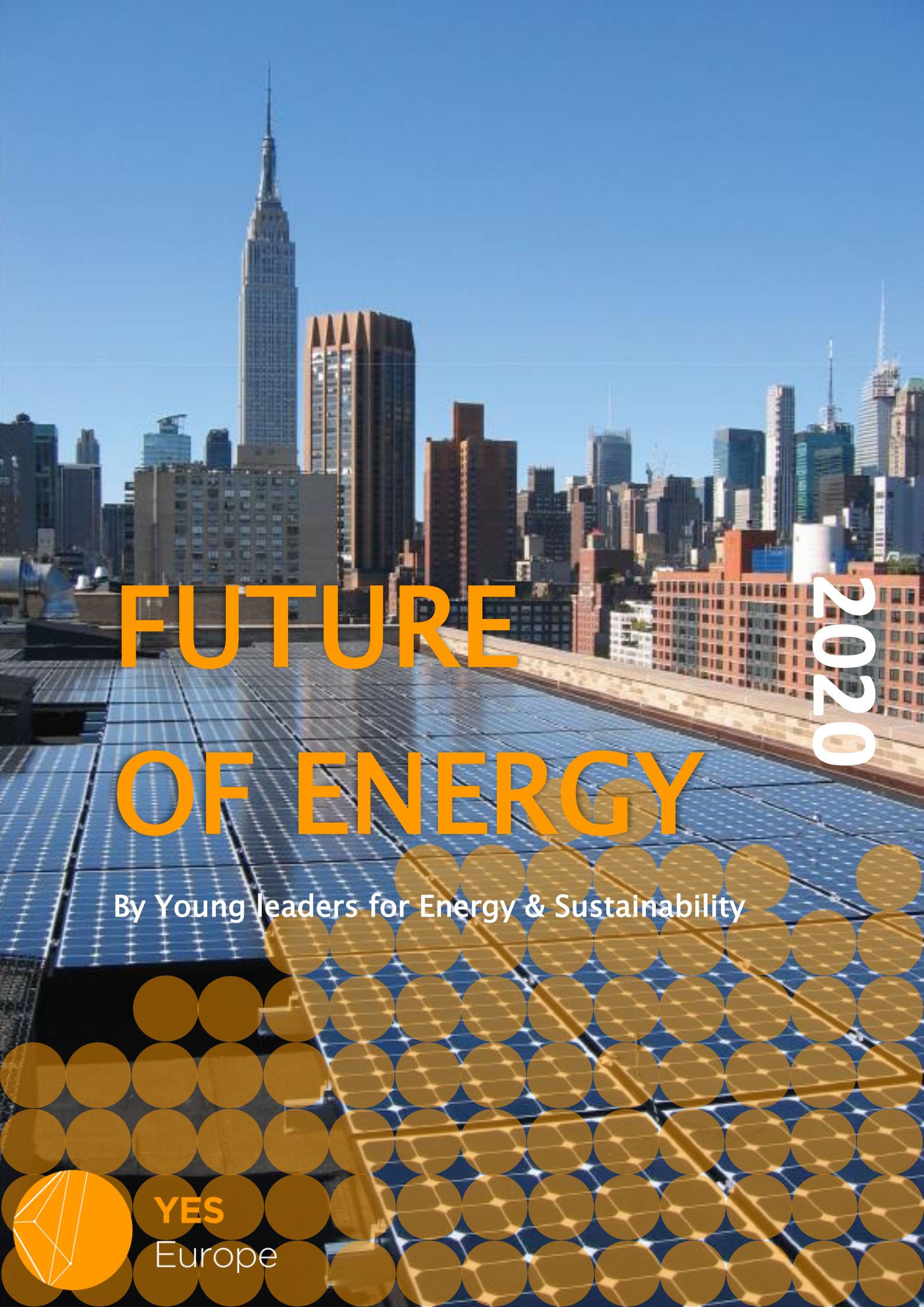

FUTURE OF ENERGY

2020

By Young leaders for Energy & Sustainability

YES Europe

Lead authors and editors:

Beatriz Ildefonso, *Knowledge Sharing team member*
beatriz.moura@sapo.pt
LinkedIn

Stefano Nebiolo, *Knowledge Sharing team member*
stefano.nebiolo@gmail.com
LinkedIn

This report was elaborated based on the results of an online survey by YES-Europe that was open since November 2019 to February 2020.

Report version 3 November 2020

Content

Preface

The energy industry is at a crossroads. Shifting priorities, strengthening mega-trends, and emerging technologies comprise a changing context for the global energy system. Furthermore, the consequences of climate change are becoming more evident. Being the energy production and consumption some of the main responsible activities for greenhouse gas emissions, the need for a change of the energy sector is an essential point.

The young generations entering the industry are to play a key role in defining these changes. Their participation is going to shape the future energy system. This report aims to understand the vision of the future energy industry the young leaders in energy and sustainability have.

The Future of Energy by Young leaders in Energy and Sustainability 2020 report is a publication by the Knowledge sharing team of YES-Europe. The YES-Europe (Young Leaders in Energy and Sustainability) network is a unique pan-European organization led by students and young professionals in energy. As part of our mission to create a community of young leaders, YES-Europe creates and disseminates fact-based knowledge through its analytical projects.

The Future of Energy 2020 report gathers the participation of 119 respondents who live in 17 countries, 92% of them in Europe, to an online survey arranged throughout 2019. About 63% are energy students (43% master students), while the rest are young professionals (21%), PhD candidates (7.5%), or are looking for a job (7.5%). The field of the participants embraces most of the different aspects of the energy sector: renewable energy (54.5%), nuclear energy (7.5%), energy efficiency (7.5%), energy and environmental policy (3.5%), and more. Participants answered an online survey, which is the input data for our analysis. The diversity of respondents (e.g., geographical location, occupation) in our sample provides confidence that our results are not biased towards the views of a single group of young professionals and students, despite being a relatively small sample.

Through the following pages, we represent the ideas of highly engaged and proactive individuals within the young energy professionals and student community in Europe. This report is a platform to spread their views. In a few years, these young leaders will be the decision-makers of the energy industry. By listening to what they have to say today, we imagine what future of energy they will build tomorrow.

Executive Summary

The goal of this report is to understand what lies ahead for the energy system according to young participants involved in the field of energy and sustainability. The results are based on a survey developed by the YES-Europe team, to whom 119 respondents from 17 different countries participated. The findings of this report do not show statistical values but an evaluation of the opinion from this cluster of young energy leaders.

The first chapter "The need for a different energy system" is divided into two sections. The first section focuses on the Forces triggering the change of the energy system. The participants believe that Affordability and Security of Supply, which have a relevant impact in the present energy scenario, will have lower relevance in 2050, while the focus will shift to Sustainability. Undoubtedly, Climate Change is the main mega-trend pushing for a change of the present energy system. The second section discusses the Consequences of the change. The shift towards a different energy system will have a great impact on society, which we quantify in terms of disruption of different aspects of the energy sector. Energy policy and Regulation will experience the most disruption due to the change. Furthermore, Asia & Pacific is seen as the region of the world most likely to experience disruption of the energy system, mainly because of demographic changes and technology and infrastructure availability. However, the main reasons for disruption around the world pointed out by our respondents is political.

The second chapter, "The vision for 2050", is divided into two main sections as well. The first section, Future of Energy, starts with displaying three different energy scenarios the young energy leaders envision for 2050. Most respondents envision a future system characterized by the energy load almost entirely covered by renewable energies and a high degree of flexibility and distributed generation of the energy system. After the definitions of the three scenarios, we analyse whether the realization of the future energy system will follow a top-down or a bottom-up approach. We also focus on the type of interaction the citizens will have with the new energy system. Lastly, we question the participant on the degree of extendibility of their envisioned energy scenario. The second section focuses on the key uncertainties shaping the path to future visions, and possible directions to follow. The majority of respondents refer to Climate Change as the biggest source of uncertainty and state that in terms of investment, they would give priority to renewable energy technologies.

Introduction

According to IEA, the decarbonisation of the power sector will be fundamental to reduce emissions, especially in an increasingly electrified world. As it stands, fossil fuels supply 80 percent of the world's energy to warm homes, charge devices and power transportation.

Although the problem of the current energy system seems to be getting louder and clearer to everyone, the road towards a new system is still highly clouded by uncertainty and conflicting interests. As renewable energy sources reach a stage of maturity and market uptake, a new set of issues arises as we try to rethink almost entirely the energy sector, and scale it globally. There is no one-size-fits-all solution for a full decarbonised system, putting an increasing amount of pressure on our current leaders to accelerate the dialogues between key stakeholders on what needs to be changed over the next three decades. However, **youth doesn't want to leave it up to the older generation to decide how the future will look like: more and more young people around the world are raising their voices, sharing their concerns and hopes for what lies ahead of them**.

There has never been a more informed and outspoken young generation. Having grown up in the digital age, surrounded by contradictory and many times misleading or outdated information, the young leaders are better prepared than ever to bring to the table a new mentality of critical thinking and openness to change.

Contrary to the older generation beliefs, young leaders in energy and sustainability are eager to engage with their governors and older peers to help shape a sustainable future.

The goal of this report is to understand what lies ahead for the energy system according to

young participants involved in the field of energy and sustainability.

Looking at the results from our previous Future of Energy report, we found that sustainability is expected to play an increasingly important role in the Energy trilemma. Climate change was pointed out as a key factor in shaping the future energy system. Technological innovation was envisioned as the main driver of change, and regulation had the highest foreseen level of disruption in the coming decades. Besides that, young energy professionals expressed a vision of the future system more decentralized and decarbonized, with demographic changes, resource scarcity and technology breakthroughs as the key determinants for what the future of energy looks like. This second edition of the Future of Energy is an initiative from the YES-Europe network to shed a light on the perspectives for 2050's energy system by young energy students and workers reports.

The need for a different energy system

Energy trilemma rebalancing

The World Energy Council's definition of energy sustainability is based on three core dimensions: Energy Security, Energy Equity (i.e. accessibility and affordability of energy supply across the population), and Environmental Sustainability of Energy Systems. Balancing these three goals constitutes a 'Trilemma', as it has historically been challenging to find a stable compromise between them. Nevertheless, solving this Trilemma is the only way to achieve a balanced system, that will enable prosperity and competitiveness of individual countries [1].

We asked the participants in this analysis where they would position their home country's energy system in the energy trilemma and where they expect it to be positioned in 2050. The grading system provided goes from 'very low', which represents the minimum, to 'very high', which instead represents the maximum.

Looking at the results, we see that the opinion of the respondents on the Security of Supply in the present energy scenario ("Today"), represented in blue on *Figure 1.1* is quite distributed between four of the five levels of importance. However, the pattern is noticeably different in the future scenario ("2050"), represented by the orange bars, with more than 75% of respondents considering it of high or very high importance.

Figure 1.1 - The three dimensions of the energy trilemma - security of supply, sustainability, affordability - perceived importance now and in 2050.

Figure 1.2- The three dimensions of the energy trilemma - security of supply, sustainability, affordability - perceived importance now and in 2050.

We can observe a drastic change in the opinions of the participants on the relevance of Sustainability from nowadays to the future energy system. **For the present scenario, the great majority of respondents believe that Sustainability is of low or medium importance in their home country.** In the future, instead, it is expected to become be a major concern, being considered of high and very high importance by most of the respondents. Lastly, Affordability is considered of medium importance overall in the present energy system. It turns to be a medium/high important concern for the future energy system. Overall, the young experts and students participating believe that, in their home countries, Security of Supply is the most relevant dimension in the present energy system, while Sustainability is receiving the least attention. Nevertheless, this is going to change in the future energy system with the energy system primarily focusing on Sustainability, while still giving a high relevance to Security of Supply. Hence, this will happen at the expenses of Affordability, the least impactful of the three elements. Figure 1.2 displays the drivers selected. As for the Energy Trilemma, the grading ranges from 1, very low, to 5, very high. It is interesting to compare this result with the data on the energy trilemma index of the World Energy Council [2]. At a regional level, the main focus for all the regions except for Africa lies on Affordability of energy. Most of the time, Security of Supply is the least relevant element of the trilemma. This is a sign of how differently young experts perceive the management and operation of their respective countries' energy sector.

Drivers of Change

Various can be the reasons for change in the present energy system [3]. When asking the participants for the most relevant triggers of this change towards the future energy system in 2050, we identified eight main drivers (*Figure 1.3*). **The young energy professionals and students consider Climate Change the most impacting driver for change**. Following Climate Change, we see that Technology Innovation is thought to greatly affect this change too, and hence expected to play a big role in starting the revolution of the energy system according to the participants. An important issue we are witnessing is the depletion of natural resources. These include fossil fuel resources, but also water, land and other important energy resources that can affect the energy system. The respondents consider Resource Scarcity one of the three most relevant key-trends motivating this change on par importance with Regulatory and Policy Change. Herein, we understand that **the respondents believe that a change in policy is needed and will noticeably influence the shaping of the new energy system.** Shifts in global economic power is the fifth most relevant driver. The economic balance of the different countries is changing, mainly affected by the economic growth of China [4]. This is going to be an important reason in the development of the future energy system. Medium to high importance is given to Social Pressure by Civil Initiatives. Although we are shifting towards a more active social participation in the topic of energy, with new groups forming such as Extinction Rebellion and Fridays for Future, the participants of this analysis believe this is not going to be one of the key elements of the transformation.

Lastly, despite the prospects from the United Nations (5) on the increase of population and migration of people towards cities (6), Demographic Changes was considered of medium relevance, with the highest level of respondents considering it of low or very low importance (27.5%).

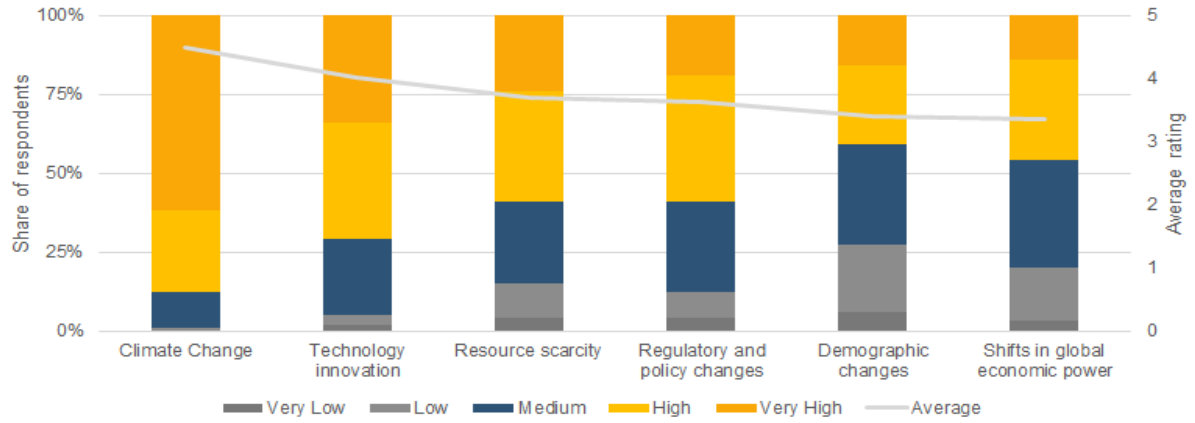

Figure 1.3- Distribution of answers about the level of importance of each mega-trend shaping the future of energy

Disruption of the energy system

Over the next 30 years, we will likely experience significant levels of disruption across all aspects of the energy system [7]. Disruptive innovation refers to an innovation that creates new market value, eventually disrupting existing market and value networks, to the point where existing markets and business models are displaced. It often comes from a combination of new technologies or business models, and it is likely to be motivated by emerging needs - needs that are not met by the existing market and that existing players cannot easily switch to provide. As an example, the current race for cleaner energy mixes is likely to result in a shift from the centralised and standardised energy system to one where digitalization and big data will allow for greater penetration of renewables, as well as a more customisable system for consumers. [8]

In regular market conditions, innovative solutions evolve from niche markets to mainstream when they present a clear advantage to either suppliers or consumers, in terms of a lower price or enhanced features over existing market assets [9]. However, ongoing political engagement towards clean energy transition targets will likely be an additional factor pushing the energy system towards disruption, even when the price signals are not yet favourable to their adoption. Other than that, considering that energy systems are highly regulated environments, it will be important to have the right policies to ensure new entrants are able to access the markets with alternative approaches.

Based on these considerations, we selected four different aspects of the energy system that are likely to suffer disruption over the next decades, influencing the energy system of 2050: policy and regulation, consumption and use, technologies, and business models.

We asked the young energy professionals and students to rate the foreseen level of disruption from 1 (very low) to 5 (very high). Other than disruption in specific sectors of the energy system, only a harmonious and holistic approach will allow for a complete disruption across the whole energy system. For this reason, we also asked the respondents to rate what they believe will cause overall disruption of the energy system.

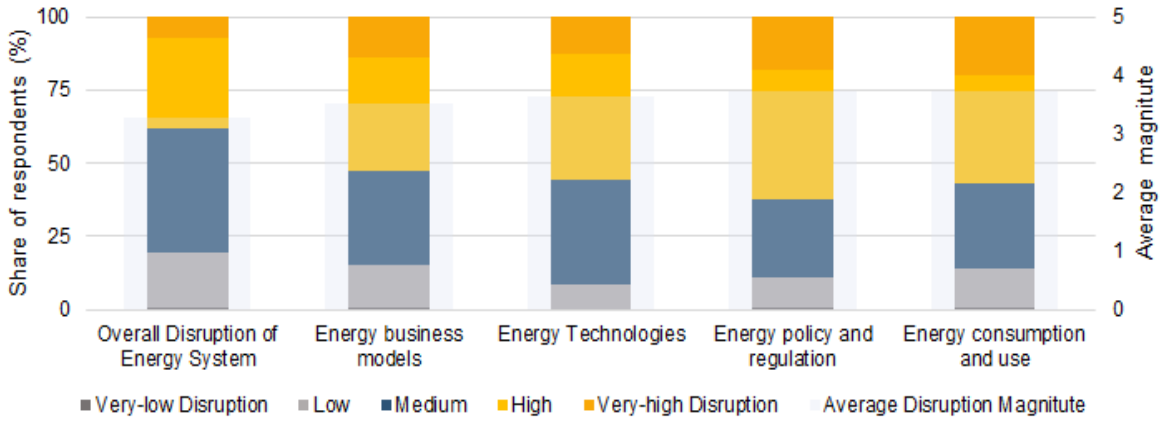

Figure 1.4 - Expected levels of disruption in key areas of the energy sector over the next three decades, ordered from lower to higher average disruption magnitudes.

Results revealed that the Overall Disruption of the energy system was rated as the aspect that will experience the lowest levels of disruption (see second axis on Figure 1.4). However, when looking at the individual aspects of this disruption, namely the technologies, policies, consumption patterns and business models, more than half believes the disruption will be high or very high for all of them individually. In particular, **62.5% believe the disruption of the Energy Policy and Regulation will be high or very high**. This reinforces the results from above - 60% of respondents considered Regulatory and Policy Changes a driver of high or very high importance - making it clearer that youth holds policy and regulation as highly accountable for the development of the energy system.

Bearing in mind the previous results - where technology innovation was mentioned as the second main driver of transformation - only about half (56%) believes the disruption in Energy Technologies will in fact reach a high or very high level.

Disruption by region

The ongoing energy transition will inevitably impact the world on a geopolitical level. There will be shifts in power, trade and supply chains based on the countries' ability to invest, adapt, and innovate towards a clean and just energy transition. Because the energy system has repercussions on the social, economic, and environmental spheres of society, the transition will bring a number of challenges and opportunities. These may be aggravated at regional level by pre-existing conditions: political and economic stability, fossil fuel dependency, extreme climate occurrences, etc.

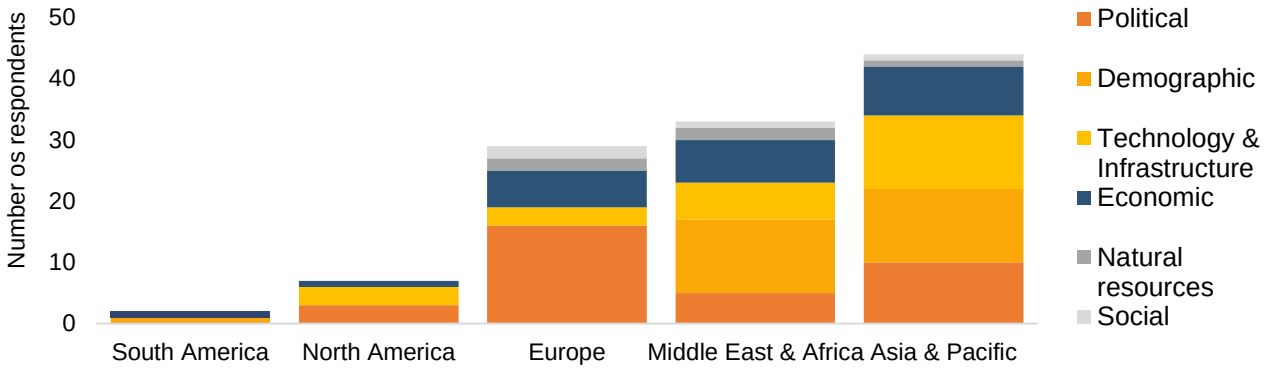

Figure 1.5 - "In which continent do you envision the most disruption on the energy sector happening in the next 30 years?" Key factors pushing disruption of the energy system on a regional level over the next decades

Large economies are increasingly powered by renewables. While Europe leads globally in terms of climate action commitment, there are a number of emerging markets in the Asia & Pacific region, like China and India, that are experiencing a renewable energy boom. On the other hand, in many countries, energy policies are not sufficiently aligned with climate goals. In particular, regions with high dependence on fossil fuel exports will likely be in a more vulnerable position, unless they adapt their economies and implement the right policies and strategies [10].

> [referring to Asia & Pacific] "That is the area with the highest demographic and economic growth at the moment and already count for half of the world population, so the role of that massive amount of people consuming and expending energy will be quite important in terms of overall energy situation worldwide."
>
> *(quote from survey respondent, with background in renewable energy sources and sustainability)*

In regions like the Middle East and North Africa, which will likely experience declining export revenues, local economies will suffer pressure to compensate for the loss of income and jobs available. The USA is an exporter of natural gas and oil, and the current political paradigm seems unfriendly to the clean energy transition. However, the nation is well positioned to lead in the clean energy industry, due to its investments in clean energy innovation, such as robotics, AI, and electric vehicles. More than defining national plans for the transition, containing climate change and global warming will depend on a closer cooperation across regions, to transfer both technology and expertise [11]. For instance, Africa as the least developed region, would significantly benefit from the expertise of developed countries to leapfrog the fossil fuel-centred economy to one based on domestically generated renewable energy, simultaneously boosting job creation and access to basic needs like electricity.

When asked to identify the regions of the world that will see the most disruption over the next 30 years, the highest share (60.5%) of the respondents, elected the Asia & Pacific region. It was followed by Europe (48.7%) and Middle East and Africa (33.6%).

Demographic reasons, as well as technology and infrastructure availability were the main reasons appointed for the disruption in Asia & Pacific region, but political reasons were also often appointed. For the European context, political reasons were by far the most mentioned reason for disruption, whilst demographic reasons are predominant for Middle East and Africa. South America and North America were the least mentioned (less than 10 mentions)

"Europe may experience problems with its high dependence on gas that is not produced there: political instabilities in Africa, Russia and so on may generate a negative impact on energy security in Europe. Africa's economy and demography will change in the future and it needs strong investment in energy sectors they do not have. China, India and other countries with developing economies may experience too many efforts in change their energy generation to fight climate change, because they cannot afford this goal alone."

(quote from survey respondent, with background in nuclear energy)

Key Highlights

- **While 75% consider sustainability today of low or medium importance, 74% think sustainability in 2050 is of high or very high importance.**
- **In the Energy Trilemma, Affordability and Sustainability are respectively the least and most relevant parameters for the future energy scenario.**
- **Climate change is undoubtedly the main driver requiring a change of the energy system.**
- **Accelerated Urbanization and Demographic changes are the least impactful of the drivers considered.**
- **When asked to rate the level of disruption of various aspects of the energy system, results revealed 62.5% expect that disruption of the energy policy and regulation will be high or very high.**
- **Asia & Pacific is seen as the region of the world most likely to experience disruption of the energy system. Main reasons for this would be demographic changes and technology and infrastructure availability.**
- **Overall, when identifying reasons for upcoming disruption globally, the main reasons pointed out by the respondents were of political nature (e.g. Europe's commitments to the energy transition).**

The vision for 2050

Future of Energy

When asked about the vision of the future energy system our respondents gave us noticeably different opinions. We can group them in three scenarios which are defined below. We distinguished the three different scenarios on the analysis of mainly two characteristics: how sustainable and how centralized or decentralized the envisioned energy system is.

Sustainable Smart Scenario (SSS)

In this scenario, the energy is supplied almost entirely by renewable energy such as solar and wind. This is possible thanks to a big advancement in storage technology which makes it possible to take bigger advantage of renewable despite their volatility.

"The residential sector is completely off-grid/self-sufficient through small island grids with PV, PVT, storage/hydrogen storage. All the sealed surfaces must have PV, directly connected to power to gas technologies. Hydrogen is applied for mobility and heat."

(quote from survey respondent, supporter of the SS scenario)

Digitalization of the energy infrastructure is a key element to reach this goal. Internet-of-Things, smart metering and demand-side management are some of the tools necessary to make the energy system more flexible and dynamic. This is necessary due to the new energy distribution system. It is not anymore centralized with big production sites but decentralized with many smaller energy production units.

The consumers become prosumers. Furthermore, thanks to the connections of these individuals, we see the emergence of microgrids and energy communities. A microgrid is a cluster of loads within the low voltage electricity grid connected into a smart grid. It can operate both autonomously and connected to the national grid. These systems offer the possibility to reduce the load on the national grid by party covering their energy demand with locally generated energy.

We see a reduction of emission of the energy system also in the transportation sector. Electric vehicles make a real impact on society and become an essential element.

Sustainable Traditional Scenario (STS)

This is a similar scenario to SSS since it mainly relies on energy generated from sustainable sources. However, renewable energies only have a secondary role in the energy mix. The entire baseload comes from nuclear energy.

Storage technology did not make an impact as in the SSS due to technological limitations. Herein, there is a more direct consumption of the energy produced. Therefore, we see a more centralized infrastructure for the distribution of energy with fewer big production sites providing most of the energy to the end users.

After years of research, we see the first fusion plants operating. This offers us unlimited clean electricity.

Renewable energy is still included in the energy mix, which is mainly used as a back-up. It covers the fluctuation of the demand over the day by using a storage technology similar to the present days.

Also, this time, thanks to greener technology, the emissions from the transport sector are drastically reduced. The transport is electrified and powered with clean electricity generation.

"Most of it is produced by nuclear power. Household energy consumption has decreased a lot. Renewables are used where it's smart to use them."

(quote from survey respondent, supporter of the ST scenario)

Neutral Balance Scenario (NBS)

In this scenario, the future is not expected to differ greatly from the present. Humanity did not hit the sustainability goals, although achieving some technological improvement in energy generation and consumption. Politics, society, and economy are the limiting factors slowing down the change.

respondents see the political system and the society of some of the developed countries not focused on pursuing greener energy. This is the case of the United States, where according to the participants to the analysis there is a need for a drastic change.

Developing countries still rely on fossil fuels. Due to the economic limitations and growth needs of these countries, they need to rely on oil, coal, and gas for the generation of energy. Moreover, the population of these countries keeps growing with a further increase in energy demand.

As a result, the improvements achieved by some countries are not enough to offset the substantial greenhouse gases emissions worldwide.

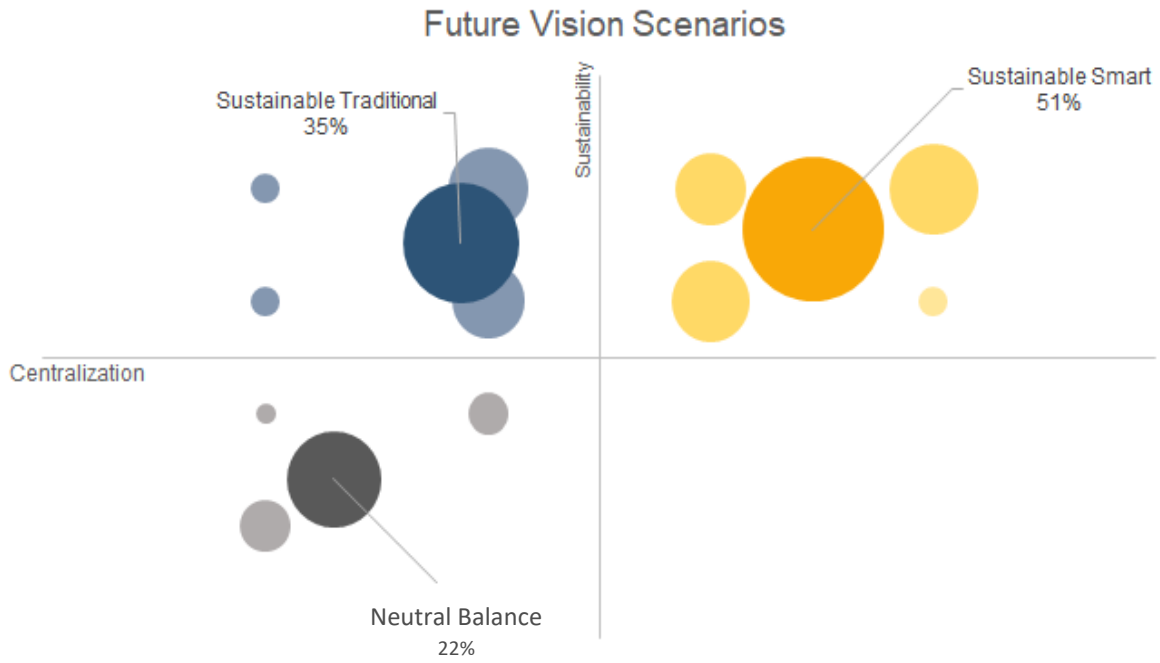

Figure 2.1 - Distribution of scenarios for the Future of Energy - Sustainable Smart Scenario (SSS), Sustainable Traditional Scenario (STS) and Neutral Balance Scenario (NBS) - according to rated levels of centralisation and sustainability

In developed countries, there is a more intense use of renewable energy or shifting to cleaner fossil fuels, such as gas. However, our

"I imagine that the energy in countries with advanced economies will be less dependent on coal and oil, but more on gas, mostly for the low capacity factor of renewables, so efforts in these countries will be driven more on efficiency. In developing economies, a strong dependence on coal may remain without the intervention of advanced economies."

(quote from survey respondent, supporter of the NB scenario)

When we analysed the vision on the energy trilemma according to the different scenarios, we better identify their opinion. In the present energy system, the scenarios do not differ noticeably. However, the STS considers Sustainability a more relevant parameter than the other two scenarios.

In the future energy system, the differences between scenarios are clearer. We see a similar order of priorities of the energy trilemma parameters between the STS and SSS, with the latter giving slightly higher relevance to all three parameters.

Nonetheless, the Security of Supply is the most important parameter for the NBS, not sustainability anymore. Furthermore, all the parameters have a lower magnitude of importance in this scenario compared to the other two.

Analysis of Scenarios

When we analyse the vision on the energy trilemma according to the different scenarios, we better identify their opinion. In the energy system of today, the scenarios do not differ noticeably. However, the STS supporters considers Sustainability a more relevant parameter than the other two scenarios.

In the future energy system of 2050, the differences between scenarios are clearer. We see a similar order of priorities of the energy trilemma parameters between the STS and SSS supporters, with the latter giving slightly higher relevance to all three parameters. On the other hand, the NBS supporters still consider Security of Supply the most important parameter for the future energy system, not Sustainability anymore. This goes in line with the NB vision for the future, where sustainability is not the main focus.

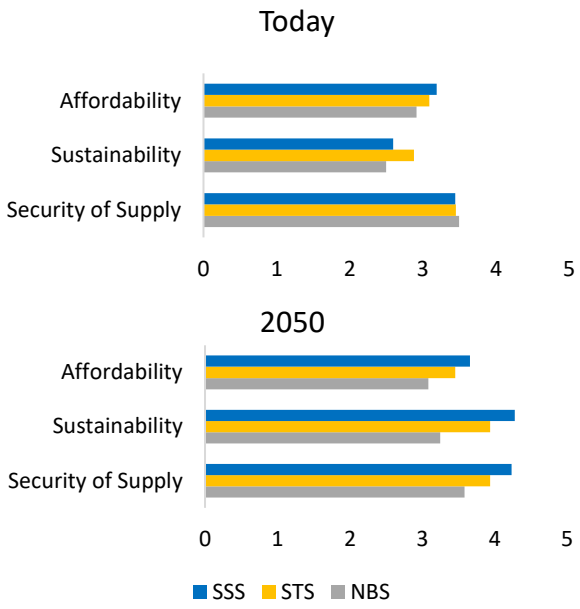

Figure 2.2 – Analysis of energy trilemma responses, grouped according to future of energy scenario (SSS, STS or NBS)

Citizens Interaction

An important aspect for the future energy system is the level of interaction from the citizens. This interaction can differ greatly, depending on the way the energy system is shaped, and which technology is applied.

Furthermore, the kind of interaction is also determined by the degree of the user's awareness upon the energy system.

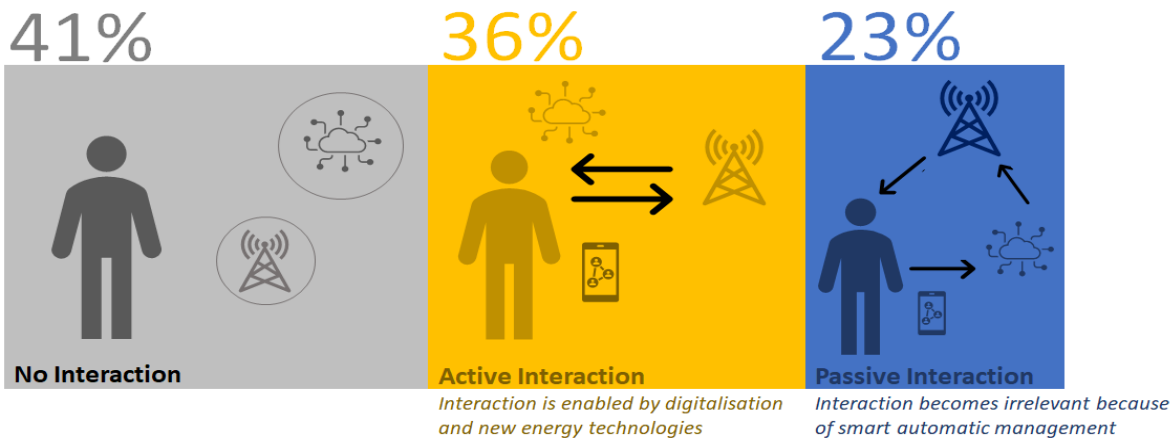

Figure 2.3 - How will citizens interact with the energy system of the future? Answers grouped according to three categories of interaction

There is an overall divided vision regarding the influence of technology. **41% of respondents consider the future interaction similar to the present** ("*I believe that despite the possibility of the citizens to operate as prosumers, an average citizen will have only a role of the consumer. [...] The problems in energy production should be solved by energy experts, not by every citizen by themselves.*"), 36% imagine an interaction mainly through digitalization and direct local generation of energy from the end-users ("*The awareness about energy policies and environmental concerns is growing fast and the last few years' trends show it. With some luck by 2050 people will have the tools and possibility to interact with this world.*"), whilst 23% imagine an advancement of technology that automates the operation of the energy system removing every need of interaction from the user ("*I imagine the citizens to have less direct interactions with the energy system due to the rise of technologies that make humans less efficient to manage it*. [...]").

The degree of user's awareness is balanced too. **A small majority of people believe that the process towards the future energy system is not going to lead to an increase of energy-related awareness (55%).**

Looking into scenarios we see a clearer pattern. In NBS we see a high majority thinking that interaction through technology is going to be like today (63%). Same for STS with 48%. For SSS respondents instead, 55% imagine an interaction between citizens and the energy system thanks to technological improvement (i.e. interaction via mobile phone). NBS and SSS both agree that the future citizen is not going to be noticeably aware of its energy usage (respectively 70% and 64%). The 69% of STS instead foresee a drastic change. SSS imagines a future where the citizens are interacting with the energy system by directly participating in the generation of energy, in the new decentralized energy system. However, this is not always going to affect their awareness over their energy consumption being this a choice mainly dependent on policies or economical interest. Regarding NBS, there is not a high expectation for the citizen to become more involved with the energy system.

Extendibility

After the respondents expressed their vision of the future energy system, we asked them whether they consider it extendable globally.

The results show that half of them do not consider that possible. The remaining expressed that either it is extendable (39%) or somewhat extendable (11%), which would depend on several factors.

When aggregating these answers according to their respective vision for the future of energy (as per the 3 scenarios described before), we can see that the ones who envision an energy system based on the SSS are the most likely to say that it is extendable globally. As for the motives behind their answers, **those who don't believe their vision is extendable attribute it mainly to economic (28%) and resource related reasons (28%)**, followed by political reasons (17%).Technology availability or lack of it (13%), social aspects (10% and demographic pressures (4%) were less often appointed.

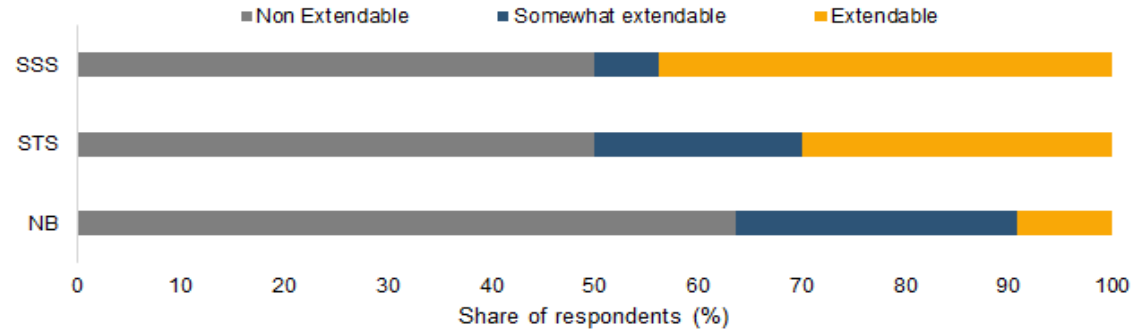

Figure 2.4 – "Is the system you envision extendable all over the world?" Answers grouped according to scenario supported

The road towards the Future Energy System

Thinking long term can leave a lot of room for uncertainty. As seen up until now from the survey results, energy students and young professionals have very different perspectives about what the future of Energy holds. To better understand what the key issues are potentially affecting the future of energy, we asked the respondents to select from an optional 9 aspects the ones worrying them the most. In the figure below we can see the share of respondents selecting each option. Looking into the results, a clear majority (72%) referred to climate change. This is a factor that seems to affect youth on a common level, regardless of what they hope or dread for the upcoming energy system. In line with previous results, lack of social and political engagement is the second most mentioned (64.7%) uncertainty. In particular, political factors have so far been mentioned often as highly impacting on the energy system. Almost half the respondents (47%) feel uncertain about the development of energy storage technologies.

When crossing these answers with the scenarios chosen, we found that SSS and STS supporters are similarly more uncertain about Climate change, however **NBS supporters are most concerned about Adverse economic policies**. Sustainability in dismantling obsolete technologies and Cyber security are factors that only raise mentionable concern for around 15% of respondents, which may be explained by the fact that they are issues that only very recently came to the attention of the general public.

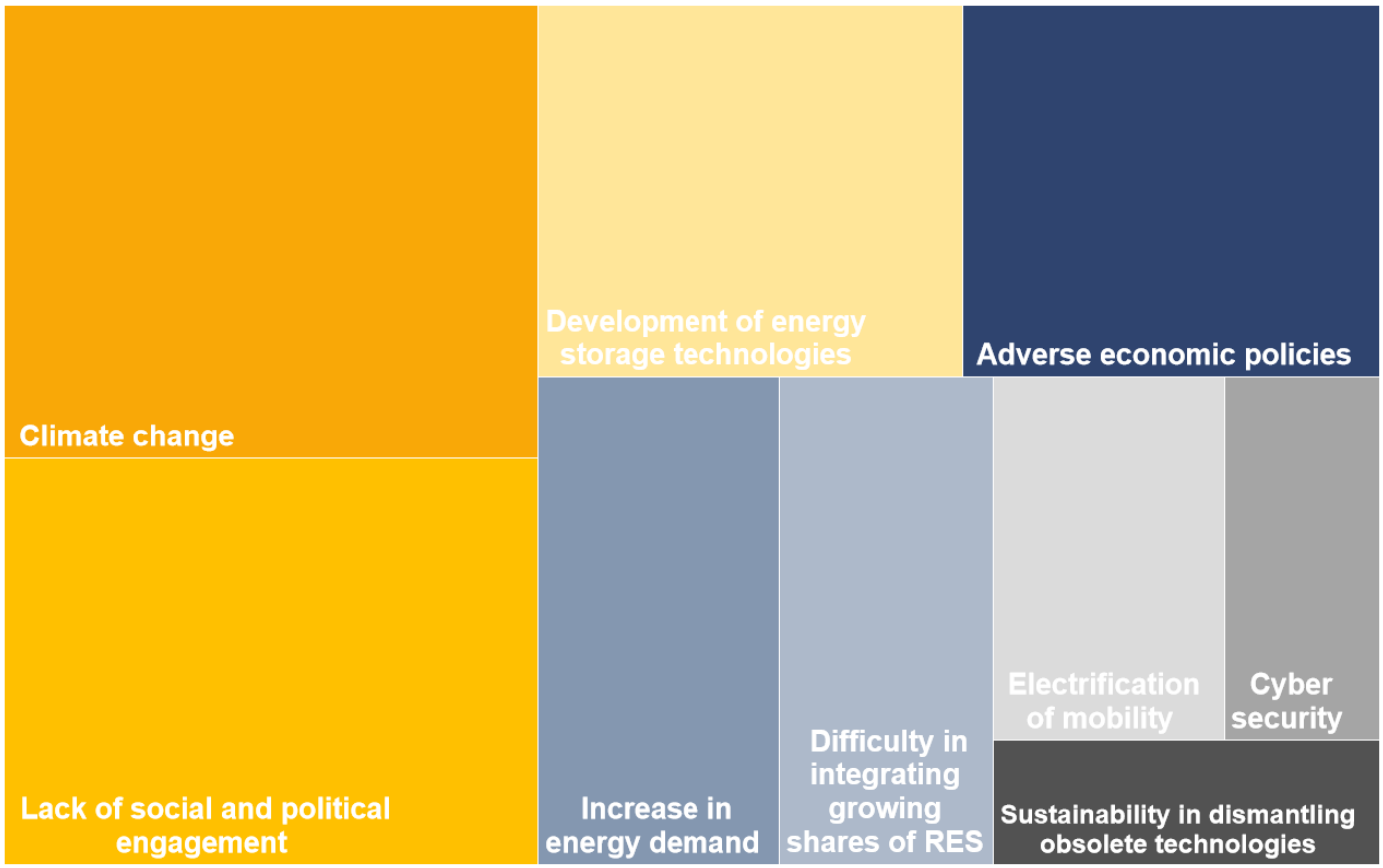

Figure 2.5 - What are the key uncertainties about the future of energy that keep you up at night?

R&D investment

In many countries, the path to replacing the current fossil fuel-based system is still unclear, partially because clean energy systems are still either too expensive or perform too poorly. To achieve a globally sustainable energy system over the next decades, considerable investments in clean energy technologies and systems are required, particularly in Research & Development (R&D), to enable innovation on a massive scale. Additionally, according to Information Technology & Information Foundation (ITIF), population growth and rising energy demand could outpace energy decarbonisation if the proper investments in R&D are not in place. One of the biggest global commitments to this cause was the Mission Innovation initiative, started in 2015 in parallel with the Paris Agreement. Under this initiative, its members (24 nations and the EU) have invested billions of dollars mostly in renewable energy ($8.7 billion), grid integration, transmission and storage technologies ($4.1 billion), followed by transport, hydrogen and fuel cells, buildings and appliances and CCS.

We wanted to check if the worldwide investments in R&D are aligned with the respondent's priorities. For that reason, we asked the energy students and young professionals how they would manage their country's funds for R&D in the energy sector given 7 options, to rate according to their relevance (see Figure 2.5). **Renewable energy technology was the most prioritized R&D option (79% ranked a high or very high priority)**, followed by efficiency in energy consumption (76%) and sustainable mobility (69%). The least chosen options were Nuclear Energy and Carbon Capture and Storage (CCS), ranked as a high or very high priority by only 28% of respondents. As expected, the respondents more likely to select Nuclear energy as a high priority were those who

shared a vision of the future according to the STS - which is mainly represented by nuclear centralized energy production. In fact, **from all R&D options, Nuclear energy is the most likely to be prioritized by STS supporters**. On the other hand, supporters of the NBS are more likely to support Renewable energy technologies than other R&D options, and less likely to support nuclear energy. Supporters of the SSS however, are most likely to choose Energy storage technologies as a high priority for R&D. This makes sense considering that a system highly based on variable and decentralized renewable energy sources will require high flexibility capacity.

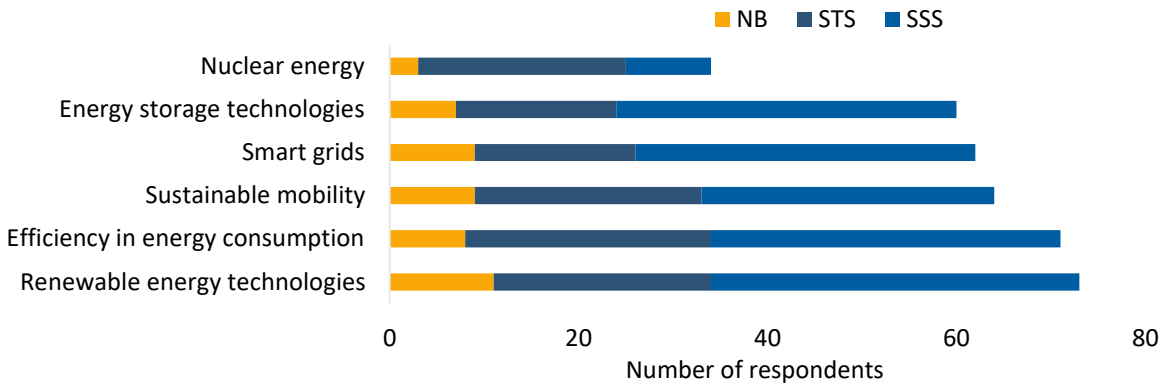

Figure 2.5 - What R&D options would you prioritize if you had the chance to manage your country's budget? R&D options more likely to be prioritized (high or very high priority) and grouped according to scenario supported

Smart systems: the future of Energy?

In the future, automation and smart systems may become key solutions to help increase energy efficiency and help integrate growing shares of renewable energy sources. We asked the energy students and young professionals how willing they would be to invest in an automated energy management system for their house, considering a scenario where smart meters and smart appliances are widely available. As shown in the figure below, from a rate between 1 (not willing) to 5 (totally willing), the average willingness to invest in such a system is 4.2 - which would be an overall positive result towards this technology.

We wanted to understand what could be the respondents main concerns about these new technologies, so additionally we asked them to rank from 1 (not concerned) to 5 (very concerned) a number of possible implications associated with domestic smart energy systems. We found that, on average, **the main concern lies in the economic factor** (60% expressed concern) and that, from the four options given, the **loss of control over residential appliances was the least worrying** (40% stated not being concerned). In addition to the four areas of concern, other factors mentioned by the respondents were hackerability, lack of confidence in how effective these technologies are to reduce energy consumption, besides likeability of them becoming obsolete. Accessible to everybody regardless of financial means was also mentioned.

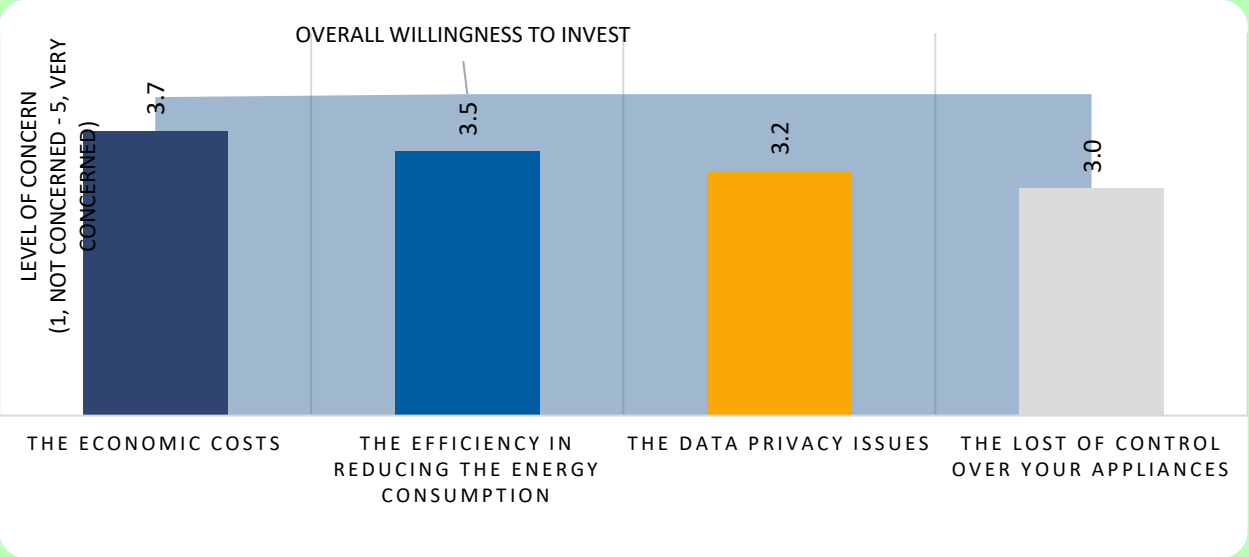

Figure 2.6 – "Consider a scenario where smart meters and smart appliances are widely available". Factors of concern regarding smart residential technologies, ordered according to level of concern, and overall willingness to invest in such technologies (from 1 to 5)

Top-down or bottom-up?

How do we need to shape our future energy system in terms of governance? Following a top-down or a bottom-up approach?

The top-down approach relies on higher authority figures to determine larger goals that will filter down to impact the lower levels, such as the citizens. In comparison, the bottom-up style features a decision-making process that gives the lower levels a voice and a possibility to participate in the process by, for instance, giving inputs.

Some of the respondents believe the best way to develop into the new energy scenario is with directions and roadmaps by the government, therefore, a top-down approach. Another possibility is to witness change thanks to the involvement of citizens, associations, and more generally non-government organizations. We consider this as the bottom-up development. Finally, there is the possibility to combine the two above mentioned by assisting change with both the government and citizens collaboration, which is represented by the Mix case.

The graph displays how balanced are the opinions of the young energy professionals participating in the survey. We see a slight difference between bottom-up and top-down both being the most selected options. Nevertheless, the mixed case still accounts for almost 24% of the responses.

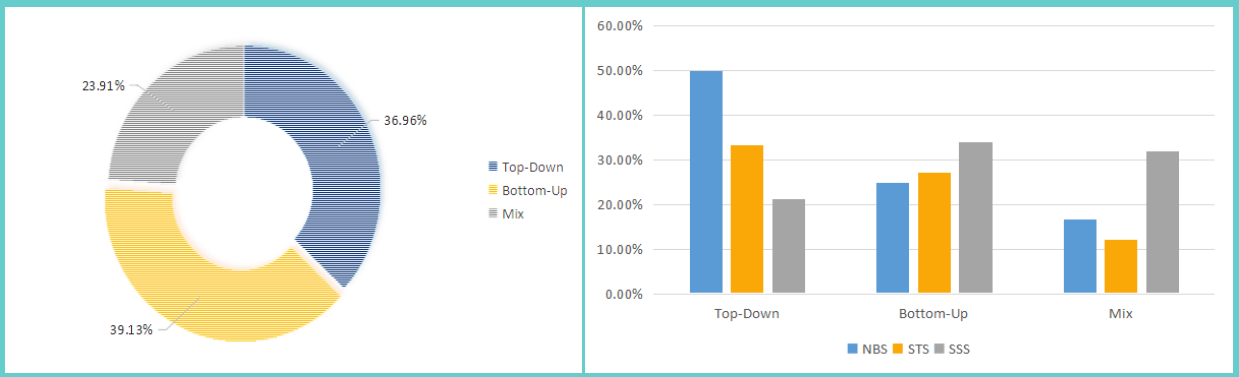

Figure 2.7 - Share of respondents supporting the two different governing approaches - bottom-up or top-down, and grouped by respective vision of the future of energy (NBS, STS or SSS)

Key Highlights

- The different visions for the future energy systems are grouped into three scenarios: neutral balance scenario (NBS), sustainable traditional scenario (STS), sustainable smart scenario (SSS).
- Overall, 39% believes that the future energy system is going to be managed in a bottom-up approach.
- A slight majority considers the citizens to have no relevant interaction with the future energy system. We see this trend more clearly in the NB and STS scenarios.
- Half of the respondents believe that their vision of the future energy system is not extendable globally.
- Most respondents (74%) referred climate change as a key uncertainty for the future of energy they imagine. In line with previous results, lack of social and political engagement is the second most mentioned (64.7%) uncertainty.
- Renewable energy technology was the option more prioritized for R&D investments by the young respondents (79% ranked a high or very high priority), followed by efficiency in energy consumption (76%) and sustainable mobility (69%).
- As for smart home energy systems related concerns, we found that the major concern lies in economic factors. The loss of control over residential appliances was rated the least worrying aspect.

Conclusions

The Future of Energy 2020 report helps us understand what lies ahead for the energy system. Young energy leaders from 33 different countries participated in this analysis. We can conclude that the overall vision of most respondents can be summarized in four main points: first, in terms of national priorities, young energy professionals foresee a strong shift towards sustainability. Climate change is seen by most as the key defining trend for the future of energy.

Second, energy policy and regulation will be the key aspect disrupting the current energy system. In terms of governance for example, this could translate into a shift towards bottom-up governance, from the traditional top-down. In the opinion of the respondents, Asia & Pacific is the region more likely to experience disruption in this sector, mainly due to demographic aspects, technology, and infrastructure availability. In fact, considering the diversity at regional level, it comes to no surprise that half of the participants do not think that the future energy they envision will look the same across the globe.

Third, most of the young energy professionals envision a more decentralized and decarbonized energy system by 2050. When it comes to citizen interaction with the energy system, there is no common vision on what the future holds. For the specific scenario of a heavy application of smart home energy systems, the cost factor was reported as the main concern.

Fourth and last, the young energy leaders believe that nations should heavily invest in renewable energies and efficiency of energy consumption.

These insights prove the young generation is aware of the challenges the industry faces. The consensus around the importance of climate change and sustainability comes together with a sobering dose of realism. Young leaders in energy and sustainability acknowledge the complexity of meeting growing energy demand while delivering technological innovations that contribute to the shift towards sustainability. However, these results should build up optimism and confidence in senior energy professionals, policymakers, and educators. The young leaders in energy understand the challenges ahead and foresees a more sustainable system, that they will work to realize.


CHANGE HUMANITY NOT
SAVE ME!
JUSTIÇA CLIMÁTICA
ATE VIM DE CAMISA PARA VER SE ME LEVAM A SÉRIO
FAZ PELO CLIMA
F**K THE SYSTEM SAVE OUR PLANET
MUDEM O SISTEMA NÃO O CLIMA!
ENERGIA LIMPA PARA UM PLANETA SAUDÁVEL
ZERO WASTE
APRENDE A NADAR

References

1. World Energy Council, World Energy Trilemma Index, World Energy Council, London, 2019
2. World Energy Council, Energy Trilemma Index [website], 2020, https://trilemma.worldenergy.org/#!/energy-index, (accessed 14 October 2020)
3. Scheidel, A. and Sorman, A. H., 'Energy transitions and the global land rush: Ultimate drivers and persistent consequences', Global Environmental Change, Volume 22, Issue 3, August 2012, pp. 588-595
4. The World Bank, GDP Ranking [website], Last Updated July 2020, https://datacatalog.worldbank.org/dataset/gdp-ranking (accessed on 27 September 2020)
5. United Nations, Department of Economic and Social Affairs, World Population Prospects 2019 Highlights, New York, United Nations, 2019
6. United Nations, Department of Economic and Social Affairs, World Urbanization Prospects The 2018 Revision, New York, United Nations, 2019
7. Strategy& and Pwc, Capturing value from disruption. Technology and innovation in an era of energy transformation, Pwc Global Power & Utilities, 2016
8. McKinnon, S., Mulhall, R. and Owen, E., 'Disruptive innovations in smart electricity systems: Opportunities and challenges for sub-Saharan Africa, Energy Insight', Energy and Economic Growth, June 2019
9. Same as 8. 8 and 9 are the same file
10. IRENA, Global Energy Transformation, A Roadmap to 2050, International Renewable Energy Agency, Abu Dhabi, 2019
11. World Energy Council, Deciding the Future: Energy Policy Scenarios to 2050, Executive Summary, World Energy Council, London, 2007

About YES-Europe

Our vision of the future

A world where energy is more sustainable, accessible, and secure!

Our Role

YES-Europe connects and empowers young leaders passionate about energy and sustainability across Europe.

Our Activities

We organise online or in-person events, either at the international or the local level. Our team releases energy reports, we organise webinars and are active at the political level.

Follow our activities on:

Do you want to be part of our team? Join us, we are recruiting! Click here for more details!

YES Europe