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Diffusion of Renewable Microgeneration on the Side of End-User: Multiple Case Study

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Abstract: The development of microgeneration plays an important part in the strategy of the decarbonization of the world economy. However, its diffusion faces different barriers, including the information and technical barriers on the side of the end-user. This paper contributes to the literature by providing a comparative cross-country analysis of the role of the corporate sector in providing the installation and technical servicing of PV solar panels and small wind turbines in the Republic of Armenia, India, Russia, and the United Arab Emirates. Business proposals from the microgeneration equipment market were analyzed by studying the official websites of companies offering autonomous and backup power supply solutions, followed by interviews with company representatives using the "mystery shopper" method. The study reveals that, of the four surveyed countries, the Republic of Armenia has the highest level of representation of service companies on the Internet (4.71 companies per million population). It is followed by the United Arab Emirates (1.9 companies per million population) and the Russian Federation (0.29 companies per million population). India ranks last in this indicator (0.02 companies per million population). The Republic of Armenia has the highest level of corporate sector development, with such essential features as cooperation with commercial banks for providing potential consumers with financial support and involvement in educational activities for the population. The main feature of the Indian corporate sector is orientation on the B2B format in building customer relationships. In Russia and the United Arab Emirates, the effect of implementing large projects with state support is still limited and does not extend to the general population.

Keywords: energy policy; renewable generation; microgeneration

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1. Introduction

In recent decades, the climate agenda has been the main driver of growth in the global market for generating equipment based on renewable energy sources (RES). According to the NetZeroby2050 strategy, the share of renewable energy in the power industry should increase from 29% in 2020 to 61% by 2030 and 88% by 2050. An accelerated transition to RES should ensure the control of greenhouse gas emissions and contribute to sustainable growth in the energy sector [1,2], while microgeneration is considered the most promising method for minimizing losses in the transmission of electricity [3]. The development of microgeneration plays a significant role in the strategy of the decarbonization of the world economy. According to NetZeroby2050, the number of households using PV panels (as the most advanced RES-based microgeneration technology) should increase from 25 million in 2020 to 100 million in 2030 and up to 240 million by 2050, and the share of solar and thermal energy in building heating should increase from 2% in 2020 to 5% in 2030 and 12% by 2050 [4,5].

Decentralized energy technologies make it possible to reduce the cost of meeting the needs of individuals, households, and small businesses. The development of microgeneration can create new sources of income for individual families and small and medium enterprises. In addition, the development of microgeneration contributes to the creation of new jobs in technical services. The number of consumers producing electricity at home is rapidly increasing in some developed countries. A vast body of the scientific literature indicates that the main incentives for the installation of microgeneration equipment based on RES are the desire for energy independence [6], lower payments for electricity [7], social beliefs [8], societal influence [9], following the trends that have developed in society under the influence of advertising, the information policy of the government, and observation of the behavior of neighboring consumers [10], as well as a high level of environmental awareness [6]. However, it should be noted that all these motives are of current interest in countries with a high level of government support for the development of RES in general and microgeneration specifically, which makes it possible to reduce financial barriers to the development of microgeneration. In addition, the markets for generating equipment are mature in these countries. They have enough manufacturing and service companies that can quickly and efficiently provide services for selecting, installing, connecting to the network, debugging, and maintaining generating equipment.

In recent years, the number of countries paying attention to the development of RES has constantly been expanding. Countries with a relatively low level of income per capita and even countries with excess hydrocarbon resources are gradually joining this process [11]. As a rule, the development of RES begins in the previously mentioned countries with the implementation of large projects with government support, which allows them to master innovative technologies, develop and adapt the legal framework, and popularize RES among the population [12]. Examples of countries that have recently implemented large solar and wind projects include Armenia, India, the Russian Federation, and the UAE (Table 1).

Table 1. Net capacity change (electricity) in 2021 (MW) in selected countries.

Country	Net Capacity Change in 2021 (MW)	Solar and Wind Capacity Change in 2021 (MW)	Solar and Wind Capacity Change in 2021 (%)
Armenia	+88	+88	+100
India	+16,505	+11,808	+71.54
Russian Federation	+1322	+1243	+94.02
United Arab Emirates	+777	+517	+66.54

Source: authors' calculations based on [13].

However, these countries have not yet paid serious attention to the development of government policy supporting the high penetration of microgeneration based on RES. The reasons vary from a lack of funds to stimulate the population (Republic of Armenia) to a lack of interest in changing the energy market structure (Russia). Nevertheless, the people of these countries are gradually becoming involved in using renewable energy and prosumerism [13,14]. The drivers of this process have not been sufficiently studied in the literature. There is still a contextual research gap in the area of study of «new players»: countries at the initial stage of expansion of the most mature RES technologies and with weak legislation and incentives in the field of microgeneration.

The purpose of this study is a comprehensive comparative cross-country analysis of the role of manufacturing and service companies in promoting the diffusion of renewable microgeneration for end-users in countries that are at the initial stage of expansion of the most mature RES technologies (solar and wind energy). This provides a starting point for tracking the political consequences of the introduction and/or improvement of the relevant legal framework by government policies for the further progressive development of this market. The central research hypothesis is that, in the absence of systematic and comprehensive government support for microgeneration based on RES, the leading stimu-

lating role is taken by manufacturing and service companies that were created due to the implementation of large-scale projects and are the most interested party for the further development of the RES equipment market.

For each country included in the analysis, the study was carried out in two phases. During the first phase, we examined the current government regulations related to the development of renewable energy sources (RES) as well as the overall status of energy development within the country. In the second phase, we analyzed business proposals from companies offering microgeneration equipment by reviewing their official websites. Additionally, we conducted interviews with company representatives using the "mystery shopper" approach to gather further information about the companies' autonomous and backup power supply solutions. The study evaluated quality, the range of the service provided for the selection and installation of generating equipment, the brands offered, the price range, the availability of warranty and post-warranty service, and additional services that facilitate the adoption of technology by the consumer. In our study, we focused on solar and wind renewable energy sources, as these types of energy account for the largest share of renewable energy in all the studied countries and are most often used for microgeneration. For example, in India, the share of biomass is 7% and of small hydropower plants is 3% compared to solar at 34% and wind at 26%; there are few companies on the market that provide these types of services. The UAE uses only solar and wind energy; other types of RES are not developed at present.

The rest of the paper is organized as follows. Section 2 reviews the existing literature on barriers and drivers for the adoption of PV and other microgeneration technologies. Section 3 describes the method of companies' analysis and evaluation of their role in market development. Section 4 reports the results of the empirical study and their discussion for each country. Section 5 presents conclusions.

2. Literature Review

The study of various barriers to introducing energy-efficient technologies, which include the microgeneration of energy based on RES, is the subject of many original research papers and systematic literature reviews. The majority of authors place emphasis on the idea that the primary obstacles to prosumer adoption are monetary and financial in nature. These obstacles are primarily related to the costs and investments associated with the acquisition of the requisite technologies and equipment [15–17]. In this case, lack of access to private or government investment funds prevents the achievement of socioeconomic potential [18,19]. In addition, existing business models in the electricity market do not allow prosumers to operate efficiently and obtain more profit from the use of microgeneration equipment [20]. Therefore, many stimulus policies in developed countries aim to remove the capital cost barrier and reduce the risk of non-return of investment in microgeneration equipment [21–23]. The lack or absence of such stimulating policies can block the development of energy-efficient technologies [24].

The broader dissemination of microgeneration faces significant obstacles such as insufficient infrastructure, institutional underdevelopment, and inadequate information, knowledge, and awareness [24–27]. Although government support, such as subsidies or tax incentives, may be necessary to overcome financial barriers, the corporate sector can play a significant role in reducing and eliminating infrastructure and information barriers [28,29].

Thus, in [30] it is proved that renewable energy development has spillover effects for stimulating innovation and increasing innovative activity and human capital development. The authors conclude that "décentralisation of the energy industry gives more room for private sector participation". The potential created because of the implementation of the first successful projects in the field of renewable energy can become a driver of RES development in the future. In [31], the role of so-called positive-impact companies (PICs) in improving customers' environmental awareness and transforming their values is analyzed. Companies help reduce infrastructure barriers by developing new services and offering their customers new business models [32,33].

It is important to acknowledge that consumers can encounter marketing or public policy campaigns throughout any stage of the adoption decision process. However, in order for a message to be effective it must be tailored to the intended audience. Consumers who are in the initial stages of the adoption process, such as the awareness stage, are more receptive to certain types of messages and information compared to those who are evaluating the innovation's characteristics, such as during the persuasion stage. Therefore, it is crucial for marketers and public policymakers to understand which individuals are aware of what, and what socioeconomic factors may influence the level of awareness. This knowledge can greatly assist in promoting the diffusion of microgeneration technologies in a more efficient manner [34]. Social recognition is necessary for the successful dissemination of new technology in society [35,36], especially for microgeneration systems that affect consumers both passively and actively [37]. The lack of adequate information about the possibilities of new technologies is reflected in the unwillingness of the local population to participate in new projects, mainly due to their uncertainty about financial results [38]. Human readiness to participate in the process of microgeneration through financial investment, providing space for installation or changing behavior is essential for the successful implementation of such technologies [39,40].

Thus, based on the results of the above papers, one can draw a conclusion that the corporate sector can become a driver for the development of microgeneration based on renewable energy sources or at least complement government efforts in this direction. The corporate sector can develop new business models that help consumers to become prosumers and play a more active role in the energy market.

However, almost all of the above studies were performed on data from developed countries (Great Britain, Greece, Spain, Denmark, Lithuania, Poland, etc.) with advanced renewable energy support institutions and mature corporate sectors. Studies on developing countries and/or countries with a weak system of institutional support for microgeneration based on RES have so far focused mainly on studying ways to overcome financial barriers. Thus, ref. [41] claims that microgeneration based on solar energy and small hydro is a critical factor for economic growth in low-income communities. Ref. [42] proves that in Chile small hydro can be an economically viable source even without supporting policies. Ref. [21] examines new subsidy systems and their economic feasibility. Ref. [43] demonstrates that inadequate financing decreases the ability of private companies to receive local loans with competitive interest rates and makes renewable projects risky and highly capital-intensive. The role of the corporate sector in developing countries with weak institutions in the diffusion of microgeneration and prosumerism, to the best of our knowledge, has not yet been explored.

Therefore, the focus of our study was directed at manufacturing and service companies working in the field of microgeneration in Armenia, India, Russia, and the UAE as representatives of developing countries with immature systems of government support of microgeneration based on RES. More precisely, we were interested in the following research areas: (1) the size of the corporate sector in the field of microgeneration and how well it is represented on the Internet (available for searching by a potential prosumer); (2) the services offered by the corporate sector for a potential prosumer; (3) the role the corporate sector plays in overcoming information and knowledge barriers.

The paper contributes to the literature by providing evidence about the role of the corporate sector in the Republic of Armenia, India, Russia, and the UAE in mitigation of barriers for the diffusion of microgeneration technologies. First of all, our study differs from others in that we studied the barriers to microgeneration not in order to improve the state regulation system but from the point of view of developing an interaction between the consumer and the supplier of microgeneration equipment. Such interaction, in our opinion, can positively affect the diffusion of microgeneration technologies even without significant improvements in the energy policy of the state.

3. Materials and Methods

The first stage of the study was to investigate the regulatory framework of each of the selected countries in the fields of renewable energy and microgeneration. In the second stage of the study, we independently collected data on companies selling/manufacturing /installing microgeneration equipment for the population. To examine the role of the corporate sector in overcoming barriers to the development of microgeneration, we found and studied the sites of 102 companies offering solutions for microgeneration and autonomous power supply: 42 companies in Russia, 14 companies in the Republic of Armenia, 27 companies in India, and 19 companies in the United Arab Emirates (Figure 1).

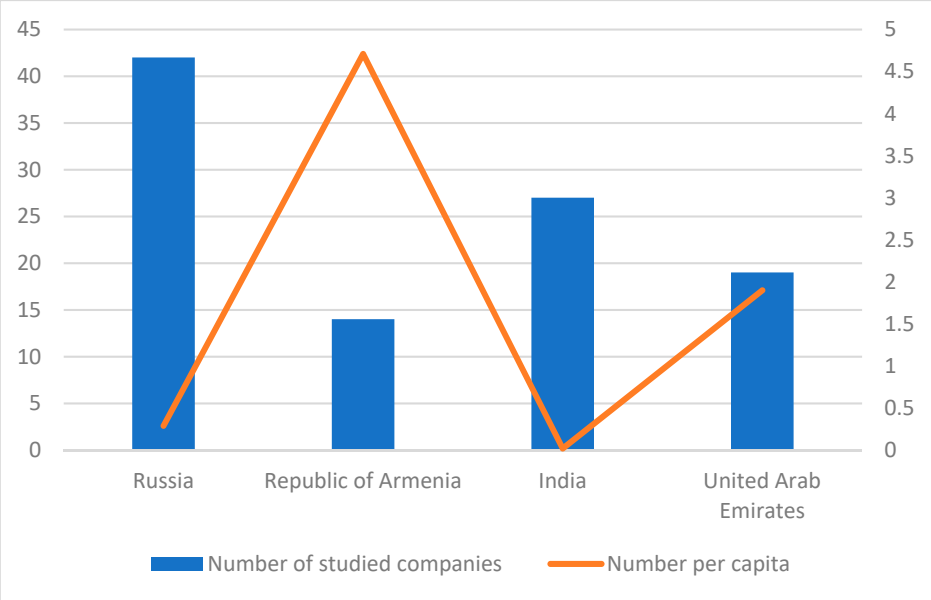

Figure 1. The share of studied companies in selected countries and proportion of the indicator to the population. Source: compiled by the authors.

As the broadest search engine, Google was used to search for information about the corporate sector. The search was conducted using the keywords "buy/install solar panels/solar heater/wind turbines" in the national language of each country. Further, the links found (usually of an advertising nature) led to the official website of a company providing services for the sale and/or installation of microgeneration equipment. Therefore, the number of companies in each country indirectly indicates how well manufacturers and sellers of microgeneration equipment are represented in the local Internet segment.

Further, the official website of each company was analyzed according to the criteria presented in Table 2. If the information provided on the website was insufficient to answer the questions, an additional phone call was made, or an e-mail request was sent on behalf of the "mystery shopper".

As can be seen from Table 2, the questionnaire (check-list) includes a number of questions that, in our opinion, are the most important for the consumer when deciding whether to install such equipment or not. If the company is a manufacturer of equipment, then for the buyer this is a guarantee of the best price and possibly a guarantee of the quality of the purchased equipment. Since the equipment for solar and wind generation is technically complex, it is very important for the buyer to see the expertise of the company (work experience, certificates, portfolio). If the company site does not have a guide for selecting equipment, this, in our opinion, limits the consumer's access to this type of microgeneration service and reduces the potential number of those wishing to install a solar panel or wind turbine.

Table 2. Questions for the analysis of company websites and interviews (102 studied companies).

№	Question	Answer/Criteria
1	Is the company a manufacturer of microgeneration equipment?	Yes/No
2	Type of equipment	Solar/Wind
3	Is the equipment/management system certified?	Yes/No
4	Is there an online guide on the selection of equipment for the needs of the buyer?	Yes/No
5	Does the company handle the installation of the equipment?	Yes/No
6	Does the company have completed projects in its portfolio? Is there a catalogue of completed projects on the site?	Yes/No
7	Is there a list of services and a price list on the site?	Yes/No
8	How clear/trustworthy is the information provided on the company's website?	From 0 to 5 points
9	How complete is the information about the services provided on the site?	From 0 to 5 points
10	How complete is the information on the equipment provided on the site?	From 0 to 5 points
11	What is the price of the installation equipment?	In US dollars at the current exchange rate
12	How long does the installation take?	Days
13	Is there a warranty? Warranty period	Years
14	Is post-warranty service available?	Yes/No
15	What is the service life of the equipment?	Years
16	Is it possible to return the equipment for recycling?	Yes/No

Source: compiled by the authors.

The absence of a price list for most buyers is a signal that this equipment is expensive or designed only for professional companies, but not intended for private consumers. Since the academic literature indicates the high price and long-term payback of equipment as barriers, we included the question about the cost of installation and the possibility of preliminary calculation. When examining the site of a particular company, the absence of the price of equipment and installation was also assessed as a repulsive fact. We also hypothesized that the installation time and lifetime of the equipment might affect the choice of the buyer, and issues regarding the environmental friendliness of the equipment and the possibility of recycling might be important for the consumer with a high level of environmental consciousness. Therefore, relevant questions were also included in the check-list.

For assessments on questions 9–11, a 5-point scale was used, and the scoring rules were developed during a pilot study based on materials from 10 company websites (Table 3).

Table 3. Criteria for evaluating the information on equipment and services of companies.

Question	Criteria
To what extent is the information presented on the company's website understandable/credible, and are the site support staff available, interested, experienced, and able to make decisions on the implementation of projects?	0—no information. 1—the information provided is poorly described and not understandable for the buyer; there is much distracting information, there are no customer reviews, and the site is not easy to use. 2—the presented information is understandable for the buyer, but there is much distracting information, there are no customer reviews, the site is not convenient to use, and the site staff does not inspire confidence. 3—the information provided is clearly described, there are customer reviews, but the company's staff is not always available, incompetent, or experienced enough. 4—the description of the presented range of equipment is clear to the consumer; there are customer reviews; there is a license to carry out professional activities; there are projects in the portfolio; site support personnel are available, interested, experienced, and have the authority to make decisions on the implementation of projects. 5—the description of the presented range of equipment is detailed; there are projects in the portfolio; there are customer reviews or a blog for information exchange; the site is easy to use; site support personnel are available, interested, experienced, and have the authority to make decisions on the implementation of projects.
How complete is the information about the services provided?	0—no information. 1—it is not easy to understand the list of services provided without a specialist. 2—the services provided are not detailed enough; there is much unnecessary distracting information. 3—the services provided are transparent, but the menu does not have a separate page for the services offered. 4—a complete list of the services provided is spelled out and the menu has a separate page for assistance. 5—a complete list of services offered is spelled out; the menu has a separate page on services, much additional information for convenience, and a preliminary calculation of the cost of services.

Table 3. *Cont.*

Question	Criteria
How complete is the information about the equipment?	0—no information. 1—the information about the equipment is difficult to understand without a specialist. 2—the information about the equipment is not detailed enough; much unnecessary distracting information. 3—the information about equipment is written in detail, but there is no separate page on equipment in the menu. 4—the site provides a complete list of equipment; the menu has a separate page for equipment. 5—the site offers a complete list of equipment, the menu has a separate page on services and much additional information for conveniently selecting equipment, including photos of objects.

Source: compiled by the authors.

The search and study of companies according to the developed checklist and the rules for scoring when assessing the quality of the information provided were carried out mainly by the team of authors. When complex issues with translation arose, colleagues from the local population were involved to resolve them. The results of the assessment of the companies' websites were entered into a common database. Further, the collected data were processed using descriptive statistics methods.

4. Results and Discussion

4.1. Russian Federation

4.1.1. Status Quo of the Government RES Support System in Russia

The mechanisms of government support for RES in Russia were introduced in 2013 by the Decree of the Government of the Russian Federation dated 28 May 2013, No. 449, "On the mechanism for stimulating the use of renewable energy sources in the wholesale electricity and capacity market". The introduced support mechanism is unique, as it is focused on the wholesale market of electricity and capacity and operates through agreements on the provision of capacity by qualified generating facilities operating based on renewable energy sources.

Solar energy is the most advanced form of renewable energy in Russia. As of the latest available data from 2020, the amount of electricity produced by solar stations was 1558.3 MWh, while wind stations contributed a mere 610.8 MWh. Other forms of renewable energy include small hydropower plants (69.6 MWh), biogas plants (39 MWh), biomass and waste power plants (26.4 MWh), and landfill gas (1.15 MWh).

The development of microgeneration in Russia received regulatory legal formalization relatively recently within the framework of Federal Law No. 471-FZ "On Amendments to the Federal Law On the Electric Power Industry" adopted on 27 December 2019, which regulates the procedure for installing and using generating equipment, as well as the process for selling generated electricity to the grid. According to this regulatory legal act, installing microgenerating devices is possible only for individual homeowners with a capacity of less than 15 kW. All owners of apartments in apartment buildings are deprived of the opportunity to install generating equipment to supply to the public network. Therefore, the demand for microgeneration equipment is formed mainly by individual homeowners living in rural areas.

4.1.2. Companies' Survey Results

Most of the surveyed Russian companies offering microgeneration equipment for private houses and owners of small- and medium-sized businesses have sufficient experience in implementing projects for selecting and installing power equipment for autonomous power supply (Figure 2). On the websites of such companies, there are photos, videos about installation, and enough helpful information to allow the buyer to decide.

The average experience in the market is nine years (the range is from 2 to 25 years). Most of the companies are not equipment manufacturers. Only 5% of 42 companies sell their own equipment, and the remaining 95% sell equipment made in China. Most common in Russia are the products of Chinese manufacturers, due to the relatively low cost compared to products manufactured in other countries (in 2020–2021, solar panels from China were

sold at almost half the price of German ones). Most often, the websites of distribution companies offer products from Yingli Green Energy, Suntech Power Co., and Himin Solar (China). Domestic manufacturers are Hevel LLC (Novocheboksarsk City, Russia), Telecom-STV (Zelenograd City, Russia), Sun Shines (Autonomous Lighting Systems LLC, Moscow City, Russia), Ryazan Plant of Metal–Ceramic Instruments OJSC (Ryazan City, Russia), the Termotron factory, etc.

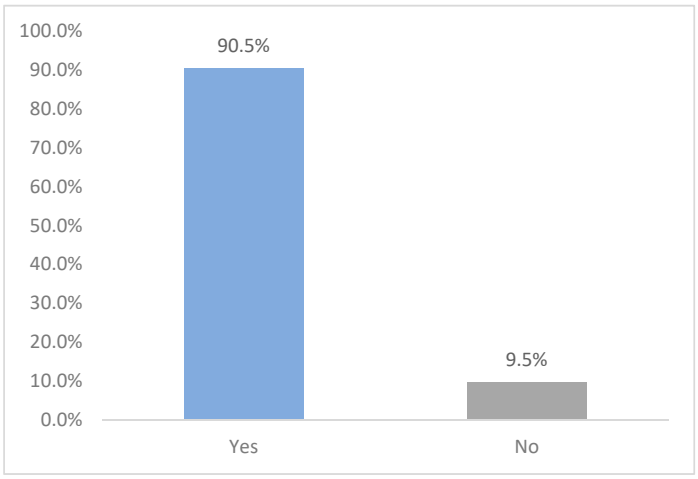

Figure 2. Availability of information on previously implemented projects of companies. Source: compiled by the authors.

All the main types of solar panels represented on the microgeneration equipment market are based on photovoltaic technology: single crystal (energy conversion factor (ECF) up to 22%), polycrystalline (ECF up to 18%), amorphous and heterostructural (ECF up to 22–25%). The only Russian manufacturer of the most efficient heterostructure solar modules is Hevel LLC.

The cost of equipment is calculated individually and depends on several parameters: the type of module, the size of the roof of a house or building, the area of panels, the intensity of sunlight, the angle of the incidence of rays, etc. In addition to the photovoltaic panels, the equipment includes an inverter, a battery, and a controller for the battery-charging voltage, charging mode, temperature, and other parameters. From any company it is possible to purchase both individual components and complete systems. At the same time, the power of devices is determined based on specific needs.

Only 14% of surveyed companies provide any information on their websites about the availability of the necessary certificates. In our opinion, the buyer prefers companies that can guarantee the quality of equipment and services provided by the presence of a certificate. At first glance, in Russia, the consumer does not always request credentials for purchased goods, unconditionally trusting the seller. However, when it comes to electricity, this approach is dangerous since the safety of the applied solutions is of paramount importance. The electrical installation's service life depends on the equipment's reliability, and the availability of quality assurance from the relevant organizations is required. Therefore, the lack of such information can adversely affect the decision to purchase.

Meanwhile, during interviews with managers and heads of companies at various levels, the phrase was often heard that solar modules are not subject to mandatory certification. To date, there are no precise legal requirements for the compulsory certification of solar modules. The solar energy market is developing dynamically, and the development of standards has not kept pace with the market's growth since this process is laborious and rather lengthy. Seven percent of companies provided certificates of conformity to GOSTs (a type of government certification), which are outdated. Of course, the presence of a certificate of conformity for a product does not guarantee its quality but at least ensures its safety and indicates a serious approach to this issue.

Almost 93% of companies strive to simplify equipment selection for the buyer and have an opportunity on the website for the buyer to select equipment online. However, our analysis showed that most buyers could not use this service since the assistance of a professional specialist is needed in equipment selection. The online guide allows you to estimate the cost of a future project superficially. For a certified piece of equipment, knowledge of many components is necessary for calculating the required power, the number of solar panels, the panel model, etc.

Only 52.4% of companies provide equipment installation and maintenance services along with equipment. However, equipment installation is not a simple process. Before organizing a solar-powered system, it is necessary to determine the disadvantages and strengths of a structure powered by solar energy. Significant factors must be considered: efficiency, seasonality of use, weak accumulation scheme, the feasibility of the system, as well as the need for extra energy. Of course, it is not at all easy to organize all these issues without professional help. Thus, the lack of services for the selection and installation of equipment by companies can have a deterrent effect on the buyer.

Maintenance contracts vary considerably in type and duration. Most companies (90.5%) provide a 2-year warranty on equipment installation services, and 9.5% offer a 1-year warranty. As a rule, companies do not provide guarantees for equipment, guided only by the well-known promise that the service life of the equipment is 25 years. This was confirmed by 100% of the surveyed companies. Solar panels' life and output depend on many factors, including climate, module type, and mounting system. Solar panels are usually given two warranty types: a product warranty against manufacturing defects and a power warranty. The first type of warranty is specific to any products/goods that are purchased. This is a warranty against damage due to manufacturing defects. The most common power warranty period for solar panels is 25 years while retaining 80% of the original power. This does not mean that the service life of the solar panel ends after 25 years; it can work for 40 or 50 years, but the further degradation of the module is not described by the manufacturer in any way and is not associated with any obligations on his part.

An expert assessment of the quality of the information provided on the websites showed that the websites of 90% of companies have a description of the presented range of equipment that is clear to the consumer; there are customer reviews, a license to carry out professional activities, as well as the presence of projects in a portfolio. Only in 10% of cases is the information on the company's website not complete enough; apart from information on the availability of equipment and customer reviews, there is no other clarifying information (Figure 3).

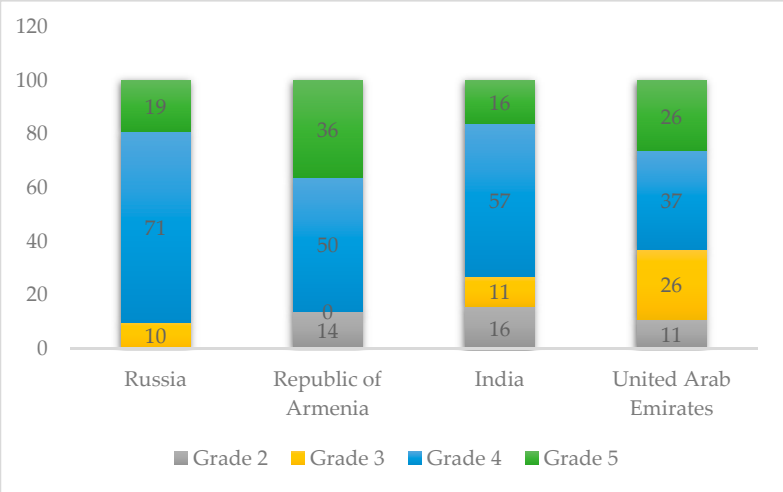

Figure 3. Expert assessments of the quality and completeness of the information provided on the company's website (%). Source: compiled by the authors.

Regarding the information on the sites about the services provided, the ratings were distributed as follows: in our opinion, in 91% of cases the services provided are spelled out, but only 36% have a separate page on the services offered in the menu, which makes it easier for the buyer to find the necessary information; information on only 5% of sites contains a complete list of services provided, spelled out in detail, with a separate page on services, additional detailed information for ease of use, and a preliminary calculation of the cost of services (Figure 4).

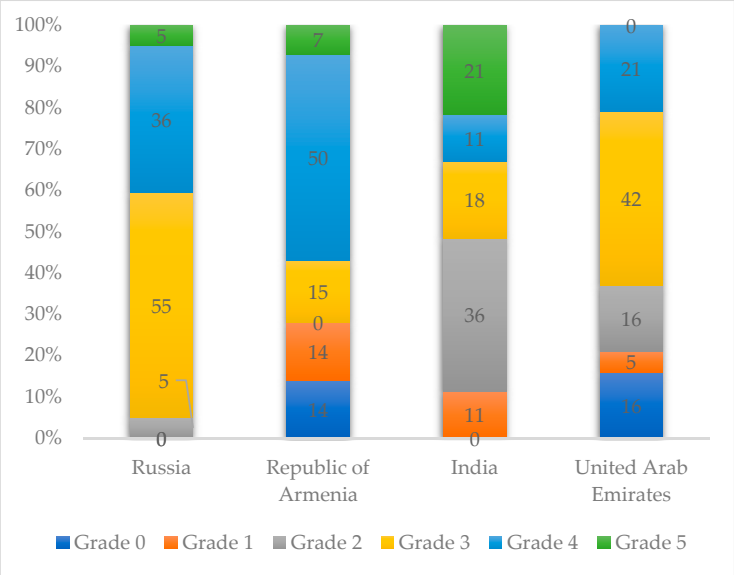

Figure 4. Expert assessments of the sufficiency of information about services provided on the company's website (%). Source: compiled by the authors.

The analysis of the presented information on equipment turned out to be approximately the same as the information on services (Figure 5). Only 7% of sites offer a complete list of equipment with the menu offering a separate page on services and additional information for conveniently selecting equipment, including photos of objects. The information on the websites of 86% of companies contains a complete list of equipment but, from the point of view of ease of use of the site, it is not easy to find the necessary information on equipment. Likely, companies do not pay attention to this issue.

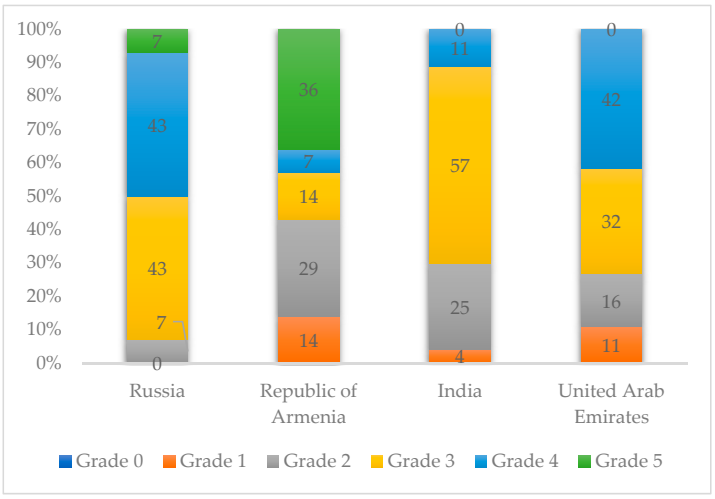

Figure 5. Expert assessments of the sufficiency of information about products provided on the company's website (%). Source: compiled by the authors.

Therefore, the study showed that the Russian market for services for selecting and installing microgeneration equipment based on RES is in the initial stages of its development. Most companies offering equipment for the autonomous power supply of private houses and owners of small- and medium-sized businesses have sufficient experience in implementing projects for the selection and installation of energy equipment for independent power supply. The spread of prices for the cost of equipment is 8–10%, which does not represent an obstacle for buyers. The proposed range of equipment for microgeneration is quite broad and is unlikely to be reduced due to the new sanctions imposed by Western countries since this equipment is either Russian or Chinese.

A feature of the Russian market of equipment and services for microgeneration is its development even in the absence of any financial subsidies and benefits (as is the case in all developed countries), which indicates the importance of such incentives as the desire for autonomous energy supply. The effect of these incentives is unlikely to decrease in the face of sanctions pressure on the Russian economy and the projected increase in energy tariffs. In addition, this incentive can be enhanced by developing services that facilitate the selection, design, and installation of equipment for the consumer. As our research has shown, such services are gradually developing. However, in the absence of a government policy of information support for developing this high-tech sector of the economy, the volume and quality of the information companies provide about their products and services are not enough to successfully promote microgeneration. The solution to this problem could be forming a centralized advertising and educational campaign, for example, within the framework of an association of manufacturers and distributors of microgeneration equipment.

4.2. Republic of Armenia

4.2.1. Status Quo of the Government RES Support System in Armenia

Armenia has a somewhat developed electric power system with more than 100 years of history. According to IRENA [44], the share of renewable electricity in Armenia in 2020 was 39% (hydropower 36%, solar energy 3%). It should be noted that, of the remaining 61% of non-renewable energy, the lion's share is nuclear energy (about 40%) and the rest is thermal power plants operating on natural gas [44]. The first and only nuclear power plant was built in Armenia in 1976 during the period of joining the USSR, so its resources have been sufficiently depleted and should be replaced in the future.

Due to favorable natural and climatic conditions, solar and wind power plants have great potential for renewable energy in the Republic of Armenia. More than 60% of the country's territory has the potential to generate electricity per unit of installed photovoltaic capacity of 1400–1600 kWh/kWp/yr (range of annual PV output per unit of power, kWh/kWp/yr) [44], which makes investments in solar energy very attractive. Over the past few years, more than 45 MW of photovoltaic capacity has been installed in the Republic [45], and a significant part of this is accounted for by autonomous microgeneration for the consumer's own needs. As of 1 August 2021, the number of independent solar power plants was 5659 [45]. In addition, solar energy is actively used for the autonomous production of heat and hot water.

The construction of wind farms in the Republic of Armenia is also considered a promising investment in renewable energy. The total capacity of economically viable wind farms in annual output is estimated at 450 MW. In 2005, the first network wind power plant in Armenia and the Caucasus, with a total capacity of 2.6 MW, was put into operation. The construction of another wind farm is planned to be completed in 2023.

Over the past few years, the Armenian government has made significant efforts to improve the framework conditions for the development of RES: the introduction of feed-in tariffs for solar power plants (2017), the introduction of a "net metering" system for microgenerating photovoltaic solar installations (2016 and 2018), the introduction of technical regulations on Energy Saving and Energy Efficiency for New Multi-Apartment Buildings and Structures Built (or Renovated) with State Support (2018). Note that these

technical regulations include not only environmentally friendly thermal insulation, low-emission windows, energy-efficient heating systems, and LED lighting systems but also the installation of photovoltaic systems on the roof.

The adjustment of feed-in tariffs and the "net metering" system in 2018 led to the country's sustainable development of solar energy projects. The fact that autonomous producers of solar energy (both individuals and legal entities), according to the current legislation, can without a license build a solar installation with a capacity of up to 150 kW for their own needs (Article 23 EMO) [46] also played a significant role. For legal entities, this limit has been increased to 500 kW in recent years, while for individuals it has remained at 150 kW. Connecting to the network of such installations has also been simplified as much as possible. An agreement is concluded for connecting a new consumer or a reconstructed consumer consumption system to electric grids. Under the contract, the supplier connects the consumption system of a new consumer (or developer) or a consumer rebuilding the consumption system (customer) to the electrical network, and the customer undertakes to pay for the connection of their consumption system to the electrical grid. To account for the supply of electricity to the network, converting-reversing multi-tariff electronic meters are installed, and issues related to their purchase and maintenance are regulated by the rules for the supply and use of electricity, approved by the Public Services Regulatory Commission of the Republic of Armenia (Decision No. 358.—N, dated 27 December 2006).

Between 2019 and 2021, the installed capacity of solar projects at feed-in tariffs increased eightfold, and the installed capacity under the net metering scheme increased tenfold [47]. The first local factories to produce solar photovoltaic panels, companies for installing and maintaining solar panels and solar collectors, and many suppliers who supply these products in addition to their main range have been established.

Nevertheless, the share of solar energy in the country's energy consumption is still insignificant and has high growth potential.

In 2021, The Foundation for Armenian Science and Technology (FAST), together with the first Armenian solar panel manufacturer SolarON, developed a roadmap for the development of solar energy in the country until 2030, according to which the share of solar energy in the country's electricity production should reach 15% in the next decade.

4.2.2. Companies' Survey Results

Through search engines, a total of 14 firms were discovered offering products and services related to self-sustaining energy production through the utilization of renewable energy sources. Around 80% of the companies utilize PV panels, while almost all of them also employ solar collectors and hybrid systems, which combine both PV panels and solar collectors. Surprisingly, none of the companies included in the survey currently use small wind turbines. Approximately 21% (3 out of 14) of the companies engage in solar panel production, as well as design and installation. One company, Lasolarfactory, solely focuses on production. The remaining companies specialize in the design, installation, and maintenance of solar panels and collaborate with a variety of manufacturers, mainly from Armenia, Europe, and China. Despite being relatively young, many of these companies have already amassed considerable experience, with most having formed or established new divisions in the field of solar energy within the past 5–7 years.

Four companies (28%) have no projects in their portfolio, one of which is engaged only in production (Lasolarfactory), and two do not specialize in solar energy but work with a wide range of heating and ventilation equipment.

Out of the companies that were surveyed, 36% of them possess certifications for management systems such as ISO 45001, ISO 14001, and ISO 9001. Additionally, 21% of these companies provide solar panel certifications, such as UL or TUV certifications. One company, Ecoville, has obtained an ecolabel, and another company, Freenergy, has received an international award for its quality standards, which it proudly showcases on its official website.

Around 43% of the companies publish an online guide on their website that helps in selecting equipment and estimating the cost of solar installation. Meanwhile, approximately 71% of the companies provide a detailed list of their services. The evaluations of experts regarding the trustworthiness of the information presented on the company's website, as well as their assessment of the completeness of information about the products and services offered, are presented in Figures 3–5.

Based on Figures 3–5, it appears that the surveyed companies have received high assessments for their information transparency regarding various aspects. Many companies have detailed information on their websites about the principles of solar microgeneration equipment, using visual aids to explain the features of different types of panels. However, not all of them provide a comprehensive breakdown of the technical specifications for solar panels. For instance, only 36% of the companies provide details on the equipment's lifespan and warranty availability. While all companies offer information on installation costs upon request, no indicative estimates are available in the public domain. Only one company, Solara, provides approximate timelines for the installation process on their website.

There is a lack of information from companies regarding the environmental characteristics of materials and raw materials, as well as the options for recycling solar panels that are no longer in use or defective.

Nevertheless, despite the identified shortcomings in the information strategy of Armenian companies operating in the field of providing microgeneration based on RES, it should be noted that the level of their information transparency is higher than that of Russian companies. Many companies conduct outreach and educational activities and provide information on financing opportunities for microgeneration projects (concessional or simplified lending programs in partner banks).

The mechanisms of government support for RES in Russia were introduced in 2013 by the Decree of the Government of the Russian Federation, No. 449, dated 28 May 2013, "On the mechanism for stimulating the use of renewable energy sources in the wholesale electricity and capacity market". The introduced support mechanism is unique.

4.3. India

4.3.1. Status Quo of the Government RES Support System in India

India's government has established a lofty objective of achieving a renewable energy capacity of 500 GW by 2030, marking the most extensive renewable energy expansion plan worldwide. As of 2021, India stands third globally in terms of total renewable energy capacity growth, having expanded from 15.4 GW, following China's 136 GW and the US's 43 GW.

According to IRENA [48], in 2021 India managed to install 13 gigawatts (GW) of renewable energy, which marks a remarkable achievement. Over the last five years, the country has added over 53 GW to its capacity, demonstrating a significant commitment towards renewable energy utilization. With abundant potential for renewable energy, India has set its sights on becoming a major player in the production of green hydrogen, which will aid in the decarbonization of its industrial economy. The International Renewable Energy Agency predicts that hydrogen will constitute around 12% of the total energy supply at 1.5 °C by 2050.

As of 31 December 2021, renewable energy sources have a total installed capacity of over 150 GW (Figure 6).

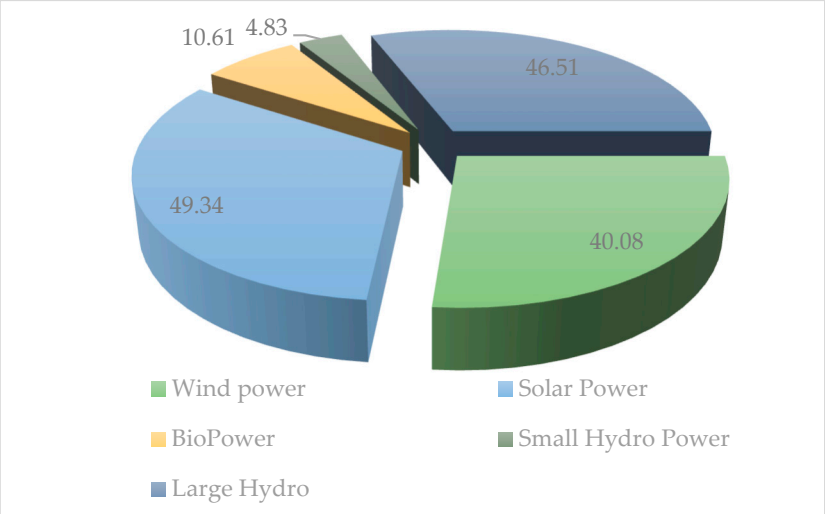

Figure 6. Distribution of total installed capacity by RES (2021, GW). Source: compiled according to [49].

The Indian government provides the renewable energy industry with strong institutional support. India is one of the few countries with a dedicated Ministry of New and Renewable Energy (MNRE). The renewable energy industry is aggressively ramping up capacity, with an annual growth rate of 17.5% between 2014 and 2020, increasing the share of renewables in India's total energy mix from 6% to 10%. To date, India has developed a comprehensive and effective system of state regulation and support for renewable energy. Active regulatory intervention by the government in the energy industry began with the adoption of the Electricity Act in 2003, which initiated reforms in the Indian energy sector. The main result of this act was the actual privatization of the electricity industry in India and the creation of a competitive and transparent electricity market in the country. At the same time, new state regulatory bodies were created: the Central Electricity Authority (CEA), the Central Electricity Regulatory Commission (CERC), as well as the State Energy Regulatory Commissions (SERCs). Their tasks were to regulate the market, protect the interests of consumers, and develop further proposals for improving market management. In addition, it was in the Act of 2003 that the need for developing renewable energy and introducing special tariffs for energy from renewable sources was first mentioned. As per the Act of 2003, the CEA was obligated to create a National Electricity Plan under the National Electricity Policy. Following the implementation of the initial National Electricity Plan, the enhancement of tariff regulation to facilitate the progress of renewable energy was undertaken in the ambit of the National Tariff Policy (NTP) and the National Action Plan for Climate Change (NAPCC) during 2006–2010. The NAPCC had established a target of 5% for the utilization of renewable electricity, which would be raised by 1% every ten years. Diverse legislative measures were implemented to attain this benchmark, such as the introduction of a preferential tariff for electricity produced from renewable sources (with partial compensation from the state to energy producers) and tax incentives. These measures were integrated in 2010 into a national regulatory and certification platform for renewable energy. Energy companies generating power from renewable sources receive specific privileges from the state, including a preferential tax regime for projects in this field, facilitated international and interregional co-operation for equipment procurement and construction work, and the elimination of regulatory obstacles for new market entrants [50].

Despite the potential benefits, the progress of Renewable Energy Sources (RES) encounters various challenges. One of these obstacles is the unequal distribution of renewable energy production opportunities across different states in India. Some states have struggled to meet the required benchmarks, such as Delhi, while others, such as Rajasthan and Tamil Nadu, have surpassed them significantly [51]. The exorbitant cost of energy production,

the unpredictable generation volumes, and the challenges in integrating renewable energy sources into existing energy systems represent significant hurdles to the advancement of renewable energy in India. Conventional non-market regulatory mechanisms such as tax incentives and preferential tariffs have proven to be insufficient in addressing these complex issues. Consequently, the Indian government decided to introduce a novel market-based approach to support the industry, known as the Renewable Energy Certificate (REC), in 2010. This mechanism was introduced through a specific directive from the Central Electricity Regulatory Commission (CERC) and has proven to be highly effective in stimulating investment and achieving targets.

Between 2007 and 2015, India implemented various initiatives aimed at developing the domestic production of solar photovoltaic systems. These included encouraging investment, imposing protective duties on imported photovoltaic cells and modules, and making BIS certification mandatory. However, despite these measures, there was no significant increase in domestic production, as companies participating in the incentive schemes did not benefit. Moreover, the protective duty led to an increase in project costs, causing a slowdown in the Indian market for photovoltaic systems, compounded by declining prices for photovoltaic cells and panels. Consequently, India remains heavily reliant on Chinese manufacturers at present.

It is worth mentioning that India has made substantial advancements in the realm of renewable energy. Nevertheless, the responsibility of India's government exceeds executing extensive projects. A crucial task for the Indian government is to facilitate electricity access to remote regions far from urban hubs, where the majority of the population is concentrated, as well as to small- and medium-sized businesses. Solar microgeneration projects have begun to emerge across the country as the only solution to the challenge of electrifying the Indian village, given the growth in per capita electricity consumption, which has grown more than 20-fold from 1992 to 2019. According to UNdata, it rose from 44 kWh/person in 1992 to 944 kWh/person in 2019.

4.3.2. Companies' Survey Results

As a component of this investigation, 28 organizations were discovered utilizing search engines, forming the foundation for examining the growth of microgeneration in India. The surveyed organizations have a collection of renewable energy products in their portfolios, including solar modules, kits, products, rooftops, hybrid storage solutions, and small wind turbines. Solar panel production, design, and installation are activities that 22 out of the 28 companies (78.6%) engage in. The remaining six companies collaborate with various manufacturers, mostly Indian, European (in the wind energy domain), and Chinese. All of the organizations surveyed possess work experience, with 18% being young firms that have emerged in the last 5–7 years, while the remainder of the companies have considerable experience in this sector.

According to the site analysis, 21% (six companies) do not have any projects listed in their portfolio. Despite this, all of the projects listed are broad in scope and typically consist of large-scale projects. Out of the companies surveyed, 78% of them are involved in the solar energy sector, while only 21% specialize in wind energy. Additionally, a mere 1% of the companies focus on a diverse range of equipment designed for use in agro-industrial enterprises.

The issue of certification does not receive much attention; as indicated by a survey, only 21% of the companies have obtained management system certificates such as ISO 45001 and ISO 9001. Additionally, 3% of the companies provide solar panel certificates, such as UL or TUV certificates, while only 7% of the companies possess ecolabels. Finally, it is noteworthy that Tata Power Solar is the sole company holding a Certificate of Appreciation for Security Excellence.

Only 1% of the companies post an online guide to assist with selecting equipment and estimating the cost of solar installation on their website, with most of this information only available upon request. While 78% of the companies provide a list of their services, the

information provided is not detailed enough and is targeted at a limited group of experts. Figure 3 shows the distribution of experts' opinions regarding the level of confidence in the information provided on the company's website, and their assessments of the completeness of information about the services and products offered.

As can be seen from Figures 4 and 5, all the estimates of various aspects of information accessibility for consumers of the surveyed companies are comparatively high. The majority of companies' websites explain the operating principles of solar and wind microgeneration equipment using visual aids to highlight the features of different equipment types. However, there are only a few companies that disclose technical details of their solar panels and wind turbines to potential customers. Specifically, only three companies (11%) furnish information about equipment lifespan and warranty availability. All the companies provide cost estimates for installation only upon request, and there are no indicative estimates accessible to the general public. The estimated duration for equipment installation is also not provided on any of the studied companies' websites. None of the companies offer information regarding the environmental properties of their materials and raw materials or provide details on the disposal or recycling of outdated or faulty solar panels.

The Indian market for microgeneration equipment has an exciting aspect in the form of microgrids, which are essentially scaled-down versions of the standard electrical grid but cater to smaller and discrete areas in India. Microgrids in India typically comprise at least one power generation source and a distribution system, with solar energy being the predominant power source. This innovative approach has helped overcome the problem of electricity shortages in Indian villages. Typically, companies are involved in the deployment of microgrids, compensating for the low participation of the local population due to the high cost of installing such equipment.

In Karnataka, SELCO has implemented DC microgrids with solar energy storage in order to provide energy access to multiple communities. Similarly, the Mera Gao Power Company constructs, owns, and operates solar microgrids in Uttar Pradesh, mainly serving self-governing villages. The objective of the Mera Gao Power model is to offer cost-effective electricity to households. In Rajasthan, Gram Power is developing microgrids of 5–10 kilowatts in remote villages, providing users with smart meters to manage their energy consumption.

In addition to Indian companies, the microgrid market is dominated by large multinational corporations such as ABB, GE, Schneider Electric, Caterpillar, and Siemens, which are investing heavily in microgrid development throughout the region.

Therefore, the microgeneration equipment market is essentially B2B. In 2021, the top ten solar rooftop companies accounted for 43% of the rooftop solar market. Several factors hamper the transformation of the market into the B2C format:

- The presence of high financial barriers: the long payback period of most RES projects makes it difficult to attract investment from households. However, the state incentive policy is constantly expanding and taking on new forms;
- The introduction of "green" technologies is hampered by the promise made by politicians of universal connection to the backbone network, which inhibits the desire of the population to use local generation technologies;
- The equipment subsidies are limited by the high requirements of the Bureau of Standards (a narrow circle of equipment manufacturers). Often, the issuance of contributions is not implemented in practice. Therefore, according to the Ministry of New and Renewable Energy Sources (MNRE) document from 1 October 2022, all open-source projects will be required to source modules from vendors listed on the Approved Lists of Models and Manufacturers (ALMM). There are concerns from the Distributed Solar Power Association (DiSPA) that this decision could hinder the further development of solar energy in India.

4.4. United Arab Emirates

4.4.1. Status Quo of the Government RES Support System in the United Arab Emirates

As of 2021, the United Arab Emirates is one of the top ten global oil producers and is a member of the Organization of the Petroleum Exporting Countries (OPEC) and the Gas Exporting Countries Forum (GECF). The UAE is currently the seventh-largest oil producer in the world. The UAE is rich in natural resources and relatively energy-intensive compared to other industrialized countries; the UAE economy is mainly powered by natural gas and oil, and different types of resources are used in small quantities (Figure 7). As can be seen from the figure, RES, such as solar and nuclear energy, began to be used relatively recently, starting in 2019; the share in the energy structure is 5% as of 2021. On one hand, this is a small contribution but, considering the implementation timeframe, the growth is rapid.

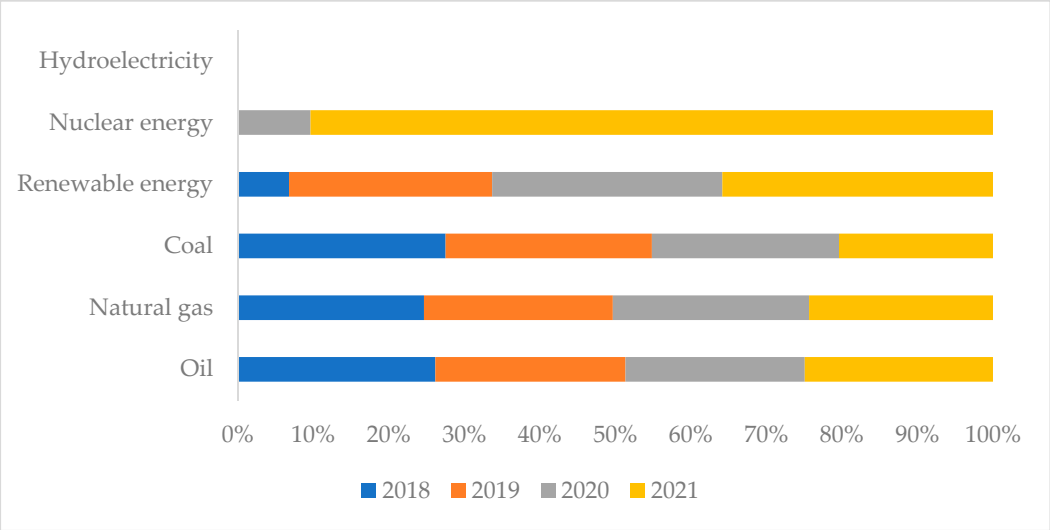

Figure 7. Total primary energy consumption in the UAE by fuel type. Source: compiled according to [52].

In January 2017, the UAE adopted an Energy Strategy until 2050 that provides for the diversification of the country's energy balance and an increase in the share of renewable energy to 44% [53]. Implementing all existing projects should lead to a 10% share of renewable energy in the total final energy consumption figure of the UAE in 2030. This achievement may seem modest against the backdrop of global efforts to develop renewables, but the growth rate of renewables in the UAE is one of the highest in the world, given the low starting point and the absence of traditional sources of renewables such as biomass and hydropower.

Climatic conditions are favorable for developing solar and wind energy, as the UAE is in the southeast of the Arabian Peninsula in the Persian Gulf, known for its hot climate, with high summer temperatures reaching 48 °C and relative humidity reaching 100%. Solar energy is the most promising renewable energy resource in the UAE, with an average of 10 h of sunshine and 300 clear days per year. According to the values of diffused horizontal radiation (DHI) and direct average solar radiation (DNI), the UAE is a country with a high potential for the introduction of solar energy [54].

The construction of several large-scale solar power plants reflects the UAE's commitment to developing renewable energy. The most significant of them are:

- The Mohammad bin Rashid Al Maktoum Solar Park, which is part of the DSCE Integrated Energy Strategy 2030 and aims to reach 1000 megawatts by 2030, providing 5% of Dubai's total electricity demand;
- The Masdar Project (also known as Masdar City), a 30,000-resident solar-powered off-grid city planned to be built near Abu Dhabi.

However, despite multi-billion-dollar projects planned for the near future, there is currently virtually no market for solar power and demand from residents and even commercial organizations is very low. To truly develop the solar energy market, solar energy must be applied at the industrial level and in residential and commercial establishments.

For a country that is energy-intensive and looking to reduce its reliance on fossil fuels as an energy source, shifting solar power generation to residential levels is highly relevant and well supported by the weather, environment, and natural environment. While the UAE government is investing billions of dirhams in solar power generation, little progress has been made at the consumer level. Currently, regulation is being developed to facilitate the implementation of systems on the roofs of residential buildings.

4.4.2. Companies' Survey Results

As part of this study, 19 companies were found using search engines, which became the basis for analyzing the development of microgeneration in the UAE. All the surveyed companies operate a range of renewable energy products that include various models of solar modules, solar roof and hybrid solution kits, energy storage, and small wind turbines. Only 5 out of the 19 companies (26.3%) are engaged in producing solar panels and related services. The remaining 14 companies design, install, and service solar panels and wind turbines cooperating with various manufacturers, mainly from the UAE, Europe (in the field of wind energy), and China; several companies (15.7%) do not provide information about the manufacturer on the company's website. A small number of the surveyed companies have extensive experience (21%), and the rest are young, formed in the last 5–7 years (79%). Since the renewable energy market is relatively young in the UAE, the information presented on the websites of companies is focused mainly on industrial demand or narrow specialists; it seems difficult for companies to understand that ordinary consumers do not require this range of products and services or this information.

In the portfolios of surveyed companies presented on the websites, 16 companies (84%) have projects, but these are just illustrated by small photos that make it difficult to understand the scale of the project; the technical information provided is mainly for technical specialists.

Only 16% of the surveyed companies have ISO 14001 and ISO 9001 certificates; perhaps not all companies post this information on their websites. A minority of companies (5%) provide solar panel certifications (such as UL or TUV). In our opinion, the presented products and services for the introduction of renewable energy sources are not designed for the opening of microgeneration facilities. This industry segment is not developed in the UAE, and all the found projects are already implemented or under implementation. There are big projects that are in no way aimed directly at the consumer.

No company has an online guide for selecting equipment and calculating approximate solar installation cost on its website; the list of services provided is presented in a limited form. On some sites, information on the services provided is not included in a separate section, which limits the choice of customers; there is no tool for calculating the preliminary cost at all. Most likely, the task now is to motivate the population to switch to renewable energy. According to analysts, a tiny part of the population (5%) receives information about solar panels from PV companies, 35% from relatives, and 14% through social networks. Thus, the only primary motivations for consumers to introduce renewable energy facilities are the existing high electricity tariffs and a future reduction in solar energy tariffs.

The expert assessments of levels of trust in the information provided on the companies' websites and evaluations of the completeness of information about services and products are shown in Figures 3–5 below.

As seen from Figures 3–5, all the assessments of the various aspects of the information transparency of the surveyed companies are high. Companies' websites cover questions about the principles of equipment operation for solar microgeneration, often using visual illustrations, but not all provide information about the features of various types of panels. Moreover, not all companies inform potential consumers in detail about the technical

characteristics of solar panels. For example, only two companies (10.5%) provide information about the life of the equipment and the availability of a guarantee, which confirms the conclusion that the information on the sites is not intended for potential consumers from among the general population. All the companies only provide information on the installation cost upon request, and there is no free access to estimated prices. The estimated installation time is also not indicated on any company website.

Information about the environmental properties of materials and raw materials, as well as the possibilities of recycling obsolete or defective solar panels, is not provided on any site. The conclusion is that microgeneration in the UAE has not yet been observed. The state's strategy is aimed at large projects. There is practically no market for solar energy, with low demand not only among residents but also from commercial organizations. For the development of the solar energy market, it is necessary to develop a strategy considering entry into the consumer market.

In addition, an expert survey conducted among potential consumers of microgeneration equipment also revealed the presence of severe problems in the maintenance of solar panels in the UAE. The pollution of the surface of solar modules with dust affects their power (by 9% [55]). Therefore, thorough cleaning is required at least once a week, which increases the requirements for maintaining and guaranteeing service levels and, as a result, reduces the commercial attractiveness of using solar panels.

Summarizing the results of the study, we can note that of the four surveyed countries the Republic of Armenia has the highest level of representation of service companies in the local segment of the Internet (4.71 companies per million population). This is followed by the UAE (1.9 companies per million population) and the Russian Federation (0.29 companies per million population). India ranks last in this indicator (0.02 companies per million population). These figures can be interpreted as the level of development in the corporate sector of companies interested in the further promotion of microgeneration. Our study found no direct correlation between the level of corporate sector development and a country's income level (Armenia: USD 4670; India: USD 2227; Russia: USD 12,172; the UAE: USD 36,284), nor between corporate sector development and the overall level of government support for renewable energy. The investigation of factors influencing the level of development of the corporate sector is the subject of further research by the authors.

5. Conclusions

In general, the study confirmed the hypothesis that an important driver for the development of microgeneration is the mature corporate sector, which consists of companies that install and maintain microgeneration equipment. These companies are interested stakeholders who, in addition to minimizing technical barriers for consumers, promote the "culture" of microgeneration and prosumerism among the population through their advertising, information campaigns, and educational events. A critical component of the advertising activities of service companies is the search for affordable forms of informing the broadest possible range of potential consumers about the possibilities and benefits of microgeneration, autonomous energy supply, and prosumerism. An effective form of reporting can be a company's website on the Internet, which is easily accessible to search engines and is focused on attracting a potential consumer with a convenient and straightforward form of presenting specialized technical information.

Of the four surveyed countries, the Republic of Armenia has the highest level of representation of service companies in the local segment of the Internet. This is followed by the UAE and the Russian Federation. India ranks last in this indicator, which is explained by the specifics of the development of microgeneration through microgrids and, as a result, the predominance of the B2B format. An essential feature of Armenian companies in the installation and maintenance of microgeneration devices (mainly solar photovoltaic panels and solar water heaters) is their cooperation with commercial banks, thanks to which a potential consumer can receive financial support in the purchase of equipment in the form of a loan under a simplified and/or preferential scheme. This is a good

example of how the corporate sector can lower barriers to the prosumer without any special government support.

Since many Russian companies represent the products of Chinese manufacturers and not the Russian manufacturer Hevel, the Russian market is fragmented. A similar situation is typical in the UAE, where large solar projects are still at a demonstration stage.

As noted above, Indian microgeneration equipment sales/maintenance companies are in a fundamentally different position, and their information policy is focused not on the general population but on business. Considering that India has the smallest GDP per capita of all the surveyed countries, such a strategy seems to be efficient. However, a higher level of Internet presence, cooperation with financial institutions, and educational activities could give a significant impetus to developing microgeneration in this country.

The main contribution of our study is a testimony of the importance of the role of manufacturing and service companies in the diffusion of renewable microgeneration technologies. In addition to well-known barriers (such as the lack of regulatory systems, the high cost of equipment and technologies, the low level of information and knowledge about technology, the lack of support from national authorities), the small number of companies offering equipment and services can also be a barrier for the development of microgeneration.

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