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# Stakeholders' perspectives on energy related Smart City technologies: POCITYF's standpoint

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**Abstract.** POCITYF – a H2020 smart-city project – supports cities with historical and cultural heritage districts, by developing innovative solutions and technologies to be applicable in cities with an architecture characterized by historic and/or cultural protected buildings and districts. To harmonise the innovative solutions with cultural heritage, the inclusion of relevant stakeholders' opinions in decision-making and implementation of the project is crucial, as stakeholders are not only affected by the solutions, but also influence their successful implementation. To identify their needs and interests in relation with the list of innovations proposed, three (3) types of surveys were carried out among different stakeholder groups: **Impact & Readiness of the solutions; Power & Interest of the local Stakeholders; Citizens' Knowledge & Acceptance of the solutions.** These surveys facilitate the selection, deployment and replication of the smart city solutions as well as strategies for social engagement, ensuring they are appropriate for the cultural heritage of cities and its citizens' requirements.

**Keywords** – Smart cities, Cultural heritage, Stakeholders, Power and Interest analysis, Citizens' Knowledge and Acceptance analysis.

## 1. Introduction

The European Commission (EC) President's (Ursula von der Leyen) moon-shot ambition for Europe to become the "[first climate-neutral continent](#)" by 2050 sets the pace for an unprecedented mobilization of resources (financial, human, and technological), for which EU cities will be determinant. Cities are expected to host 80% of Europeans by 2050 [1], while representing 60-80% of the global energy consumption and CO2 emissions. Most European cities also have buildings with historical and/or cultural interest, thus increasing the challenges when trying to follow the developments of the energy transition, primarily owed to technical limitations and regulatory barriers. [POCITYF – a H2020 smart-city project](#) [2] – supports cities with historical and cultural heritage districts, by developing innovative solutions and technologies to be applicable in cities with an architecture characterized by historic and/or cultural protected buildings and districts. On this basis, POCITYF mobilises two Lighthouse (LH) cities (Evora-PT and Alkmaar-NL), and six 6 Fellow cities (FC) (Granada-ES, Bari-IT, Celje-SI, Ujpest-HU, Ioannina-GR and Hvidovre-DK), to share knowledge, coordinate their efforts, shape their own, unique Bold City Visions while respecting their cultural heritage and improving the wellbeing of their citizens.

POCITYF’s strategy is built around four multidisciplinary and complementary **Energy Transition Tracks (ETT)**: ETT#1 focuses on achieving significant energy savings at both the building and district level, reducing energy bills for citizens, as well as enabling a high share of locally produced and consumed renewable energy; ETT#2 focuses on maximizing self-consumption, reducing grid stress, avoiding renewable generation curtailment and increasing revenue through flexibility services to the grid; ETT#3 solutions focus on electro-mobility in the energy system - increasing the penetration of electric vehicles (EVs) utilizing Renewable Energy Sources (RES) and the potential of EVs to support grid flexibility, reducing citizen’s mobility costs and better traffic management; and ETT#4 solutions focus primarily on improving citizens’ quality of life, involving citizens in the early development, design and evaluation phases of the solutions and related services of the aforementioned ETTs. Within these ETTs, POCITYF seeks to demonstrate the roll out of a set of 10 **Integrated Solutions (IS)** Figure 1, which are made up of more than 60 mature and innovative technologies.

ETT#1: Innovative Solutions for Positive Energy (CH) Buildings and Districts		ETT#2: P2P Energy Management and Storage Solutions for Grid Flexibility		ETT#3: e-Mobility Integration into Smart Grid and City Planning		ETT#4: Citizen-Driven Innovation in Co-creating Smart City Solutions		
Integrated Solutions	IS 1.1	Positive Energy (stand-alone) Buildings	IS 2.1	Flexible and Sustainable Electricity Grid Networks with Innovative Storage Solutions	IS 3.1	Smart V2G EVs Charging	IS 4.1	Social innovation mechanisms towards citizens engagement
	IS 1.2	Positive Energy Districts Retrofitting					IS 4.2	Open innovation for policy makers and managers
	IS 1.3	Feeding PEDs with Waste Streams Promoting Symbiosis and Circular Economy	IS 2.2	Flexible and sustainable district heating/cooling with innovative heat storage solutions	IS 3.2	E-mobility services for citizens and auxiliary EV technologies	IS 4.3	Interoperable, modular and interconnected city ecosystem

**Figure 1.** POCITYF Energy Transition Tracks and respective Integrated Solutions.

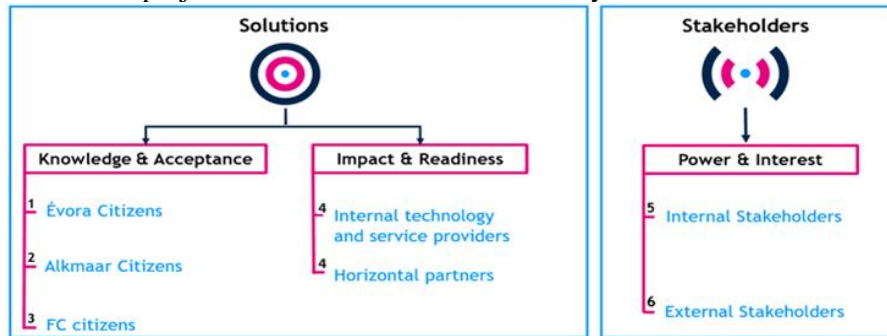
To harmonise the innovative solutions with the cultural heritage of different cities, the active engagement of relevant stakeholders throughout the project is a key element for ensuring a successful implementation. The integration of the stakeholders’ perspective is of utmost importance in the decision-making process, as they are not only affected by the solutions, but also influence their successful implementation. Due to the complexity of Smart Cities projects, there are many interdependencies among stakeholders, and a need to align various viewpoints. To identify their needs and interests, in relation with the list of innovations proposed, three types of surveys were carried out among the different groups of stakeholders identified: **Citizens' Knowledge & Acceptance; Impact & Readiness of the solutions; Power & Interest of the local Stakeholders.**

**2. Strategy for data collection**

*2.1. Surveys conducted*

Due to the complexity of Smart Cities projects, there are many interdependencies among stakeholders, and a need to align various viewpoints and interests. To highlight stakeholder’s shared interests, all the involved actors with direct influence on smart city development have been identified and grouped into the following: Energy Utilities, Consumers, Technology and Services Providers, Policy-Making Bodies and Governance, Citizens, and Representative Citizen Groups. Further, these stakeholders have also been divided in two categories: Internal Stakeholders (all stakeholders that are part of the POCITYF project consortium) and Local External Stakeholders (all stakeholders that are not part of the POCITYF consortium but have an interest in the project and can affect or be affected by it). With the help of the cities involved in the project, these relevant bodies were invited to respond to a total of 6 surveys described below. A total of 867 responses were recorded for all of the surveys, with specific numbers for each described in the dedicated sections in this paper. As the surveys were shared through various channels of communication – email, social media, municipal websites etc – a response rate is

unable to be calculated. The surveys were divided into two categories: **Solutions** and **Stakeholders**. In the first, **Solutions**, the knowledge and acceptance of the different solution to be implemented was conducted in Évora (1), Alkmaar (2), and fellow cities (3); and the perceived level of readiness and impact of the different solutions was surveyed among the internal technology and service providers, and horizontal partners (4). Regarding the second group, **Stakeholders**, two surveys (to internal (5) and external (6) stakeholders) were conducted to analyse the perceived power and interest that external stakeholders have in the project and the solutions of a smart city.



**Figure 2.** The 6 Surveys carried out and the participants in the different types of surveys

*2.1.1. Citizens' Knowledge & Acceptance.* Two surveys were carried out, one for the city of Évora (1), another for Alkmaar (2). It is expected that these surveys will be updated in 2022 and be answered for the first time by the citizens of the Fellow Cities (3). These surveys are intended to understand whether the solutions meet the needs of the citizens. The results highlight the level of knowledge citizens have about the solutions that they will use or in which they can participate, as well as their level of acceptance/interest in them. The indicator provides a qualitative measure and is rated on a five-point Likert scale for the **Knowledge/information level**: from 1 (I have no knowledge/information about this solution) to 5 (I am very well informed); and for the **Acceptance/interest level**: from 1 (I have no interest in using/participating in this solution) to 5 (I am very interested).

*2.1.2. Impact & Readiness of the solutions.* The aim of this survey is to have an idea of the impact (capacity and potential that a solution has in making a city “Smarter”) and the readiness level (solutions’ readiness level to achieve this impact, from a technological, economic and regulatory perspective). The indicator provides a qualitative measure and is rated on a five-point Likert scale for the **Impact level**: from 1 (Weak impact) to 5 (Excellent impact); and for the **Readiness level**: from 1 (very low level of Readiness) to 5 (very high level). This survey was answered by the Internal Stakeholders (*all stakeholders that are part of the POCITYF project consortium*), due to the knowledge and experience that they have on the solutions to be implemented and their participation in previous smart cities projects.

*2.1.3. Power & Interest of the local Stakeholders.* Two surveys were conducted, one for the Local External Stakeholders of the cities involved in the project, to identify the perceived level of power and interest that each group of Stakeholders of each city has in the different sets of solutions and in the project as a whole. The other survey was answered by the Internal Stakeholders of the project, in order to identify the perceived level of power and interest that each group of external stakeholders has in the project as a whole, with the goal of making a comparison with the data obtained from the survey answered by Local External Stakeholders. The indicator provides a qualitative measure and is rated on a five-point Likert scale for the **Power level**: from 1 (very low power) to 5 (very high power); and for the **Interest level**: from 1 (very low interest) to 5 (very high interest).

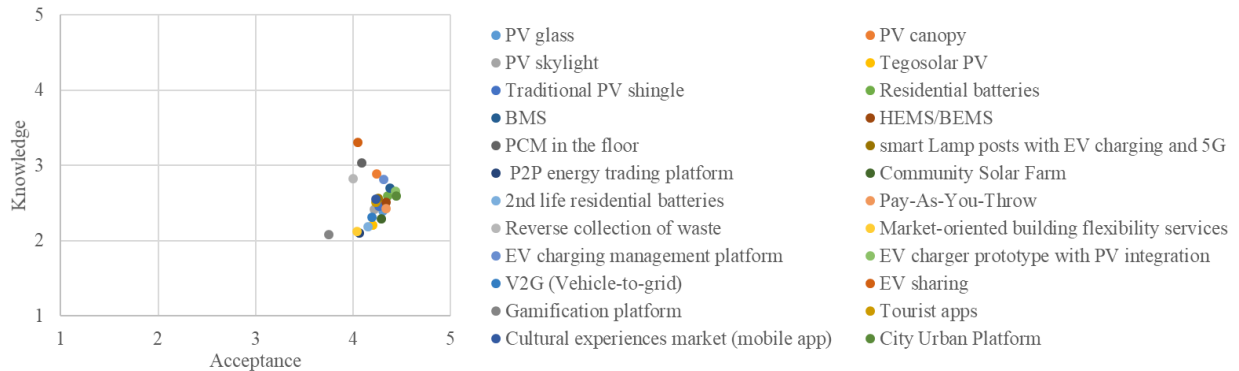
### 3. Survey results

#### 3.1. Citizens' Knowledge & Acceptance results

##### 3.1.1. Perspective of citizens of Évora.



This survey was shared with the citizens of the city of Évora, and was disseminated through the city's social platforms, with a total of 104 responses. It was conducted in June and July 2020 and will be repeated in January 2022 in order to update results. **Figure 3** shows the results, highlighting the perspectives of citizens of Évora. In general, POCITYF solutions were classified by the citizens of Évora with a high level of acceptance and low level of knowledge. Except for the EV sharing and PCM in the floor for which, despite being solutions planned to be demonstrated in Alkmaar, the citizens of Évora have showed a great acceptance in being replicated in their city.

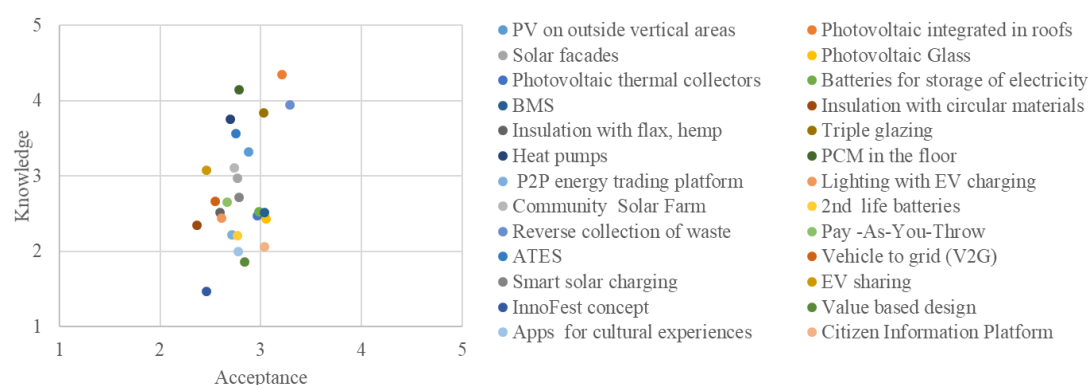


**Figure 3.** Knowledge and Acceptance of solutions for the city of Évora - Evaluation by Évora citizens on a five-point Likert scale.

In addition, it was possible to analyse the level of acceptance of solutions inside and outside the historic centre of the city of Évora. There is a decrease in the level of acceptance citizens have of solutions to be demonstrated in the buildings in the Historic City Centre. This fact is more evident with the PV canopy, whose acceptance level goes from a rating of 4.3 for areas outside the Historic City Centre to a rating of 3.5 for buildings in the Historic City Centre. This result reflects concern that citizens may have about the visual impact canopy PVs have on the landscape and highlights the greater challenge that POCITYF is working to solve – to make historic places more sustainable. For Évora, the low level of knowledge and information that citizens have about solutions is one of the main risks. It is important to develop actions that increase the knowledge citizens have of the solutions that will be implemented, to involve citizens in the participation of the project and in the development of the solutions themselves, seeking to understand their concerns in the preservation of the Historic City Centre.

### 3.1.2. Perspective of citizens of Alkmaar.

This survey was shared with citizens of the city of Alkmaar, and was disseminated through the city's communication platforms, with a total of 633 responses. It was conducted in June and July 2020 and will be repeated in January 2022 in order to update the results. **Figure 4** shows the results, highlighting the perspectives of citizens of Alkmaar, for the POCITYF solutions they may use.

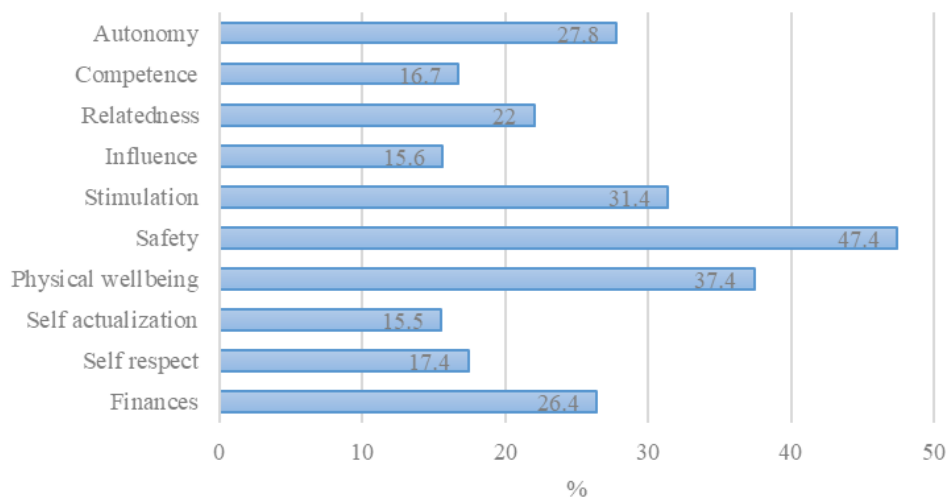


**Figure 4.** Knowledge and Acceptance of solutions for the city of Alkmaar - Evaluation by Alkmaar citizens on a five-point Likert scale.

Analysing the results for the city of Alkmaar, it is possible to observe a greater distribution of the level of knowledge and interest in the different solutions compared to Évora. Citizens have demonstrated a high level of knowledge in photovoltaic integrated in roofs and reverse collection of waste solutions, however they have a level of interest just slightly above 3. Hence, the level of acceptance of citizens must be monitored throughout the project to understand if these solutions have a good replication and scalability potential and to maintain a high level of Interest. For PV on outside vertical areas, Heat pumps, Aquifer Thermal Energy Storage (ATES) and Phase Changing Material (PCM) in the floor, there is a low level of acceptance and high level of knowledge that citizens have in relation to these solutions, representing a considerable risk in demonstrating these. As such, the project should identify what leads citizens to have these views and improve these points, increasing the level of acceptance of these solutions or reassessing their implementation. For other solutions with low level of knowledge such as V2G, Insulation with circular materials, Building management System (BMS), photovoltaic thermal collectors and others with level of knowledge below 3, actions should be developed to increase the knowledge that citizens have of the solutions that will be implemented, in order to involve citizens in the project and the development of the solutions themselves, while increasing the level of interest in the solutions.

### 3.1.3. General citizen considerations.

The *Perspective of citizens of Évora and Alkmaar* surveys not only identified the levels of acceptance and knowledge of the solutions envisaged to be implemented in their cities, but the needs and experiences from citizens related to their lives and living environment. This information acquisition was adapted for each city, and sent alongside other surveys for the project, to increase the number of responses and to prevent citizens from feeling overwhelmed with many different surveys. For Alkmaar, citizens were asked to indicate which psychological human needs they would like to see improved in their immediate living environment. The ten values are based on Sheldon[3] and the VUX framework from Kort[4]. Citizens could choose multiple options: Autonomy, Competence, Relatedness, Influence, Stimulation, Safety, Physical wellbeing, Self-actualization, Self-respect, and Finance. With this, the options most voted by the citizens of Alkmaar were Safety (47.4%) Physical wellbeing (37.4%) and Stimulation (31.4%) [3]. These results have probably been affected by the context, the first COVID-19 wave and intelligent lockdown in the Netherlands.



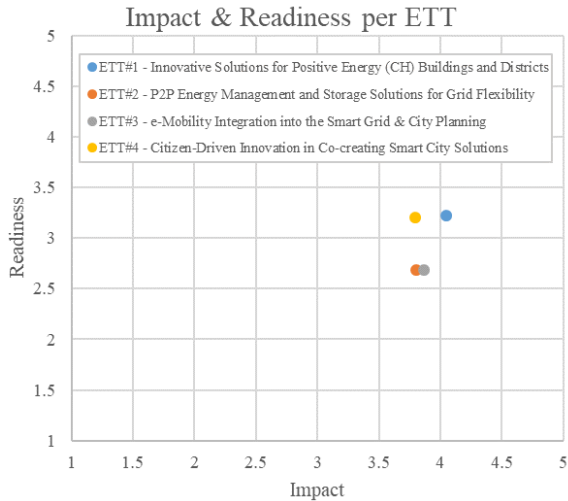
**Figure 5.** Result of voting on the aspects that the citizens of Alkmaar would like to see improved in their living environment.

Évora citizens were asked what other solutions/suggestions they would like to see implemented in the historic city centre and in residential areas outside the historic centre. Of the proposals/suggestions given by the citizens of the city of Évora, it can be stated that the vision of the citizens is aligned with the objects of POCITYF, with a large number of comments related to the reduction of car traffic within the

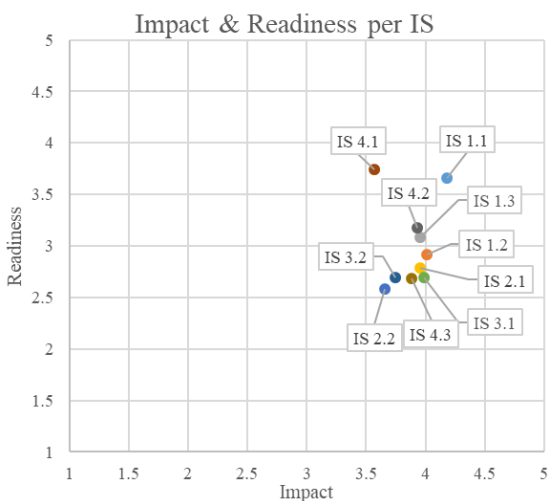
historic centre in order to increase the space for walking. This also reflects the variation in acceptance that residents of the historic centre showed for the solutions for IS 3.1 (Smart V2G EVs Charging).

3.2. Impact & Readiness results

This survey was shared with POCITYF project internal partners - technology and service providers, as well as horizontal partners. It was conducted in May 2020 with a total of 29 responses and will be repeated again in January 2022 to update the information. The impact and readiness scores of **each technology** has been aggregated into POCITYF’s grouping of technologies in **Integrated Solutions** and further into **Energy Transition Tracks** by simple averaging. **Figure 6** presents the results of this evaluation per Energy Transition Track (ETT) while presents the results per Integrated Solution (IS). All transition tracks have scored above average in impact levels while the readiness levels lie near the average score of 3/5.



**Figure 6.** Impact and Readiness of solutions grouped per Energy Transition Track - Evaluation by POCITYF's internal stakeholders on a five-point Likert scale.



**Figure 7.** Impact and Readiness of solutions grouped per Integrated Solution - Evaluation by POCITYF's internal stakeholders on a five-point Likert scale.

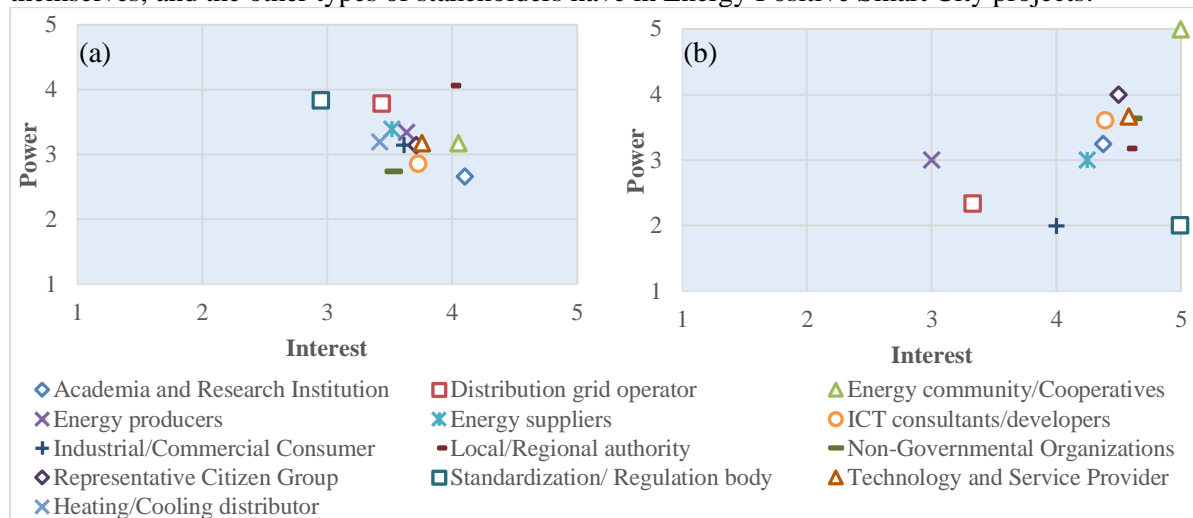
We observe that solutions under ETT#1, scored high in impact (4.05/5) and average in readiness levels (3.22/5) indicating that these solutions are considered highly influential in the Smart City scope and quite ready to be deployed. Digging deeper in the underlying technologies and integrated solutions, we note that the most impactful solutions are the ones related to Building Integrated Photovoltaics (BIPV), thermal insulation, energy management systems on a building and district level as well as incentives for waste separation and circular economy building practices having scored above 4/5. In terms of readiness levels, BIPV systems as well as thermal insulation solutions are considered as technologies with high level of readiness while solutions such as solar roads, P2P market platforms have scored low levels of readiness showcasing the need for further investigation on technical and legislative measures that will boost these technologies towards adoption by Smart Cities. Concerning ETT#2, the readiness levels are below average while the impact score of this ETT solutions is relatively high. Most of the underlying technologies have scored average or below average in terms of readiness levels with the DC grid solution having a score of 2.5/5. Solutions like the Aquifer Thermal Energy Storage (ATES) have also scored below average in terms of readiness levels (2.7/5) while there seems to be a link between the level of readiness and the impact of each solution: both ATES and DC grid technologies are considered above average in terms of impact but with the lowest scored among all other technologies in ETT#2. The most impactful technology is considered the grid energy storage systems which underlines the importance of storage in providing grid flexibility and sustainability. The other technologies such as flexibility optimization algorithms and Virtual Power Plants (VPPs) are also considered of high importance as they have scored impact levels above 4. For POCITYF’s ETT#3, technologies such as V2G, solar roads and hydrogen fuelled tracks scored below average (below 2.5/5) in readiness level, while EV charging and



electric shared mobility services have scored above average in readiness level. The fact that all solutions are considered highly impactful (average score 3.9/5) indicate the importance of e-mobility into a Smart City infrastructure. Nevertheless, technological, legislative and other barriers need to be overcome in order to reach a high readiness levels of e-mobility solutions mostly linked to storage, grid adaptability and innovative or even breakthrough technologies such as hydrogen fuel. Lastly ETT#4, a very important aspect of a Smart City where co-creation, co-development and co-implementation processes play a central role, to prevent the conflict that may arise from the deployment of non-tailored solutions, agnostic to the culture and history of the local citizens. ETT#4 encompasses various platforms and concepts towards engaging citizens, helping policy makers and managers as well as promoting an interoperable, modular and interconnected City Ecosystem. POCITYF's internal stakeholders indicate that all underlying technologies in ETT#4 are highly impactful especially technologies linked to energy consumption, innovative strategies, city urban and information platforms as well as open data governance models. In terms of readiness levels, most of the solutions had an average score while the technologies that incorporate app development (apps for cultural experiences and energy consumption) are considered more "ready" scoring on average 3.75 out of 5.

### 3.3. Power & Interest of the local Stakeholders results

The results of the two surveys carried out in this group can be seen in Figure 7. Figure 7 (a) shows the result of the responses of the **POCITYF consortium partners'** (with 41 responses) highlighting their perception on the level of power and interest that different external stakeholders have in Energy Positive Smart City projects. Figure 7 (b) shows the result of the responses of **local external stakeholders** in each POCITYF city (with 60 responses) highlighting their perspective of power and interest that they themselves, and the other types of stakeholders have in Energy Positive Smart City projects.



**Figure 7.** Power and Interest of local External Stakeholders on a five-point Likert scale, (a) Evaluation by POCITYF internal partners and (b) POCITYF local External Stakeholders.

In general, the mapping of results shows that a large majority of the stakeholder groups are in the upper right quadrant, with high levels of power and high levels of interest in developing Energy Positive Smart City projects. It's important to engage all stakeholder groups in POCITYF, as reaching them is critical for the successful implementation of solutions. The project partners perceive the external stakeholders, in general, to have less interest than the stakeholders themselves believe, with special emphasis on "Standardization/Regulation bodies" and "Energy community/Cooperatives", these stakeholders being an important area of focus for involvement in the POCITYF project. "Energy Producers" and "Distribution System Operators" (DSO) are the exception to this trend and have responded that they have less interest and less power to implement the solutions than what POCITYF partners perceived. The position of the allocated stakeholder groups in the Figures above can help determine specific actions and level of engagement required for successful implementation of solutions:

- Upper right grid – High power/high interested stakeholders: They must be managed closely, and the POCITYF coordination units should put great efforts to engage them in the project. Reaching them is critical for successful implementation;
- Upper left grid – High power/ Low interested stakeholders: These stakeholders are essential for the project and must be kept satisfied, but they should not be consumed with excessive communication and actions;
- Lower right grid – Low power/high interested stakeholders: These stakeholder groups must be kept adequately informed and be part of any major issue that may arise in their activities. The specific groups can be of great help to the project considering their high interest
- Lower left grid – Low power/ Low interested stakeholders: These stakeholder groups must be monitored, in case they become more powerful and affect the project in the future.

The survey on the level of power and interest that the Stakeholders of each city has in the different sets of solutions allows us to identify the main local stakeholders that may have the greatest influence in each city for each solution. A full breakdown of the survey results for each city and each Integrated Solution was carried out and shared with internal POCITYF partners.

#### 4. Conclusion

The data and information collected from this work will allow the City Vision and Master Plan for each Energy Transition Track (ETT) of POCITYF to be carried out. It allows to understand which of the solutions best meet the needs and requirements of citizens and local stakeholders in each city, as well as to define the most appropriate engagement strategy to be used for each specific case, identifying the risks related to the demonstration of the solutions. From the surveys of the citizens of Évora, it was found that it is necessary to increase the level of knowledge and information that they have about the solutions to be demonstrated, while maintaining their level of interest. In the city of Alkmaar the citizens have a low level of interest and knowledge of the solutions that will be demonstrated in the city, with some exceptions, so one should seek to carry out activities that allow citizens to participate actively in the development of solutions and their implementation, increasing the level of knowledge and interest of citizens. Regarding the external stakeholders, it was found that they have more interest in the project than what was foreseen by the members of the consortium, except for “Energy Producers” and “DSOs”. The data currently collected allows a better overview of each city’s perception towards smart city concepts. To gain further insights, a greater number of responses to these surveys is expected in the second phase of this work, which will take place in January 2022, since the stakeholders’ communication and engagement activities will be in a more advanced state, raising awareness of the POCITYF project. In addition, the Fellow Cities citizens will respond to the "Citizens' Knowledge & Acceptance" survey, providing insights into their particular cultural heritage context, and the most appropriate solutions for replication.

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