



GRECO

MOBILISING AND LEARNING TOGETHER FOR RENEWABLE ENERGIES

**LESSONS FROM DIALOGUES
IN BRAZIL, BULGARIA,
GERMANY, PORTUGAL,
SPAIN AND THE UK.**



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EXECUTIVE SUMMARY

Science, technology and innovation play a major role in shaping our societies. Therefore, research teams must address societal challenges by reaching out beyond their own communities, gathering everyone “around one table”. One way to do this is by organising dialogue events, called “Mobilisation and Mutual Learning” (MML). The GRECO project has performed six MMLs in different countries to discuss the main expectations, fears, concerns and priorities in solar energy. This report summarises the activities undertaken and the results from the discussions.

GLOSSARY - ABBREVIATIONS

CSO Civil Society Organisation

ED Education

GOV Government

I&B Industry & Business

MML Mobilisation and Mutual Learning

PA Public Administration

PV Photovoltaics

RE Research

R&D Research and Development

TABLE OF CONTENTS

INTRODUCTION	4
WHY MOBILISING AND MUTUAL LEARNING?	4
MOBILISATION AND MUTUAL LEARNING ACTIVITIES IN GRECO	6
OBJECTIVES	6
ORGANISATION	8
WHO PARTICIPATED?	12
OVERALL RESULTS OF ACTIVITIES – WHAT WE HAVE LEARNED	14
Concerns, fears and who should be responsible	15
- Spain	16
- United Kingdom	26
- Bulgaria	32
- Germany	36
- Portugal	44
- Brazil	48
What is important for the next generation PV technology?	50
CONCLUSION	58



INTRODUCTION

WHY MUTUAL LEARNING?

Research and innovation has a predominantly hierarchical structure – scientists assume what end-users need and want without really asking them. However, academic institutions or corporations should not make a one-sided decision for the whole of society. This involves seeking out new ways for various sectors of society to actively take part in the research process and acknowledging people's social needs with regard to next-generation technology. Research teams must address societal challenges by reaching out beyond their own communities to discuss research and innovation, engaging everyone «around one table».

Mobilisation and Mutual Learning activities (MMLs) aim at making research and innovation socially responsible and involving the public. It allows both sides to share their expectations and to raise their concerns. Thus, all stakeholders get involved, stepping outside their comfort zones and facing challenges from many different perspectives.



MOBILISATION AND MUTUAL LEARNING ACTIVITIES IN GR

OBJECTIVES

Our key objective was to find out how research and development may collaborate with different sectors of society to help introduce photovoltaics on a large scale. We divided this complex topic into three sub-objectives:

- **How can different stakeholders actively take part in the energy transition?**
- **How could photovoltaic energy have a greater presence in the daily life of citizens?**
- **From a social point of view, what would the next generation of PV products require?**

During the events, the MML organisers and moderators were allowed to address either one or all questions or they could simply let the participants' interest lead the way.

ORGANISATION

We organised six MMLs in different countries, as shown in the map. The events had different formats, such as the World café or focus groups. After each event, the organisers asked the participants to voluntarily fill in a questionnaire. This report is based on the responses that we got.

The MML activities around the world

Portugal

Local Organizer: University of Évora

Activity: World Café

Participants: 30

Focus:

- Integration of PV energy in the daily life
- PV designs
- Exploration or Encouragement of applications
- Expectation for PV energy capabilities
- Ways for active participation of citizens

Brazil

Local Organizer: IEE-University of Sao Paulo and ABSOLAR

Activity: Focus group webinar

Participants: 15

Focus:

- PV Industry, policies and need of collaboration with academia

United Kingdom

Local Organizer: Member of Social Advisory Board and Transition Newent Energy Visioning Group

Activity: World Café

Participants: 17

Focus:

- Integration of PV energy in the daily life
- Ways for active participation of citizens requirements for next generation PV products

Germany

Local Organizer: Helmholtz-Zentrum Berlin

Activity: Focus Group

Participants: 11

Focus:

- Reasons for slow pace PV expansion and how it can be changed
- Citizen's expectation of political activity, grid expansion

Bulgaria

Local Organizer: CL SENES

Activity: World Café

Participants: 19

Focus:

- How can research contribute to the advancement of Solar Energy Growth?
- Main constraints in wider PV technology penetration in Bulgaria

Spain

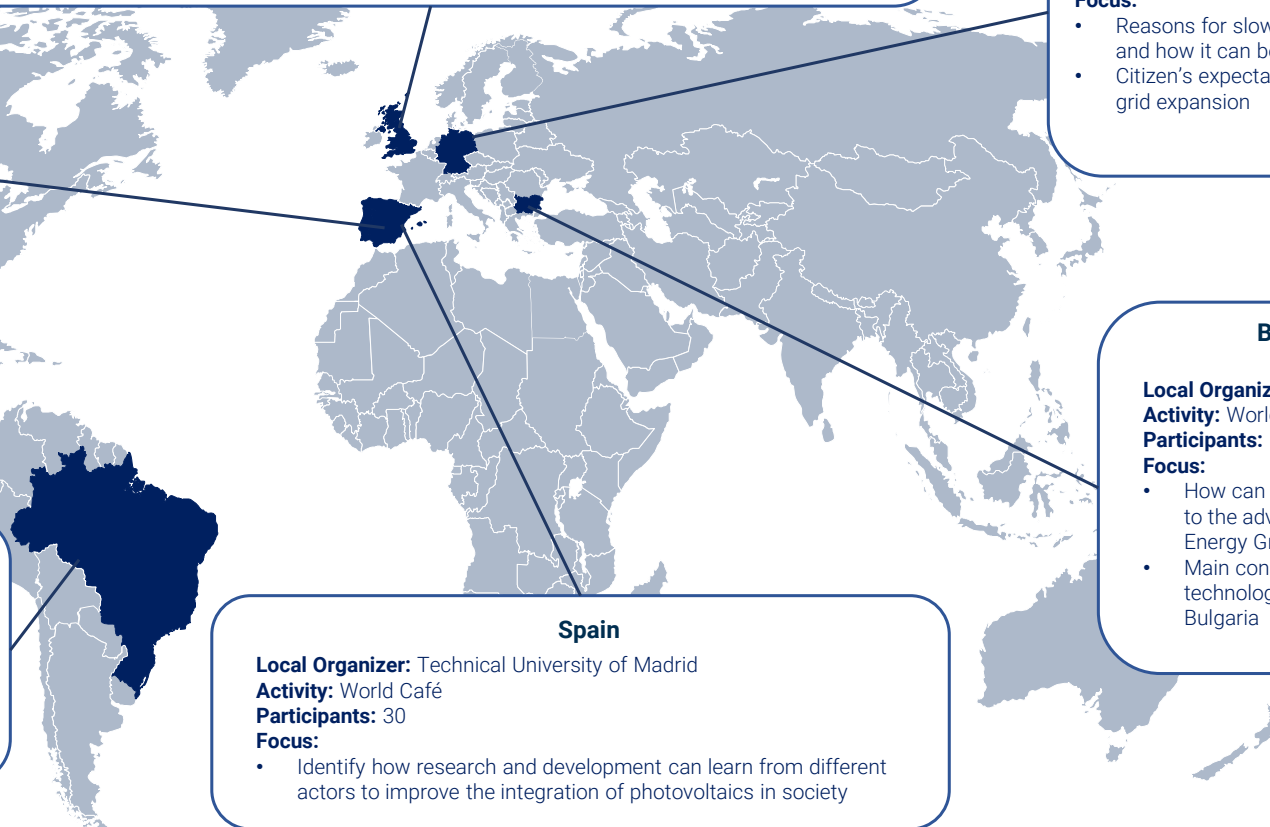
Local Organizer: Technical University of Madrid

Activity: World Café

Participants: 30

Focus:

- Identify how research and development can learn from different actors to improve the integration of photovoltaics in society



WORLD CAFÉ GROUP IN SPAIN



WORLD CAFÉ GROUP IN THE UK



FOCUS GROUP IN GERMANY



WORLD CAFÉ GROUP IN PORTUGAL





WORLD CAFÉ GROUP IN BULGARIA



FOCUS GROUP WEBINAR IN BRAZIL



WHO PARTICIPATED?

Participants in these activities had different and complementary backgrounds from various sectors of society. In addition to the different nationalities, this ensured a wide range of opinions were expressed.

100 stakeholders were engaged:

- consumer associations
- PV installers
- manufacturers of PV
- local and regional policy makers
- university teachers
- citizens
- presidents of neighbourhood associations
- specialised journalists
- architects
- ecologists
- responsible banks managers
- representatives of PV owners
- sociologists
- master students
- researchers in the fields of PV materials



- energy systems, optical materials and technologies
- solid-state physics, electrochemistry
- electronics and renewable energy
- solar energy-related companies
- NGOs
- the Fridays4Future movement
- the human resources management of universities
- big electric companies
- platforms for PV
- companies providing consultancy services on energy
- construction companies and PV distributing companies.



OVERALL RESULTS OF ACTIVITIES

WHAT WE HAVE LEARNED

This chapter shows the results from all six MML activities. It first looks at participants' expectations, concerns and fears, along with their ideas for improvements and who should be responsible for them. It then turns to expectations about next generation photovoltaic (PV) technology and the ingredients for improved research, including social acceptance.

SPAIN

“Having a PV system should be like having an Apple phone: a “customer journey”, part of an experience as a client, recognised and proud. This is the first step towards a deeper change.”

“[...] it is important to work on communication. There is still much ignorance about what PV is, what the state-of-the-art of the technology is, how a PV installation works (for example, people still think that maintenance is not needed).”

SPAIN IS CONCERNED ABOUT...

...MISCONCEPTIONS TOWARDS PV TECHNOLOGY

During the discussion, sun tax was mentioned. This regulation was introduced in 2015 and is one of the reasons citizens refrained from installing PV systems. The tax applied to PV systems exceeding 10 kW installed electricity generation capacity¹. This would not have applied to self-consumers in Spain, but the uncertainties led to a halt in PV installations. There is concern about the price of PV systems for self-consumers as well as the insufficient space for PV system installation in the city.

Citizens believe that the cost of a PV system is too high to shoulder alone. Despite this, researchers state that PV systems are economically feasible even without subsidies. The actual costs of these systems have to be

made more public. In the concerning areas for installations, participants had various opinions. One participant, a company representative, believes in the improvement of the energetic model but has to agree that the disadvantage of PV systems is the space they occupy. In contrast, another participant claims that industrial parks can offer large surfaces. Members of a Civil Society Organisation (CSO) participants reported that in Spain empty spaces are available as well. Furthermore, some participants suggest clarifying the difference between electricity generation and distribution. There seems to be different issues for grid integrated systems than for self-consumers, which are not clearly communicated.

¹ Ministry of Industry, Energy and Tourism (2015). Royal Decree 900/2015, of 9 October, regulating the administrative, technical and economic conditions for the supply of electricity for self-consumption and production for self-consumption, BOE No. 243, p.6. It has to be mentioned that this legislation has changed after the MML activity, and the new Royal Decree (244/2019, of 5 April) is much more favourable to self-consumption with PV.



Lastly, research and CSO participants emphasise the need to disseminate a realistic and clear view on PV and technology in general. A CSO representative states that a research

and development community knows about the amount of pollution involved in manufacturing the modules. Citizens need to be aware of this fact.

...UNFAMILIARITY AND INSUFFICIENT EDUCATION IN PV TECHNOLOGY

It is important for citizens to get to grips with the subject of photovoltaics as soon as possible. All participants agree that education programs are fundamental for this. Up-to-date information needs to be disseminated through school books and education. Researchers say that communication needs to be more widespread.

The PV potential and the state-of-the-art technology should be taught

to primary and secondary teachers as well as in exhibitions in the building sector.

Additionally, a researcher suggested that the learning process can be enhanced if citizens get involved in setting up their own PV system. A participant from a public administration is convinced that citizens have to be more involved as investors,



consumers, and producers. In contrast, companies offer a professional “turnkey” service. One company has installed a 20 kW PV system in the Madrid suburb of Orcasitas. Not only did they implement the system, they also supported the customer with the utility and administration. A company representative pointed out that more professionals should be trained in PV, including urbanism technicians. As citizens usually consult them first, it is important for such professionals to have profound knowledge about PV technology.

A member of a public administration assumed that citizens are actually interested in PV. Nevertheless, online information is so abundant that it is difficult for them to find a trustworthy source. To restore that trust, public

administrations should provide unbiased data and guidelines. According to one participant, public institutions such as the Institute for Diversification and Energy (IDAE) could deal with the concerns raised by the general public and promote large-scale deployment of PV. Participants from civil society emphasised that citizens should be informed about the urgency to fight climate change. Energy must not be used carelessly and PV is one of the key solutions in the energy transition.



...THE LACK OF PV TECHNOLOGY DISPLAY

Everyone agreed that PV systems should be installed in public administration buildings as well as in universities. This can set an example and raise awareness. Companies suggest that installing PV systems in social housing and using it in public transportation offers wider visibility. Even though PV integration in buildings should be supported, researchers remark that a sustainable and energy-efficient framework is necessary.

A CSO representative supported the implementation of domestic systems. This allows citizens to have control over how the energy consumption is in the household.

A different approach to incorporate PV systems in the daily life of citizens is the involvement of media companies. They can disseminate messages that inform citizens about how they can be more efficient in the use of clean energy.



During the discussion a participant came forward with information about the town Alpedrete. The town's council has seen the potential for PV systems. According to the Centre for Energy, Environmental and Technological Research the entire energy consumption of Alpedrete could be generated with only 24 percent of the available and feasible roof space. Therefore, they launched a promotion program and provided advice about

paperwork and legal issues as well as the economic support for low-income households. The participant reported that educational programs for public schools have been developed. Children have less prejudice against new technology and fewer issues with understanding and working with them. In the participant's point of view, children will play a significant role for the future.



...THE COMPLEX BUREAUCRACY

As mentioned before, Alpedrete's city council offers help for citizens when it comes to the legal issues and paperwork for the installation of a PV system. Unfortunately, this cannot be said about every town in Spain. A member of the CSO stated that the biggest issues for PV self-consumption are the changing regulations and the amount of paperwork. Participants from the CSO, research and the company sector demand a stable regulatory framework. The legal process for installing a PV system should be simplified and reduced.

One company representative said that this would naturally speed up the process. According to one researcher, government or public administration needs to ensure that citizens have access to solid companies with reliable service.



...WHO IS RELEVANT FOR RESEARCH AND INNOVATION IN THE FIELD OF PV

The graph on the next page shows that participants think that Business and Industry (B&I) is the most relevant sector for research and innovation. As mentioned before, companies have the ability to work closely with customers to build their own PV system. Besides implementing the system for customers, help with navigating the red-tape can offset some of their concerns.

Public authorities and the scientific community come in second. This could be explained by the aforementioned complex bureaucracy. If the government or public administration redesigned regulations for PV

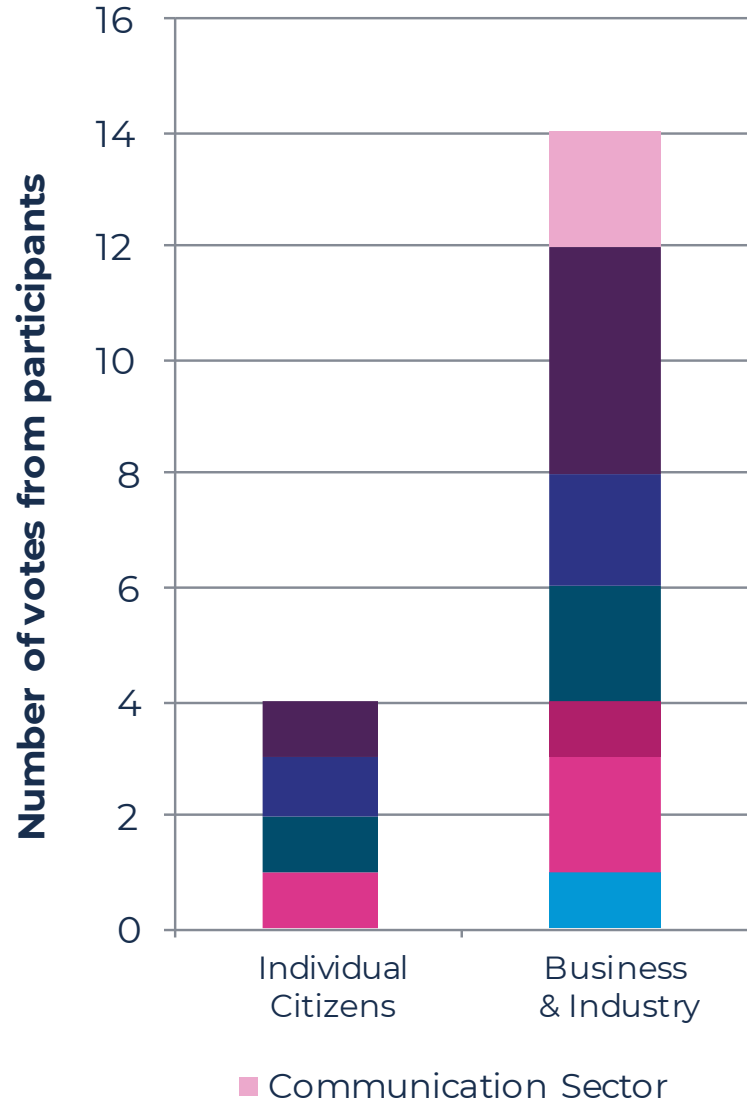
instalment, citizens might be more willing to purchase a PV system. CSO participants request better communication from the scientist community. Participants feel as though PV scientists conduct research on those technologies that interest them the most. Due to this, CSO have trouble disseminating information for citizens. Individuals have suggested two sectors which need to be included in research and innovation: the youth and the communication sector. The right communication can sway public opinion. According to some participants, research and innovation would greatly benefit from the involvement of young people in these topics.

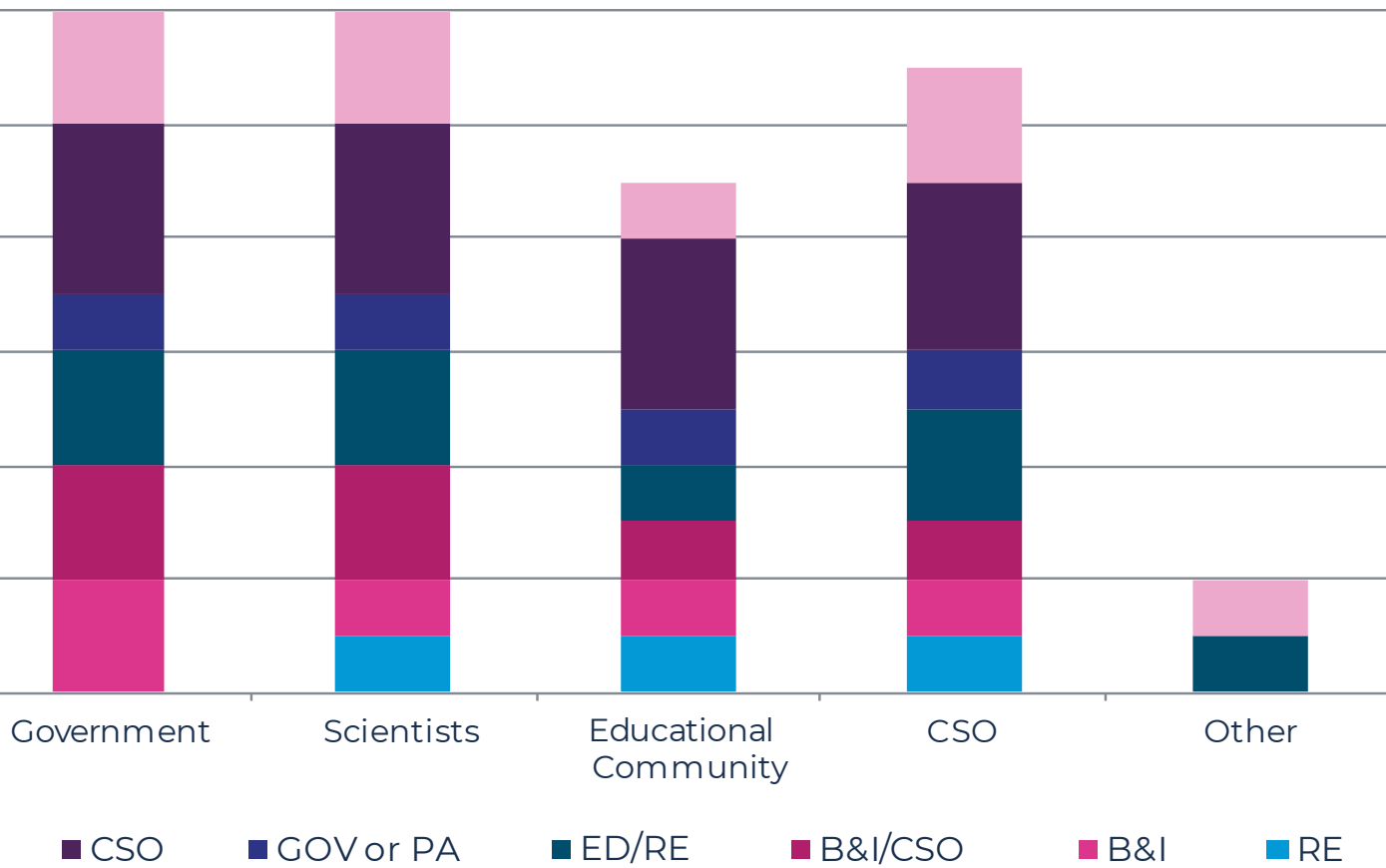
GRAPH SPAIN

Participants in Spain voted for who should play a role in research and innovation in the field of PV.

The backgrounds of the participants are shown in the legend.

Abbreviations: CSO - Civil Society Organization, GOV or PA - Government or Public Administration, ED - Education - RE - Research, B&I - Business and Industry







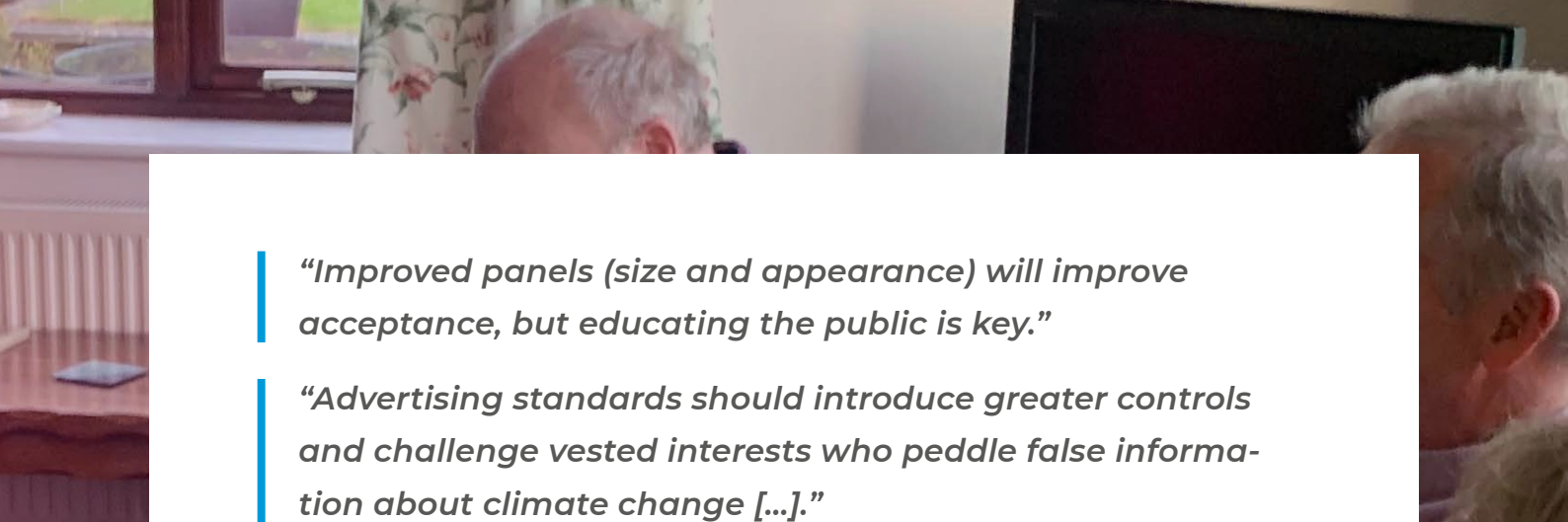
UNITED KINGDOM (UK)

THE UK IS CONCERNED ABOUT...

...THE STABILITY OF PV ENERGY SUPPLY

Participants mentioned that citizens want to own a secure grid independent electric supply. The sense of control over their own energy source gives citizens great satisfaction. Nevertheless, one of the challenges of PV technology is the intermittent energy supply.

Supply failures at night or the increase of fossil fuel prices due to increasing demand are the aspects that worry citizens the most. Participants say that neither of the local or national power grid is flexible enough to manage the growth of PV systems.



“Improved panels (size and appearance) will improve acceptance, but educating the public is key.”

“Advertising standards should introduce greater controls and challenge vested interests who peddle false information about climate change [...].”

...LACK OF GOVERNMENTAL LEADERSHIP

Government support is essential for every energy transition. Unfortunately, participants are disappointed with the UK government as it has not presented exemplary leadership regarding PV technology. This becomes evident when looking at the regulations and missing incentives for PV instalment. Participants reported that governmental policies and subsidies for PV technology are inconsistent. Due to this, emerging

businesses and citizens’ investment decisions have been undermined. For increased awareness and use of PV technology participants want to have long-term policies. They suggest tax incentives. Furthermore, it is important for the government to enforce and strengthen building regulations. New buildings should follow the “Passive House Standards”. These set limitations for heating, cooling and primary energy demand¹.

¹ Passive House certification criteria. Retrieved from https://www.passivehouse-international.org/index.php?page_id=15

...INSUFFICIENT EDUCATION IN PV TECHNOLOGY

According to the participants, education is needed in many sectors of society. There is a general lack of experts in PV technology who can give suitable advice for PV installations in various types of buildings. An improved education system has to be implemented to retrain employees working in energy companies in the design, integration and deployment of PV technology. Construction companies have to ensure they keep an innovative skill base in their

workforce. Participants consider it is important to raise awareness among young people as they are key players in achieving the energy transition. Teaching programs about the need for PV should be implemented in school and universities. For example, architecture courses need education for the best available PV technology. This would help avoid misconceptions and negative statements regarding PV.

... ACCEPTANCE AND EXPECTATIONS TOWARDS PV TECHNOLOGY

Due to the climate and heavy cloud cover in the UK, PV technology has played a minor role in the energy transition. This is made worse by negative publicity disseminated by status quo supporters. To raise the profile of PV, participants again pointed to the government but also to the media. They expect the media to promote PV technology

and disseminate a positive message through sustained information and national publicity campaigns. Citizens should learn that PV energy generation is no extraordinary way to produce electricity. As mentioned before, the government should implement financial incentives to motivate citizens to install a PV system. From the citizens' point of view, researchers

should aspire to design PV technology following the circular economy concept. New PV products should be able to be disassembled for further improvement and contain non-hazardous materials. Participants agreed that there is a need to mitigate the carbon footprint and provide a secure electric supply.

...WHO IS RELEVANT FOR RESEARCH AND INNOVATION IN THE FIELD OF PV

In the graph on the next page, all sectors are considered to play an important role. Business and Industry, the government and individual citizens come first. Looking back to the concerns of citizens, it is clear that the emphasis lies in these three sectors. Besides supporting PV technology, participants encourage individual citizens to change their way of living. This could include changing diets, encouraging employers to allow working from home, or changing the type of transportation. Participants said that the government should support efforts to integrate PV electricity generation into the general design of infrastructure and buildings. Companies should support PV integration into portable gadgets.

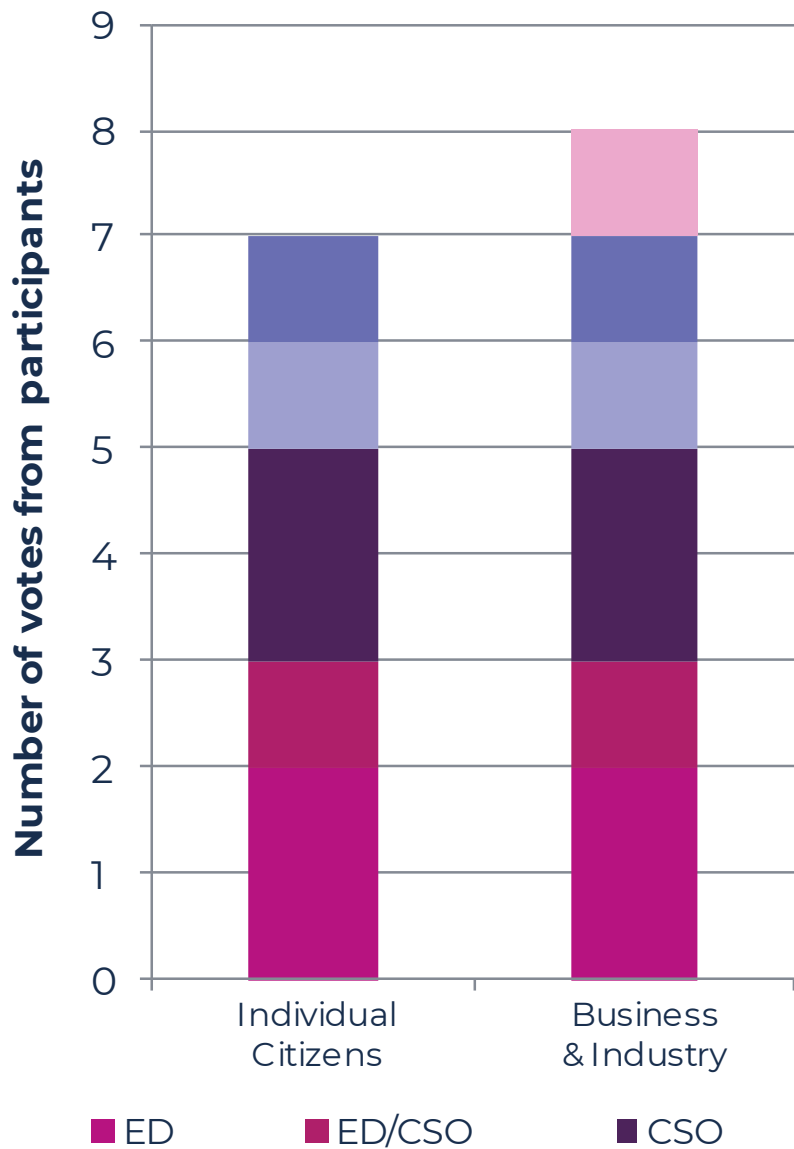


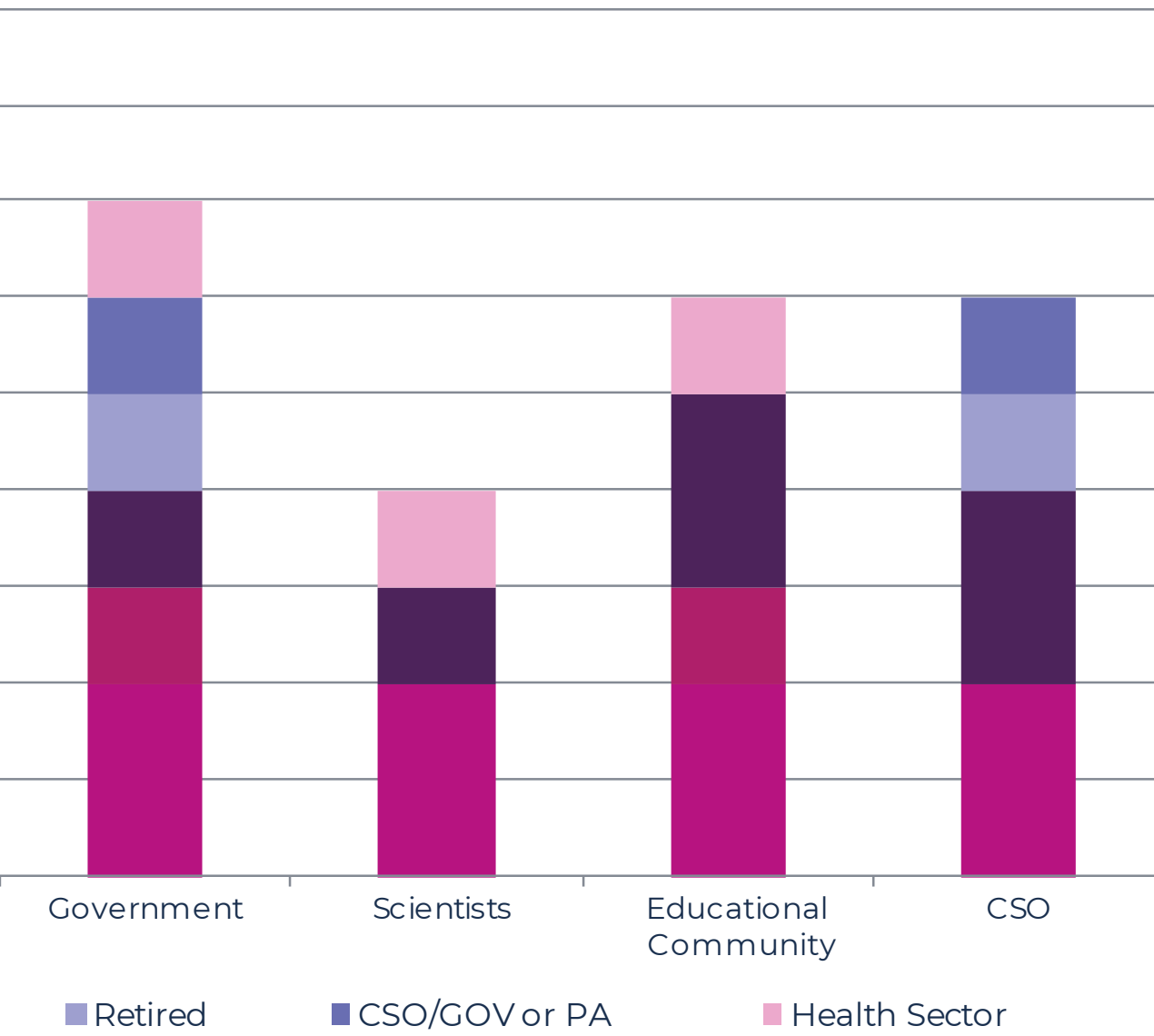
GRAPH UNITED KINGDOM

Participants in the United Kingdom voted for who should play a role in research and innovation in the field of PV.

The backgrounds of the participants are shown in the legend.

Abbreviations: CSO - Civil Society Organization, GOV or PA – Government or Public Administration, ED – Education






BULGARIA

BULGARIA IS CONCERNED ABOUT...

...THE SLOW PROCESS

Citizens in Bulgaria expect clean PV energy, green “zero-energy” buildings and easy electric urban transportation. Participants agreed that citizens would accept PV rooftop systems. These expectations put much pressure on local authorities. Furthermore, the participants felt that interest in new PV systems has been low. People are concerned about things like lifetime and maintenance of PV systems. This could be due to the insufficient funding in research. Nevertheless, a development for PV irrigation is in progress. Several local

authorities and private local investors are working together on this project. Despite the slow process, participants stated that the PV sector is growing in the energy sector and in small businesses. PV technology has to be better promoted. Participants want to encourage everyone to engage in demonstration projects.



“Better information for society would increase the trust in research and would increase investment in PV sector.”

“Dissemination of results is the main vector for mainstreaming PV integration”

...WHO IS RELEVANT FOR RESEARCH AND INNOVATION IN THE FIELD OF PV

The graph on the next page clearly shows that Research, Business & Industry department has to play a role in PV innovation and research. The participants voted for the scientists the most. The insufficient funding in new PV technology makes it difficult to meet the expectations of the public. To convince citizens, more successful projects have to be presented. Business and Industry can have great impact as well. Participants want complex turnkey solutions and new energy services to push PV

technology integration. In general, better communication across sectors is needed.



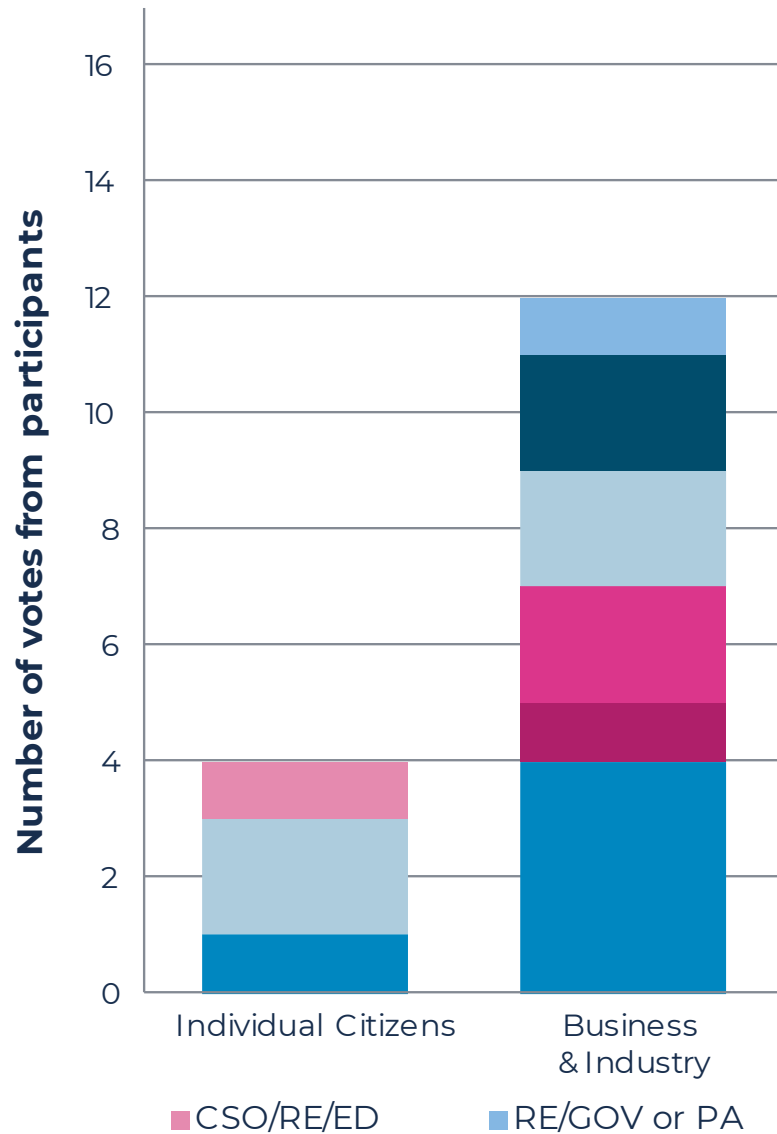


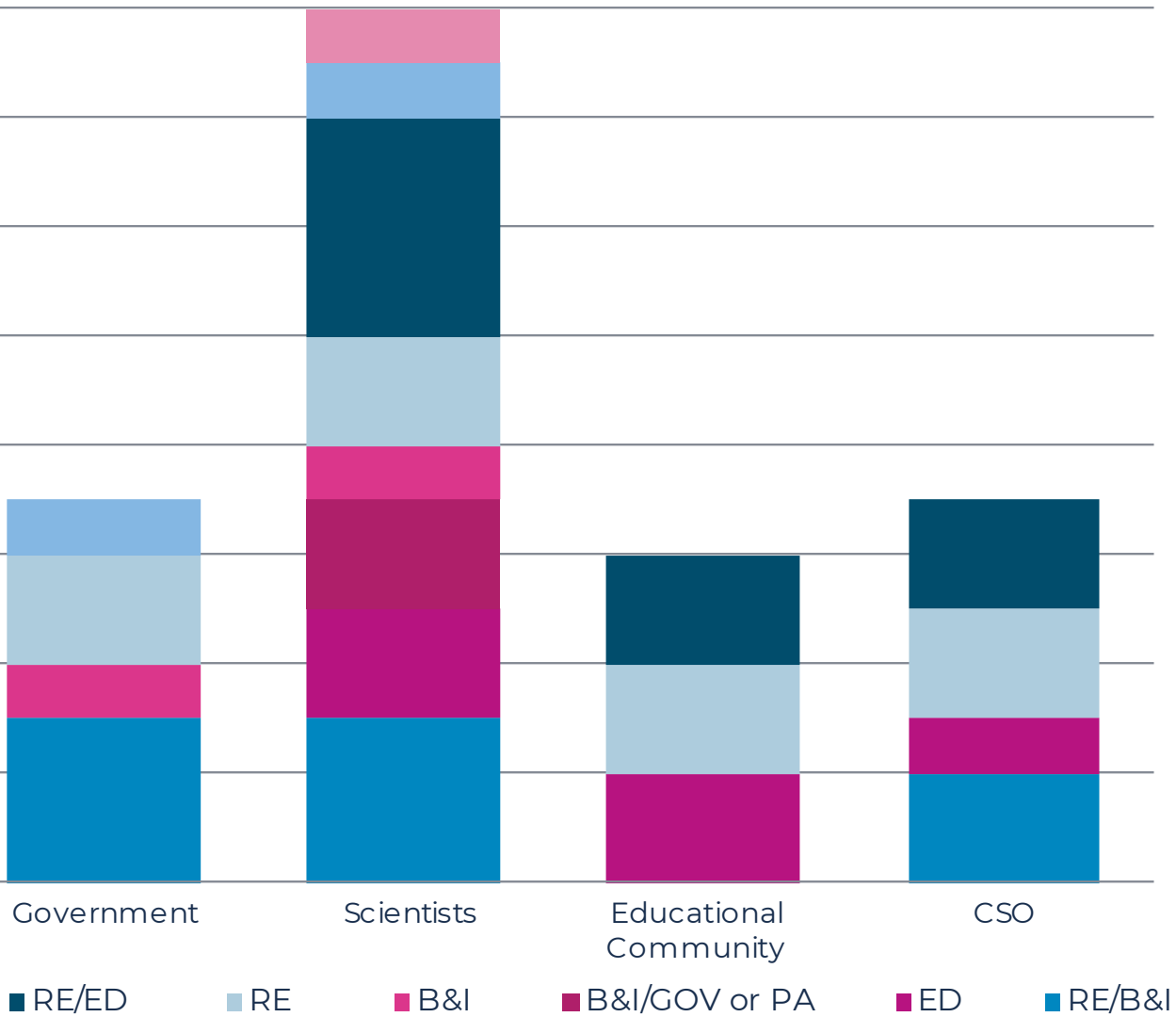
GRAPH BULGARIA

Participants in Bulgaria voted for who should play a role in research and innovation in the field of PV.

The backgrounds of the participants are shown in the legend.

Abbreviations: CSO - Civil Society Organization, GOV or PA - Government or Public Administration, ED - Education, RE - Research, B&I - Business & Industry





GERMANY

“Looking at the complete manufacturing process, from material to application and later to recycling, is an important factor, which should be investigated in more detail”

GERMANY IS CONCERNED ABOUT...

...THE LACK OF COMMUNICATION BETWEEN SECTORS

Participants wish for better communication among different stakeholders, especially between the political class and citizens. They said that positive wording may well change how people perceive PV technology. The media has a role to play here. Renewable energy sources must be increased and public awareness about the climate crisis must be raised. They mentioned that scientists should exert pressure on politicians as they ultimately have the power to make regulations in favour of PV technology integration.

...INSUFFICIENT PROMOTION OF PV TECHNOLOGY

Participants felt that PV technology lacked promotion. Studies such as the “Berlin Solar Potential” from Quaschnig¹ provide a range of information on PV roof systems. Such studies should be more readily available for citizens because there could be unknown aspects and they could improve acceptance. Participants voiced their wish for scientists to take part in Fridays4future and Scientists4Future.

¹ Quaschnig, Bergner et al. (2018). Das Berliner Solarpotenzial – Kurzstudie zur Verteilung des solaren Dachflächenpotenzials im Berliner Gebäudebestand. Retrieved from <https://pvspeicher.htw-berlin.de/wp-content/uploads/HTW-Berlin-2018-Das-Berliner-Solarpotenzial.pdf>



...THE INFLUENCE AS AN INDIVIDUAL

During the discussion about the fears and constraints from the public, participants pointed out that citizens have far too little influence in decision-making, planning of power grids and plants. The procedures are currently not clear enough. In addition, politics could again play an important role by setting boundaries with laws and regulation. The politics also have to emphasise the need of behavioural change of every citizen. Transparent communication about procedures as well as giving boundaries to citizens can encourage them to change their behaviour towards consumption and mobility choices. In Mecklenburg - West Pomerania - the acceptance for wind parks has been encouraged using a cooperative model. A set number of citizens have the opportunity to participate in wind park projects. As a reward for their active participation, citizens earn money from the nearby renewable energy systems.

...THE COMPLEX BUREAUCRACY AND POLITICAL DECISIONS

Participants are unsatisfied with the decisions made by politicians. Rather than implementing short-term goals, politicians tend to set goals which are too far-sighted. Due to the parliamentary term and elections every four years, the goals set seem impossible to fulfill. Participants feel that the energy transition in Germany is far too slow. They explained that several years ago politicians talked about measure needed to reduce the CO₂ emissions. Unfortunately, they do not follow through with their plans even though technical solutions are available. Participants demand that politicians take note of scientists' and citizens' opinions. Additionally, there is too much red tape for installing a PV system. In Germany, citizens have to register the PV system as a business and include it in the tax return statement. Therefore, regulations

have to be simplified to appeal to citizens. Another point that stood out was the subsidisation of fossil fuels and coal mining. Participants reported that citizens are not aware about the subsidisation of large energy suppliers, which is ultimately funded by taxpayers. It was made clear that they, as taxpayers, do not wish to support an unsustainable energy source. In public discussions the argument of job losses is used to subsidise fossil fuel technologies, but it was mentioned that there are only a few jobs in coal industry in Germany which rely on taxpayers' money. The challenge here is that the coal industry is mainly located in structurally weak areas of Germany (Saxony, Brandenburg, NRW). Nevertheless, politician should address this issue, something that should have been done earlier.



...TECHNICAL DEVELOPMENT

Participants have various expectations about PV technology. Firstly, future PV projects should include a life cycle analysis and also an investigation of the complete material flow. The PV technology should be built with highly recyclable materials. Secondly, existing technologies need to be improved to further reduce the CO₂ emissions. As there are physical limitations in Germany, participants expressed the desire

to improve the efficiency of a PV module. Lastly, the power grid needs to be extended throughout Germany. Currently, Germany has decentralised renewable energy production and consumption. Solar energy is mainly produced in the south of Germany, whereas wind energy is produced in the north. Therefore, the grid should be expanded to address this.



...WHO IS RELEVANT FOR RESEARCH AND INNOVATION IN THE FIELD OF PV

In the graph on the next page, you can see that scientists were considered to be the most relevant for research and innovation in the photovoltaic sector. However, they are closely followed by government and business and industry. These three sectors are ahead of the remaining three sectors.

As mentioned above, during the discussion it was said that government has the responsibility to change regulations to support the transition of the energy system.

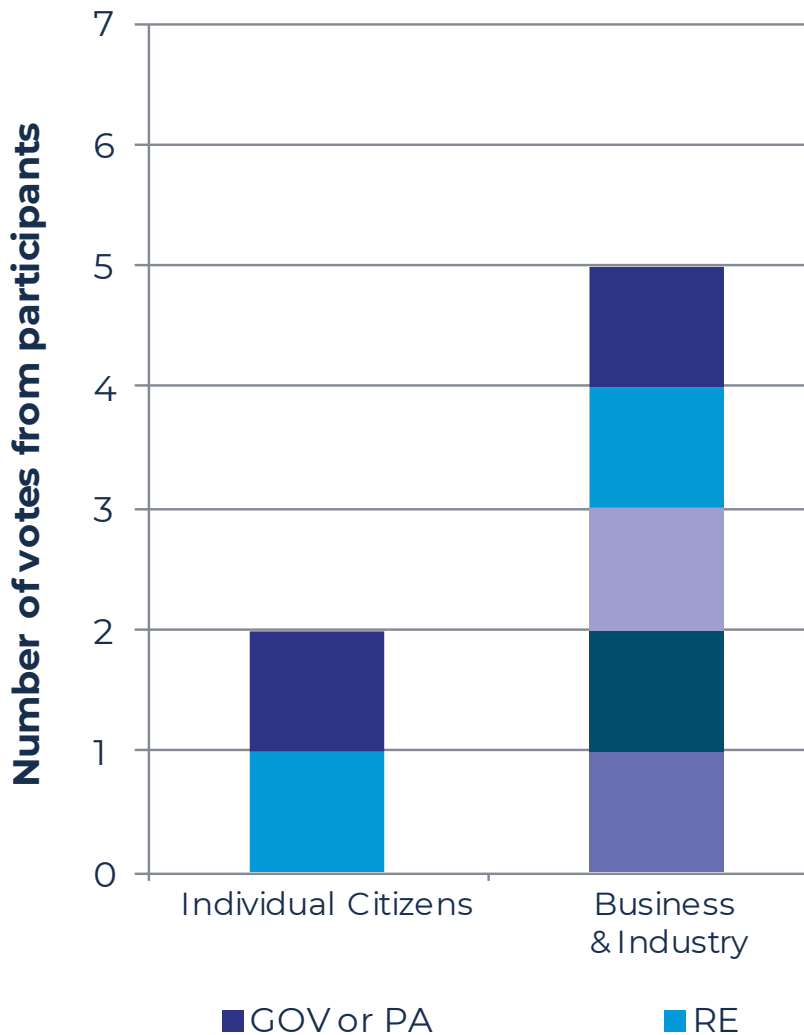


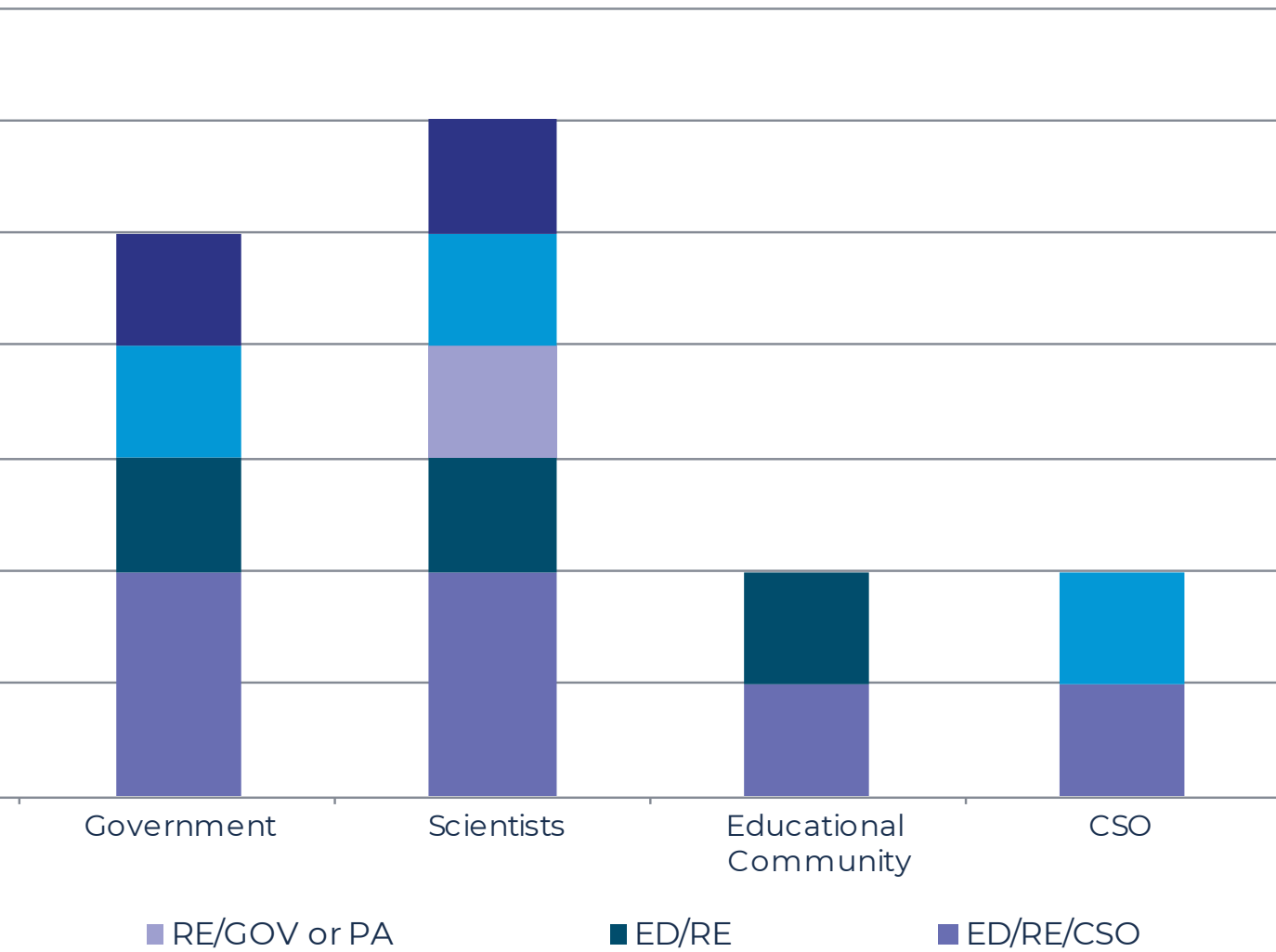
GRAPH GERMANY

Participants in Germany voted for who should play a role in research and innovation in the field of PV.

The backgrounds of the participants are shown in the legend.

Abbreviations: CSO - Civil Society Organization, GOV or PA - Government or Public Administration, ED - Education, RE - Research







PORTUGAL

PORTUGAL IS CONCERNED ABOUT...

...UNFAMILIARITY AND INSUFFICIENT EDUCATION IN PV TECHNOLOGY

Representatives of research and government or public administration suggest a better education in PV systems for citizens. Usually the knowledge transfer is not correct. Citizens need to be aware about the challenges of climate change and what kind of role PV could play in

this matter. A member of a public administration would like to organise sessions to clarify the PV system installation and show its potential. Furthermore, the participant wants to encourage citizens to become self-consumers.

...THE LACK OF PV TECHNOLOGY VISIBILITY

In this matter participants were very clear about the visibility of PV in the country. All participants want PV systems implemented in all kinds of areas such as public buildings or

transportation. They also expressed the desire for PV energy in consumer applications and self-consumption due to the increasing competitiveness of PV technology.



“Nowadays, the biggest step is to raise people’s awareness. The fruits of research can only be harvested if society is sensitive to these issues.”

“New players from other sectors bring creativity from their sectors of origin, often applicable and with high potential for photovoltaic solar energy. They can also return with more knowledge, allowing PV applications in their sectors of interest that only they could imagine due to very specific needs.”

...THE INFLUENCE AS AN INDIVIDUAL

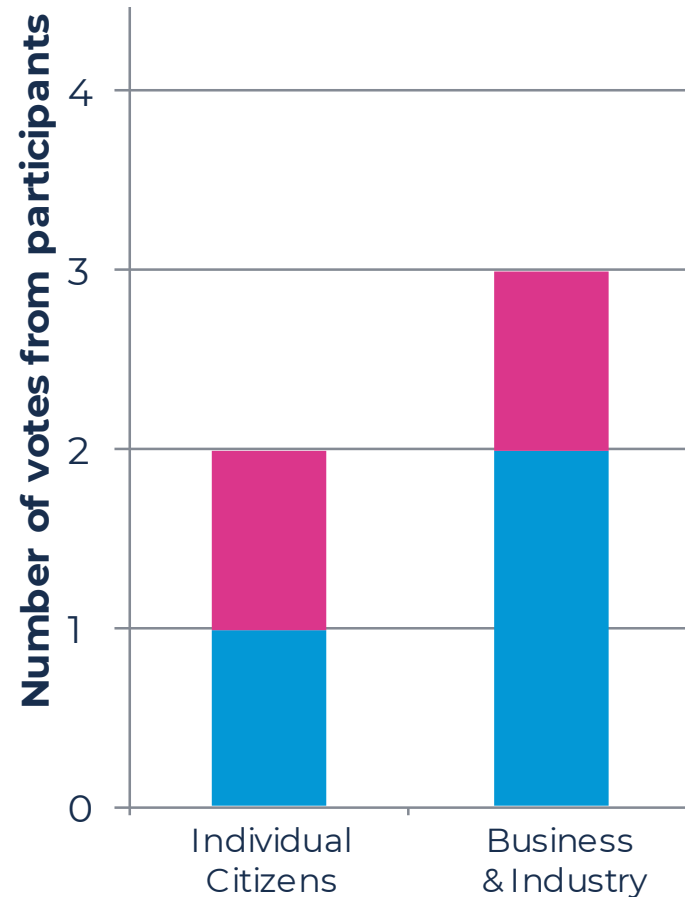
A number of participants want to have more influence in the energy transition. Despite this, the participants’ opinions have yet to be acknowledged by the political class. Citizens have little to say in deciding policy measures or how energy efficiency and clean energy are promoted. Although participants

showed their desire to be active in the transition, an administrative participant was concerned about the low turnout in Portugal for the European elections, which meant that the opportunity to vote for the «best» representative was somewhat lost.

...WHO IS RELEVANT FOR RESEARCH AND INNOVATION IN THE FIELD OF PV

The graph shows that the participants -in spite of their background or the sector they belong to- share opinions on who should be responsible for research and innovation in PV. As mentioned by all sectors, clarification and education for citizens is one of the most important aspects.

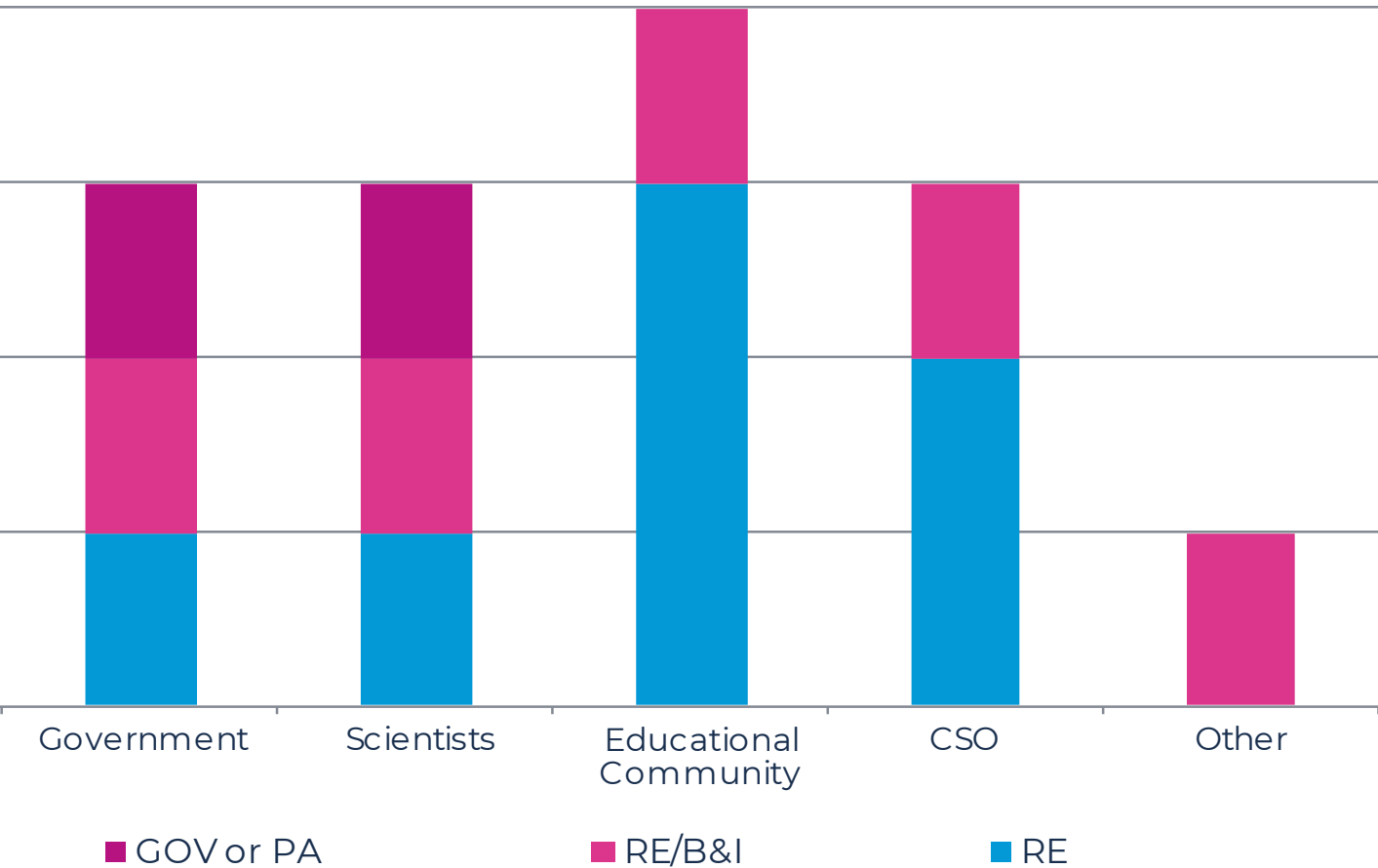
Therefore, the educational community received the most votes. A participant with a research and industry background suggested that the financing sector is one of the sectors that need to be active as well. All the other sectors received a similar number of votes. Participants demanded that the industry should be open-minded and listen to ideas from different sectors. Often, these ideas are compatible with the PV technology improvement.



GRAPH PORTUGAL

Participants in Portugal voted for who should play a role in research and innovation in the field of PV. The backgrounds of the participants are shown in the legend.

Abbreviations: CSO - Civil Society Organization, GOV or PA - Government or Public Administration, ED - Education, RE - Research





BRAZIL

BRAZIL IS CONCERNED ABOUT...

...UNFAMILIARITY AND INSUFFICIENT EDUCATION IN PV TECHNOLOGY

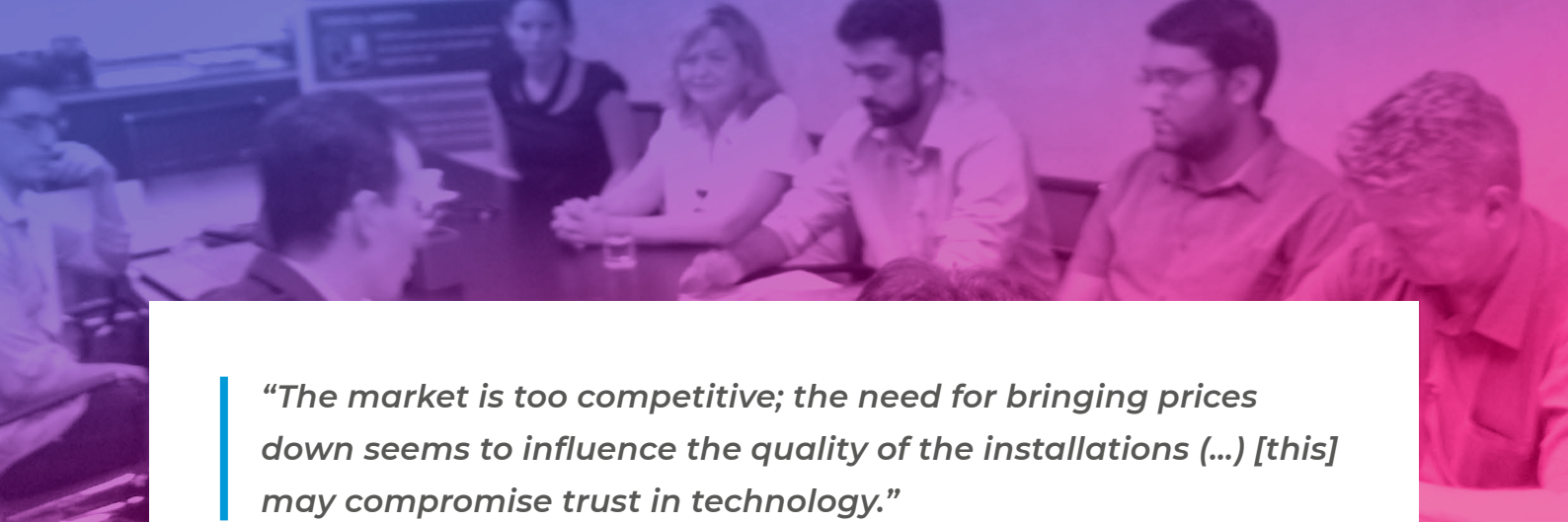
The participants stated that there is a lack of information regarding photovoltaic systems in Brazil.

Additionally, there is a need for specialised personnel to install, operate and maintain PV systems.

...PRESSURE FROM THE MARKET AND INSECURITY CONCERNING REGULATIONS

A major concern is the high market competitiveness which leads to low prices for PV systems. The participants are concerned that this could negatively influence the quality of the installations. Consequently, people may become more wary about this technology. It follows that high quality, reliable PV technology

is important to produce. Participants suggested creating standards for system implementations as well as agreeing on sufficient technical standards. Apart from that, they pointed out that there is a need for clarifying the specific regulatory requirements of PV installations.




“The market is too competitive; the need for bringing prices down seems to influence the quality of the installations (...) [this] may compromise trust in technology.”

...THE LACK OF COMMUNICATION BETWEEN SECTORS

Participants wish for better communication between academia and private companies. They also see the need for reducing the distance between academia, society and market.. To achieve this, the participants suggested creating a partnership between academia and private companies, which means that the later should found research projects. Another idea is that companies could hire trainees from academia who would act as a bridge between these two sectors. Furthermore, companies should actively contact academia

to discuss their needs. Participants further state that professional associations and trade unions should work more closely with the academic community. Communication could also be improved by using different channels and open platforms. It was also said that there is a wish for open source research about PV systems and their features.



WHAT IS IMPORTANT FOR THE NEXT GENERATION PV TECHNOLOGY?

In GRECO we aim to conduct socially responsible research in line with society's needs and expectations. In this section we summarise the recommendations made by participants in terms of PV technology research.

NEXT GENERATION PV PRODUCTS SHOULD BE...

...SOCIALLY ACCEPTED

Social acceptance seems to be important for most participants. Those from Spain said that in research and development a prime concern was whether products would be commercially accepted. However, participants thought that social acceptability studies, impact studies and financial studies should be conducted for all kinds of research. Recommendations include: visual impact, high quality and reliable products in order to instil trust.

In Portugal, social acceptance is considered highly important. In Spain and the UK, there is a wish for better

PV promotion. Furthermore, in the UK participants think PV should be covered by the mass media so that people perceive it as a mainstream method of generating power.

Toxic materials are a big issue for social acceptance and participants in Spain and Germany said that these materials might not be accepted at all. In Spain participants said that this is a topic we need to communicate about with the next generation, as younger people are thought to be more responsible about their consumption.

...ACCESSIBLE FOR THE WHOLE SOCIETY AND WIDESPREAD

This is a wish that was mainly discussed in the UK and Portugal. In the UK participants want PV to be ubiquitous across society. It should

further be available for all households on an equal basis and become the norm for power generation. In Portugal participants also thought so.

...DRIVEN BY POLITICS

Many participants are concerned about the role of politics in driving widespread integration of PV. In many locations participants asked

for regulations to support the energy transition or the wider use of PV technologies.

THE TECHNOLOGY SHOULD BE...

...OF HIGH QUALITY AND HIGHLY EFFICIENT

The wish for high quality of PV products was expressed in Brazil, Germany and Spain. In Germany a participant additionally mentioned that long-term stability is important to conserve resources and to integrate PV in facades and buildings, where the PV modules have to operate for several decades. Moreover, in Germany and Spain

participants addressed the lack of space in cities and recommended therefore producing highly efficient PV technology. However, in Spain participants commented that they would not trade a clean technology for a higher efficiency if the efficient technology contained toxic materials.

...RECYCLABLE AND CLEAN

In Spain and Germany participants commented that recyclability is important for them. Preferably, the recycling process should be implemented during the development process and not separately. It is further important that abundant resources are used.

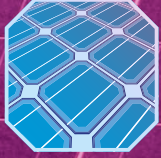
In Bulgaria participants wished for clean PV energy and in Spain participants preferred to pay more

for a clean technology than increase efficiency and reduce the cost if a dirty technology is involved. They recommend again talking with future generations as they will be affected by this matter. Also in Germany participants thought that using non-toxic materials is important, whether during mining, fabrication, application or recycling.

...WELL ADAPTED TO THE SURROUNDINGS

The next generation PV technology should not only work well but also be well adapted to its surroundings. For example, if PV technology is usually installed on rooftops – why not integrate it into the roof tops? This would probably make a significant contribution to spreading photovoltaics. In Spain and the UK participants mentioned PV integration in roofs, buildings, cars and pavements.

And they talked about products like solar tiles and transparent designs for glass surfaces. Additionally, so far PV technologies have mainly been developed in certain locations with similar local characteristics. In Brazil participants wanted better equipment that is adapted to both tropical climates and local characteristics.



RESEARCH SHOULD ALSO TAKE INTO CONSIDERATION...

...DECENTRALISED NETWORKS AND THE PARTICULAR NEEDS OF CITIES

MML participants ask researchers to take into consideration decentralised networks and the particularity of cities. In Brazil participants wish for a change of mindset and a focus on distributed generation. Decentralized energy production is also highly demanded by the Spanish participants. However, they do not want the electricity companies to manage their unique decentralised and democratic energy source but be responsible for it themselves. They ask researchers to contribute to this systemic change by developing technologically advanced

products to be integrated at the point of consumption. In addition, they mentioned the need to address the specificities of the energy transition in cities. In the UK, a more straightforward charging and paying system is needed for electric cars. Participants suggested “solar credit cards”. Spanish participants emphasised the need to ensure all new developments and changes work together with one system in the future. Spain needs to anticipate future system features as has been done in several other countries.



...ADDITIONAL NEEDED TECHNOLOGIES

PV technology research should also address other energy transition technologies. Participants in Brazil and Spain mentioned the need to focus on storage systems. In Spain participants further explained that they see two requirements for this topic: on the one hand, researchers need to work on technical solutions allowing the interconnection of several batteries and, on the other hand, the question of how to integrate many small storage systems into the electricity system.

A possible solution: using the batteries of electric vehicles as storage. In Bulgaria participants said simple electric urban transportation and green “zero-energy buildings” were important.



RESPONSIBLE RESEARCH NEEDS TO...

...IMPROVE COMMUNICATION

In Spain, participants clearly said that researchers need to learn how to communicate about what they are working on and why. They thought that this was less of an issue in the USA as there is a better connection between industry and the general public. Participants said that improved communication also involves finding out what people already know. Furthermore, researchers should consider society's demands with regard to PV products.

...CHANGE THE SYSTEM

Following on from the previous point, participants in Spain disagreed with the current rewards system for researchers. It is related to publishing in high-impact journals, where very innovative products are required and everything is written in English. This seems to increase the barrier between research and society.



...INFLUENCE POLITICS

Participants in Spain asked why research is supposed to be neutral and why it is not able to influence the policy makers' decisions. They thought research should have an impact on politics.

...BE INTERDISCIPLINARY

This topic is partly connected to communication. Participants in Spain stated that researchers do not exchange enough with communities about their needs and problems. Moreover, they ask researchers to connect PV with the rest of the research areas to fight climate change more effectively. Climate change cannot solely be fought with innovative PV technologies. Participants in Portugal added that there is an opportunity to create a new industry with new jobs by making the energy transition.

A close-up, high-angle photograph of solar panels. The panels are arranged in a grid pattern, with a prominent diagonal line of a junction box or cable running across them. The color of the panels transitions from a deep blue at the top to a purple at the bottom. A white rectangular text box is positioned in the upper left quadrant of the image.

CONCLUSION

Participants in the discussions provided considerable input. This will be very fruitful for our project and for aligning PV research with societal needs and concerns.

Our main objective was to find out how research and development can learn from different sectors of society to improve the mainstream deployment of photovoltaics. One thing is evident: research and development can learn a lot from different sectors of society; we strongly recommend other research communities to reach out across society.

This report sorts discussion results into topics where possible. Researchers on the GRECO project can refer to this report and decide which topics are relevant to them. Towards the end of the project, we will issue a report on how we actually use the input from the MML activities to adjust our practice.

HERE ARE THE MAIN CONCLUSIONS:

1. There is a **lack of information** and even **misconceptions** about PV technology which could be overcome by **improving communication** between research and society and by **interdisciplinary research**.
2. The energy transition should be supported by **governments** but **citizens** need to be part of the **decision-making process**.
3. PV technology should be **clean, recyclable, accessible, high quality** and **well adapted** to the surroundings and to the **society's needs**.

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LAYOUT & DESIGN

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