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Research article

Studying young people' views on deployment of renewable energy sources in Iran through the lenses of Social Cognitive Theory

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Abstract: Renewable energy sources (RES) have potentials to address goals of climate change mitigation at the global level. Iran has abundant RES potentials and investment into renewable energy sources can contribute to its socio-economic development and to diversification of its energy mix. Economic and technical capacities but also human factors, such as stakeholders' views, public and social acceptance, as well as willingness to use RES, willingness to pay for their deployment and to participate in decision-making processes on energy transition, are crucial factors for deployment of RES at scale. These human factors impact development and implementation of energy transition at the national and local governance levels. Deployment of new technology and energy transition can lead to conflicting views, believes and risks perceptions among involved stakeholders but also among people affected by deployment of new technology infrastructure deployment. To be sustainable and acceptable by all social groups, such process should be based on understanding of positions of different stakeholders and development of compromise solutions. It is crucial to understand the views of young people on deployment of RES as young people represent a significant share of population and are future decision makers. Their support and willingness to use RES will be a significant driver for RES deployment in short and medium term. Based on socio cognitive theory this paper examines the patters of behavior of young adults in relation to energy use. The results show positive influence of self-rewarding to encourage young adults to participate in energy transition. Another important driver is expectation of social outcome, which involves existing social norms in the community. Trust to the source of information is

another important driver and the level of information about RES has an important influence on the willingness to use them.

Keywords: renewable energy sources; human factors of energy transition; energy policy in Iran; young people

1. Introduction

Production and consumption of energy in today's world is a very complex issue requiring nexus and coordination of several policies. At one side, economic and social development policies require an increased level of energy generation to cover growing worldwide energy need [1]. At another side, environment protection policies are pointing out to the relation between energy consumption and environmental degradation. The climate change mitigation policies also require a significant reduction of greenhouse gas emissions from energy generation [2]. The energy security policies are speaking about possible depletion of fossil fuel resources and volatility of energy prices [3].

There are several options to address goals of the above-mentioned policies or at least some of them, which include such alternatives as conservation of energy, technical efficiency, transition toward renewable energy or deployment of low carbon technologies such as nuclear energy or carbon capture and storage. Deployment of renewable energies is often recognized as a viable option to meet goals of climate and energy security policies and as a backbone of any transition to decarbonized energy system. Even though the demand for green energy is emerging across all energy sectors and energy policies of several countries established priorities to increase and to speed up deployment of renewable energy, until now renewable energy constitutes only a small share of the global energy supply, which, however, is growing steadily. Energy transition is an actual challenge for Iran, taken into consideration the available potentials for renewable energy generation as well as the willingness of energy policy stakeholders to diversify the currently existing in Iran energy mix.

Existing evidence suggests that besides technical and economic capacities also positive attitudes from different stakeholders and their support of renewable energies is really crucial for their deployment. The lack of community acceptance and of willingness to use RES can become a major barrier for diffusion of renewable energies. Perceptions of different stakeholders involved into energy transition of the renewable energies are extremely important as they are shaping how technology will be embedded in society. In the environment where positive attitudes and motives for acceptance and the use of renewable energies are absent, even the most ambitious energy policies for deployment of renewable energies might not work. Komendantova and Yazdanpanah [3] argued that if the aim of energy transition interventions is to reduce negative environmental impacts caused by households' energy consumption patterns, it is necessary to consider individual's perceptions, preferences and abilities and the context in which decisions are taken. This means that any policy intervention on changing households' consumption patterns should consider interaction between psychological, cognitive, and structural antecedents. Scientific evidence shows that a wide variety of factors, such as physiological, cognitive and environmental factors, determine whether or not individuals engage into energy transition.

To our knowledge, evidence on attitudes of young people towards deployment of renewable energies in Iran is missing. As energy transition is a long-term process we suppose that today's young

adults will play a crucial role during the entire process of energy transition and will shape acceptance of communities towards renewable energy. Young adults are important stakeholders because they are the future decision-makers deciding on all aspects of society including energy issues and their positive attitude toward RES, in general, have great policy relevance and are significant. Therefore, the aim of this study is to understand young adults' intention and their willingness to use renewable energy. Based on our results and understand of attitudes of young people, we aim to develop recommendations for energy transition process in Iran.

The novelty of this study is in its in-depth research of human factors in relation to a particular group of stakeholders in Iran. We choose Iran, because this country is especially interesting for research of human factors of energy transition. The country has abundant fossil fuel reserves; it also has high-energy consumption per capita and still it is considering deployment of renewable energy sources. Therefore, human factors of energy transition should include a strong will for switch from one source to another one. This will is probably driven by others then energy security concerns.

Indeed, despite the fact that the majority of existing in energy field scientific works is focused on technical and economic factors, the numbers of works on social factors is growing. Several of these works showed a need to deal particularly with the young stakeholders as their concerns and views on energy transition are different in comparison to other social groups. The scientific works dealing with views and opinions of young people on energy transition are rare and for Iran are almost not existent. Therefore, our research contributes to the new body of knowledge by addressing concerns of young people on a particularly actual for energy transition topic of deployment of renewable energy sources.

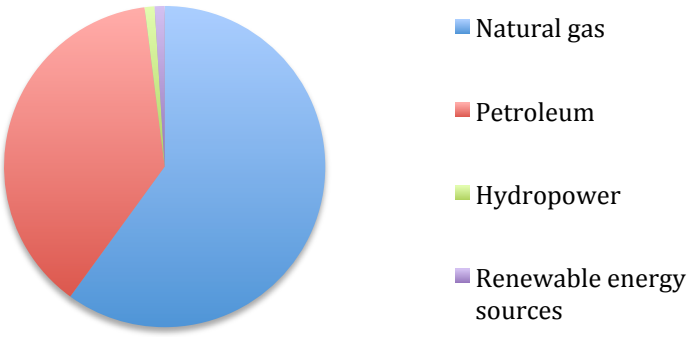
2. Background

2.1. Energy transition in Iran

The energy transition in Iran is driven by two factors. The first one is Iran being an energy superpower due to abundance of its oil and gas reserves. The second one is the high level of fossil fuels consumption, which currently represents one of the major challenges for energy transition in Iran [7,8]. Iran is the third largest consumer of natural gas in the world and its domestic consumption continues to increase at the rate of 7% per year by making Iran the largest natural gas consumer in the world in a near future [4].

Iran has rich reserves of renewable energies such as wind and solar [8]. It would have potentials to generate from 20 GW to 30 GW of wind power and with more than 300 sunny days and 2,200 kWh of solar irradiance per square meter potentials for solar are also very high [6].

But currently the share of renewable energy sources in the energy generation mix of Iran is very low [7]. The Figure 1 shows that the biggest share of energy demand in Iran is covered by natural gas and petroleum. Other energy sources such as hydro or renewable energy sources are making together 2%, despite favorable geographic conditions and availability of renewable energy sources.



Source: author, based on the BP Statistical review of world energy, 2014.

Figure 1. Iran's total primary energy consumption in the year 2013 (renewable energy sources include also hydro).

Recognizing these challenges, the government of Iran settled the policy with the direction of transition from fossil fuels consumption to diversification of energy mix with energy sources such as renewable energies including biomass, solar thermal and photovoltaic, wind and hydropower. The government settled a target to deploy 2 GW of additional renewable energy capacity by the year 2015, which was not reached so far. It also created capacities for implementation of this target, namely, allocated 500 million Euros to the National Development Fund for support of renewable energy projects and established a state-sponsored Renewable Energy Organization of Iran (SUNA) [5].

Much was written on economic and technical feasibility of deployment of renewable energies in Iran [7–10]. However, little evidence exists about human factors and their role in energy transition. This evidence is especially important for local level of governance. Even though development of energy transition can happen at the national governance level, its implementation requires understanding and consideration of human factors especially at the local level, which can be drivers of energy transition. Stakeholders such as project developers, local politicians, financing community and others, will be implementing the technology through projects deployment, and private households, industries and other stakeholders will be using this technology. Understanding of the existing level of support towards renewable energy projects at the local level is also crucial as it may vary broadly, from public acceptance, as a passive attitude towards renewable energy infrastructure being located in the vicinity of affected communities, towards willingness to use renewable energies or willingness to pay for their deployment.

The need to take care of human factors for successful implementation of energy transition was already highlighted at the end of the 20th century. Wieser et al. [11] speaks about three crucial components for implementation of energy transition, when exclusion of even one of these components can lead to less successful outcomes. Human factors such as public acceptance and consumers' voluntary renewable energy purchases are among these components. Understanding of human behavior is also essential when we speak about deployment of new technology, which was also highlighted at the recent International Panel of Climate Change report [12], giving social sciences an important role in understanding of human and behaviors factors of energy and climate policy [13].

In fact, the deployment of any technological innovation, such as renewable energy technologies, cannot be a purely rational process. It might be settled in a top-down manner by policy-makers, but its

implementation would still involve conflicting values, beliefs, views and social interactions which will affect the process of implementation of energy transition targets [17]. It can be assumed by policy-makers that development of energy transition is a primary target where experts and scientists are major stakeholders. However, attitudes of stakeholders on the ground towards implementation of energy transition targets changed significantly during the last fifty years, at least in Europe making them important stakeholders also [15]. Even though today people still might perceive deployment of technological innovation as a benefit changing the quality of life, their attitude towards this innovation changed. Nowadays people expect to participate in the implementation of new technology, especially if it affects communities where they live, and their attitudes may vary from active protests and conflicts around new generation and transmission capacities to the lack of willingness to invest into new technological projects or the lack of willingness to use this technology in everyday life.

2.2. Theories addressing human and behavioral factors of energy transition

Social Cognitive Theory (SCT), introduced by Bandura [16] is based on a psycho-social model, which exams socio-cognitive constructs of behavior. Over the last thirty years SCT was a predominant theory for understanding human behavior. SCT explains how people acquire and maintain certain behavioral patterns, for example, energy consumption. The model was developed to promote healthy behavior and disease prevention measures. It was originally developed in social psychology, as a mean for understanding consumer behavior, taken into reference especially cognitive factors influencing individuals' behaviors [16]. It was also used in marketing research to understand factors influencing sustainable consumption. Until today SCT has been used to understand a range of behaviors in different domain, which are mainly in health domain such, as inactivity and obesity, physical activity behavior [18,19] smoking behavior [20], prescription drug advertising [21], safety and health behavior [22], nutrition intervention [23] and other fields such as internet use [24], web based learning [25], sustainable consumption [26].

SCT defines human behavior within the interaction of personal, behavioral and environmental factors which influence it [21]. These are believes about abilities for certain types of behavior to go beyond challenges and deficits influencing it.

Personal factors consist of knowledge, perceived self-efficacy and outcome expectations related to the behavior adoption. It is important to note that in SCT the cognitive factors, such as outcome expectations and self-efficacy, are important determinants of intention according to SCT [16]. Bandura [16] claims that judgments of individuals about costs and benefits also have important influence. Here we are describing personal factors in detail:

- Knowledge: Knowledge of health risks and benefits creates the precondition for change. If people lack knowledge about how their lifestyle habits affect their health, they have little reason to put themselves through the travail of changing the detrimental habits they enjoy. Knowledge also provides a basis for self-evaluative reactions.
- Self-efficacy: As the action required to attain designated types of performances, self-efficacy is concerned with beliefs of what extend one can carry out an action required to deal with prospective situations [21]. In other words, if person believes that he or she has power to enact a change, he or she will try to do it. In our study, self-efficacy is defined as a perceived ability to overcome barriers to use renewable energy. Researches revealed that self-efficacy is the most important prerequisite to change behavior and is also a mediator between cognition and an

individual's behavior [21]. With regards to renewable energy, an individual's self-efficacy believe regarding own ability to use renewable energy may influence the willingness to use this type of renewable energy technology.

- Outcome expectations: They are anticipated consequences of behavior. They represent a relative value that an individual has about outcomes [18]. As such, if a person feels that an action has results for a favorable outcome, he will probably perform such action more regularly. Outcome expectation judgments are important drivers of behavior as people always intend to perform actions, which are rewarded by an incentive. For example, the belief about "effects of renewable energy on environment" is a belief about the effects from using renewable energy on environment, which is seen through the lens of values of "environmentalism". In the case of renewable energy, consumers' believes regarding the outcomes from using this sort of energy may influence their intention toward it. Expectations about outcome expectations can be operationalized regarding positive and negative aspects of renewable energy.

Behavioral factors include proximal and distal goals while environmental factors include barriers and support. Behavioral factor, such as attainable goals, also influence change in behavior. Young [21] argued that it is an individual's intention and plan to carry out behavior in future.

Environmental factors in SCT are social support and barriers, which can influence behavior. Social support refers to extent that helps to facilitate and influence an individual's engagement in a specific behavior. Barriers include personal, social and structural. They directly measure effects of different impediments to engaging in the desired behavior. The greater the number of barriers or impediments to change is, the less likely it is that individuals will engage in a certain behavior.

2.3. Research question

To our knowledge, no research based on SCT was conducted to understand the intention and willingness to use renewable energies. Why is it important to use SCT to understand willingness to use renewable energies? The theory itself received very limited attention within energy field. Here we would like to bring two known to us examples of the application of SCT.

One study, based on SCT, investigated willingness to use energy conservation measures. Besides of this, no other studies were conducted in energy domain, to our knowledge. However, scientists [28] used the theory for investigating farmers' water conservation behavior. They found that farmers' intention was mainly predicted by self-efficacy and outcome expectancy, while other variables were not significant in the prediction of intention. Interestingly, self-efficacy was the most significant predictor of intention.

Therefore, we formulate two research questions. The first one is, if SCT is a suitable methodology to understand human factors as energy transition drivers, which impact willingness to use renewable energies in Iran? The second one is, by applying the SCT on example of concrete social group, what are the factors, which shape concerns and views of young adults in Iran regarding energy transition and deployment of renewable energy sources?

We believed that SCT can be a novel and useful starting tool to understand willingness to use renewable energies, in general, and energy transition in Iran, in particular. In frames of this research we examine whether SCT can be used to predict intension of young adults to use renewable energy. We also

develop a framework, which can provide recommendations for energy transition and to guide future research in renewable energy filed.

3. Methodology

3.1. Cross-sectoral survey

The data were collected with the help of large-scale survey, which was based on a specially developed for this goal questionnaire. The questionnaire was developed on the basis of literature review of SCT variables. The measurements of constructs follow closely constructs used in the past studies. For instance, we apply a 5-part scale for all variables in order to reduce statistical problem of extreme skewness. Before the large-scale survey, the validity of the questionnaire was approved by a panel of experts and was pre-tested in a pilot study with 30 students.

The questionnaires were filled with the help of face-to-face interviews during autumn of 2013. The interviewers who filled the questionnaire were natives from the research area. The interviews lasted for 30–40 minutes and potential respondents were first assured that they did not have to participate and that, if they did, they should not feel compelled to answer any questions about which they felt uncomfortable. No payments were made to the interviewees.

The study sample consisted of students from the University of Esfahan, which is located in the middle of Iran. The sample consisted of 260 students who were selected through a random sampling. Descriptive analysis of the data revealed the following about the sample population. The age of the participants ranged from 18 to 35 with a mean value of 22.5 years (Sd. = 2.42). The sample consisted of 176 males and 84 females. There were 247 urban and 13 rural students.

We are aware that there are certain limitations connected with our selection of sampling for the survey. However, as we target a very specific group of stakeholders we believe that our target sampling is sufficient to make conclusions about the factors which shape young people' views and concerns about deployment of renewable energy sources. The aim of our sampling was to capture unbiased and representative sample of target population, such as young people. As methodological literature in social science tells it is usually impossible to survey all members of a given population, and so a subset or sampling is chosen. Statistical methods make it possible to infer the opinions of the population at large from the answers provided by the sample. The larger the sample is, the greater the precision with which the opinions of the population can be inferred. The published in social science works show that it is possible to make robust inferences with the sample sizes about 200 respondents.

3.2. Data analysis

The Cronbach alpha reliability coefficients of this pilot study were used to refine the questions for the final questionnaire. These coefficients indicated good-to-excellent reliability across all scales; generally 0.6 to 0.9. The following are examples of survey items contained in the renewable energy questionnaire.

The data analysis to test the hypotheses was done by means of structural equation modeling (SEM) using AMOS 20. In SEM, the measurement model is a confirmatory factor analysis (CFA) model and the theoretical constructs are latent factors extracted from the manifest variables. It is important to make sure that the measures, which were theoretically argued to be indicators of each construct, were

acceptably uni-dimensional. The next step was to perform a confirmatory factor analysis of SCT variables to confirm the measurement scale properties. It is desirable that constructs exhibit estimates of 0.50 or larger, because estimates less than 0.50 indicate that variance due to measurement error is larger than variance captured by the factor.

The construct validity of the research instrument was assessed via CFA. To perform a CFA, all constructs and reflective indicators were depicted and composed as a measurement model, in which they were allowed to correlate with each other.

The process of validation comprised the steps described below. First, the measurement model was tested for the goodness of fit of all empirical data to meet the requirements of certain indexes. For example, chi-square normalized by degrees of freedom (λ/df) should be less than five; adjusted goodness-of-fit index (AGFI) should be larger then 0.8, goodness-of-fit index (GFI), normed fit index (NFI) and comparative fit index (CFI) should all exceed 0.9, and root mean square error (RMSEA) should be less than 0.10.

Table 1 presents all of the fit indices for the study CFA models. It suggests an adequate model fit for the empirical data. In sum, the indices indicate that the model, which is a representation of the SCT, can be accepted from an empirical point of view.

Table 1. Models' evaluation overall fit measurements.

Models	χ^2/df	GFI	AGFI	NFI	CFI	RMSE
SCT	434/174 = 2.5	0.90	0.90	0.91	0.93	0.076

Furthermore, it is important to say that the x2-statistic generally was significant in our models. Usually the x2-statistic is affected by sample size, which is quite large in this study (N = 260). The large sample size shows significant x2. In the next step, SCT was tested consecutively. The results of SEM revealed that the standardized path coefficients indicated strong relationships between the variables.

4. Results

4.1. Applicability of the SCT model

Our results showed that the SCT model is suitable for analysis of the human factors in energy transition. The fit statistics support the SCT's criterion validity and explanatory power (Table 2). Our results also showed that efficacy of the model is even higher in comparison to other existing models such as Theory of Planned Behavior (TPB) and Health Beliefs Model (HBM), as TPB can only predict 39%–46% of intention and HBM can predict only 33% of intension, the SCT can predict 59% of variance intention towards using renewable energy (Figure 2).

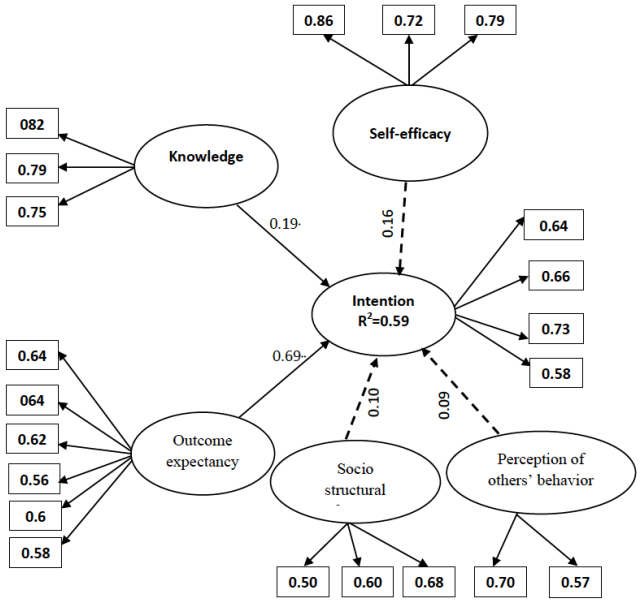


Figure 2. Structural equations modeling and path coefficients between variables.

The application of SCT showed that the behavioral goals of an individual are primarily determined by expectations about outcome and evaluations of self-efficacy. The Pearson correlation analysis (Table 2) showed a clear dependency between these two variables with coefficient 0.51 for correlation between behavior goals and outcome expectancy as well as with the coefficient 0.28 for correlation between behavior goals and self-efficacy. Coefficients for other variables, such as perceptions of others' behavior, socio-structural factors or knowledge were significantly lower.

Table 2. Pearson correlation test between all variables.

	Outcome expectancy	Perception of others' behavior	Self-efficacy	Socio structural factors	Knowledge	Behavior Goal
Outcome expectancy	1					
Perception of others' behavior	0.099 (0.055)	1				
Self-efficacy	0.11 (0.084)	−0.15 (0.016)	1			
Socio structural factors	0.31 (0.0001)	−0.27* (0.0001)	0.055 (0.37)	1		
Knowledge	0.12 (0.52)	−0.070 (0.26)	0.47 (0.0001)	0.11 (0.076)	1	
Behavior goals	0.51 (0.0001)	0.12 (0.045)	0.28 (0.0001)	0.20* (0.001)	0.11 (0.072)	1

: $p < 0.01$;: $p < 0.05$.

Our results based on the application of the SCT model showed that the intension of young people to use renewable energy was mainly influenced by outcome expectancy and the level of knowledge (Figure 1). The results show that outcome expectancy ($\beta = 0.69$, $p < 0.0001$) and knowledge ($\beta = 0.19$, $p < 0.045$) had a positive relationship with intentions to use renewable energy. Paths from other variables, such as socio-cultural factors, self-efficacy, perceptions of others' behavior and behavior goals were not significant.

Interestingly, we found that self-efficacy was not a significant predictor of intention to use renewable energy. According to available in literature evidence, outcome expectancy consists of three sub-components: i) Expected self-evaluative outcomes; ii) expected positive/negative outcomes; iii) expected social outcomes (see Yazdanpanah et al., 2015). This finding revealed that these sub components are very important. These components have a focus on attitudes, internal norms and references groups. Our results also showed that the level of knowledge has a direct effect on intention toward renewable energy.

5. Conclusions and policy recommendations

This study had two research questions. The first one was to understand the efficacy of the SCT and its application to the analysis of human factors and deployment of renewable energy sources. The second one was to understand factors which affect intension of young people and future decision-makers to use renewable energy, and, based on this understanding, to develop recommendations to policy-making process about how these human factors can be addressed and can become drivers for deployment of renewable energy in Iran. Our study follows the arguments of previous research [29] which, based on historical data, argue that the development and deployment of renewable energy sources in Iran requires policies which go beyond economic challenges and also address related non-economic concerns.

Our results showed the efficacy of the SCT model. In comparison to other psychological models, such as Theory of Planned Behavior (TPB) and Health Beliefs Model (HBM), which were applied also for analysis of human factors in energy transition and addressed similar groups of stakeholders, the prediction power of the SCT was higher. While [2,3] found that TPB can predict 46% of intention and HBM can predict only 33% respectively, the explained variance in behavioral goals (intention) was higher (59%) in this study. In meta-analyses [30] found that the average explained variance of intention by application of the TPB was even lower and made 39%. This leads us to conclusion that currently SCT can be applied for analysis of human factors in energy transition and that this model is even more efficient in comparison to other ones.

According to our findings, outcome expectancy significantly predicted intention. Expected self-evaluative outcomes as a subcomponent of outcome expectancy have an important role and influences significantly the intension of stakeholders and the willingness to do actions. From a practical point of view, the present study provides a justification for using a self-evaluative outcomes dimension in renewable energy use. As such, it may be useful to consider positive, self-rewarding feelings in order to encourage individuals to engage into energy transition based on the deployment of renewable energy technologies. Expectations about positive or negative outcomes are also influencing significantly the willingness to use renewable energies. In order to increase the intension of young people to use renewable energies we need to understand how this group of stakeholders perceives positive and negative aspects of the usage of renewable energy. This would require additional research with the focus on this stakeholders group. The third sub-component, which influences perceptions of young people, is expectation of social

outcome. This involves not only existing social norms in the community but also sources of these norms. This sub-component shows that persons who are stronger influenced by community norms would be also more eager to use renewable energy, they would be also using them more intensively. This sub-component is also connected with trust to the source of information, such as teachers of young people, their friends, family or colleagues. Further research is necessary to understand what are the most trusted sources of information among young people and how do they perceive renewable energy and what are their major concerns.

These results provide an indication for the Iranian energy policy on further development of renewable energy sources sector in the country. Further measures are necessary to encourage participation of young people in energy transition and their willingness to use renewable energy sources. Measures in the mass media and other sources of communication are needed to influence social and moral norms about using renewable energy sources. Also measures are needed to stimulate self-rewarding feeling of young people.

Our results correlate with existing literature on concerns about deployment of renewable energies infrastructure. Also in other parts of the world the availability of correct, clear and transparent information about the need of renewable energies as well as about the details of the project are key components for social and public acceptance [31]. However, this is only the first step towards participatory governance and involvement of young people into decision-making processes on energy transition. Indeed, measures are necessary to raise awareness of people about climate change mitigation and deployment of renewable energy sources however also further measures can be proposed to facilitate engagement of these people into decision-making processes and creation of opportunity for involving local knowledge and expertise [32].

Our results have implications for energy transition as they show that the level of knowledge about renewable energy has impact on the willingness to use these technologies. Therefore, it is crucial for policy-making process to developed targeted awareness raising and information campaign to address concerns of particularly young people and to provide them with additional information about benefits of usage of RE as well as other related to renewable energy development issues.

Conflict of interest

The author declares no conflict of interest.

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