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Identification of climate policy knowledge needs: a stakeholders consultation approach

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Abstract

Purpose – The purpose of this paper is to identify knowledge gaps on insinuations of possible directions of European Union (EU) and international climate policies.

Design/methodology/approach – This study has used participatory approach of highly experienced stakeholders' engagement, involved directly or indirectly in the process of policymaking. A range of priority issues has been initially identified through desk analysis and key stakeholders have been selected and invited to partake in the process. Preliminary results have been validated through interaction with stakeholders during a series of workshops.

Findings – The results show the identification of a series of sectors, where climate policy is expected to focus in the future and the definition of 11 specific topics upon which knowledge gaps are expected to appear. Results on the identified knowledge needs are analysed and categorized by each prioritized main topic and compared with literature findings. Emphasis is identified to be placed on the topics of renewable energy, EU climate policy and international climate negotiations, which are the most popular ones, followed by energy policy and energy efficiency.

Originality/value – A key element of the approach is the consideration of key experts' feedback on their specific area of expertise, instead of general public engagement, therefore leading to accurate results. Despite the fact that our approach was applied to a specific problem, the overall analysis could provide a framework for supporting applications in various problems in the field of priorities' identification and even expanding to decision-making problems.

Keywords Climate change, Participatory approach, Climate policy, Knowledge gaps

Paper type Technical paper

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1. Introduction

The international community's activity has been currently made more intense towards a collective response to climate change (Droge and Spencer, 2015). A historic climate agreement has been made at COP21. However, in order the Agreement to be put into effect and its overall objective, which is to limit global temperature increase to well below 2°C, to be reached, it is necessary to apply significant effort at both national and international level [United Nations Framework Convention on Climate Change (UNFCCC), 2015b].

Developed countries face a great challenge in restructuring their industrialized economy into a decarbonized system and adopting new consumption and production patterns. At the other end of the spectrum, developing economies have the concern that a low-carbon-oriented route might jeopardize their economic development aspirations and endanger their efforts to escape poverty. Nationally determined contributions (NDCs) that outline the post-2020 climate actions that parties plan to take under a new international agreement are being prepared and submitted (UNFCCC, 2015a). The way in which climate change measures should be embedded in domestic economic, environmental and social priorities, however, is not strictly defined.

Over the NDC preparation process, it has been highlighted that many capacity and knowledge gaps exist. Specifically, these are connected with the definition of technical options for increased mitigation effort, the understanding of finance and investment needs and more generally with the need to develop institutional capacities. International bilateral and multilateral cooperation is capable of playing a key role in advocating the different activities related to NDC review and implementation, and the associated processes. Apart from direct country support and knowledge-sharing activities, peer-to-peer learning and also the amenity of dialogue and constructive expert reviews are capable of being helpful.

However, as countries focus and align their endeavours towards the achievement of a binding global agreement on climate, the constantly changing political scenery of climate negotiations imposes the need to provide policymakers with solid and accurate knowledge (Karakosta, Doukas and Psarras, 2010a). The internationally shifting policy scenery creates uncertainties about the shape of future policies and this could have an impact on European Union (EU) policy and decision makers. EU policymakers face uncertainties regarding different possible international climate policy scenarios and the impacts they could involve in EU society, business, member states and EU wholly, in relation to economy, society and the environment (Moarif, 2015). An evidence-based approach is needed to enable policymakers deliberate on these different scenarios and even obtain the knowledge from design of climate policies globally. Consequently, the information exchange about climate policy and the transferance of knowledge among stakeholders should be facilitated to provide clear comprehension of current regimes, their possible directions, implications and consequences and to make them able to take well-informed, consolidated decisions based on current reliable facts (Ecologic Institute, 2014; Doukas *et al.*, 2010; Karakosta *et al.*, 2011).

The first step of achieving such a cause is the identification of stakeholders' knowledge needs, concerning both knowledge gaps and also knowledge presentation demands. Knowledge gaps can mean that there is either no cognizance of existing knowledge or no actual presence of scientific analysis concerning an issue.

This paper presents a methodology for the identification of knowledge gaps on insinuations of possible directions of EU and international climate policies, through a participatory process of highly experienced stakeholders' engagement. This participatory procedure allows the identification of a series of sectors, where climate policy is expected to focus in the future, and the definition of specific topics upon which knowledge gaps are expected to appear. A key element of this approach is the consideration of key stakeholders,

involved directly or indirectly in progress policymaking and capable of providing feedback on their specific area of expertise, therefore leading to more accurate results.

Following this introductory section of the paper, a literature review is provided on the integration of participatory processes in knowledge need identification. The proposed methodological approach is then presented, offering a step-by-step analysis of the successive stages. Results deriving from the methodology application are outlined, as well as relevant further discussion, whereas conclusions are drawn at the final section of the paper.

2. Integration of participatory processes in knowledge need identification

The element of active involvement of a group of people in the process of decision-making constitutes the core characteristic of a participatory approach. The synthesis of the group varies depending on the topic addressed and can be comprised by regular citizens, experts, government members, industry representatives or stakeholders of any kind with an interest in specific policies (Weaver and Cousins, 2007).

Participation of stakeholders consists in the process of affecting and sharing control over certain initiatives, as well as the decisions and resources that influence them [African Development Bank (ADB), 2001]. According to the aim of the approach, stakeholders can participate at different levels. The objective of the process could be simple conveyance of knowledge that would imply a one-way participation, or consultation, which requires bi-directional participation. It could also be the fostering of active participation, calling for a partnership in which all interested parties would actively debate (Slocum, 2003).

Therefore, a participatory process initially contains the identification of suitable stakeholders and relevant information provision. In the case that multi-directional participation is desired, the researcher should gather stakeholders' feedback and listen to their beliefs (their opinions) and involve them in the decision-making process. The results would then contribute to their capacity building, rendering them capable of managing their own self-development [African Development Bank (ADB), 2001]. As validated by Krywkow and Hare (2008), four main phases can be recognized in participatory processes:

(1) preparation, including the analysis of the problem and the stakeholder layer, as well as the development of a draft plan of the participatory process;

(2) publication, during which stakeholders become initially familiar with the problem and the plan;

(3) dialogue, through which stakeholders are provided with more solid information and contribute their knowledge and additional input on unraised issues; and

(4) response, closing the process by educating participants and validating the results.

According to Pedrosa and Guimarães Pereira (2006), participatory approaches can be useful tools in facilitating a wide range of different purposes. First, they can effectively frame the identified problems and map the associated causes and effects, as well as possible future actions and developments, based on stakeholders' opinions. Their application can also improve available information, facilitate communication and support participation towards knowledge production, as well as enhance policymaking with views that may not have been taken into account. The participation of multidisciplinary stakeholders also offers diversity to the analysis, as people characterized by different levels of expertise and of various backgrounds are represented and taken into consideration. Participatory approaches can also lead to the optimisation of existing processes in the field of learning, by making stakeholders aware of risks and possible implications of the situation under examination

and by pointing out knowledge gaps and limitations (Karakosta *et al.*, 2007; Karakosta *et al.*, 2010b).

Participatory processes have been widely applied on a diverse range of topics and problems, deriving from different fields of research. Such topics may range from assessing ethical aspects of certain activities, fostering dialogue among stakeholders of different groups (Kaiser and Forsberg, 2001), to the improvement of working by engaging workers in participatory ergonomic processes (Laitinen *et al.*, 1998).

Regarding climate and environmental issues, Scholza *et al.* (2004) applied participatory analysis to integrate local ecological knowledge into marine protected area policy planning processes. Indicators of progress monitoring in the field of sustainable development have been identified through participatory process application (Chiranjeewee and Harald, 2012), whereas participation of stakeholders has also been used for the identification and prioritisation of policy-relevant research questions in the management of natural resource (Petrokofsky *et al.*, 2010).

In the field of knowledge need identification, a limited number of studies that integrate participatory approaches have been developed. Indicatively, Palacios-Agundez *et al.* (2014) defined a knowledge gap on the synergies and exchanges between biodiversity and carbon storage, during a participatory procedure conducted to cause the development of a community vision for a sustainable future of a region. Dicks *et al.* (2013) engaged representative participants from industry, environmental non-profit organizations (NGOs) and nature conservation agencies into a collaborative exercise of identifying knowledge needs regarding insect conservation in the UK. An extensive list of knowledge needs was initially developed and later collaboratively refined and narrowed-down through a three-stage participatory process, producing the final top priority knowledge needs. A participatory methodology has also been developed in the context of a collaboration among UNFCCC, the United Nations Environment Programme (UNEP, 2010), the Global Adaptation Network and the International Centre for Tropical Agriculture towards the identification and prioritisation of knowledge gaps in climate change adaptation in the particular area of the Andes, by engaging multidisciplinary groups of stakeholders (Jarvis, 2015).

Knowledge needs and gaps, however, are more often identified by extensive literature review and use of existing bibliography, articles and reports on the field of study that is under examination (Frymus *et al.*, 2013).

Particularly in the area of environmental policy, several participatory approaches have been implemented within the EU. However, to the best of our knowledge, never in the past had a participatory approach been designed and applied in such a format to identify knowledge needs and priorities on EU in the field of international climate policy implications, by consulting with key experts involved in the process of policymaking itself. The participatory approach developed in this paper uses tools, such as questionnaires and structured interviews with identified knowledgeable experts, so as to derive preliminary results on key knowledge needs on climate policy implications, after analysing the feedback acquired. The results are then presented to stakeholders during thematic workshops and validated through the sessions.

3. Methodological approach

3.1 Overview

The methodological framework introduced by this paper consists of a series of concurrent and consecutive steps, as illustrated in Figure 1 and analysed in the following paragraphs. An initial desk analysis identified a variety of priority issues connected with climate policymaking that served as a starting point for the participatory process. In parallel, key

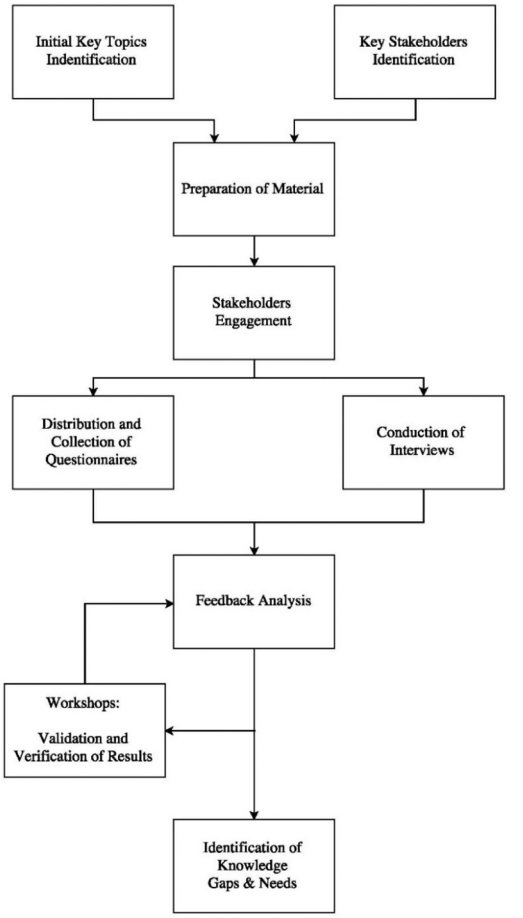

Figure 1.
Stages of the proposed methodology for identification of knowledge gaps and needs

stakeholders mapping was conducted to form a database of potential participants. Preparatory material was subsequently developed in the form of a questionnaire, to be completed individually by stakeholders and also to facilitate discussion during interviews. Stakeholders were then invited to partake in the procedure and their interest was confirmed. Simultaneously, self-filling of questionnaires and conduction of interviews took place. Feedback analysis provided preliminary results that were displayed to selected stakeholders throughout thematic workshops conducted within the framework of the EU-FP7 "Mobilizing and transferring knowledge on post-2012 climate policy implications (POLIMP)" project (Karakosta *et al.*, 2014). Results reviewed and validated through the workshops led to the identification of a finalized set of knowledge needs on EU climate policy consequences (Karakosta and Flamos, 2016).

3.2 Desk analysis: initial key topics identification

The identification of a range of knowledge gaps was conducted for a series of issues of priority, connected with climate policymaking.The final determination of these issues was

achieved in collaboration with stakeholders and through their participation. However, a range of priority issues had to be initially set as a starting point for discussion. A desk analysis including extensive literature review, as well as close monitoring of current developments in climate policy, led to the identification of eleven main topics, constituting an initial thematic area, based on which, the knowledge gap identification procedure was structured.

Further examination on current policy developments on the above main topics and of possible projections of their future development published or estimated enabled the recognition of further possible issues of core importance and interest. A total of 30 relevant issues of interest were identified, while four to six corresponded to each main topic. Several issues appeared in more than one topic. The relevant issues of interest and their adjacency to the main topics of interest identified are presented in Table I.

3.3 Stakeholders mapping

Selecting the appropriate stakeholders is vital for the result of any participatory procedure (Kok *et al.*, 2007). Therefore, it was considered necessary to include a wide stakeholders' range representing all four groups suggested as essential for participatory procedures: policymakers, business representives, citizens and experts (van Asselt and Rijkens-Klomp, 2002).

The list of stakeholders was drawn up by the contact database compiled within the framework of the POLIMP project. This fact ensured that selected participants would have active involvement in the climate policy field and would be directly or indirectly impacted by the future direction of international climate policymaking and the way it affects EU climate policymaking.

Main topics	Relevant issues					
Renewable energy	Support systems	Costs and benefits	Acceptance	Grids	Environment impacts	
Energy efficiency	Policy mix	Costs and benefits	Buildings	Industry	Barriers	
Transport	Technology and Innovation	Costs and benefits	Policy mix	Barriers	Drivers	
Emissions trading	Implementation	Costs and benefits	Technology innovation	Reform of EU-ETS	International context	
Industry	Policy mix	Costs and benefits	Green IT	Potential	International context	
Adaptation	Financing instruments	Mainstreaming	Costs and benefits	Public Participation	Evidence base	
Agriculture and forestry	Bioenergy and biomass use	Land use Change	Consumption patterns	Valuing ecosystem services	Increasing farm efficiency	Support
Financing	Financing needs	Costs and benefits	Policy mix	International context		
International climate negotiations	Mitigation	Finance	Mechanisms	Adaptation	Regime and institutions	
Energy policy	Energy markets	Costs and benefits	Technology and innovation	Grids	Security of supply	Risks and uncertainty
EU climate policy	Post-2020 targets	Costs and benefits	Policy mix	Link to energy policy	International context	

Source: Ecologic Institute (2014)

Table I.
Main topics and relevant issues of interest

The first step towards the creation of the final stakeholders' list was the categorisation of POLIMP stakeholder groups in relation to their knowledge function. This categorisation is presented in the Table II. These categories are function-based, and therefore not mutually exclusive. It must be indicated that there might be an overlap between entities identified with respective categories, e.g. umbrella organisations in business or NGOs provide both the second and third functions (users and communicators). The stakeholders' engagement plan of this paper concentrates on the first two categories, "knowledge providers" and "knowledge users".

The next step followed a portfolio approach based on combination of different modes of stakeholder consultation to fit for different purposes and for different target groups. This approach enabled our research to have an extensive coverage of regions/countries as well as sectors. It was assumed to target at the most relevant sectors for the selected topic to maximise the impacts. Reflecting on the original focus of the paper, most of the stakeholders invited to the consultation process were based on climate change mitigation policy: sectoral orientation towards "energy production and distribution", "energy-intensive industry (e.g. iron and steel, cement, chemical, metal and paper and pulp)", and to a less extent "finance and trading (e.g. investors and market traders)". The format of regional or national dialogue allowed complementing the above sectoral coverage with those sectors that are of strategic importance to the targeted countries.

The final interviews were conducted involving the following, non-exhaustive list of groups of stakeholders:

- UNFCCC Secretariat;
- EU DG Research and Innovation;
- Government officials;
- Joint Research Centre of the European Commission;
- EU DG Environment and DG CLIMA officials;
- Energy producing and/or distributing companies;
- Entities producing sustainable environmental technologies;

Knowledge functions	Activities	Examples of entities
Knowledge providers	Research-oriented (e.g. desk work, laboratory and field work)	International organisations/institutions (UNFCCC secretariat, OECD/IEA); Joint Research Centre (JRC); national and non-governmental research institutes; business; NGOs
Knowledge users/ implementers	Decision- and implementation-oriented (e.g. management, administration and lobbying/ advocacy)	EU institutions (Commission, Parliament, Council, the European Economic and Social Committee, the Committee of the Regions); EU member states (including ministries and political parties); local and regional governments; business sector representatives (trade associations); NGOs; UNFCCC parties (primarily for UNFCCC side-events)
Communicators	Intermediary and catalysing (e.g. networking and mass-mailing)	Media, umbrella organisations in business or NGOs

Table II.
Stakeholders groups

Source: Fujiwara (2015)

- Small- and medium-sized enterprises;
- Research institutes in the different related specialised fields; and
- Consumers/end users of energy (and/or their representing organisation).

3.4 Preparation of material

In this paper, the suggested methodology involves the preparation of a tailor-made questionnaire for the identification of knowledge gaps regarding climate policy implications for the EU. This questionnaire was used both for direct completion by stakeholders and as a guide for the conduction of bilateral interviews. It is envigased that this combination of the two methods also combines the most of their advantages. The questionnaire was also developed in an online form to facilitate stakeholders in their responses and also to serve as preparatory material for interviewess who wished to be informed on the interview structure beforehand. In addition, the online completed form enabled the easier and more credible analysis of responses, with the use of online analytics tools.

The questionnaire initially contained some general questions about the frequency with which additional information is needed to help stakeholders in their work, the exact task they need it for, as well as their success in finding it. The second section of the questionnaire targeted to achieve better understanding on the way interested parties search for additional information and on how they intend on using it.

The third and main part of the questionnaire was dedicated to the knowledge needs themselves and followed a top-down approach to specify as much as possible existing knowledge needs. As previously mentioned, the identification of knowledge needs was structured on 11 main topics, defined by literature review. Stakeholders are, at this stage, requested to declare their area of expertise, by choosing one or two out of the 11 main topics.

For each of these main topics, a series of relevant issues (four to six) was presented, as these were identified in Table I. Stakeholders had to select two to three of these issues that they consider of great importance and that they envision to personally focus on the most in the next years. At this point, stakeholders were asked to contribute by specifying the additional information they expect to be seeking for per selected issue and to rate a predefined list of subtopics per issue on a scale of 0 to 5, according to the extent that they personally expect to be seeking additional information on. A zero response corresponded to "I will not need additional information about this" while a five meant, "I expect to need a high amount of additional information about this".

The abovementioned top-down session is illustrated in Figure 2.

During the final session, stakeholders were asked to express their point of view on a series of questions regarding knowledge needs in society as a whole. Main subjects concerned their opinion on whether lack of knowledge impedes policy design, as well as whether they personally acknowledge the existence of real gaps in scientific knowledge. The session concluded with the provision of some additional information of personal and professional nature.

3.5 Stakeholders engagement and participation

Identified key stakeholders were invited to collaborate and provide their insights through their participation in interviews or by filling in the online questionnaire. An initial contact by e-mail was followed by an official invitation upon positive reply, accompanied by relative introductory and informative material.

Interviews were conducted with 48 stakeholders, whereas 27 stakeholders filled in the online questionnaire. The structure of the interviews and the online questionnaire

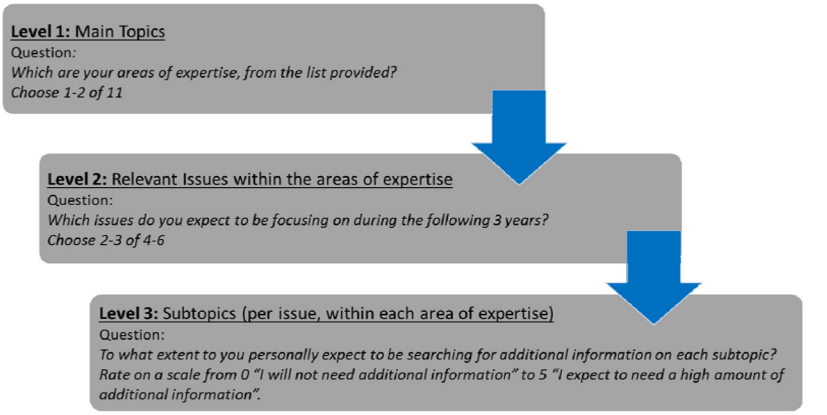

Figure 2.
Levels of questions regarding knowledge needs, structured by a top-down scheme

was similar. Considering the nature of both methods, the expert interviews focussed more on qualitative information and further analysis with regard to the methods for searching information, the needs for types of knowledge presentations and the knowledge needs themselves. On the other hand, the online questionnaire resulted in more quantitative data, identifying the range of knowledge needs that exists among stakeholders.

Stakeholders that contributed to the process came from 14 different member states of the EU, whereas 13 per cent came from countries outside the EU. Participants from Western Europe populated 22 per cent of the sample, whereas 29 per cent were from Central and Eastern Europe and the rest 37 per cent from the southern part of the continent. Although the main target audience constituted of policymakers within the EU, it is recognized that stakeholders from non-EU countries can also impact policy design at an EU and wider level. From a demographic point of view, the sample was populated by women at a 32 per cent rate. The vast majority of participants were between 30 and 50 years old, whereas 7 per cent was younger and 14 per cent older than that age group.

The stakeholders are employed at different types of organisations. Of note, 32 per cent of the respondents work for NGOs and 26 per cent for governments at European, member state level or at subnational level. A further 21 per cent is occupied in the business sector (including commercial consultancies), whereas 12 per cent is employed by research and institutions. The remaining 9 per cent works for other types of organisations.

3.6 Feedback analysis

Responses to interviews, as well as questionnaire submissions, were collected and statistically analysed to identify knowledge needs and derive conclusions. Regarding the stakeholders' area of expertise, it was observed that "renewable energy" and "EU climate policy" were the most popular main topics, followed by "international climate negotiations", "energy policy" and "energy efficiency". The full configuration of selected areas of expertise is illustrated in Figure 3.

After narrowing down the areas of expertise that were mostly selected, the most popular relevant issues per main topic were identified. Issues with little or no selection by stakeholders were discarded, as it was considered that stakeholders would not be focusing on these in the following years. For the most popular relevant issues, several subtopics were

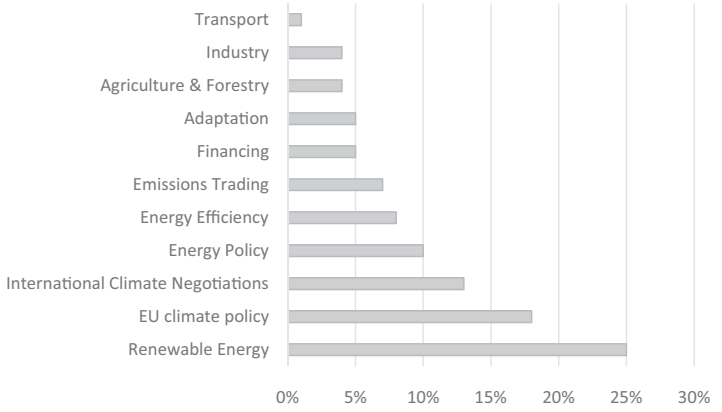

Figure 3.
Stakeholders' selected areas of expertise

rated on a scale of 0 to 5, according to the extent to which stakeholders expect to be searching for additional information on. Scores per subtopic were calculated, by multiplying each score of the scale with the frequency it was selected by stakeholders. An aggregated score derived from this procedure, according to which subtopics with the highest scores were collected and listed. This list of subtopics within issues of areas of expertise was identified as knowledge needs at a preliminary level.

However, to consider the list finalized, a verification of results was necessary. It was decided to validate these preliminary results through consolidation with stakeholders in thematic workshops, organized within the framework of the POLIMP project. The procedure is described in detail in the following paragraph.

3.7 Validation and verification of results through workshops

A workshop goes beyond information sharing to resolve differences, build consensus, pursue solutions, take decisions and plan actions (World Bank, 1996). In the case of the proposed methodology, preliminary results were verified and refined according to the feedback provided during three thematic workshops. The workshops were organized within the framework of the POLIMP project and each of those was dedicated to one of the three climate policy fields: "financing for low-carbon technology – the renewable energy example", "public acceptance of technology options and risk management" and "the role for emissions trading in low-carbon technology deployment".

The main target groups of these workshops were knowledge providers and users (Table II). In principle, participation in the workshops was provided on invitation only. The list of invited participants consisted of EU and member states policymakers, industry and business representatives, researchers from academia and think-tanks, representatives of NGOs and other stakeholder groups. The size of workshops varied, depending on the timing and topics discussed, and ranged from 30 to 50 participants. A total of 144 stakeholders joined the three thematic workshops. For selecting invited participants, organisers took into account the geographic and sector groupings that were most relevant to the chosen topic on the one hand, and the representation of knowledge providers (mainly technical experts and researchers) and knowledge users (mainly policymakers and market participants) on the other hand. The exact proportion of workshops' participant per field of activity is briefly presented in Figure 4.

The stakeholder workshops had the primary aim of stock-taking and gaining access to the expertise of stakeholders on technical issues from a wide variety of different backgrounds. In these workshops, the state-of-the art has been briefly presented to negotiators as well as stakeholders at the UN, EU or member state levels. Then the knowledge needs in each topic were presented. Precisely, stakeholders were presented with the results per thematic area during special sessions and were encouraged to study them, comment on them and give a final overview. Results were subsequently rephrased or modified when considered necessary, while the option of adding or eliminating certain subtopics was considered. The emerging list of results was validated and finalized according to participants' feedback.

4. Results

4.1 Key knowledge needs and priorities

The application of the methodology described in the previous section resulted in identifying a sequence of knowledge needs and priorities per area of expertise. The finalized outcomes, as these were defined after the validation procedure through workshops, are displayed in the main thematic area in Table III.

Results on the identified knowledge needs are analysed in the following subsections categorized by each prioritized main topic. These knowledge gaps resulted after analysing stakeholders' input on the bilateral interviews and validating their perspectives through the thematic workshops.

4.1.1 Renewable energy. Of note, 25 per cent of the stakeholders have chosen renewable energy as area of expertise, and thus contributed in the identification of needs in this field of study. As it emerges from their input, the cost development of renewable energy technologies is the main knowledge domain that needs to be further discussed and analysed. The term of cost development includes also the impact of policies on costs, and the way in which innovation can be triggered through policy. Other important knowledge needs with relation to the costs and benefits of renewables comprise the effects on job potential and energy market price signals.

Regarding support schemes and incentives for renewables, such as feed-in tariffs, the main knowledge gaps are related to the cost-effectiveness of these schemes. What is important to be next identified is the harmonisation of the different support systems for renewables, both within member states and across the EU.

Acceptance of renewables, energy grids and environmental impacts were chosen by considerably less stakeholders as relevant issues for the coming years. The explanation of why a business case is more expensive in relation to its non-monetary benefits, as well as the

Figure 4.
Workshops' participants field of activity

Prioritized main topics	Knowledge needs
Renewable energy	Cost-effectiveness of support schemes for renewable energy
	Costs development of renewable energy technologies
	Harmonisation of support schemes for renewables within and across EU member states
	Smart grids
Emissions trading	Further harmonisation of emissions trading scheme implementation across the EU
	Price stabilisation mechanisms, backloading, changes to the linear reduction factor
	Potential for and impacts of links to other emissions trading schemes around the world
EU climate policy	Interaction of different climate policy instruments and different targets
	Cost-effectiveness of targets
	Carbon-pricing instruments (ETS, taxation)
	Actions in other parts of the world, compared to the European Union
Financing	Incremental additional investment required in specific sectors
	Mobilisation of private financial flows
	Innovative finance schemes in an international context
International climate negotiations	Climate finance generating mechanisms, innovative climate finance schemes
	Types and timescales of climate change mitigation targets
	Vertical integration between decision-making levels
Agriculture and forestry	Sustainability criteria for biomass
	Indirect land use and LULUCF accounting
	Carbon sequestration
	Fertiliser, manure and livestock management
Energy policy	Electricity market design
	Energy price developments in different world regions, and its impacts
Industry	Competitiveness: carbon leakage impacts and related exemptions
	Sectoral innovation scope, reduction potential and costs
Energy efficiency	Effectiveness of existing energy efficiency policy
	Possible energy saving obligation schemes and financing options
	Energy efficiency measures savings potential
	Access to capital for energy efficiency measures
Adaptation	Institutional setup and organisation of mainstreaming of adaptation
	Methodologies for estimation of costs and benefits of adaptation measures
	Effective tools and best practices for raising public awareness and public participation
	Indicators for the evidence base for adaptation policy decisions
Transport	Increasing efficiency through intelligent transport systems
	Efficient integration of modal networks

Source: Ecologic Institute (2014)

Table III.
Key knowledge needs and priorities

discussion of these benefits, were identified as necessary issues that need to be considered, when it comes to the acceptance of renewables. In the field of energy grids, it is of high importance for the stakeholders to foster discussion on the development of smart grids and balancing (facilitating a growing share of renewable energy in the grid). Regarding the environmental impacts of renewables, the use of rare earth and other inputs, and balancing between economic development and the protection of the environment are seen as the major knowledge needs.

4.1.2 European Union climate policy in general. In addition, 18 per cent of the stakeholders selected EU climate policy in general as their area of expertise, recognising the

post-2020 targets, the overall policy mix and the international context as main issues of interest for the upcoming years.

Similar to the case of renewable energy, also for post-2020 climate targets, the cost-effectiveness of these targets is an issue of special interest, which should be further discussed. Stakeholders are also interested in information regarding target sharing among EU member states. In addition, important knowledge needs are related to the ways in which the post-2020 targets interact with each other, as well as to the interaction of different climate policy instruments in general. A significant share of the stakeholders also expresses their need for further knowledge in carbon pricing instruments, including emissions trading systems and carbon taxation.

Considering the international context of the EU climate policy, stakeholders are looking for knowledge about initiatives and actions in other parts of the world, which need to be compared to the practices followed within the EU. Especially the comparison of EU with other major emitters is a knowledge field that lacks comprehensive analysis.

4.1.3 International climate negotiations. A total of 13 per cent of the participating stakeholders offered their expertise and inputs in the area of international climate negotiations.

Main knowledge needs regarding climate change mitigation are related to target setting, specifically considering the type of the targets and the timescale of the targets. With regard to finance and mechanisms, stakeholders see innovative finance schemes, including new market mechanisms and other climate-finance generating mechanisms, along with public finance mechanisms and their application in a developing countries' context as issues that require further and updated information.

An additional knowledge need is related to the proper vertical integration of different decision-making levels, especially when it comes to policies in different international, national and local levels.

4.1.4 Energy policy in general. The area of expertise of energy policy was selected by 10 per cent of the stakeholders that identified the energy markets and costs as the most important issues for the coming three years. Issues regarding technological innovation, grids and security of supply were considered less important, whereas none of the stakeholders considered risks and uncertainty of energy policies as an issue worth analysing.

Stakeholders have identified a wide range of different knowledge needs within the aforementioned energy policy issues. The design of electricity markets, but also of capacity markets and the European internal energy markets was presented as a field were knowledge is deficient. Considering costs, stakeholders are mostly searching for knowledge related to energy price developments, both in Europe and in other world regions, and to the impacts and social dimensions of these developments. Finally, the knowledge needs regarding policies for technological innovation are mainly towards energy efficiency and renewables, whereas stakeholders have also indicated the integration of alternative energy indicators and systems for cost reduction.

4.1.5 Energy efficiency. A total of 8 per cent of the interviewees and questionnaire respondents selected energy efficiency as one of their areas of expertise, with the most important issues for the coming years being the energy efficiency policy mix and its costs and benefits. Issues related to buildings, barriers and industry are seen as less important.

With regard to the energy efficiency policy mix, all stakeholders mention similar knowledge needs. They are interested in information about the effectiveness of the existing policy mix. Therefore, they are looking for best practice examples, case studies and reviews of specific policies, both in their own country and in other EU member states. Stakeholders

also search for international benchmarks on policy incentives, for example to compare the impacts of standards and regulations as opposed to softer measures. Stakeholders are interested to learn more about possible energy-saving obligation schemes, and financing options for such schemes.

With regard to the costs and benefits of energy efficiency measures, stakeholders are mostly looking for data on the savings potential of different measures, and possibilities for accessing capital for the implementation of measures. Secondarily, stakeholders mention the potential for job creation through energy efficiency measures as a topic for which knowledge is required.

Some other knowledge needs that are mentioned with regard to energy efficiency include the costs of building refurbishment, techniques for improving the energy performance of existing buildings and legal and institutional barriers to the diffusion of energy efficiency measures.

4.1.6 Emissions trading. Emissions trading has been selected by 7 per cent of interviewees and respondents as their area of expertise. None of these stakeholders has chosen the impacts of emissions trading schemes on technological innovation as an important issue for the coming years, but the implementation, costs and benefits, potential reform and international context of emissions trading were all seen as relevant issue for the next three years.

With regard to the implementation of emissions trading, stakeholders would need more knowledge on the further harmonisation of emissions trading schemes across the EU. Furthermore, major knowledge needs emerge especially regarding the price development of allowances under the emissions trading scheme of the European Union (EU-ETS). Stakeholders detect knowledge gaps on the effective price stabilisation mechanisms, backloading, lowering the 2020 emissions cap altogether and towards the change to the linear reduction factor after 2020.

Also, information with regard to impacts of possible changes to the rules for access to international credits is required. Stakeholders need more direct and organized information on the potential for and impacts of linking the EU-ETS to other schemes around the world, and therefore there is also an interest in the background and status of these other schemes. Finally, several stakeholders mention the situations with regard to international aviation and international shipping in relation to the EU-ETS as a knowledge need.

4.1.7 Financing. The topic of financing was selected by 5 per cent of the stakeholders as their area of expertise. They identified financing needs and the international context of financing as the main issues for the coming years, followed by the financing policy mix. Since financing is a crosscutting issue with connections to virtually all of the other topics, these other areas of expertise should also be taken into account with regard to the knowledge needs about finance.

Regarding financing needs, stakeholders state that they need knowledge about incremental additional investment requirements in specific sectors. Specifically financing facilities for small- and medium-sized enterprises are mentioned as a topic that requires more knowledge. As indicated before, stakeholders also need information about access to capital for energy efficiency measures.

In an international context, stakeholders need information with regard to innovative finance schemes and ways to mobilise private financial flows. Also, information about the possibilities of financing projects through European funds is needed. One of the stakeholders mentioned that it would be useful if a "one-stop-shop" of financing options for sustainable projects were available.

4.1.8 Adaptation. The area of expertise on adaptation had the same stakeholders' participation as the topic of financing. The most important issue for the coming three years, chosen by all of the stakeholders, is mainstreaming of adaptation. Other relevant issues include costs and benefits of adaptation, public participation, evidence bases for policy decisions and financing instruments. Knowledge needs regarding these issues vary.

The stakeholders state to be searching information regarding the institutional and organisational setup of the mainstreaming of adaptation; how to design effective processes. Clear information on sectoral trade-offs is needed. Main point regarding costs and benefits of adaptation is the methodology for proving additionality of adaptation projects.

With regard to public participation, stakeholders are interested in best practices and effective tools for raising public awareness of climate change adaptation. In addition, regarding the evidence base for policy decisions, a main knowledge need is related to the indicators upon which policy decisions are based.

4.1.9 Agriculture and forestry. Even less stakeholders, only 4 per cent of the whole sample, selected agriculture and forestry as their main work area. The stakeholders selected different issues as being important the coming years: the use of biomass for bioenergy, land use change, increasing farm efficiency and farmer support. Consumption patterns, including how the public influences agricultural practices, and the valuation of ecosystem services have not been selected as main issues for the next three years.

Regarding biomass, in addition to sustainability criteria, a knowledge need was identified related to ways of making biomass economically profitable, as opposed to only using biomass for climate reasons. With regard to land use change, factual information, including clear numbers and scale information, was identified as knowledge need. In addition, biochar, Reducing Emissions from Deforestation and Forest Degradation and tropical deforestation in general are issues where stakeholders search information about.

The main knowledge needs regarding the increase of farm efficiency are related to carbon sequestration and fertiliser, manure and livestock management. Specifically, also the need of information about improving yield and efficiency of energy crops was mentioned. Stakeholders furthermore identify knowledge needs regarding farm advisory, and raising awareness about possible co-benefits development.

4.1.10 Industry. The area of expertise industry was chosen by 4 per cent interviewees and respondents. The main issue for the coming years is said to be the costs and benefits of climate-related developments in the industrial sector. Other relevant issues include the policy mix for industries, the potential for certain measures, and the international context. None of the stakeholders selected green information technology as main issue for the coming years, although the related smart grids were selected as a main knowledge need within the topic of renewables.

The main knowledge need identified by the stakeholders, regarding the costs and benefits issue, is related to competitiveness. Information is required about impacts of policies and measures, such as carbon leakage. Stakeholders also mention that knowledge is required with regard to greenhouse gas reduction potentials and costs as part of a sectoral innovation scope.

Other knowledge needs that are identified by some of the stakeholders include information about the potential of recycling in the industrial sector, the impacts of the emissions trading scheme on technological innovation and a comprehensive international comparison of regulations and programmes for industries.

4.1.11 Transport. A minority of stakeholders, namely, only 1 per cent of the involved stakeholders, has identified transport as a main area of expertise. The knowledge needs that are selected within this topic may therefore not be representative. The main issues for the

coming years identified by this stakeholder include technological innovation as well as the transport policy mix. Knowledge needs identified are centred on the increase of efficiency through intelligent transport systems, and efficient integration of modal networks.

4.2 Discussion

A literature review was conducted to compare the results to the key needs provided by relative previous research on each prioritized main topic. In their effort to address the knowledge needs of policymakers, Geels *et al.* (2016) identified different policy-relevant criteria, such as cost-effectiveness, socio-political feasibility, social acceptance and legitimacy and flexibility.

Millinger and Thran (2016) outlined how different feedstock cost developments affect the competitiveness between biofuels. In 2014, the International Renewable Energy Agency realized the difficulty in accounting the dynamic cost developments as technologies get deployed over time (Ruud *et al.*, 2015). Resch *et al.* (2004) analysed the ambiguous role of dynamic cost developments in deriving the optimal time-path for policy instruments. Johnston *et al.* (2008) discussed the requirements for least-cost development and efficient operation. Suna and Resch (2016) stated that for the economic comparison of renewable technologies and for estimating their future role in energy supply, it is important to analyse their historical cost developments.

Apergis and Apergis (2017) claimed that it is highly useful to understand the dynamic spillovers across renewable energy prices, the diffusion of technologies in relevance to renewable energy and potentially their impact on GDP growth. Energy prices are generally subject to various economic and social framework conditions, the geopolitical situation and resource availability, which influence energy supply and demand (POLIMP, 2014).

Howell *et al.* (2017) stated that little research applies in approaches, such as "smart grid", "microgrid", "virtual power plant" and "multi-energy system". In addition, Blarke and Jenkins (2013) investigated SuperGrid and SmartGrid pathways for modernizing the electricity architecture, highlighting their importance in the long-term energy system design.

Kerr *et al.* (2017) tried to consider how different benefits have been used within the overall rationale for energy efficient retrofit policy. Grueneich (2015) presented key challenges that must be overcome to attain the "next level of energy efficiency", namely, increasing the magnitude of savings, diversifying energy efficiency resources, measuring and ensuring the persistence of energy efficiency savings, integrating energy efficiency savings with a carbon reduction framework and understanding and valuing energy efficiency as part of an evolving grid. Rosenow and Bayer (2017) specifically reviewed the costs and benefits of energy efficiency obligations, a key policy instrument to achieve energy efficiency.

Liu *et al.* (2017) concluded that more tax incentives and economic benefits should be created to support greenhouse gas (GHG) emissions mitigation. Olubunmi *et al.* (2016) reviewed green building incentives, DeShazo *et al.* (2017) focused on economic incentives on transport, whereas Curtin *et al.* (2017) gathered financial incentives to mobilise local citizens as investors in low-carbon technologies. Crago and Chernyakhovskiy (2017) identified a range of initiatives aiming at increasing the share of solar generated electricity, whereas Punda *et al.* (2017) reviewed the current state of preferential tariffs for RES.

Sustainable agriculture and forestry has been set as a priority objective of European policy. Appropriate knowledge, tools, services and innovations are said as necessary to support more productive, environmentally friendly resource-efficient agriculture (EC, European Comission, 2013). The Organisation for Economic Co-operation and Development (OECD) report of 2010

(Hall and Dorai, 2010) illustrated the circumstances of the use of innovation in sustainable agricultural production, and drew out conclusions about how policy and market approaches could better enable the contribution of innovation to greener growth.

Based on United Nations' research in the field of renewable energy in industrial applications (2011), it comes that although renewable energy has received a good deal of attention for power generation and for residential applications, its use in industry has attracted much less attention. Taibia *et al.* (2012) also shared the view that insufficient attention has been paid to the potential of renewable energy resources in industrial applications. Wohlgemuth and Monga (2008) suggested that solar and biomass-based technologies have very considerable technical potential to meet in a sustainable way the growing energy needs of many industrial enterprises, especially for small- and medium-scale enterprises in developing countries.

A UK parliament publication (2015) focused on technologies for the decarbonisation of transport, and highlighted technological constraints that limit their growth, including a lack of widespread charging infrastructure, the high costs of batteries and alternative fuels and the limited options for decarbonising long-distance aviation and shipping. Chapman (2006) outlined that there is a myriad of transport technology alternatives, such as biofuels, natural gas, hydrogen and electric motors (Sperling, 2003; Maclean, 2004). However, there is a need for governments to fund research on them (DfT, 2006). In their paper, Shokrzadeh and Bibeau (2016) pointed out that to achieve the CO_2 reduction target in transport sector (IEA, 2012) ,electrification of transportation is a promising solution (Gonzalez *et al.*, 2015). Towards this direction, automakers have started mass production of new technologies, such as plug-in hybrid and battery electric vehicles, collectively known as plug-in electric vehicles (PEVs) (Natural Resources Canada, 2010). However, high cost of traction batteries of PEVs and public perception of electric mobility are among the challenges that should be addressed as Chen *et al.* (2015) noticed.

As it can easily be presumed from the literature, needs and trends identified are in line with the outcomes resulted from the approach followed, and therefore this provides a validity to the proposed methodological framework.

The added value of the paper is that it proposes a comprehensive methodological framework that effectively deploys stakeholders input and feedback, and results in a valid identification of knowledge needs in a wide variety of topics in the area of climate policy. The novelty of the proposed approach is the incorporation of the stakeholders' perspective to the procedure of needs identification, and the provision of a thorough review of climate policy needs per each of eleven key thematic fields that were previously partially analysed in literature. In addition, the paper concludes on major knowledge needs that were not previously presented in the existing literature. Examples of such needs are the impact of policies on costs, the relation between innovation and policy, best practice examples, case studies and reviews of specific policies in the field of energy efficiency and specific needs on target setting and sharing (Table IV).

5. Conclusions

A big variety of possible directions and potential consequences of climate policies on EU level are created by the continuous changing and multi-faceted political scenery of negotiations; therefore, solid policy and decision-making are hindered. A further access to enhanced knowledge transfer and the use of policy and decision makers is required, to make them able to develop clear understanding of current regimes, their possible directions and consequences and to support them in making well-informed, consolidated decisions based on current reliable facts.

Prioritized main topics	Reference	Knowledge needs and priorities
Renewable energy	Geels *et al.* (2016)	Cost-effectiveness socio-political feasibility, social acceptance and legitimacy, flexibility
	Millinger and Thran (2016)	Feedstock cost developments
	Ruud *et al.* 2015	Renewable technologies dynamic cost developments over time
	Resch *et al.* (2004)	Dynamic cost developments for optimal policy instruments time path
	Johnston *et al.* (2008)	Requirements for least-cost development and efficient operation
	Suna and Resch (2016)	Renewable technologies historical cost developments for their economic comparison and role in energy supply
	Apergis and Apergis (2017)	Dynamic spillovers across renewable energy prices, diffusion of technologies in relevance to renewable energy, RES impact on GDP growth
	POLIMP (2014)	Impact of economic and social framework conditions, the geopolitical situation, resource availability on energy prices
	Howell *et al.* (2017)	Research on "smart grid", "microgrid", "virtual power plant" and "multi-energy system"
	Blarke and Jenkins (2013)	SuperGrid and SmartGrid pathways for modernizing the electricity architecture
Financing	Liu *et al.* (2017)	Need of tax incentives and economic benefits to support GHG emissions mitigation
	Olubunmi *et al.* (2016)	Green building incentives
	DeShazo *et al.* (2017)	Economic incentives on transport
	Curtin *et al.* (2017)	Financial incentives to mobilise local citizens as investors in low carbon technologies
	Crago and Chernyakhovskiy (2017)	Initiatives aiming at increasing the share of solar generated electricity in the US energy mix
	Punda *et al.* (2017)	Current state of preferential tariffs for RES in countries of southeast Europe
Agriculture and forestry	EC, European Commission (2013)	Appropriate knowledge, tools, services and innovations for productive, environmentally friendly resource-efficient and resilient agriculture
		Research and innovation for integrating agronomic and environmental goals into sustainable production
	OECD (2010)	Agricultural innovation and application in sustainable agricultural production
		Policy and market approaches for greener growth
Industry	United Nations Industrial Development Organization (2011)	Renewable energy in industrial applications, potential of renewable technologies and factors for successful contribution
	Taibia *et al.* (2012)	Development of a detailed technology roadmap to explore the potential of renewable energy resources in industrial applications
	Wohlgemuth and Monga (2008)	Solar and biomass-based technologies' potential for small- and medium-scale enterprises in developing countries
Energy efficiency	Kerr *et al.* (2017)	Energy efficiency policy within a framework of a variety of different benefits

(*continued*)

Table IV.
Literature review of knowledge needs and priorities

Prioritized main topics	Reference	Knowledge needs and priorities
	Grueneich (2015)	Benefits exploitation within the overall rationale for energy efficient retrofit policy in different contexts Increasing the magnitude of savings Diversifying energy efficiency resources Measuring and ensuring the persistence of energy efficiency savings Integrating energy efficiency savings with a carbon reduction framework Understanding and valuing energy efficiency as part of an evolving grid
	Rosenow and Bayer (2017)	Costs and benefits of Energy Efficiency Obligations
Transport	UK parliament (2015)	Technological constraints, limited options for decarbonising long-distance aviation and shipping
	Chapman (2006)	Consideration of biofuels, natural gas, hydrogen and electric motors as options for renewable transport
	DfT (2006)	Need of governments' fund for research and development of alternative fuels
	Shokrzadeh and Bibeau (2016)	Electrification of transportation to achieve CO_2 reductions goals
	Natural Resources Canada (2010)	Higher fuel efficiency and extended electric range Technologies, such as plug-in electric vehicles
	Chen *et al.* (2015)	High cost of traction batteries of PEVs and public perception of electric mobility

Table IV.

An analysis is supplied by this paper, based on the elaboration of stakeholders' assessment that resulted in the identification and prioritisation of a series of knowledge gaps within main climate policy-related topics.

The methodological framework introduced a participatory process of key experts' engagement, involved directly or indirectly in the procedure of policymaking. A key element of the approach is the consideration of highly experienced stakeholders' feedback on their specific area of expertise, instead of general public engagement, therefore leading to more accurate results. A range of priority issues was initially identified through desk analysis and key stakeholders were selected and invited to partake in the process. A questionnaire was developed to serve as a guide for expert interviews or for direct completion by stakeholders through an online form. A total of 48 bilateral interviews were conducted, whereas 27 questionnaires were submitted by stakeholders and collected for analysis. Preliminary results were validated through interaction with stakeholders during a series of workshops and the final knowledge needs emerged as an outcome.

Emphasis was identified to be placed on the topics of renewable energy, EU climate policy and international climate negotiations, which were the most popular ones, followed by energy policy and energy efficiency. The issue of cost-effectiveness was generally considered as a priority aspect of interest within the main areas of expertise, whereas the involved policy mix also raised concern among stakeholders. The results from the proposed approach can be considered as realistic, as they were subsequently validated through a series of workshops, where stakeholders reflected upon the derived list of knowledge needs.

Despite the fact that our approach was applied to a specific problem, the overall analysis could provide a framework for supporting applications in various problems in the field of

priorities' identification and even expanding to decision-making problems. Future research efforts could therefore be placed on the stakeholders' participating in the evaluation and selection of policy pathways and sustainability strategies, in the process of climate policy decision-making and even spread to the assessment of the public acceptance of different schemes identified.

This research also outlines some obstacles encountered when implementing participatory processes that could be overcome to increase the method's overall effectiveness. As a participatory approach is based on the engagement and knowledge of key stakeholders, its success and quality of results are highly connected to the stakeholders' availability and willingness to participate. Thus, participating stakeholders must be at first clearly defined. Concerning the study's findings, intense effort for further research should be particularly placed in the fields of transport, industry and agriculture and forestry, where stakeholders' participation was limited. In addition, and to achieve appropriate and high-quality data, attempts for future research must be based on flexible participatory approaches, which could be quickly adapted to different contexts, so as to fit to participants' needs and elicit the most appropriate information.

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