Technology Watch Newsletter

Consumers at the heart of the energy transition

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Technology Watch is the Elettricità Futura initiative to monitor global technology trends having the power sector at their heart. In our quarterly newsletter you will find an article with our analysis on a specific technology trend, an article by CESI, our partner for the initiative, and technology news from all over the world selected by Elettricità Futura.
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Consumers as an effective resource for the energy transition

Author: Elettricità Futura

With the "Fit for 55" package, the European Commission set the path that the EU Member States will have to follow in order to reach the -55% greenhouse gas emissions reduction goal by 2030 (compared to 1990 levels). A first milestone towards the more ambitious goal of carbon neutrality in 2050. To achieve this objective all players will have to play a crucial part, among them the energy consumers.

The Italian power system is currently undergoing a radical transformation driven by the ever-growing number of non-programmable renewable energy plants to achieve the more ambitious electrification targets for 2030. Those plants include not only utility scale RES connected to the high-voltage transmission network, but also small utility or even private-owned systems that are widely distributed on the national territory and are connected to the medium/low-voltage distribution networks. This transformation has brought up a new set of challenges for regulators and power system operators that must correctly balance the energy supply and demand and manage the electricity grid avoiding constraints or disruptions in the service. In this scenario, consumers and *prosumers* must not to be seen anymore only as buyers of energy, but as an effective "resource". If properly involved in the energy transition process, consumers may not only benefit economically from it, but also become a central important player, by offering several

flexibility services to help system operators guaranteeing security of supply and system adequacy and to reduce the overall costs for the electricity system.

All this is made possible by the advancement in digital technologies and systems to monitor in real-time and archive the production and consumption data and efficiently manage the transmission and distribution grids, energy communities or virtual units such as the UVAMs, and by the diffusion of easy-to-use smart-home devices that can make new energy services very accessible to all consumers.

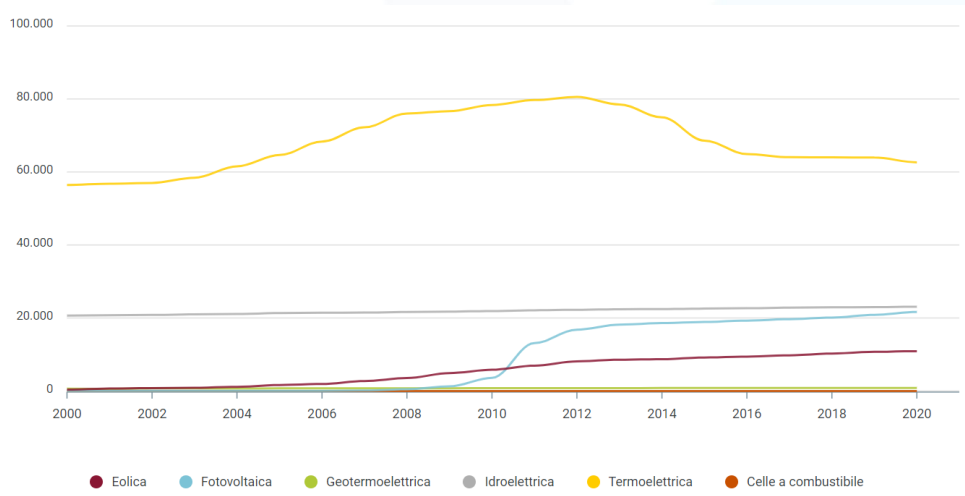

Fig. 1 – Evolution of electricity generation capacity (MW) in Italy as of December 2020

One main example of how consumers can contribute to the energy transition by improving the flexibility and security of the power system is Demand-side response, which allows to modulate the power consumption of an electric customer to better match the demand for power with the actual supply. Demand-side response services are manifold and can allow to:

1. *Shape*, to reshape the load profile through relatively long-run price response or on behavioral campaigns," such as time-of-use and critical peak pricing rates.
2. *Shift* (i.e. *load shifting*), to "move" energy consumption from times of high demand to times of day when there is surplus of renewable generation and lower energy prices
3. *Shed* (i.e. *peak shaving/shedding*), to loads that can occasionally be curtailed to provide peak capacity and support the system in emergency or contingency events

4. *Shimmy*, to use of loads to dynamically adjust demand on the system to alleviate short-run ramps and disturbances at timescales ranging from seconds up to an hour.

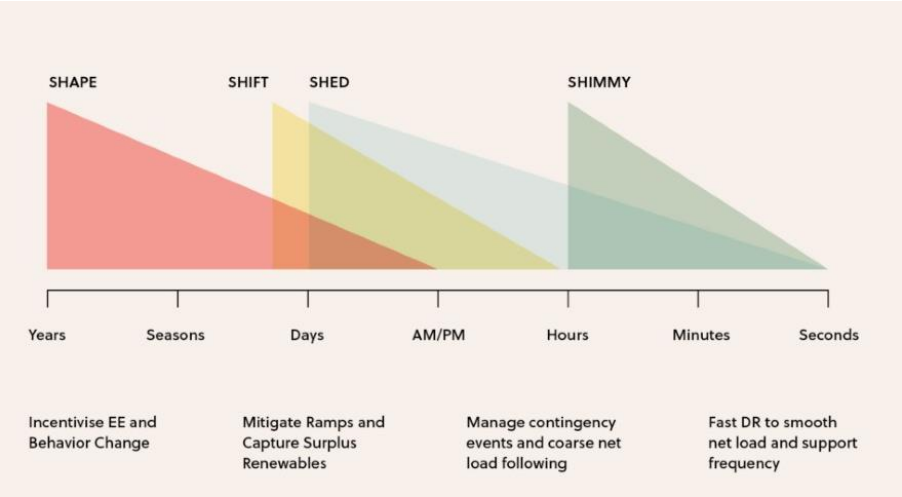

Fig. 2 – Typologies of demand-side response services (Source: Lawrence Berkeley National Laboratory)

As of now, Terna – the Italian TSO – already deploys demand-side response measures that industrial and commercial consumers (SMEs) can access: the "interruption service" (Servizio di interrompibilità") and the UVAM pilot project. The interruption service entails that Terna, if necessity arises, may curtail the electricity supply to those users connected to high and medium-voltage grids that take part into the service to guarantee the system security. The users that will suffer a reduction in supply, are economically compensated with a fixed annual (for the participation to the service) and a monthly variable quota (€/MW, depending on the amount of curtailed power). On the other hand, the UVAM – Virtual Mixed Enabled Units – pilot project allows commercial or industrial consumers to be aggregated in virtual consumption units that can participate to the ancillary services market (MSD) and provide ancillary services. As for the "interruption service", each unit is remunerated for both its availability to provide the ancillary service (capacity cost, €/MW) and the energy activated (€/MWh). Moreover, ARERA – the Italian NRA – recently greenlighted the deployment of DSO-led pilot projects to offer local ancillary services aimed at ensuring the correct and efficient functioning of the distribution grids.

If industrial and commercial consumers constitute a pool of thousands or tens of thousands of potential active players in the energy transition, residential consumers are in the hundreds of

thousands, many of which already own private RES systems and therefore are classified as *prosumers*. That's why ARERA, the Italian NRA, set the improvement of the residential consumers' empowerment and knowledge of their energy consumption habits and of the advantages of the free market as one of the main strategic objectives for the following four years [1].

To take advantage of this huge potential, policy makers and regulators are focusing on two main targets: strengthening customer empowerment to improve their capacity to manage their electricity bill and to respond price signals on the market, and promoting forms of renewable energy cooperation among citizens and small commercial users. To strengthen the customer empowerment, is necessary to improve the quality and quantity of the data provided by energy suppliers to customers – avoiding overburdening the customer with unnecessary information (more information doesn't' equal to better undestanting) – so that they are more aware of their energy consumption and can act or react accordingly, by either changing their energy consumption habits or switching to a new supplier or offer which is more sustainable and that better suits their needs. Regarding the cooperation amongst consumers, Renewable Energy Communities and groups energy self-consumers come into play and can provide significative economic, social, and environmental benefits to the consumers that decide to join them. In 2020 and 2021 the Italian NRA and Government made new crucial steps, by defining the economic regulation of the electricity shared energy communities or self-consumer groups and how the two must operate.

Electricity consumers, both commercial/industrial and residential, are willing to get involved and become active participants of the energy transition process. Their role and contribution are crucial and must not be underestimated. Policy makers and regulatory authorities, by taking advantage of the current and future technology, must deploy effective, clear and easy to understand policies and to ensure that consumers are adequately prepared and informed to take part in the energy transition and operate in the electricity market. This will be beneficial for all the parties involved: policy makers, regulators and system operators will benefit from a strengthened, more electrified, flexible and modernized power system and market, while consumers will be able to profit from renewable energy, reducing their carbon footprint and better managing their energy bills.

Technologies to make the consumer protagonist of the energy transition

Author: CESI

The energy transition is continuously changing the management of transmission and distribution networks. In this scenario, the fundamental balance between supply and demand must be maintained in order to guarantee the security of the power system. So far, the balance was guaranteed by the particularity of conventional thermoelectrical and hydroelectrical generations which allows a controlled and manageable modulation within the requested time (it is called an ancillary service). In case of emergency, it is also possible to rely (even when switching off or on upon request or opting for a reduction) on the demand-side, using both contractual and emergency load-shedding. Maintenance of voltage profiles, power flows, and quality of service must be added to the balance. These services are strongly influenced by the presence or absence of conventional generations.

Therefore, the Net Zero Emissions Scenario is reducing one of the elements that allows to monitor transmission and distribution networks, whilst also introducing new elements to be managed and included in this fundamental balance. Renewable distributed generation, which is discontinuous and non-programmable by its intrinsic nature, does not have the same controllable characteristics of the network. Thus, on the supply side, we are also moving towards the use of storage or the more structured virtual power plant (VPP). However, this may not be enough. Hence, we must also push on the demand-side which must become more and more flexible in guaranteeing the safety and resilience of the electrical system.

On the most advanced markets, industrial and commercial end users have been involved for years on demand response platforms, contributing through contracts, and incentivized to participate in the resilience of the electricity grid. In the incentive-based market, the result of demand-response actions is sold upfront on electricity markets, sometimes directly for large industrial consumers or through demand response service providers. Consumers receive a

specific reward to change their consumption upon request, triggered by high electricity prices, flexibility needs of balance-responsible parties, or a constraint on the network.

With the energy transition, these logics are now migrating even closer to residential consumers, making them more and more involved in the change.

Until now, the consumer mostly relied on price-based logics, which refers to consumers choosing to be exposed to time-varying electricity prices that reflect the value and cost of electricity in different time periods. Thanks to this information, consumers can decide or automate the decision, to shift their electricity consumption away from times of high prices, thereby reducing their energy bill. Time-varying prices are offered by electricity suppliers and can range from simple day and night prices to highly dynamic prices based on hourly wholesale prices. Examples of this include time-of-use pricing, critical peak pricing, and real-time pricing. In addition, some countries have adopted, or are investigating time-of-use distribution network tariffs, which aim at shifting consumption to avoid grid constraints.

The integration of price-based with incentive-based logics can be a first factor for a higher involvement of citizens. Of course, there must also be an increase in enabling technologies. These entail the importance of participation (in aggregated forms as well) in demand-response platforms, home automation, the Internet of Things, and the digitization of networks.

Indeed, the digitization of networks is at the root of this change. The need to manage an ever-increasing amount of data is connected to the ability to collect, transmit, archive, and manage such data from all the players connected to the network. The point of contact between the network and the consumer will be an increasingly smart meter capable of conveying data and allowing the end user to manage their homes through home automation, to which they connect their energy-consuming devices. Overlapping these basic structures contribute to the world of the Internet of Thing (IoT), where utilities and solution providers have opportunities to further integrate and automate energy management at the home level, starting to leverage new smart home assistants and device integration to increase customer engagement with their energy use.

In between, there are the demand-response platforms, which can aggregate consumers by optimizing the proposed programs. On the most advanced markets, such as the United States for the residential customer, a series of programs can already be mentioned. According to SEPA (Smart Electric Power Alliance), several key programs are:

- AC switches, a program that allows a grid operator to shed, for instance, air conditioning load by using a control switch to remotely interrupt or cycle AC compressors;
- Thermostat, a program that uses smart thermostats to cycle home heating or air conditioners on and off or to adjust the temperature setting during the day;
- Water heater, a program that limits customers' electric water heaters to run only at specific periods during the day. Water heater programs may also incorporate other DR strategies, such as storing hot water to shift load from peak to off-peak periods;
- Behavioral, which are programs that incentivize customers to reduce use during peak periods with and without a supporting technology such as those listed above;
- Electric vehicle smart charging programs, which are designed to optimize the battery charging complying to the needs of the user and the network constrains;
- Behind-the-meter generation combined with electric storage, a program created to optimize the home production, for instance, from solar panels with storage and network requests;
- Other programs that are not covered by the above category definitions. Examples include ice storage, and pool pumps.
- In the future, those programs, which are currently limited to commercial and industrial customers, can be added to the following ones, fully utilizing the potential for aggregation made available, for example, by energy communities. These are just a few examples:
- Automated, which is a program under which a utility can remotely and automatically reduce a customer's load or increase the output of behind-the-meter generation or storage, during a DR event;
- Customer initiated with notification, a program that allows a utility to send a signal or other notification informing its customers of a DR event and asking them to reduce their load or increase the output of behind-the-meter generation or storage by a specified amount over a period of time;
- Other DR programs for large consumers that is not covered by the above categories (e.g., irrigation control).

The landing point of these technologies could be, for example, the vehicle to-x (V2X) and the vehicle to grid (V2G). The bidirectionality of the energy will be managed according to the convenience of the citizen and the demands of the power network, but it will also be conditioned by further information, such as checking the traffic and the route to be taken, or weather conditions, in order to always have the vehicle available with the greatest efficiency.

In order to achieve this, the appropriate model for the coordination of market processes should be chosen and there is need for standardization or, at least, interoperability of hardware and for harmonization of market rules and energy products. At the same time, rolling blackouts caused for example by wildfires (in California in summer 2020) and extremely cold weather (in Texas in winter 2021) prompted authorities to reassess the adequacy of current market designs and regulatory approaches, including for demand-response to contribute to the reliability and resilience of the power system in case of increasingly likely extreme weather events.

We must not forget the implications linked to having citizens sharing a high quantity of data related to their consumption, which entail a series of rules on privacy as well as the need to implement cybersecurity measures as soon as possible. Each of our homes will be increasingly interconnected and flexible, but we must remember that it is part of a critical infrastructure, where strong coordination between all stakeholders is necessary and evermore required.

Technology News Worldwide

HIGHLIGHT:

Terna assigns 425 MW through the 2022 UVAMs auction

Terna, the Italian TSO, recently assigned 425MW of capacity from aggregates of production and consumption units through the UVAM (Virtual Enabled Mixed Units) pilot project to offer ancillary services in the balancing market.

LINK

- **#Smart meters:** The global market for Smart Meters estimated at US$19.9 Billion in the year 2020, is projected to reach a revised size of US$29.8 Billion by 2026, growing at a CAGR of 7.2% over the analysis period.
  Link

- **# Smart cities:** To reduce energy consumption from cellular networks, on which smart cities are founded on, researchers study ways to use machine learning techniques to switch off cellular Base Stations based on their contribution to traffic prediction accuracy.
  Link

- **# EVs:** The Michigan Department of Transportation will build the first-ever 'electric road' in the USA that wirelessly charges EVs as they drive.
  Link

- **#Storage:** Renewable energy has an intermittency problem and battery storage is considered key to solving the intermittency problem by storing energy when the wind and sun are strong. But current storage solutions, including lithium-ion batteries and pumped hydro, are expensive and challenging to scale. Therefore, researchers study how to store surplus energy as "computations".
  Link

- **#Wind:** To meet the IEA decarbonization targets, the pipeline for the construction of new wind farms must be rapidly increased. As part of answering the call to meet demand, the industry is on a continual march to get projects built quickly, while ensuring the levelized cost of energy continues to fall.
  Link

Note: weblinks last accessed in February 2022

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