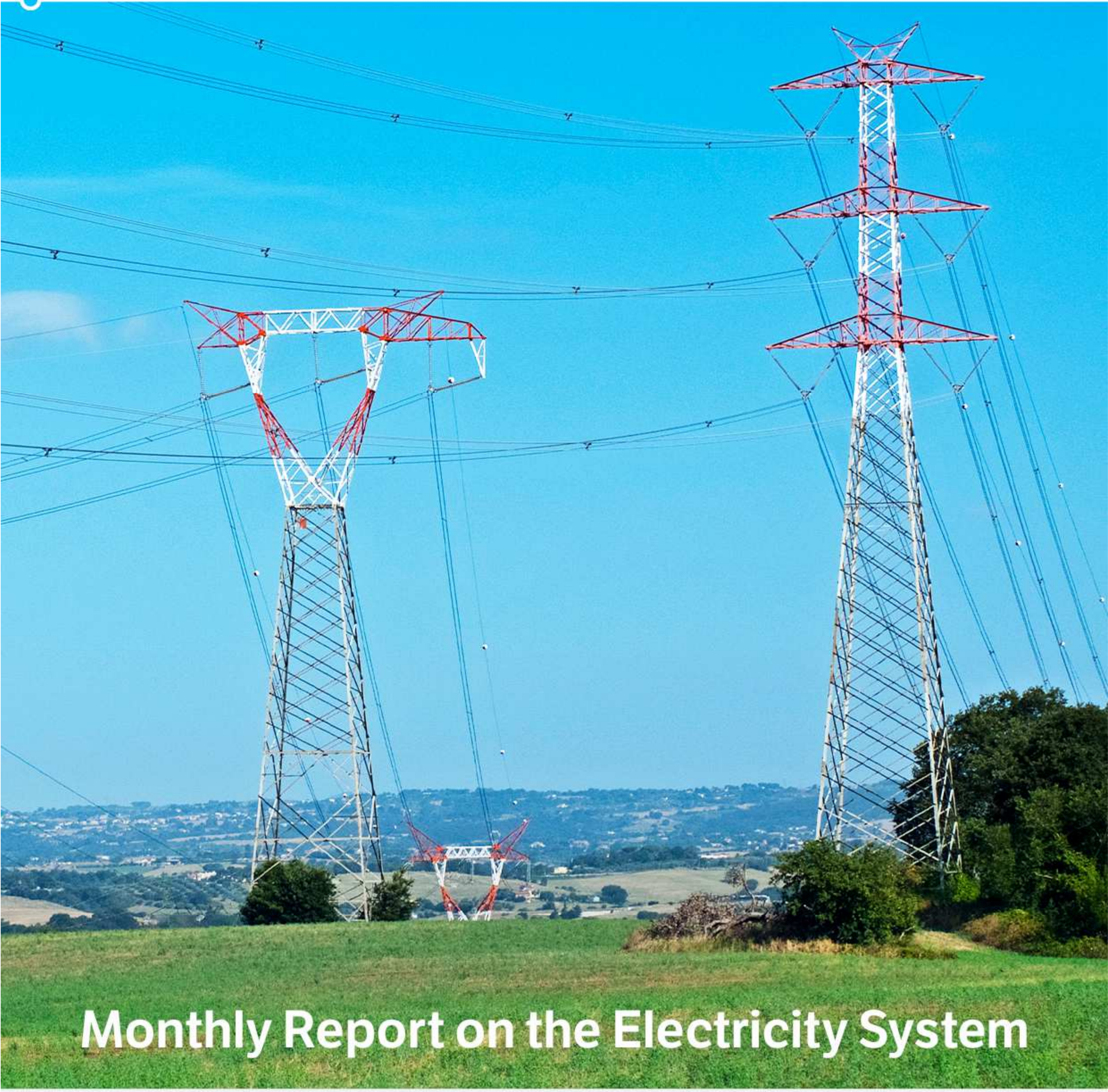
January 2018



Monthly Report on the Electricity System

Terna

TERNA GROUP

January 2018

Monthly Report on the Electricity System

01 Focus of the Month
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This Focus of the Month is a brief exploration of the future prospects of electrical vehicles (EVs) in Europe as recently conducted by some utilities, trade associations and European TSOs. Expectations about the prevalence of EVs are becoming increasingly important in the debate on energy scenarios due to the possibility that these will be a growth factor for electricity demand, as well as for investments in the transmission and distribution networks.

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In January 2018, electricity demand in Italy (27.5 Bn kWh) recorded a decrease of 2.8% compared to the volumes of January 2017.
As regards the short-term data, seasonally-adjusted demand in January 2018 recorded a decrease of -2.0% compared to December. The trend continues to be stable. In January 2018, 83.4% of electricity demand in Italy was covered by national production (-15.1% of net production compared to January 2017) and for the remainder by imports (net foreign exchange +259.5% compared to January 2017).

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In January 2018, net national production was 23,147GWh, 34% from renewable sources (7,787GWh) and the remaining 66% from thermal sources.
Focusing on monthly production from renewable energy sources (RES), an increase was recorded in wind production (+9.7%), while there was a drop in hydroelectric (-2.0%) and photovoltaic production (-5.1%) compared to the previous year.

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The January total for withdrawal programmes on the DAM was approximately €1.3 Bn, down 23% compared to the previous month and down 34% compared to January 2017.
In January, the spread between bid-up and bid-down prices on the DSM was €87.3/MWh, down by 13% compared to the previous month and down by 35% compared to January 2017. Total volumes decreased compared to the previous month (-9%).
In January, the spread between bid-up and bid-down prices was €110.1/MWh, down compared to the previous month (€116.6/MWh; -6%) and up compared to January 2017 (€102.4/MWh; 8%). Total volumes decreased compared to the previous month (-8%).

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This month, we present a selection of AEEGSI resolutions relevant for dispatching and transmission activities.

Future prospects for electric vehicles in Italy and Europe

EXECUTIVE SUMMARY

The present edition of Terna's Focus of the Month consists of a brief assessment of future prospects for Electric Vehicles (EV) in Europe that have been published in recent months by utilities, sector associations and European TSOs. In the debate on future energy scenarios, the expected diffusion of EVs is playing an ever-increasing role, given the fact that EVs could be driving the growth for electricity demand but also trigger investments in transmission and distribution grids and potentially affect balancing activities in the electricity grid.

Terna has recently published a document outlining future energy scenarios for Italy ("Documento di Descrizione degli Scenari", DDS [1]), which forms an integral part of the Network Development Plan 2018 ("Piano di Sviluppo"), elaborating two scenarios: a base case ("Terna-Base") and a high case ("Terna-Sviluppo"). Compared to the latter scenario, the base case is characterized by a lower level of economic and demographic growth as well as a slower deployment of renewables. Under these premises, Terna has assumed that there will be 1.6m EVs in 2030. In the high case scenario, with its more favorable economic and demographic conditions and a faster deployment of renewables, we assume around 4.5m EVs by 2030.

In this article, we compare EV scenarios for both Italy and other European countries with Terna's EV scenarios, concluding that the two Terna scenarios are not particularly aggressive and in line with other projections.

The EV industry itself is still in its early stages: Today, the market share of electric vehicles (EV) is less than 0.1% in most EU markets including Italy, Germany, France and Belgium, markets on which we focus on in this article. The scenarios analyzed for these four countries appear to be challenging at any rate considering that the market share of EVs is expected to rise considerably, from 0.1% today to 27% in 2030 in the most aggressive scenario. Such penetration levels imply that the share of EVs in new car registrations will have to grow exponentially. This development could be supported by new regulation at EU level such as the Clean Mobility Package, which foresees to reduce car emissions by 30% until 2030, compared to 2021.

Yet, even assuming such a strong increase in the number of electric vehicles, the impact on electricity demand is, while positive, relatively limited. In the most aggressive scenario, it could reach up to 5% of total electricity demand, assuming an annual mileage of 10,000 km per vehicle.

When it comes to the impact of electric vehicles on peak load, it is crucial to look not only at the number of EVs but as well to analyze how and when EV owners intend to recharge. Developing algorithms for smart charging could, for example, help to contain the impact on peak load. Moreover, the fact that EVs can be used to store electricity should be taken into account, which would allow for load shifting from peak to off-peak periods.

High growth expectations for EVs

Italy, Germany, France and Belgium are countries with a significant passenger car market in terms of vehicles per capita. In 2017, a number of EV scenarios have been presented for these countries, indicating that EVs could capture up to 27% of the passenger car market by 2030. The comparison of these scenarios is shown in Figure 1.

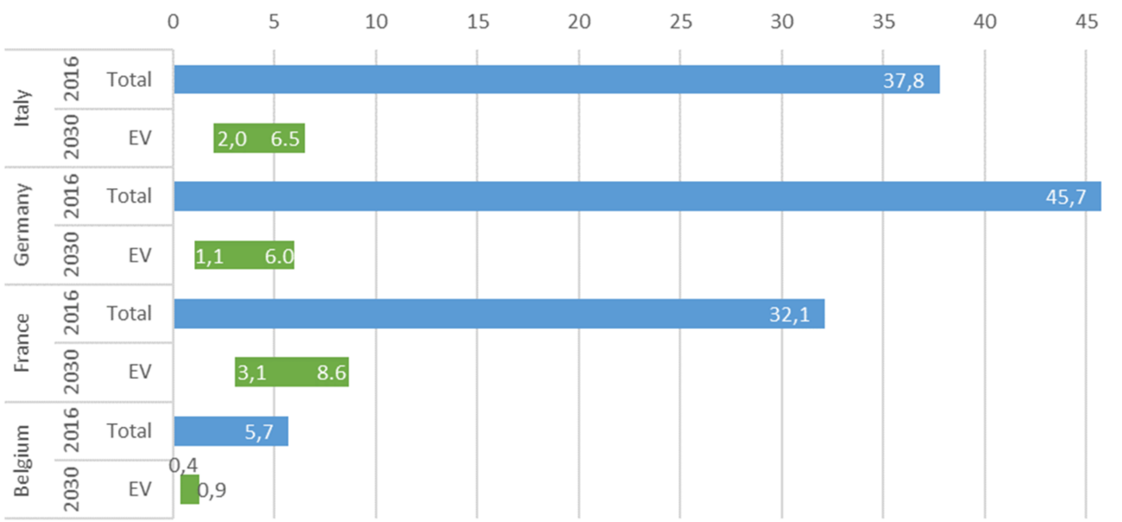
(1) See http://www.terna.it/it-it/sistemaelettrico/statisticheeprevisioni.aspx

The European association of transmission system operators ENTSO-E has developed two main scenarios for 2030 in its latest ten-year network development plant (TYNDP): Sustainable Transition (ST) and Distributed Generation (DG). The former (ST) describes a growth of renewables in line with policy objectives and a moderate growth of innovative technologies such as electric vehicles, while the latter (DG) is more ambitious in terms of renewables and electrification of the transport and heating sectors. In these scenarios, the number of EVs in Italy ranges between 4.3m and 6.2m in 2030 (ENTSO-E, 2017).

At national level, another EV scenario to consider is a recent study by Enel and Ambrosetti, which quantifies the economic impact of EV growth in Italy, developing four distinct scenarios (Enel, 2017). These are based on several assumptions including the prospective cost parity between electric and internal combustion engines. According to the study, the penetration of EVs in the Italian passenger car market could vary between 2.0 and 9.0m electric cars in 2030.

The average between the ENTSO-E scenarios and the upper Enel scenario amounts to roughly 6.5m vehicles. This would represent up to 17% of the current fleet of 38m cars (ACEA , 2017 [2]). These targets are certainly challenging, not necessarily in absolute terms but in relative terms, considering the meager starting point. For example, in 2016, plug-in electric vehicles (PHEV) or battery electric vehicles (BEV) had a market share of merely 0.03% in Italy (ACEA, 2017b).

Fig.1: Comparison of EV scenarios for Italy, Germany, France and Belgium (2030)



Source: Terna's elaboration based on ENTSO-E (2017), Enel (2017), BNetzA (2017), RTE (2017), Elia (2017)

For **Germany**, the four transmission system operators have developed three scenarios for the future development of the electricity system, which the German regulator Bundesnetzagentur approved last year (BNetzA, 2017). According to these scenarios, the number of electric vehicles could range between 1.1 and 6.0m in 2030, representing up to 13% of the current fleet, which amounted to 45 million in 2015. BEVs and PHEVs had a mere 0.02% market share in that year (ACEA, 2017b).

For **France**, the transmission system operator RTE has developed four possible scenarios for the changing trends in electricity production and consumption until 2035. The study includes projections for the EV market, indicating between 3.1 and 8.6m electric passenger cars by 2030 (RTE, 2017 [3]). This latter value represents 27% of the current passenger car fleet, which consisted of 32 million cars in 2015. PHEVs and BEVs represent merely 0.02% of that fleet (ACEA, 2017b).

(2) ACEA is the association of the European automobile industry ("association des constructeurs européens d'automobiles").

(3) RTE only indicates a 2035 value. The 2030 value is interpolated assuming an exponential growth between 2016 and 2035.

Lastly, for **Belgium**, three scenarios have been prepared by its transmission system operator Elia to assess potential future developments in the electricity sector. According to the study, the number of EVs in Belgium would grow gradually, reaching between 400,000 and 900,000 in 2030 (Elia, 2017). This would represent a share of 16% in Belgium's current passenger car fleet of 5.6 million. In 2015, PHEVs and BEVs had a market share of 0.07% (ACEA, 2017b).

It is evident that from these projections one can expect a strong EV growth throughout Europe, albeit with the level of ambition varying from country to country. The feasibility of these growth scenarios depends, among other things, on the number of new passenger car registrations and replacement rates of existing cars.

New passenger car registrations: boosting growth

The evolution of the regulatory framework will definitely influence the growth pathway, as it will set standards for new vehicles. However, also the substitution rate of the existing fleet will also have a determining role. Cars tend to have a relatively long technical lifetime: The average age of the Italian fleet currently is 10.7 years, which is above Germany, France and Belgium where the average age amounts to approximately nine years (ACEA, 2017c). Hence, the replacement process is not instantaneous and will vary from country to country.

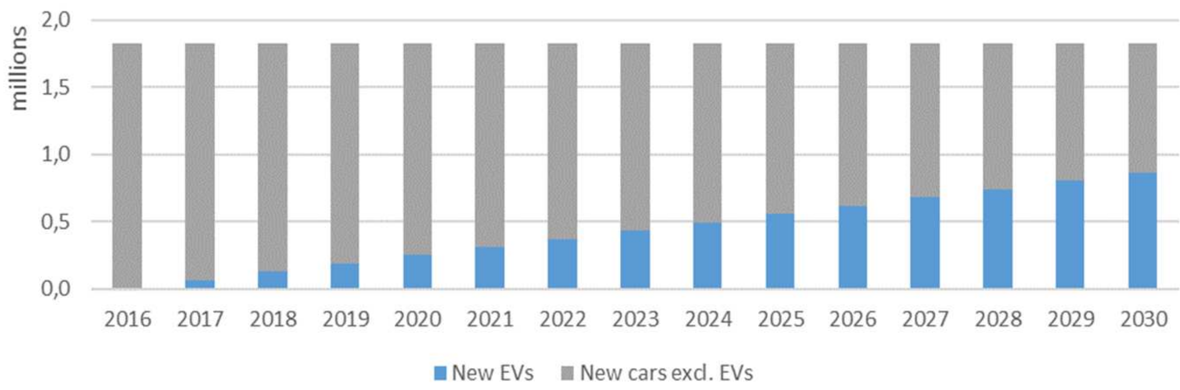
In 2016, the replacement rates ranged between 5% in Italy and 10% in Belgium. This means that a large portion of the cars that have been sold during the last years will still be in use by 2025. Another important factor is consumer preference: An ever-increasing share of new registrations will have to be electric in order to realize the indicated scenarios.

Based on these considerations, we can note that even the more aggressive EV scenarios for these four countries are generally feasible, i.e. they do not require a higher rate of replacing old cars with new cars than observed during the last 10 years. In other words, realizing these scenarios does not require a strong growth in new passenger car registrations, which could appear unrealistic.

Instead, what will have to change compared to recent years is consumer preference: assuming a constant number of new passenger car registrations, an ever-increasing share of new passenger car registrations will have to be electric, to the detriment of conventional vehicles powered by internal combustion engines.

For example, in Italy, the share of new EV registrations in total passenger car registrations will have to grow from 0.1% in 2016 to 48% in 2030 to reach the target of 6.5m electric vehicles. This implies that one out of two cars sold in 2030 would have to be electric. Already in 2019, next year, one out of ten consumers would need to choose an electric car over a diesel, gasoline or natural gas vehicle (see Figure 2). This share is significantly higher than the target share in Germany and Belgium, where even in the optimistic scenarios, only 5% of the consumers would need to choose EVs when buying a new car in 2019 (see Figure 3), while approximately 12% of the French sales would have to be electric in 2019 (see Figure 3).

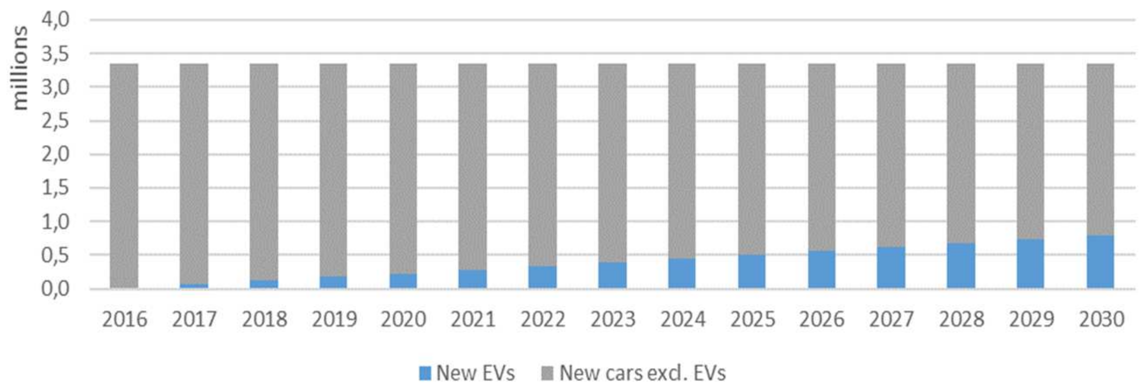
Fig.2 Annual car registrations: potential pathway towards 6.5M EVs by 2030 in Italy



Source: Terna's elaboration based on ENTSO-E (2017), Enel (2017) e ACEA (2017)

The relatively slow replacement process of passenger cars in Italy implies that the current EV scenarios are more ambitious when compared to other countries. In fact, a faster uptake is needed to reach the number of electric vehicles indicated in the upper scenario. Nonetheless, this could partly be compensated by the fact that the Italian passenger car fleet is older compared to other countries.

Fig.3Annual car registrations: potential pathway towards 6M EVs by 2030 in Germany



Source: Terna's elaboration based on BNetzA (2017), ACEA (2017)

EVs representing up to 5% electricity demand

In order to estimate the impact of electric vehicles on electricity demand, a number of assumptions have to be made that can vary from country to country based on the behavior of consumers, the population density or the mean distance between home and workplace, just to name a few.

To simplify, we consider pure battery electric vehicles instead of a mix between hybrid and battery electric vehicles. This also implies that the vehicles would mostly be used for short distances, which could lead to a rather limited annual mileage of 10,000 km (BNetzA, 2017). Considering that approximately 25 kWh are consumed for each 100 km traveled, a fleet of 1 million electric vehicles would consume 2.5 TWh of electricity each year.

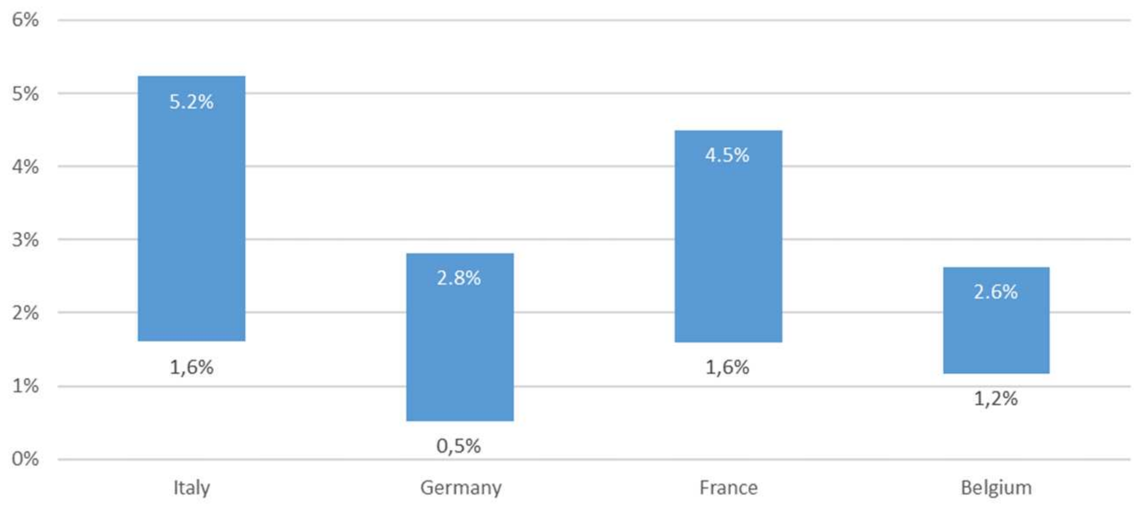
In order to compare the four countries, we calculate the share of EV electricity consumption in total electricity demand (see Figure 4). The highest impact would be observed for Italy, where the EVs could reach up to 5.2% of the 2016 electricity demand. In absolute terms, EV electricity consumption in Italy could range between 5 and 16 TWh in 2030, depending on the scenario.

Considering that it would take more than ten years to reach this share in demand, one can conclude that even a strong level of EV penetration has a modest and certainly manageable impact on electricity demand. Nevertheless, it is also evident that the electrification of the transport sector could very well become a key factor driving the growth of electricity demand after a long period of stagnation that has characterized EU countries.

For the other studied countries (and based on the analyzed scenarios) the relative impact would be even lower. In France, electric vehicles would represent up to 4.5% of electricity demand or up to 22 TWh in absolute terms. In Germany and Belgium, the relative impact could be below 3% of today's electricity demand.

It goes without saying that change is not instantaneous. The ramp-up nature of any technology diffusion process implies that its impact will be most visible in the final years of the forecast horizon, i.e. towards 2028-30 in this case. This certainly applies to the impact of EVs on electricity demand. Yet, there are other factors to consider, such as the impact of EVs on the peak load of the electricity system.

Fig.4: : Share of EV electricity demand (2030) in total demand (2016)



Source: Terna's elaboration based on Enel (2017), BNetzA (2017), RTE (2017), Elia (2017)

Impact of EVs on peak load: an open question

The diffusion of EVs could also alter peak demand and more generally change the electricity load profile, which is of particular interest from an electricity grid perspective. Consumer behavior (when does an EV owner recharge?) and charging infrastructure (how does an EV owner recharge?) are the main factors that determine the impact of EV charging on the total electricity demand profile.

Various types of charging are currently available with numerous charging modes able to accommodate vehicles of various battery capacities. Table 1 summarizes the main types of chargers along with their different power ratings and charging times.

Wall boxes are typically used for home charging and have a limited power rating (<10kW). An electric vehicle with a 200 km range could require 6-8 hours of charging at a 7.4 kW power rating (4).

Charging piles are installed in buildings for private usage or at public charging stations. They can vary from slow to ultra-fast-charging and can have multiple charging ports to support different charging modes. Currently, a number of ultra-fast-charging stations are being planned in Europe, such as:

- **E-VIA FLEX-E:** a collaboration between Enel, EDF, Enedis and Verbund, Nissan and Renault. The installation of the ultra-fast charging stations will start by the end of 2018 at 14 sites: 8 in Italy, 4 in Spain and 2 in France. The charging stations will all be high power, ranging from 150 kW to 350 kW (Enel, 2017b).
- **IONITY:** a pan-European initiative, aimed at building 400 ultra-fast charging stations with 350 kW charging piles in order to create a high-power charging network along major highways in Europe by 2020. It involves industry giants such as BMW, Daimler, Ford, Volkswagen, and Porsche. (IONITY, 2017).

It is evident that wall box charging has a rather limited power rating compared to other solutions. Despite its limited capacity, wall box charging could still have a significant impact on the electricty system's load profile, because most EV owners are expected to charge at home.

(4) N.B.: This value does not increase linearly with the number of EVs, because not all EV owners will choose to recharge their vehicle at exactly the same time.

For example, Enel estimates that 4.5m wall boxes will be deployed in Italy in their upper scenario, implying a ratio of 0.5 wall boxes per electric vehicle. For home charging, RTE estimates a load of up to 1.5 GW per 1 million electric vehicles (RTE, 2017). Multiplying this value with the number of EVs projected in the various scenarios for 2030, would increment system load substantially, especially when compared to the current system peak load.

So-called smart charging systems could dampen the impact on system load, because they could ensure that recharging takes place during the night, when electricity demand is generally low. Hence, charging would not contribute increasing peak load.

High-power charging stations will be less numerous than wall boxes but could also have a significant impact on peak load, especially when considering that one station will likely have multiple charging piles. A single high-power charging station could therefore require a 5-10 MVA transformer, making it a significant consumer node in any electricity network.

Table 1: Characteristics of different charging infrastructure types

Time to recharge for 200 km of range (50 kWh)	Power supply	Category	Illustration
12-18 hours	Single phase, 3.3 kW	**Wall box (AC)**	
6-8 hours	Single phase, 7.4 kW		
4-6 hours	Three phase, 11 kW	**Charging piles (AC)**	
2-4 hours	Single phase, 22 kW		
40-60 min	Three phase, 43 kW		
40-60 min	Direct current, 50 kW	**Charging piles (DC)** • CHAdeMO: 63 kW (Nissan, Mitsubishi, Kia) • Tesla Supercharger: 145 kW • E-VIA FLEX-E: 150-350 kW (Enel, EDF, Enedis, Verbund, Nissan, Renault) • IONITY: 350 kW (BMW, Daimler, Ford, Volkswagen, Porsche)	
20-30 min	Direct current, 120 kW		
<10 min	Direct current, 350 kW		

Source: Terna's elaboration

Conclusion

Expectations are high regarding the growth of EVs in Europe, in particular for the four analyzed countries. However, in order to see millions of EVs circulating on European streets by 2030, it will be necessary to activate numerous enabling factors and forces that ensure the economic and technical feasibility of EVs. Some operators, most notably electric utilities, have launched investment programs to introduce a widespread network of recharging stations, which appears to be a necessary enabling factor for the diffusion of EVs, together with applications that allow for smart charging of electric vehicles.

Electricity grid operators, from low-voltage to high-voltage, also play a fundamental role in this process and will continue to do so, by building and making available the necessary electricity infrastructure. Moreover, EV diffusion should have a positive impact on the growth of electricity demand while at the same time offering storage services to the grid, which should diminish the upward effect of EVs on system load, at least partially.

In fact, once smart recharging applications with a systemic view (i.e. not only at local level but system-wide) have been established, electric vehicles could also become a relevant source of flexibility, considering that one million cars correspond to roughly 40-60 GWh of storage volume. This certainly represents an amount of flexibility that an electricity system dominated by wind and solar could put to good use.

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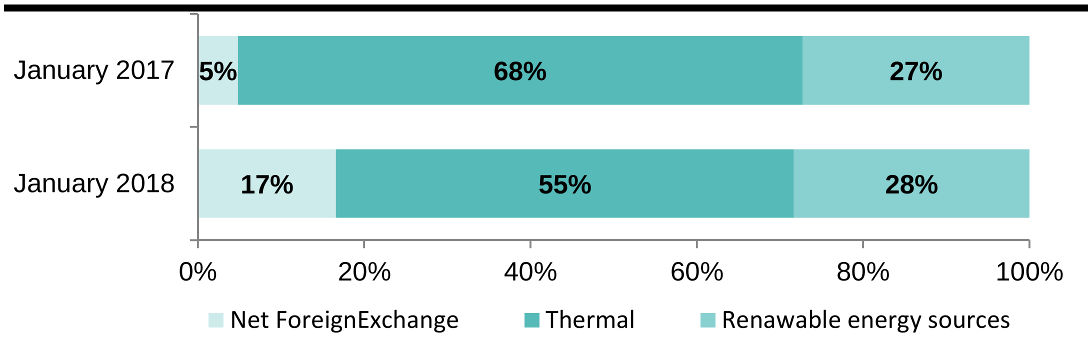
Monthly Summary

In January 2018, electricity demand was 27,490GWh, a decrease compared to the same month of the previous year (-2.8%). In particular, an increase in the net foreign exchange (+259.5%) was recorded, in line with production from renewables (+0.6%) and a decrease in thermoelectric production (-19.8%) compared to the same month of the previous year.

Demand breakdown – coverage by sources



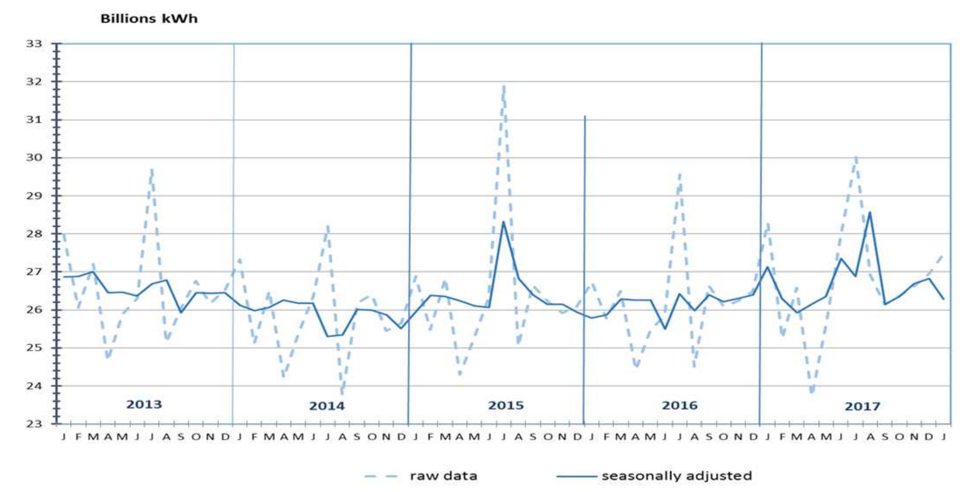
Source: Terna

In January, energy demand on the grid was down by -2.8% compared to the same month of 2017.

In January 2018, electricity demand in Italy (27.5 Bn kWh) recorded a decrease of 2.8% compared to the volumes of January 2017. This was due to the extra working day compared to the same month in 2017, yet with an average monthly temperature that was four degrees higher. At the regional level, the trend for January 2018, while being negative in all areas, was uneven: in the North (-0.8%), in Central Italy (-4.2%), and in the South (-6.0%).

As regards the short-term data, seasonally-adjusted demand in January 2018 recorded a decrease of -2.0% compared to December. The trend continues to be stable. In January 2018, 83.4% of electricity demand in Italy was covered by national production (-15.1% of net production compared to January 2017) and for the remainder by imports (net foreign exchange +259.5% compared to January 2017).

Seasonally-adjusted demand

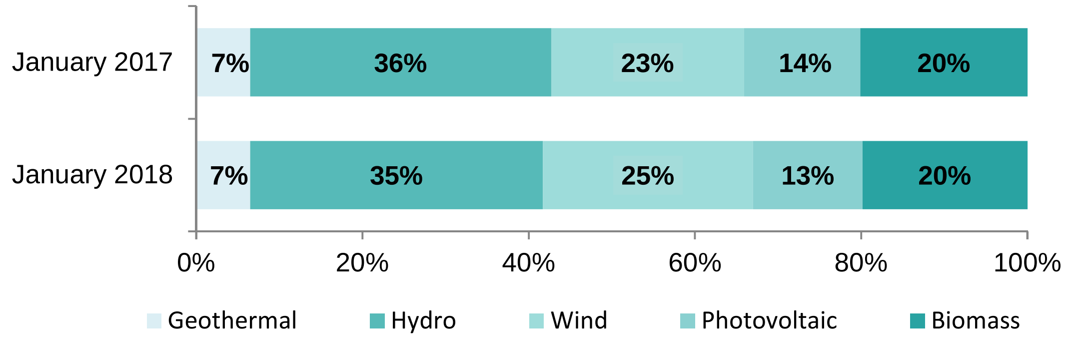


Source: Terna

The seasonally-adjusted value for electricity demand during January 2018 recorded a decrease of -2.0% compared to December.

Focusing on monthly production from renewable energy sources (RES), an increase was recorded in wind production (+9.7%), while there was a drop in hydroelectric (-2.0%) and photovoltaic production (-5.1%) compared to the previous year.

RES Production - Breakdown



Source: Terna

In January 2018, the detailed breakdown of production from renewable energy sources recorded a M-o-M percentage increase (+4.1%).

Energy Balance Sheet

In 2018, cumulative demand (27,490GWh) decreased (-2.8%) compared to the same period of 2017.

In January 2018, net national production was 23,147GWh, 34% from renewable sources (7,787GWh) and the remaining 66% from thermal sources.

Energy Balance Sheet

[GWh]	January 2018	January 2017	%18/17	Jan 18	Jan 17	%18/17
Hydro	2.747	2.804	-2,0%	2.747	2.804	-2,0%
Thermal	16.907	21.089	-19,8%	16.907	21.089	-19,8%
of which Biomass	1.547	1.557	-0,6%	1.547	1.557	-0,6%
Geothermal	495	504	-1,8%	495	504	-1,8%
Wind	1.972	1.797	9,7%	1.972	1.797	9,7%
Photovoltaic	1.026	1.081	-5,1%	1.026	1.081	-5,1%
Net Total Production	**23.147**	**27.275**	**-15,1%**	**23.147**	**27.275**	**-15,1%**
Import	4.891	2.073	135,9%	4.891	2.073	135,9%
Export	325	803	-59,5%	325	803	-59,5%
Net Foreign Exchange	**4.566**	**1.270**	**259,5%**	**4.566**	**1.270**	259,5%
Pumping	**223**	**265**	**-15,8%**	**223**	**265**	-15,8%
Electricity demand(1)	**27.490**	**28.280**	**-2,8%**	**27.490**	**28.280**	**-2,8%**

(1) Electricity Demand = Production + Net Foreign Exchange – Pumping Consumption.

Source: Terna

In 2017, a decrease in exports (-59.5%) was recorded compared to the previous year.
In January 2018, a reduction was recorded in production from thermal sources (-19.8%) and in hydroelectric production (-2.0%) and an increase in wind production (+9.7%) compared to the previous year.

In 2018, net total production (23.147GWh) met +84% of national electricity demand (27.490GWh).

Monthly Energy Balance Sheet

[GWh]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Hydro	2.747												2.747
Thermal	16.907												16.907
Geothermal	495												495
Wind	1.972												1.972
Photovoltaic	1.026												1.026
Net Total Production	**23.147**												**23.147**
Import	4.891												4.891
Export	325												325
Net Foreign Exchange	**4.566**												**4.566**
Pumping	223												223
Electricity demand(1)	**27.490**												**27.490**

In January, net total production decreased (-15.1%) compared to 2017. In 2018, the month with the maximum demand for electricity was January, with 27,490GWh.

Source: Terna

(1) Electricity Demand = Production + Net Foreign Exchange – Pumping Consumption.

The evolution of the monthly statement for 2017 is given below.

Monthly Energy Balance Sheet

[GWh]	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Hydro	2.804	2.249	2.648	2.759	3.896	4.718	4.434	3.860	3.485	2.226	2.101	2.350	37.530
Thermal	21.089	16.850	14.618	13.803	14.186	16.333	17.292	16.079	15.243	17.081	19.032	17.894	199.500
Geothermal	504	454	501	479	488	473	492	478	462	480	476	498	5.785
Wind	1.797	1.536	1.935	1.369	1.251	915	1.255	1.079	1.353	1.265	1.509	2.228	17.492
Photovoltaic	1.081	1.193	2.322	2.492	2.816	2.845	3.023	2.920	2.195	1.918	1.074	932	24.811
Net Total Production	**27.275**	**22.282**	**22.024**	**20.902**	**22.637**	**25.284**	**26.496**	**24.416**	**22.738**	**22.970**	**24.192**	**23.902**	**285.118**
Import	2.073	3.568	5.155	3.613	3.701	3.290	4.161	3.012	3.887	3.782	2.991	3.662	42.895
Export	803	383	404	537	498	461	508	372	347	203	308	310	5.134
Net Foreign Exchange	**1.270**	**3.185**	**4.751**	**3.076**	**3.203**	**2.829**	**3.653**	**2.640**	**3.540**	**3.579**	**2.683**	**3.352**	**37.761**
Pumping	265	211	190	248	204	172	130	144	140	172	250	315	2.441
Electricity demand(1)	**28.280**	**25.256**	**26.585**	**23.730**	**25.636**	**27.941**	**30.019**	**26.912**	**26.138**	**26.377**	**26.625**	**26.939**	**320.438**

In 2017, the month with the maximum demand for electricity was July with 30,019GWh.

Source: Terna

Demand by Geographical Areas

In January 2018, there was a decrease in demand in the Northern zone (TO-MI-VE), in the Centre (RM-FI), in the Southern zone (NA) and on the Islands (CA-PA) compared to the same period of the previous year.

Demand by Geographical Areas

[GWh]	Turin	Milan	Venice	Florence	Rome	Naples	Palermo	Cagliari
January 2018	2.846	6.059	4.138	4.309	3.710	4.027	1.627	774
January 2017	2.949	6.022	4.206	4.318	3.952	4.288	1.748	797
% January 2018/2017	-3,5%	0,6%	-1,6%	-0,2%	-6,1%	-6,1%	-6,9%	-2,9%
Cumulated 2018	2.846	6.059	4.138	4.309	3.710	4.027	1.627	774
Cumulated 2017	2.949	6.022	4.206	4.318	3.952	4.288	1.748	797
% Cumulated 18/17	-3,5%	0,6%	-1,6%	-0,2%	-6,1%	-6,1%	-6,9%	-2,9%

In 2018, the Y-o-Y percentage change in demand was -1.0% in the Northern zone, -3% in the Centre, -6.1% in the South and -5.7% in the Islands.

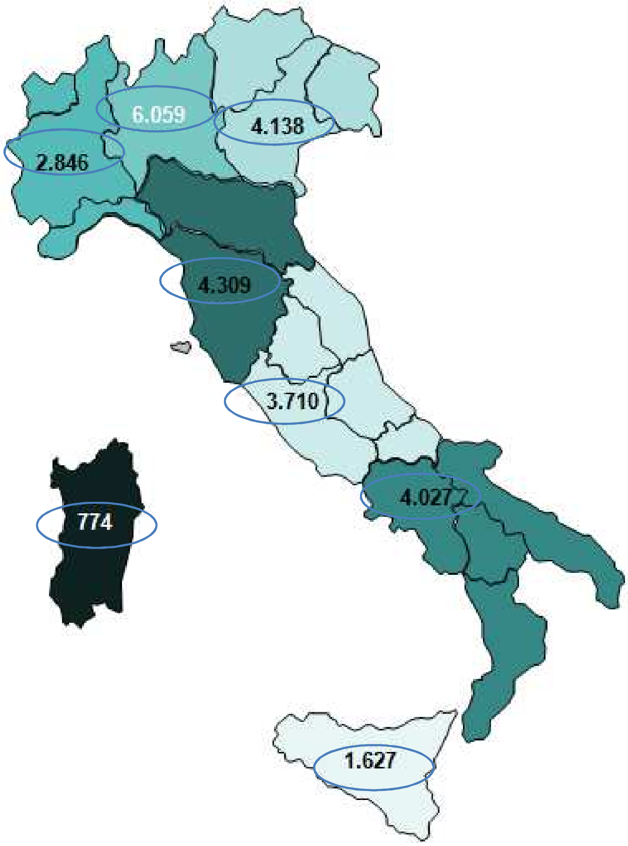
Source: Terna

Demand by Geographical Areas: map chart

[GWh]

The regions are combined in clusters on the basis of production and consumption:

- TURIN: Piedmont - Liguria - Valle d'Aosta
- MILAN: Lombardy (*)
- VENICE: Friuli Venezia Giulia - Greater Venice - Trentino Alto Adige
- FLORENCE: Emilia Romagna (*) - Tuscany
- ROME: Lazio - Umbria - Abruzzo - Molise - Marche
- NAPLES: Campania - Apulia - Basilicata - Calabria
- PALERMO: Sicily
- CAGLIARI: Sardinia



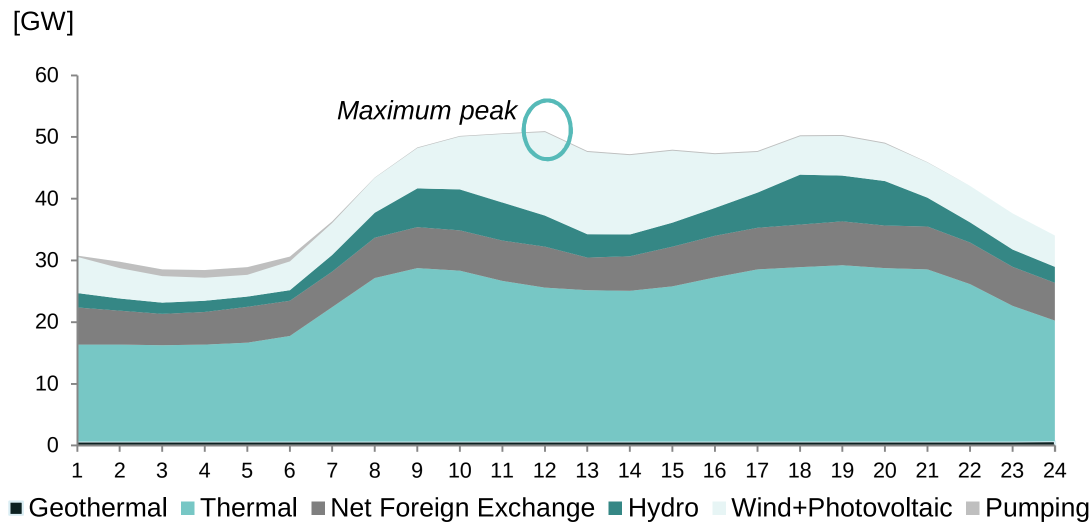
Source: Terna

(*) In these two regions the geographical borders do not correspond to the electrical borders. Lombardy includes production plants that are part of the geographical-administrative territory of Emilia Romagna.

Peak Demand

In January 2018, Peak Demand was recorded on **Wednesday 17 at 12:00** and was 50,808MW (-6.9% Y-o-Y). The hourly demand diagram of the peak day is presented below.

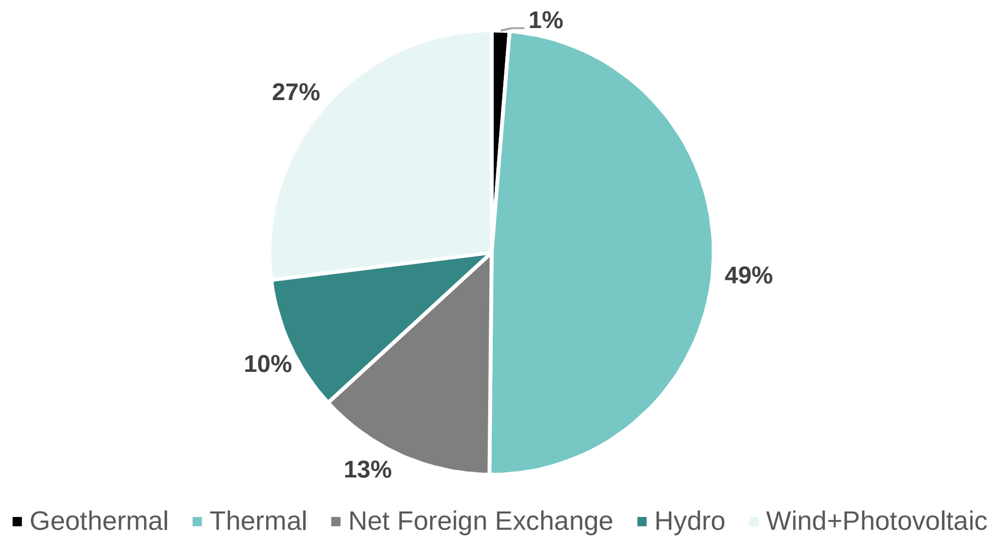
Peak Demand



At peak, the contribution of thermal production was 24,936MW.

Source: Terna

Coverage at Peak demand – 17 January 2018, 12:00



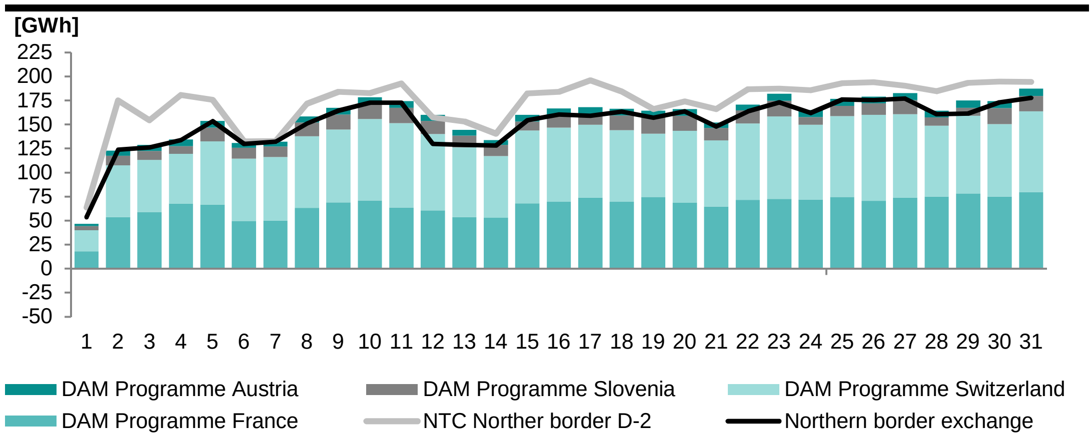
At peak, production from renewable sources contributed to covering demand for 38%, thermal production for 49% and the remainder was the net foreign exchange.

Source: Terna

Net Foreign Exchange – January 2018

In January, there was low saturation of the planned figure for NTC (Net Transfer Capacity) calculated in D-2 compared to the exchange programmes on the Northern border.

Net Foreign Exchange on the Northern border



In January 2017, there were Imports of 4,892GWh and Exports of 325GWh.

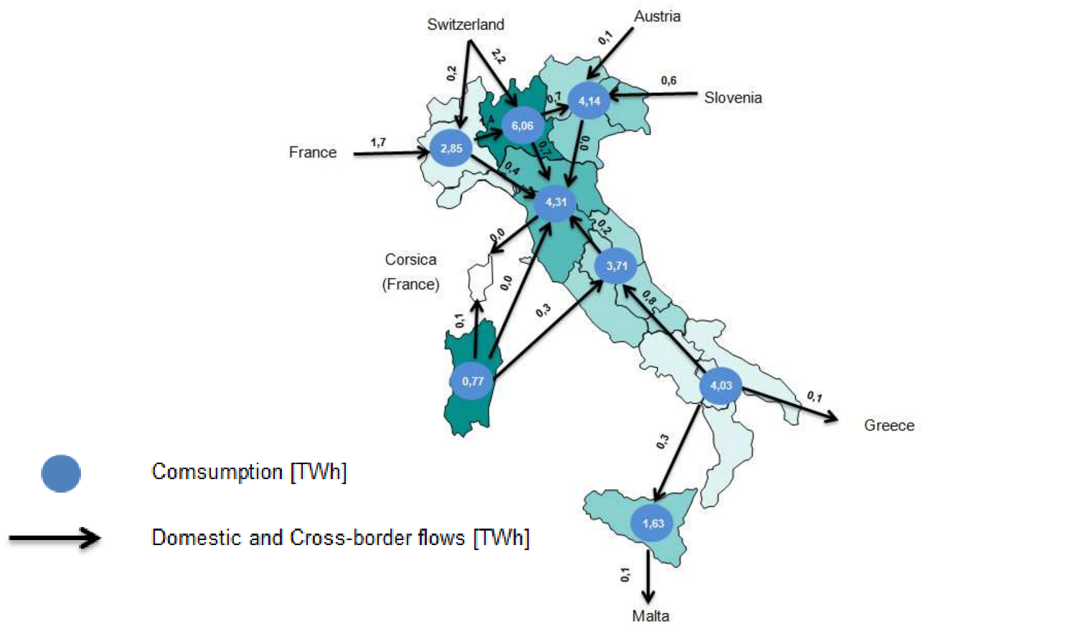
Source: Terna

Balance of Physical Exchanges – Annual Cumulative Figure

The balance of physical exchanges of electricity mainly shows the energy flows among the various areas identified in the Italian electricity system.

The 380kV connection between Sicily and the Continent ensures secure management of the electricity system in Sicily and Calabria.

Balance of physical electricity exchanges: map chart



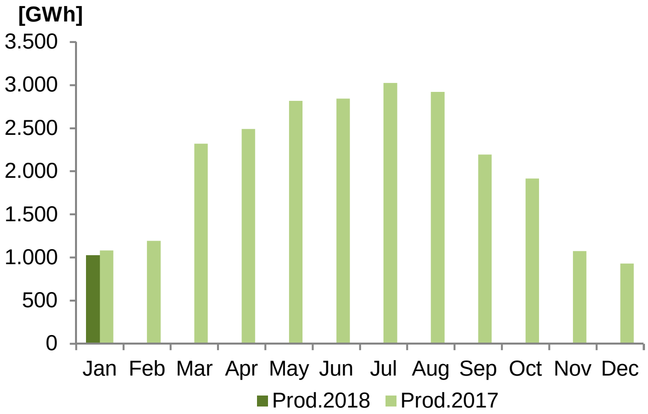
In 2018, a net exchange was recorded from the Northern zone to Emilia Romagna and Tuscany of around 1.1TWh. The Continent recorded a net exchange towards Sicily of 0.3TWh

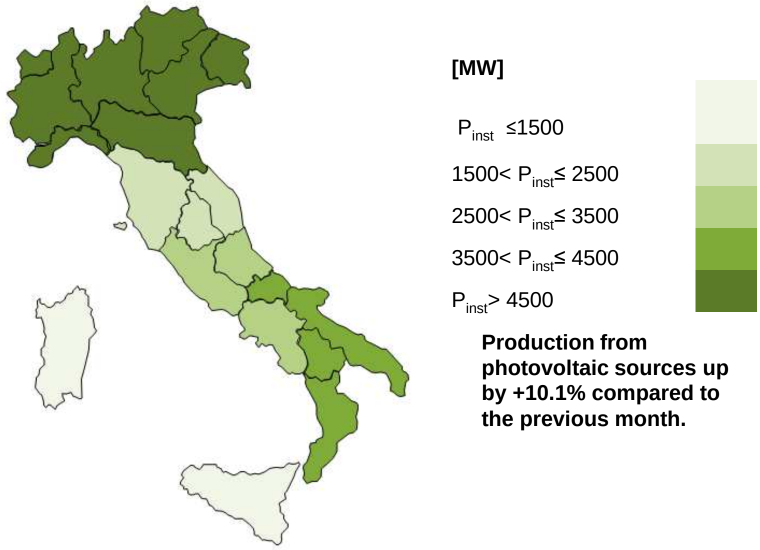
Source: Terna

Production and installed capacity

The energy produced by photovoltaic sources in January 2018 came out at 1,026GWh, up compared to the previous month by 94GWh. The annual cumulative figure fell compared to the previous year (-5.1%).

Photovoltaic Production and Capacity



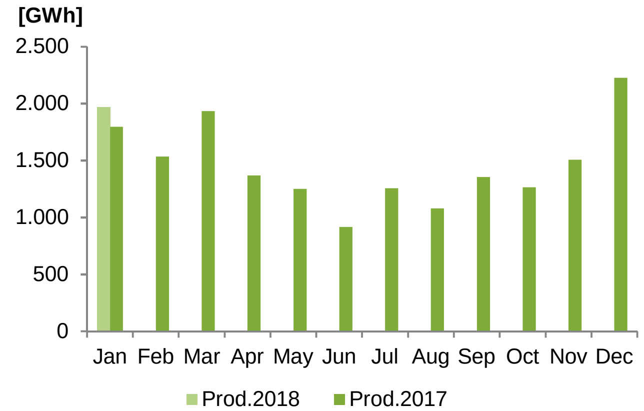


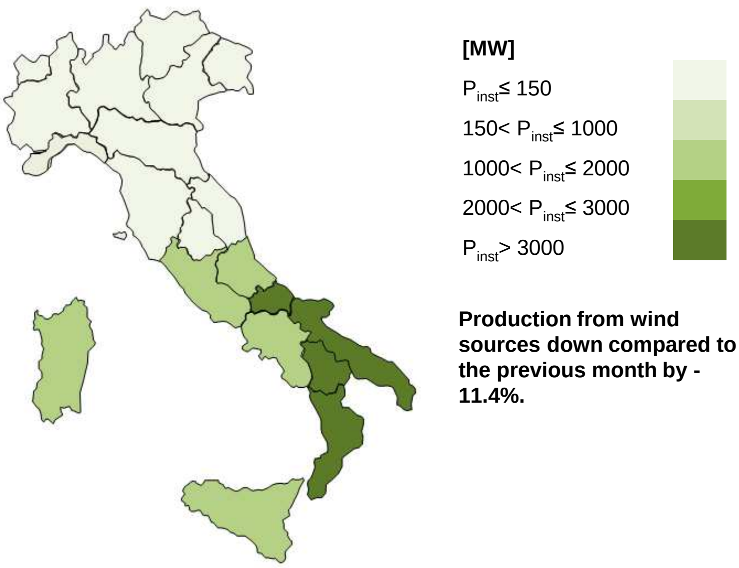
Production from photovoltaic sources up by +10.1% compared to the previous month.

Source: Terna

The energy produced by wind power in January 2018 was 1,972GWh, down compared to the previous month by 256GWh. The annual cumulative figure increased compared to the previous year (+9.7%).

Wind Production and Capacity



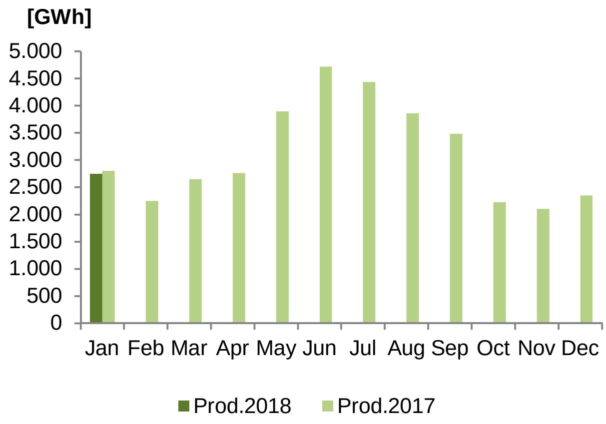


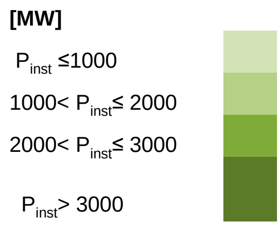
Production from wind sources down compared to the previous month by -11.4%.

Source: Terna

The energy produced by hydroelectric sources (e.g. reservoirs and run-of-river) in January 2018 was 2,747GWh, up compared to the previous month by 397GWh. The annual cumulative figure was down (-2.0%) compared to the previous year.

Hydroelectric Production and Capacity



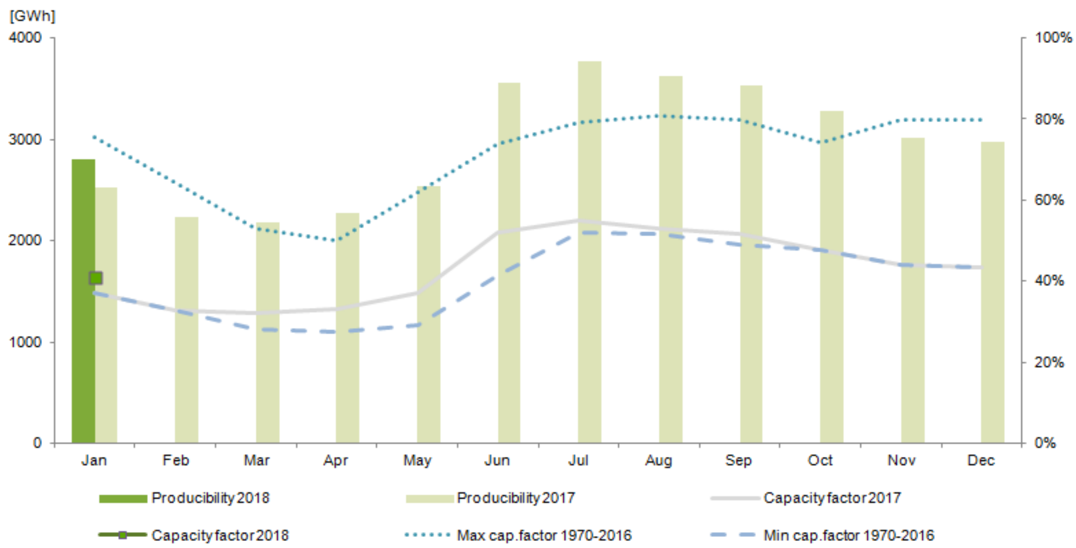


Production from hydroelectric sources up compared to the previous month (+16.9%).

Source: Terna

In January, hydroelectric producibility fell compared to the previous month.

Hydroelectric Producibility and Reservoir Percentage



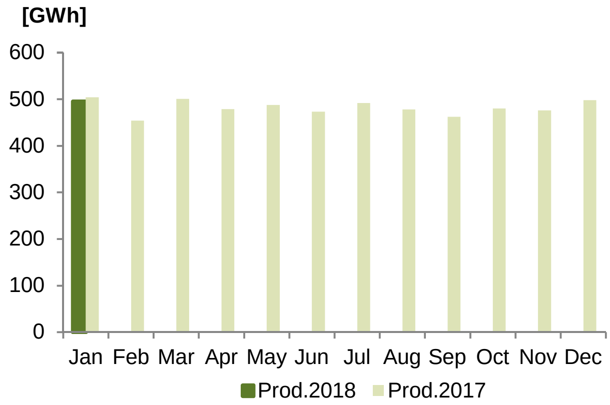
	Reservoir Capacity	NORTH	CENTRE SOUTH	ISLANDS	TOTAL
2017	[GWh]	1,887	762	156	2,805
	% (capacity/max capacity)	40.6%	42.0%	40.8%	41.0%
2016	[GWh]	1,535	754	239	2 528
	% (capacity/max capacity)	33.0%	41.6%	62.8%	36.9%

In January 2018, considering Italy as a whole, the current reservoir percentage compared to the maximum reservoir capacity was +41.0%, an increase compared to January 2017.

Source: Terna

The energy produced by geothermal sources in January 2018 came out at 495GWh, down compared to the previous month by 3GWh. The annual cumulative figure was down (-1.8%) compared to the previous year.

Geothermal Production and Capacity



[MW]

$P_{inst} = 0$

$0 < P_{inst} \leq 500$

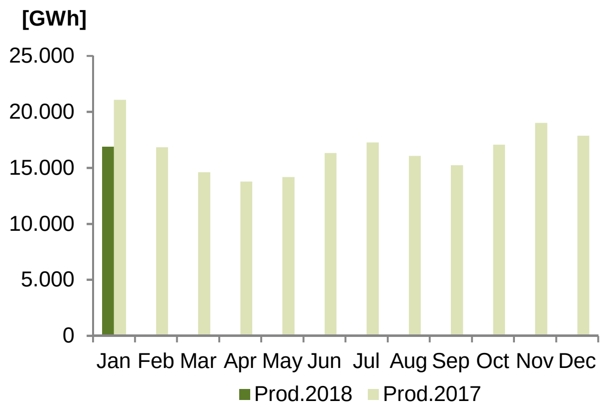
$500 < P_{inst} \leq 1000$

Geothermal production decreased (-0.6%) compared to the previous month.

Source: Terna

The energy produced by thermal sources in January 2018 came out at 16,907GWh, down compared to the previous month by 987GWh. The annual cumulative figure was down (-19.8%) compared to the previous year.

Thermal Production and Capacity



[MW]

$P_{inst} \leq 5000$

$5000 < P_{inst} \leq 10000$

$10000 < P_{inst} \leq 15000$

$15000 < P_{inst} \leq 20000$

$P_{inst} > 20000$

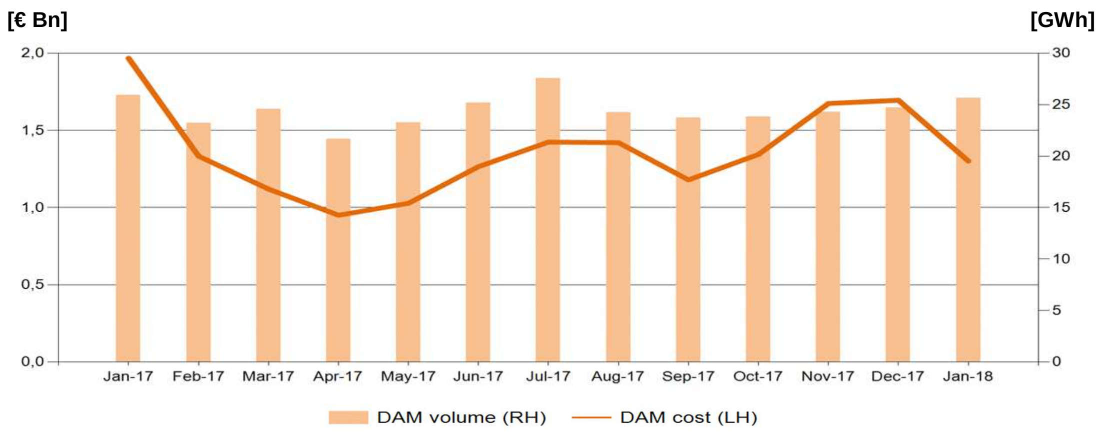
Thermal production was down (-5.5%) compared to the previous month.

Source: Terna

Day-Ahead Market

The January total for withdrawal programmes on the DAM was approximately €1.3 Bn, down 23% compared to the previous month and down 34% compared to January 2017.
The decrease during both periods was due to a reduction in the average PUN. In fact, the average PUN fell from €72.2/MWh (January 2017) to €49/MWh (January 2018).

Day Ahead Market – amounts and volumes

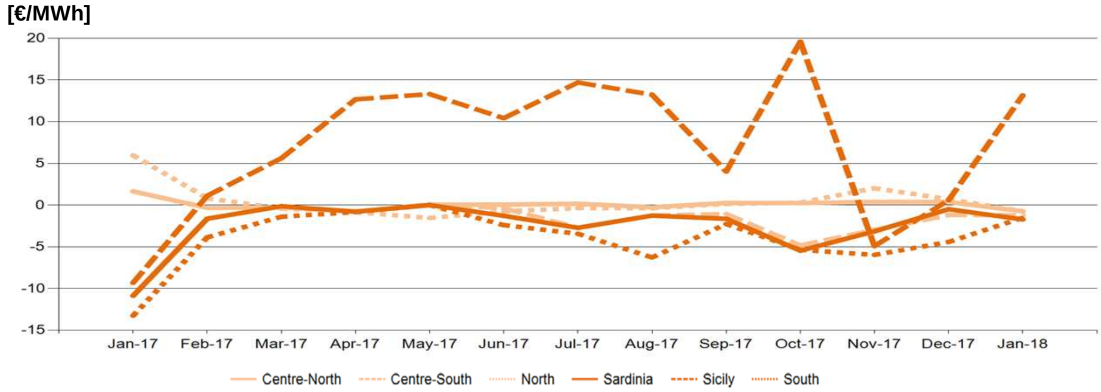


Source: Terna calculation on GME data

Total amount in January 2018 down by 34% compared to January 2017

In January, the zonal prices were predominantly in line with the PUN, with the exception of the Sicily zone, which recorded a spread of +€13.1/MWh.
Compared to January 2017, the price of the Sicily zone remained constant, while the other zones recorded an average reduction of €18.9/MWh.

Spread compared to the PUN



Source: Terna calculation on GME data

January 2018 zonal prices in line with the PUN for all zones except Sicily

In January, the spread between the peak and off-peak prices was 15.9 for the Sicily zone and €10.9/MWh on average for the other zones.
In December, on average it was €25.9/MWh for the Northern, Centre-North, Centre-South and Sardinia zones and €14.3/MWh for the Southern zone, while Sicily was €10.6/MWh on average.

Day Ahead Market – PUN and zonal prices [€/MWh]

€/MWh	PUN	North	Centre-North	Centre-South	South	Sicily	Sardinia
Average	49.0	48.3	48.2	47.8	47.5	62.1	47.3
Y-o-Y	-23.2	-29.9	-25.6	-13.6	-11.5	-0.8	-14.1
∆ vs PUN	-	-0.7	-0.8	-1.2	-1.5	13.1	-1.7
∆ vs PUN 2017	-	6.0	1.6	-10.9	-13.3	-9.3	-10.9
Peak	56.4	55.8	55.7	54.7	54.0	72.4	53.8
Off Peak	44.9	44.1	44.1	43.9	43.9	56.5	43.7
∆ Peak vs Off Peak	11.5	11.7	11.6	10.8	10.1	15.9	10.1
Minimum	10.0	10.0	10.0	10.0	10.0	10.0	5.0
Maximum	78.9	74.4	74.4	74.4	74.4	196	74.4

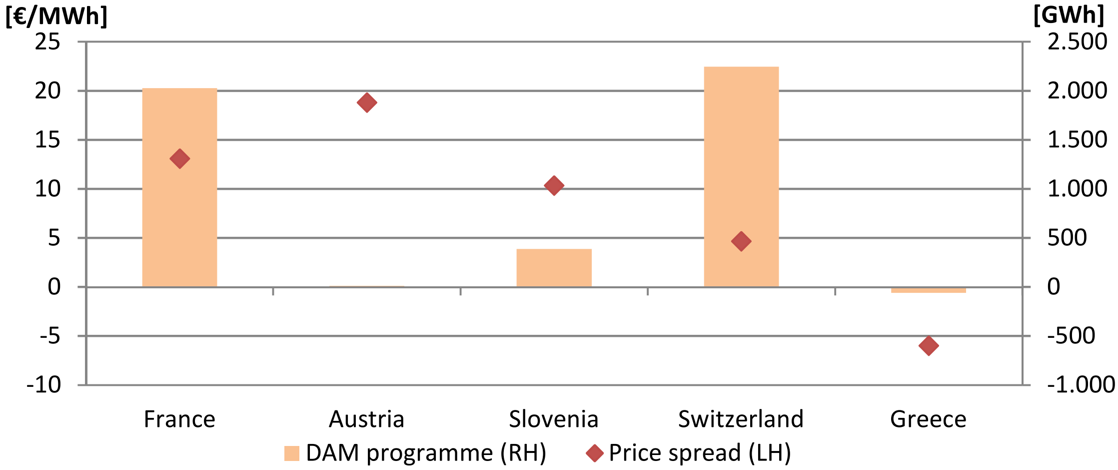
Source: Terna calculation on GME data

Peak-off peak spread down compared to the previous month for all zones, with the exception of Sicily

January saw a decrease in price spreads on the borders with Austria, Slovenia and Greece compared with the previous month, and an increase in the price spread on all other borders.

In January, imports totalled 4.9TWh, with France and Switzerland accounting for 41% and 47% of the total respectively. Total exports were 0.3TWh, with Greece accounting for 74%, and Switzerland 25%.

Price spread with foreign exchanges and day-ahead programmes



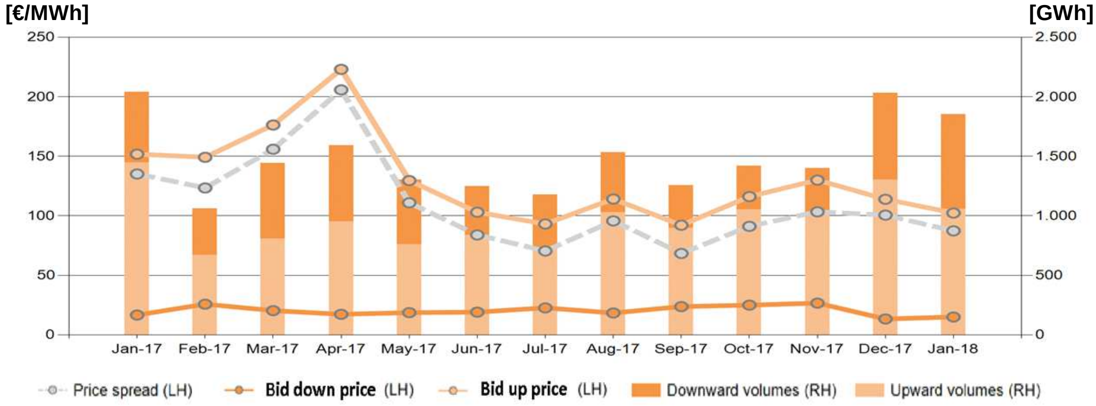
Source: Terna calculation

Net imports on the Northern border of 4.7TWh

Ex-ante Ancillary Services Market

In January, the spread between average bid-up and bid-down prices was €87.3/MWh, down compared to the previous month by 13% and down by 35% compared to January 2017.
The total volumes fell compared to the previous month (-9%), in particular upward volumes decreased by 19% and downward volumes increased by 9%.
The upward volumes fell by 27%, while the downwards volumes rose by 35% compared to the same month of the previous year.

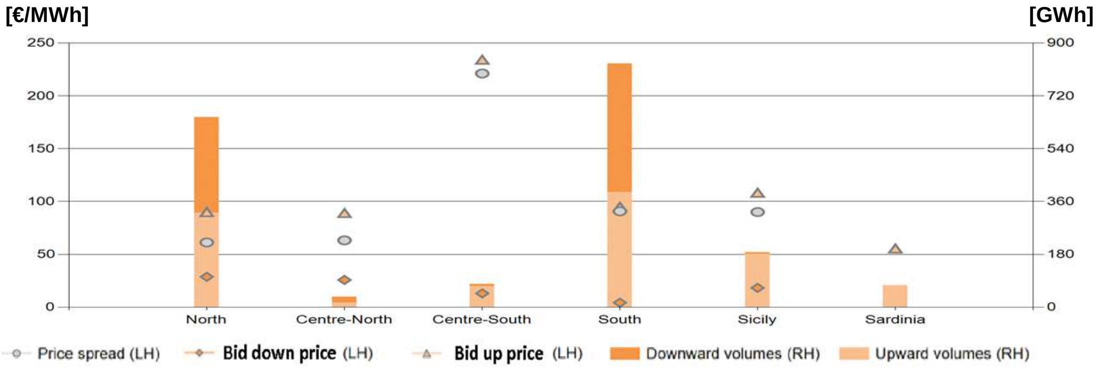
Ex ante Ancillary Services - prices and volumes



Average bid-up price in January 2018 of €102.3/MWh
Average bid-down price in January 2018 of €15.0/MWh

The market zone characterised by the highest spread (€221.1/MWh) is the Centre-South, as in the previous month.
This spread recorded a 37% increase compared to the previous month, due to an increase in the average bid-up price of 29% (from €182/MWh in December to €234.1/MWh in January) and to a reduction in the average bid-down price of 36% (from €20.4/MWh in December to €13/MWh in January).

Ex-ante Ancillary Services - prices and volumes by market zone



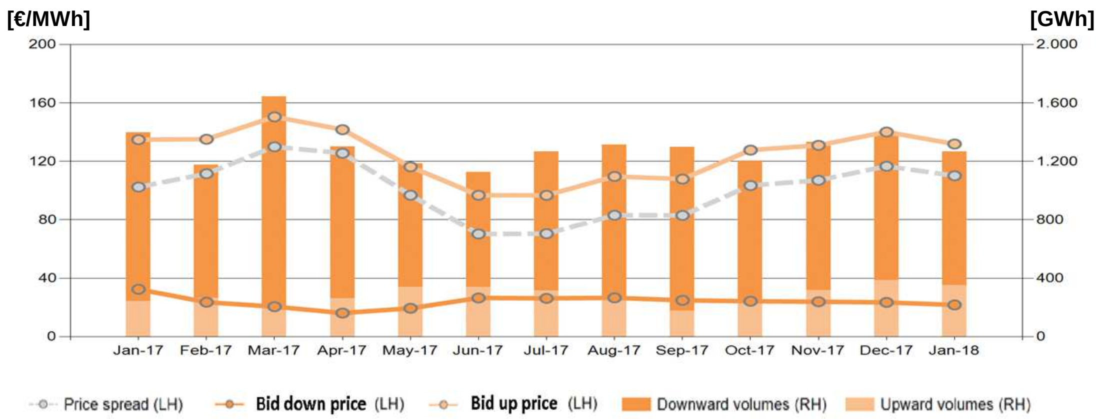
Source: Terna

Centre-South: zone with the highest price spread
South: zone with the most volumes moved

Balancing Market

In January, the spread between bid-up and bid-down prices was €110.1/MWh, down compared to the previous month (€116.6/MWh; -6%) and up compared to January 2017 (€102.4/MWh; 8%).
The total volumes fell compared to the previous month (-8%), in particular upward volumes decreased by 9% and downward volumes decreased by 7%. Compared to January 2017, upward volumes increased by 45% and downward volumes fell by 21%.

Balancing market – prices and volumes

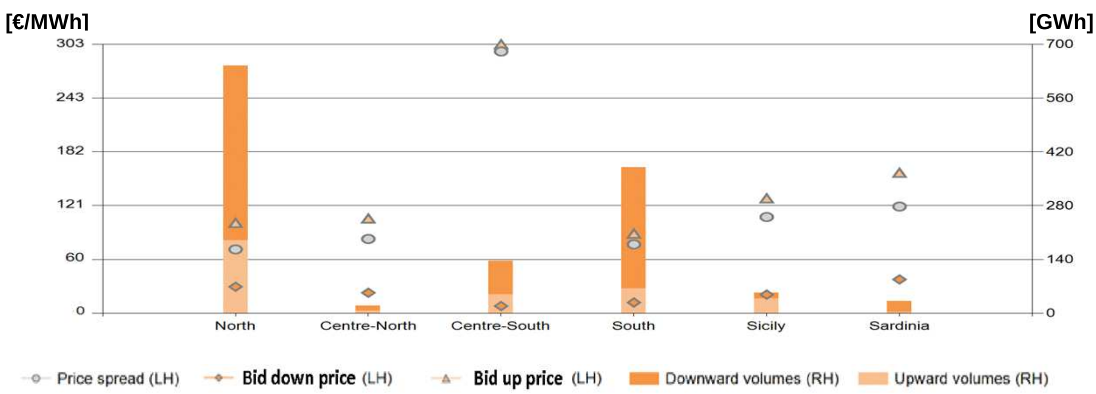


Source: Terna

Average bid-up price in January 2018 of €131.9/MWh
Average bid-down price in January 2018 of €21.7/MWh

The market zone characterised by the highest spread (€ 296/MWh) is the Centre-South, similar to the previous month (spread of € 326/MWh).
In January, the Northern zone was confirmed as the zone characterised by the highest bid-down volumes, as in the previous month. In January, the Northern zone was confirmed as the zone characterised by the highest downward volumes (455GWh), followed by the Southern zone (316GWh).
The price spread decreased in the North, South and Centre-South zones, while it increased in all other zones.
Sardinia was the zone with the highest increase over the previous month (+64%).

Balancing market – prices and volumes by market zone



Source: Terna

Centre-south: zone characterised by the highest price spread
North: zone with the most volumes moved

Spot Commodities Market

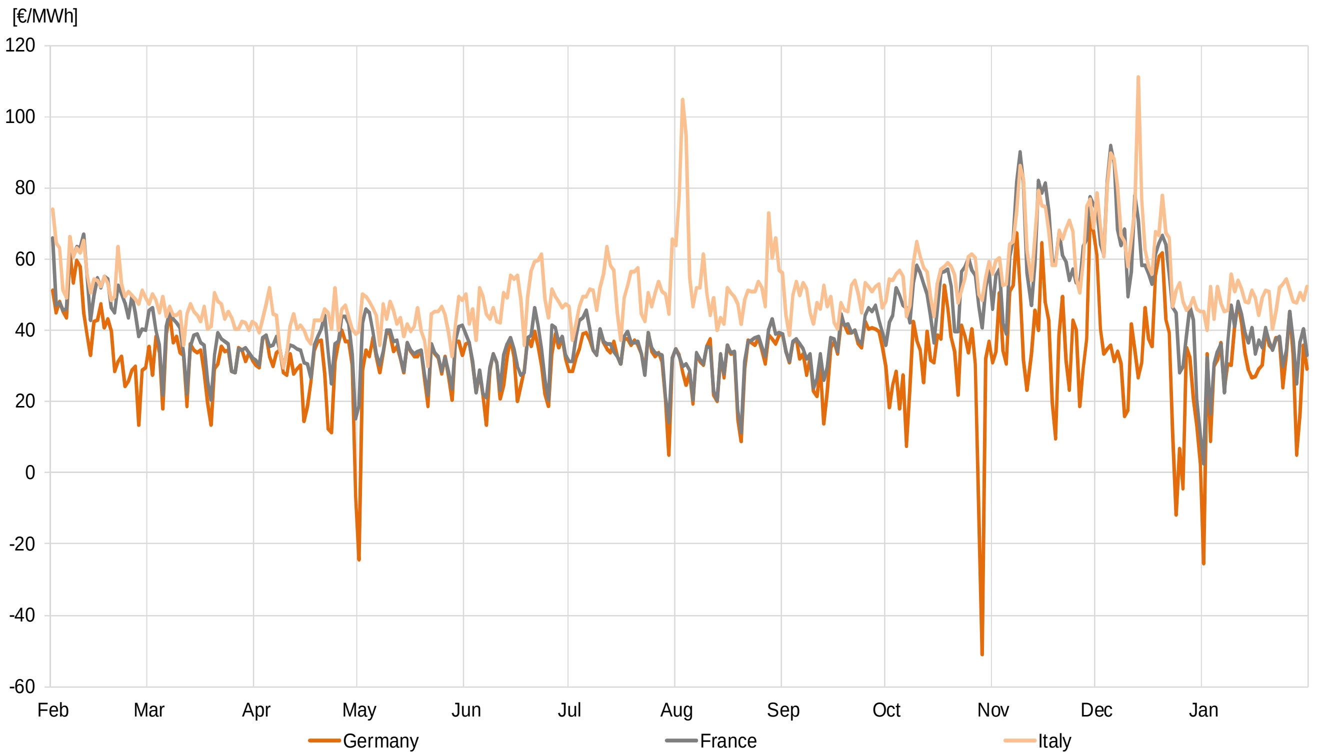
In January, the prices of Brent stood at around $69/bbl, up compared to the $64/bbl of December (+7%).

Coal prices (AP12) came out at approximately $95/t, in line with the prices of December which were around $95/t (+0%).

Gas prices in Europe decreased in January compared to the previous month, coming out at €19/MWh; the PSV recorded an average of €20/MWh, down compared to €27/MWh in December.

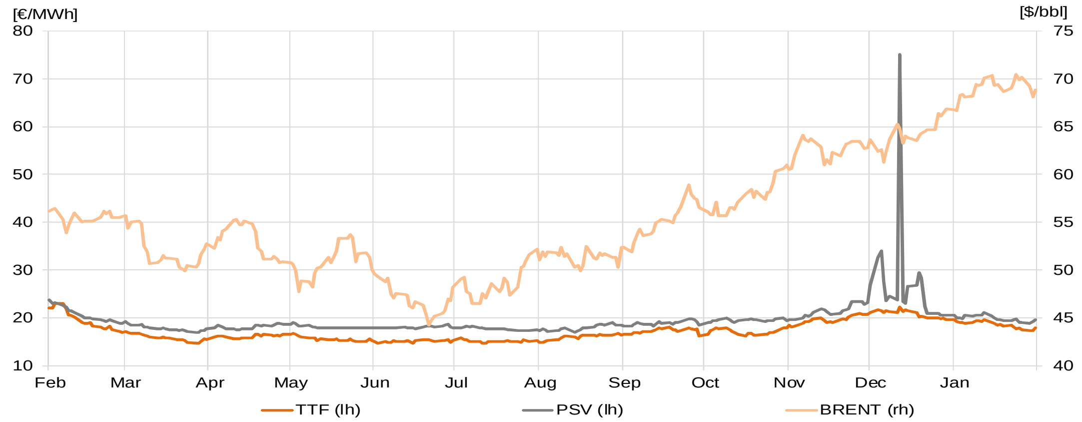
Electricity prices in Italy in January decreased slightly compared to December with a monthly average €50/MWh (-29%).

Spot electricity prices



Source: Terna calculation on GME and EPEX data

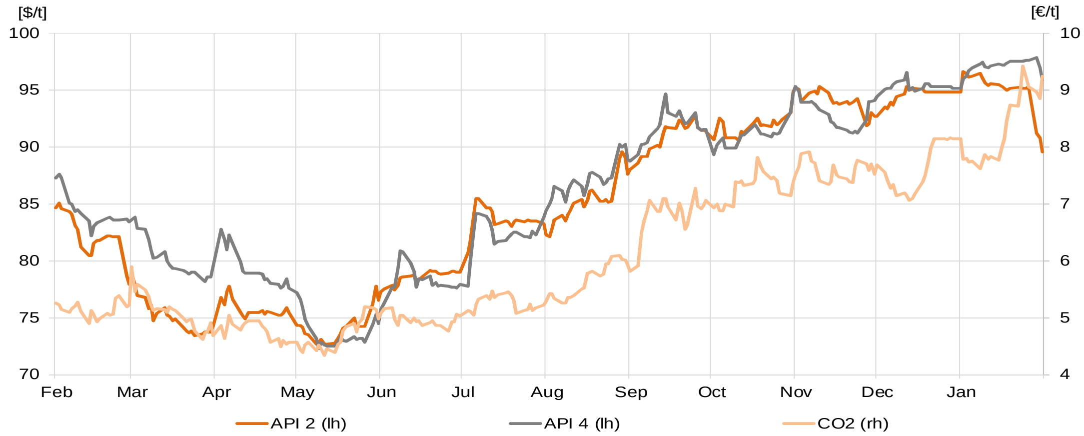
Gas & Oil spot prices



Source: Terna calculation on Bloomberg data

Monthly average change PSV-TTF = €1.3/MWh

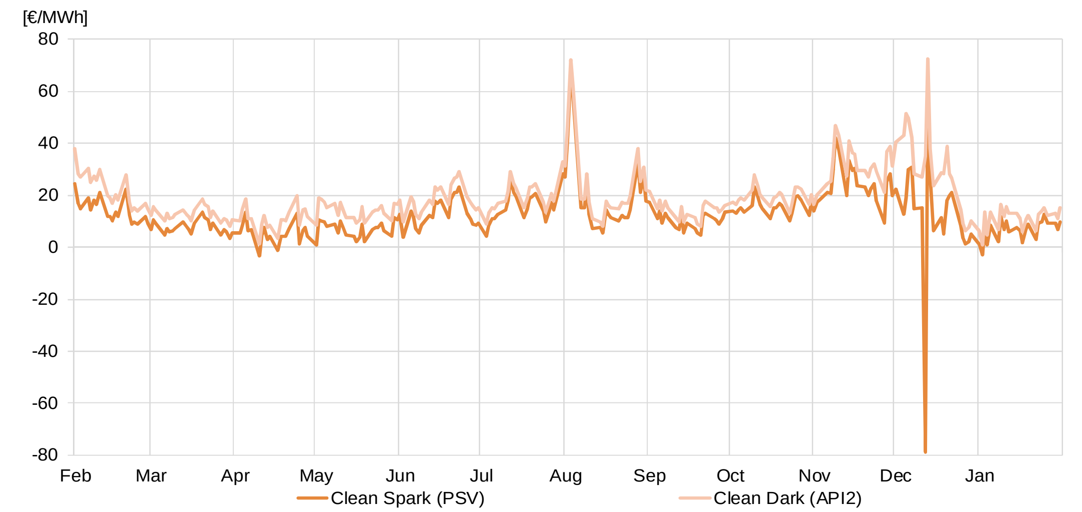
Coal & Carbon spot prices



Source: Terna calculation on Bloomberg data

Monthly average change API2-API4 = -$2.1/t

Clean Dark & Spark spreads Italy



Source: Terna calculation on Bloomberg data

Clean spark spread PSV monthly average = €7/MWh (-45% M-o-M)

Clean dark spread API2 monthly average = €11/MWh (-64% M-o-M)

Forward Commodities Market

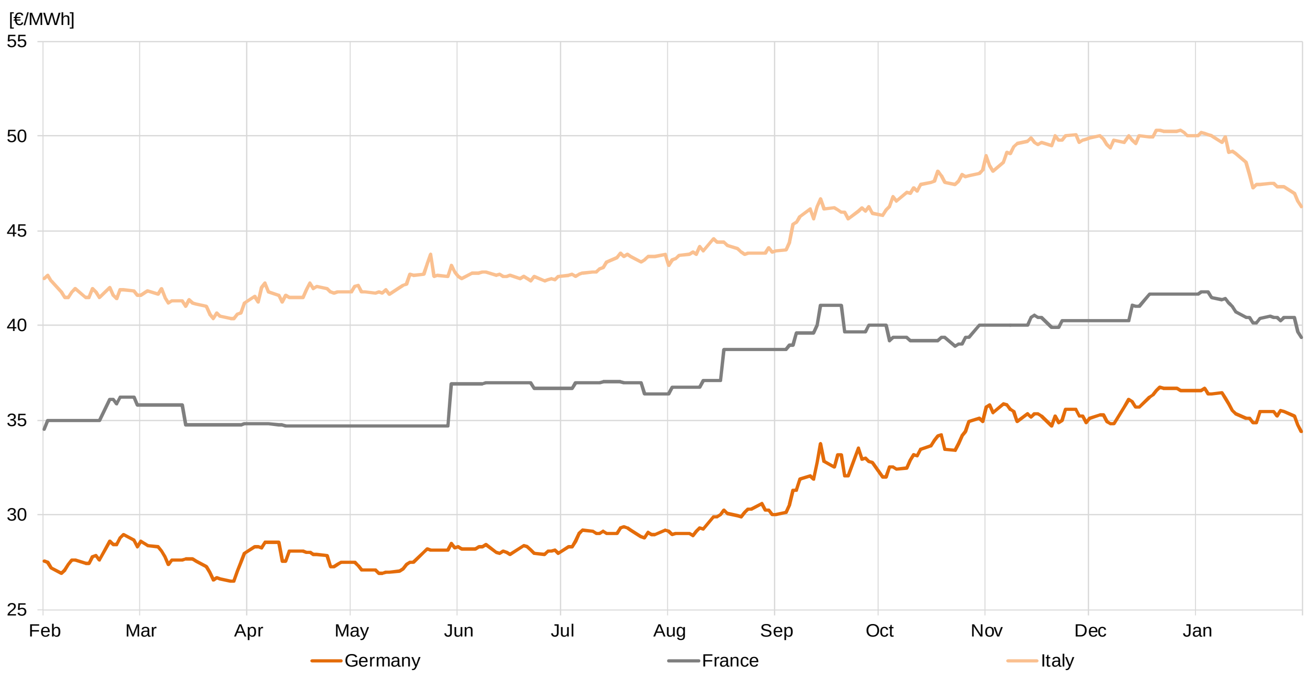
In January, the 2019 Brent forward prices were around $63/bbl, up compared to the $60/bbl of December with an increase of 6%.

The 2019 average forward prices of coal (API2) increased to approximately $85/t (+3%) compared to the $83/t recorded in December.

The 2019 average forward prices of gas in Italy (PSV) were in line between January and the previous month, coming out at around $19/MWh.

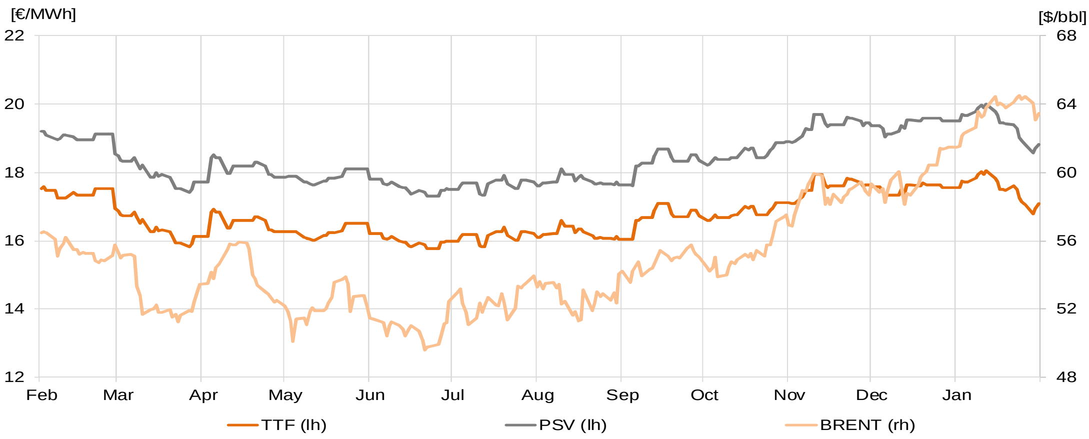
The 2019 average forward prices of electricity in Italy stood at around €48/MWh, a decrease of -3% on the previous month. A negative trend was recorded for the French exchange where the price was approximately €41/MWh, while in Germany it came out at approximately €36/MWh.

2019 Forward Electricity Prices



Source: Terna calculation on Bloomberg data

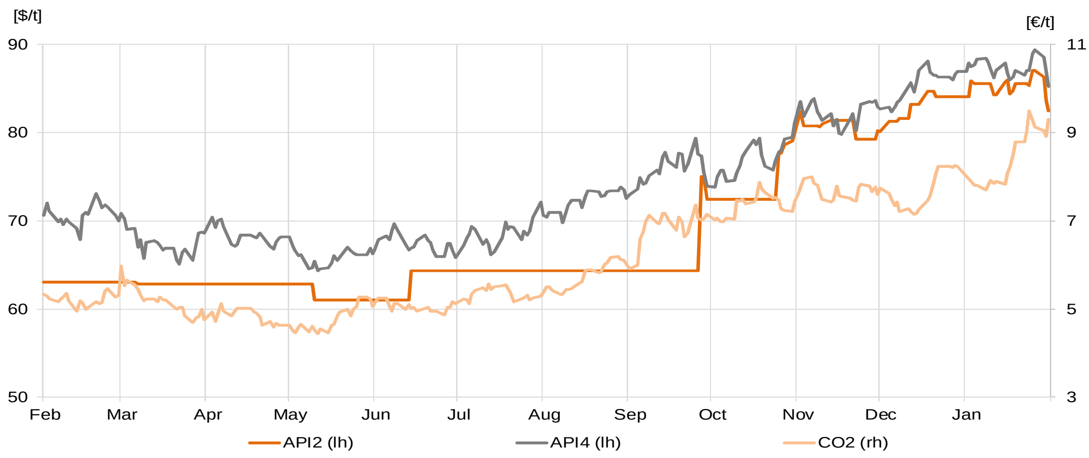
2019 Forward Gas & Oil prices



Source: Terna calculation on Bloomberg data

Monthly average change PSV-TTF = +€ 1.9/MWh

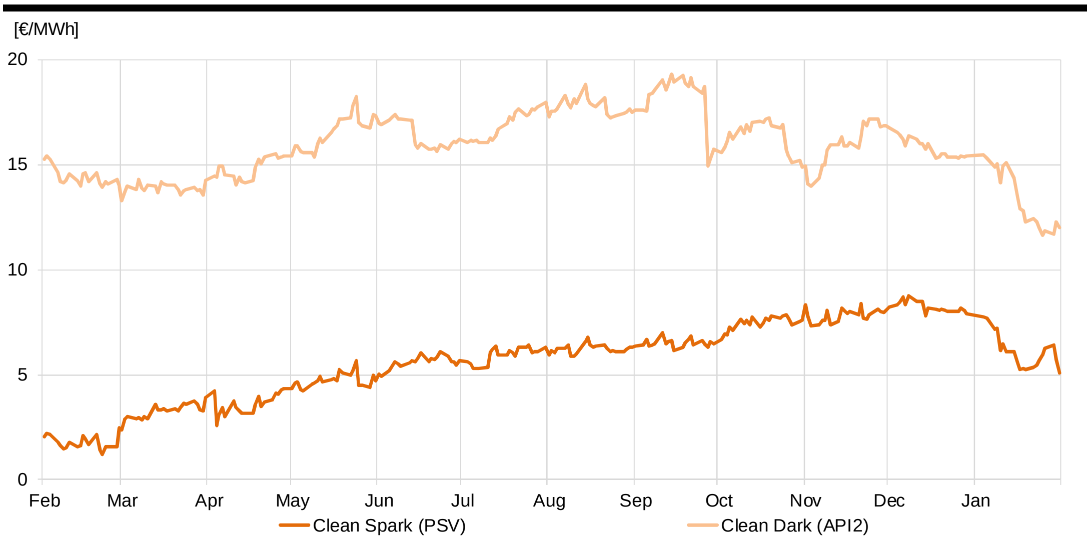
2019 Forward Coal & Carbon prices



Source: Terna calculation on Bloomberg data

Monthly average change API2-API4 = -$2.0/t

Clean 2019 Forward Dark & Spark Spreads Italy



Source: Terna calculation on Bloomberg data

Clean spark spread PSV monthly average = €6.3/MWh (-24% M-o-M)

Clean dark spread API2 monthly average = €13.6/MWh (-15% M-o-M)

Below is a selection of ARERA measures of major interest for dispatching and transmission activities in January 2018. This selection is not exhaustive with respect to the regulatory framework.

Prescriptive measures pursuant to resolution 342/2016/E/EEL – confirmations and reviews

Resolutions 3-7/2018/E/EEL and 16-20/2018/E/EEL

In the context of the measures initiated with resolution 342/2016/E/EEL, for non-diligent programme strategies put in place for dispatching services, the Authority ordered the confirmation of 10 prescriptive measures, along with the review of Annex B of the same measures (containing the criteria for calculating the amount of undue relief paid to dispatching users as a result of their non-diligent conduct).

Approval of the proposal for fall-back procedures for the Italy North capacity calculation region (CCR), pursuant to article 44 of (EU) Regulation 2015/1222 (CACM), resulting from the unanimous vote given by all the Regulatory Authorities for the Italy North region within the Energy Regulators' Regional Forum

Resolution 21/2018/R/EEL

The Authority, along with the other Italy North Regulatory Authorities, has approved the proposal of the regional TSOs for the Italy North capacity calculation concerning fall-back procedures, prepared pursuant to Regulation CACM. These are allocation procedures for daily capacity that are to be implemented in exceptional circumstances when it is not possible to use the market coupling of the Day-Ahead Market – DAM. Specifically, the proposal of the TSOs provides for:

- explicit auctions, so-called shadow auctions, on the Italy North zone – France and the Italy North zone – Austria borders and capacity allocation on the intra-day market in the event that the shadow auctions are cancelled;
- on the Italy North zone – Slovenia border, a session of the DAM with the joint allocation of capacity and energy on this border (regional coupling). In the event that the regional coupling fails, the use of the shadow auctions already provided for other regional borders is called for.

Provisions regarding zonal grid subdivisions and the launch of the review of the same pursuant to Regulation 2015/1222 (CACM)

Resolution 22/2018/R/EEL

The Authority:

- launched the review of the zonal configuration concerning the national electricity grid pursuant to the CACM Regulation, providing that Terna:
    - ✓ consults zonal configurations as alternatives to the current configuration, providing an indication of the relative implementation times, the analysis methodology and the summary indicators consistent with CACM Regulation criteria:
    - ✓ sends the proposal for the new zonal configuration to the Authority and publish it on its own website (or confirm the current zonal configuration will be maintained). The Authority will confirm receipt of the proposal within 45 days;
- defined the ways in which future reviews of the zonal configuration will be carried out.

Lastly, the Authority modified resolution no. 111/06 concerning the zonal grid subdivision criteria, in order to take the provisions of the CACM Regulation into consideration.

Directives for the integration of sections concerning the resilience of the electricity system in distributor development plans

Resolution 31/2018/R/EEL

The Authority introduced obligations to prepare resilience plans for all distributors and the integration of sections within development plans dedicated to increasing the resilience of electricity distribution grids for the main distributors.

Key

Ancillary Services Market: the trading venue of the resources for the dispatching service.

API2 – CIF ARA: the reference index for the coal price (with PCI of 6,000 kcal/kg) imported from north-west Europe. It is calculated on the basis of an assessment on the CIF (Cost, Insurance and Freight) prices of coal contracts, with delivery to the ports of Amsterdam – Rotterdam – Antwerp (ARA).

API4 – FOB Richard Bay: the reference index for the coal price (with PCI of 6,000 kcal/kg) exported from Richards Bay in South Africa. It is calculated on the basis of an assessment on the FOB (Free On Board) prices of contracts excluding transport starting from the port of Richards Bay.

Balancing Market (BM): the set of activities for selecting the offers presented on the market to resolve the congestions and establish secondary and tertiary reserve power margins, carried out on the same day as that to which the offers refer.

Brent: the oil price as global reference for the crude oil market. Brent Crude is the result of a mixture deriving from the union of different types of oil extracted from the North Sea.

Clean Dark Spread: the difference between the price of electricity and the cost of the fuel of a coal power station and the cost of the CO2 emission quotas.

Clean Spark Spread: the difference between the price of electricity and the cost of the fuel of a gas power station and the cost of the CO2 emission quotas.

Dirty Dark Spread: the difference between the price of electricity and the cost of the fuel of a coal power station.

Dirty Spark Spread: the difference between the price of electricity and the cost of the fuel of a gas power station.

Day-Ahead Market (DAM): the trading venue of offers to buy and sell electricity for each relevant period of the day after that of trading.

Ex-Ante Ancillary Services: the set of activities performed for selecting the offers presented on the Ancillary Services Market to resolve the congestions and establish secondary and tertiary reserve power margins, carried out in advance with respect to real time.

NET TRANSFER CAPACITY - NTC: the maximum transfer capacity of the grid for interconnection with other countries. NTC D-2 indicates the same capacity defined in day D-2.

Peak hours: are the hours between 8:00 and 20:00 of working days only. **Off-peak hours**: all the other hours.

PSV - Punto Scambio Virtuale: the price at the virtual exchange point for the buying and selling of gas in Italy.

PUN - Prezzo Unico Nazionale: the electricity national price calculated as a result of the Day-Ahead Market.

TTF - Title Transfer Facility: the price at the virtual exchange point for the buying and selling of natural gas in the Netherlands.

Territorial Areas: these consist of one or more adjacent regions and are aggregated as indicated:

TURIN: Piedmont - Liguria - Valle d'Aosta;
MILAN: Lombardy (*);
VENICE: Friuli Venezia Giulia - Greater Venice - Trentino Alto Adige;
FLORENCE: Emilia Romagna (*) - Tuscany;
ROME: Lazio - Umbria - Abruzzo - Molise - Marche;
NAPLES: Campania - Apulia - Basilicata – Calabria;
PALERMO: Sicily;
CAGLIARI: Sardinia

(*) In these two regions the geographical borders do not correspond to the electrical borders. The Lombardy region includes production plants that are part of the geographical-administrative territory of Emilia Romagna.

The data related to the reservoirs table of tanks are aggregated by **ZONE** as indicated:
NORTH – includes the Territorial Areas TURIN, MILAN and VENICE;
CENTRE and SOUTH – includes the Territorial Areas FLORENCE, ROME and NAPLES;
ISLANDS – includes the Territorial Areas PALERMO and CAGLIARI.

Zonal Price: the price of each zone calculated as a result of the Day-Ahead Market (DAM).

Disclaimer

Data reported for 2017 (Energy Balance Sheets) and 2018 are reported on a provisional basis.

Provisional data can be subject to adjustments and recalculations.