer online learning programme (referred to as mPOWER Digital) where around 90 municipalities will participate. This publication deals with the first part of the project, the bespoke learning process, in which 27 cities are involved. In order to choose the cities, Covenant of Majors [36] and Energy Cities [43] platforms were used to share the possibility of participating in the project across all European cities. Furthermore, the institutions leading the mPOWER project (see Acknowledgments) offered hundreds of municipalities the possibility of applying to take part in the selection process.

Among all the candidate cities, a ranking was developed by the Glasgow University members so as to choose the most appropriate cities. The ranking was made following an online survey, interviews and online research and was developed a selection of main learning preferences of cities based on motivation and participation for an energy transition; experience in renewable energy integration; experience in energy efficiency and consumption organisation. It is important to note that the cities were selected not only for their expertise, but moreover for their interest in participating in a learning programme. The selected cities were classified into three topics: Local Energy Communities, Renewable Energy Integration and Energy Efficiency. Finally, in order to start the learning process, one or two working groups have been created for each of the topics. In each of the five different working groups created, a group leader was selected by the project organiser. The group leaders have the role of showing the rest of the members the initiatives that have been developed or are planned to be developed.

The mPOWER Exchange programme is based on city visits to share knowledge, and enables technicians and policy-makers to invest face-to-face time researching, understanding and contrasting existing and new energy infrastructures and projects, with the aim of promoting participation and enhancing the exchange of practical knowledge and expertise.

3. Methodology of the Research Baseline

At the initial stage, a baseline evaluation was planned within mPOWER in order to establish a reference framework to be compared with the situation at the end of the project. This baseline will serve to gain knowledge on the energy reality of the participating cities and to help to evaluate the expected impacts from the mPOWER project:

1. To increase energy savings;
2. To increase renewable energy production;
3. To increase the capabilities of public authorities on energy supply and production management;
4. To create city-based strategies for encompassing energy transition.

Because of the lack of a public European or worldwide database about energy consumption and production at the municipal level [36], and the fact that there is very little up-to-date online information in this field, our strategy was to directly collect the data via an online survey (see Appendix A Material for accessing the survey) to be completed by the municipal technicians or politicians in charge of the mPOWER project in each participating city.

The questions from the survey cover both qualitative and quantitative aspects related to the objectives and the expected impacts of the project: Amount and type of consumed energy; greenhouse gas emissions (GHG); renewable energy systems (RES); municipal public staff in the energy sector and in energy transition projects; municipal public investments related to energy transition; municipal plans for renewable energy power development; municipality led initiatives and policies for energy transition; citizenship/cooperative-led initiatives and campaigns for energy transition.

Taking into account the impacts for mPOWER and specific targets for energy transition listed above, several indicators were chosen to be analysed in this baseline. Some of them were directly obtained from the survey, some were found in the literature on the topic and some were calculated by the authors. The following table lists all the analysed indicators, relating them to the expected impacts and targets, as well as indicating where in the paper they can be found. Note that impact 3 is transversal to all targets that is why it is not appearing in Table 1.

The performance of these indicators, by assessing them at the beginning and at the end of the project, will be used to evaluate the impacts achieved and the success of different strategies and actions that will be carried out throughout the project. Some of the indicators, such as total energy consumption and RES percentage, are analysed in this paper in order to evaluate how cities are currently performing. However, others such as RES installation and production are left for a future analysis and comparison with the end-of-project situation. This is due to the difficulty in obtaining a reference target to compare with.

3.1. Survey Data Standardisation Methodology

As mentioned above, we faced difficulties with the data collection since some of the cities did not complete the survey (or part of it) and, among those cities that did, in some cases the collected data was not consistent. After compiling all the information on a database, the validity of the RES production, energy consumption and GHG emission data was assessed as explained below.

In the case of municipal RES production, we related the data on installed power (in MW) with the total annual production (in MWh) in order to obtain the capacity factor (CF), i.e., ratio of actual energy output over a whole year to the maximum possible energy output over that year [44]. We considered the data were consistent only when the CF ranged between 1 and 90%. In those cases where only installed power or annual production was given, the data could not be checked for consistency (which is regarded as a lack of data in Figure 1). See Table A1 from the Appendix B. for checking how the RES data were interpreted.

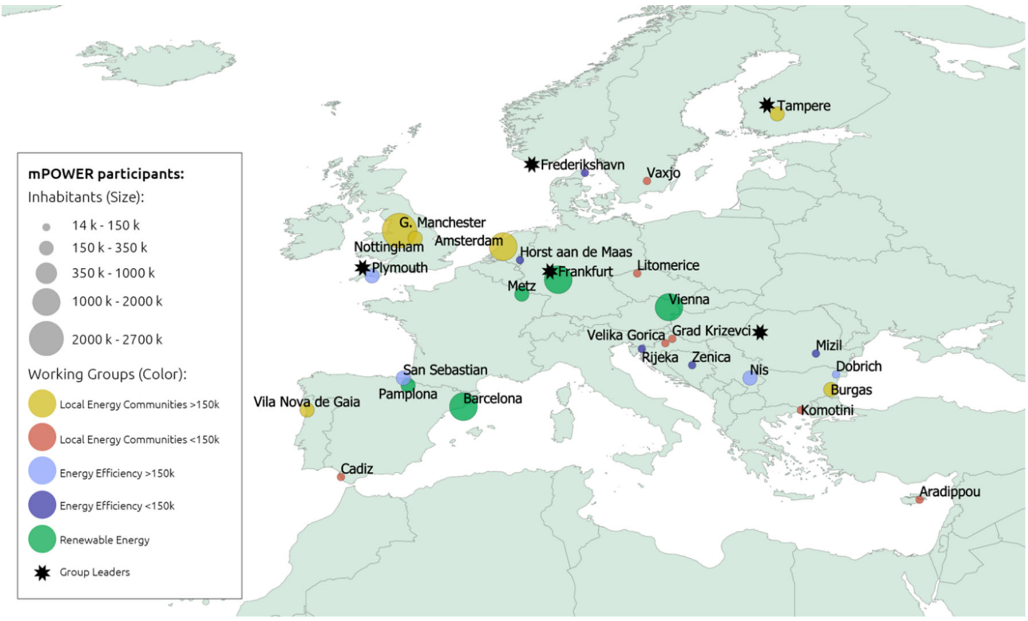

Figure 1. Municipalities selected for the mPOWER exchange programme. The selected 27 municipalities are classified in five different working groups.

In the case of the energy consumption and GHG emission data, first the values per capita were obtained by dividing the values given by each city by the number of inhabitants. We then compared them to the national per capita average consumption and emission data, taken from the International Energy Agency (IEA) database (2016) [24]. The data given by the cities were considered consistent when they were on the same order of magnitude as the ones taken from the IEA: specifically, when the data of the cities were no lower than one-third of the IEA data, or they were no higher than three times the IEA data. When the data were not considered consistent or when no information was given, the IEA data were used instead.

3.2. Survey Data Assessment Methodology

In this section, we analyse some of the above-mentioned indicators, comparing the obtained data across all the 27 cities. The number of resources that each municipality assigns to the energy transition (number of campaigns, people and budget) has been analysed as an indicator of energy democracy. Total energy consumption was analysed next (how much energy per capita is consumed in each city), quantifying also what the main energy sources are and in which sectors that energy is consumed. Hidden Energy Flows were included among the analysed sectors.

Energy consumption has been linked to GHG emissions by comparing the obtained emission and consumption data, and additionally by estimating the emissions that should be obtained from the consumed energy; this was done by taking into account each city's energy mix and the emission intensities of each type of fuel (eqtCO_2 per kWh) provided by the IPCC [45], as well as the electricity mix per country [24].

Finally, various economic, climatic or size indicators, such as the gross domestic product (GDP), the human development index (HDI), the heating and cooling degree days (HDD and CDD) and the number of inhabitants of each city were plotted as a function of the energy consumption and fitted to a logarithmic equation in order to try to find a correlation, following the methodology of Steinberger et al. [46], Arto et al. [10] and Akizu et al. [11].

4. Results and Discussion

The aim of this section is to provide an overview of the obtained data, in order to give the cities an insight into the steps needed for an energy transition, as well as to gain an indication of what to learn from each other, by comparing their energy consumption and GHG emission data. Nevertheless, before doing so, careful effort has been made to check the reliability of the data received.

4.1. Survey Data Standardisation

As can be observed, Figure 2 shows the ratio between valid and non-valid data, as well as the absence of any answer for the energy consumption, GHG emission and RES production data given by the cities, which was standardised as previously explained in Section 3.1. Regarding energy consumption, the highest uncertainty corresponds to the case of liquid fuels, where only 37% of the cities provided reliable data. In the case of coal, all of the received answers were considered valid, since the consumption of this fuel is very low and most of the cities reported no consumption. Apart from coal, natural gas consumption data present the highest reliability, with 63% of the answers considered valid.

Regarding GHG emissions, 59% of the cities provided reliable data. As for RES installation and production, we observe a better knowledge in the case of electric RES (48% of answers valid) as compared to thermal, where only 41% of the cities provided an answer, with a validity rate of 33%.

With respect to the total energy consumption per capita, Figure 3 shows the data that we were able to collect. Note that, in order to calculate this total, only the final consumptions of electricity, natural gas, liquid fuels and coal were included in the survey. This, in some cases, resulted in a gap between the total real energy consumption of a city and the total energy consumption calculated in this assessment. As a further check of the validity of the results, the direct energy consumption data obtained from the surveys is compared with the national total primary energy supply (TPES) per capita of the corresponding countries in Figure 2. The ratios between these two range from 26% to 95%, meaning that this standardisation process has allowed us to map a 49% average TPES per inhabitant of a country. The gaps, on the one hand, may be due to the fact that a specific city is being compared to its national average reality. On the other hand, the energy losses in transformation (in order to produce electricity and heat from coal, gas or biofuels and waste), the fuels employed for non-energy uses (crude oil for asphalt and oil products used in agriculture and chemical industry) and other fuels such as biofuels (biomass, biogas, bioethanol), butane gas or waste were not considered in the survey, which certainly led to differences.

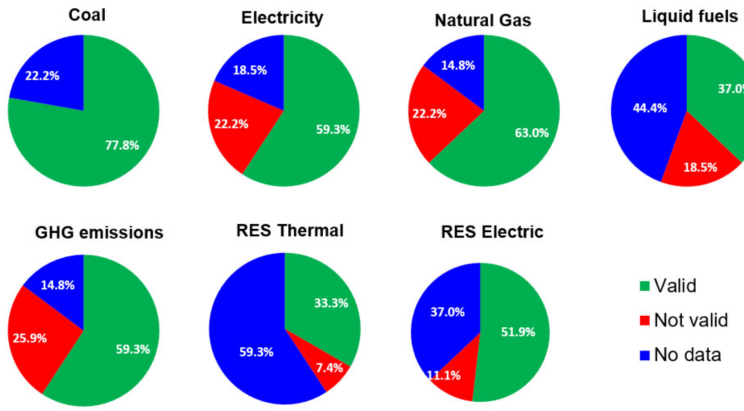

Figure 2. Data standardisation.

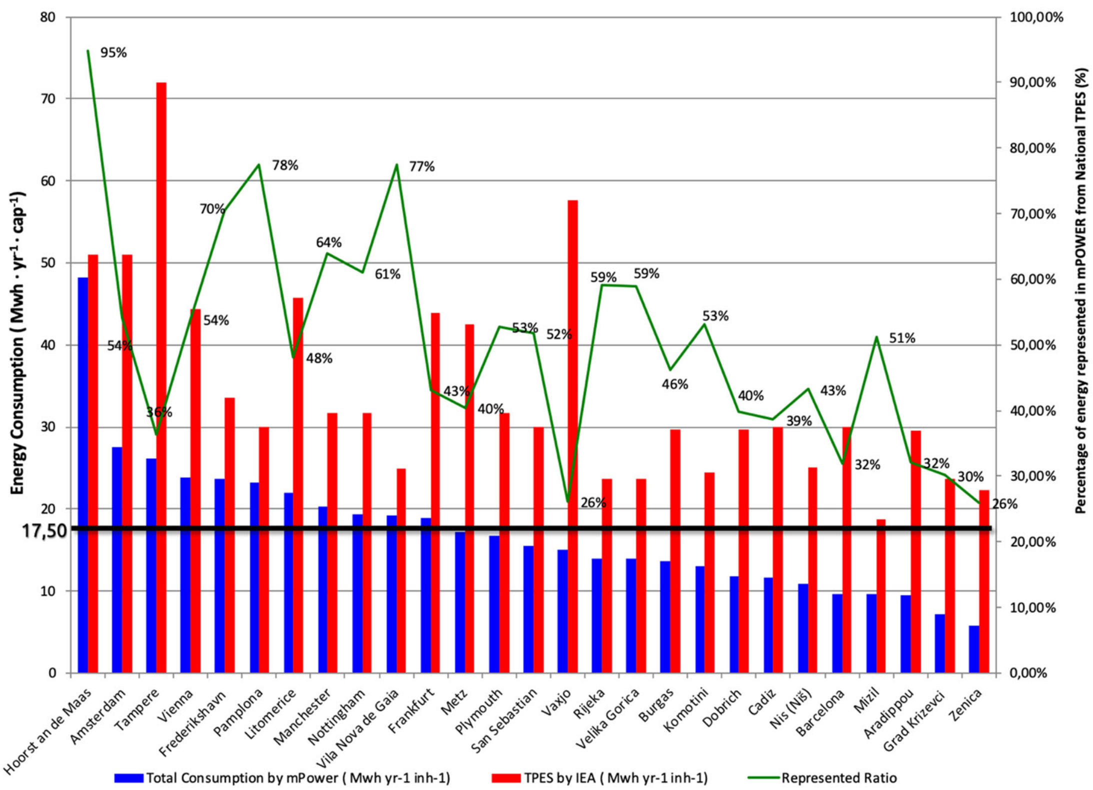

Figure 3. The total energy consumption by inhabitant computed for the selected cities (by mPOWER project) and the national reality reflected by the International Energy Agency averages. The goal in energy reduction of 17.5 MWh·cap^{-1}·yr^{-1} has been indicated [30].

Another difficulty in the calculation of the total energy consumption was the case of those cities with significant production by Combined Heat and Power (CHP) plants, commonly fed by natural gas. In CHPs, energy consumption is measured, such as the consumed amount of natural gas, but similarly the electricity produced by the CHPs is also taken into account when energy consumed at homes is measured. Thus, this could generate small amount of double accounting that this project has not been able to correct. For future research, a specific question could be included to understand the energy production from CHPs, and thus avoid this double accounting.

From this standardisation we obtained the data to be used in the evaluation of the results (Section 3.2), which is listed in Table A2 from the Appendix B.

4.2. Survey Data Assessment

Figure 4 shows some of the indicators related to energy democracy: the staff working on energy and transition, the municipal energy or transition campaigns, and the budget dedicated to energy transition (shown in Table A3 from Appendix B). These indicators are a measure of the resources dedicated to energy and transition by enrolled authorities at both the technical and the social level. With some exceptions, such as Barcelona, Frankfurt, Horst aan de Maas, Vienna and Zenica, most of the municipalities have from 0 to 20 employees working on energy and energy transition issues. Similarly, excluding Nis, Pamplona and Rijeka, most of the cities have from 5 to 15 annual campaigns. In the annual budget for the energy transition, the values differ much more. Whereas most of the cities dedicate several thousands of euros (within a broad range from 20,000 € to 792,000 €), some of the cities dedicate millions of euros to the energy transition. Such is the case of Mizil (1 M€) or Frankfurt (1.8 M€). The highest budgets correspond to Vila Nova de Gaia (5 M€), Manchester (7 M€) and Amsterdam (87.5 M€), which were left out of the Figure in order to make the rest of the cities visible. It is important to note that those budgets often depend on external projects (European or national, for instance), that make it difficult to define a fixed and constant annual budget. Some cities also pointed out the difficulty to define a budget solely related to energy transition, since this is normally spread out over the overall budget of the city.

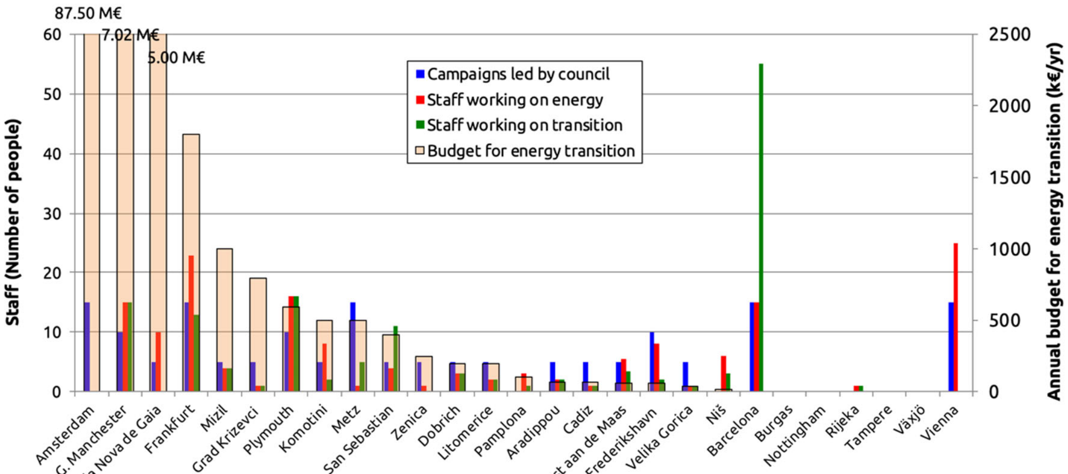

Figure 4. Annual budget, number of campaigns led by the city councils and number of people working on energy transition.

Regarding the total energy consumption per capita, and going back to Figure 3, we can observe how energy consumption differs among the cities analysed. Thus, Zenica (Bosnia and Herzegovina) is the city with the lowest consumption per capita (6 MWh·cap^{-1}·yr^{-1}) while in Horst aan de Maas (Netherlands) the consumption is as high as 48 MWh·cap^{-1}·yr^{-1}, meaning that Zenica consumes 87.5% less energy than Horst aan de Maas. Comparing it to the previously cited target of 17.5 Mwh per person and year [30], 17 out of 27 cities do reach the target. From the ones that do not reach it, the total energy consumption of Frankfurt (Germany), Vienna (Austria), Aradippou (Cyprus), Nottingham (United Kingdom) and Metz (France) is especially high. Alternatively, when national TPES data are taken into account, most of the values are higher than the total energy consumption mapped by mPOWER. For instance, the values change to 22 MWh·cap^{-1}·yr^{-1} in the case of Zenica and 51 MWh·cap^{-1}·yr^{-1} in the case of Horst aan de Maas, leading to a 57% smaller energy consumption in the former. In this case, all the consumptions are above the target level, meaning that none of the municipalities is able to reach it.

Figure 5 depicts the distribution of the municipal energy consumption by type of fuel, taking into account the national electric mix as that of the municipality. That assumption was made due to a lack of data on the RES production of some of the municipalities, based on the fact that the electricity consumed in each city is supplied by the national grid. This data changes considerably from city to city. It can be observed that in northern countries like Tampere (Finland) and Vaxjo (Sweden), around a 50% of the whole consumed energy is in the form of electricity. Other countries, such as the Netherlands (Amsterdam, Horst aan de Maas) and Austria (Vienna) present a stronger dependence on natural gas. It needs to be clarified that in Horst aan de Maas the high consumption of natural gas is due to the massive use of heated greenhouses for intensive vegetable production [47]. Finally, southern and eastern cities, such as Pamplona and Cadiz (Spain), Zenica or Krizevci (Croatia) make, in proportion, a higher use of liquid fuels, but this could be due to the generalised use of other fuels, such as biofuels or butane gas (instead of natural gas) that was not taken into account in the calculations. In Figure 5, the electric consumption has been disaggregated by source, according to the national electricity mix, in order to obtain the RES percentage of the total municipal energy consumption. It can be seen that only Vaxjo is above the target of 27% of renewable energy from the total energy consumption, with a 27.1% share. In the rest of the municipalities, renewable energies cover a maximum of 25.8% (Tampere) and a minimum of 1.5% (Horst aan de Maas) of the total energy consumed. Northern countries (Finland, Denmark and Austria) and Croatia show particularly high RES percentages. However, we have observed that a high renewable electricity mix (in green in Figure 5) does not assure low fossil fuel consumption. On the other hand, a lower energy consumption does not assure a high renewable share, i.e., none of the cities that are able to reduce their fossil fuel consumption to below 10 MWh·cap^{-1}·yr^{-1} (Aradippou -Cyprus-, Barcelona, Krizevci, Mizil -Romania-, Nis -Serbia-, Vila Nova de Gaia -Portugal- and Zenica) have an integration of renewable energy above 17.3%.

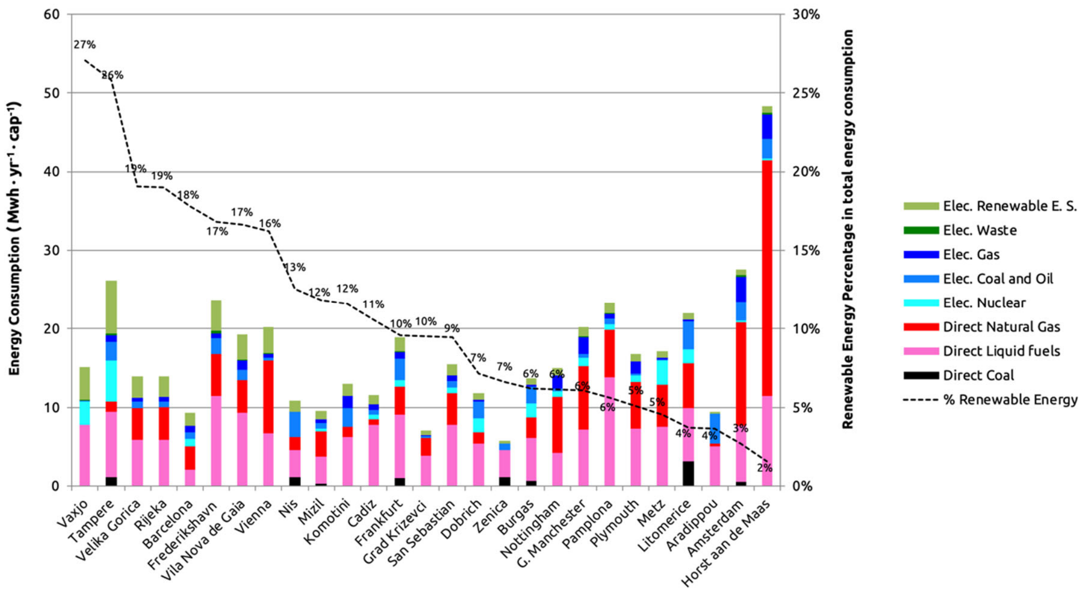

Figure 5. Energy consumption by fuel within the direct and indirect (in electric vector) energy consumptions by municipality (note that the total consumption of cities obtained from mPOWER survey differs, as shown in Figure 3, from the national average data provided by International Energy Agency (IEA)).

In order to complement the information given in Figure 5 (taking into account the differences shown in Figure 3), Figure 6 has been created, where sectorial national direct energy consumption averages have been included from IEA balances [24], and national hidden energy flows (HEF) have also been added from previous analyses carried out by the authors [11]. In order to take into account the displacements that the impacts related to the consumption of the citizens generate elsewhere, energy embodied in imported products and services in each country have been included using the latest data from the year 2014 to obtain the difference between total primary energy footprint (TPEF) and TPES per capita at a national level, adding it to each city (HEF = TPEF/TPES). The calculations have been developed using global multi-regional input-output (GMRIO) methodology, and data are available in Appendix B, Table A4. The accuracy of these calculations could be improved with municipal hidden energy flows data instead of national average ones, but this would require an input-output analysis at a local level. Although a methodology for local input-output analysis is currently being developed by Cazcarro et al. [48] as well as by our team [49], it is currently beyond the scope of this paper.

This last figure shows how only a small percentage of the energy consumption, between 9 and 24%, is consumed by private households in terms of electricity and heat (green numbers in Figure 5), whereas from 76% to 91% is not consumed in the residential sector (imported and national products and services, transportation needs for humans and trade, and transformation and distribution losses of energy).

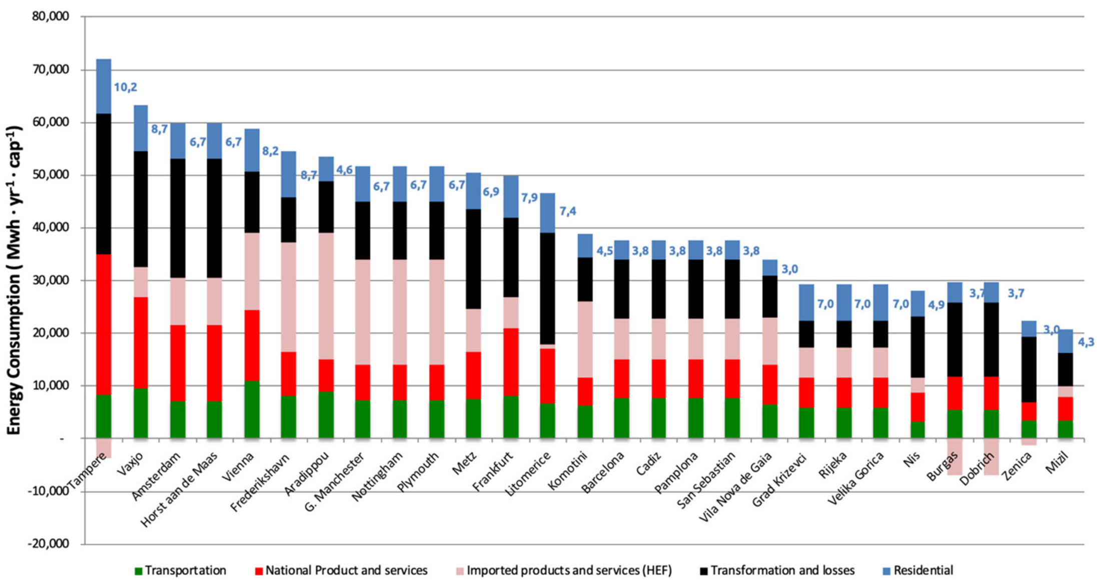

Figure 6. National energy consumptions by sector.

Figure 7 shows the relation between energy consumption (in red bars) and GHG emissions (in blue and green). The red bars correspond to the total per capita energy consumption calculated by mPOWER. The blue line corresponds to the per capita GHG emission data obtained from the survey and standardised using the IEA national values (as explained in Section 3.1). Finally, the green line corresponds to the GHG emissions calculated from the total energy consumption mapped from the surveys, taking into account the GHG emission intensity of each fuel given by the IPCC (tonnes of CO_2eq per kWh), as well as the emission intensity of the national electricity mix. This way, when the IEA standardised values and the IPCC estimated values are on the same order of magnitude, it can be regarded as a further check of the validity of the results. We consider that both GHG emission values are on the same order of magnitude when the IEA standardised values are within the IPCC estimated error bars, which cover a range from 50 to 150% of the IPCC estimated value. It can be observed in general trends that energy consumption and the corresponding CO_2eq emissions are related.

Even if the general trend is that the higher energy consumption, the higher the emissions, there are some exceptions, such as Litomerice, Manchester, Nottingham and Pamplona, which have a low IEA standardised GHG emission despite their high energy consumption. This can be explained by the use of different energy sources (a high natural gas and RES rate in the case of Manchester, Nottingham and Pamplona) or the uncertainty found in the data (low GHG emission data in the case of Litomerice). In some other cities, such as Frankfurt, Nis and Tampere, the opposite relationship is observed: the IEA standardised GHG emission data is high compared to the total energy consumption. This could be due to an overestimation of the GHG emissions or due to an underestimation of the energy consumption. In this last case, as well as in the case of Litomerice, we know the inconsistencies between IEA standardised GHG emissions and energy consumption are due to uncertainties in the data (and not due to the use of different energy sources), because the GHG emissions estimated from the IPCC intensities and those standardised with the IEA values are not on the same order of magnitude.

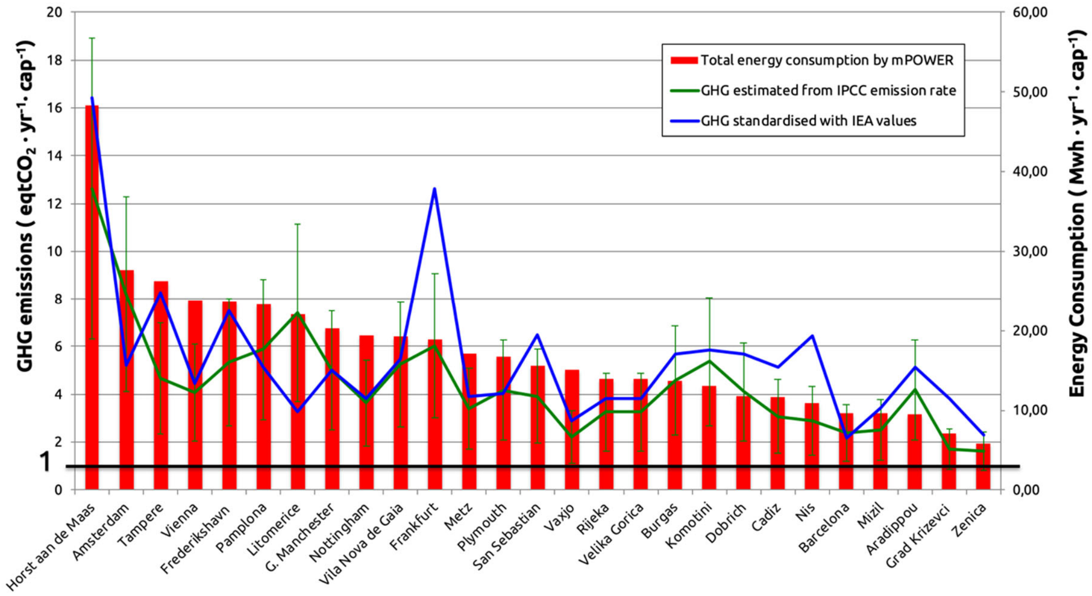

Figure 7. Energy consumption per capita by municipality, and the respective greenhouse gas (GHG) emissions obtained from the survey (IEA standardised) and calculated from the energy consumption and the IPCC emission intensities.

Finally, in order to understand the energy consumption differences in all the 27 cities, the total energy consumption detected by mPOWER has been related to the achieved national HDI [50] and national GDP [51], and also to physical conditions like the climate or the size of each city. All data were fitted to the equation "y = A ln(x) + B" following the methodology presented by Steinberger et al. [46], Arto et al. [10] and Akizu et al. [11]. Note that Horst aan de Maas was left out of the analysis because a large part of its energy consumption is used for industrial agriculture, making it difficult to correlate with the rest of the cities. This phenomenon could also occur in cities with a high presence of industrial production, but our results for rest of the analysed cities have not shown alterations as significant as those detected in Horst aan de Mass, so it has not been taken into account for the rest of the cities.

Figure 8 gives us a comparison of the consumed energy and the benefits obtained from it, using HDI and GDP indicators as they are the most commonly used in this respect [10,11]. The former, more related with human behaviours, allows us to understand how energy can affect education, life expectancy and economy, and the latter only focuses on national economy. The general trends among analysed cities show that life quality standards, measured in national HDI (Figure 8a) and GDP (Figure 8b), are directly related to consumed energy. Nevertheless, it can be observed that some cities can achieve high standards of living with markedly low energy (such as Vaxjo, Frankfurt and Frederikshavn). It must be noted that since HDI and GDP data are national averages, they are not fully sensitive to the realities of the cities, and it would be helpful to include city data for both indicators in the future.

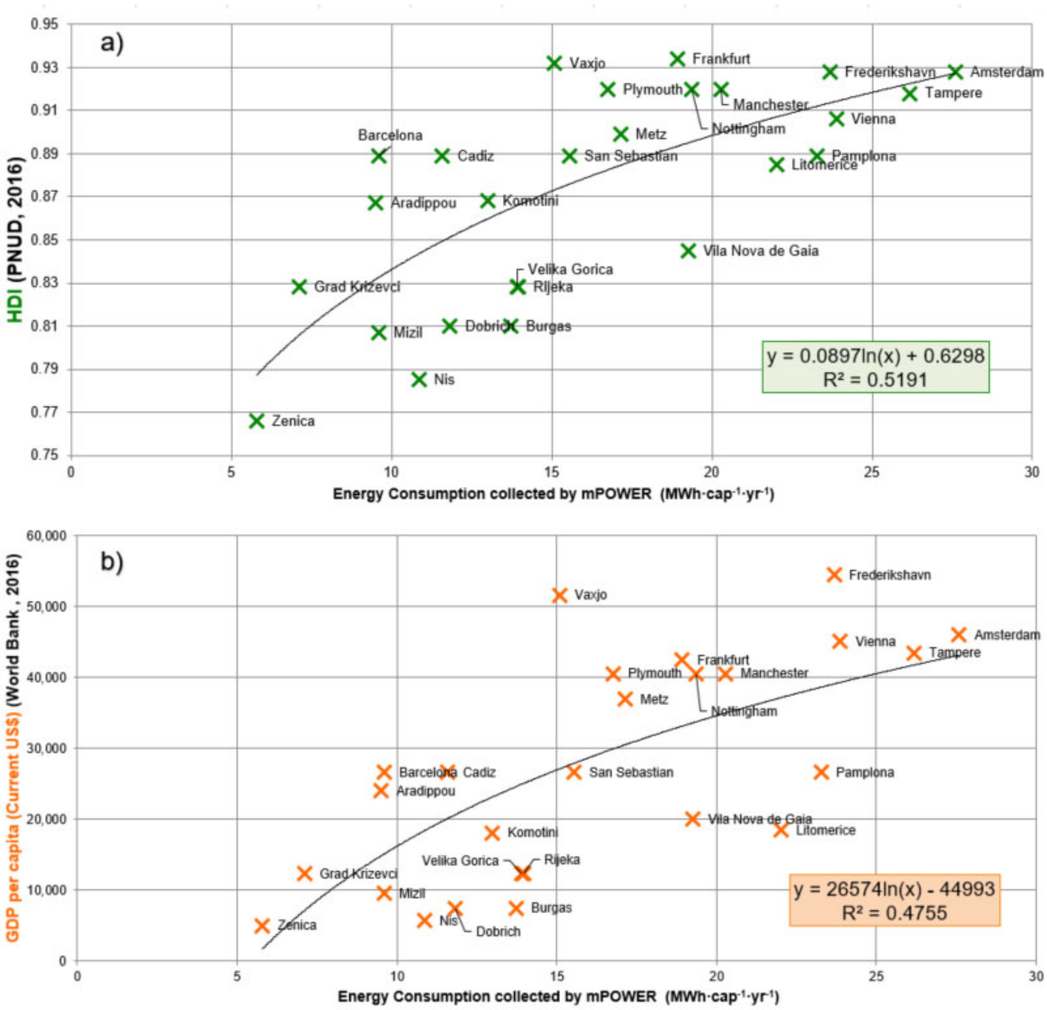

Figure 8. Energy consumption of each city compared to the corresponding national Human Development Index (HDI) (**a**) and the national Gross Domestic Product (GDP) (**b**).

In Figure 9a, the climate of each city was taken into account by using the heating degree day (HDD) and cooling degree day (CDD) factors [52]. In the analysed cities, according to the obtained fitting and R^2, there is a low correlation between the energy consumption and the HDD plus CDD, as shown in Figure 9a. Cities such as Zenica or Krizevci, with a high heating need, have a very low energy consumption per capita, whereas cities like Amsterdam and Pamplona have a higher energy consumption with a lower heating and cooling requirement. This could also be related to the difference in GDP. Figure 8b compares the size of each city (measured in inhabitants) and the energy consumption per capita, with the previous hypothesis that bigger cities might be more efficient than the smaller ones. However, Figure 9b shows that this assumption does not correspond to reality. Small cities like Aradippou show low energy consumption, whereas big cities such as Amsterdam are not especially efficient because of their large number of inhabitants.

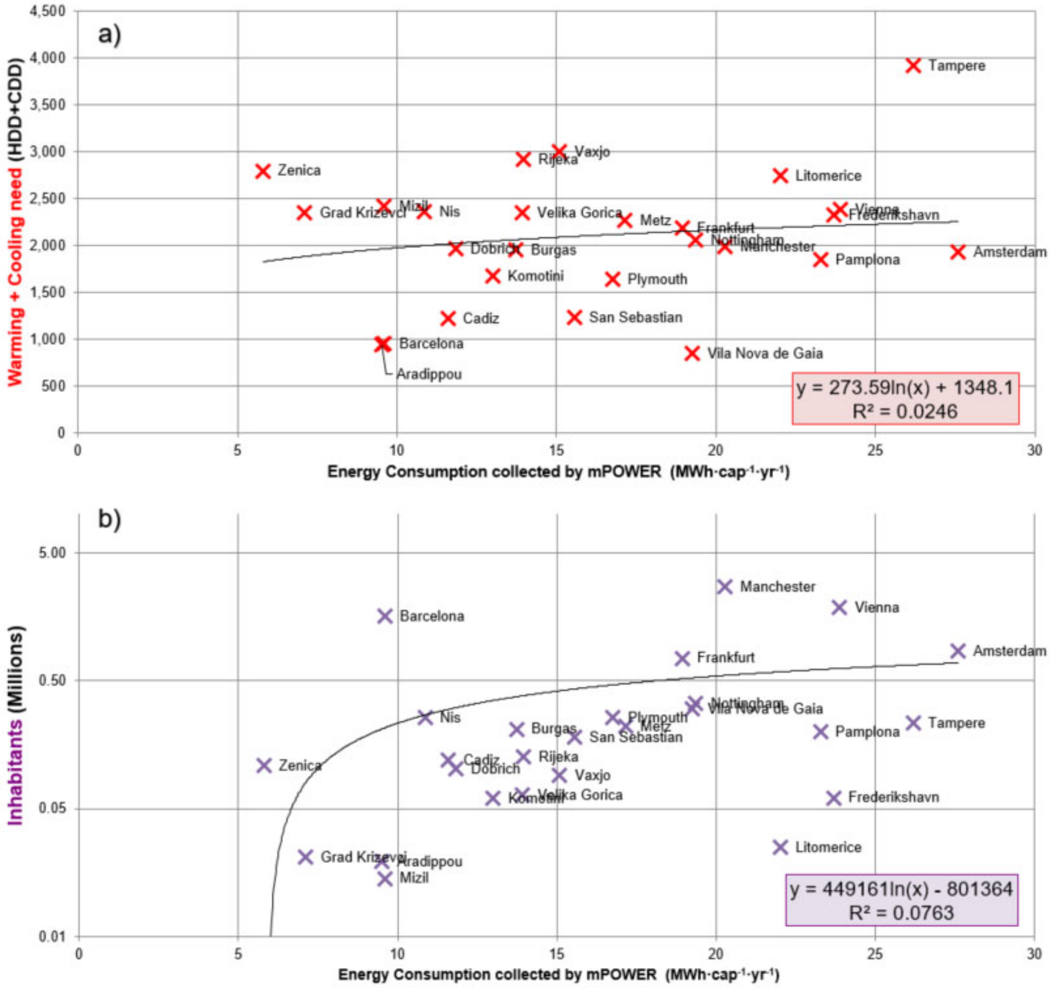

Figure 9. Energy consumption of each city, and the corresponding heating and cooling need according to the climate of each city (**a**), and the corresponding inhabitants (**b**).

Table 1. Indicators used in the paper in order to analyse and compare the 27 cities.

Indicator	Impact	Target	Description	Unit	Where
Validity of the gathered data	3	Energy democratisation	Indicates the level of knowledge of public energy employees on municipal energy issues.	%	Figure 2
Municipal campaigns	4	Energy democratisation	Indicates the number of campaigns that city has create in order to boost energy transitions.	No. · yr^{-1}	Figure 4 Table A3
Staff on energy	3,4	Energy democratisation	Indicates the human capacity of the cities in energy transition field.	No. · yr^{-1}	Figure 4 Table A3
Staff on transition	3,4	Energy democratisation	Indicates the human capacity of cities in ecological transition field.	No. · yr^{-1}	Figure 4 Table A3
Budget for transition	1,2,3,4	Energy democratisation	Amount of public resources dedicated to boost the energy transition: increase efficiency, increase RES or increase participation.	€ · yr^{-1}	Figure 4 Table A3
RES percentage	2	Increase of renewable share	RES percentage of the total mapped energy consumption by taking into account the national electricity mix.	%	Figure 5
Installed RES	2	Increase of renewable share	Total RES installation of the whole municipality.	MW	Table A2
RES production	2	Increase of renewable share	Annual RES production of the whole municipality.	MWh·yr^{-1}	Table A2
Plans for RES investment	2	Increase of renewable share	A measure of the increase of RES, by comparing the plans to the actual installed	MW for 2020	Table A3
Total energy consumption	1	Reduction of energy consumption	Total consumption of the municipality that mPOWER was able to map.	MWh·yr^{-1}·cap^{-1}	Figures 3, 5 and 7 Table A2
Total Primary Energy Supply	1	Reduction of energy consumption	Total average national energy consumption.	MWh·yr^{-1}·cap^{-1}	Figure 6
Total Primary Energy Footprint	1	Reduction of energy consumption	Total average national energy consumption, including energy embodied in imported/exported goods and services.	MWh·yr^{-1}·cap^{-1}	Figure 6
Hidden Energy Flows (HEF)	1	Reduction of energy consumption	Percentage energy embodied in imported/exported goods and services (HEF = TPEF/TPES).	(%)	Figure 6 Table A4
GHG emissions	1	Increase of renewable share	Total GHG emissions of the municipality.	eqtCO_2·yr^{-1}·cap^{-1}	Figure 7 Table A2
Human Development Index (HDI)	3,4	Reduction of energy consumption	This indicator allows to compare the acquired life quality in comparison of consumed energy.	HDI	Figure 8a
Gross Domestic Product (GDP)	3,4	Reduction of energy consumption	This indicator allows to compare the acquired national economic development in comparison of consumed energy.	US$·$yr^{-1}$·$cap^{-1}$	Figure 8b
Heating Degree Day (HDD) and Cooling Degree Day (CDD)	1	Reduction of energy consumption	This indicator allows us to compare the consumed energy and need of heating and cooling due to the climate conditions.	Degree Days	Figure 9a
Inhabitants	1	Reduction of energy consumption	This indicator allows us to compare the energy consumption according the inhabitants of a city.	Number of inhabitants	Figure 9b

5. Conclusions

In relation to the difficulties in collecting municipal energy data, we have several considerations that may be relevant for the specific goals of the project and to be taken into account when boosting the general energy transition in Europe. The low quality of the data gathered by the municipalities (sometimes literally non-existent) is a clear sign of public disempowerment in energy issues. Despite the high effort of each municipality, there are not enough public up-to-date municipal data at the European level and the energy sector is mostly owned by private companies that manage the information according to their own interests [53]. Therefore, this project reflects how significant it is to have real energy consumption and production data in order to lead an energy transition at city level.

Nowadays, participation in different energy transition initiatives, such as the Covenant of Mayors, and thus, the sharing of energy consumption and GHG emission data with citizens is a voluntary act. However, in some regions, such as the Basque Country [54], the publication of data related to energy consumption is starting to become compulsory for their cities and villages. We claim this kind of law to provide citizens with information could boost the incoming energy transition. This knowledge could facilitate evaluating energy policies, analysing the real needs of each city, or creating roadmaps and energy plans for incoming sustainable energy transitions. We expect that this project will help in revealing these kinds of issues, enabling initiatives such as the creation of public databases, and empowering local public institutions in the management of low-carbon energy transition. Similarly, it is important to spread the know-how of the current energy reality among citizens and other agents in cities in order to boost citizen-led initiatives. As an example, and as an alternative to private energy management, renewable cooperatives could be an opportunity to start a transition towards a democratic and sustainable energy system [55–57].

Going back to the data collection, it has been observed that the mPOWER baseline survey has allowed us to map an average of 49% of the energy consumption per capita (in comparison with national average total primary energy supply values offered by the IEA) consumed by citizens. The remaining 52% is mainly due to transformation losses, and also, to a lesser extent, due to the lack of integration of non-common energy vectors such as biomass (like firewood or biofuels), butane gas, waste use for energy purposes and fuel oil boilers. In some cases, the use of CHPs could also generate alterations in results because of the double accountability they tend to cause when taking into account the gas they consume, but the electricity produced in homes is also taken into account.

The obtained results reveal that European cities still present a strong dependence on fossil fuels, ranging from 72% of fossil fuels in the total energy mix mapped in this paper to 98.4%. The low percentage of electricity in energy supply is also noteworthy, where renewable generation is still generally minimal. In addition, because of the small percentage of the total (renewable and non-renewable) energy that is consumed by private homes in the form of electricity and heat, it must be underlined that energy transition not only needs to be focused on the energy consumption of private dwellings, but it especially needs to challenge the current model of products and goods consumption. In this sense, this work provides a view of how consumers have the potential to improve the national energy system, partaking in shared responsibility with governments [58].

The comparison among the 27 cities analysed clearly relates the achieved human development index and gross domestic product in a city to the consumed energy, showing a dependence on energy consumption to maintain the current living standards, and improve them. However, some cities already show that they can achieve high GDP and HDI values with relatively low energy consumption (as Vaxjo and Plymouth); hence these cities should be taken as a reference. On the other hand, we can see that the climate and size of a city do not positively or negatively affect the energy efficiency, and thus, this gives various types of cities the opportunity to think about different strategies to improve their own energy systems.

Finally, in relation to the mPOWER project, this baseline has been shown as an effective tool to obtain an initial picture of the energy situation of different European cities. The results of the baseline and of this paper will help to improve the development of the project and can encourage participant cities to identify the above-mentioned key obstacles and information gaps in the transition to a participative low-carbon energy system.

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Conflicts of Interest: The authors declare no conflict of interest.

Appendix A. Online Survey

We need some data and information to carry out a baseline assessment of your municipality. This will allow us to calculate the evolution of the energy transition and the learning process in the coming years. Thank you very much for your involvement and the data you provide! *Required

1. Name*
2. Municipality*

Renewable energy data

Please fill in the 'data year', it is very important for us. The data should be from 2017 or as close as possible.

3. Installed renewable thermal power MW and (year)
4. Renewable thermal energy production MWh and (year)
5. Installed renewable electric power MW and (year)
6. Renewable electric energy production MWh and (year)

Non-renewable energy data

Please fill in the 'data year', it is very important for us. The data should be from 2017 or as close as possible.

7. Natural gas consumption MWh and (year)
8. Electricity consumption MWh and (year)
9. Liquid fuels MWh and (year)
10. Coal MWh and (year)
11. Greenhouse Gas Emissions eqCO_2 tonnes and (year)
12. If your city/municipality has any data documents with more information about energy data, you can share the link with us here! (or email to name@ehu.eus)

Staff and budget for energy transition

Maybe you have answered these questions before, but it is important that we have the most up-to-date information.

13. People working in energy issues (number of equivalent full-time municipal employees or subcontracted)
14. People working in energy transition issues (energy efficiency, promotion of RES, energy democracy, sustainable mobility, etc.,)
15. Annual budget for energy transition (Should exclude personal costs)

16. If you have any documents about the staff and budget for energy transition that you want to share, you can paste the link here or email name@ehu.eus

Plans for investment and citizen participation

In this section we are interested in the plans for energy transitions in the future, and the information about citizen participation in the energy transition of your municipality

17. Does your municipality already have published plans for renewable energy power development?

- Yes
- No

18. If the previous answer was yes, what is the amount of additional MW planned during the next tax year?
19. Number of municipality-led initiatives and campaigns for energy transition

- 0
- 1–5
- 6–10
- 15+

20. Number of citizenship/cooperative-led initiatives and campaigns for energy transition

- 0
- 1–5
- 6–10
- 15+

21. If you have any interesting documents that you want to share with us about the energy transition in your municipality, you can paste the link here or send an email to name@ehu.eus

Appendix B. Standardised Data of the Research Project

Table A1. Interpretation of some of the received RES data.

City	Data Type	Received Value	Considered Value	Reason
Metz	Installed RES electric (MW)	13,100	131.00	Received data is quite high and presents no proportionality with the energy generation indicated
Horst aan de Maas	Installed RES thermal (MW)	3.07 PJ/year	852,777 MWh	Unit change from International System to required (MWh) is applied. Data is allocated in the energy column
Horst aan de Maas	Installed RES electric (MW)	3.45 PJ/year	958,333 MWh	Unit change from International System to required (MWh) is applied. Data is allocated in the energy column
Manchester	Installed RES thermal (MW)	53.82017	53.8	The last 4 digits refer to the year of the data
G. Manchester	Installed RES electric (MW)	1,262,017	126	The last 4 digits refer to the year of the data
G. Manchester	Consumption Electricity (MWh/year)	139,322,016	13,932	The last 4 digits refer to the year of the data
G. Manchester	Consumption Gas (MWh/year)	216,720,002,016	21,672,000	The last 4 digits refer to the year of the data
G. Manchester	Consumption Coal (MWh/year)	5,162,016	516	The last 4 digits refer to the year of the data
Mizil	Installed RES electric (MW)	1735	1.735	Based on data given in a preliminary survey 1.735 MW PV
Mizil	Production RES electric (MWh)	0.67	670	Produced energy-power ratio is logical with this figure (value was introduced in GWh)
Nottingham	Production RES electric (MWh)	-	6	Based on data given in a preliminary survey: 6 MW PV
Pamplona	Production RES electric (MWh)	190	0.19	Produced energy-power ratio is logical with this figure (value was introduced in GWh)
Tampere	Production RES thermal (MW)	-	315	Based on data given in a preliminary survey: 83 MW Biomass, 232 CHP
Tampere	Production RES electric (MW)	-	16	Based on data given in a preliminary survey: 16 MW Hydro
Zenica	Produced RES electric (MWh)	0.9	900	Produced energy-power ratio is logical with this figure (value was introduced in GWh)
Zenica	Produced RES thermal (MWh)	0.2	200	Produced energy-power ratio is logical with this figure (value was introduced in GWh)

Table A2. GHG emission, energy consumption and RES installation and production data of all 27 municipalities, after the standardisation of the results.

		Energy Consumption (MWh/Year)					RES Installation and Production			
City	**GHG (t CO_2 eq/Year)**	**Electricity**	**Gas**	**Liquid Fuels**	**Coal**	**Total**	**Thermal Power (MW)**	**Thermal Energy (MWh/Year)**	**Electric Power (MW)**	**Electric Energy (MWh/Year)**
Amsterdam	4500	5,787,800	11,386,400	6,123,200	437,723	23,735,122	-	-	-	-
Aradippou	98,383	77,482	8737	94,480	2103	182,802	-	9675	1.08	1742
Barcelona	3,413,260	6,825,200	4,755,340	3,414,760	0	15,145,912	101.00	81,268	13.00	16,414
Burgas	1,192,800	1,041,600	558,600	1,146,600	136,416	2,883,216	-	-	-	-
Cadiz	611,660	374,036	84,169	921,060	0	1,379,264	-	-	1.07	1385
Dobrich	585,040	510,880	145,710	562,380	0	1,218,970	0.00	0.00	0.00	0.00
Frankfurt	9,467,655	4,699,832	2,708,405	6,045,000	745,125	14,198,362	64.44	10,697	31.00	25,181
Frederikshavn	458,000	420,277	326,944	697,222	0	1,444,443	418.30	-	42.30	330,408.56
Horst aan de Maas	695,050	286,111	1,269,444	486,111	0	2,041,666	-	852,777.78	-	958,333.33
Komotini	350,415	329,450	75,474	373,776	0	778,700	-	-	-	-
Krizevci	79,800	21,211	47,153	81,000	8	149,371	0.00	0.00	0.03	29.60
Litomerice	81,765	161,500	142,250	168,750	78,035	550,535	1.57	-	0.68	672
G. Manchester	13,500,000	13,581,000	21,671,998	19,521,000	516	54,774,514	53.80	-	126.00	-
Metz	869,712	953,885	1,1163,280	1,689,420	0	3,806,585	45.00	94,454	131.00	179,347
Mizil	49,376	38,499	45,655	47,945	5295	137,395	-	-	1.74	670
Nis	1,679,600	1,201,200	442,000	868,400	311,451	2,823,051	-	-	-	-
Nottingham	1,257,583	1,240,386	2,333,802	1,395,843	8713	4,978,744	-	-	-	-
Pamplona	1,028,000	667,975	1,223,742	2,747,484	14,394	4,653,595	0.20	350	0.19	225
Plymouth	1,053,000	904,000	1,557,000	1,879,800	17,000	4,357,800	1.80	-	7.30	-
Rijeka	486,400	508,160	524,800	753,920	0	1,786,880	0.00	0.00	0.11	86.43
San Sebastian	1,170,181	680,702	732,568	1,400,855	0	2,814,125	7.34	9159	1.63	1,630
Tampere	1,920,960	3,589,040	283,040	1,939,520	263,065	6,074,664	99.00	-	-	-
Vaxjo	268,000	670,000	0	718,000	100	1,388,100	-	670,000	-	235,000
Velika Gorica	241,365	252,162	257,800	374,115	0	884,077	-	-	0.15	-
Vienna	8,356,000	7,815,00	17,314,000	12,621,000	8,007	37,758,006	283.00	1,270,000	256.00	1,401,000
Vila Nova de Gaia	1,640,837	1,750,868	1,225,720	2,801,294	0	5,777,882	-	-	6.50	32,040
Zenica	253,085	132,156	0	379,489	124,534	636,179	3.00	200	1.44	900

Table A3. Number of campaigns led by the council or cooperatives/citizens, staff on energy, staff on transition/reducing energy use or RES, budget dedicated to energy transition and plans for RES investments.

City	Council Led Campaigns	Staff on Energy (# of FTE Staff)	Staff on Transition/Reducing Energy Use/RES (# of FTE Staff)	Annual Budget Dedicated to Energy Transition (€)	Plans for RES Investment (MW for 2020)
Amsterdam	>15	-	-	87,500,000	-
Aradippou	1–5	2	2	70,000	6.00
Barcelona	>15	15	55	-	1.50
Burgas	-	-	-	-	-
Cadiz	1–5	1	1	70,000	-
Dobrich	1-5	3	3	200,000	-
Frankfurt	>15	23	13	1,800,000	-
Frederikshavn	6–10	8	2	58,000	-
Horst aan de Maas	1–5	5,5	3,5	60,000	<1
Komotini	1–5	8	2	500,000	-
Krizevci	1–5	1	1	792,000	-
Litomerice	1–5	2	2	200,000	-
G. Manchester	6–10	15	15	7,020,000	10.00
Metz	>15	1	5	500,000	Yes
Mizil	1–5	4	4	1,000,000	-
Nis	-	6	3	20,000	1.00
Nottingham	-	-	-	-	Yes
Pamplona	1–5	3	1	100,000	-
Plymouth	6–10	16	16	589,000	Yes
Rijeka	0	1	1	-	-
San Sebastian	1–5	4	11	400,000	0.07
Tampere	-	-	-	-	-
Vaxjo	-	-	-	-	Yes
Velika Gorica	1–5	1	1	40,000	-
Vienna	>15	25	-	-	Yes
Vila Nova de Gaia	1–5	10	-	5,000,000	0.50
Zenica	1–5	1	0	250,000	

Table A4. National average energy consumption data corresponding to each city. TPES data have been extracted from IEA, while TPEF and HEF data have been calculated by the authors using GMRIO methodology.

Country	City	Transportation	National Products and Services	Imported Products and Services (HEF)	Transformation and Losses	Residential	TOTAL (MWh/yr/Cap)
Netherlands	Amsterdam	7.12	14.40	8.91	22.68	6.74	59.85
Cyprus	Aradippou	8.88	6.25	23.92	9.82	4.58	53.46
Spain	Barcelona	7.74	7.29	7.68	11.17	3.81	37.69
Bulgaria	Burgas	5.46	6.38	6.87	14.07	3.74	22.79
Spain	Cadiz	7.74	7.29	7.68	11.17	3.81	37.69
Bulgaria	Dobrich	5.46	6.38	6.87	14.07	3.74	22.79
Germany	Frankfurt	8.06	12.86	5.99	14.98	7.94	49.84
Denmark	Frederikshavn	8.06	8.35	20.91	8.54	8.65	54.52
Netherlands	Horst aan de Maas	7.12	14.40	8.91	22.68	6.74	59.85
Greece	Komotini	6.24	5.35	14.49	8.30	4.53	38.91
Croatia	Grad Krizevci	5.89	5.77	5.65	5.00	6.95	29.26
Czech Republic	Litomerice	6.75	10.44	0.81	21.13	7.39	46.52
UK	G. Manchester	7.23	6.87	19.93	10.95	6.70	51.68
France	Metz	7.61	8.95	8.07	18.98	6.91	50.51
Romania	Mizil	3.35	4.65	1.95	6.42	4.31	20.67
Serbia	Nis	3.34	5.42	2.87	11.51	4.85	27.99
UK	Nottingham	7.23	6.87	19.93	10.95	6.70	51.68
Spain	Pamplona	7.74	7.29	7.68	11.17	3.81	37.69
UK	Plymouth	7.23	6.87	19.93	10.95	6.70	51.68
Croatia	Rijeka	5.89	5.77	5.65	5.00	6.95	29.26
Spain	San Sebastian	7.74	7.29	7.68	11.17	3.81	37.69
Finland	Tampere	8.36	26.63	3.74	26.75	10.25	68.25
Sweden	Vaxjo	9.50	17.45	5.56	22.06	8.68	63.24
Croatia	Velika Gorica	5.89	5.77	5.65	5.00	6.95	29.26
Austria	Vienna	11.06	13.38	14.57	11.69	8.18	58.88
Portugal	Vila Nova de Gaia	6.49	7.47	9.02	7.89	3.05	33.91
Bosnia and Herzegovina	Zenica	3.46	3.45	1.31	12.38	3.04	21.02

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