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Identifying social determinants of urban low carbon transitions: the case of energy transition in Bilbao, Basque Country

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Identifying social determinants of urban low carbon transitions: the case of energy transition in Bilbao, Basque Country

Marta Olazabal*[a,b], Unai Pascual[a,b,c]

Cities are widely defined as complex systems formed by coupled social, ecological and economical systems. The complexity of urban dynamics goes far beyond its boundaries due to the strong influence of larger scales and the deep dependence of cities on outside resources. Such crucial cross-scale effects can fuel maladaptive behaviour, conducting cities to rigid and unsustainable traps. Urban energy systems have all the ingredients of complexity, dependence and vulnerability to global environmental change. Presumably, transformability, like adaptability, depends on perceptions, values and culture of each society. Here it is hypothesized that often social behaviours related to the scepticism, close-minded attitudes, traditional economic models, lack of trust in institutions and in self-capacities are those which limit the potential of transformation in cities (favouring lock-in status). The type of energy and the way it is supplied depends largely on utilities, urban planning and design, economic incentives, regulations, investment opportunities etc. These determinants, together with household factors depending on lifestyle, rent, etc. affect the level of consumption and choices. Altogether, these determinants play a decisive role in decision making processes at individual and institutional level and therefore can limit the transformation potential. We use a case study in Bilbao (Basque Country) to illustrate barriers and hidden opportunities of a local energy transition through an analysis of its cognitive dimension. This is done by applying a semi-quantitative methodology (Q method) which aids to investigate the stakeholders' perceived capacity of change. This results in four distinct discourses with direct implications in the potential of transformation of the city of Bilbao.

Keywords: urban sustainability; transitions; low carbon; Q method; Bilbao

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1. Introduction

The literature shows an actual discussion on the role of cities in transitions to sustainability (Hodson and Marvin 2010; Smith 2010; Truffer and Coenen 2011; Westley et al. 2011; Hodson and Marvin 2012) arguing that the lack of competencies on the politics of many sectors such as energy policy or transport infrastructures planning might leave cities aside. Either way, cities are great emitters and consumers of energy accounting for 70% of the global CO_2 emissions demand 70% of the primary energy (IEA 2008). Even though industrial and transport-related activities explain a big part in these figures, the share of residential resource use in urban areas is relatively important (26.5% according to Eurostat statistics[1]).

Given this, it is difficult to contradict the big responsibility that cities have on the quest for sustainability transition management. Urban energy systems have all the ingredients of complexity, dependence and vulnerability to global environmental change. The type of energy and the way it is supplied depends largely on utilities, urban planning and design, economic incentives, regulations, investment opportunities etc. These determinants, together with household factors affect the level of consumption and choices. As argued by Madlener and Sunak (2011) over the next decades urban structures and management will be influential for global energy demand. In this context, where most of the competencies rely on the local and regional authorities and where lifestyles are influencing factors on the final use of energy, the primary hypothesis of this paper is that the role of cities in sustainable transitions is not as limited as transpired by the rigid institutional architectures and the often claimed lack of urban competencies.

This paper focuses specifically on the implications that the values and culture of the urban society (including ethics, knowledge, attitudes to risk and culture) affect the opportunities that cities might have in the process of change. We argue that transformation depends on them and on the flexibility of the urban social structure, analogously following propositions of Adger et al. (2009) for the social limits of adaptation.

The number of people living in cities in the next decades is increasingly used as an argument to call for action at local level. Eighty per cent of the world population is expected to be urbanite by 2050 (UN 2011) and undeniably, satisfying the demand of resources in cities will be a global challenge. Given that it is a long way until technology is finally developed enough to feed 100% of the society's demands (Bermejo 2008) and this scenario calls for action at local level where institutions, stakeholders and society engage in the process of transition of reducing resource needs. We argue that for this to happen, the acceptance of the need of change (in order to gain capacities to face climate change and resource scarcity) and of the current unsustainable patterns is crucial. Both depend on the perspectives and values of the urban society.

In this paper we analyse different stakeholders' perspectives in relation to the urban energy model in Bilbao, Basque Country, by applying the Q method. This method, developed in the 1930s, is a semi quantitative methodology that aids to generate significant discourses around a specific topic (see Dziopa and Ahern 2011 for a review on applications of the technique). In this study, the discourses are built around the stakeholders' perception about the capacity of transformation of the city, or in other

[1] http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Final_energy_consumption,_EU-27,_2009_%281%29_%28%25_of_total,_based_on_tonnes_of_oil_equivalent%29.png&filetimestamp=20120112112000

words, around the city's transformability. We extrapolate these results to generate significant conclusions around the governance of Urban Sustainability Transitions (UST).

The paper is structured as follows. The nextbriefly introduces the concept and framework of UST, as used in this paper. Sect. 3 describes the methodology and the case study. Sect. 4 details the particularities of the Q method and its application to the case study. Sect. 5 builds the main transformability discourses that emerge from the analysis and discusses the implications for the governance of UST in Bilbao. Finally, the last section concludes and points out potential areas of further research.

2. Governance of urban sustainability transitions

Cities are widely defined as complex systems formed by coupled social, ecological and economical systems. In many terms, they are understood as social–ecological systems (Ernstson et al. 2010; Schandl and Capon 2012) which can also encompass the many dimensions of cities and its multiple dynamics including technology and economy. The unsustainable nature of cities (Olazabal and Pascual 2013) adds to this complexity, generating pernicious cross-scaled dynamics that can fuel maladaptive behaviour. This potentially pushes cities to rigid and unsustainable traps, which in other words, determines cities' degree of unsustainable resilience.

Notwithstanding, the currently emerging literature on resilience, transformability and sustainability of cities agrees on that there is an unique opportunity relying on cities and it is using them as laboratories of innovation and experimental action given that their exceptional capacity to start actions "on the ground" (see for instance Ernstson et al. 2010; Evans 2011; McCormick et al. 2013) linking scientific knowledge, community participation and stimulating private investors. The first step in an UST process is breaking unsustainable traps by providing elements to bring enough flexibility and adaptability to the system so it can easily embrace the process of transformation.

Olazabal and Pascual (2013) (see Fig. 1) introduce the conceptual framework of potential pathways to urban sustainability transitions (UST) which identifies three potential pathways of urban transformation depending on the type of governance used when facing (or perceiving) a crisis (or the need to change). **Path 1** offers the most sustainable outcome, is strongly driven by socio-technical transformation, innovation and creativity where collective efforts stimulate change. **Path 2** is associated with crisis and is embraced within policies on optimization of resources and efficiency although short term planning is still present in urban management and planning. This can lead to two potential resulting paths: **Path 2a** where a slow process of social behavioural change improves sustainability but at higher costs in comparison with Path 1, and **Path2b** where urban planning lock-in hinders sustainable development. Eventually, in **Path 3**, crisis is ignored and unsustainable patterns are maintained.

We hypothesize that in governance processes, often social behaviours related to the scepticism, close-minded attitudes, traditional economic models, lack of trust in institutions, communities or in self-capacities are those which limit the potential of transformation in cities. Analogous to the historical way of understanding the city and its metabolism (Wolman 1965), McCormick et al. (2013) discern two dimensions in USTs (or as McCormick et al. call it, "sustainable urban transformation"): processes and structures. This network perspective is useful to understand the interactions between the components of social-ecological systems, and the ways in which this affects the performance of the system (Allenby and Fink 2005; Janssen et al. 2006; Bodin and Crona 2009; Zhang et al. 2009).

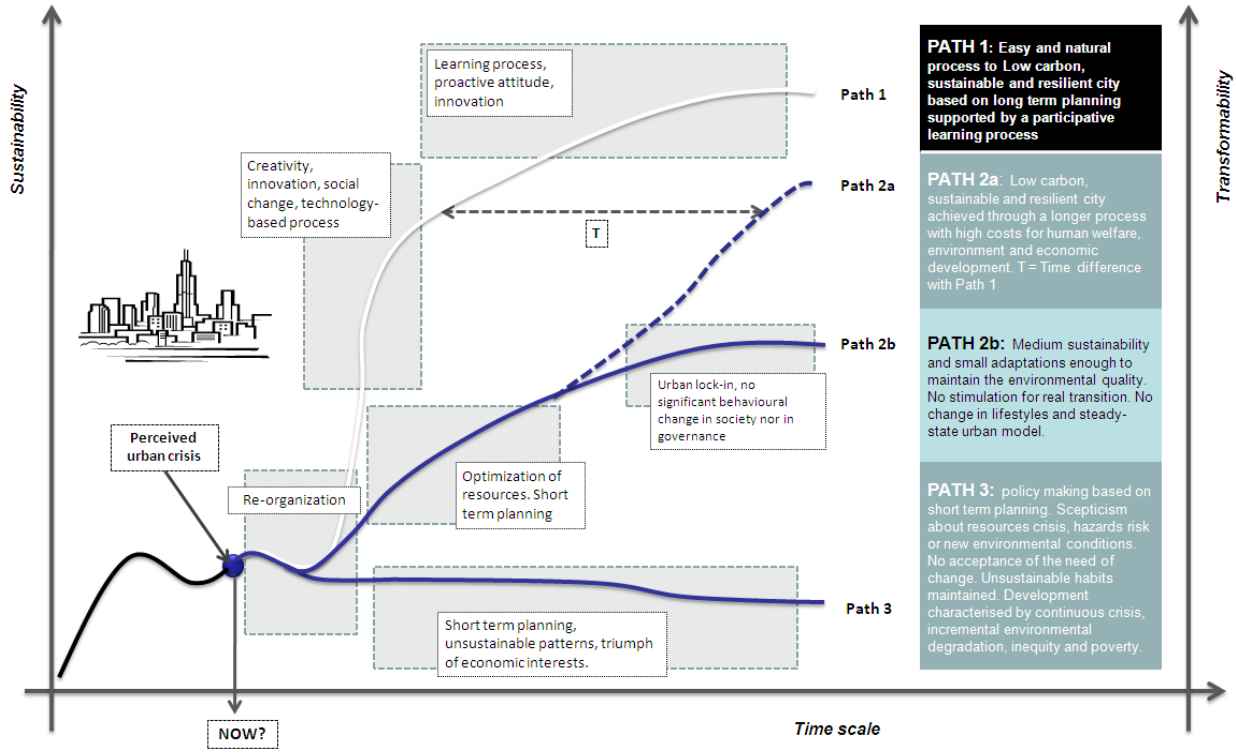


Figure 1: Potential transition pathways in cities (Olazabal and Pascual 2013). Adapted from various sources (Foliente et al. 2007; Loorbach 2007).

Urban governance is about processes and processes affect structures in the short and long term. The challenge of energy consumption reduction implies a need for a radical and widespread social and institutional change (Lorenzoni et al. 2007). For this reason, understanding stakeholders' perspectives and values related to the governance (planning and management) of the energy challenges in cities is the key to identify barriers and opportunities of transformation towards sustainable resilient cities.

3. The case study of Bilbao

Bilbao is a medium-sized city (see Fig. 2 and Table 1) of 41 km^2 and 353,296 inhabitants in 2011 (Basque Government 2013b). It is located in Bizkaia province of the Basque Country in northern Spain. As a consequence of special geographical conditions of this mountainous region, the population density (8,662.95 inhab./km^2 in 2012) and compactness of Bilbao's urban form (114,15 dwellings per hectare in 2012) (Basque Government 2013a) provide objective conditions for moving towards a sustainable development plan for the city of Bilbao.

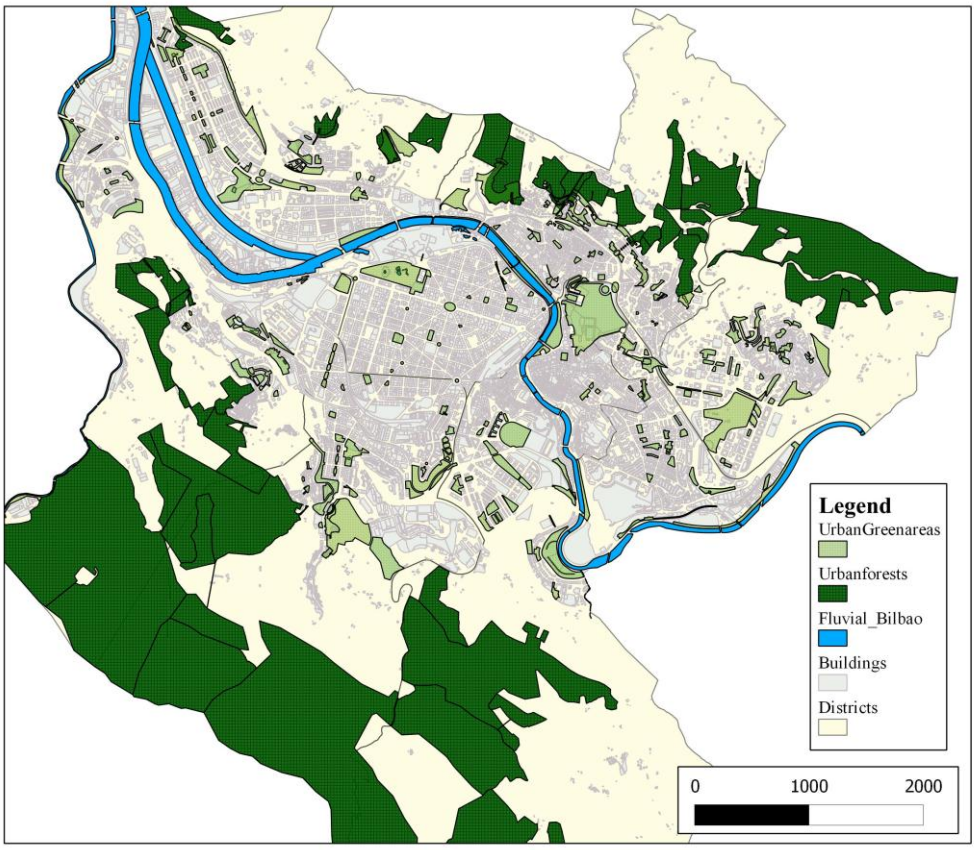


Figure 2: Administrative limits and general land uses of Bilbao municipality.

Table 1: Socio-economic data of Bilbao. Source: Eustat (Basque Government 2013b) and Udalmap (Basque Government 2013a).

BILBAO	2001	2006	2011
Total population	349972	351179	351965
Population density (inhab./km^2)	8474	8501	8486
Number of dwellings	146295	156446	.
Hot water (%)	100	100	.
Bathroom (%)	99	100	.
heating (%)	64	66	.
Landline (%)	100	100	.
Gas (%)	70	71	.
Comfort Index (%)	70	72	.
Number of private cars	135152	135938	138173
Unemployment (%)	-	5.95	12.03

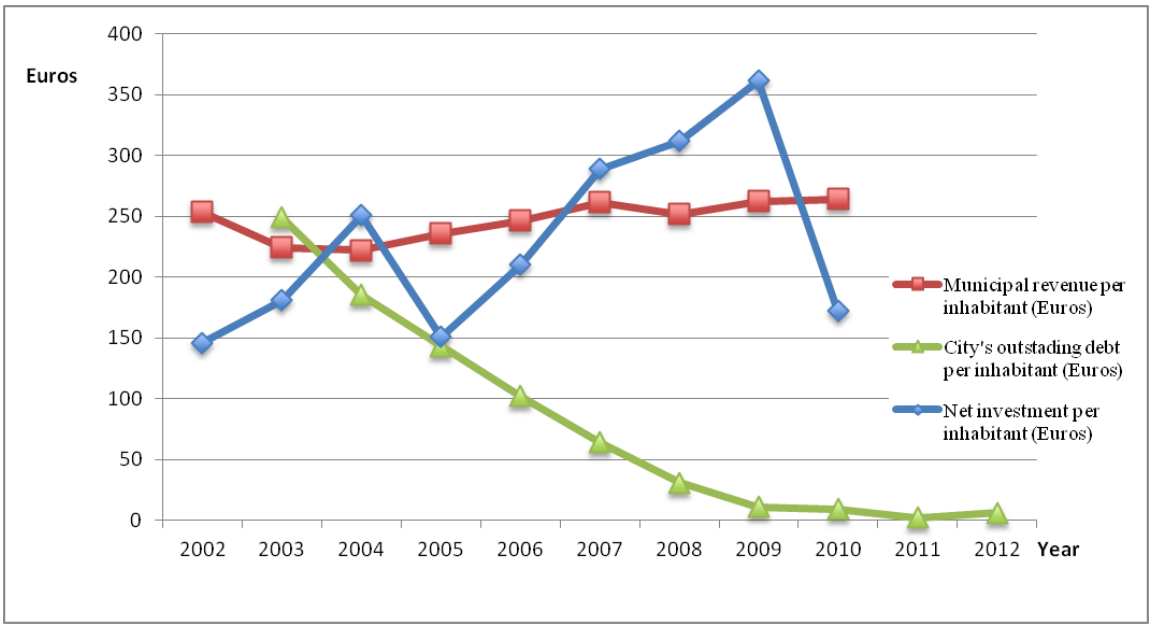


Figure 3: Taxes, investment and public debt per capita in Bilbao (2002-2012). Source: Elaborated from data published in Udalmap (Basque Government) and by the Ministry of Economic Affairs and Public Administration of the Spanish Government.

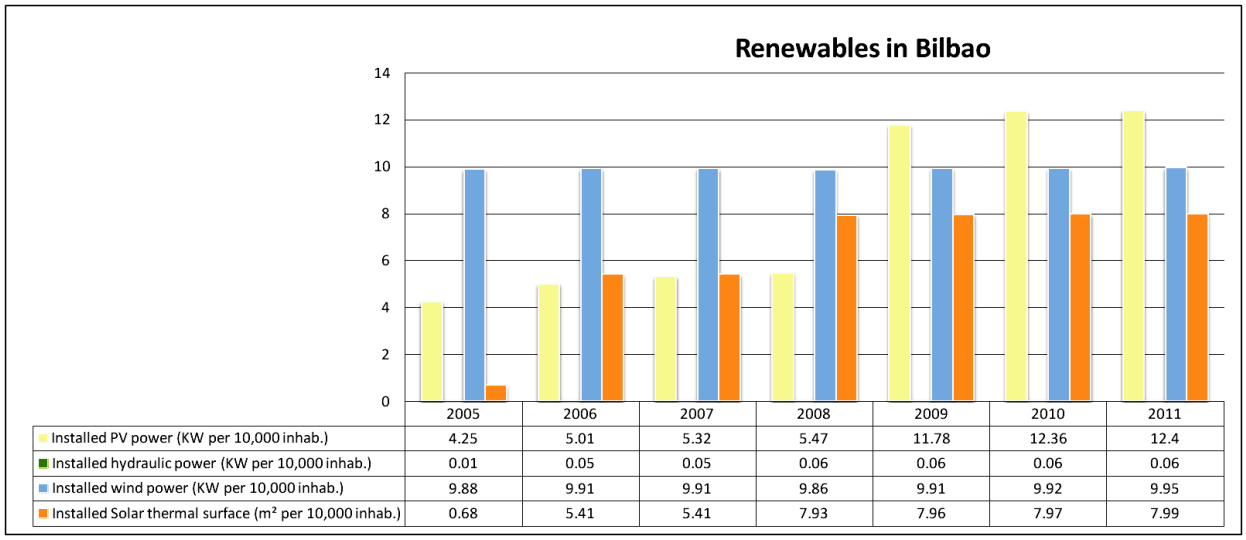
The economy of Bilbao was traditionally based on the steel and shipyard industry until the major industrial crisis of the 1980s, after which Bilbao transformed itself into a service-led city. Today Bilbao has emerged as the economic motor of the Basque Country. The municipal GDP per capita of Bilbao was 30,572 Euros (2008), being the total average income 20,081 Euros (2009) (Basque Government 2013a).

After the heavy transformation of its economic structure in the 1990s, which also included the renovation and revitalization of its riverside, the financial debt of Bilbao has been reduced with the time and taxes have not been significantly increased (see Fig. 3), which is presumably an evidence of the economic return of the investment of the local and regional authorities.

Nevertheless, being Bilbao an economic engine of the Basque Country and an important tourism hotspot, the motorized means of transport is prevalent. Yet, the location of the city alongside the River Nervión (see Fig. 2), allows a certain degree of air circulation that improves the thermal comfort and the mix of air layers, reducing localized high levels air pollution.

With a well-established Local Agenda 21, the local government claims it is committed to sustainability, through initiatives to restore peri-urban green infrastructure (Bilbao's Green Belt), and through policies on climate change and sustainable energy, such as the recently approved, although not forceful in its objectives, Sustainable Energy Action Plan or PAES (Bilbao City Council 2012), under the Covenant of Majors agreement.[2] Although there was willingness from the local authority to introduce a couple of District Heating (DH) projects into the PAES, a strong social rejection (originated

[2] The Covenant of Mayors is the mainstream European movement involving local and regional authorities, voluntarily committing to increasing energy efficiency and use of renewable energy sources on their territories. By their commitment, Covenant signatories aim to meet and exceed the European Union 20% CO_2 reduction objective by 2020. URL: http://www.eumayors.eu/ (Last accessed February 10th, 2013)



	2005	2006	2007	2008	2009	2010	2011
Installed PV power (KW per 10,000 inhab.)	4.25	5.01	5.32	5.47	11.78	12.36	12.4
Installed hydraulic power (KW per 10,000 inhab.)	0.01	0.05	0.05	0.06	0.06	0.06	0.06
Installed wind power (KW per 10,000 inhab.)	9.88	9.91	9.91	9.86	9.91	9.92	9.95
Installed Solar thermal surface (m² per 10,000 inhab.)	0.68	5.41	5.41	7.93	7.96	7.97	7.99

Figure 4: Installed power of different types of renewables (+hydraulic) in Bilbao (2005-2011). Source Udalmap (Basque Government 2013a).

in the nearby neighbourhoods of the new area and motivated by the lack of information and presumably, energy efficiency or renewables alternatives to the plan) have made these new measures to be finally dropped from the plan. Thus, at the moment, the plan is mostly a compilation of ongoing initiatives related to climate change mitigation and energy efficiency. Some trends related to renewables presence in the city and energy consumption are illustrated in Figs. 4 and 5. These figures show that, although the deployment of renewables has increased until 2011, these just cover 2 % of the demand originated in the city, which has been tolerably maintained over these years,

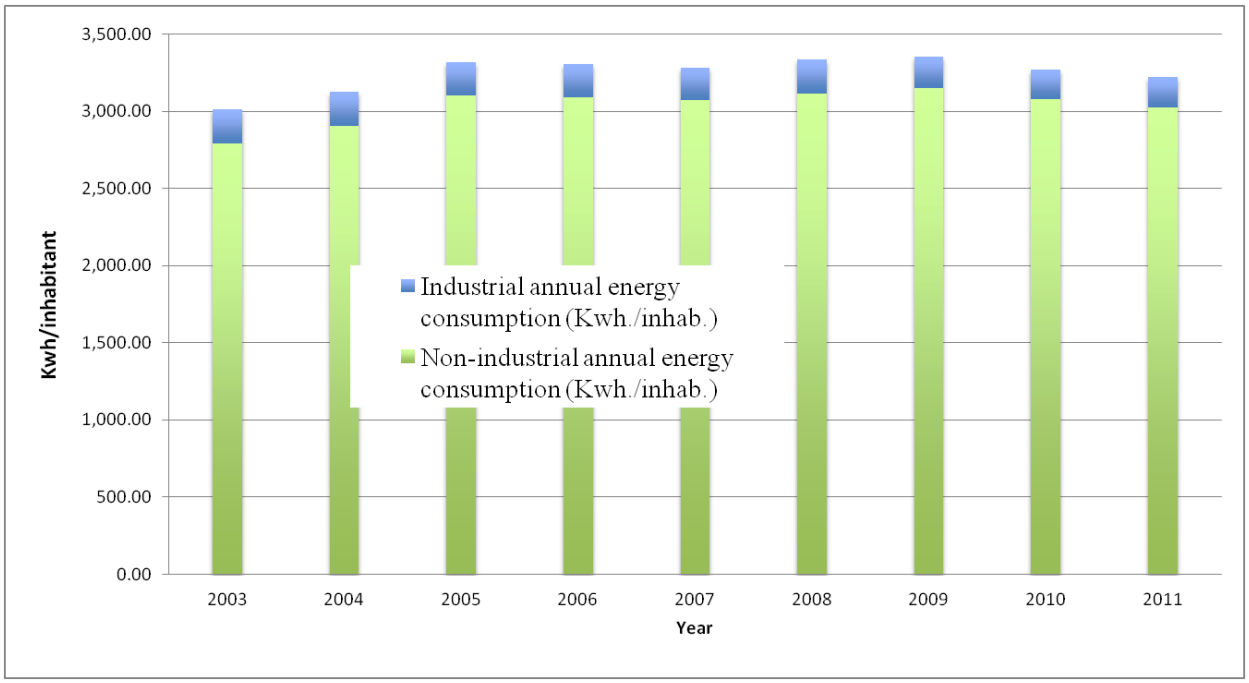


Figure 5: Annual energy consumption in Bilbao. Source Udalmap (Basque Government 2013a).

The interest of Bilbao city council in energy issues is translated also with the participation of Bilbao in the ICE-Wish 7FP project, through the collaboration of Bilbao Municipal Housing. In addition, the local authority provides support to the rehabilitation of buildings (not only in terms of energy efficiency measures but also related to accessibility and structural improvements) through Surbisa, a public company with a long tradition of intervention in the old quarters of Bilbao. However, the ongoing economic crisis and the cuts in public expending are increasingly hindering such types of public-led initiatives.

4. Application of the Q method

a. General methodology

In USTs, it is essential to generate a transformation engine supported by institutions including influential societal groups. This requires to accept the need of change and to trust institutional and societal capacities to move ahead. To understand how Bilbao through its stakeholders is positioned in this regard, the Q method is applied.

Q method is a semi-quantitative method concerned with the viewpoint of the participant on one topic irrespective of the hypothesis of the researcher (Dziopa and Ahern 2011). This is specifically important when personal beliefs, philosophy of life, personal experiences and perceptions are influencing decisions to be made in fairly complex, critical and uncertain situations. This also includes decisions influencing the energy metabolism of the city. The driving motivations application of the Q method requires some steps which are described in the following subsections (for a detailed and accesible description of the method see for example Brown 1993; Van Exel and de Graaf 2005). For a wider understanding of the process of analysis in Q methodology and its statistical underpinnings see Zabala and Pascual (2013). Terminology specific to Q is summarized in Table 2.

Table 2: Main terminology used in Q.

Term	Description
Q sample	Is the collection of statements (S) from the initial interviews, or from different sources such as literature on the topic, press or media, etc.
P-set	Is the group of respondents who are focus of analysis and will participate in the Q sorting process.
Q matrix	Is the matrix designed ad-hoc for each specific Q application. It allows respondents placing the statements in different columns according to their preferences/perspectives. The particularity of this method is that it limits the amount of possible answers in the extremes as it has inverted pyramid form. See Sect. 3.
Q sorting	Is the process of placing each statement in the column of the Q matrix. The Q sorting can be undertaken during a personal interview, through a questionnaire or electronically.
Q sort	Is each respondent's final matrix translated into a ranking.
Factor	Is a correlation of Q sorts of similar typology (according to their agreements or disagreements) using either principal components analysis (PCA) or centroid extraction.

Factor loading	Is the extent to which each Q sort is associated with each factor (Van Exel and de Graaf 2005).
z-score	Is the weighted average of the score of the respondents that define that factor (or perspective) (Van Exel and de Graaf 2005)
q-score (or factor score)	Is the normalised Z-score of respondents that define that factor (Van Exel and de Graaf 2005) so it can be understood as the value that an ideal respondent 100% loading on that factor would give to that statement.
Flagging	Process of identifying significant Q sorts within a factor through rotation of factors (through manual rotation or for example varimax rotation).

In this application, we have followed a four-stage process illustrated in Fig. 6. In ***Stage 1***, a smaller group of stakeholders representing the different perspectives on the topic of urban energy transition is interviewed (Group 1). The discourses are analysed and together with a review of the press and media, different statements are extracted in relation to the determinants of transformation in Bilbao (e.g. local regulations, economic incentives, lifestyles, etc.). In ***Stage 2,*** a wider group of stakeholders (P-set in Q terminology or here, Group 2) is asked to order the statements in accordance with their preferences/opinions/perspective following the Q methodology (see Sect. 4 for wider and detailed description of the method). **Stage 3** encompasses the analysis of the Q sorts and its interpretation obtaining different discourses related to the determinants of the transformation of Bilbao into a low carbon city. Eventually, in **Stage 4,** the discourses are contextualised and discussed in the wider framework of urban sustainability transitions.

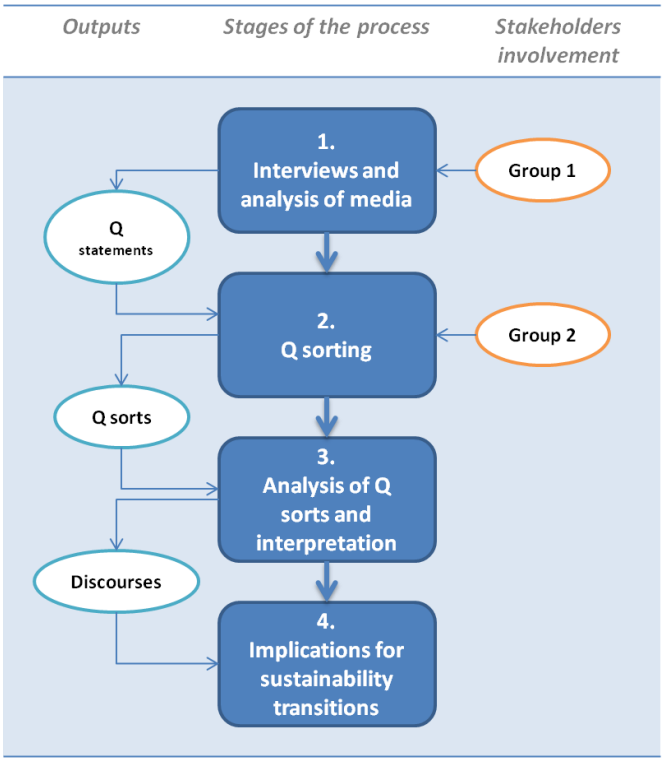


Figure 6: Application of the Q methodology: a four-stage process.

The following subsections explain the critical choices made for the application of the Q methodology in the case study of Bilbao.

b. Matrix selection

A matrix in a range of [-3;+3] and a [2;4;6;8;6;4;2] column depth was selected (Fig. 7). This matrix adds one more levels to the Likert-type item (which could be for example: (1) strongly disagree, (2) disagree, (3) neither agree nor disagree, (4) agree, (5) strongly agree). A seven-option matrix provides more space for doubt which drive respondents to reconsider and prioritize in a more defined way their thinking and perceptions.

A matrix like the one defined shows three areas which must be identified: an area of agreement (which allows different levels of agreement from +1 to +3), an area of disagreement (also allows different levels of agreement from -1 to -3) and a bigger area of no priority or no formed opinion topics in 0 column.

c. Participatory process

Fifteen stakeholders were interviewed face to face during Stage 1 (Group 1 in Fig. 6) and 32 stakeholders (out of 46 invited) responded to the Q sorting in Stage 2 (P-set or Group 2 in Fig. 6). Only stakeholders with competences or interests on energy matters (including urban planning, managing, strategic policy making, also at different decision making levels) or representing social and ecological interests (such as social movements, NGOs, communities, etc.) were invited to participate (see Table 2).

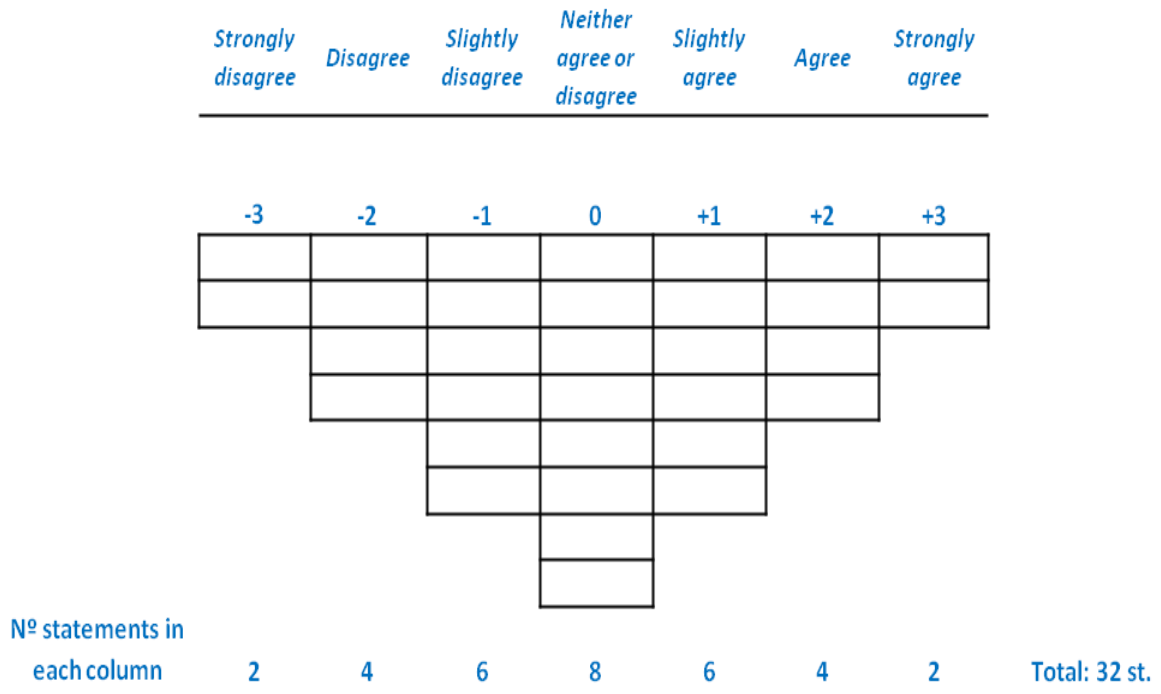


Figure 7: Q Matrix definition.

Table 3: Types of stakeholders included.

Representative stakeholders of
Social movements
Ecologist groups
Citizen communities
Research and consultancy
Architects and contractors
Local authorities and public offices / companies
Regional authorities and public offices / companies
Political parties
Utilities and energy companies in general
Media

d. Development of the statements (Q sample)

- Q sampling involves the collection of a wide range of views on the topic under investigation from multiple different sources (Dziopa and Ahern 2011). In our case, 66 statements were drawn from the interviews made to the 15 stakeholders plus some statements extracted from local media. These 66 raw statements were subject of a process of cleaning and refining following these criteria: avoid duplicates.
- Avoid multiple perspectives within the same statement.
- Clarity and understanding of the wording (for this, the statements were tested with a small group of 7 volunteers – Test-group).
- Representation of the study interests (areas included: Pressures, Barriers/obstacles, Solutions, Lobbies, Governance, Citizens/behaviours, Technology/regulations).
- Ability to classify the statements into "proactive" and "locked-in" (in the researcher's view), and that the two groups are balanced (see Annex Table A1 – column 3).

This led to identifying 32 final statements at the end of this process (see Annex Table A1).

e. Q sorting

Most of the Q studies are undertaken face to face but there have been experiences in which Q sorting was realized online or through questionnaires (see Bryan et al. 2000; Davies and Hodge 2007). In this study, we selected the electronic format for time efficiency reasons given that most of the interviewees were contacted in an earlier stage and already agreed to participate and to clarify when required.

There are a few software programs that can support the Q sorting and the collection of data (e.g. Qassessor[3]). Given that most of them were in English language or required either hosting server or being an advance user of Internet and computers, an ad-hoc homemade platform was developed. Several options were considered (including Google forms) but the special requirements of the method and the rigidity of the free existing online tools to design polls or questionnaires were critical in opting for a Q sorting board developed in Power Point Microsoft Office ® (PP) (see Fig. 8).

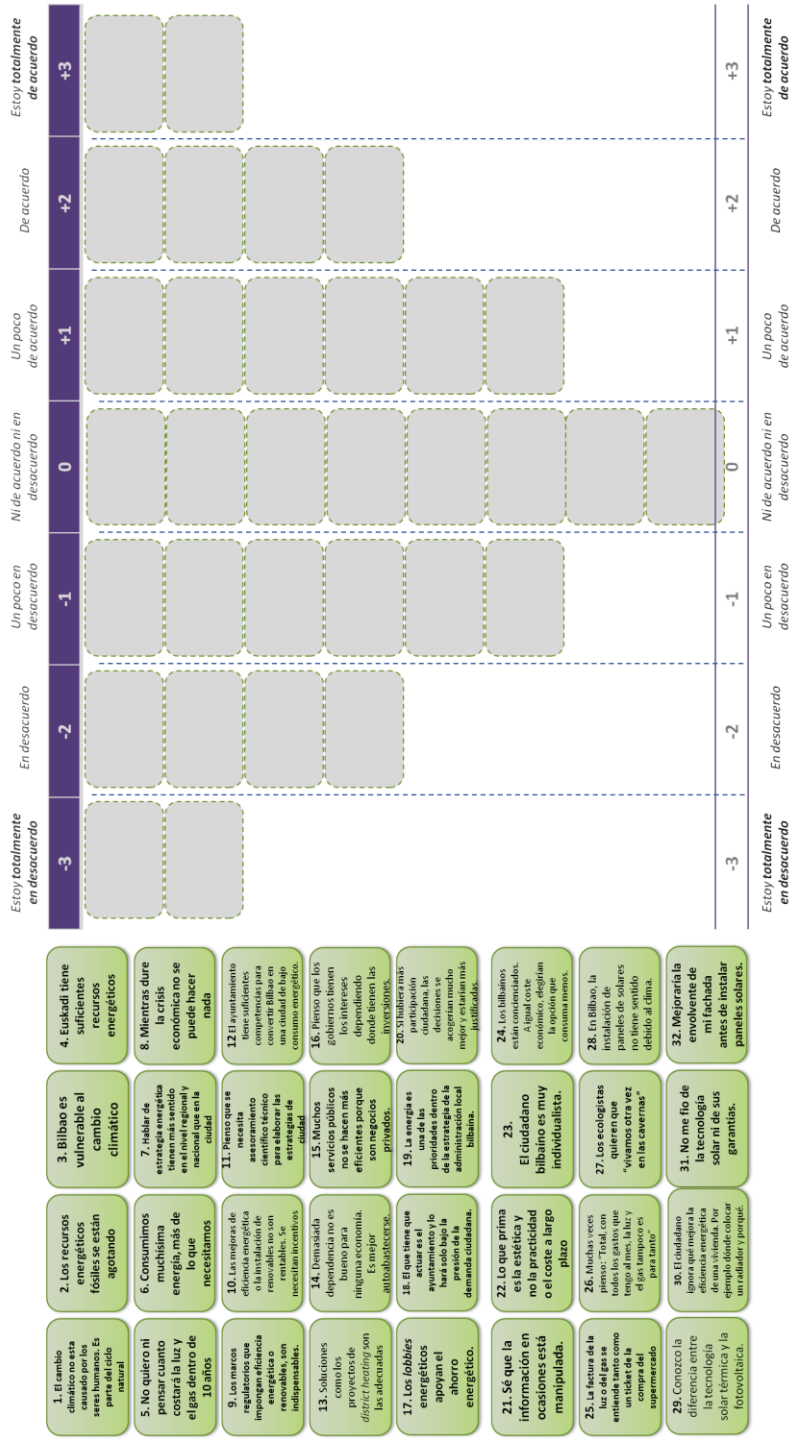


Figure 8: Q sorting electronic board designed ad-hoc for the study.

[3] See URL: http://q-assessor.com/ (Last Accessed May 8, 2013)

This template including the instructions on how to position the statements in the columns was sent to seven people (Test-group) (including advanced and beginner PC and electronic email users) in order to test the understanding and to correct the design and the wording. Other designs in Google forms were sent to these people and all agreed in that PP is an easier tool and friendly enough and had no problems in interpreting the instructions and "moving" the statements boxes (see green boxes in the left of Fig. 8) into the matrix columns, following their preferences/priorities.

After this, an email was sent (in 95% of the cases after a personal contact on the phone or face to face, or on behalf of a colleague) to 46 potential respondents during March 2013. Thirty two of these responded (69.6% of response rate) and 75% of them did it during the first week. This could be a measure of the interest of the topic in the city. The last response was received almost one month later (Fig. 9).

f. Results and analysis

The analysis of the results has been done through the PQmethod MS-DOS software.[4] PQMethod is a statistical program tailored to the requirements of Q studies. It allows entering the Q sorts and provides the results allowing enough flexibility to select the number of factors and manage rotations in a way that better fit the context of the study and interpretation. For this specific case, we followed specific criteria to select the factors to rotate (see Annex Table A2) by Zabala and Pascual (2013). Presumably, the selection of the factors is supported by meeting at least one of these criteria. In this study, this resulted in a preferred four factors option, meeting at least four out of the six supporting criteria identified by Zabala and Pascual (2013) (see Table A3 in the Annex).

In order to be able to interpret the different factors and identify areas of consensus among the different discourses or, on the contrary, distinguishing topics, z-scores and factors scores are calculated

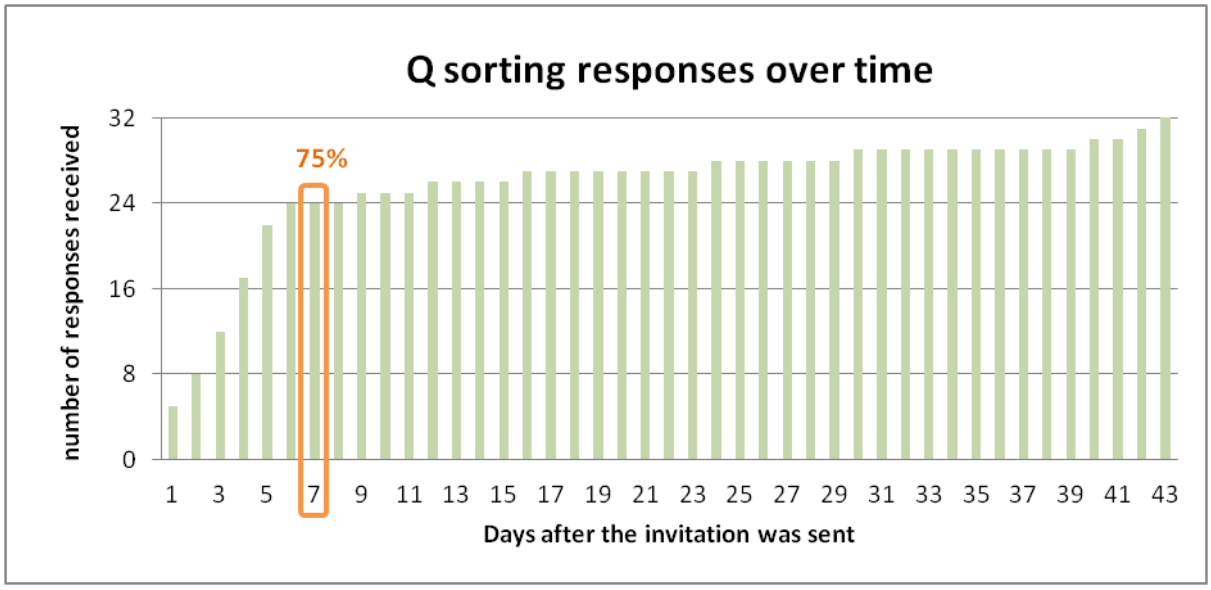


Figure 9: Responses over time: 75% of the responses were received during the first week.

[4] PQmethod – 2.20 (December 2011) by Peter Schmolck (URL:http://schmolck.org/qmethod/)Last accessed 25/04/2013. New version 2.33 –Dec 2012) available.

(see in the Annex, Table A4 for z-scores and factor scores of each statement and Table A5 for the ranked z-scores of each Q sort for each one of the factors).

Looking at these results one can identify distinguishing statements (statistically significant at $p<0,05$) and consensus statements (those non-significant at $p>0.01$, which are not distinguishing statement between any pair of factors) (Van Exel and de Graaf 2005). Both are defining variables that can be used to interpret the four different factors (discourses/perspectives on the topic under study, see Sect. 5). The list of consensus and distinguishing statements can be found in Table A6 and Table A7 in the Annex).

5. Mapping low carbon transition discourses in Bilbao

From the resulting factors, four different discourses by distinct clusters of stakeholders (typologies) have been drawn, and named as follows: Discourse A, local followers; Discourse B, confidant visionaries; Discourse C, problem-solvers; Discourse D, workaday sceptics.

Discourse A (local followers) represents a local-driven discourse highly driven by a disbelief in self-capacities to act and into a need to follow others in energy matters. Local followers trust scientific knowledge, accepting scientific consensus of the anthropogenic causes of climate change and resource scarcity and therefore, recognition of the vulnerability of Bilbao to such impacts. They think regulatory frameworks are needed and also that without science and consultancy supporting them, a public local action would be difficult. In this discourse, action should be shared with upper institutional levels. Stakeholders following this discourse feel a great deal of social empathy, however there is not such a big knowledge about the communities' opinion and capacities and therefore they do not think that social communities have a big role in a potential transition phase. For them action is a top-down issue. They are believers but followers, non-tractors of a process of change.

Discourse B (confidant visionaries) is strongly driven by being forward looking based on a technical background. This discourse has also a clear socio-technical profile but also is driven by non-confidence both in the institutional context and also against ecologist more radical positions. Confidant visionaries believe action is required now and that institutions are not taking their part of the responsibility in leading the process of change. Particularly, they are concerned about the priorities of the local authority given that energy efficiency issues are not reflected in the plans of the City Hall. Still, they have a great confidence in bottom-up action and trust in the capacities of cities to stimulate niches of innovation and transformation. They have strong social and environmental principles. They still believe in the need of regulatory frameworks as stimuli and in the need of scientific support to formulate strategies.

Discourse C (problem-solvers) concerns practical thinking at short term and problem-oriented. In this discourse the urban and the regional scales have shared responsibilities in the energy transition and regulations are key instruments which can make it possible. As a discourse of those working in the interface of science and policy, stakeholders behind this discourse admit that information to public is sometimes manipulated to serve political strategies but do not think this is completely wrong. They believe in top-down action and social participation is not central in the discourse. They do believe in individual capacities to think and change but prefer not to rely on grass-root social movements as catalysers of action. They do believe in climate change and that makes a difference in relation to Discourse D.

Discourse D (workaday sceptics) is dominant in the regional scale. This is the most differential discourse as it is radical in that it is based on the mistrust that climate change is anthropogenically driven. Nevertheless they do believe in that fossil fuels might be running out and that current energy demand is too high, and this is the only issue that would stimulate action towards transition. In terms of alliances, they do not value scientific knowledge and think that the local scale has neither a significant role nor enough legal competencies in energy matters. Bottom up, individuals and communities are not in their line of thinking. They do believe that regulatory frameworks are essential to move towards a more resilient system and extraordinarily, this discourse is also based on the idea that even in times of financial crisis, it is possible to make structural some changes towards transition.

The four discourses have been drawn from the distinguishing statements resulted from the analysis of the results (see Sect. 4). However, the analysis also found consensus in terms of both agreement and disagreement (see Table A6 in the Annex, statements marked with (*) asterisk have stronger consensus). Some of these findings are remarkably interesting: there is a high consensus regarding the idea that in the Basque Country, more energy than needed is consumed (S6) and that fossil fuels are scarce (S2). Because of this, and also somehow motivated by the aspiration of making a more economically independent region (S14), all discourses agree that some kind of action is needed. If part of the solution is through energy efficiency and renewables, they agree on that it must be accompanied by regulatory frameworks (S9) that set the minimum requirements and make some measures compulsory for the building sector, industries etc. Also, the discourses concur with the idea that solutions such as the development of District Heatings (DH), which are proliferating in UK and have a long history in Scandinavia (Hawkey et al. 2012; Hawkey 2012), can fit in a potential transition to a low carbon city. This contrasts with the sensed general social rejection to the projected DH in Bilbao (see Sect. 3) which has been stalled because of social contestation. Also, in contrast to the general belief that the typical weather in Bilbao makes solar energy systems non-efficient, particularly solar photovoltaic (PV), all discourses agree on that this is not the cause of its poor implementation in the city (S28). Among the many factors that affect the solar potential in cities (Gadsden et al. 2003; La Gennusa et al. 2011; Vettorato et al. 2012) there is the irradiation. Apparently, Bilbao has optimal irradiation conditions (according to the PVGIS[5] Estimates of long-term monthly averages) which should make the city to be subject of a solar potential specific study (Grauthoff et al. 2012). However, in spite of this, the "lack of enough sunny days" argument has been often used to reject the general boost of this technology. Eventually and remarkably, some statements representing social behaviour (about the individualism of the citizen in Bilbao, S23) and participation (about the need of social participation to improve the decision making process, S20) where positioned in non-prioritised or almost neutral areas in all discourses. This throws a worrying debate about the importance of the role of local communities in contributing to the co-design and co-development of the city, which seems at this moment, mistreated.

Looking at the different discourses and correlating these with the types of stakeholders involved in the study one realises of the huge gap that exists between stakeholders with different levels of responsibility and power (city hall and regional authorities) and those stakeholders which could be tractors of the process of transition (think tanks, social movements, scientists, consultants, etc.). As illustrated in Fig. 10, which overlaps types of participating stakeholders with the discourses A, B, C and D described above, the need to build a knowledge, discussion and communication (KDC) platform that serves to connect the different discourses, becomes clear in the city of Bilbao.

[5] EC Photovoltaic Geographical Information System. URL: http://re.jrc.ec.europa.eu/pvgis/apps3/pvest.php (Last acessed May 8th, 2013)

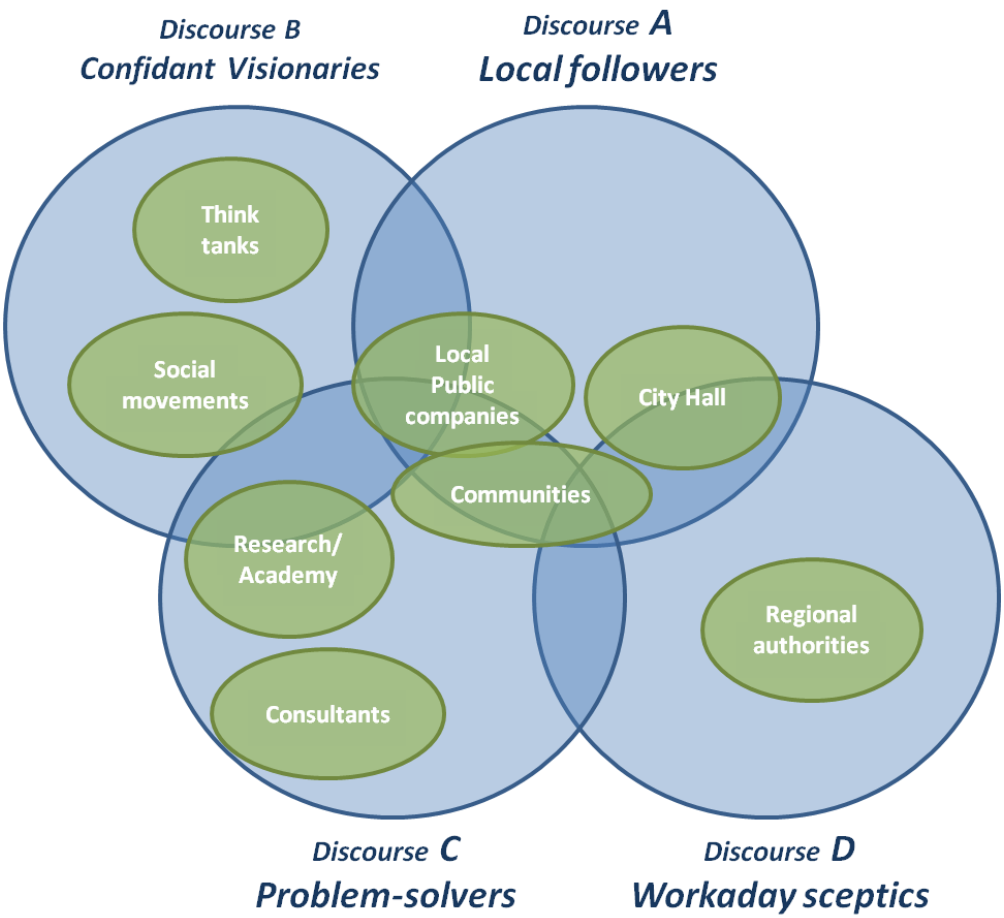


Figure 10: Overlapping of discourses and stakeholders groups.

It can be argued that a predominance of **Discourse B (confidant visionaries)** would lead to a transition in the **Path 1** (see Fig. 1) putting in the process the doses of creativity, innovation and experimentation that processes of change need. The venturing spirit of this kind of discourse is essential to engage **local followers (Discourse A**). However, the case of Bilbao shows that, in order to engage **Discourse B (workaday sceptics**), those stakeholders bringing a practical sense to the table such as those represented by **Discourse C (problem-solvers**) need to be involved. Problems that may arise in this KDC platform would be potentially related to the uncertainties of scientific knowledge, distributions of legal competences between the local and the regional, and in the delineation of means to engage with the general public including grass-root movements and communities in the quest for a transition process and in the role that they should have in the definition of future desirable scenarios for the city.

6. Conclusions

Cities are crucial to global climate change mitigation efforts (Rosenzweig et al. 2010) in some measure given that according to previous studies (OECD 1995), 80% of the energy use might be linked to cities. As argued by Milner et al. (2012) the opportunities for decarbonization in cities are multiple and complex, but require combinations of technological development, infrastructure investments and

behavioural change. This paper argues that the transition to low carbon cities is undeniably, a challenge of the next 20 years and is a crucial stage of the global sustainability transition process.

Moreover, using a case study of the city of Bilbao, here we argue that cities need to be engaged in the process of transition to sustainability, but not only as mere actors but, as transition tractors, provided the legal competences of cities in urban planning and management and observing the growing share that residential use has in resources consumption. The opportunity lies on that cities are places where stakeholders, authorities, public companies, communities and individuals have the best potential for generating the most fruitful and participative context for Urban Sustainability Transitions (UST). For this we argue that actors need to be motivated and understand the need to change and also, build self reliability and capacity to act as tractors of the process of change.

In order to analyse the perceptions and willing of the different stakeholders and its implications for UST in a specific context, we have used the case study of Bilbao. The Q methodology has been applied to engage stakeholders in a process of articulating their perspectives and perceptions into different discourses, which have been interpreted to analyse the implications in a potential process of change towards a low carbon city.

Through the case study of Bilbao this paper provides some new evidence that, in order to turn cities into transition tractors, social networking to link pragmatists and visionaries with decision-makers is essential. The analysis throws insights related to governance strategies of urban sustainability transitions including potential divergences in the definition of the relevance of science and knowledge in paths definition and the role and relevance of social participation together with disagreements on the competences and responsibilities in the development and implementations of actions resulted from the transition plans. These social-cognitive limitations, we argue, should be part of the parameters to be included in studies related to urban transitions modelling, as they can be determinants of transitions success.

Cities are complex systems and, adding to their dependence on external resources, many factors can influence their dynamics, including maintaining competitiveness or world-wide attractiveness (McCormick et al. 2013). We are in the century of the city (Nature News 2010) and all this attention to cities creates external costs not only at local but also at global level (Olazabal et al. 2012). Even in the path for sustainability, this may affect the resilience of cities and networks of cities, future well-being and survival. It is this challenge that should motivate cities to be engaged in the process of change, not only as actors (followers) but also as tractors learning along the way, the nuts and bolts of the governance of these transitions. The immediate role of cities, as social–ecological and technical networks, is to explore their transformability capacities by strengthening its social capital and foster opportunities in the process of change.

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Annex

Table A1: Q Statements (S#) classified in 7 study focus.

S#	Statements used in the Q sorting	English version	Position (+ proactive; - locked-in)
	Pressures		
1	*El cambio climático no está causado por los seres humanos. Es parte del ciclo natural.*	Climate change is not caused by humans. It is part of the natural cycle.	-
2	*Los recursos energéticos fósiles se están agotando.*	Fossil resources are running out.	+
3	*Bilbao es vulnerable al cambio climático.*	Bilbao is vulnerable to climate change.	+
4	*Euskadi tiene suficientes recursos energéticos.*	Euskadi (Basque Country) has enough energetic resources.	-
5	*No quiero ni pensar cuánto costará la luz y el gas dentro de 10 años.*	I don't even want to think how much it will cost the electricity and gas in 10 years.	+
6	*Consumimos muchísima energía. Más de lo que necesitamos.*	We consume too much energy. More than what we need.	+
	Barriers/obstacles		
7	*Hablar de estrategia energética tiene más sentido en el nivel regional o nacional que en la ciudad.*	Energy strategy discourse has more sense in the regional/national than at city level.	-
8	*Mientras dure la crisis económica no se puede hacer nada.*	While there is economic crisis, we can do nothing.	-
9	*Los marcos regulatorios que impongan eficiencia energética o renovables, son indispensables.*	Regulatory framework which impose energy efficiency and renewables are indispensable.	+
10	*Las mejoras de eficiencia energética o la instalación de renovables no son rentables. Se necesitan incentivos.*	The improvements in energy efficiency or the installation of renewables are not profitable. Economic incentives are needed.	-
	Solutions		
11	*Pienso que se necesita asesoramiento científico técnico para elaborar las estrategias de ciudad.*	I think that technical and scientific support is needed to develop urban strategies.	+
12	*El ayuntamiento tiene suficientes competencias para convertir Bilbao en una ciudad de bajo consumo energético.*	The city hall has enough competences to turn Bilbao into a low carbon city	+
13	*Soluciones como los proyectos de district*	Solutions such as the district heating	-

	heating son las adecuadas.	projects are appropriate.	
14	*Demasiada dependencia no es bueno para ninguna economía. Es mejor autoabastecerse.*	Too much dependency is not good for any economy.	+
	Lobbies		
15	*Muchos servicios públicos no se hacen más eficientes porque son negocios privados.*	Many public services are no more efficient because they are private businesses *(they have been subcontracted and respond to private interests).*	+
16	*Pienso que los gobiernos tienen los intereses dependiendo donde tienen las inversiones.*	I think that governments have their interests where they have investments.	+
17	*Los lobbies energéticos apoyan el ahorro energético.*	Energy lobbies support energy saving.	-
	Governance		
18	*El que se tiene que actuar es el ayuntamiento y lo hará solo bajo la presión de la demanda ciudadana.*	The city hall must be the one who takes the lad and it will do so only under social pressure/demand.	+
19	*La energía es una de las prioridades dentro de la estrategia de la administración local bilbaína.*	Energy is one of the priorities within the urban strategy of Bilbao city hall.	-
20	*Si hubiera más participación ciudadana, las decisiones se acogerían mucho mejor y estaría más justificadas.*	If there were more social participation, decisions will be much supported and much more justified.	-
21	*Sé que la información en ocasiones está manipulada.*	I know that information is sometimes manipulated.	+
22	*Lo que prima es la estética y no la practicidad o el coste a largo plazo.*	Aesthetics is prioritized over practicality and cost in the long term.	+
	Citizens/behaviours		
23	*El ciudadano bilbaíno es muy individualista.*	The citizen from Bilbao (Bilbaíno) is very individualist.	+
24	*Los bilbaínos están concienciados y, a igual coste económico, elegirían la opción en la que se consuma menos.*	Citizens from Bilbao are environmentally concerned, and at same cost, they would choose the less consuming option.	-
25	*La factura de la luz o del gas se entiende tanto como un ticket de la compra del supermercado.*	The electricity/gas bill is understood so much as the receipt of a supermarket shopping.	-
26	*Muchas veces pienso: "Total, con todos los gastos que tengo al mes, la luz y el gas tampoco es para tanto."*	Many times I think: "All in all, taking into account all monthly expenses, electricity and gas are not such a big deal."	-

27	*Los ecologistas quieren que "vivamos otra vez en las cavernas."*	Ecologists want that we "come back to the caves."	-
	Technology/regulations		
28	*La instalación de paneles de solares no tiene sentido en Bilbao debido al clima.*	The installation of photovoltaic panels does not have any sense in Bilbao due to the climate conditions.	-
29	*Conozco la diferencia entre la tecnología solar térmica y la fotovoltaica.*	I know the difference between solar thermal technology and solar photovoltaic technology.	-
30	*El ciudadano ignora qué mejora la eficiencia energética de una vivienda. Por ejemplo dónde colocar un radiador y porqué.*	The citizen form Bilbao ignores which measures improve the energy efficiency of a dwelling. For example, where to place the heaters and why.	+
31	*No me fio de la tecnología solar ni de sus garantías.*	I don't trust solar technology and its guarantees.	+
32	*Mejoraría la envolvente de mi fachada antes de instalar paneles solares.*	I would rather improve the isolation of my facade than installing solar panels.	+

Table A2: Criteria to select rotating factors

Criteria	**Arguments that support a 4 factors' selection**
1. Eigenvalue >1	6 factors had Eigenvalue > 1
2. 2 or more respondents are flagged in the QAnalyze module	Factor 1: 3 flags; Factor 2: 10 flags; Factor 3: 4 flags; Factor 4: 3 flags (in Qvarimax rotation selecting 6 factors, factor 3 had only one flag; selecting 5 factors, factor 3 and 4 had only one flag each. $, 3 and 2 factors selection gave good flagging results)
3. PCA (diagnosis)	Not applied
4. % explained variability > 50	% explained variability = 66
5. Size of residuals < 0.10	Not applied
6. Feasibility in the interpretation and parsimony	4 factors: reasonable interpretation (*) 3 and 2 factors: difficult to interpret. Very different people in the same factors and ambiguous interpretation of the results.

Table A3: Four factors with an X indicating the defining sort (flagged sort) in each factor.
Q varimax has been applied and two manual rotations were implemented after that.

	FACTORS							
Q-sorts	**Factor A**		**Factor B**		**Factor C**		**Factor D**	
1	0.3266		0.5168		0.4176		-0.1233	
2	0.4172		0.6581	X	0.294		0.1871	
3	0.477		0.5502		0.4497		0.0282	
4	0.2454		0.7681	X	0.1813		0.3239	
5	0.0405		0.52	X	0.5139		-0.004	
6	0.4132		0.6611	X	0.1092		0.2243	
7	-0.1513		0.4153		0.386		0.4259	
8	0.0268		0.6891	X	0.3827		0.1253	
9	0.475		0.5634		0.3664		0.3091	
10	0.3647		0.3114		0.6715	X	0.219	
11	0.5964		0.402		0.2562		0.3987	
12	-0.079		0.6556	X	0.0572		0.0764	
13	0.166		0.1397		0.7817	X	0.0903	
14	0.3377		0.5342		0.5694		0.1616	
15	0.1187		0.4162		0.5242		0.4517	
16	0.488		0.1551		0.6289	X	0.3495	
17	0.4878		0.2655		0.6333	X	0.1925	
18	0.1937		0.4849		0.5178		0.2503	
19	0.4721		0.6511	X	0.2932		0.2079	
20	0.5785	X	0.3573		0.3135		0.2679	
21	0.158		0.0648		-0.0406		0.8472	X
22	-0.1529		0.1772		0.501		0.5676	X
23	0.4629		0.5007		0.5426		0.2622	
24	0.3736		0.4906	X	0.1914		0.1519	
25	0.4784		0.4905		0.4865		0.1749	
26	0.509		0.5497		0.119		0.2436	
27	0.5026	X	0.4689		0.0861		0.0471	
28	-0.0971		0.72	X	0.0566		0.1007	
29	0.4287		0.5194		0.5027		0.1298	
30	0.2729		0.4373		-0.1606		0.6092	X

31	0.7394	X	0.2239		0.3259		0.0707	
32	0.4767		0.6262	X	0.0097		0.2912	
Total Flagged		**3**		**10**		**4**		**3**
% explained variance	**15**		**25**		**17**		**9**	
Total % expl.var.	**66 (total)**							

Legend

Non-influencing sorts
Flagged sorts

Table A4: Z-scores (z-sc) and Factor Scores (q-sc) for each statement and for each factor

		Factors							
		A		**B**		**C**		**D**	
S#	**Statement**	z-sc	q-sc	z-sc	q-sc	z-sc	q-sc	z-sc	q-sc
1	Climate change is not caused by humans. It is part of the natural cycle.	-2.58	-3	-0.99	-3	-1.17	-3	2.04	3
2	Fossil resources are running out.	2	3	0.61	3	0.08	3	1.22	2
3	Bilbao is vulnerable to climate change.	-0.07	2	1.39	2	1.43	2	-0.47	-1
4	Euskadi (Basque Country) has enough energetic resources.	0.04	-1	-1.18	-2	0.07	-1	-1.51	-2
5	I don't even want to think how much it will cost the electricity and gas in 10 years.	0.4	0	-0.57	-1	-0.51	0	1.74	2
6	We consume too much energy. More than what we need.	0.05	2	0.66	2	1.83	3	0.97	3
7	Energy strategy discourse has more sense in the regional/national than at city level.	-0.82	-2	0.32	1	-1.28	0	1.09	2
8	While there is economic crisis, we can do nothing.	-0.46	-3	-0.53	-2	-1.31	-3	-1.43	-3
9	Regulatory frameworks which impose energy efficiency and renewables are indispensable.	1.41	2	0.7	2	0.87	2	0.12	2

10	The improvements in energy efficiency or the installation of renewables are not profitable. Economic incentives are needed.	0.21	0	-0.61	-1	-0.34	0	-0.37	-1
11	I think that technical and scientific support is needed to develop urban strategies.	1.38	3	1.12	2	0.15	1	-1.12	0
12	The city hall has enough competences to turn Bilbao into a low carbon city.	-1.42	-2	-0.18	0	2	2	-0.92	-2
13	Solutions such as the district heating projects are appropriate.	0.87	1	-0.07	0	-0.25	0	0.3	1
14	Too much dependency is not good for any economy.	0.35	1	-0.3	1	1.12	1	0.57	1
15	Many public services are no more efficient because they are private businesses *(they have been subcontracted and respond to private interests).*	0.44	1	0.74	1	-1.44	-2	0.51	0
16	I think that governments have their interests where they have investments.	-0.1	0	1.13	1	-0.37	0	0.48	0
17	Energy lobbies support energy saving.	1.09	0	-2.47	-3	0.1	0	0.05	0
18	The city hall must be the one who takes the lad and it will do so only under social pressure/demand.	-1.03	-2	0.37	0	0.05	-1	0.17	0
19	Energy is one of the priorities within the urban strategy of Bilbao city hall.	0.52	1	-1.82	-1	0.48	0	0.71	1
20	If there were more social participation, decisions will be much supported and much more justified.	-0.64	0	0.95	1	0.96	1	0.66	0
21	I know that information is sometimes manipulated.	-0.09	0	2.34	3	-1.8	-2	0.22	1
22	Aesthetics is prioritized over practicality and cost in the long term.	0.17	0	0.54	0	-0.28	-1	-1.56	-3
23	The citizen from Bilbao (Bilbaíno) is very individualist.	0.64	0	-0.07	-1	-0.85	-1	-0.82	-1
24	Citizens from Bilbao are environmentally concerned, and at same cost, they would choose the less consuming option.	-1.85	-1	-0.02	0	1.66	2	0.71	0
25	The electricity/gas bill is understood so much as the receipt of a supermarket shopping.	-1	-2	0.3	0	-0.54	-1	-0.89	-1

26	Many times I think: “All in all, taking into account all monthly expenses, electricity and gas are not such a big deal.”	-0.4	-2	-1.15	-2	0.77	0	-0.92	-2
27	Ecologists want that we “come back to the caves.”	-1.22	-1	-0.14	-1	-1.06	-2	-0.43	-1
28	The installation of photovoltaic panels does not have any sense in Bilbao due to the climate conditions.	-0.23	-1	0.15	-1	-0.7	-2	-1.83	-2
29	I know the difference between solar thermal technology and solar photovoltaic technology.	0.45	1	0.72	1	0.27	1	0.84	1
30	Te citizen form Bilbao ignores which measures improve the energy efficiency of a dwelling. For example, where to place the heaters and why.	-0.16	0	0.3	0	0.98	1	-0.95	-1
31	I don’t trust solar technology and its guarantees.	0.55	-1	-1.53	-2	-0.85	-1	-0.19	0
32	I would rather improve the isolation of my facade than installing solar panels.	1.5	2	-0.69	0	-0.08	1	1.02	1

Table A5: Analysis of z-scores per factor and ranked statement (from agreements to disagreements)

Factor A		Factor B		Factor C		Factor D	
S#	z-sc	S#	z-sc	S#	z-sc	S#	z-sc
11	2.014	21	1.599	6	2.051	1	1.785
2	1.68	2	1.542	2	1.609	6	1.62
9	1.524	9	1.463	3	1.597	2	1.416
3	1.478	6	1.44	9	1.501	5	1.381
6	1.185	3	1.406	12	0.983	7	1.081
32	0.85	11	1.048	24	0.865	9	1.06
14	0.582	20	0.991	20	0.842	29	1.025
15	0.582	29	0.917	29	0.769	21	0.916
29	0.516	16	0.871	14	0.742	32	0.725
13	0.491	15	0.434	11	0.589	13	0.595
19	0.447	14	0.347	32	0.454	14	0.41
10	0.38	7	0.341	30	0.276	19	0.315

30	0.38	13	0.288	19	0.203	16	0.3
20	0.182	30	0.192	26	0.156	24	0.295
21	0.157	24	0.037	16	0.143	20	0.28
5	0.092	18	-0.046	13	0.12	15	0.041
23	0	22	-0.087	5	0	11	0.02
16	-0.021	32	-0.096	17	-0.023	17	-0.15
22	-0.046	25	-0.189	7	-0.325	18	-0.28
17	-0.046	12	-0.199	10	-0.338	31	-0.41
31	-0.313	23	-0.258	4	-0.613	27	-0.465
28	-0.405	5	-0.347	18	-0.674	30	-0.636
27	-0.582	28	-0.52	23	-0.695	3	-0.671
24	-0.714	10	-0.695	25	-0.707	23	-0.725
4	-0.739	27	-0.736	22	-0.73	25	-0.745
12	-0.941	19	-1.059	31	-0.755	10	-0.91
18	-0.941	26	-1.197	15	-0.902	26	-1.06
25	-1.367	31	-1.247	28	-1.008	12	-1.101
26	-1.432	8	-1.281	21	-1.116	4	-1.155
7	-1.478	4	-1.48	27	-1.186	28	-1.175
8	-1.609	1	-1.553	8	-1.632	22	-1.546
1	-1.903	17	-1.929	1	-2.196	8	-2.236

Legend

S# Number of statement

Area of agreement (> +1.00)

Area of no priority / no formed opinion

(set between -0.04 and +0.04)

Area of disagreement (< -1.00)

Table A6 shows the statements which have been identified as consensus statements either in agreement, disagreement or no priority issue. Table A7 shows the distinguishing statements of each factor.

Table A6: Consensus statements (they do not distinguish between any pair of factors)
Statements are non-significant at p>0.01, and those flagged with an * are also non-significant at p>0.05.

	Factor A		Factor B		Factor C		Factor D	
S#	**q-sc**	**z-sc**	**q-sc**	**z-sc**	**q-sc**	**z-sc**	**q-sc**	**z-sc**
2*	3	1.68	3	1.54	3	1.61	2	1.42
6	2	1.19	2	1.44	3	2.05	3	1.62
9*	2	1.52	2	1.46	2	1.5	2	1.06
13*	1	0.49	0	0.29	0	0.12	1	0.6
14*	1	0.58	1	0.35	1	0.74	1	0.41
20	0	0.18	1	0.99	1	0.84	0	0.28
23*	0	0	-1	-0.26	-1	-0.69	-1	-0.72
27*	-1	-0.58	-1	-0.74	-2	-1.19	-1	-0.47
28	-1	-0.4	-1	-0.52	-2	-1.01	-2	-1.18
29*	1	0.52	1	0.92	1	0.77	1	1.03

Legend	
	Agreement consensus
	Area of no priority / no formed opinion
	Disagreement consensus

Table A7: Distinguishing statements ($p < 0.05$; asterisk (*) indicates significance at $p < 0.01$)

	Factor A		Factor B		Factor C		Factor D	
S#	**q-sc**	**z-sc**	**q-sc**	**z-sc**	**q-sc**	**z-sc**	**q-sc**	**z-sc**
11	**3**	**2.01***	**2**	**1.05**	**1**	**0.59**	**0**	**0.02**
24	-1	-0.71	0	0.04	2	0.87	0	0.29
7	**-2**	**-1.48***	**1**	**0.34**	**0**	**-0.33**	**2**	**1.08**
21	0	0.16	3	1.6	-2	-1.12	1	0.92
7	-2	-1.48	1	0.34	0	-0.33	2	1.08
12	-2	-0.94	0	-0.2	2	0.98	-2	-1.1
19	**1**	**0.45**	**-1**	**-1.06***	**0**	**0.2**	**1**	**0.32**

17	**0**	**-0.05**	**-3**	**-1.93***	**0**	**-0.02**	**0**	**-0.15**
12	**-2**	**-0.94**	**0**	**-0.2**	**2**	**0.98***	**-2**	**-1.1**
26	**-2**	**-1.43**	**-2**	**-1.2**	**0**	**0.16***	**-2**	**-1.06**
7	-2	-1.48	1	0.34	0	-0.33	2	1.08
15	1	0.58	1	0.43	-2	-0.9	0	0.04
21	0	0.16	3	1.6	-2	-1.12*	1	0.92
1	**-3**	**-1.9**	**-3**	**-1.55**	**-3**	**-2.2**	**3**	**1.79***
5	**0**	**0.09**	**-1**	**-0.35**	**0**	**0**	**2**	**1.38***
7	-2	-1.48	1	0.34	0	-0.33	2	1.08
30	0	0.38	0	0.19	1	0.28	-1	-0.64
3	**2**	**1.48**	**2**	**1.41**	**2**	**1.6**	**-1**	**-0.67***
22	0	-0.05	0	-0.09	-1	-0.73	-3	-1.55

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