Impact of COVID-19 pandemic on renewable sources implementation: case of PV systems in Romania

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Abstract. In 2020, the world population was surprised by the spread and aggressiveness of a pandemic outbreak of the SARS-CoV-2 disease (caused by COVID-19 coronavirus). In a world-spread effort to diminish the medical effects, the measures employed by a large majority of countries severely influenced all economic sectors, including the energy one. This paper reports on the status of energy sources and usage on the Romanian market within worldwide context and current effects of the national contingency plan measures on the energy market, especially on solar photovoltaic area. The conclusions should offer a perspective of changes occurring on national and international level in the energy area, in both existing and future investments market.

1. Introduction

Life on Earth depends largely on few essential factors, such as Sun, air and water. The human race, in its evolution, became dependent on energy resources as well. Throughout the quest for affordable and cheap energy, the climate conditions were neglected and deteriorated at an accelerated pace within the last century. During the oil crisis of the 1970’s, when the limits of fossil fuel reserves were taken into account, the exploration of new and less polluting energy sources became an important goal for scientists and researchers.

Last decades witnessed important advancements in developing new methods and technologies to harvest energy sources that are renewable and ensure sustainable development. Significant progresses were achieved in converting energy from solar, wind, hydro, geothermal and biomass energy, which represent the five areas of renewable energy sources (RES).

As with any type of energy source, there are advantages and disadvantages. However, with RES, the two main positive outcomes, limitless and clean energy, overshadow the problems (discontinuous supply and availability, large initial investments, minor environmental issues). Newer methods, materials and technologies, developed during the last decades, make the RES more attractive not only in the business areas, but also within national and international economic and political strategies.

Several international meetings and forums have recognized the importance of RES development and implementation in order to achieve two goals: energy sustainability and pollution reduction. The most important outcomes translated into worldwide-adopted treaties: United Nations Conference on Environment and Development (UNCED) - 1992, Rio de Janeiro, United Nations Framework Convention on Climate Change (UNFCCC) - 1997, Kyoto and 2016, Paris. In addition, there are rules and regulations applicable at European level, such as EU directive ‘20-20-20’ on climate and energy targets. Romania ratified and adopted the above-mentioned protocols and directives.
2. Romania within world energy context

World energy usage is being shaped and reshaped rapidly depending on resources, production and demand. With all agreements and protocols oriented towards implementation of a sustainable energy production and efficient usage, the bulk (4/5) of total final energy consumption is obtained from fossil fuel combustion. Subtracting the nuclear energy and traditional biomass, the energy from modern renewables amount for 11% of the total, out of which only about 1% represents the energy from solar resource. Also, an important observation is that a large percentage of modern RES is represented by biomass and hydropower, Figure 1.

Romania is no exception from the rule.

Energy data is submitted by each country to International Energy Agency (IEA) and Eurostat, and is compiled and analysed with certain lag in operation. Therefore, the most recent data submitted by Romanian National Institute of Statistics and Romanian Ministry of Energy is from 2018.

Romanian energy market relies largely on fossil fuel combustion, large hydropower and nuclear power. The share of renewables is based on solid biomass and hydropower, which are not considered to be “green renewables”. The share of green renewables (solar, wind, geothermal, small hydro) in the electricity production is just above 12% (amounts are rounded to unit percentage), Figure 2.

Official data show 6,037.6 ktoe for total energy supply from RES, for Romania in 2018. More than half (3,462.6 ktoe) comes from combustion of solid biofuels and 25% (15.18.8 ktoe) is represented by hydropower. Only 152.3 ktoe comes from PV solar, the rest up to 3% being solar thermal, [2].

Figure 1. Share of renewable energy of total final energy consumption, 2018, [1].

Figure 2. Share of renewable energy and solar energy in Romania, 2018.
3. Romanian solar renewable market: availability and reality
From the geographical point of view, Romania is located at the crossroads of Central, Eastern, and South-eastern Europe, being bordered at Southeast by the Black Sea, and neighbouring countries of Moldova, Ukraine, Hungary, Serbia and Bulgaria. The predominant climate is temperate-continental with four seasons and the total surface area of 238,397 square kilometres encompasses all relief forms, from mountains to sea shore. The yearly average temperature ranges from 8.5° to 11.1°C, with about 40 days with temperatures exceeding 35°C in the South. The yearly sunshine duration ranges from 2200 hours in plain areas to 1800 hours in the mountains, [3].

From the solar irradiation point of view, Romania is situated in the European zone category “B”, Figure 3. Larger yearly solar radiation values of 1,450 – 1,750 kWh/m² are recorded in the South (Oltenia, Muntenia, Dobrogea), being the best areas for solar installations. Lower range values of 1,300 – 1,450 kWh/m² are in sub Carpathians regions, Banat, Transylvanian plateau and most part of Moldova. In the North part of Transylvania and Moldova, as well as in the mountain regions, the solar radiation value is between 1,150 – 1,300 kWh/m², Figure 3, [4].

The development of Romanian solar photovoltaic sector recorded the first power capacity of 30 kW in small scale PV installations in 2006. Until the end of 2011, this remained relatively unchanged and usage was limited to some governmental organizations in remote services areas (telecom and highway emergency stations, forest fire observation towers, solar lighting solutions). Between 2008 and 2011, several legislative measures implemented support mechanisms for the RES energy market in Romania: Law 220/2008 and subsequent amendments, ANRE (Regulatory Authority for Energy) Order 69/2009, EGO 88/2011 and GD 935/2011.
As a consequence, PV energy market started to increase during the second half of 2012, with an impressive growth in 2013, being amongst best performing solar markets in the world. The cumulative photovoltaic installed capacity exceeded 1,293 MW (1.29 GW) by the end of 2014. The Romanian Government considered that the 2020 target for PV was exceeded in 2013 and introduced negative regulatory changes by GD 224/2014 with a 50% reduction of green certificates per MW of solar power. As a consequence, Romanian PV market virtually stalled since 2015 with only minor increases in the last five years. Data compiled from International Renewable Energy Agency (IRENA, [5]) show the trends for the last decade (2010 – 2019) for all RES in Romania., Figure 4.

A SWOT analysis performed in 2016, [3], indicated the positive and negative issues of the RES implementation in Romanian energy market.

The analysis of strengths topics revealed the technological and socio-economic advantages that increase the potential of PV usage in Romania. At the international level, the country was an active part and ratified the agreements and protocols, as well as included the EU directives into strategic plan for sustainable energy development. A positive response received the measures taken to encourage investments and to educate the population. Other topics included here were concerned with research and development capabilities from the academia and research institutes, suitable geographical location and diversity of applications. Positive outcomes also stem from the opportunities analysis, related to energy efficiency, lower prices for utilities and newer technologies and installation, proper usage of otherwise useless land (locations), or improvements in demographic changes.

The weaknesses and threats pointed out two major areas of concerns. First is related to technical issues: virtually non-existent infrastructure, connectivity on multiple suppliers and users, dependence on imports for supplies, weak technology transfers from academic theoretical research, insufficient know-how and expertise. The second area of concern relates to governmental performance: adopted legislative framework showed little or no transparency or flexibility, support schemes were suddenly changed in type and level, no long term guarantees on prices or purchases.

But the analysis failed to take into account the effects of a crisis generated by a pandemic.
4. Impact of COVID-19 pandemic on energy market. Specific case of Romania

Energy suppliers represent an essential commodity, even during crises of any kind, and their services are often included in national contingency plans as major impact area.

Initially, in December 2019 and early January 2020, the disease was considered an exclusively Chinese medical problem. This was minimized even by World Health Organization (WHO), and thus, the main economic concern was related to disruptions in the chain of supplies from Asia. The impact on solar industry was considered a major issue, since 6 out of top 10 manufacturers are from China (Table 1) and faced major difficulties in manufacturing modules due to social lockdown measures. Compiling data from multiple internet resources and [6] on 2019 shipments, another three Chinese companies should make into to the top, LONGi Solar (9.0 GW), Risen Energy (7.0 GW) and GLC System Integration Technology (4.8 GW), increasing the ratio to 7 out of 10.

When medical specialists realized in the early months of 2020 the COVID-19 coronavirus spread and aggressiveness, WHO declared the SARS-CoV-2 pandemic outbreak. Some countries choose not to act on the information, but the large majority of countries choose to impose shelter-in-place orders social distancing measures and even strict lockdown.

As a consequence of the medical measures, the effects of pandemic disrupted other aspects of life, with obvious and expected contraction of economic activities. Many of restriction orders issued made exemptions for certain types of business, considered essential services, but they have not been uniform in their designations.

Nevertheless, energy services were considered essential, while construction and installation of new energy investments were not included. However, the energy demand patterns have shifted affecting the energy markets from both non-renewable and renewable sources. But the impact of coronavirus pandemic was largely different: while the oil and gas markets experienced a massive price volatility, recording even negative oil prices on April 20th, 2020 for the first day in history, the energy from RES was mostly shielded from lower electricity demand or declining prices by being granted priority access to the grid and fixed price contracts.

Table 1. Top 10 PV manufacturers (compiled from [6] and various company internet data).

| Rank | Company          | Country   | Shipments 2019, [GW] | Manufacturers of                                                                 |
|------|------------------|-----------|----------------------|----------------------------------------------------------------------------------|
| 1.   | Jinko Solar      | China     | 14.2                 | • Mono- and Poly-crystalline and PV Modules                                     |
| 2.   | JA Solar         | China     | 10.3                 | • Mono- and Multi-crystalline Solar Cells, Module                               |
| 3.   | Trina Solar      | China     | 9.8                  | • Ingots, Silicon Wafers, Solar Cells, Solar Modules                            |
| 4.   | Canadian Solar   | Canada    | 8.5                  | • Ingots, Silicon Wafers, Solar Cells, PV Modules                               |
| 5.   | Hanwha Q CELLS  | South Korea| 7.3                 | • Mono- and Polycrystalline Silicon PV Cells and Solar Panels                   |
| 6.   | First Solar      | USA       | 5.5                  | • Cadmium Telluride (CdTe)-based PV Modules                                     |
| 7.   | SFCE             | China     | 4.0                  | • Solar Wafers, Solar Cells, Solar Modules, Solar Related Products              |
| 8.   | Yingli Green     | China     | -                    | • Crystalline Silicon Solar PV Modules                                          |
| 9.   | ReneSola         | China     | -                    | • Solar Cells, PV modules, Solar Panel, Inverters, Solar Kits                   |
| 10.  | SunPower Corp    | USA       | -                    | • Crystalline Silicon PV Cells, Solar Panels                                   |
Figure 5. Estimated price for PV module in China, pre- and post-COVID, [7].

In solar industry, the supply shortage from Chinese manufacturers could lead to a short-term price increase, Figure 5. Despite the gradual recovery, the persistent effect of production declines will see post-pandemic module prices increase (of about 12%). Later, as most plants will resume operation and narrow the gap between supply and demand, the module prices will decline towards Q4-19 price, [7].

The global solar industry has shifted from a supply problem to a demand problem. The lockdown measures shifted demand patterns: weekly electricity demand decreased by 10-35% across affected regions, increasing the overall share of variable renewables to meet this demand; the daily decreased demand pushed the daytime intraday prices below night-time prices; the residential – non-residential balance shifted as non-essential businesses were shut down and workers were under shelter-in-place orders and travel restrictions. Countries in full lockdown and partial lockdown are experiencing an average decline in energy demand relative to typical levels of 25% and 18%, respectively. The level of decrease varied widely depending on commodity type: oil experienced shock decrease of 60% largely due to decrease in aviation and transportation activity, coal 8%, gas 2% and electricity from 5 to 20%.

An online survey conducted by Global Solar Council in April 2020, identified the problems of the companies in solar PV industry and suggested actions to avoid long-term operational damage, [9]:

- High cancellation rates (19%) and job postponement rates (53%) for residential solar systems
- Termination of door to door sales implies elimination of retail solar sales in stores
- Complete shutdown of operation (work stoppage), shortage of manpower, lost sales
- Companies are reporting complete work stoppage and sales lost for six months to a year
- Orders for shipments are cancelled, up to 4 months-delay for previous product orders
- Previous financing support may not be available in the same terms.

Romania was not sheltered from economic disruptions caused by government lockdown measures taken to counteract the effects COVID-19 pandemic. The adopted strict medical measures imposed a total lockdown, with only essential sectors still in operation. Most of the population is under shelter-in-place orders and travel restrictions. Staff travel, face-to-face meetings with potential clients or investors were cancelled and insecurity of clients to making decisions, were other important topics in stalling the activity of the companies in the solar PV industry.

Moreover, the PV industry, that already suffered from lack of investments and proper regulations, was held back from the only program in the sector that might have revived the RES implementation: Green House Photovoltaics. This program should grant financial incentives to private beneficiaries to stimulate the installation of solar photovoltaic systems within the limit of €4,200. This solar rebate scheme includes as eligible expenses the purchase of panels, the inverter, connection materials, the system installation structure and the power board, the communication module and the smart meter.
"National Energy Sector Strategy (2016-2030) with prospects to 2050" has been approved by the Romanian government and represents the base of the National Energy Strategy on Medium Term and Long Term. Another whitepaper was launched in 2019, "Energy Strategy of Romania 2019-2030, with the perspective of 2050". Both strategies emphasized the government’s concern with increasing energy efficiency, boosting renewable energy, diversifying import sources and transport routes, modernizing lines, protecting critical infrastructure.

Although the strategic plans were well elaborated and stated ambitious goals, their implementation was curtailed by lack of proper investments, lack of longstanding and transparent rules and regulations and poor government performance. For example, the program for Green House Photovoltaics was announced in December 2018, beneficiaries were allowed to submit proposals in September 2019 and by April 2020, the proposals were not yet fully analysed, and no system was installed in 15 months.

Positive public support and private business investment interest towards RES triggered some public announcements made before and during lockdown from state-owned and private companies, which would invest in solar PV systems: Oltenia Energetic Complex in 310 MW PV systems, OMV-Petrom in PV systems on stations rooftops, 600.000 EURO from ROMGAZ in PV systems and a 5-year plan from CONPET.

On the other hand, the Romanian government re-introduced directly negotiated long-term bilateral Power Purchase Agreements (PPAs) after a 7-year ban. The emergency ordinance is intended to shore up investor confidence in the country’s renewables sector, to deregulate the electricity market and hopes to counteract the volatility risk on Romanian OPCOM (gas and electricity market) exchange, where power prices have dipped by 20-30% since the outbreak of Covid-19.

5. Conclusions
Since mid-March when WHO characterized COVID-19 as a pandemic, governments all over the world rushed in medical and administrative measures to counteract the spread and aggressiveness of the disease. The shelter-in-place orders, social distancing measures or even total lockdown disrupted all facets of life, with a huge toll on economic sector. Particularly, authors analysed how the global solar PV industry is being disrupted by the COVID-19 pandemic and the particularities of the similar Romanian market.

During the early stages of the pandemic, the biggest concern was related to the impact on supply chain of modules, panels and systems from the Asian manufacturers. Concerns were raised in both quantities and prices, but as the production resumed, the problem shifted from supply to workforce and logistics.

The impact on labour market encompassed various measures, from pay cuts, working fewer hours to layoffs, for whole or part of the work force, temporary or permanent. The basis of such measures was mobility limitation, i.e. restrictions on work/access to sites, on travel and accommodation, as well as downsizing or cancellation of orders and near-future projects. However, the impact on operational solar plants was minimal as they may be operated and maintained remotely.

Energy from RES in general and solar PV in particular sensed little or no effect from falling energy demand or shift in energy demand patterns. Actually, the share of RES into final energy supply has increased as the oil, coal and gas contributions decreased, sharply in some cases.

The case of Romanian solar PV market followed the general lines of the international markets, but with some specific issues. Following the 50% decrease in price for TGC from 2015, the investors trust in RES market was shattered. Moreover, the zero-investment governmental policies during the last five years, despite the official statements and strategies, poor governmental performance on its own proposed and regulated support programs, generated the framework to virtually no-increase in new RES technologies implementation.

The economic instability of -20% to -30% on Romanian energy market caused by the coronavirus pandemic may be counteracted by introduction of directly-negotiated PPA’s for new installations, and a good chance to add more cumulative installed PV capacity in the next 2 years, especially under net metering and self-consumption commercial and residential installations (Green House PV program).
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