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Public attitudes, co-production and polycentric governance in energy policy

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1. Introduction

The climate and energy policies for 2020–2030 for the European Union (EU) require decarbonization of the energy sector, including energy generation, transportation, and the industry as a whole (COM, 2013). The energy and climate security policies framework supports EU member states in achieving such energy policy targets as reducing greenhouse gas emissions by 80–95% below the 1990-year level by 2050; reducing the EU's dependence on energy imports, especially fossil fuels; and replacing and upgrading the energy infrastructure (COM, 2014). The Paris Agreement within the United Nations Framework Convention on Climate Change requires limiting global warming to 2 °C above preindustrial levels. It also recognizes that further reducing global warming to 1.5 °C will reduce the risks and impacts of climate change (Bodansky, 2015). According to the Paris Agreement, each country should develop a national plan for mitigating climate change, establish nationally determined contributions, and regularly report on the implementation of the plan. Nationally determined contributions are the defining targets of every country acting to mitigate climate change. The climate security policies foresee a global reduction in carbon emissions by 45% compared to the year 2010 and a complete decarbonization of electricity generation by 2050.

The decarbonization of energy generation can be achieved with various technologies and measures such as the use of renewable energy sources (RES) and greater energy efficiency (Directive [EU] 2018/2001; Patt, 2015). Achieving a certain degree of or full decarbonization of energy and electricity generation will transform systems from centrally planned systems with energy generation and demand centers located close to each other and with fossil fuels as baseload technologies to more diversified energy generation systems (Reusswig et al., 2018; Sovacool and Dworkin, 2015). Various energy producers will enter the market, and consumers will become prosumers. Various forms of energy generation, as well as digital and smart technologies, will arise, and there will be a need to manage peaks of supply and demand while also considering the volatile nature of energy generated from RES. This will lead to the creation of distributed energy systems and social innovations around the generation, transmission, and distribution of energy (Komendantova and Neumueller, 2020).

The targets of climate and energy security policies are determined at the national level. Furthermore, they are put into effect at regional and local levels, leading to various patterns of social acceptance of innovations connected with their implementation. Social acceptance of innovation mainly takes place at the market and community levels, and conditions to support this innovation are shaped by sociopolitical acceptance (Wü;stenhagen et al., 2007). As the generation of energy becomes less centralized, the communities in which such infrastructure is constructed and the laypeople who live in them and use these technologies are gaining greater influence (Komendantova et al., 2018). The emergence of distributed energy systems might lead to polycentricity in governance and a need to reframe the discourse on social acceptance from a focus on technologies to a focus on the acceptance of social innovations and new forms of governance, including co-production in the

Abbreviations: CEM, climate and energy model; DAD, decide–announce–defend; EU, European Union; NIMBY, not-in-my-backyard; PV, photovoltaic; RES, renewable energy sources.

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generation and management of energy (Wolsink, 2020a, 2020b).

Despite the fact that energy policy targets and reliable energy supplies are questions of national security, and therefore identified at the national level, the details of these projects, the amount of decarbonization, and the choice of available technologies can be discussed at the local level (Komendantova et al., 2018). Also, people's growing willingness to participate in decision-making processes that affect their lives, and their communities makes possible a discussion of energy policy targets, especially if it goes beyond simple public and social acceptance to active participation and a willingness to use various technologies (Wolsink, 2020a, 2020b).

To date, various policy initiatives as well as efforts of the academic community have been directed at understanding and implementing the technical and economic drivers necessary for the use of RES. These drivers include the creation of necessary technological infrastructures and the implementation of required technological solutions. They also include the development and evaluation of economic and financial instruments to make RES economically attractive and cost competitive with fossil fuels (Hess and Sovacool, 2020). Yet although the availability of technology and infrastructure, economically and financially attractive conditions, and strong political will are essential drivers of the use of RES, human factors, such as acceptance, awareness, attitudes, and willingness to engage, also play an important role, especially when we speak about polycentric governance. However, according to a 2015 meta-analysis, only 3% of Scopus studies on energy policy, the use of RES, and the transformation of energy systems considered human factors (Sovacool et al., 2015).

Over the years the number of studies on human factors grew, but many took a so-called not-in-my-backyard (NIMBY) tack in which acceptance was framed as a necessary factor in a top-down process in which the need for infrastructure was identified and the details of projects were decided without involving the public or a broad range of stakeholders. Such studies were framed as studies on acceptance or on various social protests and factors that should be addressed to facilitate planned projects. This kind of thinking dealt mainly with issues of social protests against planned infrastructure and described inhabitants of affected communities mainly as protesters of global solutions with impacts at the local level. Such understanding ascribed to RES infrastructure projects benefits at the national or global level but risks at the local level.

Later on, the scope of studies broadened to include various human factors, such as awareness and social and public acceptance, as minimal conditions for infrastructure (Wolsink, 2007). Human factors were also connected with the visions of various stakeholders of societal transformations to function as a framework for formulating policies and their objectives. Later on the scope of studies was broadened to include factors that go beyond nonparticipation or token levels of public involvement. Such factors include the willingness to use technology, the willingness to pay higher energy prices for certain technologies, and the willingness to participate in decision-making processes. The claim appeared that accepting social innovation is not about providing information and educating the public—in particular, not by usually distrusted authorities—but is about listening and seriously implementing the essence of existing awareness in society (including the public) and creating frameworks to implement new strategies fostering that awareness (Wolsink, 2012). A growing number of scientific works are being published on participatory governance for the implementation of energy and climate security policies while trying to understand the worldviews, aspirations, and perceptions of different stakeholders and social groups (Landauer and Komendantova, 2018). These studies recommend that energy and climate security policies address various perceptions of procedural and output justice from laypeople and other stakeholders (Sari et al., 2017).

Energy policy is full of such terms as "energy transition"; "baseload technologies"; "intermittent" versus "variable" resources; and "smart," "NIMBY," or "decentralized" instead of "distributed" generation. These terms are all frames used in energy policies. However, it is unclear the extent to which the terms "participatory governance," "polycentric governance," or "co-production" can be used in relation to a reliable energy supply. The term "participatory governance" here refers to the involvement of many stakeholders, including laypeople, in decision making on energy transition, including discussions of the use of various technologies to cover the demand for energy but also of the centralized versus distributed nature of energy generation. This term refers to empowering people to make choices regarding services that affect their communities and their lifestyles but also providing them with a variety of choices and alternatives.

Given the available scientific evidence, our primary research question is as follows: What are current potentials for polycentric governance and opportunities for the co-production of energy policy given existing levels of awareness and willingness to participate among the general public?

Three secondary questions are as follows:

- What is the general public's level of awareness of climate change and targets of energy policy?
- What are perceptions and attitudes of laypeople regarding energy policy for decarbonization of the energy sector?
- How, if at all, would laypeople like to engage in decision-making processes and the implementation of various measures foreseen by energy policy?

2. Background

2.1. Co-production and energy policy

The term "co-creation" has various meanings and is frequently connected with such terms as "co-production" and "co-design." The concept of co-creation was introduced by Ostrom and Ostrom (1977) in her work on public goods and public choices. It was extended to the governance of common goods as well as to polycentric governance by Parks et al. (1981) in their work on consumers as co-producers of public services. Later it emerged in relation to the involvement of end users in the process of product development (Vargo and Lusch, 2004). Later on, a new understanding emerged of co-production as an innovative process in which governments and citizens co-create public values (Uppström and Lö;nn, 2017). There are three types of co-creation, in which citizen are co-implementers, co-designers, and co-initiators of policy interventions (Voorberg et al., 2015). Currently the majority of studies focus on citizens as co-implementers. The number of studies that consider citizens as co-developers is limited (Voorberg et al., 2015).

The term "co-production" is closely connected with participation in decision-making processes and policy design. In the present context, the notion of participation in decision-making processes is based on the assumption that through the involvement of local communities, the measures necessary for the decarbonization of the energy sector can be implemented with great benefits at not only the national but also the local level and without significant risks or costs for local communities. These measures can also improve the outcomes of decision-making processes through the implementation of good governance practices, democratic processes (Weiss, 2000), and improvements to governance (Coelho and Favareto, 2006).

Co-production is connected with the notion of polycentric governance systems described by Ostrom in her work on the governance of complex economic systems and institutional arrangements to govern, provide, and manage public goods and common-pool resources. Following this framework, Wolsink (2020a, 2020b) spoke about polycentricity in energy systems that come with the development of distributed generation, transmission, and distribution of energy. Such polycentricity, which is connected with the emergence of multiple centers of decision making at different levels, is replacing hierarchy. In polycentric governance systems RES have become a common good

rather than a private or public one. The acceptance of polycentric governance relates to institutional changes that are replacing hierarchy by co-production.

Previously, the NIMBY attitude toward social and public acceptance dominated the literature, and acceptance was understood as a component of satisfaction with an infrastructure project in the communities where such projects were planned or realized. NIMBY implies that local communities accept policy goals but do not want to house the infrastructure projects needed to reach these goals. Such acceptance is a kind of passive attitude toward infrastructure that is set in a top-down manner through decide–announce–defend (DAD) models. In DAD models, decisions are made at the national level and then implemented at the local level; however, communities are not involved in these decisions. They are simply informed of the need for these decisions.

NIMBY and DAD models are based on an understanding that the potential for including laypeople in decision-making processes is limited. A NIMBY attitude implies that perceptions of interventions, like the need for infrastructure to mitigate climate change, are positive but impacts at the local level are rather negative. People accept the change in question in general, but not close to their homes. NIMBY has frequently received negative feedback in science as a kind of social gap or hostility in local communities. Many scientists argue that it is frequently used as an argument in top-down decision-making processes and that this is a misleading way to understand local objections (Devine-Wright, 2012; Wolsink, 2006). In a DAD model, decision-making processes are frequently led by a number of educated experts, whose advice is then transferred to policymaking and implemented in a top-down manner. Such a model can frequently lead to social conflicts over the implementation of planned projects (Wolsink, 2010).

The concepts of co-production and participation in energy policy certainly go beyond any NIMBY understanding (Komendantova and Battaglini, 2016). They are more connected with concepts of procedural justice (i.e., how various stakeholders, social groups, and inhabitants of affected communities are involved in decision-making processes) and output justice (i.e., how benefits, risks, and costs of decarbonization are split between local and national governments or between various communities and social groups). Co-production reflects a more active position of stakeholders and inhabitants in energy policy, as these people are given an opportunity to shape decision-making processes. When many stakeholders, not just educated experts, are involved in decision making, the outcomes of these processes frequently enjoy a higher level of legitimacy and trust (Renn, 2008). Integrating the knowledge and feedback of people from local communities also allows for more sustainable projects with smaller negative impacts on human health and the environment (Komendantova et al., 2018).

The notion of social acceptance is currently changing from a focus on public attitudes toward technologies to an acceptance of processes that involve diverse stakeholder groups at various levels. This shifts the focus from the idiosyncrasies of each technology to the institutional frameworks that frame decision making and provide possibilities for engagement (Xavier et al., 2017; Yazdanpanah et al., 2015). The use of distributed energy systems as well as various options for engagement and participation in this process also lead to the acceptance of conditions for social innovation, of conditions for its implementation, and of its consequences (Wolsink, 2020a, 2020b).

2.2. Energy and climate security policy in Austria

In line with the targets of international and European climate and energy security policies, the Federal Government of the Austrian Republic determined targets for decarbonization for Austria's energy sector, including decarbonization of energy generation, energy transportation, and the industry as a whole. To reach these national targets, the Austrian government implemented Climate and Energy Strategy 2030, or "Mission 2030," to guide investment in the energy sector while also decarbonizing and ensuring the competitiveness of Austria's economy (Federal Ministry of the Republic of Austria for Sustainability and Tourism, Federal Ministry of the Republic of Austria for Transport, Innovation and Technology, 2018).

The key objective of Austria's climate policy is to reduce greenhouse gas emissions by 36% by 2030 compared to 2005. Its major aim is to implement a modern decarbonized energy system. The share of RES used in energy should increase to 45–50%. The share of RES used in electricity should increase to 100%. The main objective of the strategy is to guarantee a secure energy supply in Austria and to explore the potential of domestic energy resources.

The current share of RES in Austria is higher than the average in the European Union (16.7% by 2015). By 2016 the share of RES in the Austrian energy mix reached 33.5%, mainly because of the use of hydropower (36.4% of the total volume of RES energy) and solid biomass (29.6%). The contribution of wind, solar, geothermal, and biogas totaled 11.2%. In recent years the share of RES has increased mainly because of a production-related increase in the use of black liquors from the paper industry, an increase in the use of wood fuels due to weather, and an increase in the amount of electricity generated from hydropower. By 2016 the share of RES in electricity generation in Austria reached 71.7%.

As stated in Mission (2030), regional, urban, and local authorities in Austria are vital partners in energy transition who have developed their own energy and climate strategies with specific targets. The report calls for collaboration between governments at different levels as well as the coordination of decarbonization efforts in a "cost-efficient manner" and "with clear division of responsibilities and powers" to avoid duplication. The initiatives of the Austrian government, such as the Climate and Energy Fund, put more emphasis on bottom-up approaches while emphasizing local governance and the engagement of various stakeholders as well as providing opportunities for laypeople to engage in decision making on the decarbonization of the energy sector.

Mission 2030 also puts a special emphasis on social affordability and requires cooperation and participatory governance to avoid energy poverty and to reach targets of energy policy:

"One policy objective should be that all sections of the population can meet their basic energy and mobility requirements. Consumers should be able to manage this now and in future at a socially affordable cost. High energy costs put low-income households in particular at risk of poverty. It is therefore important to minimize energy poverty in tune with climate and energy targets. Economists, politicians and civil society can work together to find social solutions to help mitigate hardship cases. Maximum transparency in the form of easy and fast access to information and further training should be guaranteed in order to increase social acceptance." (Federal Ministry of the Republic of Austria for Sustainability and Tourism, Federal Ministry of the Republic of Austria for Transport, Innovation and Technology, 2018).

Furthermore, Mission 2030 outlines three factors that are key to social and public acceptance: (a) economic rationality, namely, levelized costs of energy generation and the impact of changes in energy prices on private households and the competitiveness of the economy; (b) participatory governance, namely, working together to find social solutions to mitigate consequences; and (c) good governance in terms of access to clear, comprehensive, and reliable information as well as awareness-raising measures to increase social acceptance.

This statement attributes a rather passive role to energy users. Participatory governance is mainly understood as involvement in local governance. Mission 2030 does not set targets for participatory governance or polycentric governance and treats issues of engagement rather technically as cooperation mechanisms or as mechanisms for collecting feedback without any guarantee that the feedback will be implemented.

The goals of energy and climate security policies are implemented at the local level in frames of so-called climate and energy model (CEM) regions. The CEM initiative is being implemented by the Austrian Climate and Energy Fund and aims to help regions become independent from fossil fuels with the help of a regional bottom-up approach to

governance. The number of CEM regions varies from year to year around 100. When we started our research, there were 104 CEM regions. The initiative covers around 43% of the Austrian population. The population of a CEM region may range from 1200 to 82,000 people. It should have at least two municipalities with a minimum of 3000 and a maximum of 60,000 inhabitants. The size of a CEM may range from 150 to 60,000 ha. The majority of CEMs are moderately or thinly populated rural areas with expectations of investment in RES to boost their regional economy. The average CEM region uses 29.95 MWh per capita of energy per year, 6.59 MWh per capita for electricity, and 16.72 MWh per capita for heat, and 9 MWh per capita for mobility and transportation. The average CEM region produces 33% of its needed heat and 25% of its needed electricity.

Several CEMs have developed plans to use a high amount of RES, especially in generating electricity. Some aim to generate up to 100% of electricity with locally available RES. They also provide information about possible ways of achieving this goal. Available alternatives for achieving the large share of RES are discussed with local stakeholders and also with laypeople. In some CEMs, special governance forums, such as energy groups, have been established in which interested persons can discuss available alternatives and suggest how funding should be used to reach targets. There are also opportunities for financial participation in the form of crowdfunding.

3. Methodology

This research is a case study of two CEM regions, Freistadt and Amstetten, that have set ambitious goals for the use of RES. The socio-economic characteristics of the regions are identical, which allowed us to test one critical variable that differs by region: available opportunities for participation in decision-making processes on deployment of RES. In Freistadt, polycentric governance centers such as energy groups have been established. Anybody who is interested can join these groups and debate the use of RES as well as possible projects to be implemented with the provided funding. People can also co-create solutions for implementing the goals of energy and climate security policies. In Amstetten such practices do not exist, and laypeople are involved in more traditional ways as decisions are made by their representatives, such as CEM managers.

The design of this research was based on the multiple cases methodology developed by Yin (2014) for the planning, design, preparation, collection, analysis, and reporting of data. We used the definition of case study developed by Yin as an empirical inquiry that investigates a contemporary phenomenon (the 'case') in depth and within its real-world context. We chose this method because it captures the complexity of a case and can also be used to explore temporal changes and contextual conditions.

For data collection, we administered a large-scale survey among laypeople to evaluate their perceptions and attitudes as well as their level of awareness. Our methodology included several steps: the development of a research protocol, including questions for the survey; the identification of the two case regions; sampling; data collection; and the analysis of the empirical data. We describe each of these steps below.

The focus of this study was two particular CEMs: Freistadt and Amstetten. Freistadt is in the northern part of Upper Austria and has 27 municipalities. Agricultural land dominates the region (53%), whereas forests account for 42% of it. The economy of the region is dominated by small companies, mainly one-person operations. The major challenge to the region is the high number of commuters (29%) who need to travel to Linz for employment. Freistadt established the ambitious goal of reaching the highest possible rate of energy self-sufficiency based on RES. RES is considered useful in the region because of the perceived insecurity of the Temelin nuclear power plant, located at the nearby Czech border. The region is home to one of the biggest solar power stations in Austria, which is financed by locals. There are also several local initiatives promoting RES. These initiatives manage the implementation of CEM targets. To date, they have already built 30 district heating facilities, five biogas plants, and some small-scale hydropower plants.

Amstetten Nord and Süd work in very close interaction and have pretty similar programs. Both regions have only few activities: energy accounting for municipalities; energy activism (e.g., putting old dishwashers and freezers in public spaces to raise awareness among high–energy consumption households); information provision through websites, social media, and newsletters; and a focus on energy-saving streetlights. In these regions there is no large-scale energy infrastructure, like photovoltaic (PV) power plants or wind parks, and none is planned. Concerning governance, it did not make a big difference which of these two regions was the case study for this research because they coordinate their activities. Amstetten Süd was selected as the case study because it is more comparable to Freistadt in its regional structure.

We developed the questionnaire based on a comprehensive review of the literature on participatory governance in energy transitions as well as on experience from previous projects. The final layout of the survey was provided by Triconsult Wien, which also led the data collection. The questionnaire contained several sections, including awareness of climate change and the CEM process; RES, energy efficiency, and perceptions of their impacts; energy transition and goals of energy independence; willingness to install RES in one's own household and to pay for RES; as well as willingness to engage in the energy transition. Demographic variables included age, size of the community, type of housing (private or rental), education, employment, number of people in the household, and number of children in the household. The survey was multiple choice and took around 20 min to complete. It was developed first in English and then translated into and administered in German.

We started the survey phase by contacting by phone all heads of offices of municipalities from CEM Freistadt and CEM Amstetten, which agreed to participate in our research. After the municipality agreed to participate, we distributed the questionnaires either in paper form or as Web surveys. Links to the Web surveys were put on the homepages of the municipalities. They were also published in local news releases or communicated by employees of the municipalities via local media. Local newspapers also published a description of the project and a call for participants. Surveys were also available in print form in the municipalities, where anybody interested could take one, fill it out, and return it to a specially prepared box.

We used random sampling of respondents while using the sampling methods of large-scale surveys used for collecting data for various opinion polls. We calculated proportions of various social groups according to demographic characteristics such as age and sex. We used multiple methods of data collection, from the online survey to phone interviews and personal interviews. Prior to the personal interviews the number of respondents was calculated and the number of missing responses from certain social groups was identified. Then the interviewers approached representatives of the underrepresented social groups using other methods of data collection.

In Freistadt we contacted 25 municipalities in the CEM region. The project team provided additional information about the project and questionnaires via e-mail. After this, the questionnaires had to be discussed with the mayors of every community. Ultimately, 17 municipalities agreed to support the project: 7 sent out the questionnaire as an attachment to their municipal newspapers; and the other 10 communities placed the survey on their homepages, promoted the link to the survey in their local newspapers, or displayed copies of the questionnaire in the community office. The remaining eight communities refused to participate mainly because of lack of time and personnel to distribute the survey. In total 4500 questionnaires were sent out to inhabitants of Freistadt, and around 7% were returned with valid information. In addition, 322 questionnaires were collected online.

In Amstetten a similar procedure was conducted, and 19 municipalities agreed to participate. The questionnaire was also published in the regional newspaper *Iocum Mostviertel*. Several municipalities agreed

to put a link to the survey on their homepages. Approximately 30,000 questionnaires were sent out to inhabitants of the Amstetten region. The response rate was 1.2%. In addition, 240 questionnaires were collected online.

These are rather low response rates considering the large number of people who were contacted, but they are common for surveys conducted using random sampling and online data collection. The results can be considered robust because we followed up on the online data collection among underrepresented social groups and approached people proactively, giving them the choice of a telephone or personal interview. This netted 1600 complete questionnaires, enough to conduct data analysis using various statistical methods.

Based on the demographic section of the questionnaire, quotas were calculated for missing or underrepresented social groups according to the conducted sampling. Following this, a team of interviewers spent 5 days in each region collecting empirical data. As part of this data collection the team collected another 369 completed questionnaires. The total number of completed questionnaires was 1601 (Table 1).

The raw data were weighted according to population data published by ÖSTAT. The basis for weighting is shown in Table 2.

In Freistadt men (50%) and women (50%) were represented equally. Respondents ages 45–64 were the most represented group (37%), followed by people ages 65–84 (17%), 35–44 (16%), 25–34 (16%), and 20–24 (8%). People ages 18–19 (3%) and older than 84 (3%) were least represented.

Just as in Freistadt, in Amstetten the representation of men (50%) and women (50%) was equal. Respondents ages 45–64 were most represented (36%), followed by those ages 65–84 (18%). People ages 35–44 (16%) and 25–34 (16%) were less represented. People ages 20–24 (8%), 18–19 (3%), and older than 84 (3%) were least represented.

4. Results and discussion

Our results focus on awareness of climate change and targets of energy and climate policies, perceptions and attitudes regarding energy policy for the decarbonization of the energy sector, and willingness to engage in decision-making processes.

4.1. Awareness of climate change and goals of energy and climate security policies

4.1.1. General awareness of climate change and renewable energies

Inhabitants of both regions are well aware of the climate change happening now and its impacts. For instance, 96% of respondents in Amstetten and Freistadt believe that climate change is happening. Although the majority of respondents believe that climate change is real, their understanding of its causes varies by sex, age, household size, and occupation. For example, most respondents (78% of all respondents) indicate that climate change is caused by human activity; only 18% believe that climate change is caused by natural fluctuations in climate. However, farmers seem less convinced that climate change is caused more by human activity than by natural variability in the climate. Farmers' perceptions of the causes of climate change closely mirror those of unemployed respondents, who unequivocally indicate that climate change is a result of natural variability instead of anthropogenic activity.

In general, RES enjoy high levels of support among inhabitants of Freistadt (Fig. 1) and Amstetten (Fig. 2). Being aware of climate change, the majority of inhabitants support the mitigation of climate change, such as the use of RES or energy efficiency, and the majority of inhabitants are completely against nuclear energy. For instance, 61% of respondents in the CEM regions support the use of RES to mitigate climate change, 54% are in favor of increasing efficiency in the production and storage of energy, 51% support a reduction in energy needs, and 46% support limiting emissions from existing power stations. An

Table 1
Number of collected questionnaires.

Modality	Amstetten	Freistadt	Total
Via mail	354	316	670
Via Web	240	322	562
Face to face	207	162	369
Total	801	800	1601

Table 2
The Freistadt and Amstetten climate and energy model regions.

Freistadt			Amstetten		
	Number of inhabitants	%		Number of inhabitants	%
Freistadt	7703	12	Allhartsberg	2110	4
Grünbach	1887	3	Aschbach-Markt	3757	6
Gutau	2719	4	Behamberg	3295	4
Hagenberg im Mühlkreis	2727	4	Biberbach	2253	4
Hirschbach im Mühlkreis	1149	2	Ertl	1263	2
Kaltenberg	630	1	Euratsfeld	2599	4
Kefermarkt	2082	3	Ferschnitz	1718	3
Königswiesen	3190	5	Haidershofen	3611	6
Lasberg	2760	1	Hollenstein an der Ybbs	1693	3
Leopoldschlag	1058	1	Kematen an der Ybbs	2619	4
Liebenau	1633	3	Neuhofen an der Ybbs	2920	5
Neumarkt im Mühlkreis	3145	5	Opponitz	972	2
Pierbach	1000	2	Seitenstetten	3346	6
Pregarten	5234	8	Sonntagberg	3824	7
Rainbach im Mühlkreis	2948	4	St. Georgen am Reith	599	1
Sandl	1400	2	St. Peter in der Au	5099	9
St. Leonhard bei Freistadt	1365	2	Weistrach	2198	4
St. Oswald bei Freistadt	2874	4	Ybbsitz	3498	6
Schönau im Mühlkreis	1952	3	Wadhofen/Ybbs	11,366	19
Tragwein	3058	5			
Unterweißenbach	2224	3			
Unterweitersdorf	2059	3			
Waldburg	1351	2			
Wartberg ob der Aist	4210	6			
Weitersfelden	1039	2			
Windhaag bei Freistadt	1590	2			
Bad Zell	2867	4			

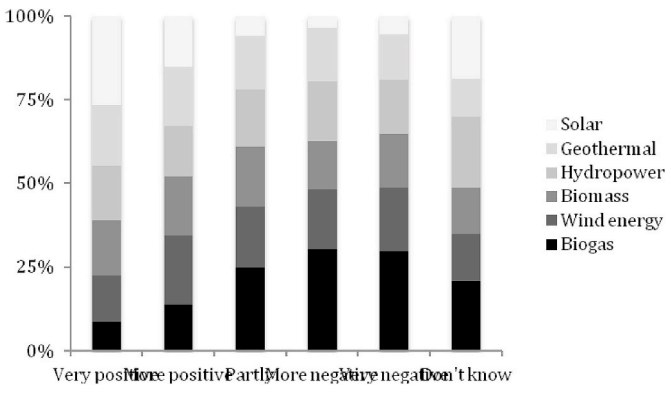

Fig. 1. Support for renewable energy sources in Freistadt.

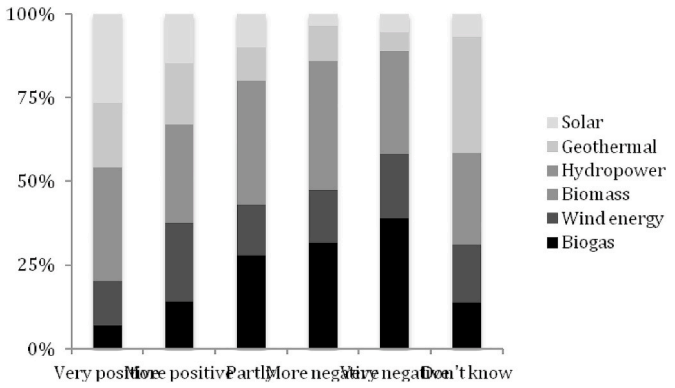

Fig. 2. Support for renewable energy sources in Amstetten.

overwhelming 75% of respondents in both Amstetten and Freistadt reject nuclear energy as a potential energy source.

Of the different RES technologies, solar energy is the most popular, supported by respondents in both regions. More than 60% of all respondents in Freistadt and Amstetten have in general a very positive attitude toward solar power. The next most popular source of energy in both regions is geothermal, followed by biomass and wind energy. Biogas is the least popular source of energy, with less than 20% of inhabitants in Freistadt and Amstetten having a very positive attitude toward it. More than 14% of respondents in Amstetten and more than 10% in Freistadt have a very negative attitude toward biogas (Figs. 1 and 2).

Factors such as the visibility of the renewable energy infrastructure and the aesthetics of the landscape, which have sparked severe protests elsewhere, are not polarizing in Freistadt and Amstetten. The majority of people do not have strong opinions about this. Many people even expect positive impacts on the landscape from renewable energies (Fig. 3).

4.1.2. Awareness of the CEM process and the decarbonization of energy generation

More than 60% of respondents are aware of measures aimed at using RES technologies in their local communities, and around 40% are unaware of these initiatives. The 40%, a sizeable number of residents (n = 727), are unaware that there are plans in their communities to provide a significant amount of energy from RES. This shows the differences in awareness of renewable energy technologies and energy policy targets for their use as well as the need for specially developed awareness-raising measures among certain groups of stakeholders or the use of alternative communication channels.

Despite being well informed about climate change and the need to mitigate it, as well as available options for mitigating climate change, inhabitants are less well informed about the implementation of these

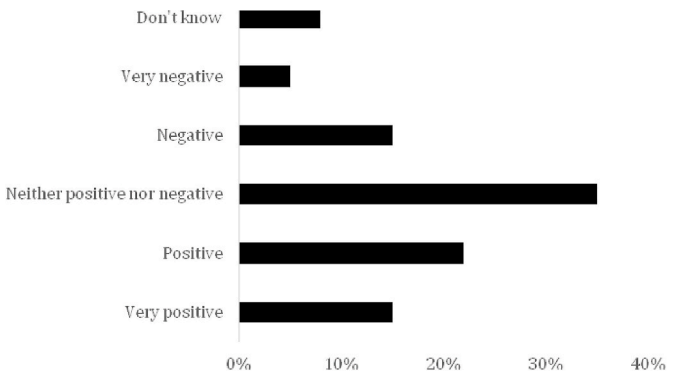

Fig. 3. Perceptions of the impacts of renewable energy sources on the aesthetics of the landscape.

options in the framework of the CEM process. We found that 36% of respondents do not know about the CEM regions initiative, and 46% have heard about the initiative but do not have sufficient information about its implementation. Only 17% of respondents confirm their knowledge of the CEM regions initiative. Awareness is higher in Freistadt than in Amstetten. Awareness also increases with age (Fig. 4).

Awareness of renewable energies and the goals of energy and climate security policies also increases with age. Awareness is highest among people older than 61. At the same time, almost half of people younger than 20 say they are not familiar with the CEM process (Fig. 5).

Pensioners and respondents ages 41–60 are the most informed group. Young people constitute the majority of uninformed respondents.

Education does not have significant influence on awareness. For example, 40% of people with a university degree are not familiar with the CEM process, and half of people with mandatory school education have heard about the CEM process (Fig. 6).

Middle-aged professionals have the highest awareness of the CEM regions initiative. Only 3% of youth know about the CEM regions, with more than 40% having heard about the initiative and more than 50% never having heard about it. Nearly half of all respondents are unaware that their community is participating in the CEM initiative. Although awareness of the CEM process is low, two thirds of inhabitants are aware of the fact that their region is in the process of deploying RES. Inhabitants of Freistadt are better informed about energy policy for the decarbonization of the energy sector than inhabitants of Amstetten.

People mainly receive information from such media as TV, newspapers, radio, and the Internet. All other sources of information, such as social media, friends or family, nongovernmental organizations, local authorities, and scientific publications, are used by significantly fewer people (Fig. 7).

Respondents receive information on regional energy transitions from a mixture of traditional and new media that includes the Internet, television, radio, and newspapers. The results show that education influences preferences for information sources. For example, respondents with university degrees receive some information on regional energy policy from scientific publications. Also, respondents with a university education use a variety of information sources rather than just a few. In contrast, respondents with primary and secondary education rely on limited sources of information about regional energy policy, with their information mainly coming from family and/or friends, private companies, and local nongovernmental organizations.

4.2. Willingness to use and pay for RES

4.2.1. Willingness to use RES

The current share of renewable energy generated by distributed generation units installed by private households or local communities such as associations, energy communities, or cooperatives is an indicator of willingness to use RES. Despite a high level of awareness of RES, more than one third of all respondents do not use energy generated by distributed generation units at all (33%). Inhabitants who do not explain this mostly by saying they are not able to do so because they rent an apartment or they do not have sufficient financial means to invest in RES. Of the respondents who use RES, 13% cover more than 75% of their household energy demand with RES, 11% cover 51–75% of their demand, and 19% cover up to 50% of their demand (Fig. 8). Inhabitants who use RES mainly use private solar power systems, including PV systems. Some also use public or common and collective PV systems in communities where such opportunities exist. For example, Helios in Freistadt allows for decentralized energy generation but also for the distribution of locally generated energy among community members.

Although the mitigation of climate change is the major driver of the use of RES (57% in Freistadt, 24% in Amstetten), energy security is an equally important driver (Fig. 9). This includes independence from fossil energies (52% in Freistadt, 20% in Amstetten), independence from energy providers (48% in Freistadt, 26% in Amstetten), use of local

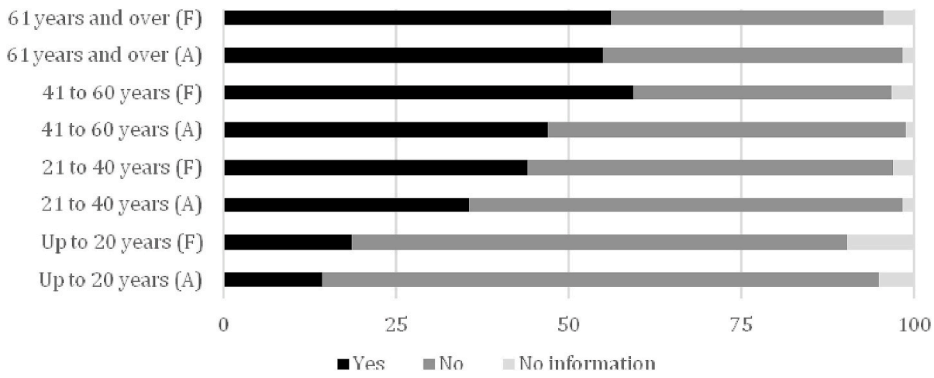

Fig. 4. Awareness of the local community's participation in the climate and energy model initiative. F = Freistadt, A = Amstetten.

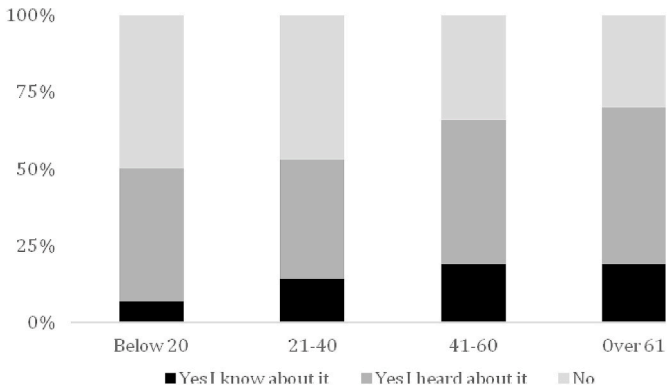

Fig. 5. Awareness of the Austrian climate and energy model process by age.

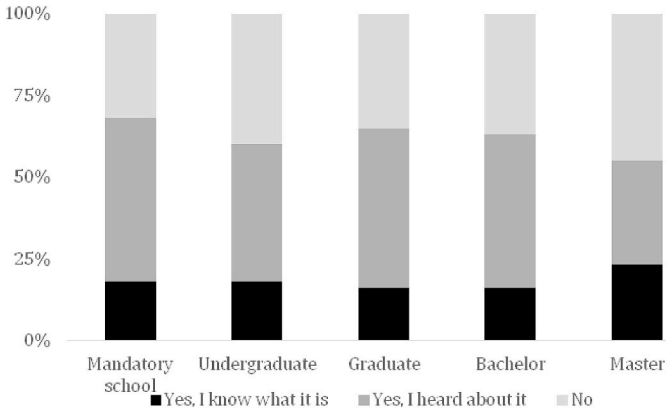

Fig. 6. Awareness of the Austrian climate and energy model process by education.

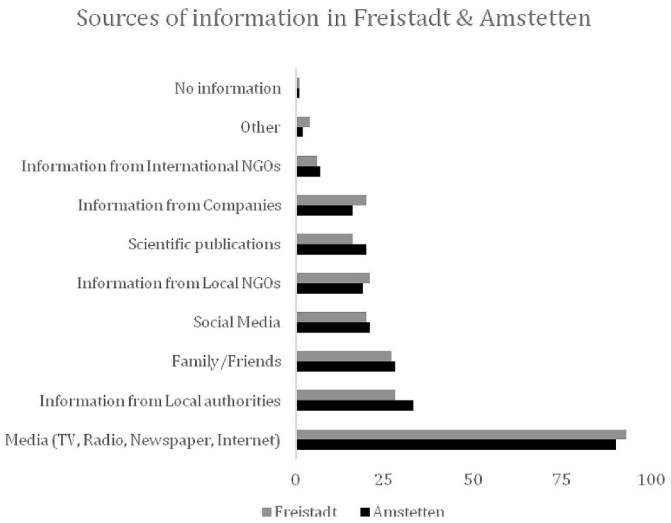

Fig. 7. Sources of information in Freistadt and Amstetten. NGO = nongovernmental organization.

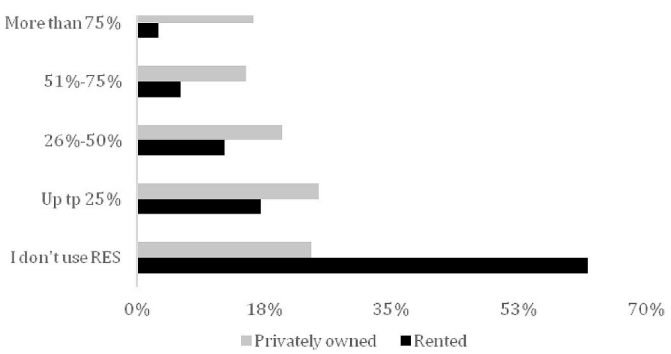

Fig. 8. What part of your household's energy is covered by renewable energy sources (RES)?.

resources (45% in Freistadt, 21% in Amstetten) and the potential to save money (44% in Freistadt, 32% in Amstetten).

These results show a stronger motivation to contribute to climate change mitigation among inhabitants of Freistadt than inhabitants of Amstetten. At the same time, among inhabitants of Amstetten motivations to use RES are driven more or less equally by concerns about climate change mitigation, energy security, and economic rationality.

4.2.2. *Willingness to pay for RES*

Respondents were asked how much they were willing to pay for renewable energy. Results suggest that most respondents are willing to pay up to 10% more if electricity is generated from renewable energy. However, there is large variation in results depending on education, occupation, size of household, and type of ownership.

Despite a high level of awareness of the need to mitigate climate change and overall positive perceptions of RES, almost one third of all respondents (26%) answer a clear "no" to the question about paying more for electricity from RES (Fig. 10).

The major reasons why people are not willing to pay more are that they cannot afford it (36% in Freistadt, 22% in Amstetten) and that they believe that paying more for RES is not worth it and RES should not be more expensive (17% in Freistadt, 27% in Amstetten). Others are concerned about existing RES technologies, saying that "technologies are

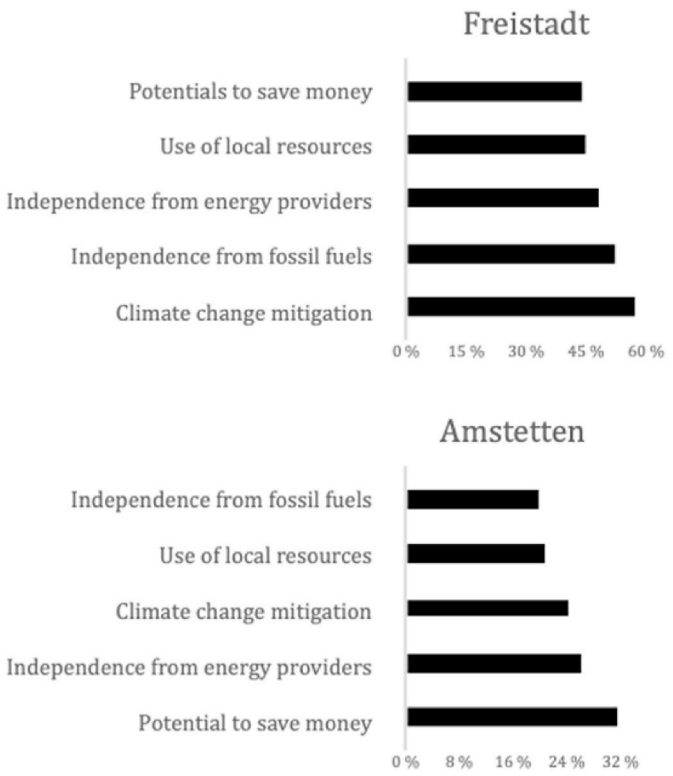

Fig. 9. Motivations to use renewable energy sources in Freistadt and Amstetten.

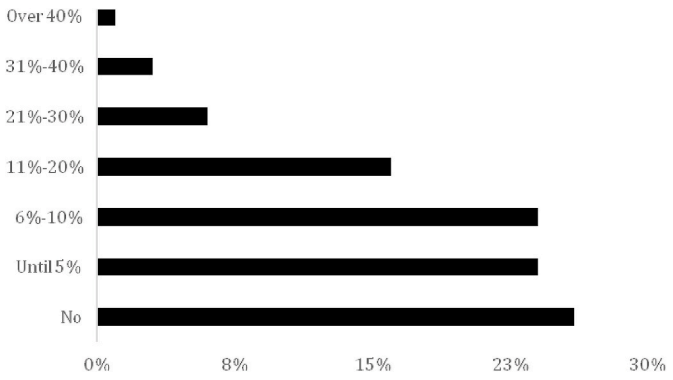

Fig. 10. Are you ready to pay more for electricity if it comes from renewable energy sources?.

still not mature enough and surely they will bring problems" (12% in Freistadt, 20% in Amstetten).

Our results show that willingness to pay for RES also depends on household size. Larger households, which are probably those with children, are willing to pay more for RES. The highest number of "no" answers for paying more for RES come from single-person households. Those who would agree to pay more are satisfied with a small price increase up to 5–10%. A minority (2% of all respondents) would agree to pay significantly more (more than 40%) for RES.

4.3. Willingness to participate in decision-making processes

Less than half of all respondents in Freistadt (46%) and Amstetten (44%) wish to participate in decision-making processes around the use of RES in their region.

Across all social groups (except the self-employed), participation in the process of selecting technology is the most desirable option. A significant share of all respondents would like to participate in decision making around the selection of RES technologies in their region. This is followed by the selection of a site for the project and definitions of needs and goals of energy policy. Significantly fewer people would like to participate in the planning of the project. Currently financing the project is the least preferred option (Fig. 11).

People who do not wish to participate in decision-making processes mainly feel this way because they think they do not have sufficient knowledge or time or they do not trust policymakers (Fig. 12).

The number of people who think that participating is not important or who have no interest in participating is really small. Also, the argument that the issue does not affect one personally is one of the least frequently chosen options.

5. Conclusions and policy implications

Respondents in this study are aware of climate change in general—for instance, that climate change is happening, that it is caused by human activity, and that it has specific impacts. This awareness is almost universal. However, there are different understandings of the causes of climate change. The majority of people think it is caused by human activity. Some people think it is caused by nature. Awareness of energy policy toward decarbonization and the large-scale use of RES in respondents' own communities is much lower. It also varies significantly by age, occupation, and education. Awareness of energy policy increases with age. People receive information mainly from TV, radio, newspapers, and the Internet. The influence of other sources, such as social media, is much lower. The tendency to use multiple sources of information increases with education.

Our results show a high level of awareness of the need to mitigate climate change; however, this decreases with peculiarities of the topic. For instance, more than 95% of respondents are aware of climate change and the need to mitigate it. But only 60% of respondents are aware of measures aimed at using renewable energy technologies in their local communities, and around 40% are unaware of this initiative. The 40% represents a sizeable number of residents ($n = 727$) who are not aware that their region is planning to cover a significant share of its energy needs with RES generated in the immediate community. Awareness also varies significantly by age, occupation, and education. This reveals the need for additional communication channels or awareness-raising campaigns tailored to particular stakeholder groups.

RES projects enjoy support and a positive image among inhabitants of both case study regions. The majority of people support the use of RES and other energy-efficient measures to mitigate climate change and reject nuclear power. Solar power enjoys the highest level of support among all RES. Geothermal, biomass, and wind are also supported. Solar energy technologies are the most popular RES technologies (supported by more than 60% of respondents), followed by hydropower and geothermal energy. Wind and biomass are less favored technologies, supported by fewer than 30% of all respondents. Biogas is the least preferred technology.

The majority of inhabitants support RES and think that RES will have positive effects at the global and national levels and also in their local communities. Overall, respondents indicate that the use of RES will have positive impacts on their lives, their localities, and their regions. Residents also believe that the use of renewable energy technologies will have positive effects not only on climate change mitigation in general but also on the environment in their community. This is connected with a perception of RES as less polluting than traditional fossil fuels.

Concerns identified in previous studies as factors negatively influencing attitudes toward RES, such as perceived impacts of RES on the aesthetics of the landscape, are not significant in either Amstetten or Freistadt. We did not identify any concerns that have previously created opposition to the large-scale deployment of RES, such as environmental impacts on local communities (Wolsink, 2010) or negative impacts on the aesthetics of the landscape (Wolsink, 2020a, 2020b). In fact, some

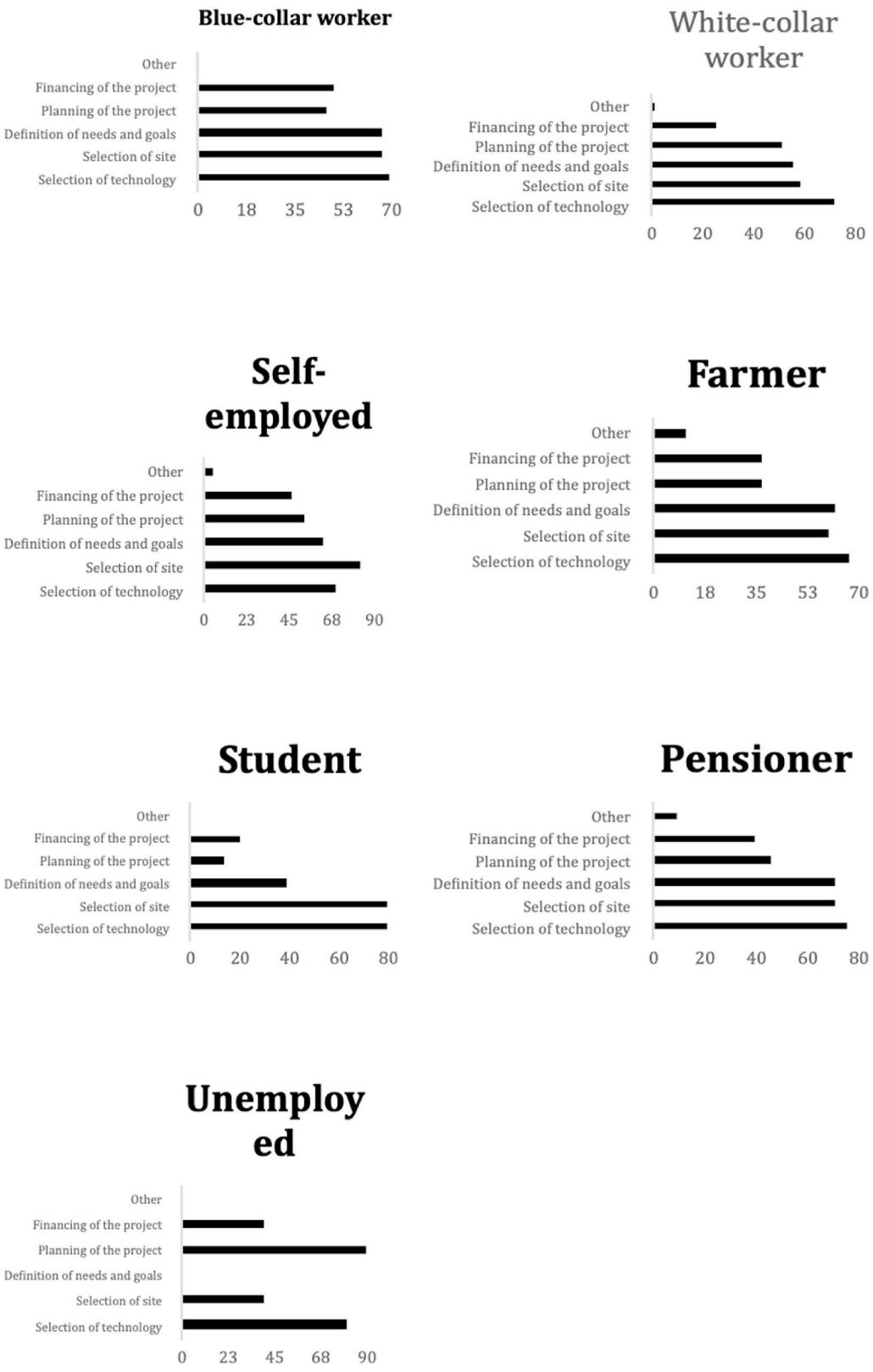

Fig. 11. Preferred means of participating in decision-making processes.

people even believe that RES will have positive impacts on the landscape, and more than 30% of people believe that RES will have positive impacts on their surrounding community. However, more than 60% of people are not sure what the impacts of RES will be on water, land, or biodiversity.

Blue-collar workers and unemployed respondents feel that the use of RES might create socioeconomic benefits for them and their community. This is connected with perceptions of job creation from investment in RES and the use of RES in projects (Del Río and Burguillo, 2008; Lehr et al., 2012). However, people are also concerned that large-scale use of

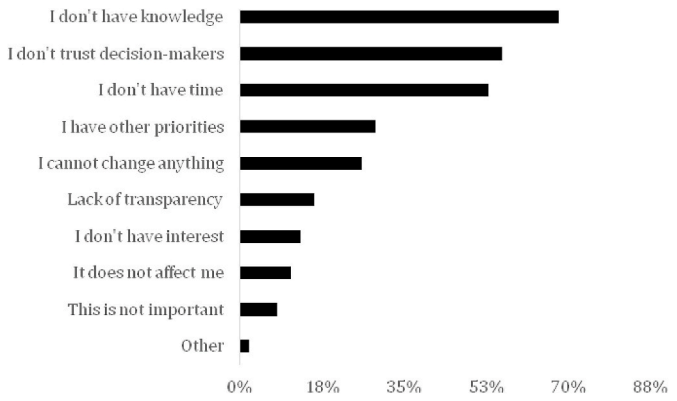

Fig. 12. Reasons for not taking part in decision-making processes.

RES might lead to an increase in levelized costs of electricity.

With regard to the willingness to use RES, the results show that people either do not use RES at all or use RES to cover a significant part of their energy demand. More than a third of all respondents currently do not use RES, mainly because of a lack of initial investment or because they live in rental apartments. People who use RES cover a significant part of their household energy demand with these technologies.

On average people are willing to pay 10% more for electricity if it comes from RES. The willingness to pay more depends on the size of the household and is higher in households with more people. The results for willingness to pay for RES among these inhabitants of Austria correlate with available evidence from other countries and regions. Case studies from other parts of Europe reveal a high willingness to pay among respondents with high family incomes or large households, mainly families with children. There is also a positive correlation between willingness to pay and education (Bigerna and Polinori, 2014; Zografakis et al., 2011).

One third of all respondents are not willing to pay more for electricity, even if it comes from RES. The majority of these households are single-person households. The major reason for this is that people cannot afford to pay more or believe that RES is not worth paying more for or that RES technology is not mature enough.

A comparison of responses from these two case study regions shows an impact of participatory governance measures such as energy groups. Awareness of energy policy is higher among inhabitants of Freistadt. Willingness to use RES is higher among inhabitants of Freistadt. Economic rationality is much stronger in Amstetten than in Freistadt. In Freistadt the motivation to use RES is mainly driven by concerns about climate change, whereas in Amstetten it is driven by the potential to save money and to be independent of energy providers. More people in Amstetten than in Freistadt think that it is not worth it to pay more for electricity from RES or that RES technologies are not mature enough and there will be problems managing them.

The availability of energy groups and participatory governance measures do not have a strong influence on the willingness of people to participate in decision-making processes. Results show that the number of people who would like to participate is only slightly higher in Freistadt than in Amstetten. The majority of those who would like to participate wish to be engaged in the process of selecting technology or selecting the site for a project. Participating in the financing of the project is the least desirable option. These results correlate with available scientific evidence that uncertainty regarding financing is a major factor influencing the willingness of laypeople to invest in RES projects (Frodel et al., 2010; Maryuama et al., 2007; Warren and McFadyen, 2010).

If people are not willing to participate in decision-making processes, it is mainly because they think they do not have adequate information or time. The number of people who think that participating is not important or not interesting is small. These results reveal the willingness of people to participate in decision-making processes; however, suitable conditions have to be created.

Based on our empirical findings, we provide the following recommendations for energy policy regarding awareness, willingness to use RES, and willingness to participate in decision-making processes. These recommendations consider the fact that both regions, Amstetten and Freistadt, actively support goals of climate and energy security policies and have set targets for the decarbonization of their energy sectors.

The first recommendation has to do with awareness of climate change and communication of the need to mitigate climate change. Previous research showed that a decade ago awareness of climate change and the role of human activity in it was lower than it is today; today such awareness is almost universal. However, awareness decreases when we speak about details of projects or policy measures. Therefore, we recommend the development of specially targeted information campaigns on particular projects and energy policies by media from which the majority of people receive information. Special information campaigns should target young people. Therefore, we recommend a shift from campaigns to raise awareness of climate change and the need for climate change mitigation to more specific campaigns related to local communities or the details of renewable energy projects being implemented in these communities. Also, these campaigns must be targeted to specific social groups. There is a need to understand further the role of emerging technologies, such as social media, in raising awareness of renewable energy projects.

The second recommendation has to do with the need for further research on how to turn a high level of awareness of the need for climate change mitigation into action, willingness to use RES, and willingness to participate in decision-making processes. For instance, further understanding is required on behavioral drivers and incentives among people who are currently less willing to use RES, such as renters or small households. Concerns about the impacts of RES on the cost of electricity, the maturity of the technology, and how to manage it have to be addressed. A further recommendation is that energy policy address behavioral drivers that will motivate active behavior, such as a willingness to use or pay for renewable energies. Such energy policy measures should go beyond raising awareness to stimulate behavioral changes and actions.

The third recommendation has to do with the availability of opportunities to engage in energy policy, such as through energy groups. These opportunities increase awareness and the willingness to use RES. They also increase the influence of behavioral drivers other than economic rationality. Given the public's willingness to participate in decision making, conditions should be created to facilitate such participation. These conditions should include the availability of information on not only general impacts of climate change but also energy policy in specific regions. Further methods should be developed to facilitate participation that is not time consuming. Various methods of electronic governance might be an option here.

CRediT authorship contribution statement

Nadejda Komendantova: Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Sonata Neumueller:** Formal analysis, Data curation, Writing – original draft, Writing – review & editing. **Elvis Nkoana:** Formal analysis, Data curation, Writing – original draft, Writing – review & editing.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Supplementary data

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