The role of natural gas in the Heating and Cooling sector and its contribution to the decarbonization strategy in Italy

Gas heat pumps: a pathway towards low-carbon buildings

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The parties that signed this *Position Paper*:

- share the vision of a **strategy for combating climate change** capable of determining an energy transition towards a low-carbon economy **founded on sustainability, efficiency and a circular use of resources**;
- consider **the role of natural gas and biomethane** to be **fundamentally important** as a tool for activating efficient decarbonisation options for the country;
- consider **the achievement of ambitious building emission reduction targets** to be **crucial**, taking account of some unavoidable conditions:
  (1) The **entire building stock in Italy must be able to contribute actively to the decarbonisation process**;
  (2) **The characteristics of the existing buildings influence** the range of efficient technological options;
  (3) **Measures must be sustainable for families and companies in order to improve effectiveness in line with the targets**;
  (4) Energy (in terms of capacity and delivery) in the **decarbonisation of buildings sets important "Heating & Cooling" solutions, with their implications on the country's energy infrastructure system.**

In this setting, the **availability, on the one hand, of gas heat pump technology, which ensures primary energy savings of over 40% compared to a conventional boiler, and, on the other, of a widespread infrastructure system for transmission, distribution and storage of gas, offers an effective solution to decarbonisation needs**.

The *Position Paper* subscribing parties highlight that, using **gas heat pump technology** and **the availability of a widespread gas network,** an **efficient and immediately implementable strategy for decarbonising the country's buildings is achievable.**

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The country's decarbonisation targets and the characteristics of the buildings

Heating and Cooling is one of the key sectors for reaching the decarbonisation targets set by the European Union. In fact, buildings alone account for well **over 30% of the energy consumption and emissions** in Italy (and in Europe) and **Heating & Cooling** accounts for over 80% **of the energy consumption of buildings.**

The European Roadmap for decarbonisation in 2050 sets a reduction in emissions of about 90% with respect to 1990, as a target for the Heating & Cooling sector. The **construction of new buildings** that can be classified as "Nearly Zero Energy/Emission Buildings" (NZEB) and the **renovation of a significant proportion of the existing buildings** are cornerstones for reaching this objective by 2050.

The construction of **new buildings** gives architects and heating designers many degrees of freedom (exposure, opaque and glass surfaces, insulation, low-temperature emission systems, controlled ventilation systems, etc.) for reaching the **Nearly Zero Energy Building (NZEB) classification** laid down in the recent legislation. It should, however, be observed that the **renewal rate of existing buildings is well below 1% per year** and so the contribution that new buildings will make to the country's decarbonisation, though significant, will not be the most important.

Most of the **existing buildings** (which amount to a total property value of over 6,000 billion euros and 87% of which are owned by private individuals) have heating systems based on a low-efficiency **conventional boiler**, with **radiators** as their heat emitting systems.

In this setting, since 2015, an extremely important step forward has been made with the switch, now obligatory by law, to the production and sale of condensing boilers instead of conventional ones. Nevertheless, in order to achieve the 2050 decarbonisation targets, **further reductions in emissions from existing buildings will be necessary.** These reductions can be obtained both by improving their envelope and by introducing a cheaper and more rapid requalification of the equipments.

One of the crucial steps of the country's decarbonisation process is to promote the diffusion of heat pump technology, which, by taking a significant amount of renewable energy from the environment, makes heat pumps much more efficient than boiler-based systems.

1. Heat pump technology and its integration in buildings

With a view to gradually involving the country's entire building stock in the decarbonisation process, it is essential that the barriers to the entry of heat pumps on the market are minimized.

From this point of view, it should be observed that electric heat pumps, which are a mature and suitable technology for the new buildings market, present some major limitations, which are confirmed by the **difficulties encountered[1] in their introduction in the replacement of existing systems and the renovation of existing buildings**.

[1] In Italy, years after the installation of the first heat pumps, the annual sales of heat pumps for heating systems are about 23,000 units; data supplied by the European Heat Pumps Association, 2015.

There are two main reasons for this:

- Electric heat pumps installed in existing residential buildings often entail a **major investment**, due both to the higher cost of the machinery compared to the boiler and, above all, to the transformation of the heat distribution system from radiators to lower distribution temperature systems (such as a radiating floor), so as to ensure optimum performance of the generator.
- **A higher price of electricity to the end consumer than that of gas** for an equivalent amount of energy[2]. The operating cost of an electric heat pump does not always ensure significant economic savings for the end consumer compared to the traditional technology used in existing buildings.

2. The opportunities offered by gas heat pump technology

The latest developments in gas heat pump technology overcome the limitations presented by the electric heat pump by activating the thermodynamic cycle without using electricity. This opportunity is offered by gas-fired heat pumps, which can be divided into gas absorption heat pumps (GAHP) and gas endothermic heat pumps (GEHP).

While the former use the heat produced by a heat generator to supply an absorption cycle, the latter have a vapour compression refrigeration circuit activated by an endothermic engine.

These two types of gas heat pumps present similar application benefits in terms of energy efficiency and the recovery of renewable energy from the environment because:

1. They provide a **primary energy saving of at least 40%** with respect to a conventional gas boiler, obtained through the recovery of renewable energy from the outside environment;
2. **They reduce the operating cost of heating for the end consumer by more than 30%** and thus ensure one of the lowest energy costs of all the technological options for heating buildings.

At the same time, each of them presents specific advantages in relation to the use, type of building and climate zone:

- **GAHP technology** produces tangible, proven advantages for the end consumer because it is easy to integrate in buildings, both in new buildings and in renovated existing buildings, as it is fully compatible with heat distribution systems based on radiators, which are much more widespread in Italian buildings than the low-temperature systems (such as radiating floors), and can operate efficiently even using ambient air as the source. This feature significantly reduces the size of the investment required of the end consumer and has a particularly broad field of application (in that it does not require a radiating floor and geothermic well). It is therefore a low-cost option for decarbonising heating sector, the most widely used in buildings, capable of minimizing the financial burden of the renewable energy incentive systems for consumers and taxpayers.

[2] The ratio between the price of electricity and the price of gas for the end consumer is approximately 3:1 (AEEGSI, Yearly report on the services and the activity carried out, 31 March 2016), and this value does not take into account the costs for the larger amount of power required by the electric heat pump.

- **GEHP technology** optimizes the energy performance of buildings, whether new or subjected to renovation/energy requalification, by recovering the residual heat of the endothermic engine and thus eliminating the inefficiency associated with defrosting cycles and the need for integration with other devices under conditions of intense cold, and producing hot water at a high temperature free of charge. During the summer, by adding this recovered energy to the cooling power produced, extremely high energy performance levels of more than 180-190% are achieved. This technology is therefore particularly advantageous in sectors with major heating and cooling requirements, such as the service and industrial sectors.

Both these technologies also present various possibilities of integration with other technological applications, such as micro-cogeneration, tri-generation and solar thermal energy, which can further improve their energy efficiency and renewable energy footprint.

In addition to these significant advantages for the end consumer, gas heat pumps bring **major benefits for the country's economy, such as**:

- **reduction of greenhouse gas emissions** (carbon dioxide), which can be eliminated if the heat pump is fired with renewable gases (biomethane and bio-syngas obtained from power-to-gas systems);
- **reduction or, in some cases, elimination of harmful emissions for human health**, such as nitrogen oxide, particulate and organic gaseous compounds;
- **maintenance of high performance also with extreme weather**: the different thermodynamic cycle enables high powers and levels of efficiency to be reached also under conditions of intense cold, reducing the use of defrosting cycles;
- **optimization of use and development of both gas and electricity energy network:**
  - Avoiding costly upgrades of the electricity network that would be necessary if a model based on the Heating and Cooling electrification were to be adopted;
  - Making best use of the existing gas infrastructure (transmission and storage) already sized to efficiently cover peak winter cold and able to increase load factor in the summer with use for cooling;
- **with particular reference to GAHP technology, positive repercussions on the specific sectors of advanced research and manufacturing in Italy**, currently the world leader in the development of these heating technologies.

The possibility of **reaching the decarbonisation targets in an economically efficient way is a must** to avoid consumers and the country's economy extra cost for adapting the energy system, thus also contributing to the **competitiveness of Italy's economic system**.

The parties that signed this *Position Paper* wish to make the following recommendations to allow the Italian economy to take advantage of the benefits offered by **gas heat pump technology and the availability of its supporting gas infrastructure** in the decarbonisation process.

3. Recommendations

The **European and Italian legislation under discussion should favour the exploitation of the numerous advantages offered by the gas heat pump so as to ensure an efficient and economically sustainable decarbonisation pathway**.

To reach these decarbonisation objectives, the following principles are essential:

- **technological neutrality**,
- **unitary system vision**,
- **effectiveness in terms of primary energy** and, above all,
- **ease of application** and **affordability for end consumer**s

To obtain this result, it is important to:

1) Make sure that the revision of Directive 2009/125/EC *Ecodesign of Energy-Related Products* considers the **actual** (i.e. not simply based on trends or hopes) **energy conversion factors** and the **affordability factor for the end consumer**. Adding information about the economic saving alongside the primary energy saving **will help the end consumer to be more aware of the available options in terms of cost and environmental sustainability**.

2) **Review the implementation of Directive 2010/31/EU, the Energy Performance of Buildings Directive (EPBD), specifically where restrictions on the integration of renewable energy sources in buildings are dealt with.** This is because an insufficiently well-considered transposition of this Directive in the Italian legislation through Annex 3 of Legislative Decree 28/2011 has:
   a) applied the "Nearly Zero Energy Buildings" (nZEB) requirements to buildings subjected to major renovation works: in Italy, this has resulted in the practical impossibility to respect the legal provision;
   b) imposed renewable energy integration requirements indiscriminately to any type of new building (or building subjected to major renovation), irrespective of the climate zone and the size of the electrical, heating and cooling loads, thus eliminating the possibility of applying a general technical and economic optimization criterion;
   c) strongly limited the adoption of a principle of **rationality** and **technological neutrality** by defining renewable energy source accounting criteria based on final energy instead of primary energy, thus introducing a significant inconsistency with the rest of European and national legislation. This has resulted in the practical exclusion of gas heat pump technology from the market of new buildings or those subjected to major renovation.

3) Make sure that **the technological solutions introduced on the market maintain a correct cost allocation**, in particular, avoiding possible forms of cross subsidization between gas consumers and electricity consumers also through changes to the tariff structure. Situations in which the gas system is given the responsibility of covering the peak demand for heating and paying the applicable costs, while the electrical system is to cover most of the energy consumption at non-peak times, create an evidently **inefficient allocation of costs detrimental to the gas system**. Gas heat pump technology intrinsically overcomes this problem of inefficient cost allocation.

The application of these principles will enable **part of the heating requirement to be covered with energy taken from renewable sources**, using an **economically efficient and easily implementable solution for the entire heating and Cooling sector**, made available by **efficient use of the existing and widely distributed gas infrastructure**.