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Commercial Prosumers as Catalysts for Solar PV Adoption in South East Europe

BULGARIA, CROATIA, GREECE AND ROMANIA

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Key Findings

1	**Tens of gigawatts (GW) of customer-sited solar power are poised to come online throughout South East Europe (SEE) in the years ahead, driven by a powerful combination of economic, financial, and environmental factors as well as by political plans to accelerate the phase-out of coal throughout the region.** Policymakers in the region continue to underestimate the potential of prosumers, leaving many unprepared to deal with the more decentralized power paradigm the rise of prosumers entails.
2	**Interviews with local prosumers and developers indicate payback times for commercial rooftop solar PV investments of as low as three years.** These attractive payback periods are mainly driven by two interrelated factors: **low installed costs**, with commercial-scale solar PV projects now being developed across the region for between EUR 500/kW – EUR 700/kW) and **rising electricity prices**. Indeed, electricity prices on the day-ahead and intraday markets in several jurisdictions throughout SEE have reached unprecedented highs in recent months, further strengthening the business case for investing in solar.
3	**However, attractive economics are not enough: smart policy frameworks are needed to catalyze investment at scale.** National energy and climate plans (NECPs) across the region need to be updated to recognize the growing importance of prosumers, including in particular commercial prosumers. Without targeted policies and without systematically addressing barriers to market development such as streamlined grid access for exporting surplus generation and improved pricing conditions, policymakers are passing up a major opportunity to drive investments.
4	**As the share of commercial prosumers and other forms of distributed generation grows, the need for targeted policies grows,** including more dynamic and real-time pricing, greater interactivity and digitization of grid and metering infrastructure, as well as policies allowing greater prosumer participation in providing system services. It is only through such targeted policies that countries throughout the region can accelerate the transition to a more interconnected and prosumer-centric energy paradigm, as envisioned in the EU's latest Renewable Energy Directive.

Chapter 1: The current situation in the SEE region

The solar PV market in the South East Europe (SEE) region is on the cusp of a significant transformation, driven by a combination of factors including stronger project economics, the improved availability of financing, as well as rising electricity and carbon prices. Overarching these local market dynamics, there is the increasingly urgent imperative to decarbonize the electricity mix in the region.

This analysis focuses on the rise of commercial prosumers in four countries across the region: Bulgaria, Croatia, Greece and Romania. While each country has a different electricity market and faces unique challenges, the economic fundamentals of customer-sited solar PV investments have entered a promising new phase. **Payback times in certain markets such as Greece range as low as three (3) years**, and even with relatively flat commercial electricity prices, the economic fundamentals of investing in onsite solar generation for commercial customers are attractive and expected to remain strong.

Why national policymakers should pay more attention to the commercial prosumer market segment

The commercial prosumer market can be considered the mid-sized market between large-scale and household-level solar PV adoption (see Figure 1).

Figure 1: Three Main Solar PV Market Segments

Although policymakers throughout the SEE region have largely ignored this market segment, there is a strong case to be made for directing more policy and regulatory focus on strategically supporting this **mid-scale market segment**.

In particular, governments throughout the SEE region have several reasons to devote more attention to the medium-scale, commercial prosumer market:

- **Current feed-in tariffs and renewable energy auctions being implemented in most countries (not only in the SEE region) are failing to bring sufficient new volumes of renewable energy capacity online.** In addition to increasing the ambition of feed-in tariff and auction policies, **stronger policies for self-consumption are required** in order to support the decarbonization of the power system.[1]
- **Company competitiveness:** Encouraging more low-cost, customer-sited generation can help **improve companies' competitiveness** by reducing their overall energy costs. For many companies, investing in onsite solar can also generate a range of brand-related benefits, which may further boost companies' market share.
- **Greater local co-benefits**: Investments in distributed renewables like customer-sited solar PV generate more local job creation and investment than large-scale solar PV projects.[2]
- **Large-scale rooftop solar PV projects benefit from greater economies of scale than household-sized systems:** whereas household-scale rooftop systems are currently being installed in the region in the range of EUR 1.000 – 1.300/kWp, commercial systems are currently being installed between EUR 500 – 700/kWp.
- **Using existing rooftops, especially large rooftops, for solar PV development can have a lower environmental impact, and generate fewer conflicts with other land-uses** such as agriculture, or real estate.
- **Unlock greater company engagement in the energy transition where no roof goes unused:** A more integrated power system with high shares of variable renewables will require greater participation from electricity consumers than has been the case in the

[1] For instance, in 2020, Croatia put out an auction to procure 88MW of solar and biomass; in the end, only 25,5MW were actually contracted and built.
(Bellini, E., 2021, February 19th. Croatia announces 400 MW renewables auction. In *PV Magazine*. Retrieved from https://www.pv-magazine.com/2021/02/19/croatia-announces-400-mw-renewables-auction/)

(Buck, M. et al., 2019. *European Energy Transition 2030: The Big Picture* https://www.agora-energiewende.de/fileadmin/Projekte/2019/EU_Big_Picture/153_EU-Big-Pic_WEB.pdf)

(International Renewable Energy Agency, 2020. *Global Renewables Outlook.* https://irena.org/-/media/Files/IRENA/Agency/Publication/2020/Apr/IRENA_GRO_Summary_2020.pdf?la=en&hash=1F18E445B56228AF8C4893CAEF147ED0163A0E47)

[2] (Farrell, J., 2019, *Is bigger best in renewable energy?* https://ilsr.org/wpcontent/uploads/2016/09/ILSRIsBiggerBestFinalSeptember.pdf)

past. In practice, this means that customers (either by choice, or by default due to the underlying digital backbone of the energy system) are going to be become increasingly active participants in providing flexibility to the power system. Encouraging more investment in distributed renewable energy supply among commercial and industrial customers can open up a dialogue about how these actors can be better integrated and mobilized in the energy transition.

Currently, many commercial customers remain passive observers rather than active participants and with higher targets on EU and national level this reality will have to change in order for SEE-EU countries to achieve high shares of renewable energy integration and broad-based decarbonization. Moreover, a rapid growth of investments by companies and SMEs in onsite solar in countries like Bulgaria are starting to push the issue up the political agenda.[3]

In addition, countries throughout the SEE region have to take steps to transpose and implement EU Directives, including the recent RED-II. This obligation creates opportunities to focus strategically on the commercial prosumer market segment, rather than purely focusing on large-scale and household-level projects.

Table 1: Key Insights about Commercial Buildings

Understanding Commercial Buildings in the EU*	
1	In the EU, **commercial buildings consume on average 40% more energy per m² than residential buildings** (250kWh/m² vs. 180kWh/m² for residential).[3]
2	**Commercial electricity customers are a major part of the electricity mix, representing between 40% and 70% of national electricity demand in the four markets surveyed**.
3	**The overall energy use of commercial customers is becoming more heavily dependent on electricity:** over the last number of decades, the share of electricity in commercial buildings' overall energy use has grown from 26% in 1980 up to 54% in 2010 and continues to rise, as the share of both coal and oil in particular declines.[4] This reflects a broader transition toward electrification in particular for buildings' heating and cooling needs.

*For the purposes of this analysis, commercial buildings are considered to include all non-residential buildings, while excluding heavy industry. As such, the category of potential commercial prosumers includes warehouses, manufacturing plants, shopping centers, agricultural buildings, small and medium-sized industrial buildings,

[3] (European Commission, 2021. *Energy use in buildings*. Retrieved from https://ec.europa.eu/energy/eu-buildings-factsheets-topics-tree/energy-use-buildings_en the 10.11.2021)

[4] (Ürge-Vorsatz, D., et al., 2015. Heating and cooling energy trends and drivers in buildings. In *Renewable and Sustainable Energy Reviews*, pp. 41, 85-98. http://dx.doi.org/10.1016/j.rser.2014.08.039)

hardware stores, grocery stores, office buildings, as well as publicly-owned buildings such as universities, schools, and administrative buildings. While large industries are starting to self-supply with solar PV in many countries throughout the SEE region as well, this report focused primarily on small and medium-sized commercial customers.

As electricity comes to represent a growing share in commercial buildings' energy use, commercial prosumers can become an important accelerator of the energy transition, helping to transform the energy use of buildings toward a greater reliance on onsite (or near-site) renewable energy sources.

The potential in the SEE region remains largely untapped

At the end of 2020, the total installed solar PV capacity across all three major market segments all four countries is currently 6 373MW.[5] IRENA estimates that the total cost-effective solar PV potential in the region (across all three market segments) is in the range of 300GW, or roughly 50 times the current installed capacity.[6]

[5] Greece = 3.740MW; Croatia = 108 MW; Romania = 1.386MW; Bulgaria: 1.139MW.

(Bhambhani, A., 2021, May 24th. 913 MW New Solar PV Capacity In 2020 In Greece. In *Taiyang News*. Retrieved from http://taiyangnews.info/markets/913-mw-new-solar-pv-capacity-in-2020-in-greece/)

(Bellini, E., 2021, February 19th. Croatia announces 400 MW renewables auction. In *PV Magazine*. Retrieved from https://www.pv-magazine.com/2021/02/19/croatia-announces-400-mw-renewables-auction/)

(Bellini, E., 2021, February 4th. Romania improves rebate scheme to speed up rooftop PV development. In *PV Magazine*. Retrieved from https://www.pv-magazine.com/2021/02/04/romania-improves-rebate-scheme-to-speed-up-rooftop-pv-development/)

(Bhambhani, A., 2021. March 9th. Bulgaria Installed 77 MW Solar PV Capacity in 2020. In *Taiyang News* . Retrieved from http://taiyangnews.info/markets/bulgaria-installed-77-mw-solar-pv-capacity-in-2020/)

[6] (International Renewable Energy Agency. 2018, June 29th. *Renewable Energy in the CESEC region.* https://ec.europa.eu/energy/sites/ener/files/documents/renewable_energy_in_the_cesec_region_irena_22_june_2018.pdf)

	Greece	Croatia	Bulgaria	Romania
Total customer-sited PV capacity (early 2021)	51 MW	48 MW	Approx. 50 MW	Less than 10 MW
Predominant project type	Both residential and commercial	Predominantly commercial with some residential	Mainly commercial	Mainly commercial and industrial
Total installed solar PV capacity (approx.)	3 740 MW	108 MW	1 139 MW	1 386 MW
Solar share of national power Mix	8.2%[7]	0.4%[8]	3%[9]	3.4%[10]

Table 2: South East Europe Market Snapshot

However, despite the presence of significant untapped potential, there are a number of barriers that continue to hinder the adoption of solar by the commercial sector in the region. Although the local specifics differ, several common challenges persist:

Internal Barriers	External Barriers
❖ Commercial customers often rent, rather than own, their buildings ❖ Energy costs are often only a small part of company operating costs ❖ Company decision-making processes often stand in the way ❖ Time constraints/Lack of knowledge and capacity	❖ Complex and time-consuming administrative procedures ❖ Lack of clear policies governing the compensation of surplus generation ❖ Difficulties obtaining the approval from distribution system operators ❖ Lack of local expertise to develop renewable energy projects onsite

[7] (Greensolver, July 2020. *Country Overview | Greece – Renewable Energy 2020-2030.* https://greendealflow.com/wp-content/uploads/2020/07/Greece.pdf)

[8] (Spasić, V., 2021, March 4th. Croatia's solar energy potential estimated at 6.8 GW. In *Balkan Energy News.* https://balkangreenenergynews.com/croatias-solar-energy-potential-estimated-at-6-8-gw/)

[9] (Couture, T. et al., June 2021, *Scaling-up Distributed Solar PV in Bulgaria.* https://www.e3analytics.eu/wp-content/uploads/2021/06/E3A_Bulgaria_Analysis_of_Distributed_PV_ENG_FINAL.pdf)

[10] (Ernst & Young, 2021, April 1st. *EY Romania report.* https://www.ey.com/en_ro/news/2021/04/ey-romania-report--renewables-can-accelerate-the-decarbonisation)

❖ Misconceptions about the cost of RE technologies; ❖ Difficulty accessing finance ❖ Occasionally a lack of suitable rooftop space, even for commercial customers	❖ Complex metering and other grid connection requirements ❖ Lack of clarity on tax implications

Table 3: Internal and External Barriers for Companies to Adopt Solar PV

By taking steps to address these barriers, policymakers can help ensure that commercial prosumers play a central role in driving to power system transformation in South East Europe[11].

The SEE region is well positioned to accelerate the adoption of solar PV

Each of the four countries targeted has tremendous untapped solar power potential,[12] and each has an active solar PV developer market driven by the increasingly compelling economics on customer-sited generation. Also, some utilities and distribution grid system operators (DSOs) in the region are starting to become more active in the market for distributed PV development themselves, setting up subsidiaries to encourage small and medium-sized enterprises (SMEs) to invest in rooftop systems themselves.[13] Taken together, these factors point to a favorable market environment for SMEs to invest in their own solar PV projects, either independently, or with partners via leasing models, or in partnership with their utilities and DSOs.

Policy frameworks in the region remain inadequate

Many national energy plans in the SEE region still do not include a clear goal or target for the contribution of prosumers (whether household, commercial, or industrial) to the achievement of national energy targets, and many utilities continue to ignore, or underplay, the potential contribution of such prosumers to the energy transition.

In addition, many policy and regulatory frameworks remain inadequate, and many such frameworks in jurisdictions across Europe still do not have provisions to deal with a range of

[11] For a more detailed analysis of the four countries covered in this report, Bulgaria, Croatia, Greece, and Romania, see Annexes 1-4 at the end of the report.

[12] (International Renewable Energy Agency, 2017. *Cost-Competitive Renewable Power Generation: Potential across South East Europe.* https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/IRENA_Cost-competitive_power_potential_SEE_2017.pdf)

(Agora EnergiewendeOctober 2019. *Unlocking Low Cost Renewables in South East Europe.* https://static.agora-energiewende.de/fileadmin2/Projekte/2019/De-risking_SEE/161_Unlocking_SEE_EN_WEB.pdf)

[13] (Couture, T. et al., June 2021, *Scaling-up Distributed Solar PV in Bulgaria.* https://www.e3analytics.eu/wp-content/uploads/2021/06/E3A_Bulgaria_Analysis_of_Distributed_PV_ENG_FINAL.pdf)

topics that are starting to reshape the prosumer landscape, including virtual self-consumption, bilateral PPAs, solar leasing, and peer-to-peer energy sharing between customers. Moreover, many jurisdictions have not yet done enough to prepare their legal and regulatory frameworks to ensure the integration of such prosumers into the market such as advanced inverter standards, clear rules for aggregators, advanced spatial planning to anticipate commercial PV adoption patterns, as well as guidelines for the integration of customer-sited storage and demand-response technologies. Thus, despite the progress that has been made in certain countries in the region, there is still much to be done.

Chapter 2: Understanding the Rise of Commercial Prosumers

There are Three Main Phases of Prosumer Market Development[14]

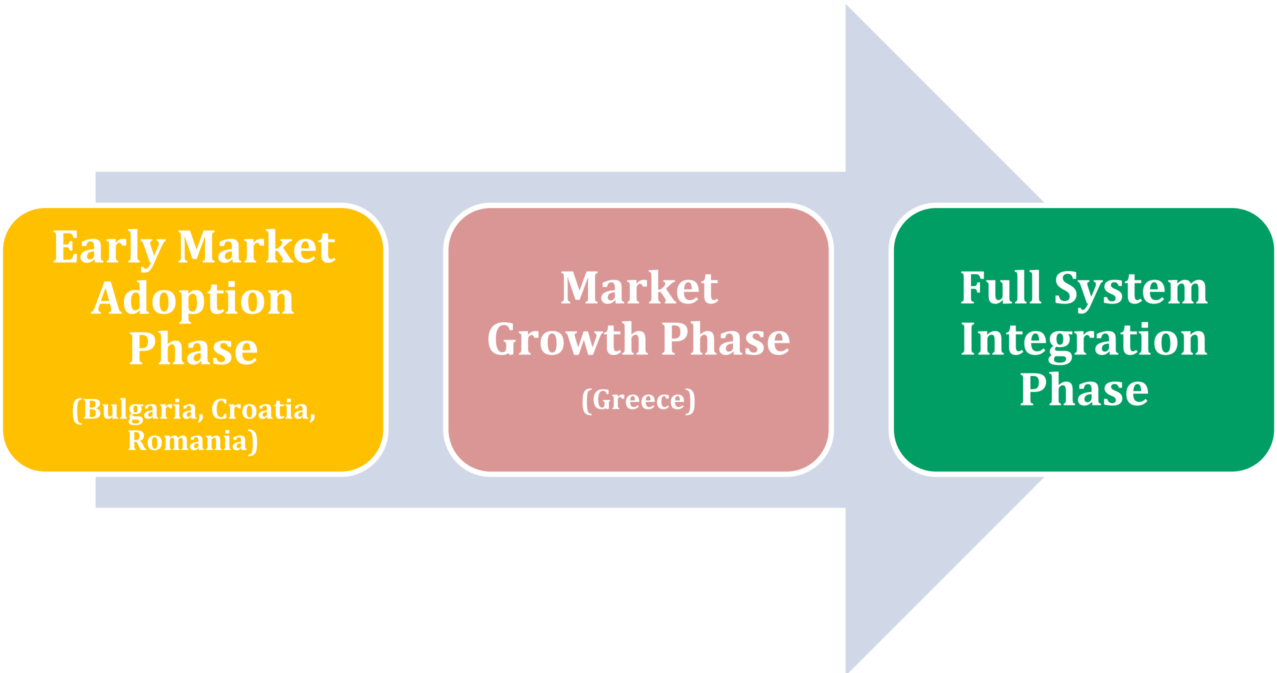


Figure 2: The Three Main Phases of Prosumer Market Development

In the **Early Market Adoption Phase,** many of the rules and regulations around commercial self-consumption are unclear, and regulations governing surplus electricity sales in particular are often weak, or non-existent. At this stage of market development, the tax implications are frequently unclear and the process to get a project connected to the grid is often long, and lacks transparency, with different grid operators applying different rules, and some refusing to connect projects altogether. In this phase, the market is mainly driven by early-adopters and remains small, with few projects getting built, and the majority of projects is focused purely on self-consumption (with little or no surpluses being exported to the grid). As a result, at this early stage of market development, projects are often under-dimensioned, and awareness of the financial and economic attractiveness of investing in solar for onsite use remains limited. Currently, **Bulgaria** and **Romania** remain with the early market adoption phase, despite the fact that some jurisdictions

[14] Note that this framework is primarily meant to be descriptive; developments in individual markets may differ from the structure outlined here.

such as Romania already have certain policies for prosumers in place, many issues and hurdles remain.

Countries in the SEE region are at different stages of development

In the **Market Growth Phase**, policy and regulatory frameworks start to become clearer and rules are the market starts to develop and gain momentum. There are typically rules governing the sale of surplus generation and the overall tax implications are becoming clearer. Awareness of the business case for becoming a prosumer starts to spread and a growing number of companies starts to look to meet a portion of their onsite electricity needs with solar PV. Policies such as Net Metering, Net Billing, and Net-FITs (also referred to as "**surplus power tariffs**")[15] start to emerge and policies enabling remote self-consumption (production elsewhere than at one's premises) such as virtual net metering start to be adopted to enable wider market participation and to overcome some of the barriers faced by prosumers who lack the necessary roof space or surrounding land.

Critically, during the Market Growth Phase, the overall permitting and administrative processes start to become clearer, and rules are applied more consistently, including for grid connection procedures. In the market growth phase, the main policy instruments used to govern the market include Net Metering, Net Billing, as well as Net-FITs, or Surplus Power Tariffs. Figure 3 provides an overview:[16]

[15] (Petrick, K., 2021, February 25 th. *Surplus Power Tariffs – Boosting renewable investment through fair remuneration (short version).* https://proseu.eu/sites/default/files/PROSEU_Surplus%20Power%20Tariffs%20-%20Position%20Paper%20%28short%20version%29_2021-02-25.pdf)

[16] Note that this overview is a simplification and that policies adopted in certain jurisdictions may differ from the characterization presented here. Net-FITs have also been referred to as Surplus Power Tariffs.
(Petrick, K., 2021, February 25 th. *Surplus Power Tariffs – Boosting renewable investment through fair remuneration (short version).* https://proseu.eu/sites/default/files/PROSEU_Surplus%20Power%20Tariffs%20-%20Position%20Paper%20%28short%20version%29_2021-02-25.pdf)

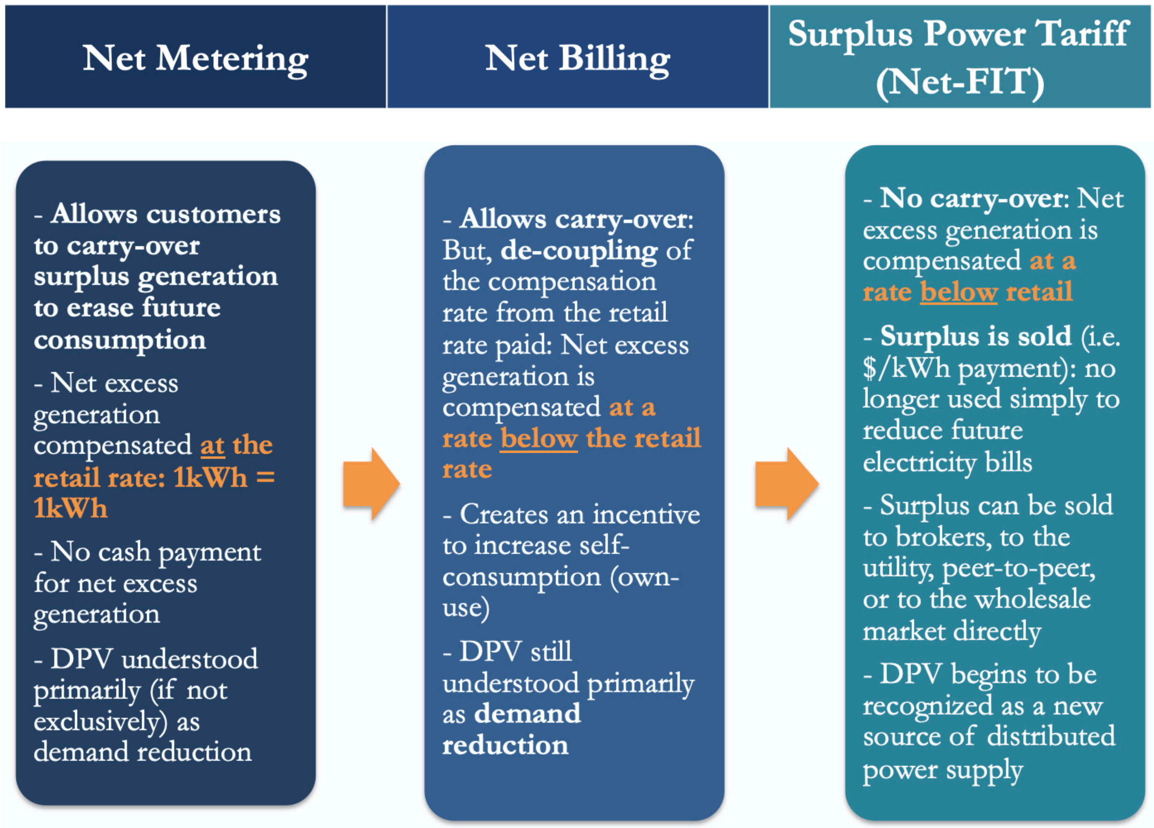


Figure 3: Main Policy Approaches for Dealing with Customer-Sited Generation

At the same time, as market growth gains momentum during this phase, a series of challenges and debates starts to emerge, partly around electricity system cross-subsidies between different customer classes (and between solar and non-solar customers) and partly with regard to issues such as voltage and frequency control. "Hotspots" start to emerge at certain locations on the grid, and issues such as reverse power flows start to occur on certain feeders during certain days of the year, prompting debates about how to better integrate prosumers into the overall power system. **Croatia** can be considered to be entering, while **Greece** can be considered to be firmly within, the market growth phase.

Policy frameworks to evolve toward full system integration

During the **Full System Integration Phase**, awareness of the business case is widespread and market deployment is occurring at a sustained pace, fueled by a large, diversified and competitive solar installer market. Projects in this phase are increasingly likely to include advanced inverter and metering technologies, and the use of demand response and storage technologies to enable greater self-sufficiency (i.e. higher self-consumption ratios) starts to grow. Policies in this phase are increasingly geared toward full market integration, with compensation levels being linked either to time-differentiated rates, or directly to wholesale market prices. The overall administrative and permitting procedures are clear, and project approvals and site inspections are conducted in a streamlined manner.

In the Full System Integration Phase, the overall policy debate starts to include broader discussion of the responsibilities of prosumers for system stability, and for better managing the timing of their surplus generation and their overall interaction with the grid, including supporting with voltage and frequency control. Policy frameworks start either directly, or via market prices, to discourage supply during daytime hours and encourage load shifting to soak up abundant daytime electricity.[17] For instance, prosumers in California have been required since 2017 to rely on time-differentiated rates for both self-consumption and surplus generation, while several utilities in Australia are now offering a range of time-differentiated rate options, with some even including higher rates during the early evening hours (see Text Box 1).

At the same time, in the Full System Integration Phase, utilities and distribution system operators push for stricter limits on PV system output in order to better manage the growing shares of supply during the daytime. This is already happening in Australia, where the latest decision by the Australian Energy Market Commission (AEMC) allows utilities to introduce a range of limitations on project size.[18] Such restrictions and curtailments can be avoided (or at least heavily mitigated) through better power system management, including by encouraging the use of storage, hydrogen production, the storage of surplus electricity in thermal form (either heating or cooling), or through better demand side management.

A related dimension of the Full System Integration Phase is the need to **re-envision the roles and responsibilities of the distribution system operators** (DSOs). As part of a major utility proceeding in California, the Public Utilities Commission has set out a vision according to which the DSO "should act as a technology-neutral marketplace to coordinate situational awareness and facilitate information exchange": the underlying vision (similar in some ways to the vision laid out by the EU's Internal Market Directive) is to enable prosumers to bid their services (whether surplus generation, battery storage capacity, demand response, or various ancillary services) into the market, much like larger-scale generators currently do via the wholesale market.[19] Under such a DSO paradigm, commercial prosumers would be in a better position to respond to market signals, and potentially even provide a range of services to support system flexibility. Indeed, the need for changes in Europe's regulation of DSOs to enable more flexibility and interactivity has also been highlighted in a series of recent reports.[20]

[17] (Brakels, R., 2020, April 6th. Will SA's "Solar Sponge" Tariff Make 'Batteries Without Solar' Worthwile? In *Solarquotes Blog*. https://www.solarquotes.com.au/blog/sa-solar-sponge-tariff/)

[18] (Roberts, E., 2021, August 25th. Solar export rule not the consumer "win" it's cracked up to be. In *One Step Off The Grid*. https://onestepoffthegrid.com.au/solar-export-rule-not-the-consumer-win-its-cracked-up-to-be/)

[19] (State Of California, 2021, July 2nd. *Order Instituting rulemaking to modernize the electric grid for a high distribute energy resources future*. https://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M390/K664/390664433.PDF)

[20] (Bundesverband Neue Energiewirtschaft e.V., 2015. *Decentralized Flexibility Market*. https://www.bne-online.de/fileadmin/bne/Dokumente/Positionspapiere/2015/20150130_bne_De-Flex-Market_final.pdf)

(Bunesverband Neue Energiewirtschaft e.V., 2016. *Decentralized Flexibility Market 2.0*. https://www.bne-online.de/fileadmin/bne/Dokumente/Englisch/Policy_Papers/20160704_bne_De-Flex-Market_2.0_final.pdf)

During the Full System Integration Phase, customer-sited solar (whether at residential, commercial, or industrial facilities) becomes part of power system planning. Currently no SEE country is in the Full System Integration Phase.

Text Box 1: Utilities compete to offer best surplus tariffs
In Australia, it is now retailers who compete to offer customers the most attractive surplus power tariffs. In most Australian states, the state regulator publishes a benchmark rate for the settlement of surplus generation, which is adjusted regularly; individual retailers can choose to offer a tariff that is either above, below, or equal to this benchmark. As daytime electricity wholesale market prices have declined in recent years, state regulators have progressively reduced the surplus power tariff, in order to keep it more in line with solar's approximate market value. What is also happening in Australia is a move toward time-of-use tariffs, with a premium for surplus power provided to the grid during peak times (e.g. 5-7PM). In this way, prosumers can be incentivized to reduce their own demand during this time (in order to increase their available surplus), or they can orient their PV systems westward to take advantage of early evening sunshine and even invest in storage systems and start providing power back to the grid.[21]
Source: https://onestepoffthegrid.com.au/nsw-regulator-slashes-rooftop-solar-feed-in-tariff-by-25-per-cent/

[21] (Mazengarb, M., 2021, July 2nd. NSW regulator slashes rooftop solar feed-in-tariff by 25 per cent. In *One Step Off The Grid.* https://onestepoffthegrid.com.au/nsw-regulator-slashes-rooftop-solar-feed-in-tariff-by-25-per-cent/)

Table 4: Overview of the Main Prosumer Market Development Phases

Prosumer Market Development Phase	Main Characteristics	Main Challenges	Sample Jurisdictions
Early Market Adoption Phase	• An absence of clear prosumer policies • Few regulations governing administrative and permitting issues • Tax implications often unclear • Market mainly driven by early-adopters • Awareness of attractive economics remains limited	• Lack of clear administrative procedures (grid connection, permits) • Long delays to obtain necessary permissions • Utilities and local authorities slow to react	• **Romania** • **Bulgaria** • **Croatia**
Market Growth Phase	• Rapid market development • Administrative and permitting increasingly clear • Awareness of attractive economics increasingly widespread • Tax implications increasingly clear • Debate over cross-subsidies grows • Storage starts to be adopted by some users	• Issues with reverse power flows, frequency, and voltage control start to emerge • Duck curve* starts to occur on certain days • Utilities start to act to better control prosumer market growth	• **Greece** • Spain • Vietnam • Australia • California • Massachusetts • South Africa

Full System Integration Phase	• Stable market growth • Widespread adoption of solar by customers • Targeted policies emerge to support flexibility, storage, and demand response • Role of flexibility, storage, sector coupling, and demand response increasingly important	• Managing real-time voltage and frequency control • Forecasting net (post-prosumer) load in the distribution system • Reverse power flows • Duck curve* mitigation	• None. Potential candidates: South Australia, Hawaii

*The duck curve refers to the shape of the electricity demand of a region as the share of solar PV starts to grow. For more information on the duck curve, see Denholm et al. 2008. "Production Cost Modelling for High Shares of Solar Photovoltaics."[22]

[22] (Denholm, P. et al., February 2008. *Production Cost Modeling for High Levels of Photovoltaics Penetration.* https://www.nrel.gov/docs/fy08osti/42305.pdf)
(Couture, T. May 2018. *Enter the Shark Curve,* http://www.e3analytics.eu/wp-content/uploads/2019/11/Analytical-Brief_May-2018_FINAL.pdf)

Chapter 3: The Economics of Commercial Prosumers

The business case for companies is getting stronger and stronger

The economics of solar powered self-consumption for commercial and institutional customers in South East Europe are becoming increasingly compelling, supported by a range of factors:

Decreasing costs of solar PV projects: Current installed costs for projects built in 2020 and 2021 range between roughly EUR 500/kW to EUR 750/kW depending on the maturity of the market, whether trackers and/or bifacial panels are used,[23] and the project size, down by roughly 50% since 2017.

Increasing electricity market prices: driven by a range of factors including scarcity, rising gas and, to a lesser extent, CO2 prices, wildfires, and steady power demand, electricity prices on the day-ahead and intraday markets have risen dramatically in recent months. These high prices increase the attractiveness of onsite generation by making surplus sales more attractive, particularly in markets like Romania and Bulgaria where surplus sales are market linked.

The decreasing cost of capital: in line with the global and EU trends, the cost of debt in particular is at near-record lows.[24] Based on the market research conducted in Bulgaria Croatia, Greece, and

[23] Using trackers and bi-facial panels can increase installed costs by approximately 20%. However, these higher installed costs are typically offset by higher solar PV output. Single-axis trackers, for instance, can boost output by between 7% and 37% and are widely considered more economic than costlier dual-axis trackers.
(Rojo Martín, J., 2020, June 5th. Bifacial with single-axis trackers is low-cost king for global solar – SERIS. In *PV Tech* https://www.pv-tech.org/bifacial-with-single-axis-trackers-is-low-cost-king-for-global-solar-seris/)

Whether it makes economic sense to install trackers at all, or in combination with bi-facial panels depends on a range of factors, including the orientation of the system (e.g. roof shape and orientation), as well as the size of the project. Note that using trackers can also increase operations and maintenance costs.

[24] (Diacore. 2021, October 14th. *Rozważania dotyczące portfela energii odnawialnej.* http://www.diacore.eu/images/files2/WP3-Final%20Report/diacore-2016-impact-of-risk-in-res-investments.pdf)

Romania, the weighted average cost of capital (WACC) for commercial prosumer projects ranges from 3.2 – 9.0 %.

Development of expertise and increased competition: in each of the markets surveyed here, there are now dozens of installers serving the market and competing for market share (in the case of Greece, the number is in the hundreds). Growing competition is helping push down costs while helping drive greater efficiencies in terms of project design, grid connection, as well as construction and wiring.

The rise of more innovative business models: New business models such as ESCOs and solar leasing providers are also emerging and are starting to make it easier for commercial and industrial customers to go solar. In these models, prosumers can overcome some of the barriers of investing in a solar system, such as the need to shoulder the initial upfront cost and ensure maintenance over the course of the system's life. In addition, prosumers obtain a range of benefits in the form of lower and less volatile energy bills.

Increased awareness and brand-related considerations: besides policy, technical and economic drivers, the impact of rising awareness as well as brand recognition is also playing an important role in driving solar PV adoption among commercial customers. In addition, as pressure for supply chains to become carbon neutral continues to grow, companies are starting to look more seriously at supplying their own renewable electricity themselves, rather than procuring it from others.

Table 5: Main Catalysts for Commercial Prosumers

Taken together, these factors are starting to create a stable set of drivers pushing commercial customers to explore their own onsite generation. The section below takes a closer look at the first three factors listed above.

The costs of installing solar PV continue to decline

Across all four markets surveyed, installed costs for commercial-scale solar PV systems have experienced a substantial decline in recent years, down approximately 50% since 2017. And yet, despite the relative geographic proximity of some of the four markets to one another, significant differences in installed costs persist.

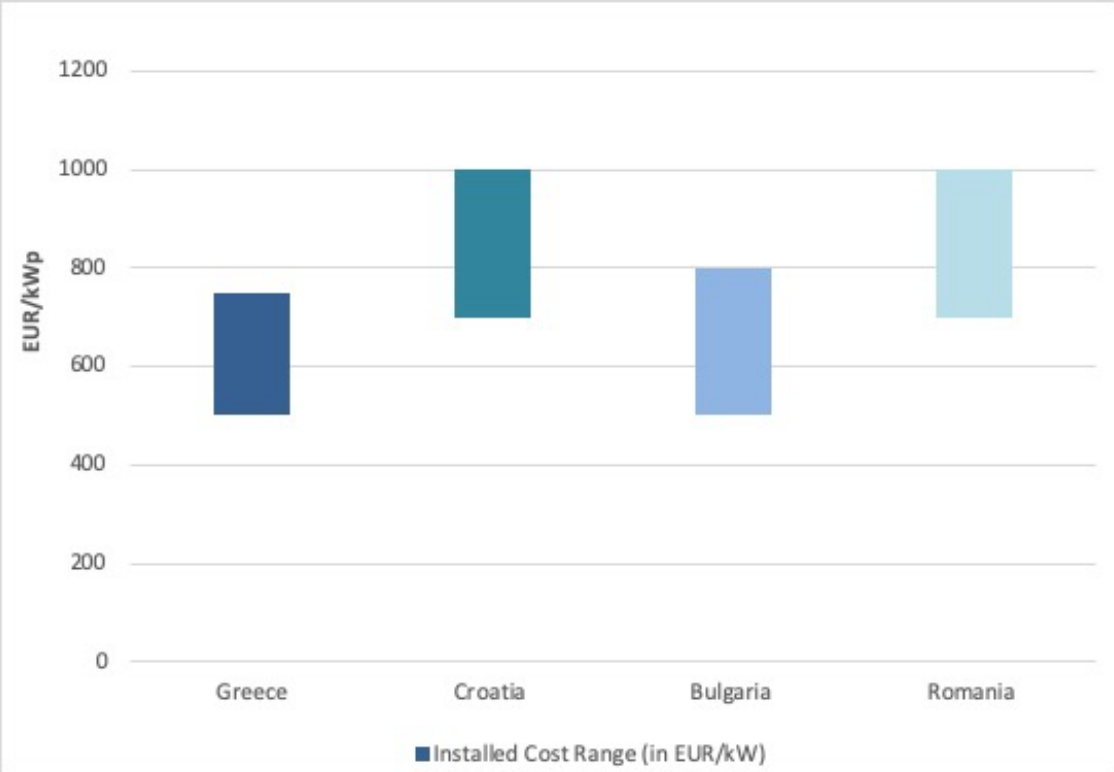


Figure 4: Installed Cost Range of Commercial Prosumer Solar PV Projects

Across the four markets surveyed, the upper range of installed costs for commercial-scale solar PV projects (between 50kW – 2MW) plateaus at roughly EUR 1.000 per kW installed. However, in both Bulgaria and Greece, some recently constructed projects reported installed costs as low as EUR 500 per kW installed, mainly for larger, MW-scale projects.

These lower installed costs translate into lower levelized generation costs. As Figure 5 shows, the achievable range (in mid-2021) for the levelized cost of electricity generation from commercial-scale (approximately 100kW – 5MW) solar PV projects in the four markets surveyed ranges from approximately EUR 0,03 – 0,07/kWh.[25]

[25] The wider range shown in Figure 5 is based on a « worst case » project, including the outer high-end range for installed costs and the cost of capital, as well as the lower range for country-specific solar insolation.

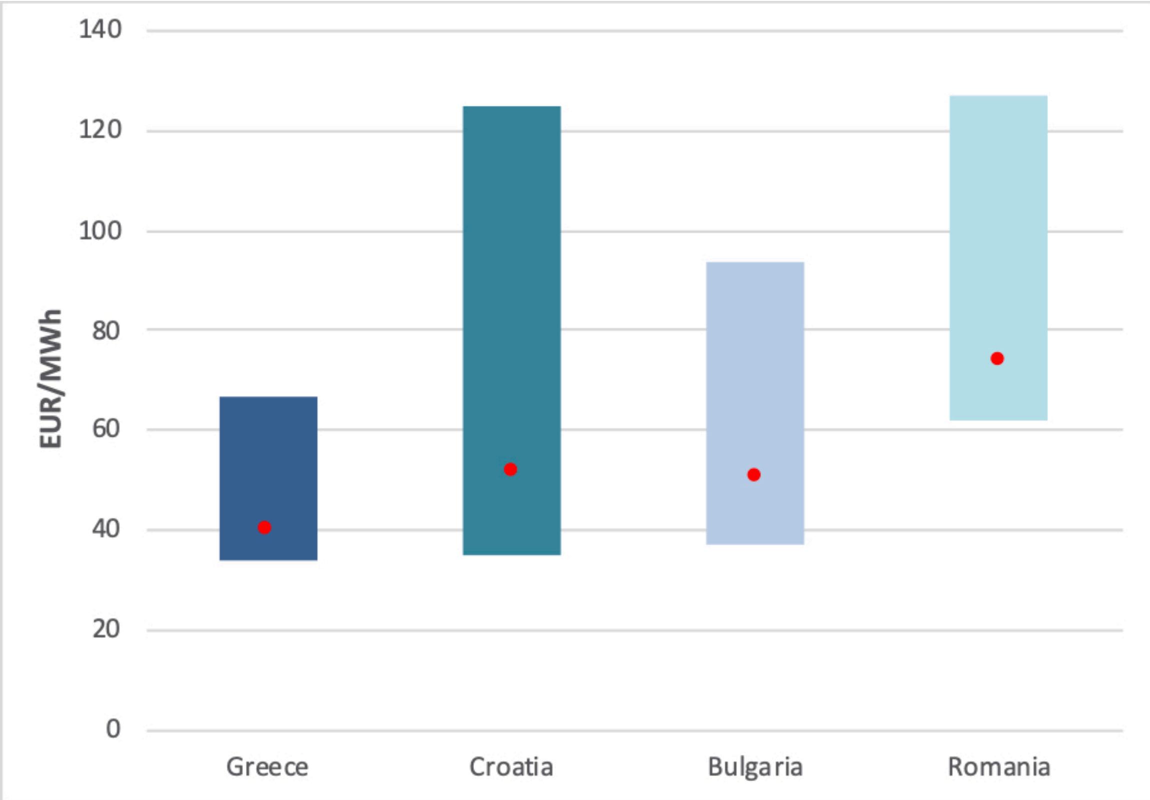


Figure 5: Range of Levelized Cost of Energy for Customer-Sited Solar PV Projects[26]

Note: the red dot represents the realistically achievable LCOE price for projects built in mid-to-late-2021. For detailed input data for these and other graphs in this section, see Annex 5 at the end of the report.

With these LCOEs, particularly in markets like Greece, interviews with local prosumers and developers indicate **payback times of as low as three years**, depending on local installed costs, solar resource quality, and the retail electricity prices currently being paid. With such short payback periods, the economics of investing in onsite solar is not only attractive for private companies and industries, but also for public sector buildings and fully (or partially) publicly-owned infrastructure such as airports and bus terminals. A prominent example of this is Athens' international airport, which has recently announced plans to increase its onsite solar PV capacity from 8MW to just over 24MW in order to supply a greater share of its onsite electricity needs.[27]

[26] Note that the wide range in Croatia is due to a range of factors: the country has a wide range of solar irradiance (low in the north, high in the south), still significant differences of investment costs, and widely varying cost of capital depending on the specific project proponent.

[27] (Grimanes, S., 2021, May 24th ΔΑΑ: Στην…πίστα απογείωσης και τα νέα φωτοβολταϊκά. In *New Money*. https://www.newmoney.gr/roh/palmos-oikonomias/energeia/daa-stinpista-apogiosis-ke-ta-nea-fotovoltaika/)

Text Box 2: Understanding the system-level value of DERs

Throughout the debate on the role of distributed energy resources (DERs) such as prosumers in future power system planning, it is commonly assumed that centralized resources are cheaper, on a per-kWh basis, than distributed resources. As a result, the main priority among policymakers in many countries is to procure renewables at the lowest cost by launching competitive auctions, the bulk of which are focused on procuring large-scale renewable energy projects.

However, a growing body of research is starting to show that although large, centralized resources cost less in per-kWh terms, they are also ***worth*** less in terms of their system-level benefits:[28] larger projects face higher transmission and distribution losses, they tend to have higher overall grid connection costs, and they face greater opposition from citizens and communities, which can lead to delays and create additional administrative and legal costs, both for developers and for society. Distributed resources, by contrast, are frequently located closer to loads, and suffer from fewer line losses, and do not face the same challenges with regard to local acceptance.

Electricity wholesale market prices are on the rise

Another positive factor driving interest in self-consumption is that **the LCOE of commercial-scale solar projects in jurisdictions throughout the region is now significantly below daytime wholesale market prices** (including both day-ahead as well as intra-day prices), particularly during the summer months. For commercial customers that have moved to market-based prices in recent years (as many have been required to do in line with EU regulations), the recent surge in market prices is propelling further interest. In Bulgaria, rapid rises in electricity prices in 2016 that coincided with the move made by many commercial customers to open market prices helped fuel growing interest and awareness of investing in onsite generation.

While wholesale market prices remained subdued in most of the region from 2017 to 2020, recent developments in the SEE region have helped rekindle interest among commercial customers, with average day-ahead market prices experiencing a sustained rise since mid-2020:

[28] (Australian Energy Regulator, July 2021. *DRAFT DER integration expenditure guidance note.* https://www.aer.gov.au/system/files/Draft%20DER%20integration%20expenditure%20guidance%20note%20%286%20July%29.pdf)

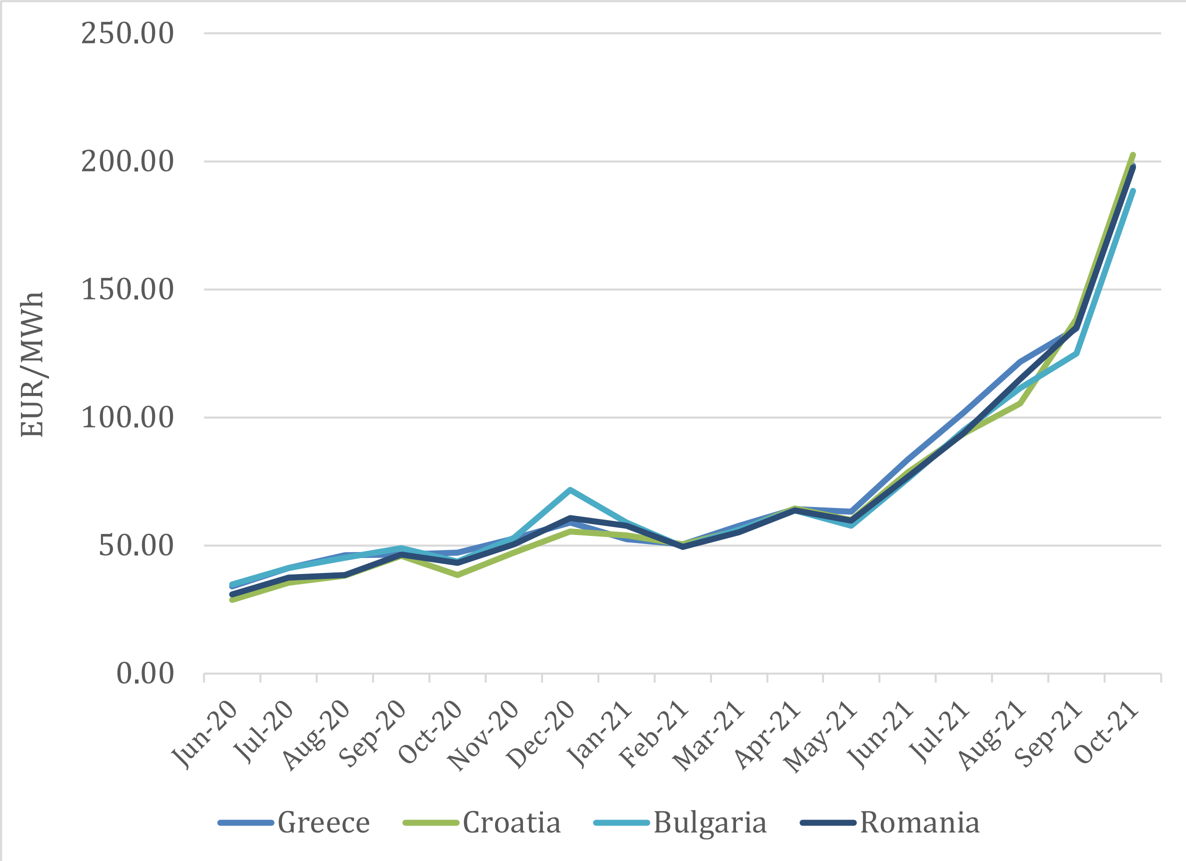


Figure 6: Average Day-Ahead Market Prices through October 2021 (in EUR/MWh)

Sources: HEnEx, CROPEX, IBEX, OPCOM

Prices on the day-ahead market have averaged over EUR 100/MWh in all four countries during the months of August, September and October 2021, and nearly EUR 200/MWh in the month of October. This represents **a four-fold increase** from average day-ahead market prices one year ago.

For electricity traded on the intra-day market, prices have escalated even higher, reaching a maximum price of EUR 400/MWh in Greece, with average prices also hovering in the range of EUR 200/MWh.[29]

At these high daytime prices, commercial prosumers can not only improve the economics of their own project by selling the surplus they cannot consume onsite, they can also provide a further

[29] (Hellenic Energy Exchange S.A., October 2021. *Day Ahead & Intraday Markets – Greek Bidding Zone.* https://www.enexgroup.gr/c/document_library/get_file?uuid=c0f1e95b-7e7d-6cf6-e926-dff174f51290&groupId=20126)

benefit to the system and to other electricity customers on the network: by increasing supply during peak hours, they can help reduce both intraday and day-ahead market prices.

Commercial prosumers are well positioned to capitalize on high daytime prices

The summertime in Europe is not only the period when solar output is at its highest, it also coincides with the period during which commercial prosumers in markets like Greece, Croatia, Bulgaria and Romania have reduced electricity demand due to summer holidays. This lower electricity demand helps increase the amount of onsite generation available for export to the grid: critical in this regard are the specific rules and regulations governing the sales of such surplus generation (see Figure 9 for an overview of the main options for compensating surplus generation).

In the meantime, a number of commercial prosumers in markets like Bulgaria, Croatia, and Romania are starting to market their surplus generation directly on the wholesale market, often via brokers or aggregators. These developments have been made possible by the ongoing liberalization of the electricity market, which has opened up new possibilities for generators to market their surplus generation.

The cost of capital has broadly declined

As outlined in analyses of the cost of capital from 2015, 2018, and 2020,[30] there is little doubt that the overall cost of capital for financing renewable energy projects has declined across the EU in recent years. Thus far, however, many of the analyses have focused on onshore wind, and comparatively little research has been published on the cost of capital for commercial-scale solar PV projects.

Interviews conducted as part of this project indicate a weighted average cost of capital (WACC) ranging from 3.2% up to 9%, depending on the project and country, featuring notable differences across the four markets covered (see Figure 7):

[30] (Brückmann, R., 2015, May 5th. *Financing Renewables: comparison of cost of capital in 28 EU Member States.* https://www.ceps.eu/wp-content/uploads/2015/05/Comparison%20of%20cost%20of%20capital%20in%2020%20EU%20MS_Robert%20Bruckmann_eclareon.pdf)

(Agora Energiewende, 2018. *Reducing the cost of financing renewables in Europe.* https://www.agora-energiewende.de/fileadmin/Projekte/2016/De-Risking/Agora_RES_CRF-Dialogue_WEB.pdf)

(Roth, A., October 2020. *Trends and evolution of the Costs of Capital in RE Financing.* http://aures2project.eu/wp-content/uploads/2020/11/9_AURES_II_5RW_eclareon_WACC_financing.pdf)

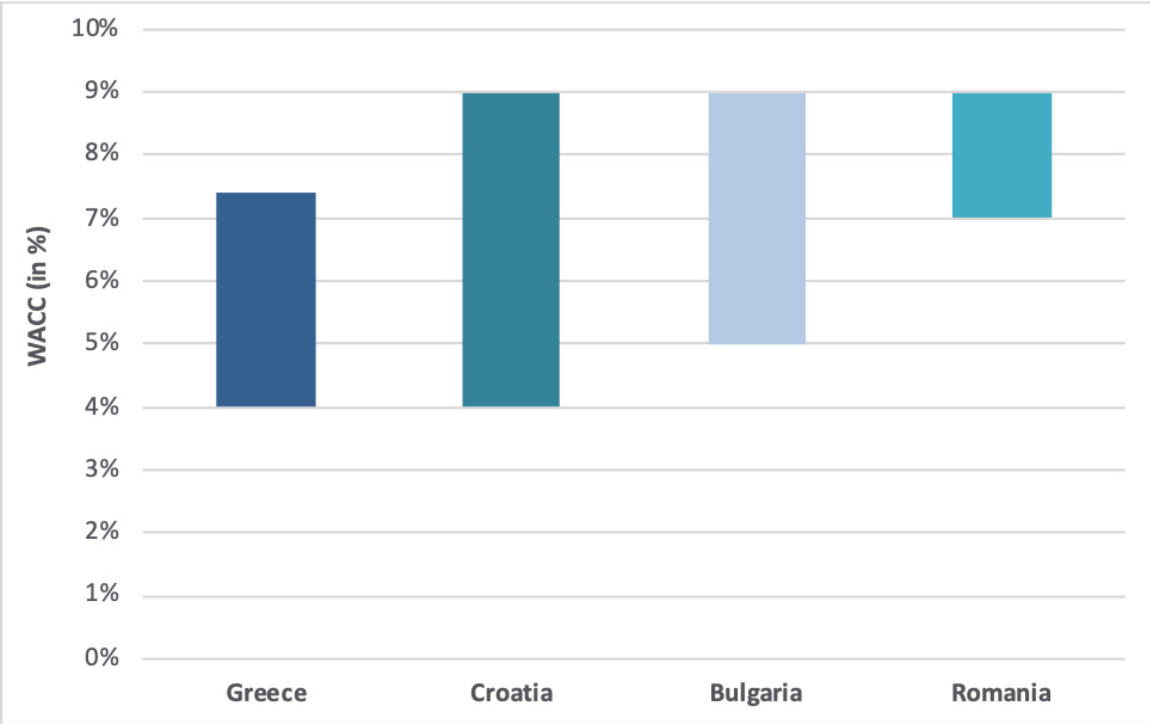


Figure 7: Range of WACC by Country

The market with the widest range in terms of the cost of capital is Croatia, a factor that is partly attributed to the relative immaturity of the country's solar market, and to the wide variety of different developers and prosumers active in the market, some with easy access to capital and others facing challenges.

Access to capital remains an issue for many SMEs in the region

Indeed, a number of small and medium-sized companies continue to report difficulties accessing capital: in Greece, 22% of SMEs report having difficulties accessing capital, and the number of vulnerable firms has gone up rapidly due in large part to the Covid-19 pandemic.[31] In markets like Bulgaria, Romania, and Croatia, SMEs have difficulties accessing capital markets or alternative sources of financing; as a result, bank loans and traditional credit lines remain the primary source of capital for most SMEs.[32] In the case of Croatia, approximately 60% of the country's solar projects have benefited

[31] (European Central Bank, 2020. *Survey on the Access to Finance of Enterprises.* https://www.ecb.europa.eu/stats/ecb_surveys/safe/html/ecb.safe202011~e3858add29.en.html)

[32] For Bulgaria:
(European Central Bank, 2020. *Survey on the Access to Finance of Enterprises.* https://www.ecb.europa.eu/stats/ecb_surveys/safe/html/ecb.safe202011~e3858add29.en.html)

For Croatia:
(Kolakovic, M. et al., March 2019. Access to Finance – Experiences of SMEs in Croatia. In *Zagreb International Review of Economics and Business.* https://www.researchgate.net/profile/Mladen-Turuk/publication/332256262_Access_to_Finance_-_Experiences_of_SMEs_in_Croatia/links/5cbed9d892851c8d22feb105/Access-to-Finance-Experiences-of-SMEs-in-Croatia.pdf)

from the government loan facility (for more information, see Croatia's country analysis below in Annex 2).

Depending on the type of prosumer, the cost of capital varies widely, as does the ratio of debt and equity used to finance projects. For some prosumers within markets such as Romania and Bulgaria, projects have been financed purely with company equity, without relying on any debt at all, while in other projects and jurisdictions such as in Greece, it is common for projects to be financed with 70-80% debt financing.

Text Box 3: Impacts of the Covid-19 Pandemic on Lending Practices

Despite the impacts of Covid-19, lending rates remain at near historic lows, including for banks located in the South East Europe region. For banks engaged in providing lending to companies investing in their own onsite generation, the cost of debt provided depends to a significant degree on the creditworthiness of the client rather than the attractiveness of the project, with some companies (particularly larger companies) being able to mobilize debt at rates between 1,5% and 3% over 10 to 15-year time horizons.

The Covid-19 pandemic, however, has led to greater uncertainties and risks for many companies. Those factors can affect companies' ability to obtain bank loans and may increase companies' reluctance to making substantial capital investments, even when the likely payback period is relatively short.

Chapter 4: Policy Pathways

The EU's RED-II sets the stage for a new, more prosumer-centric energy paradigm

The EU's recently promulgated Renewable Energy Directive II[33] and Internal Electricity Market Directives[34] set out a number of conditions and objectives for the policy frameworks to encourage more "prosumer-centric" energy system across Europe. Among the core principles of these Directives are that the **regulations for prosumers should be non-discriminatory**, that the overall **administrative procedures should be streamlined and efficient**, and that the **policy frameworks should be transparent** and should serve to **empower new actors to participate**.

Text Box 4: The EU sets out new rules to support prosumers

The overall vision emerging at the EU level is that consumers should be granted the right to participate in energy markets as equals, and provided with the ability to buy and trade their energy (and/or the associated services) on an open platform or exchange. In particular, Article 15 of the IEMD entitles consumers to:

- operate either directly or through aggregation,
- sell self-generated electricity, including through power purchase agreements,
- participate in flexibility and energy efficiency policies,
- be subject to cost reflective, transparent and non-discriminatory network charges.

In order to comply, Member States are required to implement supportive regulations to encourage citizen and business-owned renewable energy infrastructure. RED II similarly outlines rules to remove barriers, stimulate investment, as well as drive cost reductions in renewable energy technologies, while specifically aiming to empower citizens, consumers and businesses to participate in the energy transition. In this regard, the IEMD and RED II provide a clear and forward-looking foundation on which Member States can develop their own policies and regulations.

Seeking a lasting approach for compensating surplus generation

Central to policy frameworks for commercial prosumers is the question of how the overall policy environment deals with and remunerates surplus generation: this refers specifically to the electricity

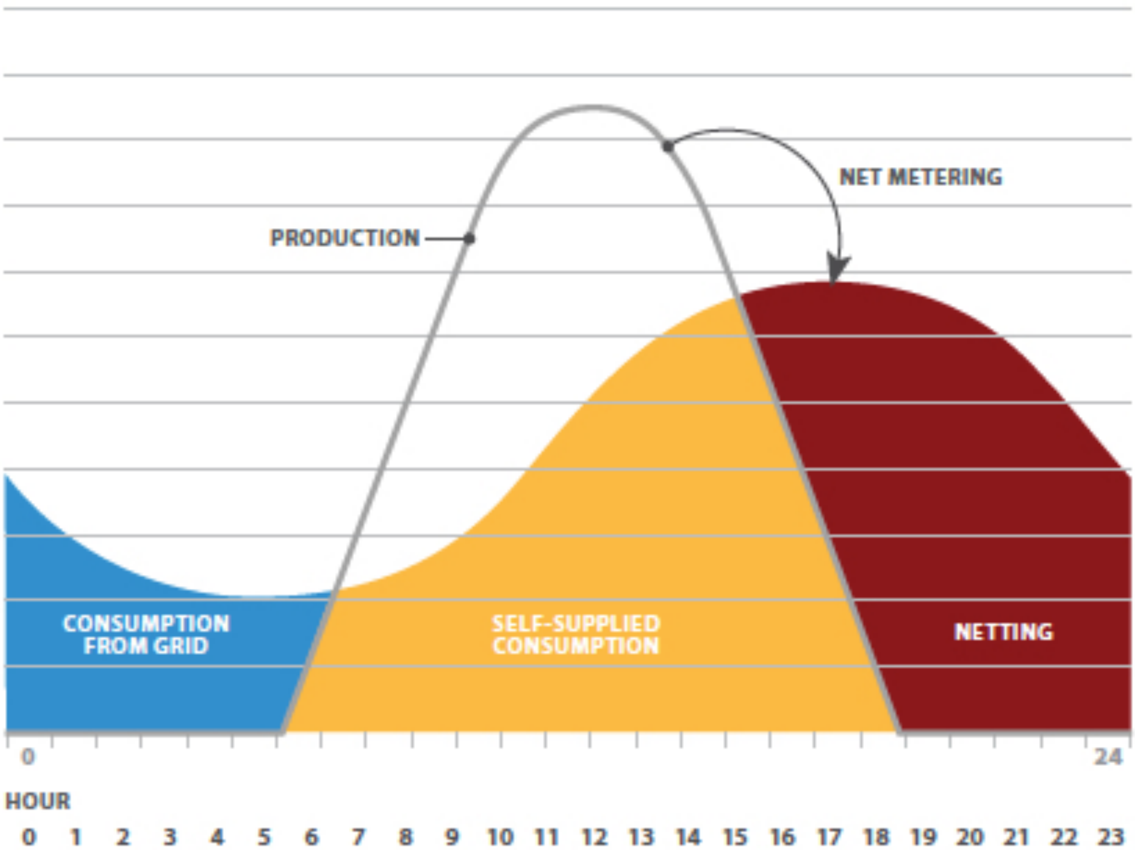
[33] (European Commission, 2021. *Renewable Energy Directive.* https://ec.europa.eu/energy/topics/renewable-energy/directive-targets-and-rules/renewable-energy-directive_en)

[34] (European Parliament, 2019, June 5th. Directive (EU) 2019/944 of the European Parliament and of the Council on common rules for the internal market for electricity. In *Official Journal of the European Union.* https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32019L0944&from=EN)

output that cannot be instantaneously consumed onsite by the user. Seasonal factors, such as summer break or religious holidays, or decreases in onsite electricity consumption caused by changes in the business cycle, by economic downturns, or as seen recently with Covid-19, due to pandemics, can all contribute to commercial prosumers having more solar output than they can consume in a given month.

Another critical factor determining how much electricity is considered surplus is the design of the net metering or net billing policy: in many jurisdictions, net metering rules enable a customer to use surpluses that occur in one time period (e.g. in one hour) to erase demand at other times of the day, or month. Under this approach, only the surplus that cannot be used to erase demand within that month, or billing cycle, gets treated as surplus and compensated accordingly. Under net billing rules, similar rules frequently apply, with the exception that the compensation rate typically differs from the retail rate paid, with surplus generation typically receiving a lower per-kWh compensation.[35]

Figure 8 below provides an illustration of how surplus generation get carried over from one time period to another under net metering or net billing:



[35] For a more detailed overview of the various compensation mechanisms, see Zinaman et al., (2017). Grid-Connected Distributed Generation: Compensation Mechanism Basics, National Renewable Energy Laboratory.

Figure 8: Illustration of surplus generation and netting under net metering/net billing

Source: https://gridworks.org/wp-content/uploads/2018/01/Gridworks_SustainingSolar_Online.pdf

The menu of payment and compensation options is vast

Regardless of exactly how surpluses are determined (in particular whether the netting period is hourly, daily, or monthly), the question of how surplus is compensated can have a decisive impact on the business case for various commercial prosumers. Figure 9 below lays out the main options for compensating surplus generation:

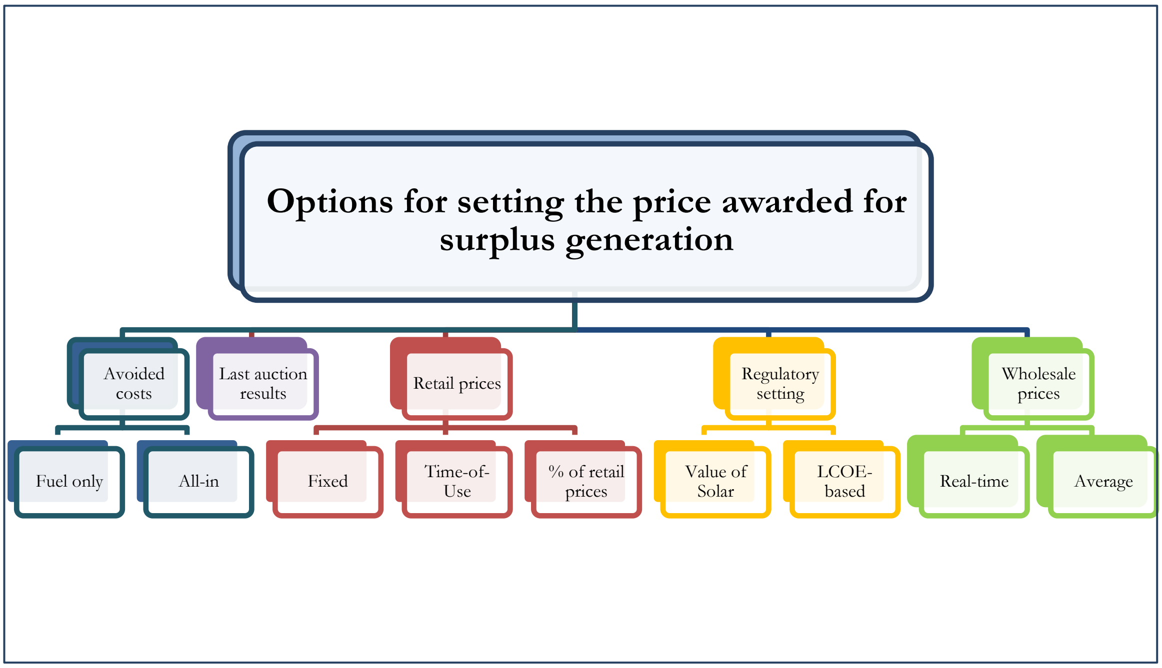


Figure 9: Options for setting the price awarded for surplus generation[36]

Some jurisdictions in the SEE region such as Croatia continue to link the compensation to a percentage of the retail price, while others such as Greece have recently introduced a framework that draws on the latest auction results for projects in that size category to set the compensation levels for prosumers, as part of efforts to ensure that compensation levels remain "market-based". In the case of Bulgaria, the absence of a clear policy and regulatory framework has led most commercial prosumers to rely either on pure self-consumption (with no grid injection), or on wholesale market pricing by selling their surplus to a broker, or other intermediary. And Romania's recently announced policy framework also

[36] Note that a central distinction is whether the compensation levels are determined by utilities (as is commonly the case in the U.S.) or by governments (as is more commonly the case in the EU). Also, for avoided cost-based approaches, some jurisdictions differentiate depending on who owns the power plant that would be providing the offset power, or what the appropriate benchmark is (e.g. wholesale market prices, recently signed power purchase agreements, or otherwise).

relies on wholesale market prices, linking the payment for surplus generation to an average of day-ahead market prices for the preceding year (see individual country case studies in the Annex).

Different policies required for different phases of market development

As these few examples underscore, there is a wide range of approaches to determine the compensation awarded for surplus generation. There are a number of other elements, however, that make up the overall policy environment in addition to the compensation levels on offer. Building on the three main phases laid out in Chapter 2, Table 6 lays out some of the main policy measures organized by phase of market development:

Table 6: Policy measures by phase of market development

Prosumer Market Development Phase	Main Policy Measures by Phase
Early Market Adoption Phase	• Introduce a registry of solar PV systems, including behind-the-meter installations • Start establishing clear permitting and application procedures (e.g. grid connection, maximum processing times,) • Establish policies and regulations governing prosumers (e.g. Net Billing, Net-FITs) • Instruct tax authorities to articulate clear rules and guidance on the tax treatment of onsite generation, and surplus generation • Lower the time needed for approval of the documentation • Start mapping commercial rooftop space to anticipate potential adoption patterns • Start identifying suitable sites for government prosumer investment (e.g. municipal buildings, schools, daycares, universities, sports facilities, etc.) • Introduce clear national targets for prosumers
Market Growth Phase	• Establish or refine prosumer policies such as Net Metering / Net Billing / Surplus Power Tariffs to further de-risk the business case • Introduce Virtual Net Metering in order to allow off-site self-consumption • Start establishing regulations to allow for collective self-consumption and peer-to-peer energy trading, including rules allowing large prosumers to wheel power on the distribution grid • Explore linking the compensation for surplus generation to time-of-use tariff structures or to daytime wholesale market prices

	• Start weighing changes to network tariffs and introducing incentives to encourage the smarter use of distribution grid infrastructure (e.g. minimizing high levels of grid injection during times with low net load, encouraging self-consumption during periods of peak demand) • Establish simplified administrative and permitting processes, including via dedicated agencies where applicable (so-called one-stop-shops). • Publish clear guidance on the tax treatment of self-consumption and of surplus generation, including both for individuals and for companies • Explore steps to change the regulation of DSOs toward a non-discriminatory platform for the exchange of services (demand, supply, flexibility, and storage) to reduce DSOs monopoly power • Develop incentives to encourage prosumers to contribute more actively to power system flexibility (e.g. demand response, customer-sited storage whether electrical or thermal, time-varying export pricing) • Start to introduce regulatory measures to better deal with market integration (e.g. more stringent inverter standards)
Full System Integration Phase	• Evolve the market for surplus generation toward direct market sales or toward Surplus Power Tariffs. • Transition the regulation of DSOs to make them open platforms for the exchange of energy and grid related services; this could include requirements to move toward dynamic voltage management systems to improve visibility over voltage levels in the distribution system as well as to foster a better use of network hosting capacity. • Introduce clearer control measures to govern reverse power flows and mitigate the effects of the duck curve: this can include peak pricing for surplus generation to incentivize supply in the early evening hours, as is being done in parts of Australia. • Ensure that the rules governing peer-to-peer power trading and new business models like aggregators and power cloud providers support, rather than stifle, innovation and customer participation. • Continue to refine policies to support flexibility, storage, and demand response as the market evolves, such as providing expedited approvals for projects using storage or other innovative technologies. • Make smart inverters mandatory to provide grid support and interact more intelligently with the grid.

	• Leave no rooftop unused, starting with requirements for rooftop solar on all new buildings

Prosumer policy frameworks must remain bankable

In some cases, efforts undertaken to introduce more advanced or sophisticated policy frameworks as the market matures can even make it *more difficult* for projects to achieve bankability, as additional fees, surcharges, or requirements are imposed (such as for smarter inverters, or a separate meter to monitor gross PV system output). In some cases, such policy changes can introduce additional risks for prosumers, or even serve to undermine the business case. And while some changes are triggered directly by policymakers, others occur organically as the solar PV market grows and the share of solar in the overall power mix increases.

In the early stages of market development, where the share of solar power is relatively small, daytime prices may be quite high, as seen recently in all four markets surveyed here; however, as the cases of Australia[37] and California[38] demonstrate, as the share of solar power in the wider electricity system grows, daytime market prices tend to decline, and in some cases, may even turn negative due to the inability of other generators (mainly coal and nuclear generators) to modulate their output and ramp down. Such circumstances can lead to over-generation in the system and have prompted regulators in certain parts of Australia[39] as well as in Hawaii to stop accepting grid exports from residential and commercial solar prosumers during certain hours of the day (or to start taxing exported electricity).[40] Such market developments underscore the importance of focusing on encouraging smarter engagement with the grid, and more investment in flexibility and in storage capacity already in the Market Growth Phase.

As the market moves from the Market Growth to the Full System Integration Phase, commercial prosumers tend to seek to rely more on brokers and other intermediaries such as aggregators and

[37] (Peacock, B., 2021, April 28th. South Australia sets record as electricity prices consistently plunge below zero. In *PV Magazine*. https://www.pv-magazine.com/2021/04/28/south-australia-sets-record-as-electricity-prices-consistently-plunge-below-zero/)

[38] (Scully, J., 2021, July 15th. 'Concerning' decline in California solar prices reducing incentive for new installs. In *PV-Tech*. https://www.pv-tech.org/concerning-decline-in-california-solar-prices-reducing-incentive-for-new-installs-report/)

[39] (Lucas, C., 2021, March 14th. Power failure: Homes hit by solar limits as distributors protect network, and profits. In *The Age*. https://www.theage.com.au/politics/victoria/power-failure-homes-hit-by-solar-limits-as-distributors-protect-network-and-profits-20210311-p579xz.html)

[40] (Wesoff, E., 2017, February 7th. Rooftop Solar in Oahu Crashes With Loss of Net Metering, Lack of Self-Supply Installs. In *Greentech Media*. https://www.greentechmedia.com/articles/read/rooftop-solar-in-hawaii-crashes-with-loss-of-net-metering-lack-self-supply)

virtual power plant operators to obtain more stable pricing conditions, rather than relying strictly on wholesale (day-ahead or intraday) market prices, or on the prices offered by utilities; these and other similar changes can be the impetus for a range of new business models to find a niche within the market.

In fact, such market developments are already starting to push stakeholders in some jurisdictions such as in the UK, Australia, the U.S. and Malaysia to develop entirely new business models, for instance by establishing **peer-to-peer energy trading platforms**.[41] Such platforms can enable prosumers to share power with one another at agreed-upon prices, prices that may be higher (or simply more stable and predictable) than real-time market prices. In turn, such local settlement of electricity can help provide a range of benefits to the system, including reducing the need for high-cost marginal generation, reduced congestion, and even reduce line losses by enabling a greater share of load on the distribution system to be met by energy resources within the distribution system. As the market develops so too do the policies required to support its further development.

[41](International Renewable Energy Agency, 2020. *Peer-to-Peer Electricity Trading*. https://irena.org/-/media/Files/IRENA/Agency/Publication/2020/Jul/IRENA_Peer-to-peer_trading_2020.pdf?la=en&hash=D3E25A5BBA6FAC15B9C193F64CA3C8CBFE3F6F41)

Text Box 5: Designing Network Charges

Another issue that grows in importance while transitioning from the Market Growth to the Full Market Integration phase is the role of rate design, and in particular, **the design of network charges**. The EU's IEMD states clearly that such network fees should be non-discriminatory, and in particular that they should not hinder the ability of prosumers to install their own generation (or customer-sited storage) and interact with the grid and the overall energy market, including by providing energy and flexibility-related services.

One key feature of future network charges is that they should be designed so as to support (rather than discourage) the kinds of behaviors. For instance, grid operators can offer lower network tariffs for commercial prosumers with advanced metering and inverter infrastructure who can interact intelligently with the grid and provide real-time services such as demand response (e.g. activating or de-activating major onsite loads such as thermal loads), storage capacity, or modulating their solar PV system output.[42] Such lower network charges would then be justified by the fact that such customers impose fewer costs on the grid, and even provide some benefits (i.e. enable cost reductions for network operators).

In some cases, fixed demand charges ($/kW of peak demand, generally billed on a monthly basis) are already being used to provide such price signals:[43] for commercial customers in the U.S. as well as in certain EU countries such as Spain, demand charges can exceed 50% of a customer's total electricity bill. Many commercial customers in the U.S. pay demand charges of over USD $30/kW of peak demand, while some are required to pay more than USD $50/kW, making it highly attractive to invest in customer-sited generation, greater demand response, and/or storage infrastructure.

Network charges and demand charges can be adjusted to provide clear incentives for system-smart investment. **As prosumers become a growing part of the energy system, smarter network charges will be essential both to ensuring cost recovery for network operators and to providing the better price signals for market participants such as commercial prosumers**.

A further set of policies that become more widespread as the market matures is that jurisdictions are starting to rely more heavily on **direct mandates** requiring buildings above a certain size (for instance) to adopt solar power. France introduced a law requiring buildings above a certain size to install either onsite solar PV or solar thermal generation,[44] while cities like San Francisco have mandated that all commercial buildings with over 4.600m^2 in floor space have to be powered by renewable electricity by 2030, regardless of whether the electricity is generated onsite or purchased

[42] (Bundesverband Neue Energiewirtschaft e.V., 2019, March 15th. *The bne Flex Market – Proposal for the Demand Response Management Provision in §14a EnWG*. https://www.strommarkttreffen.org/2019-03-15_Tausendteufel_The_bne_Flex_market.pdf)

[43] (National Renewable Energy Laboratory, August 2017. *Identifying Potential Markets for Behind-the-Meter Battery Energy Storage: A Survey of U.S. Demand Charges*. https://www.nrel.gov/docs/fy17osti/68963.pdf)

[44] (REN21, 2021. *Global Status Report on Renewable Energy in Cities*. https://www.ren21.net/wp-content/uploads/2019/05/REC_2021_full-report_en.pdf)

from elsewhere. Similar mandates exist in a wide range of cities around the world as well, including Barcelona (Spain), Davis (California), Vienna (Austria),[45] and Karimnagar (India),[46] and have been included in Germany's most recent coalition proposals to accelerate renewable energy deployment.[47]

Encouraging prosumer investments delivers clear win-win for governments

As this section highlights, the menu of policy options is vast, and wide-ranging. Critical to creating more attractive policy and regulatory frameworks for commercial prosumers is to recognize that in addition to helping achieve governments' energy and climate targets, commercial prosumers can unlock a variety of benefits and help nudge the overall electricity system toward a cleaner, more interconnected, and more dynamic paradigm.

[45] (Wolf, B., 2020, May 30th. Solar Roofs for All New Buildings in Vienna & a Turbocharged Climate Budget. In *Metropole*. https://metropole.at/solar-roofs-for-all-new-buildings-in-vienna/)

[46] (REN21, 2021. *Global Status Report on Renewable Energy in Cities*. https://www.ren21.net/wp-content/uploads/2019/05/REC_2021_full-report_en.pdf)

[47] (Wehrmann, B. et al., 2021, October 15th. SPD, Greens, FDP to enter negotiations for new government focussed on 1.5°C path. *Clean Energy Wire*, https://www.cleanenergywire.org/news/spd-greens-fdp-set-enter-negotiations-new-german-government-focussed-ecologic-modernisation)

ANNEXES: Country Profiles

Bulgaria

Bulgaria's energy strategy continues to envision a central role for large-scale, centralized energy technologies like natural gas and nuclear power while under-estimating the tremendous potential of distributed renewables, including specifically the potential of prosumers.[48] In Bulgaria's most recent NECP, much of the anticipated increase in renewable energy deployment is back-loaded to the period 2045 to 2050, despite the fact that several GW of cost-effective solar and wind power potential exists today.[49] Given that renewables like solar PV are highly cost-competitive today, Bulgaria is missing a valuable opportunity not only to mobilize investment, both domestic and foreign, but also to help transition the electricity mix to higher shares of renewables.

23.5%

Current share of renewable energy sources in Bulgaria's electricity mix[50]

Bulgaria's current targets for renewables envision that 30% of its electricity needs will be met from renewables by 2030, up from 23,5% today. In order to achieve this target, solar PV generation is expected to grow from 1.400 GWh per year in 2020 to approximately 4.600 GWh by 2030.[51] Additionally, the plan relies on extremely ambitious assumptions regarding the future growth of biomass use, which is projected to increase from 14.4 TWh to 21 TWh in gross energy demand (or 10% of total gross energy consumption).[52] As a further sign that change is on the way, Bulgaria has recently announced its intention to phase-out coal by 2038, a fact that is likely to create further opportunities for solar PV development, including among companies and industries interested in developing their own onsite systems throughout the country.[53]

However, **Bulgaria's current NECP does not have a separate goal, or specific forecasts, for the growth of prosumers, nor does it include specific policies to encourage investment in the sector**. The main policy instrument still in place is the country's feed-in tariff, which offers long-term contracts mainly for grid-connected solar PV installations up to 30 kWp. However, the FIT policy targets projects configured to export 100% of their electricity to the grid, rather than for customers' own use.

[48] (Republic of Bulgaria, 2020. *Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030.* https://ec.europa.eu/energy/sites/default/files/documents/bg_final_necp_main_en.pdf)

[49] (Agora Energiewende, October 2019. *Unlocking Low Cost Renewables in South East Europe.* https://www.agora-energiewende.de/fileadmin/Projekte/2019/De-risking_SEE/161_Unlocking_SEE_EN_WEB.pdf)

[50] (National Statistical Institute of the Republic of Bulgaria, 2021. *Infostat.* https://www.nsi.bg/en/content/5062/electricity-generated-renewable-sources-share-gross-electricity-consumption)

[51] (Republic of Bulgaria, 2020. *Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030.* https://ec.europa.eu/energy/sites/default/files/documents/bg_final_necp_main_en.pdf)

[52] (Center for the Study of Democracy, May 2020. *Lost in Transition: Bulgaria and the European Green Deal. Policy Brief No. 92.* https://csd.bg/fileadmin/user_upload/publications_library/files/2020_05/BRIEF_92_ENG.pdf)

[53] (Petrova, A., 2021, October 15th. Bulgaria to propose coal exit by 2038 at earliest. In *SeeNews.* https://seenews.com/news/bulgaria-to-propose-to-phase-out-coal-by-2038-at-earliest-govt-757447)

Over the last few years, in the absence of clear policies from the government, industrial and commercial electricity customers have started to take matters into their own hands: as of mid-2021, **over a hundred SMEs in Bulgaria have developed behind-the-meter solar PV projects**, as part of a wave of private sector investment in the distributed solar sector. In contrast to Greece and Croatia, where projects benefit from a policy framework designed to allow self-consumption and the sale of surplus generation, the majority of commercial prosumer projects in Bulgaria is currently configured for **pure self-consumption**: structuring projects this way helps owners avoid many of the administrative and procedural hurdles, as well as costs and delays, required to obtain a grid connection.

Bulgaria's electricity market structure

The electricity market in Bulgaria, like that in many other EU Member States, has been undergoing a transition from a centralized, state-owned system to a more open, liberalized system. This process of liberalization started in the early 2000s with the privatization of the electricity distribution network and some of the state-owned lignite- (coal) fired power plants. However, over 60% of the generation mix is still owned by the legacy utility supplier, BEH and is made up of large lignite (coal) fired power plants and hydropower. While the high-voltage transmission grid remains largely state-owned, the distribution network is privately-owned, with three regional monopolies covering different parts of the country.

Figure 10 illustrates the market share of the three utility companies operating the distribution system:

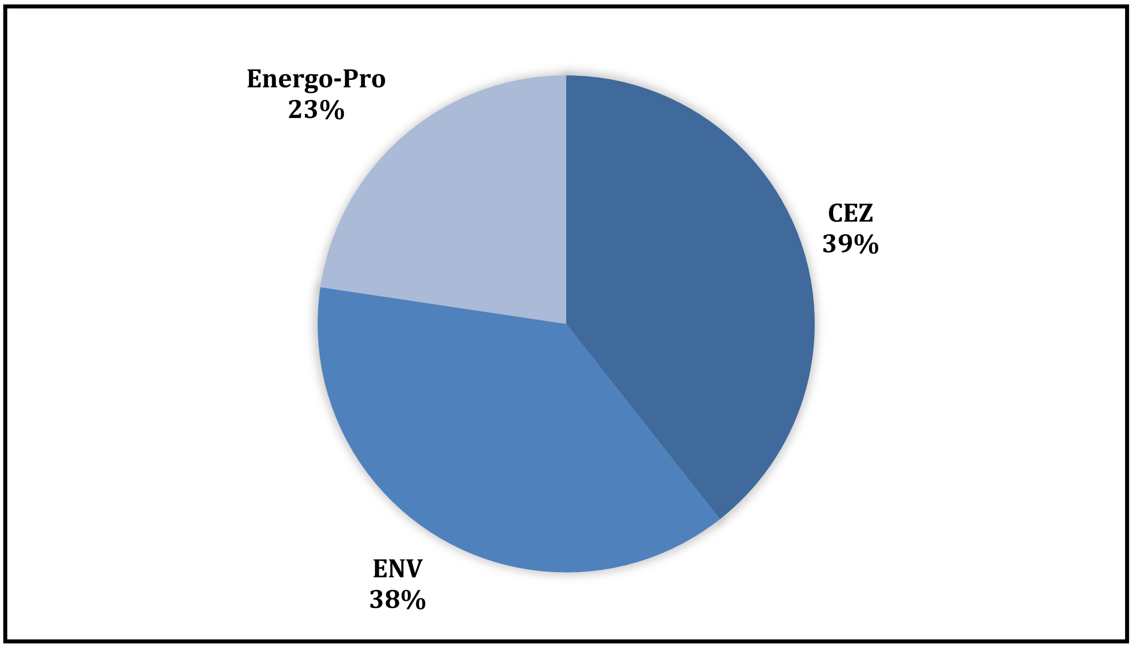


Figure 10: Market Share of DSOs in Bulgaria

Source: EWRC Report to the European Commission 2020[54]

A cornerstone of the country's liberalization efforts is the Independent Bulgarian Energy Exchange (IBEX), which was established in 2014 and started operating in 2016. **Since 2016, all large industrial consumers have been required to purchase their electricity on the exchange**, a requirement that now extends to all small and medium-sized business consumers in the country as well (starting October 2020).

The move to open market prices has been a key catalyst for industrial and commercial prosumers in Bulgaria: for many companies and industries in the country, it has meant a substantial increase in their electricity costs. In turn, increasing electricity costs have prompted a surge in interest in self-generation (including specifically in solar PV).

Current status of prosumers in Bulgaria

The market for commercial solar PV systems for self-consumption is starting to grow rapidly in Bulgaria, albeit from a small base. Remarkably, this rapid development is occurring despite the near-absence of policy and regulatory framework for prosumers in the country.

There are few main factors behind this increased interest:

1. First, the increasingly low upfront cost of investing in solar PV, which makes it easier for companies to finance small and medium-sized projects outright rather than relying on bank lending;
2. Self-produced electricity is cheaper than buying electricity on the open market, which enables companies investing in self-generation to reduce their energy costs.
3. Another factor is that becoming a prosumer allows commercial consumers to increase their independence (in part, if not in full) from the state-governed electricity sector and its unpredictability.

According to the Joint Research Center of the European Commission, **Bulgaria has 150 km^2 available rooftop area, enough to generate over 17 TWh/year,** which represents more than the current share of coal-fired electricity in the country.[55]

17.3TWh[56]	Technical potential of rooftop solar PV in Bulgaria, enough to supply roughly 40% of current electricity demand

[54] (EWRC, 2020. *Report to the European Commission.* https://www.dker.bg/uploads/2020/EWRC_report_EC_2020.pdf)

[55] (Bódis, K. et al., October 2019. *A high-resolution geospatial assessment of the rooftop solar photovoltaic potential in the European Union.* A high-resolution geospatial assessment of the rooftop ... (europa.eu))

[56] (Bódis, K. et al., October 2019. *A high-resolution geospatial assessment of the rooftop solar photovoltaic potential in the European Union.* A high-resolution geospatial assessment of the rooftop ... (europa.eu))

31.8 TWh	Annual electricity demand in Bulgaria (2020)[57]
4.6 TWh	Current National Target for Solar PV Generation by 2030
43%	Approximate share of electricity demand represented by commercial electricity customers[58]

With regard to the real market potential, there are about 420 000 small and medium sized companies (with up to 249 employees) in Bulgaria in 2019, with almost 10% in manufacturing, 1/3 in retail, and approximately 1/5 in administration, office buildings, health, education, and culture.[59,60]

Regarding the type of small and medium-sized businesses currently investing in solar PV systems for self-consumption, interviews with developers suggest that **manufacturers, waste management and sewage facilities and retail and office buildings are currently the most active players**. In general, these clients have three key characteristics:

1) they have recently been required to move to open market prices;
2) they have available rooftop space, and
3) they have relatively predictable daytime electricity demand.

Taken together, these factors help make investments in self-consumption more reliable, and more profitable. Depending on the installed capacity of the system, investors report payback periods between 5 and 8 years and a return on investment of up to 20% in some cases.

Data gathered from conversations with developers and official press releases suggest that **about 100 commercial solar PV projects for self-consumption have been developed and realized every year over the last 2-3 years in the country.** In 2020 alone, one developer (CEZ ESCO) reported 13 realized commercial projects configured for self-consumption with a cumulative installed capacity of over 3MW. A few more projects were built in Q1:2021 and eleven more are in the process of realization, one of which is a large-scale industrial installation with an installed capacity of approximately 10 MW. In total, this single developer reports a total of 27 self-

[57] (Republic of Bulgaria, 2020. *Integrated Energy and Climate Plan of the Republic of Bulgaria 2021-2030.* https://ec.europa.eu/energy/sites/default/files/documents/bg_final_necp_main_en.pdf)

[58] (European Commission, 2021. *Energy Balances.* https://ec.europa.eu/eurostat/web/energy/data/energy-balances)

[59] (National Statistical Institute of the Republic of Bulgaria, 2021. *Infostat.* https://www.nsi.bg/en/content/8231/number-enterprises)

[60] (National Statistical Institute of the Republic of Bulgaria, 2021. *Infostat.* https://www.nsi.bg/en/content/8250/number-enterprises)

consumption projects with total installed capacity of 14.5 MW, of which 3.4 MW is already in operation.[61]

Another developer focusing primarily on larger-scale projects reports five new projects totaling 3.5 MW realized in 2020 alone. The breakdown shows that there two of the projects are larger than 1 MW and thee are of 0.4 MW each. Another 1 MW of project was realized in 2019 and 3.7 MW of projects are in the process of realization.[62]

In total, it is estimated that by mid-2021, there is approximately 25MW of commercial-scale projects configured for self-consumption in Bulgaria.

Electricity Rates in Bulgaria

Despite having some of the lowest electricity prices in the EU, recent increases to electricity prices combined with the requirement that all commercial customers purchase their electricity on the open market starting October 2020 is starting to act as an important catalyst for commercial prosumer investments in the country. Until that date, commercial customers in Bulgaria were allowed to purchase their electricity at regulated rates, which ranged between EUR 0,04 – 0,10/kWh depending whether purchasing during the nighttime or the daytime peak, and were relatively flat.[63]

With the launch of the day-ahead market at the Independent Bulgarian Energy Exchange in 2016 electricity prices for large industrial consumers spiked (see Figure 11 below). Despite having moderated somewhat since, the move to more volatile market-based pricing is starting to act as a catalyst for certain commercial customers to start investing in their solar PV systems for self-consumption. Figure 11 shows the average monthly prices of the day-ahead market segment of the Independent Bulgarian Energy Exchange from its launch in 2016 until September 2021.[64]

[61] (CEZ ESCO Bulgaria, 2021. *Accomplished Projects*. Retrieved from https://cez-esco.bg/%d1%80%d0%b5%d0%b0%d0%bb%d0%b8%d0%b7%d0%b8%d1%80%d0%b0%d0%bd%d0%b8-%d0%bf%d1%80%d0%be%d0%b5%d0%ba%d1%82%d0%b8 the 11.11.2021.)

[62] (Solarpro Holding, 2021. *Accomplished projects – Bulgaria*. Retrieved from https://solarpro.bg/projects/bulgaria/ the 11.11.2021.)

[63] (Republic of Bulgaria, Energy and water regulatory commission, 2020. *Decisions for 2020*. https://www.dker.bg/bg/resheniya/resheniya-za-2020-god.html)

[64] (Republic of Bulgaria, Energy and water regulatory commission, 2019. *Report on the activities of the commission for energy and water regulation for 2019*. https://www.dker.bg/uploads/2020/god_doklad_2019.pdf)

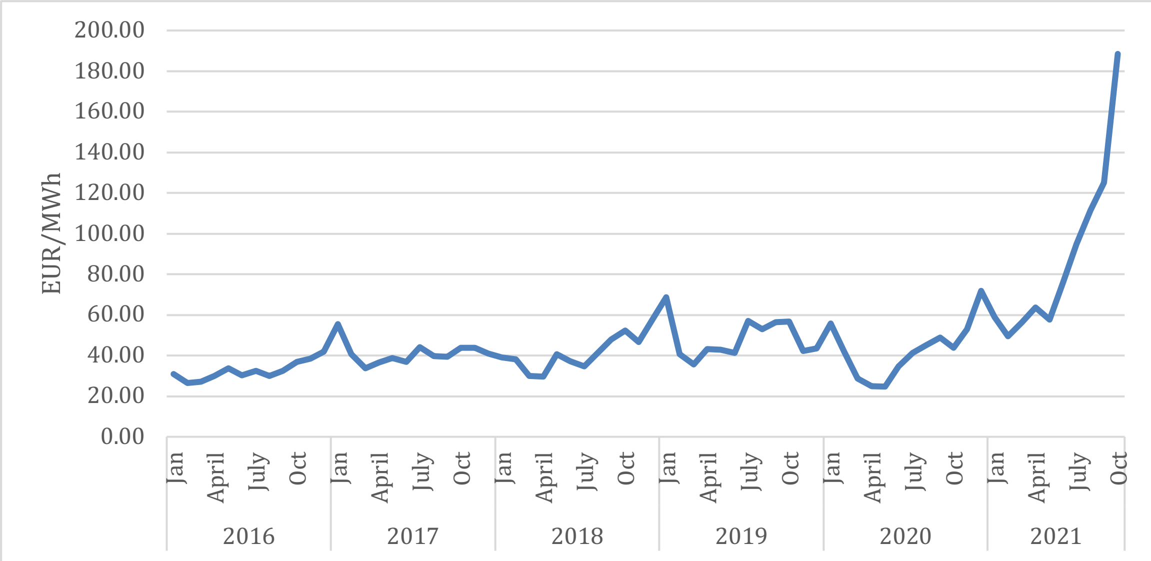


Figure 11: Average monthly prices of the day-ahead market on the Bulgarian Power Exchange (Jan-2016 to Oct-2021)

Source: IBEX[65]

When fees and charges are added in, electricity prices for non-household customers have increased approximately 30% between 2012 and 2019, and price rises in the summer of 2021 have served to push energy bills up even higher.

[65] (IBEX, 2021. *Day Ahead Market*. http://www.ibex.bg/en/)

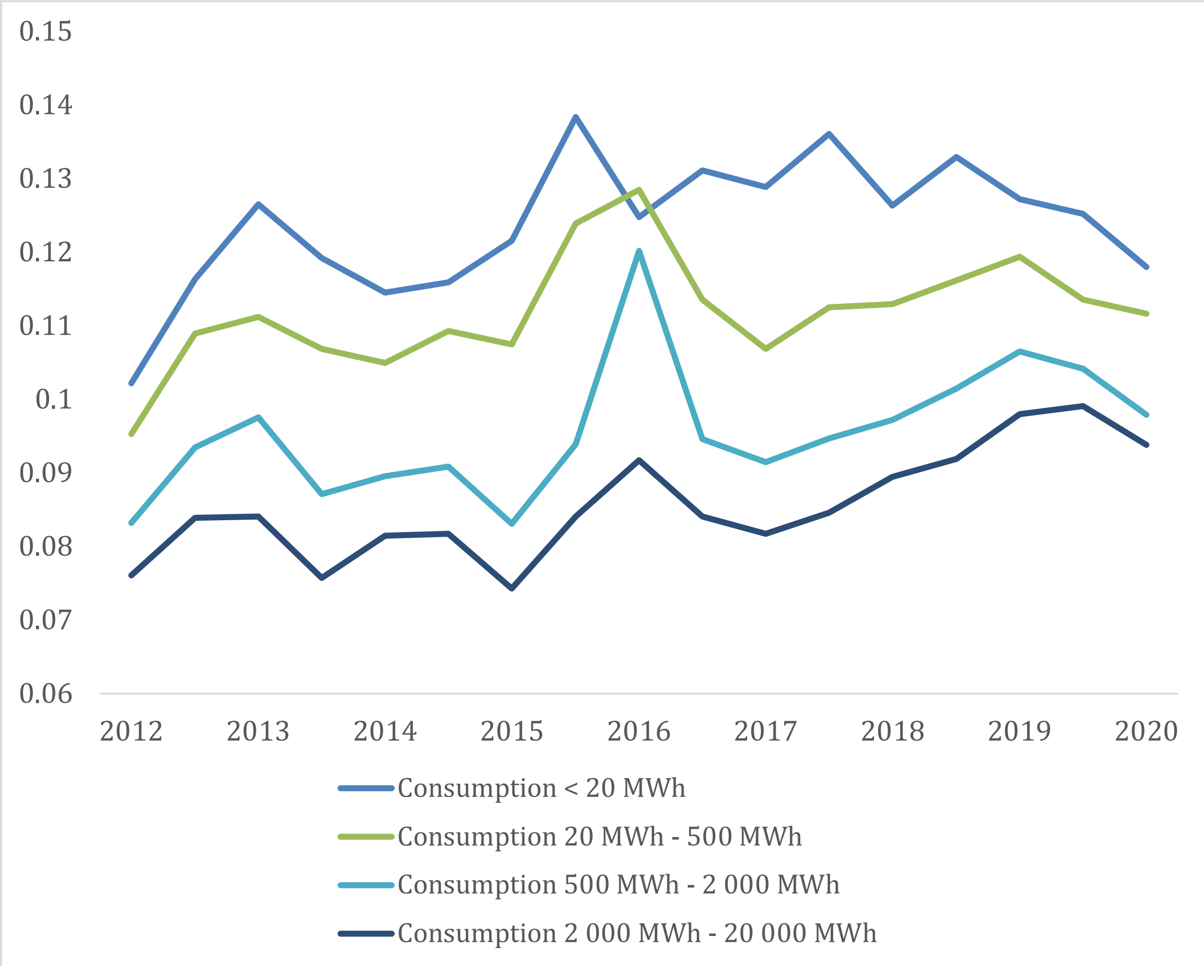


Figure 12: Electricity Prices for Industry Consumers in EUR/kWh (2012 - 2020)

Source: Eurostat (2020)[66] Note: prices include all taxes and levies.

The main component of the electricity rates is the cost of electricity, which represents about 65% of the total electricity rate. The remaining 35% is made up mainly of network costs (transmission and distribution) as well as a range of taxes, charges and levies.[67] When customers engage in self-consumption, these additional fees are avoided.[68]

[66] (European Commission, 2021. https://ec.europa.eu/eurostat/databrowser/view/NRG_PC_205)

[67] (Couture, T., June 2021. *Scaling-up Distributed Solar PV in Bulgaria.* https://www.e3analytics.eu/wp-content/uploads/2021/06/E3A_Bulgaria_Analysis_of_Distributed_PV_ENG_FINAL.pdf)

[68] Note: Network fees (fees to access to transmission and distribution networks) and the "Obligation to society" fee are determined by EWRC and vary from year to year. For 2020-2021 regulatory period "Obligation to society" fee is set at 10.97 EUR/MWh. The final component is Taxes, levies and charges which includes VAT of 20% and a customs levy of 1 EUR/MWh produced.

Policy framework for commercial prosumers in Bulgaria

Bulgaria does not currently have a policy framework in place for prosumers. As a result, prosumers are either signing bilateral agreements to sell their surplus with market intermediaries (who engage directly with the wholesale market) or they are engaging in pure self-consumption.

One of the main issues holding back the development of the commercial prosumer market in Bulgaria, and one of the factors that continues to lead many companies to choose pure self-consumption, remains the complexity of the administrative procedures required to connect projects to the grid. In order to connect to the grid, there are several hurdles in front of the prosumer:

1. The owner has to establish a contract with a coordinator of a balancing group to guarantee balancing of the network.
2. The prosumer has to negotiate a price for its surplus electricity with an intermediary, or with the DSO;
3. In addition, Bulgaria's customs agency imposes an additional levy for every MWh produced. While the amount of the levy is not significant (approximately 1 EUR/MWh), producers have to register with the Customs Agency and submit paperwork on a monthly basis, even if the surplus sold is small.

Faced with these procedures, **many commercial prosumers are opting to configure their systems for pure self-consumption**, foregoing the costs, delays, and complexities of applying for a grid connection. Another consequence of these administrative hurdles is that many prosumers are choosing to **under-dimension** their solar PV installations in order to avoid having any surplus generation at all, regardless of their available roof space.

DSOs in Bulgaria get in on the action

One positive development that has occurred in recent years is that DSOs have started to actively offer solar PV systems to commercial customers within the country, as part of their efforts to comply with the EU's Energy Efficiency Directive.[69]

DSO CEZ Bulgaria and Energo-Pro have set up subsidiaries (CEZ ESCO and Energo-Pro Energy Services respectively) to provide energy efficiency solutions to their clients. In recent years they have started offering development of solar PV systems and energy management services. The two companies offer a full range of project development including design, construction, grid connection and maintenance. Combined the two companies have more than 30 realized projects with total installed capacity of about 8 MW. Additionally, they offer alternative methods of financing such projects. CEZ ESCO Bulgaria, for example, offers an

[69] (Bertoldi, P. et al., 2015. *How is article 7 of the Energy Efficiency Directive being implemented? An analysis of national energy efficiency obligations schemes.* https://www.eceee.org/library/conference_proceedings/eceee_Summer_Studies/2015/2-energy-efficiency-policies-8211-how-do-we-get-it-right/how-is-article-7-of-the-energy-efficiency-directive-being-implemented-an-analysis-of-national-energy-efficiency-obligations-schemes/)

option for deferred payment of the investment. The contract period is usually 60 months with an initial installment of 20% of the investment costs.[70]

Regulations for the Storage Market in Bulgaria Out of Date

There is a very small number of solar PV projects that also have invested in storage solutions.

One big obstacle for the development of storage systems, especially on a large scale, is the current regulatory framework. While the current energy law allows the use of storage provided it is located close to a generating facility, the current framework restricts storage systems from offering network services such as balancing, frequency regulation, or the provision of reactive energy, unlike in other active storage markets. The current framework allows only torque converter systems relying on traditional inertia such as hydropower or thermal power plants, for example, to do so.[71]

Barriers for Commercial Prosumers in Bulgaria

While the commercial prosumer solar PV market in Bulgaria is currently on the rise, several significant barriers persist:

Main Barriers to Self-Consumption in Bulgaria	
Access to financing	Despite the fact that globally the cost of solar PV has decreased dramatically over the last decade and that a growing number of banks and investors are keen to pour funds into the sector, access to capital remains an issue in Bulgaria. Banks in general are unwilling or uninterested in engaging in solar projects, especially prosumer projects.
Lack of a clear regulatory framework for surplus generation	One major barrier to invest in solar PV systems is lack of a clear policy framework governing the sale of surplus generation. In addition, there are several fees that project owners have to pay to sell their electricity back to the grid, including an excise charge that has to be paid to the customs agency for every MWh sold along with the need to file a monthly report.[72] As a result, many

[70] (Stanchev, I., 2020, September 8th. The business is switching to solar Energy. In *Capital.* https://www.capital.bg/biznes/energetika/2020/09/18/4115294_biznesut_prevkljuchva_na_sluncheva_energiia/)

[71] (Republic of Bulgaria, 2021. *Energy Law.* https://lex.bg/laws/ldoc/2135475623)

[72] (Couture, T., June 2021. *Scaling-up Distributed Solar PV in Bulgaria.* https://www.e3analytics.eu/wp-content/uploads/2021/06/E3A_Bulgaria_Analysis_of_Distributed_PV_ENG_FINAL.pdf)

	commercial prosumers are dimensioning their solar PV systems in order to avoid having any surpluses.
Cumbersome administrative procedures	Bulgaria requires prosumers to obtain several different permits from various state and municipal authorities as well as a number of permits and approvals from their distribution system operator. Moreover, procedures are different for each of the three main DSOs in the country, adding further challenges. In addition, the nationwide Electricity System Operator (ESO) in Bulgaria refuses to publish data on the available grid hosting capacity. Thus, investors lack clarity and face difficulties in planning.
Legal issues	Prosumers are not currently recognized, or defined, in Bulgaria's legal and regulatory framework. This was expected to change with the transposition of the revised Renewable Energy Directive 2018/2001/EU (RED II) into Bulgarian legislation in 2021, but the situation in Bulgaria remains highly uncertain. In November 2021, Bulgaria held its 3rd elections within the same year and there is no functioning parliament; as a result, the implementation of the Directive is likely to be delayed into 2022.
Investment uncertainty	The political landscape in Bulgaria has been tumultuous in recent years. This political instability has translated into policy and regulatory instability in the energy sector as well, specifically in the renewable energy sector.

Policy Recommendations for Commercial Prosumers in Bulgaria

- Introduce clear definitions of prosumers as well as clear regulations governing the sale of surplus power.
- Introduce streamlined administrative procedures for commercial prosumers, including a one-stop-shop for all permits and requirements.
- Introduce clear targets for the share of supply coming from prosumers, and commercial prosumers in particular, in national energy plans.
- Require DSOs to implement and enforce simplified procedures enabling commercial prosumers to connect to the grid, including maximum time allowances for different steps in the permitting and grid connection process.
- Simplify all taxes, fees, and charges to reduce the administrative and financial burden of exporting surplus to the grid.
- Regulatory changes should prevent DSOs from arbitrary changes to the administrative procedures for selling or exporting excess electricity to the grid.

Figure 13: Key Recommendations for Bulgaria

Croatia

Croatia has already achieved its goal of supplying 20% of its final energy consumption with renewable energy sources by 2020, and has now set its eyes on meeting its 36% target by 2030.[73] In the electricity sector, the share of renewable energy in 2019 was 49.8%, with a provisional goal of reaching 63.8% by 2030.[74] Currently, the majority of renewable energy comes from existing hydropower plants while most of the recent renewable energy deployment has been driven by the country's feed-in tariff policy that was in place between 2009 and 2015. Under the country's feed-in tariff, projects were configured to export 100% of their output to the grid rather than consuming a portion onsite first.

49.8%

Share of renewable energy sources in Croatia's electricity mix in 2019[75]

As of the end of 2020, Croatia had a total of 717 MW of wind power connected to the grid, 127 MW biomass/biogas power plants, and 108 MW of solar PV (out of which approximately 53 MW solar PV was built under the feed-in tariff policy). Currently, share of solar energy in gross electricity consumption in Croatia stands at less than 1% (see Figure 14). Thus, despite Croatia's favourable geographical location in Southeast Europe and relatively good solar insolation, in 2019 the country ranked third last in the EU in terms of the installed solar PV capacity per capita.[76] Indeed, although the two countries have similar solar resources, nearby Italy currently has over 210 times more solar PV installed than Croatia (21.000 MW vs. 100 MW), with a land area only five times larger.[77]

One of the main factors behind the slow pace of renewable energy development in Croatia has been an unstable policy and regulatory environment. The country's feed-in tariff policy was discontinued for new projects in 2015, causing investment in the country's renewable energy industry to grind to a halt. A further contributing factor has been the frequent changes of governments as well as the frequent shuffling of key government officials responsible for overseeing the energy sector. As a result, Croatia's overall energy strategy has frequently lacked a clear vision on the development of the sector and on the role of solar energy in particular, including on the potential role of prosumers.

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[73] (European Commission, 2020, October, 14th. *Assessment of the final national energy and climate plan of Croatia.* https://ec.europa.eu/energy/sites/ener/files/documents/staff_working_document_assessment_necp_croatia.pdf)
(European Renewable Energies Federation, May 2019. *PV Prosumer guidelines for eight EU member states.* https://www.pvp4grid.eu/wp-content/uploads/2019/05/1904_PVP4Grid_Bericht_EUnat_web.pdf)
(Jäger-Waldau, A. 2019. *PV Status Report 2019.* https://ec.europa.eu/jrc/sites/jrcsh/files/kjna29938enn_1.pdf)
(Mateo, C. et al., December 2018. Impact of solar PV self-consumption policies on distribution networks and regulatory implications. In *Solar Energy.* https://www.sciencedirect.com/science/article/abs/pii/S0038092X18309940?via%3Dihub)

[74] (Republic of Croatia, December 2019. *National Energy and Climate Plan for the Republic of Croatia.* https://ec.europa.eu/energy/sites/default/files/documents/hr_final_necp_main_en.pdf)

[75] (European Commission, 2021, April 2nd. *SHARES 2019 summary results.* https://ec.europa.eu/eurostat/documents/38154/4956088/SUMMARY-results-SHARES-2019.xlsx/4e5eb100-822c-ec50-cf04-803e6ef9ad05?t=1607706049587)

[76] (Eurobserv'er, 2021. *Photovoltaic barometer 2020.* Retrieved from https://www.eurobserv-er.org/category/all-photovoltaic-barometers/ the 11.11.2021.)

[77] (International Renewable Energy Agency, 2021. *Renewable Capacity Statistics 2021.* https://www.irena.org/-/media/Files/IRENA/Agency/Publication/2021/Apr/IRENA_RE_Capacity_Statistics_2021.pdf)

Since 2019, however, the situation has improved somewhat and Croatia has succeeded in publishing its Energy and Climate Action Plan[78] as well as its new Energy Strategy.[79] On the basis of these new documents, the government plans that the bulk of future investments in electricity generation will be based on solar and wind power, with the installed capacity of solar PV expected to grow at least 7-fold from approximately 100 MW[80] in 2020 to 768 MW in 2030.

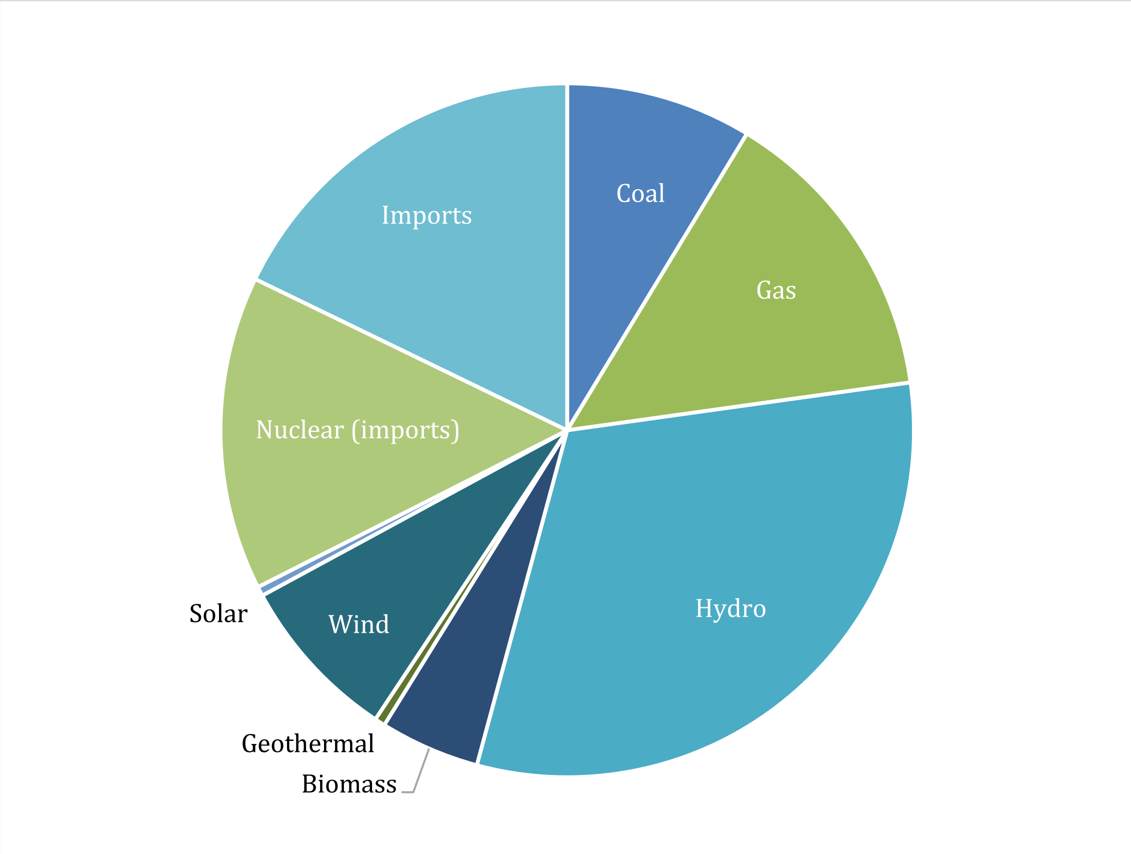


Figure 14: Electricity generation mix in Croatia (2019)

[78] (Republic of Croatia, December 2019. *National Energy and Climate Plan for the Republic of Croatia.* https://ec.europa.eu/energy/sites/default/files/documents/hr_final_necp_main_en.pdf)

[79] (Republic of Croatia. Ministry of the Economy and sustainable development, 2020. Energy Development Strategy of the Republic of Croatia until 2030 with a view to 2050. In *Strategies, plans and programs.* https://mzoe.gov.hr/o-ministarstvu-1065/djelokrug-4925/energetika/energetska-politika-i-planiranje/strategije-planovi-i-programi-2009/2009)

[80] (Republic of Croatia, 2021, March 1st. *Energy Transition Council of the President of the Republic of Croatia Presents Guidelines for Encouraging Citizens and Entrepreneurs to Construct Integrated Solar Power Plants.* https://www.predsjednik.hr/en/news/energy-transition-council-of-the-president-of-the-republic-of-croatia-presents-guidelines-for-encouraging-citizens-and-entrepreneurs-to-construct-solar-power-systems/)

With regard to the commercial sector in particular, the total electricity consumption in commercial sector in 2019 in Croatia was 9,619 GWh, representing 59,5% of total electricity demand in the country. Out of this share, roughly one-third (3,618 GWh) was in industry and the other two thirds (6,001 GWh) in services (Figure 15).[81]

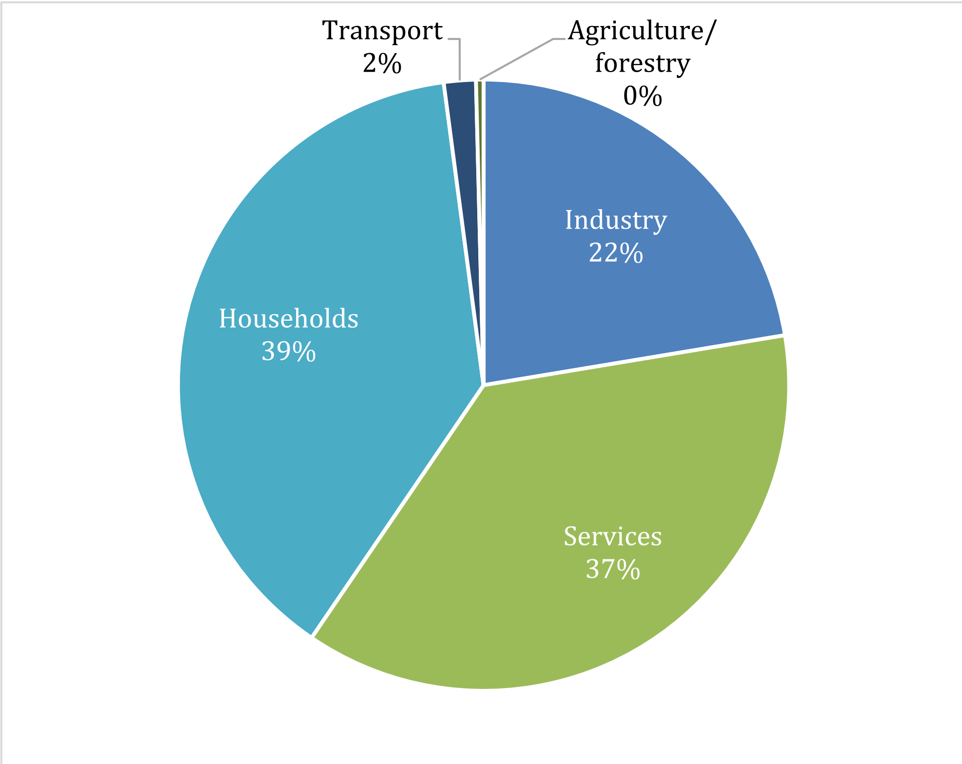


Figure 15: Final electricity consumption by sectors

Figure 16 shows the overview of electricity consumption by commercial sub-sectors.[82] Both administrative buildings (public and private offices) and retail represent a significant share of commercial electricity demand in Croatia. Significantly for the prosumer market potential, buildings in those sectors not only pay higher electricity prices than other user categories, they also frequently have rooftops that are well-suited for the installations of solar PV plants (i.e. mainly flat).

[81](Republic of Croatia, Ministry of Environment and Energy, 2018. *Annual Energy Report.* http://www.eihp.hr/wp-content/uploads/2019/12/Energija2018.pdf)

[82] (Enerdata, 2021. *Odyssee Database.* https://www.indicators.odyssee-mure.eu/energy-efficiency-database.html)

Given Croatia's solar resources, it would take approximately 7,400 MW of installed solar PV capacity to fully meet the demand of the commercial and industrial sectors in the country, roughly ten times more than its recently adopted solar PV targets.

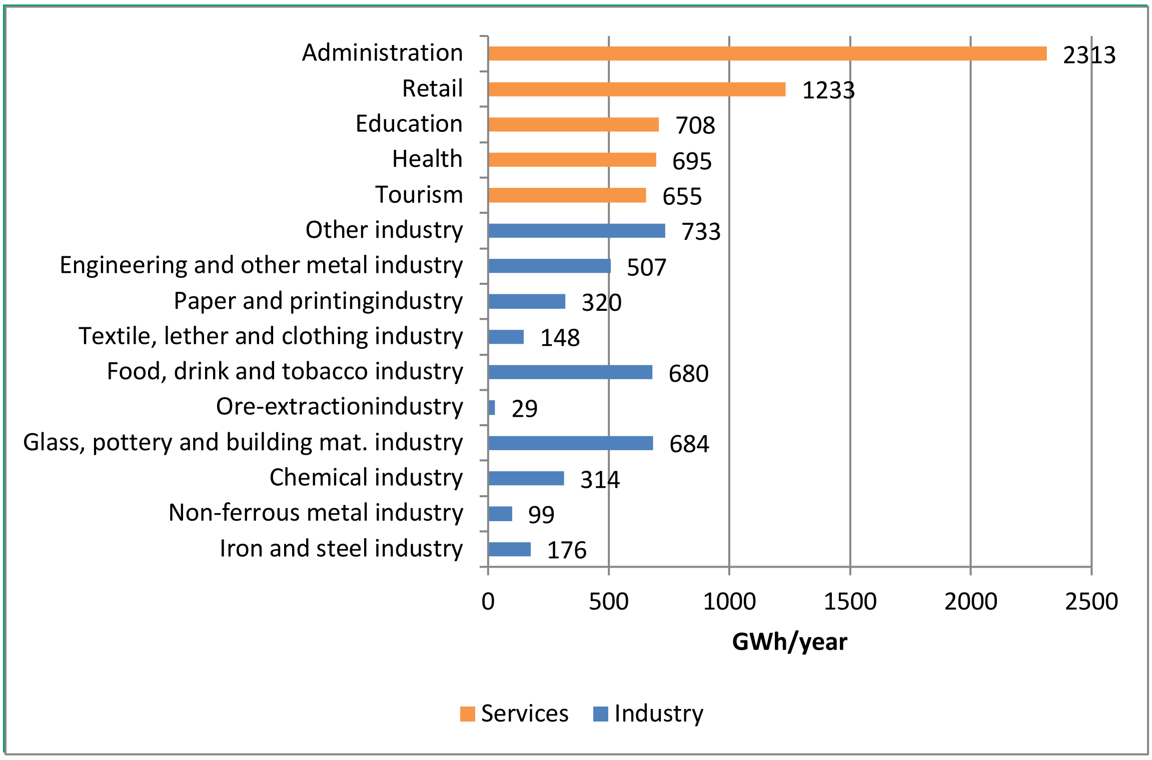


Figure 16: Distribution of electricity consumption in commercial sub-sectors (2018)

Electricity Market Structure in Croatia

However, the market as a whole remains heavily concentrated: despite progress in opening up the electricity market, the legacy supplier, HEP Group, has managed to increase its market share in recent years from a low of 78% in 2015 up to approximately 90% today. Also, the total number of electricity suppliers in the market has decreased from 12 in 2015 to 7 in 2020.[83] In 2016, Croatia launched day-ahead trading via the Croatian Power Exchange (CROPEX)[84] and intraday trading in 2017.

State of the Solar PV Market

[83] (Croatian Energy Regulatory Agency. 2021, November 8th. *List of suppliers that have concluded an agreement on participation in the electricity market with HROTE.* https://www.hera.hr/hr/html/aktivni_opskrbljivaci_ee.html)

[84] (HROTE, 2021. *Electricity market.* https://www.hrote.hr/trziste-elektricne-energije)

After several slow years, **there are signs that the commercial prosumer market is starting to pick up pace.**[85] In 2020 there was 108 MW of installed solar PV capacity in Croatia, out of which about 53 MW were developed under the country's feed-in tariff between the years 2007 and 2015.[86] In total, 60 MW (over 1 400 systems in total) are registered as producer-only (i.e. are configured to export 100% of their output to the grid), and the remaining 48 MW are prosumer-based. Out of the prosumer share, the majority (43 MW, spread across about 5000 systems) has been installed by commercial prosumers,[87] while the rest (approximately 5 MW) comes from the residential sector.[88]

The growth in solar PV installations in Croatia is shown in Figure 17.

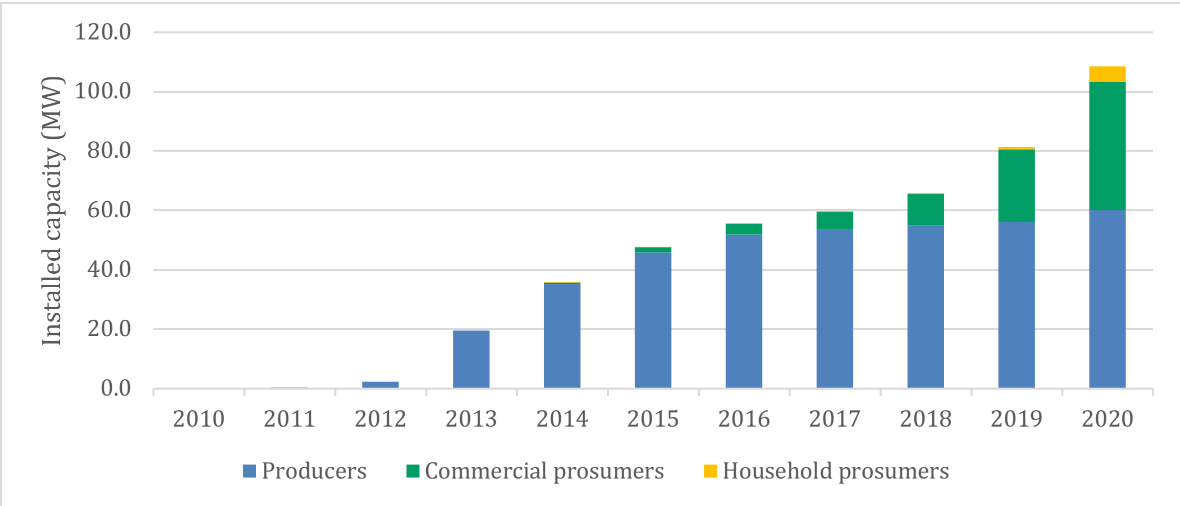


Figure 17: Growth of Solar PV Installations in Croatia (including commercial prosumers in green)

In addition, interviews with developers indicate that there is a growing pipeline of projects in the works both in the rooftop and ground-mounted market segments, with over 70 commercial rooftop systems in various stages of development with installed capacities typically ranging from 30 to 300 kW.[89, 90, 91]

[85] (Eurobserv'er, 2021. *Photovoltaic barometer 2020*. Retrieved from https://www.eurobserv-er.org/category/all-photovoltaic-barometers/ the 11.11.2021.)

[86] (Trstenjak, J., 2020, June 12th. Croatia and the Feed-in-Premium Model: What Will the New System Bring and how Will it Function? In *News-RES-Croatia* https://oie.hr/en/ii-croatia-and-the-premium-model-what-will-the-new-system-bring-and-how-will-it-function/)

[87] Note that approximately 50% of these commercial prosumer installations have benefited from subsidies including low interest loans from the country's Environmental Protection and Energy Efficiency Fund.

[88] (Energy Sector and Investment Monitoring Center Croatia, 2021. *SMiV - System for measuring, monitoring and verifying energy savings*. Retrieved from http://cei.hr/smiv-sustav-mjerenje-pracenje-i-verifikaciju-usteda-energije/ the 11.11.2021.)

[89] (Solvis, 2021. *Croatia References*. Retrieved from https://solvis.hr/en/croatia/ the 11.11.2021.)

[90] (E-On, 2021. Retrieved from https://www.eon.hr/hr/tvrtke/tvrtke-solarna-energija.html the 11.11.2021.)

[91] (HEP, 2021. Retrieved from https://www.hep.hr/esco/esco-projekti-1830/projekti/25 the 11.11.2021.)

6.5 GW	Technical potential of rooftop solar PV in Croatia,[92] enough to supply roughly half of current electricity demand
16,2 TWh	Annual electricity demand in Croatia (2019)[93]
1.0 TWh	Current National Target for Solar PV Generation by 2030
60%	Approximate share of electricity demand represented by commercial, institutional and agricultural customers

Electricity Rates in Croatia

The average cost of electricity for commercial customers with a yearly consumption in range of 500-2000 MWh in Republic of Croatia in 2019 stood at 11.92 EUR Cent/kWh after taxes and fees, 19.35% below the EU-27 average of 15.34 EUR Cent/kWh.[94] The average rate paid differs however significantly between different consumption bands (see below).[95]

[92] The Green book for Energy Strategy estimated potential to about 1.5 GW based on the state in 2017, with expacted growth up to 2.7 GW in 2050. Out of it, about 300 MW is estimated potential for non-residential buildings, and 60 MW for multi-apartment buildings. On the other hand, JRC estimated technical potential on 7.8 GWh/year or about 6.5 GW, while the economic potential to 5 GWh/year, or about 4.2 GW.
(Bódis, K. et al., October 2019. *A high-resolution geospatial assessment of the rooftop solar photovoltaic potential in the European Union.* https://publications.jrc.ec.europa.eu/repository/handle/JRC113070)

[93] (Enerdata, 2019. *Croatia Energy Information.* Retrieved from https://www.enerdata.net/estore/energy-market/croatia/ the 11.11.2021.)

[94] (European Commission, 2021. *Electricity prices for non-household consumers - bi-annual data.* https://ec.europa.eu/eurostat/databrowser/view/nrg_pc_205/default/table?lang=en)

[95] (Croatian Energy Regulatory Agency, 2019. *Annual Report for 2018.* https://www.hera.hr/hr/docs/HERA_izvjesce_2018.pdf)

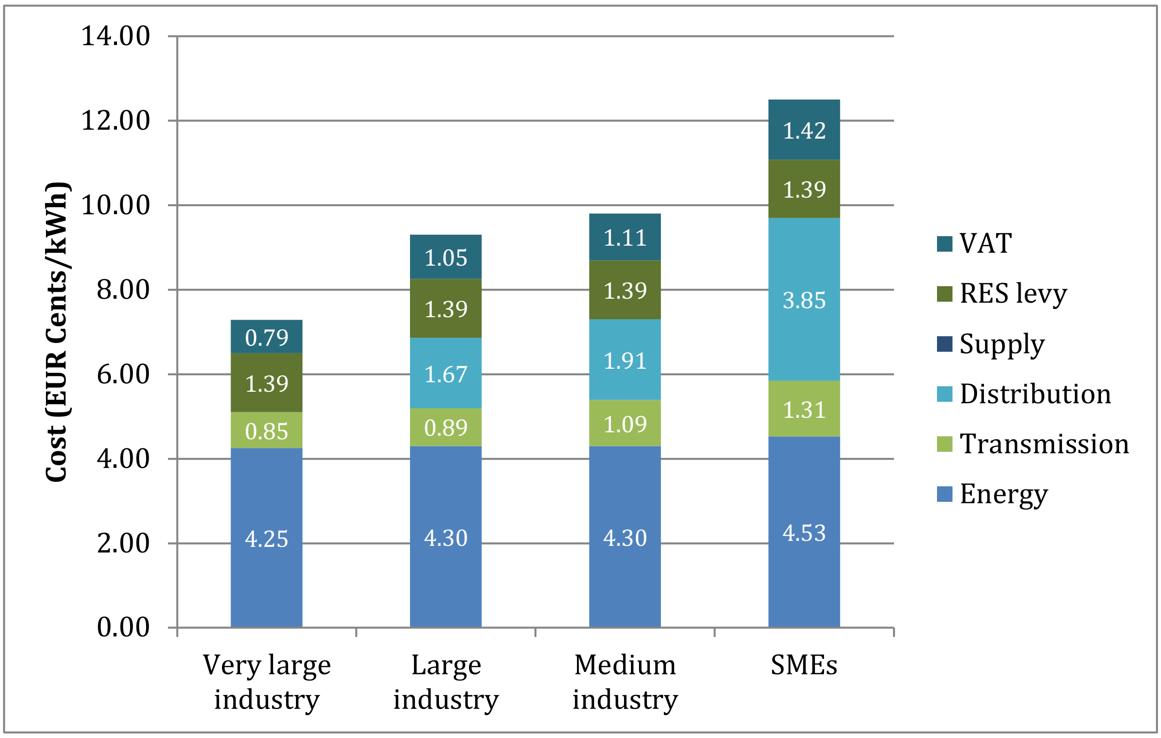


Figure 18: Breakdown of the current electricity rate structure for commercial users[96]

As a result, the attractiveness of commercial prosumer investments is significantly higher for small and medium enterprises (SMEs) than for very large industries.

[96] Very large industry refers to companies with yearly electricity consumption of 100.000 MWh, large industry with 24.000 MWh, medium industry with 2.000 MWh, and SMEs with 150 MWh.

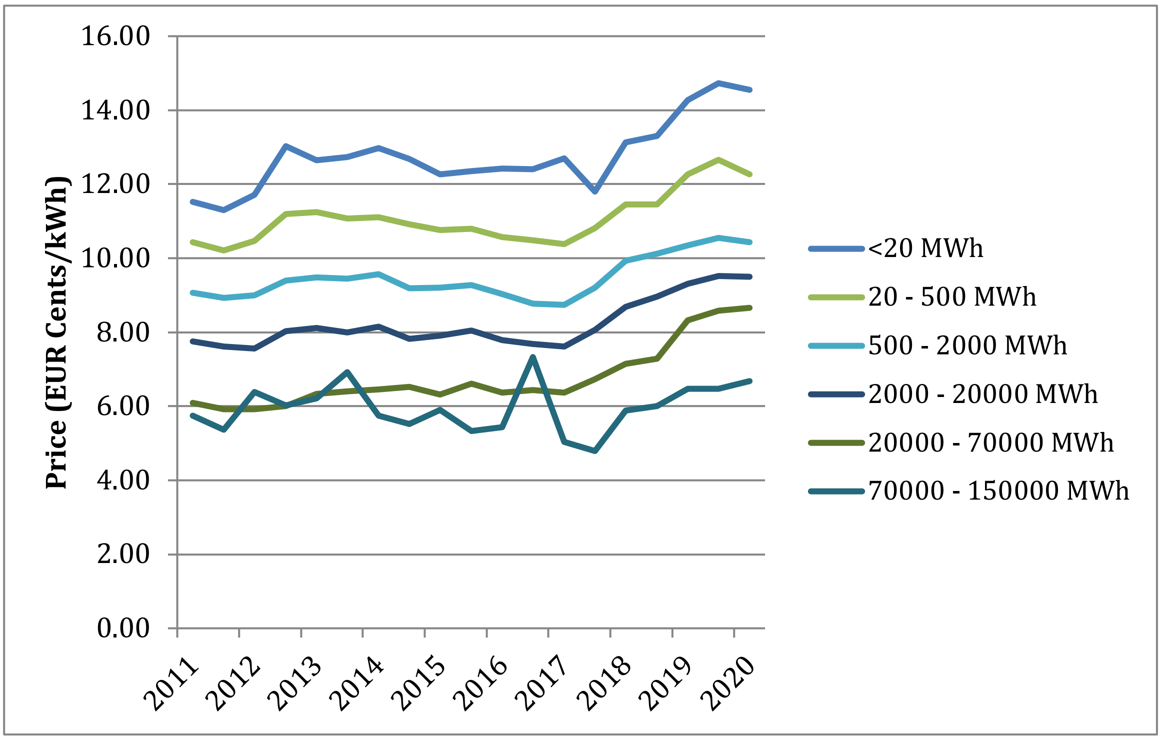


Figure 19: Evolution of commercial electricity rates by type of users, without VAT

Between 2011 and 2019, commercial electricity rates have increased by roughly 16%.[97]

Policy Framework for Commercial Prosumers in Croatia

The current regulatory provisions for rooftop-mounted solar PV systems for the commercial sector were set up in 2015 in Article 44 of the Act on Renewable Energy Sources (OG 100/15, 123/16, 131/17, 111/18). In particular, the 2015 Act introduced a requirement for suppliers to purchase the surplus electricity from prosumers. However, Croatia's framework differs from many other countries in the region.

REGULATORY FRAMWORK GOVERNING THE TREATMENT OF SURPLUS ELECTRICITY FROM THE COMMERCIAL PROSUMERS

Croatia applies a formula based on the ratio between the energy consumed from the grid, and the energy delivered to the grid. In particular, the price paid for surplus electricity depends on the ratio

[97] (European Commission, 2021. *Electricity prices for non-household consumers - bi-annual data.* https://ec.europa.eu/eurostat/databrowser/view/nrg_pc_205/default/table?lang=en)

of energy taken from the grid (Ep_i) and energy delivered to the grid (Ei_i) in each billing period (i.e. each month):

- Provided that the electricity purchased from the grid is greater than or equal to the electricity delivered to the grid ($Ep_i \geq Ei_i$), the suppliers are required to purchase the surplus at a price equal to at least $0.9 \cdot PKCi$, where $PKCi$ is the average unit price of electricity that the customer pays to the supplier for the sold electricity, excluding network usage fees and other fees and taxes, within that billing period. In other words, the prosumer receives a payment that is 90% of the average retail price paid, net of fees and taxes, in that month.

- However, if the electricity purchased from the grid is less than the electricity delivered to the grid ($Ep_i < Ei_i$),, the suppliers are required to purchase the surplus at a price equal to at least $0.9 \cdot PKCi \cdot \frac{Ep_i}{Ei_i}$, where $\frac{Ep_i}{Ei_i}$ represents the share of the electricity purchased from the grid divided by the share of electricity delivered to the grid.

Figure 20 below provides a graphical illustration of how the rate paid for surplus generation changes in relation to the total volume of surplus electricity. Since the amount paid is calculated before taxes and fees are added, the rate paid for surplus is around EUR 0.06/kWh, and starts to decrease as soon as surplus electricity is greater than the electricity purchased from the grid (i.e. beyond a ratio of 1:1 between consumption and surplus).

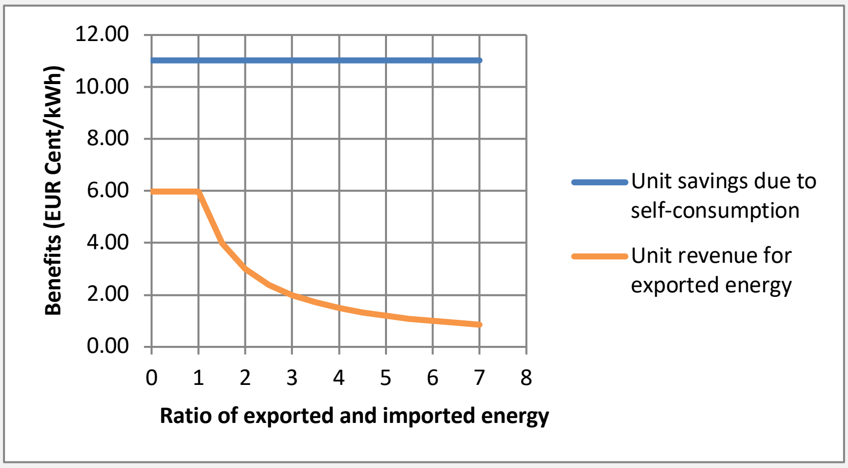


Figure 20: Overview of savings for prosumers under Croatia's current policy

As can be seen above, **the value of saved energy is almost twice as high as value of exported energy** for the months where energy imported is higher than energy exported, because the purchase rate is based on 90% of the retail price before taxes and fees, which means it is closer to 55% of the total retail price paid. As the ratio between exported and imported energy grows, the value of the exported energy decreases towards zero. Thus, prosumers are incentivized to dimension their solar PV plants to maximize on-site consumption.

However, **this approach ends up discriminating against certain types of prosumers:** for instance, due to the fact that the billing period is monthly, users that have low consumption during the summer months (such as schools and sport halls) end up having far too much surplus during this period and face the situation that the price they are awarded for their surplus generation approaches zero. However, Croatia's legal framework stipulates this as a minimum, but prosumers and suppliers can negotiate different (including higher) prices, including by selling their surpluses to other suppliers or energy traders.

As can be seen in the text box above, the current regulations are designed to encourage the so-called "right-sizing" of prosumer installations. Interestingly, the rate paid for surplus electricity according to this formula can be ***lower*** than the average daily market price of electricity on the CROPEX exchange, which could make it more attractive for projects to export their electricity directly onto the market.[98, 99]

Given the current regulatory environment in Croatia, the prosumer's load profile and overall self-consumption ratio plays a significant role in determining a particular project's economic attractiveness.

There are three other important aspects of the overall policy landscape in Croatia that are worth noting:

1. **Environmental Protection and Energy Efficiency Fund**[100]: The Fund provides grants for solar PV systems for solar PV installations covering between 40% - 80% of total investment costs. Out of the 43 MW of current commercial prosumer capacity, approximately one third was financed with support from the Fund. The Fund stems from a range of different sources: revenues generated from the EU's Emissions Trading Scheme (EU ETS), national contributions and taxes, as well as from European structural and investment funds.[101]
2. **Feed-in premium and guaranteed purchase price system**: Based on the Act on Renewable Energy Sources (Art. 34), the Croatian Energy Market Operator is required to use auctions to determine the feed-in premiums that will be offered to eligible RE projects. The tenders are divided into two categories, one for systems between 50 and 500kW and another for systems above 500 kW. The first tender for smaller systems (50 – 500kW) was published in November 2020 with a quota of 50 MW and a ceiling price of 83.6 EUR/MWh. However, the awarded capacity was only 13.4 MW, with average price of 77.8 EUR/MWh[102]. Thus, on the basis of the most recent feed-in premium auctions in

[98] (Croatian Power Exchange, 2021. *Day Advance Market.* Retrieved from https://www.cropex.hr/hr/ the 11.11.2021.)

[99] Note, however, that there are reportedly cases where the purchase prices for surplus generation are higher than the legal minimums established in the Act; interviews indicate that suppliers are, at times, offering to buy this surplus generation for more than the legally stipulated minimums.

[100] (The environmental protection fund and energy efficiency fund, 2021. https://www.fzoeu.hr/en/about_us/)

[101] Most of the EU SIF is distributed through the Environmental Protection and Energy Efficiency Fund, but also one part through other public bodies.
(European Structural and Investment Fonds, 2021. *Project Slavonij, Baranja and Srijem.*
Retrieved from https://strukturnifondovi.hr/en/ the 11.11.2021.)

[102] (HROTE, 2021. Retrieved from https://files.hrote.hr/files/PDF/OIEIK/2020/2020-12-30%20Javna%20objava%20rezultata%20natje%C4%8Daja.pdf the 11.11.2021.)

Croatia, the quota was just 27% filled; one factor behind this low success rate is likely that for many commercial users, the electricity retail price is higher than the feed-in premium on offer, making it more attractive to install systems configured for self-consumption. This signals that the market has reached something of a tipping point.

3. **Energy efficiency obligation scheme**: Energy suppliers in Croatia are obliged to achieve a certain level of energy savings over time. The savings can be achieved by providing co-financing for energy saving projects, educating customers, or by conducting different actions that lead to energy saving in final consumption. The implementation of solar PV systems for self-consumption in the commercial sector is recognized as a viable measure for achieving the energy savings obligations. As a result, some suppliers have started to offer solar PV systems to their customers as well as financing, mirroring recent developments in Bulgaria (see Annex 1).

In addition, another recent development has emerged in 2021: with funding from the European Investment Bank (EIB) the PVmax was launched to provide technical assistance including support with filling out the required documentation for integrated solar PV systems for the commercial, public and household sectors.[103] The aim of the PVmax project is to support approximately 70 million EUR worth of investments, or roughly 100 MW of prosumer PV projects.

What is the current status of battery storage systems in Croatia?

The installation of energy storage systems remains relatively rare for prosumers in commercial sector in Croatia. However, a few projects have been developed in recent years, mostly financed through research projects, pilot schemes, or as part of demonstration projects.

For instance, a lithium-ion battery energy storage system was installed in the City of Križevci as part of the EU's COMPILE project: the aim of the system is specifically to help increase the self-consumption of energy produced by the solar PV systems. One of the project's longer-term aims is to allow peer-to-peer energy trading within a "virtual" energy community composed of a larger number of individual prosumers.

Another example is the investment in battery energy storage system based on the salt water[104] in tourist apartments on the island of Krk.[105]

[103] (Balkan Green Energy News, 2021, July 7th. *PVMax project expected to bring rooftop solar to 3,000 buildings in Croatia.* https://balkangreenenergynews.com/pvmax-project-expected-to-bring-rooftop-solar-to-3000-buildings-in-croatia/)

[104] (BlueSky Energy, 2018. *Greenrock Saltwater Battery.* https://www.bluesky-energy.eu/en/saltwater_battery/)

[105] (Gnjidić, L., 2020, 27th. 'Račun za struju za dva stana i dva prostora smanjili smo s 800 na 100 kuna': Piršići su postali skroz energetski neovisni, imaju i više nego im treba. In *Slobodna Dalmacija.* https://slobodnadalmacija.hr/mozaik/tehnologija/racun-za-struju-za-dva-stana-i-dva-prostora-smanjili-smo-s-800-na-100-kuna-pirsici-su-postali-skroz-energetski-neovisni-imaju-i-vise-nego-im-treba-1018430)

	Besides investments in battery energy storage systems, there is a significant potential to increase the adoption of thermal storage systems in industry, tourism and administrative buildings based on the energy generation from the solar PV systems and by increasing the amount of electric demand that participates in demand response.

Barriers to Commercial Prosumers in Croatia

Despite signs of growth, there are still a number of barriers that continue to hold the commercial prosumer market back:

Main Barriers to Self-Consumption in Croatia	
Access to capital remains challenging for many companies	In order to obtain a loan for a commercial prosumer project, banks focus first and foremost on the company's overall creditworthiness, rather than the attractiveness of the solar PV project as such, and most require collateral before issuing the loan. The collateral requirement in particular puts smaller companies in a disadvantageous position, as they often lack the kinds of collateral needed to qualify for the loans. While this barrier is to some extent mitigated by the presence of the Environmental Protection and Energy Savings Fund, access to finance remains a major barrier, particularly as nearly 80% have an annual consumption of less than 20MWh, and are therefore frequently unable to post the required collateral.
Distortions caused by existing government subsidies to the sector	While the grants provided by the Environmental Protection and Energy Efficiency Fund as well as from EU funds have helped fuel market adoption of solar PV, there is also evidence that they have had distortionary effects: many businesses opt to wait for the government funding windows to open with the result that much of the activity in the market is concentrated around these windows. A further consequence of this reliance on funding windows is that many good projects are delayed. Moreover, among the projects that apply for grants, many get cancelled, as not all projects ultimately receive funding.
Despite substantial improvements in recent years, grid connection procedures remain a challenge in certain cases	Although the grid connection process has been improved in recent years, market participants have pointed out that several challenges remain: • Depending on the number of requests for solar installations in different areas of the grid, there can be delays in obtaining a response from the DSO; • Thus far, inverter standards have not been amended to allow inverters to participate in balancing or voltage regulation, capabilities that many of the newest inverters offer, and which could ease grid impacts while potentially enabling prosumers to qualify for larger solar installations.

	• The control calculations used to determine the maximum allowable solar PV system size are conducted based on a worst-case analysis of the local grid. This often leads to permits for electricity exporting capacities that are significantly lower than importing capacities. However, depending on the conditions in local distribution grid, most prosumers who would like to install systems larger than 500 kW, or who wish to have a higher export capacity than initially calculated, have to pay for an additional technical study, conducted by the DSO, to evaluate the available grid capacity.[106] As highlighted previously, such grid impact studies can cost in between EUR 5 000 and 10 000, which can be a prohibitive sum, especially for smaller commercial prosumer systems; • In some cases, DSO have required prosumers to relocate the point of common coupling between the grid and the prosumer's installations from the prosumers' building to the edge of the property – this requirement can also lead to significant additional costs.
Split incentive problems (between owners and tenants)	Many SMEs rent the space where they operate. In such cases, even though it may be economically attractive to invest in a solar PV system, many commercial customers will hesitate to do so as they would have to obtain permission from the building owner and would have to accept the additional risk that they move locations before the solar PV system has paid for itself. There is also the related issue of how to adapt the metering infrastructure in a building with multiple tenants. There is currently no scheme in Croatia that allows for collective self-consumption, or peer-to-peer energy trading, which would make such arrangements easier to operationalize.
Inability to locate projects off-site	Certain potential prosumers lack appropriate or suitable roof space to install solar PV systems. The current regulations prevent solar PV systems from being built off-site, at a point of connection other than where the electricity itself is consumed. Those provisions bar many potential commercial prosumers from investing in solar projects.
Quality issues	The solar market in Croatia is still in its infancy with approximately 15 active companies providing installations. Although rare, reports of poor installations have led to concerns about the quality and reliability of installations.

[106] (HEP, 2021. *Rules on connection to the distribution network*. http://www.hep.hr/ods/UserDocsImages/dokumenti/Pristup_mrezi/Pravila_o_prikljucenju_na_distribicijsku_mrezu_%202021_final_.pdf)

Heritage restrictions	In certain city centers, many buildings are protected as cultural heritage. Obtaining permits to install solar PV plants on such buildings can be challenging and lead to additional costs.

What is Peer-to-Peer Energy Trading?

In Article 2(18) of the EU's Renewable Energy Directive II, 'peer-to-peer trading' of renewable energy is defined as the *sale of renewable energy between market participants by means of a contract with pre-determined conditions governing the automated execution and settlement of the transaction, either directly between market participants or indirectly through a certified third-party market participant, such as an aggregator.* Within the Directive, it is stated clearly that prosumers should be allowed to participate in peer-to-peer energy trading.

Even though peer-to-peer energy trading in theory could be conducted in the current regulatory framework throughout the South East Europe region,[107] specific provisions governing peer-to-peer energy trading are still lacking.

Debate on transposition of provisions stemming from the Clean energy for all Europeans package

Based on the Clean energy for all Europeans package[108] member states have to, inter alia, transpose provisions governing development of renewable energy and electricity market, to allow easier market participation of citizens and prosumers, and to remove certain barriers. The public debate in Croatia with regard to revisions to the Electricity Market Act has been ongoing throughout 2021 (OG 22/13, 95/15, 102/15, 68/18, 52/19)[109] and Renewable Energy Act (NN 100/15, 123/16, 131/17, 111/18). As a consequence, the Electricity Market Act (OG 111/21) was recently revised in October 2021, opening doors to further reform of the electricity market and active participation of prosumers. The process now needs to continue forward with the revision of certain by-laws and ordinances.

The definitions and regulatory framework governing active customers, peer-to-peer electricity trading, citizen energy communities, renewable energy communities, aggregation, renewables self-

[107] (Kelava M., et al., December 2020. *Uzajamno (peer-to-peer) trgovanje energijom iz obnovljivih izvora u kontekstu paketa propisa Čista energija za sve Europljane.* https://www.researchgate.net/publication/346604537_Peer-to-peer_trading_of_renewable_energy_in_the_context_of_the_Clean_energy_for_all_Europeans_package)

[108] (European Commission, 2021, June 3rd. *Clean energy for all Europeans package.* https://ec.europa.eu/energy/topics/energy-strategy/clean-energy-all-europeans_en)

[109] (e-Savjetovanja, 2021. P*rijedlog ijedlog tržištu energije zakon o električnoj*. Retrieved from https://esavjetovanja.gov.hr/ECon/MainScreen?entityId=16312 the 11.11.2021.)

consumption, and collective self-consumption need to be established.[110] The introduction and fine tuning of such provisions for the Croatian context, could allow new business models and speed-up the solar PV uptake in the commercial sector if done adequately. This issue is recognized as important, as even President of the Republic of Croatia formed the Energy Transition Council, which published the Guidelines for Encouraging Citizens and Entrepreneurs to Construct Integrated Solar Power Plants.[111]

Policy Recommendations for Commercial Prosumers in Croatia

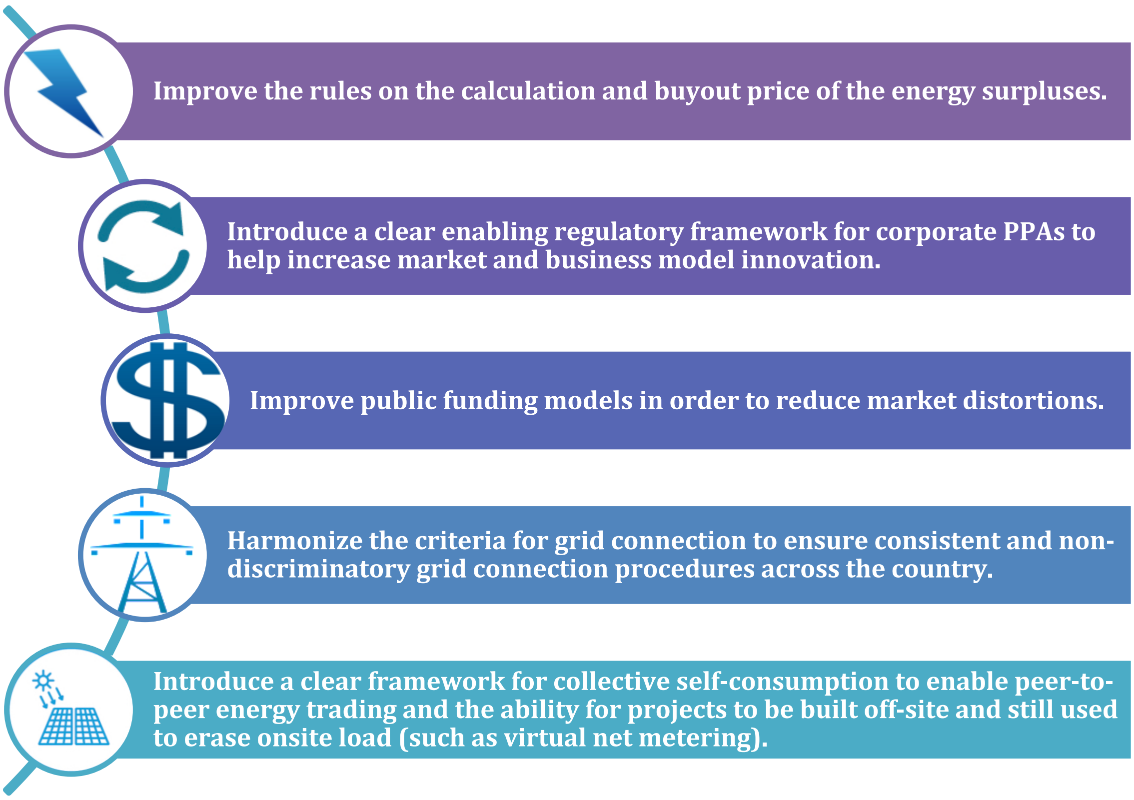


Figure 21: Key Recommendations for Croatia

[110] (Compile, October 2020. *Deliverable 2.3: Regulatory frameworks for energy communities in the pilot site countries Croatia, Spain, Greece, Portugal and Slovenia.* https://www.compile-project.eu/wp-content/uploads/COMPILE_D2_3_Regulatory_frameworks_for_EnC_v1_1.pdf)

[111] (Republic of Croatia, 2021, March 1st. *Energy Transition Council of the President of the Republic of Croatia Presents Guidelines for Encouraging Citizens and Entrepreneurs to Construct Integrated Solar Power Plants.* https://www.predsjednik.hr/en/news/energy-transition-council-of-the-president-of-the-republic-of-croatia-presents-guidelines-for-encouraging-citizens-and-entrepreneurs-to-construct-solar-power-systems/)

Greece

Greece is charting an ambitious pathway forward with its energy transition. It has set an ambitious target of covering 61%-64% of its electricity needs with renewables by 2030, up from 31,3% in 2019,[112] and according to its National Energy and Climate Plan (NECP)[113], **all of Greece's existing lignite power plants will be phased out by the end of 2025**.[114]

> **31.3%**
>
> Current share of renewable energy sources in Greece's electricity mix[115]

Solar PV is poised to play a key role in Greece's energy transition, with at least 7.7 GWp of PV installed capacity anticipated by 2030, yielding an estimated annual output of 11.82 TWh (or approximately 20% of the country's electricity demand). **While Greece currently has an installed solar PV capacity of over 3.7 GWp,**[116] only a small portion of this is configured for self-consumption; most PV systems in the country are currently injecting 100% of their output directly to the grid under long-term contracts. Out of the 3.7 GWp of installed capacity, only an estimated 51 MWp consist of behind-the-meter, prosumer systems.

Building Type	Number of Buildings
Hospital and Health Centres	1 749
Hotels	34 736
Industrial Use Buildings	30 731
Retail and Office Buildings	153 510
Schools	19 474
Total Number of Commercial Buildings	**240 200**

[112] (Euopean Commission, 2021. *Energy from renewable sources*. Retrieved from https://ec.europa.eu/eurostat/web/energy/data/shares the 11.11.2021.)

[113] Greece (2019a). Official Journal 4893B'/31.12.2019 (in Greek)

[114] With the exception of one new coal unit, which is currently being built, which will be required to cease burning lignite by 2028.
(Filippou, K., 2021, May 24th. ΔΕΗ: Τέλος Ιουνίου η επενδυτική απόφαση για τη μετατροπή της «Πτολεμαΐδας 5» σε μονάδα φυσικού αερίου. In *Energypress*. https://energypress.gr/news/dei-telos-ioynioy-i-ependytiki-apofasi-gia-ti-metatropi-tis-ptolemaidas-5-se-monada-fysikoy)

[115] (Euopean Commission, 2021. *Energy from renewable sources*. Retrieved from https://ec.europa.eu/eurostat/web/energy/data/shares the 11.11.2021.)

[116] (Hellenic Association of Photovoltaic Companies, 2021, May 18th. *Greek PV Market statistics – 2020.* https://helapco.gr/pdf/pv-stats_greece_2020_18May2021_eng.pdf)

However, **demand for self-consumption installations is growing rapidly** and could play a significant role in helping Greece meets its energy and climate targets in the coming years.

According to Eurostat, the final consumption of the commercial and public sector in Greece was represented approximately 49% of nation-wide electricity demand.[117] This commercial and public sector demand is spread across over 240,000 single use buildings.[118] Even harnessing a portion of this rooftop potential would be enough to achieve several gigawatts of PV for self-consumption.

17 TWh	Technical potential of rooftop solar PV in Greece, enough to supply roughly 31.5% of current electricity demand[119]
50 TWh	Annual electricity demand in Greece (2019)[120]
11,8 TWh	Current National Target for Solar PV Generation by 2030[121]
49%	Approximate share of electricity demand represented by commercial electricity customers[122]

Greece's electricity market structure

Greece has had a state monopoly in the electricity sector for decades; however, the market is being gradually liberalized in line with EU regulations. While there are over 30 different electricity suppliers in the country, the market as a whole remains relatively concentrated, as only 9 of these suppliers currently have a market share of over 1%; moreover, the legacy monopoly supplier, Public Power Corporation, remains dominant with a 63.2% share of the market (measured in terms of final electricity sales) as of October 2020.[123]

[117] (Euopean Commission, 2021. *Energy from renewable sources*. Retrieved from https://ec.europa.eu/eurostat/web/energy/data/shares the 11.11.2021.)

[118] (Hellenic Statistical Authority, 2015, May 18th. *Απογραφή Κτιρίων 2011*. https://www.statistics.gr/documents/20181/1204362/A1601_SKT01_DT_DC_00_2011_01_F_GR.pdf/33bc3e1f-ea63-47ec-93b8-a96179b2ee59)

[119] (Bódis, K. et al., October 2019. *A high-resolution geospatial assessment of the rooftop solar photovoltaic potential in the European Union*. https://www.sciencedirect.com/science/article/pii/S1364032119305179)

[120] (Euopean Commission, 2021. *Energy from renewable sources*. Retrieved from https://ec.europa.eu/eurostat/web/energy/data/sharest the 11.11.2021.)

[121] (Hellenic Ministry of the Environment and Energy, December 2019.*National Energy and Climate Plan.* https://ec.europa.eu/energy/sites/default/files/el_final_necp_main_en.pdf)

[122] (Euopean Commission, 2021. *Energy from renewable sources*. Retrieved from https://ec.europa.eu/eurostat/web/energy/data/sharest the 11.11.2021.)

[123] (Energy Exchange Group, 2021. http://www.enexgroup.gr/fileadmin/groups/EDRETH/DAS_Monthly_Reports/202010_DAS_Monthly_Report_en.pdf)

Current Status of Commercial Prosumers in Greece

According to statistics from the Hellenic Electricity Distribution Network Operator (HEDNO)[124-125] there were approximately 44.1 MWp of commercial self-consumption PV systems installed in the country by the end of 2020 (almost all of them under the country's Net-Metering policy)[126].

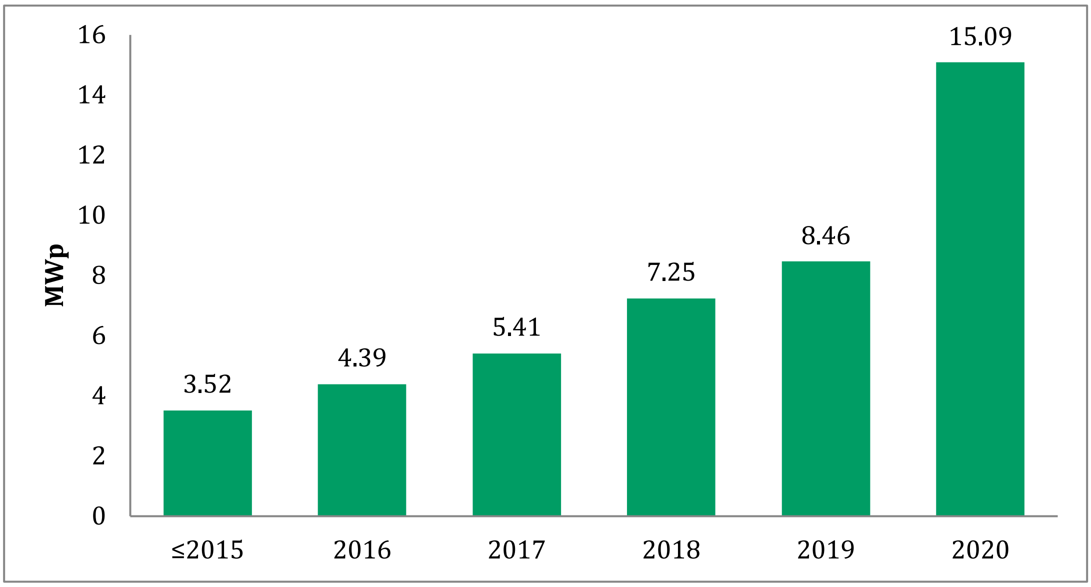


Figure 22: Commercial Prosumer Installations in Greece (in MWp)

[124] (Hedno S.A., 2021. *Αρχεία Αιτήσεων*. Retrieved from https://www.deddie.gr/el/themata-stathmon-ape-sithia/fv-apo-autoparagwgous-me-energeiako-sumpsifismo-ne/arxeia-aitisewn/ the 11.11.2021)

[125] (Hedno S.A., October 2020. *Αρχείο Αιτήσεων Φωτοβολταϊκών Σταθμών, Φ/Β Ειδικού Προγράμματος και Φ/Β net Metering στα ΜΔΝ.* https://www.deddie.gr/el/themata-tou-diaxeiristi-mi-diasundedemenwn-nisiwn/ape-sta-mdn/sundeseis-stathmwn-ananewsimwn-pigwn-energeias/arxeio-aitiseon-fv-netmetering-oktwvrios-2020/)

[126] Published data cover systems connected to Greece's mainland grid as of July 2020, while for the non-connected islands (most of which have autonomous grids) the data covers the period until the end of October 2020.

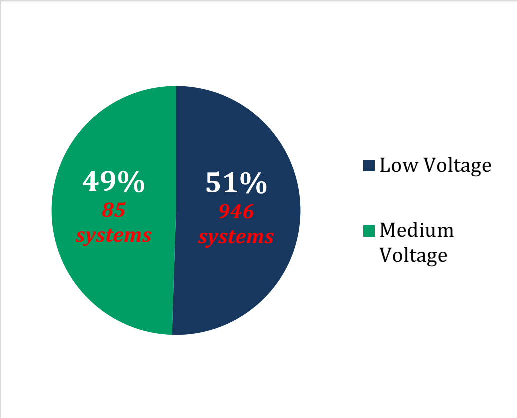


Figure 23: Commercial prosumer installations by voltage level

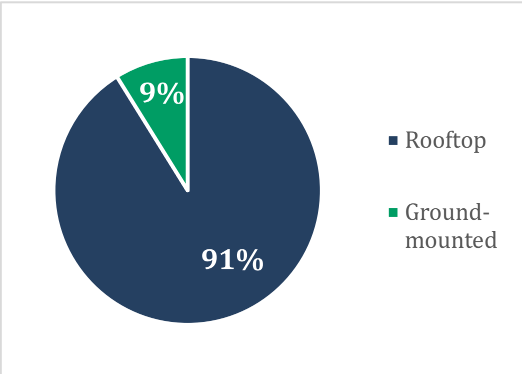


Figure 24: Installations by type (by installed capacity)

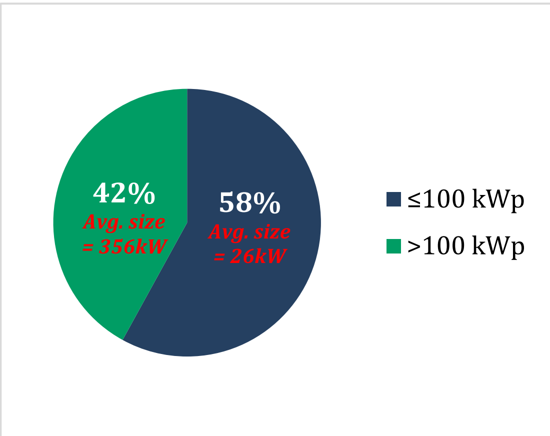


Figure 25: Installation size (by installed capacity)

In a sign of the improving economics of self-consumption, **Greece is witnessing broad-based development of commercial prosumers in all regions of the country.** As can be seen in Figure 24, **over 90% of the projects are roof-mounted.**

In addition, some solar PV installations are now beginning to be installed under Greece's recently adopted **Virtual Net Metering** framework, a policy that allows installations to be installed elsewhere on the grid, and the electricity generated can be used to offset onsite load virtually. As of the end of 2020, 1.9MW has been installed across 42 different installations nation-wide.

Overview of commercial electricity rates

In contrast to many other jurisdictions worldwide, commercial electricity rates in Greece have started to flatten. However, this flattening is offset by rapidly decreasing installed costs for solar PV installations. Currently, commercial prosumer projects can be installed in the range of EUR 500/kW range, down by over 50% since 2016. The following Figure 26 shows the historical evolution of average commercial electricity rates in Greece[127].

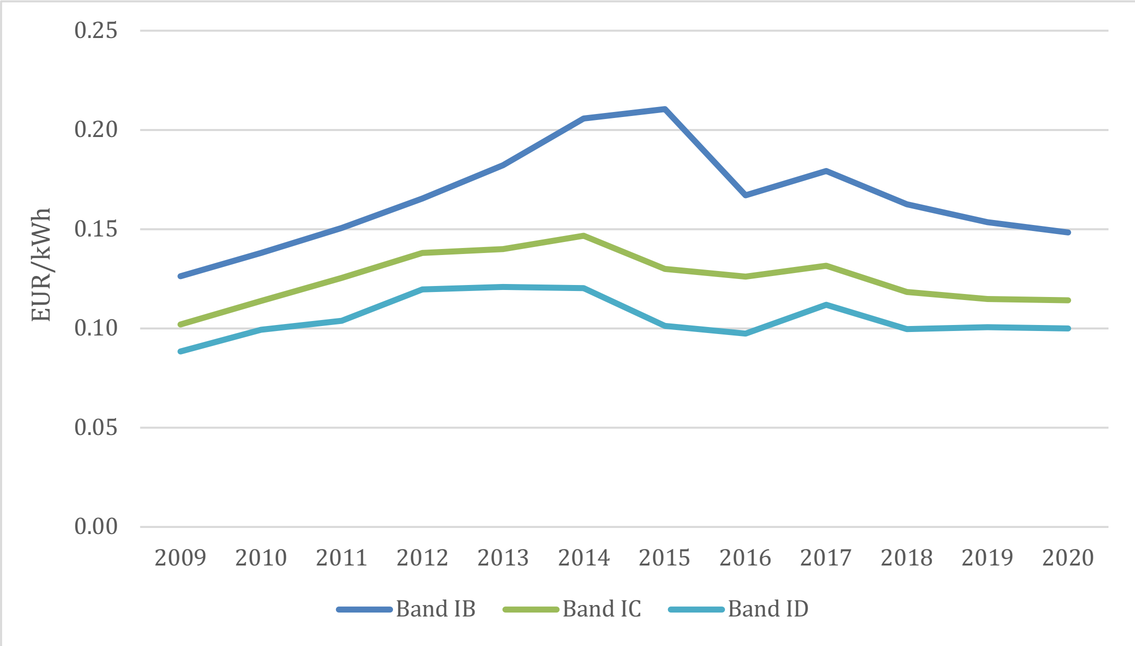
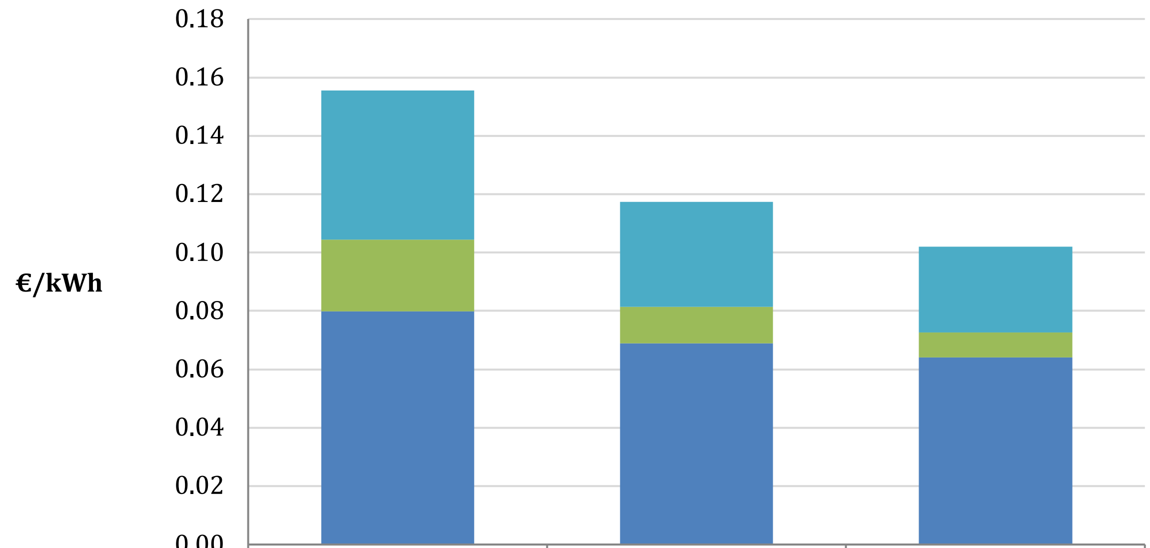


Figure 26: Evolution of Electricity Rates for Commercial Customers in Greece

Figure 27 shows the average commercial electricity rates for three different annual consumption bands.[128]

[127] (European Commission, 2021. *Electricity prices for non-household consumers - bi-annual data.* https://ec.europa.eu/eurostat/databrowser/view/nrg_pc_205/default/table?lang=en)

[128] The sudden drop in Band IB electricity rates from 2015 to 2016 is explained by lower "Regulated" charges imposed during that period.
(European Commission, 2021. *Energy Database.* https://ec.europa.eu/eurostat/web/energy/data/database)



	Band IB	Band IC	Band ID
Taxes & charges	0.0511	0.0360	0.0293
Network costs	0.0246	0.0124	0.0086
Energy & Supply	0.0799	0.0689	0.0641

Figure 27: Overview of Commercial Electricity Tariffs in Greece

*Band IB = ; Band IC =; Band ID = .

However, recent changes to Greece's electricity market have made it possible for commercial and industrial customers to purchase electricity directly on the wholesale market, opening up new possibilities both to purchase and to sell electricity on the power exchange.[129]

Current policy framework in Greece

There are currently two distinct support schemes for commercial prosumers in Greece: [130]

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[129] (Stambolis, C., 2020, November 13th. The big bang of Greece's electricity market. *New Europe*. https://www.neweurope.eu/article/the-big-bang-of-greeces-electricity-market/)

[130] Greece (2019b) Basic legislation related to the self-consumption scheme: L.2773/1999, art. 40, Official Journal 286A/22.12.1999; L.3468/2006, art. 2, 13, Official Journal 129A/27.6.2006; L. 3851/2010, art. 4, Official Journal 85A/4.6.2010; L.4414/2016, art. 2, 23, Official Journal 149A/9.8.2016; L.4643/2019, art. 62, Official Journal 193A/3.12.2019

Greece (2021). Basic legislation related to the net-metering scheme: Ministerial Decision ΑΠΕΗΛ/Α/Φ1/οικ.24461, Official Journal 3583B'/31.12.2014; L.4414/2016, Official Journal 149A'/9.8.2016; L.4513/2018, art. 11, Official Journal 9A'/23.1.2018; Ministerial Decision ΥΠΕΝ/ΔΑΠΕΕΚ/15084/382; Official Journal 759B'/5.3.2019, L4759/2020, art. 162. Official Journal 245A'/9.12.2020; ΥΠΕΝ/ΔΑΠΕΕΚ/74999/3024, Official Journal 3971B/30.8.2021

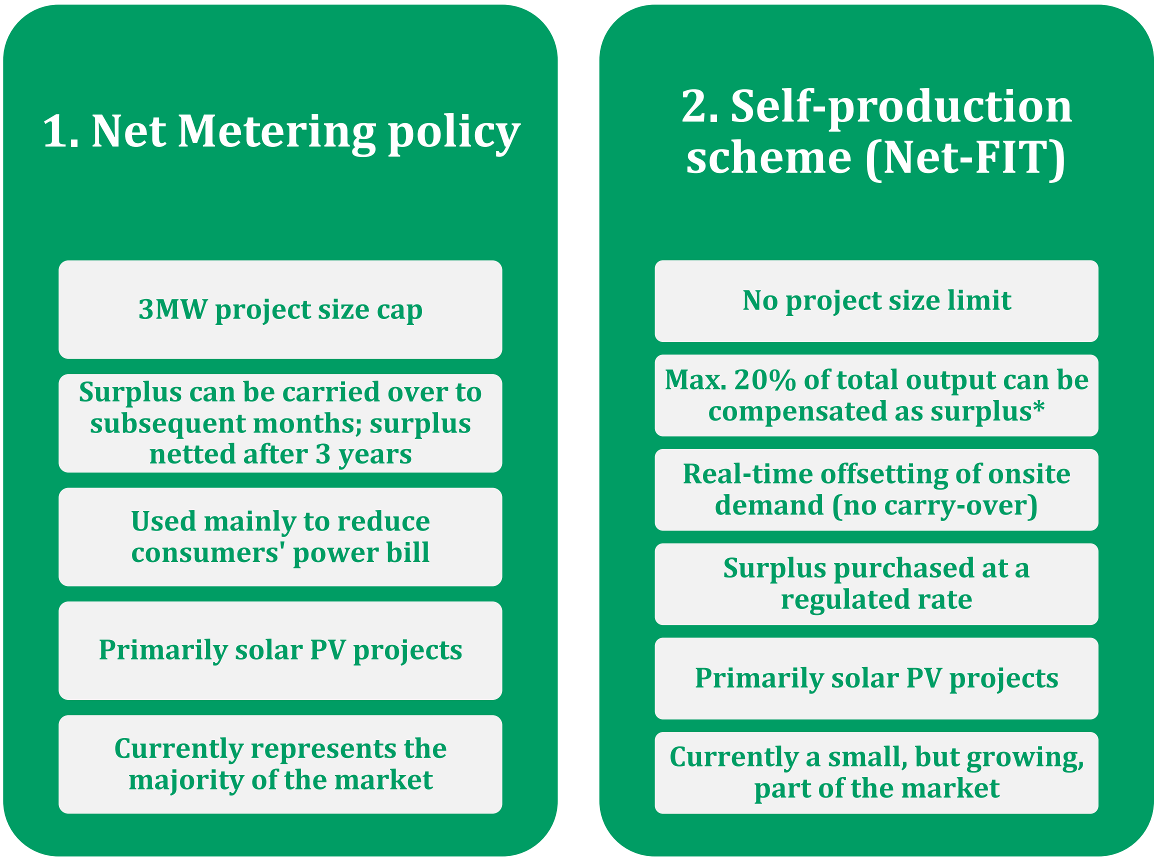

Figure 28: Overview of two main policies for self-consumption in Greece

* Under the Self-Production Scheme, special treatment is awarded to agricultural installations, which are allowed to export up to 75% of their surplus.

Thus far, the majority of the installed prosumer capacity in Greece has been installed under the Net Metering policy. **Interviews with stakeholders indicate that the Net Metering scheme is currently more attractive to commercial prosumers than the Self-Production scheme, and accounts for an estimated 94% of total installed commercial prosumer capacity.** However, since the Net Metering framework is limited to systems up to 3 MWp, the Self-Production scheme is better suited to larger PV systems. However, **most commercial prosumer systems installed to date in Greece have a capacity of less than 500 kWp**.

What is the current status of battery storage systems in Greece?

In contrast to neighbouring Italy, which is witnessing the emergence of a thriving battery storage market including both large-scale as well as small-scale battery systems,[131] battery storage (BESS) is not yet regulated in Greece. The relevant framework is expected by the end of 2021. There is an exception however, regarding residential and small commercial systems under the Net-Metering scheme: as of March 2019, battery storage is allowed provided that the storage system converter (in kVA) does not exceed 30 kVA.[132] Also, the nominal power of the storage system converter (in kVA) must not exceed the nominal power of the PV system (in kWp). Exceptions to this rule are provided for state bodies or private entities serving the public interest for whom the storage system converter (in kVA) can be up to the nominal power of the PV system (in kWp) and up to 3 MWp in mainland Greece and on Crete.

Only a few pilot PV systems with storage have been installed so far, although there are signs that the market for larger scale BESS could take off as soon as there is an appropriate regulatory scheme in place. In the case of Italy, the majority of the larger-scale BESS market is driven by the growing need for frequency regulation, which is related to the growing shares of variable renewable energy technologies in the overall supply mix.[133]

[131] (Frontis Energy, 2019, November 30th. *Energy Storage in Italy.* https://frontis-energy.com/2019/11/30/energy-storage-in-italy/)

[132] Greece (2019c). Ministerial Decision ΥΠΕΝ/ΔΑΠΕΕΚ/15084/382; Official Journal 759B'/5.3.2019

[133] (Frontis Energy, 2019, November 30th. *Energy Storage in Italy.)*

Innovative Aspects of Greece's policy framework for prosumers

A few aspects in Greece are noteworthy:

1. **The country has developed an innovative approach to determine priority for grid connection** for different customers and developers wishing to connect to either the low or medium-voltage grid. The framework provides higher priority for some project types, based on a five-fold scheme running from A to E:

Category	Level of Priority	Project Types
A	Most favoured	Biogas projects operated by public bodies
B		RES projects developed under Net Metering or VNM
C		Self-Production projects; Low-voltage projects; PV and wind projects operated by non-profit energy communities
D		PV and wind projects operated by for-profit energy communities
E	Least favoured	All other RES projects

As of Q4:2021, PV systems configured for self-consumption with a capacity of 50 kWp or less are exempted from this priority list and can be connected to the grid with a simple notification to the Grid Operator.

2. **The determination of the purchase price awarded to surplus generation under the Self-Production** (Net-FIT) policy represents an innovative and market-linked approach for determining the price paid. The government establishes a reference tariff that defines the price paid for the surplus generation that prosumers export to the grid.

How is the Reference Tariff under the Self-Production Scheme calculated?

Under the self-production model, **the Reference Tariff** refers to the actual tariff that prosumers receive for the surplus generation. It is based on the weighted average Reference Tariff of the **most recent solar PV tender** issued for that specific size category. This approach ensures that the compensation level for self-production remains market-based, and reflects the approximate levelized cost of generation of such installations. This is in line with recent proposals to adopt "**surplus power tariffs**" in EU Member States, and beyond.

See: https://proseu.eu/sites/default/files/PROSEU_Surplus%20Power%20Tariffs%20-%20Position%20Paper%20%28short%20version%29_2021-02-25.pdf

Main Barriers to Self-Consumption in Greece	
Lack of knowledge about the benefits of self-consumption	With regard to awareness, the situation is improving as certain electricity providers have started to advertise self-consumption (and in particular Net Metering). By comparison, the old feed-in tariff scheme for rooftops ten years ago was well advertised by banks offering loans for such systems. This is not the case for self-consumption systems, indicating that banks are less keen to provide financing for self-consumption systems.
Lingering effects of the economic recessions and Covid-19	The economic recession has certainly played a major role. When the Net Metering scheme was launched in mid-2015, capital controls were imposed making it extremely difficult to finance even small systems. As economic growth is currently hindered by the COVID-19 epidemic, companies are still reluctant to invest in long-term projects regardless of their viability and profitability.
Larger self-consumption systems can experience difficulties in getting a grid connection	Self-consumption projects are not currently given sufficient priority.
Self-producers are subject to relatively high fees in relation to their self-generated electricity	The fact that prosumers have to pay the charges related to the "Services of General Interest" on both their self-produced, and the electricity they purchase from the grid, worsens project economics. It is also arguably in conflict with article 21 of the EU Directive in this matter (2018/2001).
The demand profile of many SMEs does not always fit the limitations of the Self-Production scheme in particular	In the Self-Production scheme, up to 20% of produced energy on an annual basis can be sold to the grid with a Reference Tariff defined by the law. This means that a prosumer needs to achieve an 80% self-consumption rate. This can be done in three main ways: 1) by under-dimensioning of solar PV installations, 2) by the installation of a battery storage system, or 3) by adjusting one's own onsite load to better coincide with daytime solar output.
Self-consumption projects are more "complicated" than	With regard to financing, banks are more familiar with projects supported with a feed-in tariff rather than with self-consumption projects. Some banks are nevertheless starting to lend to self-consumption projects, most commonly when

FITs and more difficult to finance	backed by existing clients who are already deemed creditworthy.

Policy Recommendations to Catalyse Investment in Commercial Prosumers in Greece

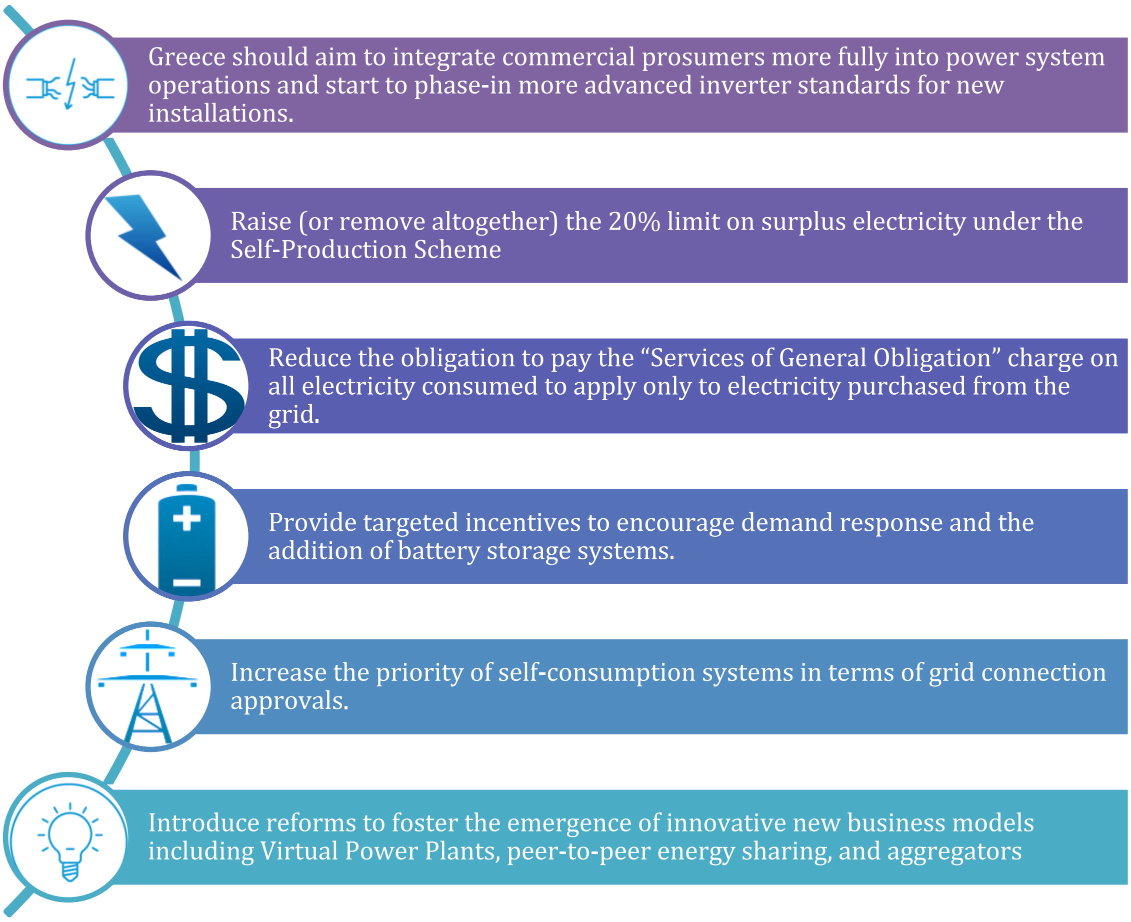

Figure 29: Key Recommendations for Greece

Romania

Under the latest version of Romania's National Plan for Energy and Climate Change (NPEC) for 2021-2030, Romania aims to meet 49.4% of its electricity needs with renewable energy sources. While solar PV has been largely neglected in Romania in recent years, the significant drop in costs for PV systems, combined with an increasingly active and dynamic solar PV market, led policymakers to include a more prominent role for solar power in the NPEC for 2021-2030. Based on the latest available data, at the end of 2020 Romania had a solar PV energy installed capacity of 1,548 MW, producing approximately 1,831 GWh, thus covering around 3.2% of total electricity consumption.

43.4%

Current share of renewable energy sources in Romania's electricity mix[134]

The NPEC anticipates an additional 3,692 MW of solar capacity by 2030. Additionally, the total gross energy produced from PV is expected to increase in 2030 to approximately 7,500 GWh, more than four times the current levels.[135]

While the Romanian government has legally recognized prosumers since 2008, it took ten years (i.e., until the end of 2018) for the country to design and implement a regulatory regime for the sector. Due to the numerous administrative barriers, the lack of policy support and that the prosumer sector is a relative newcomer to the country's electricity sector, the sector as a whole remains small, with only 4 800 recognized prosumers as of April 2021.[136] While the National Authority for Energy Regulation (ANRE) does not legally distinguish commercial prosumers from residential or industrial customers, recent data shows that only a fraction has been designated as non-household legal entities. This means that the largest share of prosumers in Romania remains residential. According to the Environmental Fund Authority (AFM) there are now over 260 licensed solar installers in the country, spread throughout all 40-territorial divisions.

Electricity Market Structure

Following the European legislation, Romania has unbundled its electricity market in recent years, with the liberalization process being concluded at the end of 2013. As of 2019, there are 124 licensed producers of electricity operating in Romania, owning generation units from hydropower, nuclear, heat, wind, PV and biomass production sources. These units where responsible in 2020 for the production of 56.2 TWh of electricity. Out of the 124 producers holding commercial licenses, 97 were active on the retail market as suppliers, although only five (5) were designated as suppliers of last resort by

[134] (Ernst & Young, 2021, April 1st. *EY Romania report: Renewables can accelerate the decarbonisation of the Romanian energy sector, but public initiatives must be synchronised with business intentions.* https://www.ey.com/en_ro/news/2021/04/ey-romania-report--renewables-can-accelerate-the-decarbonisation)

[135] As in Bulgaria, a significant share of the country's existing solar PV capacity was installed under its previous feed-in tariff policy regime, and is thus configured to export 100% of system output to the grid, rather than being configured for self-consumption.

[136] (Petrescu, R. 2021, June 30th. România a ajuns la 4.800 de prosumatori, mici consumatori de energie care şi-au obţinut independenţa faţă de sistem: piaţa este în creştere, dar există nevoia de aliniere a legislaţiei. In *Ziarul Finaniar* https://www.zf.ro/companii/romania-a-ajuns-la-4-800-de-prosumatori-mici-consumatori-de-energie-20163876)

ANRE. Electricity transmission is a regulated natural monopoly provided by Transelectrica, while distribution is operated by four companies operating in eight different sub-national regions.

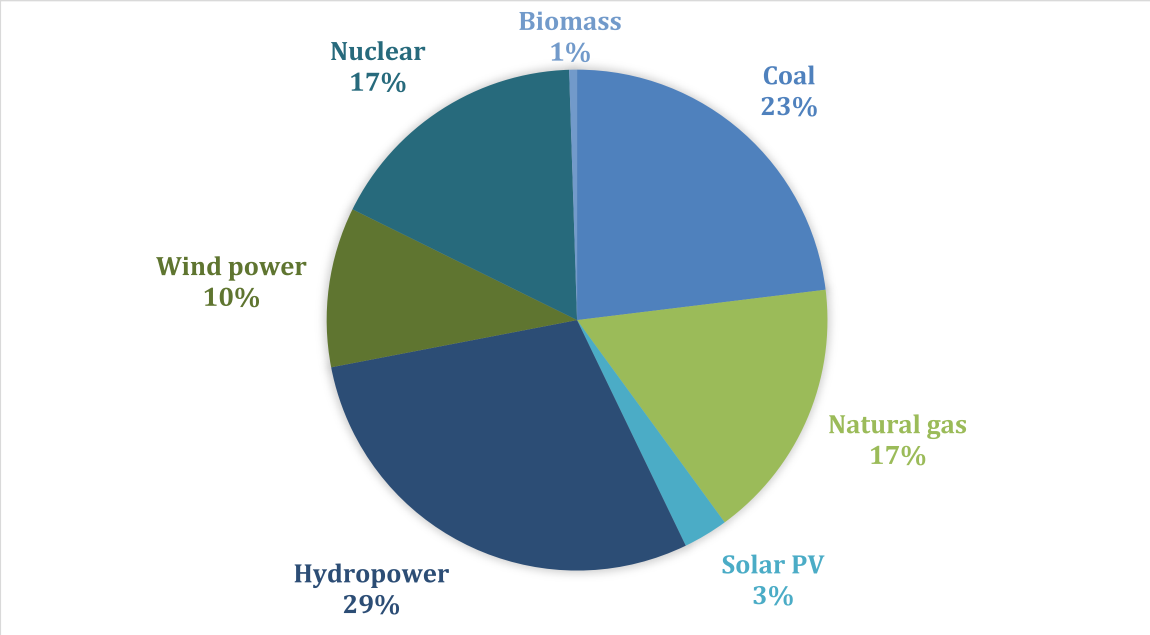

Figure 30: Electricity Mix of Romania (2019)

Source: Bankwatch (2021)[137]

Despite the competitive market for electricity generation, three producers of electricity, Hidroelectrica, CE Oltenia and Nuclearelectrica, dominate the market, having provided approximately 69% of the total electricity consumed in the country in 2020. A distinctive feature of the Romanian wholesale electricity market is that similar levels of concentration exist in the balancing market, with a few major actors having a dominant position.

Policy Framework for Commercial Prosumers in Romania

As of 2021, prosumers in Romania are defined as owners of renewable energy installations with a maximum installed capacity of 100kW, up from a maximum of 27kW previously. This increase is specifically related to the distinction between residential and non-residential (i.e. commercial and industrial) prosumers, which are now allowed to have installed capacities above 27 kW. This recent development has been achieved through a new scheme initiated by Romania's Environmental Fund Authority in December 2020.

Under regulations adopted in late 2020, **prosumers can now sell electricity to the electricity supplier under a net billing scheme. The price for the sale of surplus generation is based on**

137 (Bankwatch Network, 2021. *The Energy Sector in Romania.* Retrieved from https://bankwatch.org/beyond-coal/the-energy-sector-in-romania the 11.11.2021.)

the weighted average price recorded on the day-ahead market in the previous year. In order to sell power to the grid at this rate, prosumers need to obtain a connection certificate from the grid operator. The measurement of the electricity is done either with smart meters in compliance with the provisions of the Electricity Measurement Code in force.[138]

35.9TWh[139]	Technical potential of rooftop solar PV in Romania, enough to supply 72% of current electricity demand
56.2 TWh	Annual electricity demand in Romania (2020)
7.5 TWh	Current National Target for Solar PV Generation by 2030
36%	Approximate share of electricity demand represented by commercial electricity customers[140]

The PV prosumer market in Romania remains at an early stage of development compared to other countries in Central or South-Eastern Europe such as Greece and Poland. The slow pace of development is due to a range of factors, including administrative hurdles and a lack of awareness from potential commercial prosumers. In fact, in the two years since the framework was announced in 2018, only 59 commercial prosumers were recorded.

As in Bulgaria, the electricity market is divided into both regulated and competitive components, with regulated customers paying government-set rates. Currently, the overwhelming majority (97%) of total commercial electricity demand is made up of customers participating in the competitive market. Since it is customers in this market segment that have faced the fastest electricity price increases in recent years, it is this market segment that is most likely to grow.

Consumer type	Regulated market		Competitive market	
	No. of consumers	Volume (GWh)	No. of consumers	Volume (GWh)
Household	6,489.134	9,656.82	2,127.461	3,116

138 Usually, large companies that have been previously authorised bear the costs of purchasing, installing and sealing the meters necessary. The installation is often times done by smaller companies that have been subcontracted for this particular task.

139 (Bódis, K. et al., October 2019. *A high-resolution geospatial assessment of the rooftop solar photovoltaic potential in the European Union.* A high-resolution geospatial assessment of the rooftop ... (europa.eu))
(Friends of the Earth Europe, December 2018. *Energie fără limite.* http://fiiprosumator.ro/static/brosura-greenpeace-energie-fara-limite.pdf)

140 (European Commission, 2021. *Energy Balances.* https://ec.europa.eu/eurostat/web/energy/data/energy-balances)

Non-Household	186,362	993.4	175.493	36,256

Table 7: Overview of Electricity Customers by Type

Source: ANRE (2020)

In order to better understand the potential development of the commercial prosumer market, it is necessary to assess the structure of the commercial sector in Romania. Currently 99.7% of the companies registered in the country are identified as SMEs, representing a total of 485,757[141] companies in 2019. The majority of the SMEs are operating in the manufacturing, transport and logistics, and research and development. Becoming a commercial prosumer is particularly attractive for SMEs like retail and manufacturing which often consume most of their electricity during the daytime, and thus can benefit from higher self-consumption ratios.

Commercial Electricity Rates

Currently, there is no distinction between industrial and commercial electricity rates in Romania: both customer types are considered non-household consumers, and pay the same rates. Commercial enterprises are allowed to conclude electricity-supply contracts with any supplier holding a license from the National Authority for Energy Regulation (ANRE). However, it is important to note that electricity suppliers offer a large variety of price packages, tailored to different types of enterprises and their respective load profiles.

In most cases, the electricity rate for non-household customers is significantly lower than the average household electricity rate.[142] This (in combination with the current subsidy programme for households) is one of the factors that makes investments in customer-sited solar PV systems more attractive for households than for SMEs in Romania.

However, due to the fact that electricity tariffs in Romania are largely volumetric (featuring few fixed components), becoming a prosumer can enable customers to reduce their bills more effectively than in other markets such as Spain where a substantial part of the electricity bill is fixed, and does not depend on actual monthly electricity demand. **In other words, generating one's own electricity in Romania reduces both the energy components of the power bill as well as the other tariff components.** The various non-energy components include a transmission tariff, a system services tariff[143] that covers grid and congestion management, system balancing and other ancillary services,

[141] file:///Users/vladsurdea/Downloads/Romania%20-%20SBA%20Fact%20Sheet%202019.pdf

[142] There are two main categories of electricity rates for non-household consumers: the universal service price, and the inactive consumer price. The universal service price is guaranteed for commercial consumers with fewer than 50 employees, or with an annual turnover of less than EUR 10 million. Other consumers that are ineligible for the universal service price are covered by another electricity rate, the inactive consumer price.

[143] (Autoritatea Naţională de Reglementare în Domeniul Energiei de România, 2017, June 14th. *Metodologia de stabilire a tarifelor pentru serviciul de sistem din 13.06.2017 Parte integrantă din Ordin 45/2017.* https://lege5.ro/Gratuit/ge3dgnzvgyyq/metodologia-de-stabilire-a-tarifelor-pentru-serviciul-de-sistem-din-13062017?pid=199846416#p-199846416)

and a distribution tariff, calculated based on the voltage level[144] (low voltage, medium voltage and high voltage)[145]. For many customers, these bill components represent the majority of the electricity price.

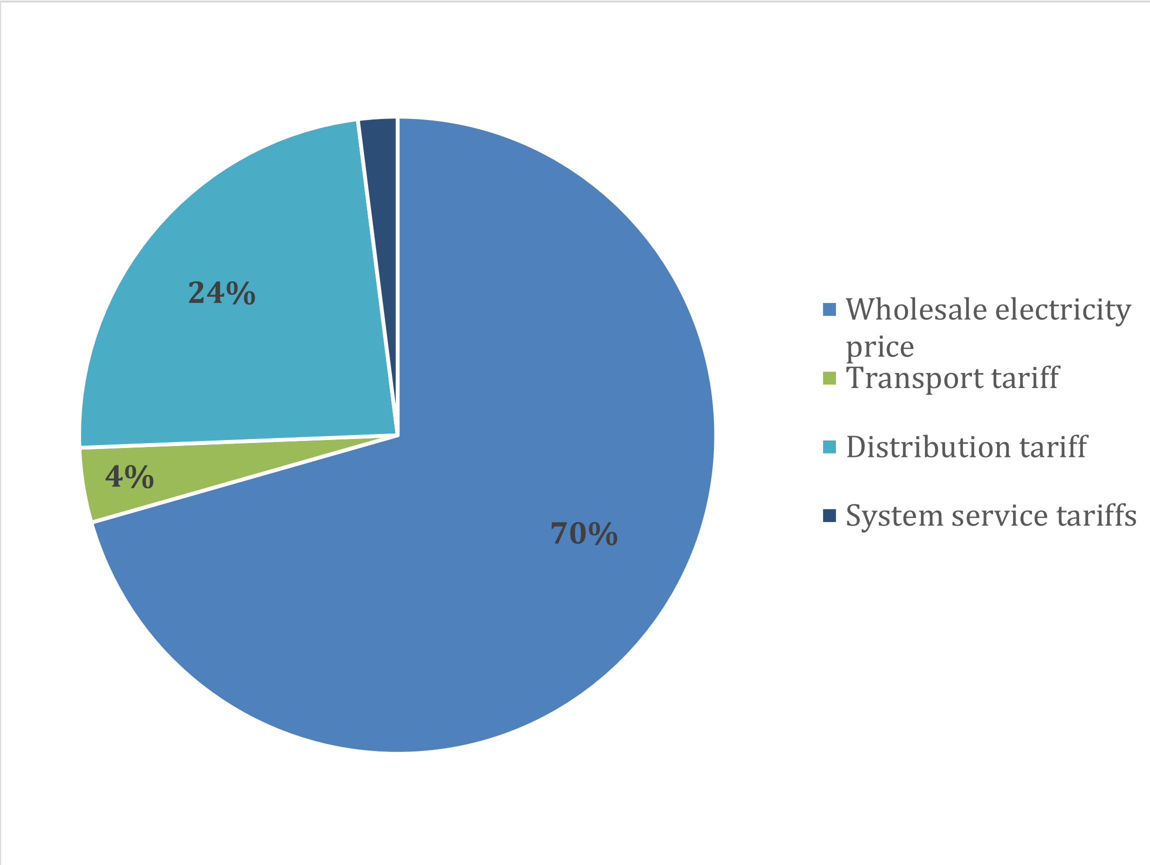

Figure 31: Commercial Electricity Price Structure in Romania[146]

Source: Electrica Furnizare (2021)[147]

In addition to the existing regulated tariffs, commercial consumers are expected to separately pay a cogeneration contribution, an excise duty and a fee for the green certificates support scheme. By law, these payments are separated from the commercial electricity bill. In 2019, the average retail commercial consumer electricity rate was EUR 0,1206/ kWh, with slight differences between the main providers in the market.

[144] (Autoritatea Naţională de Reglementare în Domeniul Energiei de România, 2021. *Distribuţie energie electrică.* Retrieved from https://www.anre.ro/ro/legislatie/metodologii-tarife/distributie-energie-electrica the 11.11.2021.)

[145] (Autoritatea Naţională de Reglementare în Domeniul Energiei de România, 2016. *Dispoziţii generale - Definiții și abrevieri - Art. 6.* https://lege5.ro/Gratuit/geydkmrwg4ya/art-6-definitii-si-abrevieri-ordin-11-2016?dp=he2danjxgi3dq).

[146] Excluding green certificates, cogeneration tariffs, VAT and excise duties.

[147] (Electrica furnizare S.A., 2021. Retrieved from https://www.electricafurnizare.ro/business/preturi-si-tarife/ the 11.11.2021)

While commercial retail electricity rates in Romania are low compared to the EU average, they have started to rise in recent years: since 2017, rates have gone up roughly 30% (or approximately 3 cents EUR/kWh). Like in Bulgaria, one of the main drivers of this increase is the liberalization of the electricity market.

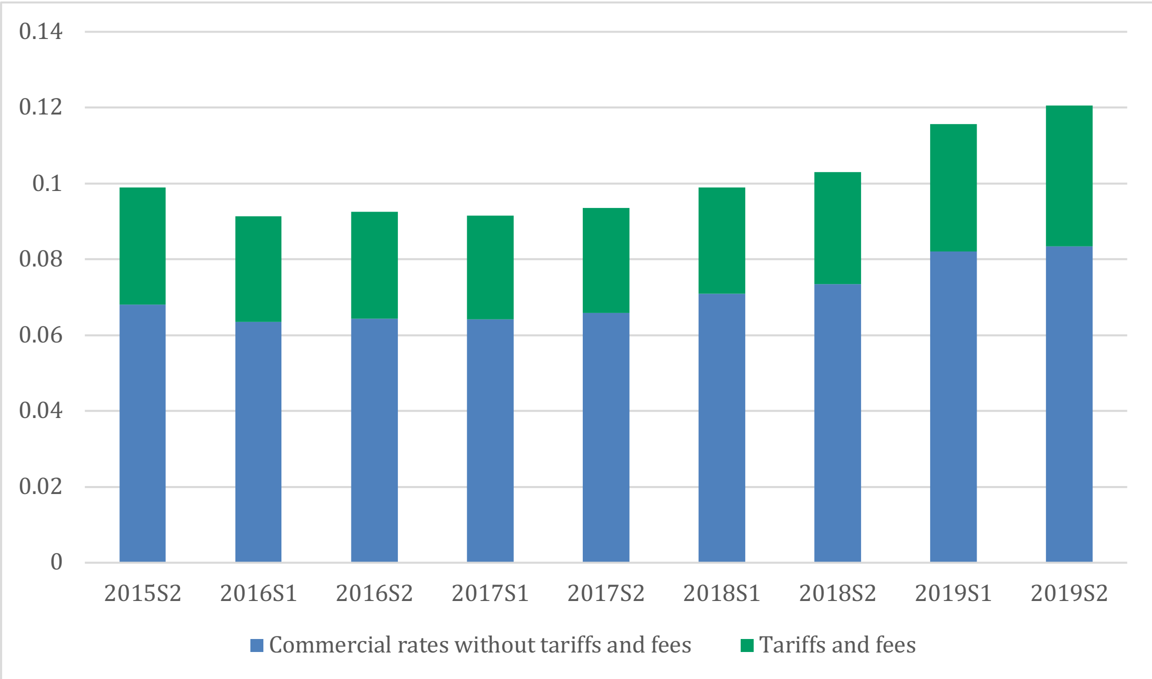

Figure 32: The evolution of non-household electricity prices in Romania

(Note S1 and S2 refer to the first and second halves of the year, respectively.)

Source: Eurostat (2021)[148]

Barriers to Commercial Prosumers in Romania

In addition, like in many other markets throughout Europe, there is a wide range of administrative requirements that deter companies from investing in their own generation, despite the fact that it is increasingly economic to do so. Such barriers make it difficult for the sector to achieve sustained growth.

Main Barriers to Self-Consumption in Romania

[148] (European Commission, 2021. *Electricity prices for non-household consumers - bi-annual data.* https://appsso.eurostat.ec.europa.eu/nui/show.do?dataset=nrg_pc_205&lang=en)

Size thresholds	Currently, Romania's policy framework for prosumers only applies to projects with a total installed capacity of up to 100kW. As a result, large facilities such as shopping malls and department stores are effectively excluded, cutting out a potentially important market segment.
Administrative issues	There is currently a lack of official documentation explaining the steps necessary to become a commercial prosumer. Currently, large utilities active on the electricity retail markets have been the responsible for initiating PV installation projects for companies, as the authorities have not drafted any official guidelines for SMEs.
Authorizations	The process for obtaining an authorization to install a solar PV project is complex, and can take over a year to complete. Such delays are costly both for prosumers as well as for developers.
Technical specifications	The high technical specifications required by the Environmental Fund Authority (AFM) have led to comparatively high installation costs, as well as less competition on the market for installers. Installed costs in Romania are currently 20-30% higher than in neighboring markets, despite having comparable labor costs. In addition, neither utility companies nor the government have dedicated sufficient resources to solving technical problems, leading to delays. In turn, such delays reduce the demand for new installations, as the small numbers of commercial prosumers are not satisfied with the way in which the authorities solve physical problems.
Lack of awareness, including among financial institutions	Interviews with stakeholders indicate a widespread lack of sector knowledge and interest from the traditional banking sector to provide loans to the sector. As a result of these factors, most banks in the country have done little to increase lending to the sector.

Ultimately, the scale-up of commercial prosumers in Romania will require more awareness of the economics of the sector. Fortunately, economic news spreads quickly, and companies that invest in their own onsite generation are already starting to reap the benefits through lower electricity costs. Addressing the short-term barriers that hinder the development of the market can help drive more systemic change in the future as growth and investment gain momentum.

Policy Recommendations for Commercial Prosumers in Romania

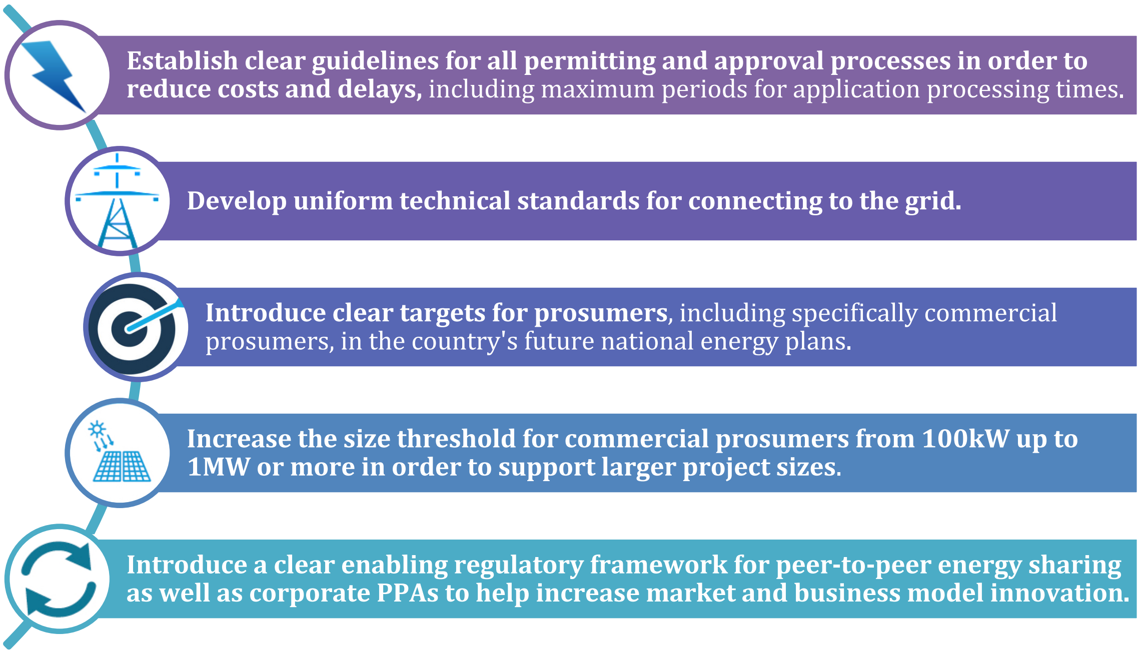

Figure 33: Key Recommendations for Romania

Summary of Input Values for LCOE Analysis

The following input values by country are based on ranges provided during in-country interviews with local stakeholders, including developers, investors, and industry association representatives. Interviews were conducted between October and March 2021.

Bulgaria

	Low LCOE Case	High LCOE Case
Installed Cost (EUR/kW)	500	800
Inverter Cost (EUR/kW)	50/kW	60/kW
Inverter Lifetime (years)	15 years	10 years
Operations and Maintenance Costs (EUR/kW/year)	10	14
PV system lifetime (in years)	25	20
WACC (%)	5.0%	9.0%
Degradation (%/year)	0.4%	0.6%
Full load hours (in hours per year)	1300	1100

Croatia

	Low LCOE Case	High LCOE Case
Installed Cost (EUR/kW)	700	1000
Inverter Cost (EUR/kW)	50/kW	100/kW
Inverter Lifetime (years)	15 years	10 years
Operations and Maintenance Costs (EUR/kW/year)	10	15
PV system lifetime (in years)	25	20

WACC (%)	3.20%	9.0%
Degradation (%/year)	0.4%	0.9%
Full load hours (in hours per year)	1550	1100

Greece

	Low LCOE Case	High LCOE Case
Installed Cost (EUR/kW)	600	750
Inverter Cost (EUR/kW)	40/kW	50/kW
Inverter Lifetime (years)	20 years	10 years
Operations and Maintenance Costs (EUR/kW/year)	10	12
PV system lifetime (in years)	25	20
WACC (%)	4%	7.4%
Degradation (%/year)	0.25%	0.5%
Full load hours (in hours per year)	1850 (ground mount, single axis tracker, bifacial)	1350

Romania

	Low LCOE Case	High LCOE Case
Installed Cost (EUR/kW)	700	1000
Inverter Cost (EUR/kW)	50/kW	60/kW
Inverter Lifetime (years)	15 years	10 years

Operations and Maintenance Costs (EUR/kW/year)	11	14
PV system lifetime (in years)	25	20
WACC (%)	7.5%	10.0%
Degradation (%/year)	0.4%	0.6%
Full load hours (in hours per year)	1250 (ground mount)	1100

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