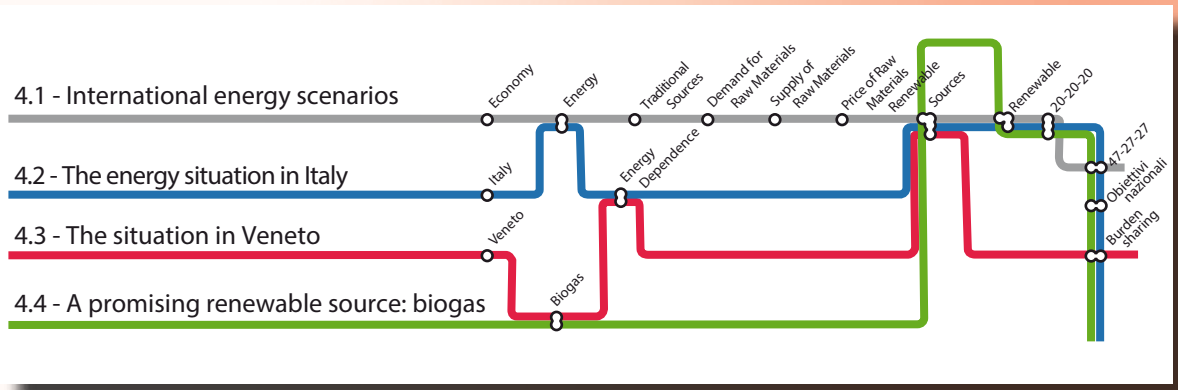
Today, the global economy is showing signs of recovery and an increase in the demand for energy, as a result. The forecasts of OECD indicate a growth in the demand for oil which should rise to 111 million barrels per day (mb/d) by 2040.
The effects connected to the economic crisis and recent U.S. policies related to the management of oil and gas resources, have caused a reduction in their relative prices and generated a favourable situation for countries which import raw materials.
In addition to the economic aspects linked to the demand and offer of raw materials for the production of energy, the environment also plays a role of primary importance. The great challenge to be faced in the coming years will be the containment of rising atmospheric temperatures through the reduction in greenhouse gas emissions in a way that mitigates the resulting natural phenomena. The European Union has been working towards this for many years. With this in mind, the "20-20-20" strategy in 2007, and the recent "40-27-27", which the European Council approved new climate and energy objectives updating those which had been previously set, and which take the time horizon forward to 2030.
The new objectives foresee:
• a 40% reduction in the emissions of greenhouse gases;
• the consumption of energy from renewable resources to rise to a share of 27% at the European level, though not setting targets for individual Countries;
• a 27% increase in energy efficiency.
In this context, as previously mentioned, there is more possibility for Italy to relaunch its economy which would help the Country to exit from the economic recession which took hold in recent years. The same observation is as true for the Veneto as it is for the rest of Italy, even if the development of renewable sources becomes increasingly more important to reducing the heavy burden of energy dependency, as well as reaching the environmental objectives of greenhouse gas reduction. In recent years, in fact, some important steps have been taken in this direction, thanks to a highly



Energy, moving towards a new equilibrium for a sustainable future

4. Energy, moving towards a new equilibrium for a sustainable future

4.1 International energy scenarios

The topics of energy and the economy are strongly linked, as they in some way complement each other. This means that it is impossible to analyse the performance of the energy market without understanding the economic context which frames it. On the international scene, the economy is showing signs of recovery and the forecasts, while indicating continued fragility, do talk of growth, even if contained. At the same time, on the energy front, the demand for petroleum should increase by over 21 million barrels a day (mb/d) in the period of 2013-2040, reaching 111 mb/d by 2040.

This dynamic will mainly be due to the developing countries, whose growth is estimated to be about 28 mb/d while in OECD countries, this should contract by 7 mb/d. It should also be noted that, beyond the growth factor and the total numbers which show a greater overall consumption by non-OECD countries, the per capita consumption is likely to remain higher in those belonging to the OECD.

The demand for petroleum in 2040 it will reach 111 million barrels per day

From the supply point of view, in the medium term from 2013 to 2019, the forecast are that crude oil and liquid natural gas from non-OPEC sources should increase by approximately 4 million barrels a day (mb/d), rising from 47.5 to 52.1 million. From 2020, the supply of crude oil and gas from non-OPEC countries should begin to curve downwards and the high demand for oil will be met by OPEC countries where the supply is expected to grow by over 13 mb/d from 2020 to 2040.

The changes in the medium term for the supply of crude oil and gas are largely attributable to the United States which has greatly increased production from its own oil fields, resulting in a rise in world supply and contributing to the lower prices which we are witnessing at this time.

The slowdown in the growth of demand...

Focusing attention on the oil market, the drop in the barrel price in recent months, with repercussions on the cost of its derivatives, primarily fuels, as well.

But what has caused of this reduction in the price of "black gold"? These are essentially two: on the one hand a slowdown in the growth of demand due to the difficult economic situation of recent years, and a large increase in supply resulting from the change in the U.S. policy for oil production which has, for several months, pushed for higher rates of oil extraction from its domestic supply leading to an imbalance in the supply on international markets.

...the increase in supply due in large part to increased oil production the United States...

The lowering of crude oil prices, which we are witnessing, is quite dramatic, if one stops to consider that Brent crude, in only a few months, dropped from $110/barrel to around $64 in the middle of April, 2015.

Tab. 4.1.1 - Forecast of the worldwide demand for oil from 2013 to 2040 and macro-areas (millions of barrels per day mb/d)

	2013*	2015	2020	2025	2030	2035	2040
OECD countries	45,9	45,8	45,0	43,8	42,0	40,0	38,2
Developing countries	39,0	41,2	46,5	51,9	57,1	62,2	67,0
Eurasia	5,1	5,2	5,5	5,6	5,7	5,8	5,9
World	90,0	92,2	97,0	101,3	104,8	108,0	111,1

(*) Final figure
Source: OPEC

.have caused the fall in the price of oil

This has been made possible, because the previously mentioned American policy has been reinforced by the decision of OPEC Countries, especially Saudi Arabia, to continue at full capacity rather than compensate the increase in demand by lowering their own production, and accepting lower revenues due to lower prices. This decision, which penalises these countries in the short / medium term has, however been taken in consideration of the long term view, as America's resources are still limited and are estimated to be exhausted within 12 years. At that point, the oil market will once again be fully governed by OPEC countries, and in a position to recover their current losses as well. The economic effects of this situation are many; in fact, the lower cost of crude oil, and its derivatives, gives a new momentum to the economy of the importing countries, both in terms of increased competitiveness in production, and greater disposable income for families. In contrast, there is also the risk of a boomerang effect which could limit this positive trend, as these producing countries have less revenues, with more or less damage to their respective economies. This translates, on the one hand, to fewer imports of manufactured goods produced by industrialised nations (who import oil) and on the other, difficult situations for the populations of the oil producing countries, with consequences, even serious ones, for their socio-political equilibrium. On the subject of gas, as previously mentioned, the United States is also becoming involved in a policy aimed at the maximum exploitation of the so-called "shale gas" with levels of production so high that gas has overtaken coal in the domestic production of energy, despite the fact that the United States has among the largest reserves of coal in the world. As a consequence, and due to its contained price, American coal has taken off in Europe, where the production of energy using coal has become more competitive compared to the cost of production using gas. As with oil, this is contributing to some changes to the economic balance, in the medium term, for countries which produce fossil fuels, as a result of a reduction in demand and prices, as well. Relative to these prices, it should be noted that the gas contracts are indexed to oil, that is they are linked to formulas based on a "basket" of petroleum products: the drop in the price of petroleum has, among other knock-on effects and with a delay of 6-9 months, lowered the price of gas, as well. This could, in some way, particularly hurt the main producing countries such as Algeria and Russia. Looking at the latter, for example, Gazprom - the largest Russian company which controls 70% of all gas produced by the Country and 19% of the world supply - has maintained this system of contracts in a rather rigid manner, not pursuing more flexible policies which would adjust to the trends of the individual gas market. Slightly less affected by this trend, is Norway, the other large producer which is of interest to Europe, whose principal company, Statoil, has corrected their pricing policies over time, making them more "susceptible" to market fluctuations. In reality, since the 6-9 months from the fall in the price of oil and the resulting fall in gas prices, another phenomenon is being observed; the greater importation of gas, itself, with countries resorting to storage on a massive scale in order to take advantage of the favourable economic situation. This increased flow should, in large part, compensate for the lower revenues to exporting countries resulting from lower prices.

The increased availability of gas has caused a fall in prices...

It came up in the discussion about gas storage and, in fact, in countries which are almost totally dependent on foreign sources of energy (such as Italy), all the policies whose aim to ensure the most secure supply possible, as well as the improvement of the storage of this gas, are fundamental.
One of the fundamental issues at the heart of ensuring a secure supply is in the diversification of gas suppliers. Italy is one of the major importers, mainly purchasing gas from Russia, Algeria, Norway and the Netherlands. The largest quantities of gas come from Russia and Algeria, countries with rather complicated socio-economic equilibriums which could easily have an effect on the export of gas. It is enough to consider that the gas pipeline used by Gazprom to transport its gas to Italy crosses through Ukraine and, with the current political tensions, the risk of an interruption to the flow of gas is always lurking. These same high tensions, currently ongoing in the

....and greater opportunities to create stockpiles for importing countries

Middle East, as well as in nearby Libya, put the entire market for gas (and oil) from these countries in difficulty, which is needed by the whole of Europe. From the consumers' point of view, the current situation of lowered prices should return some breathing space, as even domestic energy bills should decrease, albeit with a few months of delay.
Turning attention to other sources, nuclear energy is of vital importance, even though the cluster of related environmental risks, swings overhead, as well as the disposal of radioactive waste. With regard to the events such as those which occurred at Fukushima weigh heavily, after which the Japanese government decided to close all nuclear reactors. Currently, only the Ohi nuclear power station has planned recommissioning of two of its reactors, while the others are in a stage of review before the start of re-commissioning. At the same time, the German government decided to definitively close eight nuclear power stations. In addition, the Germany has also announced its intention to gradually eliminate and close all its remaining nine reactors by 2022. In China, after the accident of Fukushima, the government suspended the approval of new reactors though highly strict safety regulations had been established. However, looking in the long term, this source does not seem destined to disappear. India should insert a significant number of reactors in the medium term: six new reactors will be added to the current 21. Developments are also under way in OPEC member states, while the United Arab Emirates are constructing their first three reactors.
With regard to renewable sources should continue to grow, thanks also to the support of governments, though due to the rather modest base from where they started, it is not expected that their effect in 2040 will become truly prevalent in all sectors.
It has been observed, however, that the new installed power goes more and more from fossil fuels to renewables: in fact, it rose from a rate of 19% of renewables of the total of new installations in 2001 to one of 58% in 2013, the year when the installed power produced by RES overtook the share produced through the use of fossil fuels.

The renewable sources to go expansion

Focusing attention of the demand for energy, this is linked, in addition to the performance of the economy, to the social and demographic dynamics, as well. In detail, the impact from the population growth and the change to its age demographic have important implications on energy requirements. From UN figures, there is expected increase in population will near 9 billion people on the planet by 2040, with over 60% of these will live in cities.
The global economy, in the same period from 2013 up to 2014, is expected to grow by an average rate of 3.5% per annum. In particular, China should equal and surpass all OECD countries in terms of GDP (equal to purchasing power), while India should move closer to the EU.

The demand for energy will increase by 2040 8+60%)

In this scenario, the demand for energy should Increase by 2040 approximately 60% and up to 2030, oil will be the fuel with the greatest impact, after which the use of the three fossil fuels - oil, gas and coal - should level out each having a share of between 24% and 27% with the higher percentage (27.1) in favour of coal.
Nevertheless, after 2040 it should be gas to have the most consistent increase overtake both coal and petroleum.

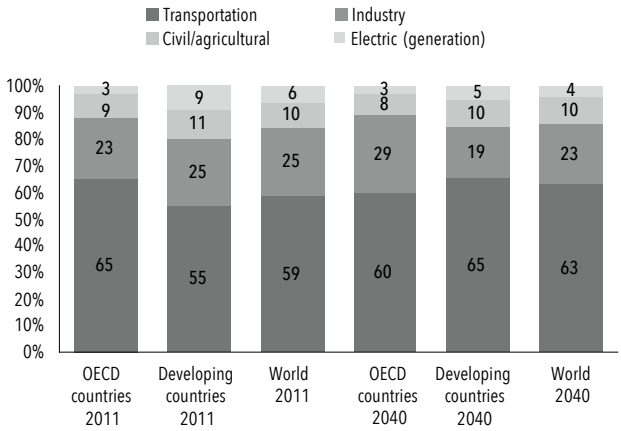
.... and will account for OPEC reaching 63% by 2040

With regard to the sectors, transportation accounts of all petroleum for the greatest quantity of petroleum: just take a moment was responsible 2011.
Based on studies carried out by, this share is destined to increase, of the entire demand for petroleum by 2040. This means that all the other sectors use just over 40% of petroleum consumption. In detail, industry uses 25% of the petroleum, 10% used by the residential sector, together with agriculture and a part of the commercial sector, while the energy accounts for just the remaining 6%.

...e ne assorbirà il 63% entro il 2040

Turning to the transportation sector and focusing attention on so-called "alternative" fuels and technologies, it has been observed that both offer high potential in terms of a reduction in operating costs, pollution and, in particular, CO2 emissions from

Fig. 4.1.1 - The forecast of world oil demand by sector, in OECD and developing countries (% value by sector) - Years 2011 and 2040



Source: Compiled by Veneto Region - Regional Statistics System Section from OPEC data

road going vehicles. In fact, progressive growth is forecast for the penetration of these technologies in the road transportation sector.

Among the alternative source for transportation is natural gas, though it still accounts for a marginal share

An alternative source of great interest, and already commonly used, is natural gas. In any case, today, it is still difficult to forecast how this source will develop in the road transportation sector.

Natural gas is used as a fuel for vehicles in two forms: compressed natural gas (CNG) or liquefied (LNG).

GNC has greater flexibility for use in cars and commercial vehicles: in fact, the surcharge for natural gas technology, compared to twin models fuelled by petrol has been contained. GNC is becoming always more attractive for light commercial vehicles, such as taxis, vans and pick-ups. In Italy, thanks to a substantial network of GNC stations already across the country, current new registrations of cars powered by natural gas has reached a share of 5% of the total. On the other hand, LNG must be maintained at very low temperatures to avoid it returning to a gaseous form. This requires the installation of special tanks to the vehicles, which are quite expensive.

In spite of these prospects, the road towards alternative sources in transport still seems long. In 2011, gasoline and diesel powered engines represented 97% of the entire fleet in circulation and will predominate for some time to come, according to OPEC forecasts, notwithstanding the increase hinted at prior to alternative technologies.

The reduction in pollution will be reached by reducing use of private vehicles and increasing efficiency of the latter

There are, however, two factors which should contribute to the reduction in energy consumption in the transportation sector: the progressive decrease in the mileage of private vehicles and the technological improvement aimed at greater efficiency. With regard to the first factor, which will manifest itself more widely in OECD countries, the age demographic of the population, the greater availability of public transport and traffic congestion will lead to the reduction in kilometres travelled per vehicle. In relation to the second factor, it is estimated that the improvements to the efficiency of vehicles, on a global level, could reach 2.2 % per year in the period 2013-2040.

Another rather import topic to consider is the environment. The production and consumption of energy generates pollution, especially through the use of traditional sources. In particular, it produces carbon dioxide (CO2). the main cause of the greenhouse effect and the rising temperature of the earth. The energy resources currently available on earth are always a concern with plans being developed to stretch the available reserves as far as possible, and continue to speak and promote renewable sources because traditional sources will "shortly" run out, however, there is another aspect to reflect upon.

The current reserves of fossil fuels are more than sufficient to cause a rise in temperature of greater than 2 degree

Or rather, from the environmental point of view, how much more pollution is possible through the use of traditional sources before the point of no returned is reached, for example, the rise in the average temperature on earth of 2 degrees centigrade? It has emerged from several studies that there are more than enough reserves currently available to exceed the limit by much greater than 2 degrees. This takes us to ano-

ther question on which to reflect, that is "how many resources can we still consume before we arrive at the point of no return?". If in the medium term, the components which can cause a global rise in temperature are multiple, in the long term, the root cause remains identifiable in the amount of carbon gases introduced into the atmosphere, and therefore CO2, a gas which due to its high stability in the atmosphere, in contrast to what occurs to other gases more easily disposed by the atmosphere (such as methane and nitrogen oxides). Therefore particular attention should be given to CO2: there is a direct link between the emissions of carbon dioxide and rise in temperature. This means that it is possible, though always with the necessary approximations, to understand, on the basis of what has been emitted till now, how much the atmosphere has heated, and also , based on what will be emitted, what rise in temperature we will face. It is possible to estimate the quantity of CO2 that can possibly be released in to the atmosphere and still contain the rise in temperature below 2 degrees centigrade. From studies carried out by the Intergovernmental Panel on Climate Change (IPCC), it has emerged that to achieve a 66% probability of containing the risk of a 2 degree rise in temperature, the overall emissions of CO2 (from the pre-industrial period, onwards), must be limited to within 2.890 billion tonnes (equal to 790 billion tonnes of coal). Up to now, 1.890 billion tonnes of CO2 (515 of coal) have already been emitted, therefore according to this calculation, there remains a residual credit of not more than 1.000 billion tonnes of CO2 (275 billion tonnes of coal). In other words, more than 65% of the coal which is admissible before exceeding the hypothetical target for limiting damage has already been emitted. Currently, 9.8 billion tonnes of carbon are released into the atmosphere per year, and if the trend continues we will have used up our carbon credit of 2275 billion tonnes of coal within 28 years. This imposes quite radical choices on a worldwide level with highly important cuts to the emissions of climate altering gases. There is also need for a strong change in direction across the entire system of energy production. This is very complicated because it involves radical change to an already highly consolidated system. In addition, on the basis of data about the reserves of fossil fuels, at the current time, these are much greater than what would be necessary to go through the above analysed ceiling and those countries whose economies are based on these sources, will have difficulty abandoning their use in order to face the environmental problems.

However, it is in this international context that the front-line effort of the European Union in the struggle for climatic change should be highlighted as, for years, it has been engaged in the development of a model for society which is more sustainable for the environment.

From the "20-20-20" strategy....

With this in mind, the "20- 20-20", launched in 2007 by the European Council and consolidated the following year with the approval of the Climate and Energy Package.

This last series of measures through six legislative instruments, establishes how it will be possible to achieve the expected objectives by the year 2020.

....to the strategy "40-27-27"

Another step forward was made in October 2014, when the European Council approved new climate and energy objectives updating those which had been previously set, and driving forward project forward to 2030.

The new objectives foresee:

- a 40% reduction in the emissions of greenhouse gases;
- the consumption of energy from renewable resources to rise to a share of 27% at the European level, though not setting targets for individual Countries;
- a 27% increase in energy efficiency. As with the "20-20-20" strategy, the next step will be the beginning of the road to the adoption of the legislative instruments aimed at achieving the new targets, expected in 2015.

  The first step was taken on 25 February of this year, when the Vice-President of the European Commission, project leader of the Energy Union team, and the Commissioner for Climate Action & Energy presented the three reports which will form the framework of the Energy Union strategy. The three communications were, respectively:
- "A framework strategy for a resilient Energy Union with a forward-looking climate change policy";

- "Achieving the 10% electricity interconnection target";
- "The Paris Protocol - A blueprint for tackling global climate change beyond 2020".

The first communication identifies a framework for the realisation of an Energy Union capable of ensuring that Europe has secure source of sustainable energy at prices which are affordable to all citizens. The second communication identifies the tools needed so that each member state is able to export at least 10% of its own energy production to their neighbouring countries. Lastly, the third communication sanctioned the position of the EU in view of the UN climate change conference to be held in December 2015. It contains the new European objectives for 2030 in the areas of energy and the already described reduction of greenhouse gases. The current trend of the indexes related to the "20-20-20" objectives show progressive improvement at the European level, resulting from a rather heterogeneous situation across member states.

With regard to greenhouse gases, the objective of the reduction of 20% seems achievable, as the Union of 28 member countries had already achieved an overall reduction of 17.9%, in 2012. Italy is slightly behind when compared to the European average, though it is still following a positive trend with a reduction (still looking at 2012) of 10.3% compared to the base year of 1990.

The 20% reduction in emissions of greenhouse gases is within reach: in 2012-17.9% at EU28 level

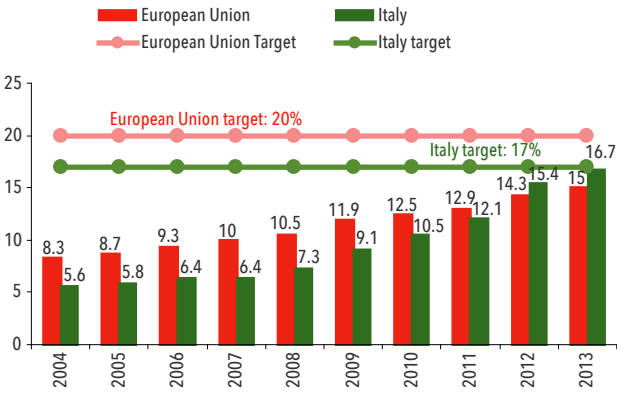
As regards renewables compared to final energy consumption, data are updates as of 2013 and the European figure is 15%. In terms of renewable sources of a national target of 17%, Italy has already reached 16.7%.

Renewable resources in the UE28 achieved 15% of consumption in 2013...

Lastly, with regard to efficiency and therefore energy savings, the calculation is slightly more articulated: to achieve a savings of 20% compared to 1990, it uses 2005 as the base year, giving it an index of 100. The target which emerges relative to the final energy consumption is equal to 91% by 2020 compared to 2005. The last figure available, from 2013, confirmed a European index of 93.1% for which, in this instance as well, the projection for 2020 is positive. With regard to each single country, they are not tied to individual targets. However, individual performances will be monitored as the achievement of the final European target is dependent upon them. On this front, Italy is doing its part, with an index number for 2013, equal to 88.2 and marking a reduction of 11.8% compared to 2005. With regard to this last index, the effect of the economic crisis, which surely contributed significantly to reduced consumptions of energy, must always be taken into consideration.

...and 16.7% in Italy

Fig. 4.1.2 - Percentage of renewables compared to total final consumption of energy (% value). EU28 and Italy - Years 2004:2013



Source: Compiled by Veneto Region - Regional Statistics System Section from Eurostat data

Tab. 4.1.2 - The 20-20-20 targets for the year 2020: the current situation in the EU28 - Year 2013

	2013 figures	2020 target
Greenhouse gas emissions (*) (% variation)	-17,9	-20,0
Renewable energies (% Impact on end consumption)	15,0	20,0
Energy efficiency (final energy consumption - index number compared to 2005)	93,1	91,0

(*) Value refers to 2012 Source: Compiled by Veneto Region - Regional Statistics System Section from Eurostat data

In evaluating the trend of the 20-20-20 indexes, it must be remembered that the final result is derived from the performances of all the member states

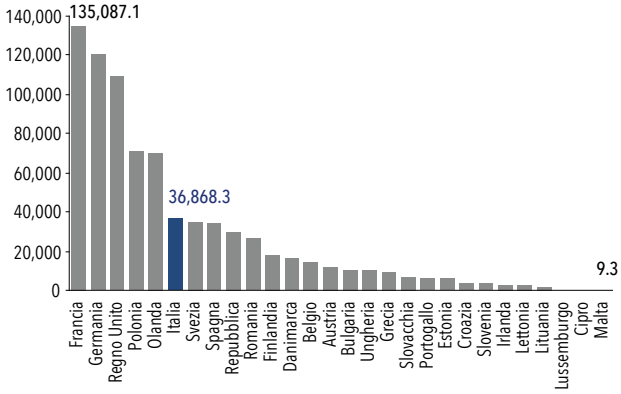
of the EU and that no individual situation or context is the same. The energy production capacities and relative consumptions are quite homogeneous between them, and this can be seen from the two following figures which show the data for primary production and final consumption in the 28 member states of the EU and from which can significant differences can be deduced.

The primary production of energy in Europe for 2013 was equal to 789,672 kilotonnes of oil (KTOE), compared to an internal gross consumption of 1,666,196 KTOE. This alone, shows the European problem of energy dependence on the countries exporting energy sources and, from this, the importance of the previous consideration about the relevance to their secure supply can be understood, as well as the development of alternative energy sources.

The energy dependence of the UE28 exceeded 53% in 2012

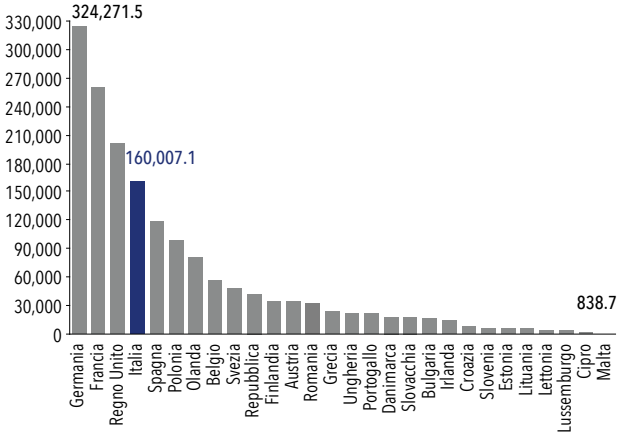
In greater detail, the data shows that the energy dependency of Europe, calculated as a percentage ratio between imports and gross internal consumption, was over 53% in 2013, a value stemming from situations among the various member states which were rather homogeneous: from Malta which was totally dependent to Denmark and Estonia, each with a dependency near 10%. Italy is still in a difficult situation with an energy dependency ratio equal to 77 %.

Fig. 4.1.3 - The production of primary energy (KTOE) in member states of the EU28 - Year 2013



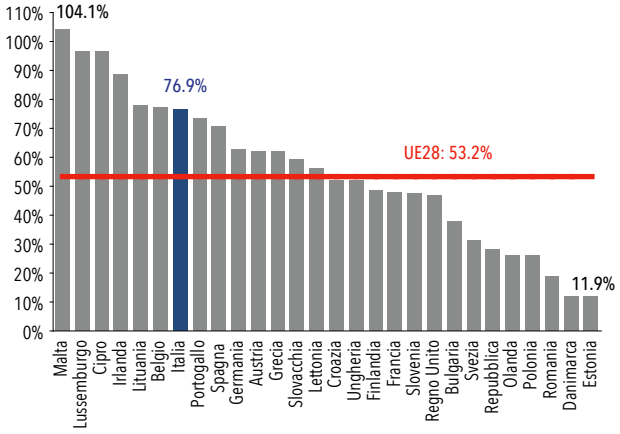
Source: Compiled by Veneto Region - Regional Statistics System Section from Eurostat data

Fig. 4.1.4 - Gross domestic consumption of energy (KTOE) in member states of the EU28 - Year 2013



Source: Compiled by Veneto Region - Regional Statistics System Section from Eurostat data

Fig. 4.1.5 - The energy dependency (*) of the EU28 and of the member states - Year 2013

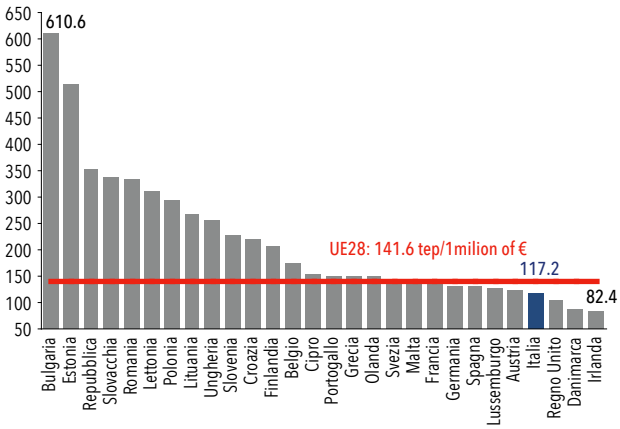


(*) Energy dependence is calculated as a % ratio between imports and gross internal consumption
Source: Compiled by Veneto Region - Regional Statistics System from Eurostat data

Beyond the problem connected to the supply of energy sources, what is the degree of efficiency in European countries? Here is the index which describes the energy intensity of GDP, which measures the quantity of energy necessary (KTOE) to produce one unit of income (€1 million of GDP). In this instance, as well, the difference between states

appears to be rather wide. It is enough to consider that faced with a European average of 141.6 ktoe/ million Euros, there is a range of 82.4 (Ireland) to a maximum value exceeding 610 ktoe/million Euros (Bulgaria). The situation in Italy is rather good, with an energy intensity of only just over 117 ktoe/million Euros, a value below the European average and which places our country in fourth place among the member states in order of energy efficiency in the production of wealth.

Fig. 4.1.6 - Energy intensity of GDP (ktoe/million Euros) (*) in the EU28 - Year 2013



(*) The energy intensity of GDP is the ratio between gross internal consumption and GDP, and measures the amount of energy (ktoe) required to produce a unit of GDP (€ 1 million of GDP). Source: Compiled by Veneto Region - Regional Statistics System Section from Eurostat data

4.2 The energy situation in Italy

In the context of energy, described in the previous paragraph, Italy may find a good possibility to relaunch its economy which would help the Country to exit from the economic recession which took hold in recent years.
Shares in Brent crude have almost halved compared to a year ago: in January they dropped to 45 dollars a barrel, then rose to between 60-65 dollars compared to an average price of 108 dollars in the first 8 months of 2014. This reduction was a breath of fresh air to all importing countries like Italy, allowing a short-term savings on several products such as fuels and electricity (even if here, due to the effect of heavy taxation, the reduction in costs for the consumer is by far lower than the price of crude), but also in the medium term on other goods and services, as well as on production costs which are progressively decreasing.
Thanks to this situation, from the middle of 2015, a reduction in energy prices should start to be seen and Italian families should benefit from this, especially those belonging to the lower income groups. In fact, the actual effect of the reduction of the drop in oil will, in countries like Italy , have less of an effect compared to the one which could have been enjoyed a few years ago as it has changed the energy mix of the country: it is enough to consider that the price of oil alone in 1995, 67.8 ktoe was consumed to produce € 1 million of GDP, while in 2013 its consumption decreased to less than 40.
The official figures on the energy balance stop at 2013 and, because of this, it is not possible to highlight the changes which over the recent months described previously regarding international markets.
It is, however, possible to some considerations on the changes already observable in 2013: in the year in question, the production of energy in Italy overall was equal to 43,821 ktoe, with an increase of 16.7% compared to the previous year.

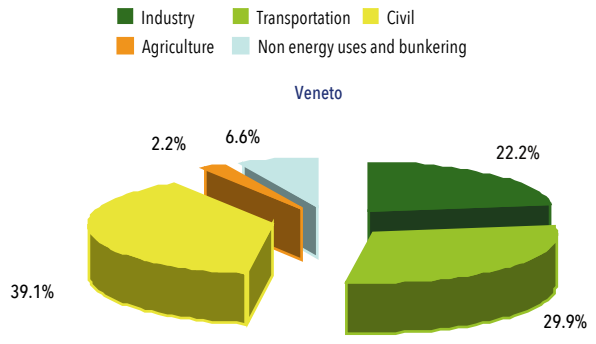
Energy production In Italy increased by 16.7% in 2013 compared to 2012...

This figure is explained by observing that, in the face of a sharp drop in energy produced from gas and solid sources, oil has slightly increased (+1.9%) but, above all, there has been a sudden rise in renewable sources which alone account for over 72% of the entire national production and which in one year increased by 29.4%. In view of the 43,821 ktoe produced, Italy imported 154 114 ktoe, exported 24,956 with a 15 ktoe variation in its stockpile and recording a gross domestic internal consumption of 172,994 ktoe, down 1.9 % compared to 2012. From the economic sectors point of view, the one that required the greatest amount of energy was the civil sector, absorbing over 39% of the final national consum-

....thanks to the sudden rise of renewable sources, which grew by 29.4%

ption, followed by transport with about 30%, then industry at just above 22%.

Fig. 4.2.1 - Final energy consumption (% values) in Italy by sector - Anno 201447



Source: Compiled by Veneto Region - Regional Statistics System Section from ENEA data

4.3 The situation in Veneto

On a regional scale, energy monitoring today is highly complicated and the heating and cooling, and transport sectors are paying the consequences and for which no statistics are no systematic and updated statistic are available on which to carry out in-depth analysis. Only the electric energy sector shows less criticality, as consolidated figures for annual production and consumption are available, allowing analysis the trends and transformation which have occurred over the course of almost 20 years.

Therefore, focusing attention on the electricity sector in Veneto, the data on the production of electricity in the period from 2000 to 2013 show two different realities between the Veneto and the rest of Italy: while the latter there was an increase occurred in 2008, a reduction 2009, a strong recovery in 2010 and 2011 and another decrease in the last two years, for the Veneto, production already began to contract from 2002, reaching an historic low in 2011. Only 2012 and 2013 saw a recovery in the regional production of energy. On the consumption side, however, unlike for the production, the regional trend rather faithfully reflects the national trend which was characterized by growth until 2008, followed drop in 2009, further recovery in 2010 and 2011, then a new downturn in 2012 and 2013. With regard to meeting the demand of energy consumption, Italy's high dependence on foreign imports has already been discussed.

Energy production decreased from 2000 to 2013 in Veneto

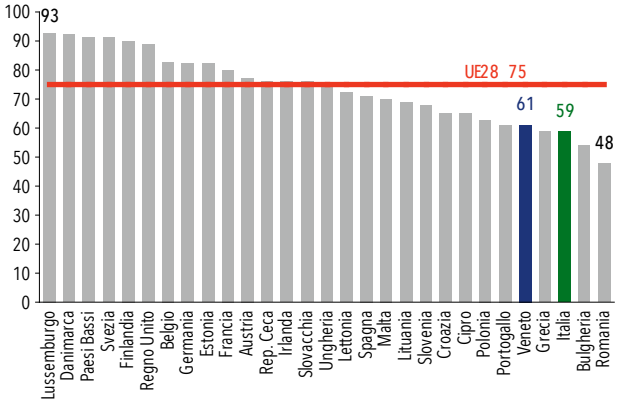
The energy dependence of the Veneto will exceed 58%

The situation in Veneto was even more difficult due to the ten year decline in the production of energy: in 2013, in view of a final consumption of 28,982 GWh, production stopped at 16,877 GWh, covering need by only 58.2% of consumption.

With reference to 2013, an analysis of the consumption of individual sectors shows that industry was the more expensive in energy terms, absorbing 42% of the total consumption of electricity in Italy. In Veneto, the same situation can be seen though it is even more accentuated, as industry exceeded 49% in the same year. The tertiary sector, in both Italy and Veneto occupied the second position, with 33.6% in Italy and 29.3% in Veneto, respectively. As for the domestic sector, it occupied third place in electrical energy absorption, with 22.5% in Italy and 19.1% in Veneto.

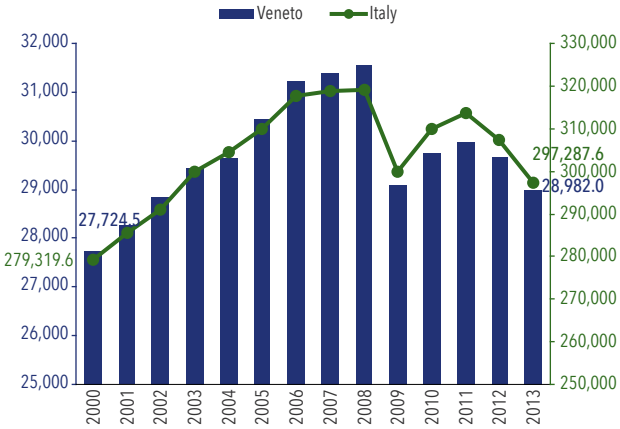
Industry in the Veneto accounts for over 49% of total energy consumption

Fig. 4.3.1 - Gross and net production (*) of electric energy (GWh). Veneto and Italy - Years 2000:2013



(*) Net production corresponds to the gross to net production of services auxiliary to the production
Source: Compiled by Veneto Region - Regional Statistics System Section from TERNA data

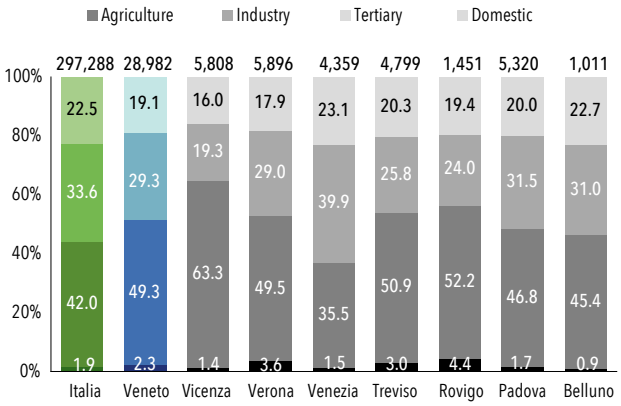
Fig. 4.3.2 - Final consumption of electrical energy (GWh) Veneto and Italy - Years 2000:2013



Source: Compiled by Veneto Region - Regional Statistics System Section from TERNA data

In contrast, agriculture used the remaining shares of just under 2% nationally and arriving at 2.3% regionally.

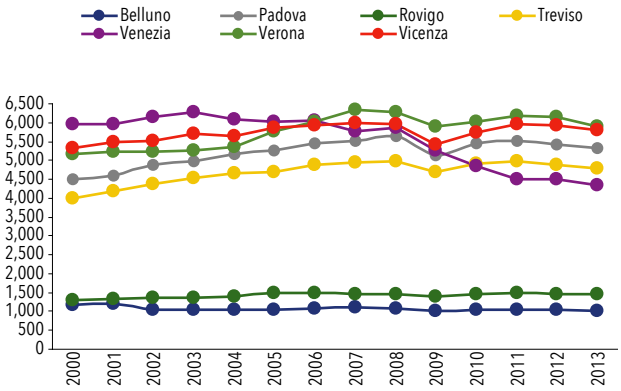
Fig. 4.3.3 - Final consumption of electrical energy by sector (% values and GWh) in Italy, Veneto and the provinces of Veneto. Year 2013



Source: Compiled by Veneto Region - Regional Statistics System Section from Terna data

Focusing attention on consumption at the provincial level and, in particular, the trend over time, three distinct groups can be observed: the first composed of Padova, Treviso, Verona and Vicenza which showed constant growth from 2000 until 2008, a downturn in 2009, recovery in 2010 and 2011, ending in a decrease over the final two years, faithfully mirroring the average performance of the region; the second group of Rovigo and Belluno, is characterized by a lower average final consumption compared to the and Belluno, is characterized by a lower average final consumption compared to the below the four provinces in the first group, a result of the drop in production in Porto Marghera.

Fig. 4.3.4 - Final consumption of electrical energy (GWh) by province. Years 2000:2013



Source: Compiled by Veneto Region - Regional Statistics System Section From TERNA data

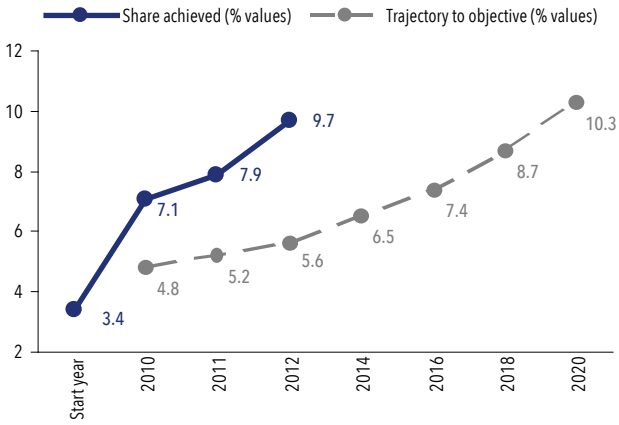
Touching on the issue of renewable sources and returning to the issue related to the European objective of 20 % coverage of consumption through their use, Italy responded to European Directive 2009/28/EC with Italian Law 4 June 2010, no. 96 and with Italian Legislative Decree 3 March 2011, no. 28. The Ministry for Economic Development later issued the Decree of 15 March 2012, more commonly known as "Burden Sharing": this divides the national target of 17 % coverage of the final energy consumption from renewable sources between the regions and autonomous provinces, assigning each its own target. For the Veneto, it has been determined that 10.3% of gross final consumption of energy will come from renewable sources by 2020 [1].

The regional objective of 10.3% of consumption from renewables is near: 9.7% in 2012

[1] The ratio is calculated as gross final consumption from renewable sources in the electric and thermal sector compared to gross final consumption in the electric, thermal and transportation sectors

The current situation shows a positive regional trend as the index for consumption from renewable sources on the target. However, some observations should be made on the results achieved up to now: in fact , if on one side, the contribution of renewables has grown significantly, the economic crisis has also led to a reduction in gross final consumption of energy should be considered. Therefore the 9.7% matured to up to now stems from the increase in both the numerator and decrease of the denominator.

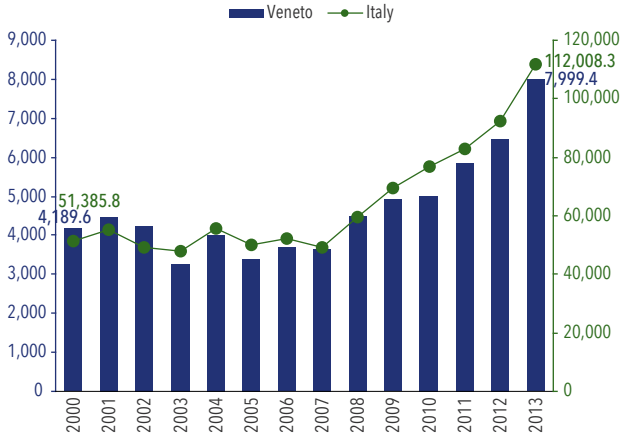
Fig. 4.3.5 - Share of gross final energy consumption covered by renewable sources (percentage values reached and trajectory of the objectives). Veneto - From the base year of reference up to 2020 (*)



(*) Performance of the index recorded in the base year of reference up to 2012 and trajectory of the established objectives starting from 2010 up to 2020
Source: Compiled by Veneto Region - Regional Statistics System Section from Energy Section data and compilations by University of Padova Department of Industrial Engineering, and Ministry of Economic Development data

Still looking at renewable sources, a positive trend in production can be observed in the electric energy sector which gradually increased over the years. In reality, both in Veneto and in Italy, it is possible to identify two distinct periods, that of 2000 to 2007 and from 2008 to 2013. In the first period, production from renewables remained fairly constant with the only oscillations due to the uneven performance of the principal renewable source, hydro-electric, while the second period experienced strong growth which carried forward to the current development. Fig. 4.3.6 shows the evolution of renewable source in Italy and in Veneto from 2000 up to 2013, the last year available and, as can be seen, the two performances are similar to each other.

Fig. 4.3.6 - Gross production of electrical energy from renewable sources (GWh). Veneto and Italy - Years 2000:2013

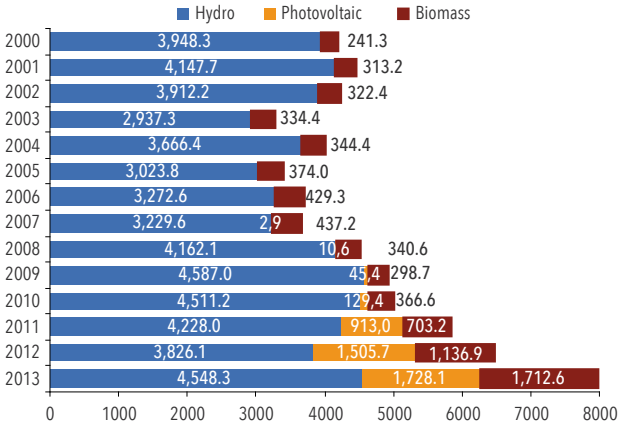


Compiled by Veneto Region - Regional Statistics System Section from TERNA data

But what has caused the change in gears beginning in 2008? The national policy of providing incentives surely played a significant role in the march towards renewable sources, particularly in photovoltaics which experienced a real explosion in 2010. Veneto saw a rise in production of just over 129 GWh in 2009 to 913 GWh, continuing its upward growth, until reaching 1,728 GWh, in 2013. The phenomenon can also be studied from the point of view of the plants and the installed power. In Veneto, in fact, PV plants grew by 1.068% from 2009 to 2013, increasing from 6,861 to 81,110 with the installed power also increasing at very high rates, rising from 78,303 MW in 2009 to 1,648,400 MW in 2013. At the same time as photovoltaic, a strong impetus also came from biomass, which had already produced an average of over 300 GWh in the previous decade, but starting in 2011, has experienced a boom similar to photovoltaic plants, where over the span of three years grew to produce 1,713 GWh of electricity (21.4 % of the production from renewables). The final result was an increase of over 62% in the regional production of electricity from renewable sources over the five year period from 2009 to 2013, reaching 8,000

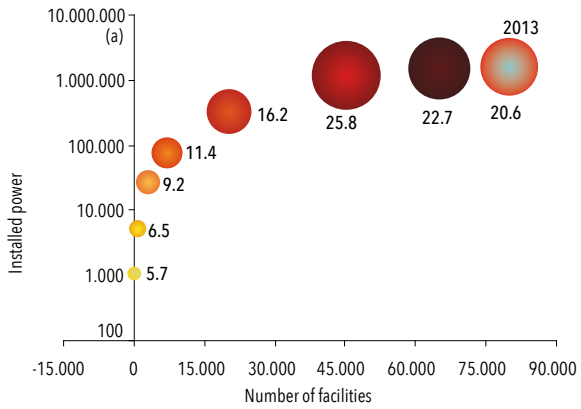
GWh overall in the final year, or rather 44.9% of the total production of electricity in Veneto.

Fig. 4.3.7 - Gross production of electrical energy from the principal renewable sources by type (GWh). Veneto - Years 2000:2013



Source: Compiled by Veneto Region - Regional Statistics System Section from Terna data

Fig. 4.3.8 - Number, power (*) and average power (**) of the photovoltaic plants operating in the Veneto Region by year - Years 2006:2013



**) The measurement of power is expressed in Kilowatts (KW)*
(**) The diameter of the bubble represents the average power
Source: Compiled by Veneto Region - Regional Statistics

4.4 A promising renewable source: biogas

Bioenergies represent a portion of renewable sources and are proving very interesting for the development opportunities they present and for the contribution they can make to reducing dependence on foreign sources of energy and the development of an energy system more sustainable from an environmental point of view.
Among the bioenergies, there is biogas which is obtained from organic substances sourced from agriculture, from livestock and by industry, through the anaerobic digestion of batteries. It involves a mixture of gases, among which methane (between 50 and 80%) and carbon dioxide predominate, each having a share between 20% and 50%, with hydrogen, oxygen, nitrogen compounds and sulphur also present in smaller quantities. The biogas produced is dioxide predominate, each having a share between 20% and 50%, with hydrogen, oxygen, nitrogen compounds and sulphur also present in smaller quantities. The biogas produced is industry (whey, liquids from the distillation of alcohol or fruit juices, fats, blood, slaughterhouse waste), water treatment sludge and organic fraction derived from municipal solid waste. Regarding dedicated crops , the use of agriculture for energy use could be a solution to reduce agricultural overproduction, as well as an alternative to using uncultivated areas and land left fallow. In relation to this, production has expanded over time focusing on certain types of plants such as the autumn-winter cereals (triticale, wheat, barley, rye), which also grow in unfavourable soil with a scarce supply of water, have low cultivation costs and, in some cases, are able to resist diseases and environmental stresses; as well as guarantee digestion for the fertilization of spring-summer crops. Also of significant importance are the livestock effluents which guarantee an important supply of microorganisms which trigger the anaerobic digestion stage digestion. It has been calculated that the average excrement from an average adult pig or cow can produce 0.100 and 0.750 m³, respectively, of biogas each day.

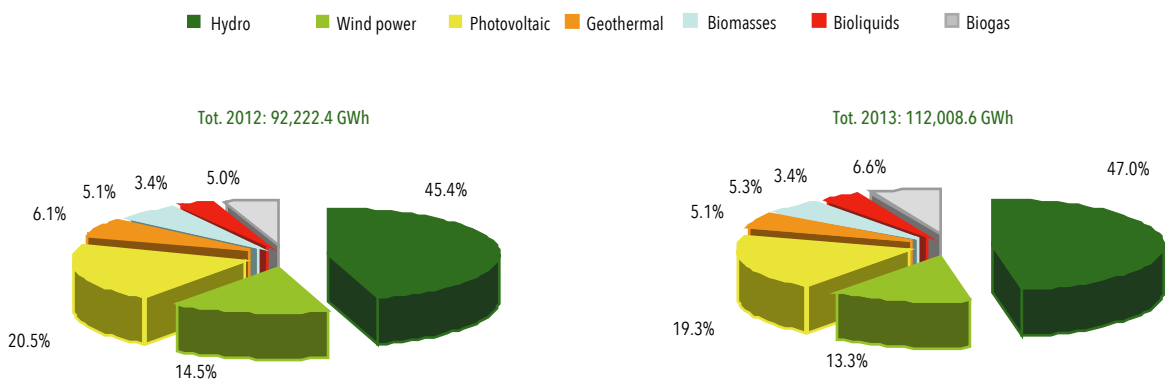
Biogas (from agriculture, livestock and industry) stands out among the bioenergies

The residue from the process of treating urban and urban and industrial waste water is classified by waste water sludge and their anaerobic digestion allows the stabilisation of the substance and the destruction of any pathogenic microorganisms, also aiding in the final disposal.
The organic fraction of municipal waste varies between 25% and 35% in terms of weight and has a high degree of putrescibility which makes it ideal for fermentation.
Lastly, crop remains, organic waste and waste water produced by the food industry are often used as cosubstrates combined with other biomass. The mixing of organic substrates from various sectors allows an increase in the production of biogas or its methane content, optimising the facilities and the recycling of nutrients. In addition, the mixing of various products allows compensation for the fluctuation of seasonal mass, therefore guaranteeing the stability and reliability of the process.
Biofuels used for the production of biogas do not all have the same potential, as this is linked to the composition of the material. A feature which has a significant negative impact on the production capacity is moisture content.
The contents of the dry substance, called total solids, is of fundamental importance to the treatment of the entire quantity of the biomass. By quantifying the TS percentage, we can again break it down into a mineral part and a part consisting of the so-called volatile solids (which represent 70-80% of total solids); this fraction corresponds to the portion of substrate which can potentially transform into methane and carbon dioxide. Among the various usable substrates, those which provide the potential for high quality biogas are the wastes from animal slaughter, which allow the production of approximately 730-1,000 cubic metres from a tonne of dry matter, while the main crops dedicated vary between 400 and 650 m^3/tonnes, similar to values for urban refuse. The matrices values for animal waste were, in contrast, lower. Among resources with a good potential for production, though till now under-utilised across Europe, there is biomass.. With the objective of promoting these resources, a source of renewable energy, the European program, Intelligent Energy Europe has financed Project GR (Grass to Green Gas) with 1.5 million Euros. Italian partners of the project are Veneto Agriculture and the University of Verona and, today, sees the cooperation of various stake-holder types such as organisations and companies engaged in the maintenance of green space in urban and semi-urban areas, farms and protected lands, land reclamation, social cooperatives, operators and owners of biogas producing plants, of biogas, planners and manufacturers of custom-built machinery, the collection and handling of herbaceous biomass, universities, associations, administrators, political, technical and legislative bodies.
A closer look at how a biogas system works, shows it is based on the anaerobic digestion of the biomass. This biological process occurs in the absence of oxygen and allows, through the degradation of organic substances, the production mixture of gases, among which carbon dioxide carbon dioxide and methane.
This process involves different microbe groups: hydrolytic bacteria, acidifying bacteria (acetogenic and homoacetogenic) and, lastly, methanogenic bacteria, or rather those which produce methane and carbon dioxide. The biogas produced through fermentation may be stored inside the digester or may be transported in an external tank. In the first instance, storage will be above the residue from digestion, beneath a suitably flexible, PVC based, gas-resistant cover.
From the process of digestion, biogas and digestate is obtained, or rather the by-product of the fermentation, which can be used as fertilizer on the main agricultural crops. The anaerobic digestion a reduction in the amount of less stable organic substances, but does not lower the nitrogen, phosphate and potassium content of the biomass loaded in the digester. In the majority of systems, the digestate is divided into solid and liquid parts: the solid part may be used in pre-plowing of renewable crops or autumn-winter cover, or in horticulture and fruit growing when there is a need for the supply of organic fertilizer with the ability to slowly release its nutritional elements. With regard to the liquid part of the digestate, in this fraction soluble compounds are concentrated, including ammoniacal nitrogen, which can account for up to 70-90 % of the total nitrogen present. The high percentage of nitrogen guarantees a nutritional effect to the crop and being liquid allows easier filtration in the soil.

The digestate interacts differently with the various crops, in particular corn and sorghum which have an excellent capacity to use the by-product while, among crops with a higher propensity for receiving the digestates, there are grasslands. Less adapted to the use of digestates are the autumn-winter cereals, because the requirement of nitrogen is rather limited. The sugar beet is also rather unsuitable to digestates, in that the excess nitrogen in the final stage of the cycle has a negative impact on the technological properties of the product.
Finally, for horticultural crops and orchards the solid fraction of the digestate, which should have a good degree of stabilization, is better to use.
The proper use of digestate implies, in addition to the benefits in terms of improved yield provided by fertilization, reductions to the impact caused by farming activities, as well. In the first place, the use of the transformation of biomass through anaerobic digestion allows for decrease in the emissions of methane.
A second feature regard ammonia, as digestion brings a reduction in the viscosity of the digested substrate allowing a more rapid absorption in the soil and also results in less ammonia being lost due to vaporisation. In addition, anaerobic digestion reduces the emissions of nitrous oxide, lowering the bacterial load of the biomass and, lastly, thanks to the organic stability of the digestate produced, has a resulting decrease in the production of odours.

The key to the growth of this sector in the coming years will be the transition from the biogas to biomethane. Biogas is composed of 50 to 80 % methane (CH4), with a lower percentage of carbon dioxide (CO2); therefore biomethane refer to when the biogas undergoes a refining process that allows this gas to arrive at concentrations similar or superior to those of natural gas. In fact, to be used, biogas must be brought to a share of at least 80% of methane, just as it is for the gas of fossil origin. Each year, Italy imports approximately 70 billion cubic meters of natural gas, and the production of biomethane could help to reduce the dependence on imports. It should also be noted that, unlike other renewable sources such as wind or solar, biomethane produced from biogas is a programmable source, therefore it can be used throughout the year without major fluctuations. Once the quality of the biomethane is optimised, it can be used as fuel for transport or sent to the network.
As for motor vehicles, 2011 recorded sharp downturns in the consumption of diesel and petrol , and an increase in consumption of LPG and natural gas; in 2012, particularly, the registrations of vehicles powered by natural gas (bi-fuel , buses and Dual Fuel) increased by 42.6 %. It is also important to remember that a car powered by methane saves on emissions by 21% compared to diesel, and 24% compared to petrol. Also, if the natural gas was used with a mixture composed of 20% biomethane emissions would be further reduced and, if 100%

Fig. 4.4.3 - The production of energy from renewable sources in Italy by source (% values) - 2012 e 2013



Source: Compiled by Veneto Region - Regional Statistics System Section from Ismea data

of the latter were used the emissions could be reduced to just 5 gr of CO2 per km.

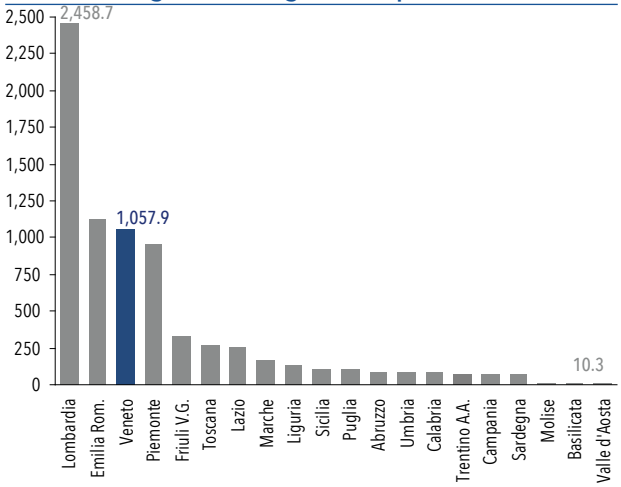
Biogas accounted for 6.6% of the production of RES in Italy in 2013

What is the current relevance of the biogas sector compared to the rest of the energy sector in Italy. and, particularly with respect to the rest of the renewable sources? In Italy, 7,447.7 GWh of biogas energy were produced in 2013, which corresponds to 6.6% of the total production of RES; with regard to the power supply from biogas production facilities in Italy, this achieves 3% of the power installed with reference to the total of RES.

The development of biogas in the period from 2006 to 2013 experienced a strong evolution in this sector; just consider that in 2006, the production of this source in Italy stopped at 1,336 GWh, approximately one third of that from biomass, and thanks to the 7,447.7 GWh produced in 2013, the overtake occurred.

As for the geographical distribution of the production of energy from biogas, it can be seen that more than 82 % of the national total is concentrated in the regions of Northern Italy, particularly in the Pianura Padana, characterised by its large farming operations, ideal for development of biogas, itself. For a complete analysis of biogas, as well as the division between plants which are cogeneration and not, the data for the arrays used to produce it was also studied. It emerged that the biogas co

Fig. 4.4.1 - Energy production from renewable sources, from bioenergies and biogas in the provinces of Veneto



Source: Compiled by Veneto Region - Regional Statistics System Section from GSE data

mes, principally, from agriculture and forestry (66 %); the substrates derived from the waste, which account for 22% of total energy production, are also of significant importance, while for cogeneration production the matrices derived from animal manure, of 12%, are highlighted. Of less importance to the production of energy are instead, sludges, with percentages which do not exceed 2%. The large increase in biogas recorded in recent years

Tab. 4.4.1 - Power from plants using renewable sources in Italy by source (KW and % impact) - Years2012 e 2013

	2012		2013	
	KW	% Impact	KW	% Impact
Hydro electric	18.231.993	38.3	18.365.890	36.9
Wind power	8,119,401	17.0	8,560,808	17.2
Solar	16,689,505	35.1	18,053,038	36.3
Geotermica	772,000	1.6	772,990	1.5
Biomass	1,432,107	3.0	1,603,872	3.2
Bioliquid	1,026,807	2.2	1,041,184	2.1
Biogas	1,342,659	2.8	1,388,366	2.8
Total	**47,614,472**	**100.0**	**49.786.148**	**100.0**

Source: Compiled by Veneto Region - Regional Statistics System Section from GSE and Terna data

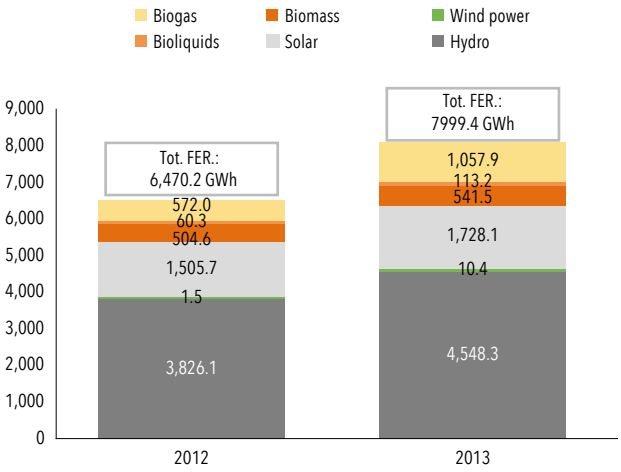
is related to the use of dedicate crops and waste from agriculture: in fact, if the production of biogas from waste has remained fairly constant, starting from 2010, the production of biogas from plants using matrices from agriculture and forestry has grown exponentially. But it is also considerably lower than the increase in production which uses animal manure.

Shifting attention to the Veneto observed that the impact of biogas on the other renewable sources is greater compared to the Italian average, having exceed 13% in 2013, thanks to the nearly]1,058 GWh of energy produced. If we focus only on bioenergy, the importance of biogas can be even understood, again in 2013, accounting for almost 62 % of the regional total of bioenergy production.

Biogas accounted for 13% of the production of RES in Veneto in 2013

Lastly, we take a more detailed regional comparison of the production from RES, bioenergy and biogas, in the different provinces of Veneto in the year 2013. With regard to renewable sources, it emerges that the province of Belluno sits in first place with 2,688.2 GWh (33.6% of the total), followed by Verona with 1,456.1 GWh (18.2% of the total). For bioenergy, it is the province of Venice in first position, with 495.6 GWh, corresponding to 28.9 % of the regional total, followed by Padova, with 393.1 GWh , equivalent to 23 %. The province of Padova is at the top for production of energy from biogas with 28.2%, which corresponds to 297.9 GWh, with the province of Verona in second position with 253.2 GWh. The province of Belluno, which among the RES sat in first place, does not even reach a 1% share of biogas. This is because, as we have seen, biogas is produced mainly from the use of dedicated crops or agricultural waste which requires large flat areas to cultivate the raw material to be used to supply the plants, without having to transport the material for long distances as that would impact on costs.

Fig. 4.4.2 - Energy production from RES (GWh and % values) by source in Veneto -Years 2012 and 2013



Source: Compiled by Veneto Region - Regional Statistics System Section from GSE data

Tab. 4.4.2 - Energy production from renewable sources, from bioenergies and biogas in the provinces of Veneto

	2012			2013		
	Production from RES	Biogas production	Biogas production	Production from RES	Biogas production	Biogas production
Belluno	2,193.4	212.6	4.5	2,688.2	205.1	7.4
Padova	543.5	250.1	169.3	784.1	393.1	297.9
Rovigo	452.9	87.5	86.9	448.0	136.7	119.2
Treviso	1,002.9	37.5	32.0	1,166.9	71.9	74.8
Venezia	452.9	325.1	109.8	672.0	495.6	245.8
Verona	1,184.0	136.4	132.7	1,456.1	273.4	253.2
Vicenza	640.5	87.5	36.6	784.1	136.7	59.6
Total Veneto	**6,470.2**	**1,136.7**	**571.8**	**7,999.4**	**1,712.6**	**1,057.9**

Source: Compiled by Veneto Region - Regional Statistics System Section from GSE data