ECCO

THE ITALIAN CLIMATE CHANGE THINK TANK

THE NATIONAL ENERGY AND CLIMATE PLAN

A plan for action

SECTORAL SCENARIOS

Building sector

SECTORAL DECARBONISATION SCENARIOS

The new version of the NECP must update national and sectoral targets on the basis of a more ambitious EU- wide greenhouse gas (GHG) reduction target of **-55% by 2030 compared to 1990 levels,** as redefined with the approval of the *"Fit for 55"* package, i.e. the set of directives and regulations that sets climate and energy objectives for Member States aligned with the climate neutrality objective in 2050.

This objective translates into the achievement of the objectives set out in the following table:

	Unit of measure	Data 2021	Fit for 55 target
Greenhouse gas reduction targets			
ETS reduction target (compared to 2005)	%	-47	-62
Effort Sharing reduction target (compared to 2005)	%	-17	-43,7
Absorption Increase Target (LULUCF)	$MtCO_{2eq}$	-27,5	-35,8
Renewable Targets			
Share of RES in gross final energy consumption	%	19	38,4%-39%
Share of RES in gross final energy consumption in transport	%	8	29%
RES share in gross final consumption for heating and cooling	%	20	29,6%-39,1%
Share of hydrogen from RES on the total used in industry	%	0	42%
Energy efficiency targets			
Primary energy consumption	Mtep	145	115 (±2.5%)
Final energy consumption	Mtep	113	94,4 (±2,5%)
Annual savings in final consumption	Mtep	1,4	73,4

Table 1 – *Objectives of the National Integrated Energy and Climate plans as identified by the Fit for 55 Package. The ETS objective is intended at EU level, while other targetsare to be seen at national level. (Source NECP 2023)*

Without considering the emissions under EU ETS which have a EU-wide reduction target[1], in line with the new objectives, national emissions by 2030 relating to the sectors included under the *Effort sharing Regulation* should fall from the current 284$MtCO_{2eq}$ to **194 $MtCO_2eq$[2],** meaning more than 30% compared to 2021 levels. It is important to underline that the reduction target is only the end point of a reduction trajectory with **binding annual targets,** so that any non-compliance in each of the years cumulates over the period 2021-2030.

[1] Equal to -62% compared to 2005, and also includes emissions from the maritime and aviation sectors.

[2] Estimated by applying a reduction of -43.7% compared to the 2005 level of 343.8 MtCO2e and as also indicated in the 2023 NECP proposal https://commission.europa.eu/system/files/2023-07/ITALY%20-%20DRAFT%20UPDATED%20NECP%202021%202030%20%281%29.pdf

In addition, **under current policies,** and taking into account the effects of measures adopted up to 2021, including those defined in the NRRP (National Recovery and Resilience Plan), an emissions gap of more than 10 $MtCO_{2eq}$ already appears in 2021. As shown in the table below, this gap, continues to grow to 52.5 $MtCO_{2eq}$ by 2030 in the absence of further measures.

	1990	2005	2021	2025	2030
			MtCO2 eq.		
Greenhouse gas emissions (excluding LULUCF), of which:	**523**	**594**	**418**	**373**	**350**
ETS Sectors		248	132	124	110
Effort Sharing Industries (ESR)		344	284	263	246
Effort Sharing Objectives (*)			273	241	194
Distance to ESR targets			***10,9***	***22***	***52***

Table 2 – *Historical greenhouse gas emissions and projections under current policy baseline for the ETS and non-ETS sectors. Source: ISPRA - NECP 2023*

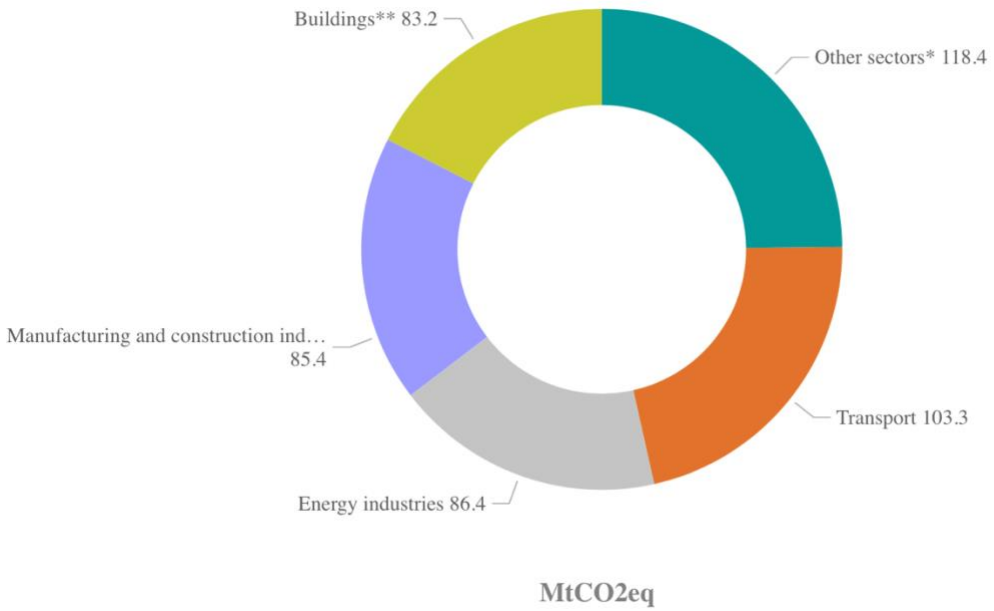

Figure 1 – *Contribution of individual sectors to total GHG emissions in 2021. Consistent with the NECP scenarios and the greenhouse gas inventory, the building sector includes emissions from Agriculture 'energy'; Other sectors include the remaining fugitive and non-energy emissions (Industrial Processes, Agriculture and Waste).*

The Effort sharing sectors, for which it is necessary to achieve annual and binding reduction targets for Italy, include the building and transport sectors, both of which are very significant in terms of emissions, accounting respectively for about 29% and 36% of the total ESR[3] sectors and the industrial sector with installed capacity of less than 20MWt (14% of the total ESR including emissions deriving from industrial processes and the use of products (IPPU)). Agriculture (only non-energy, i.e. livestock and crops, 11%) and waste (7%) are also included (Figure 1).

[3] Source: Table 5.5 https://www.isprambiente.gov.it/files2023/pubblicazioni/rapporti/rapporto_384_2023_le-emissioni-di-gas-serra-in-italia.pdf, 2021 data

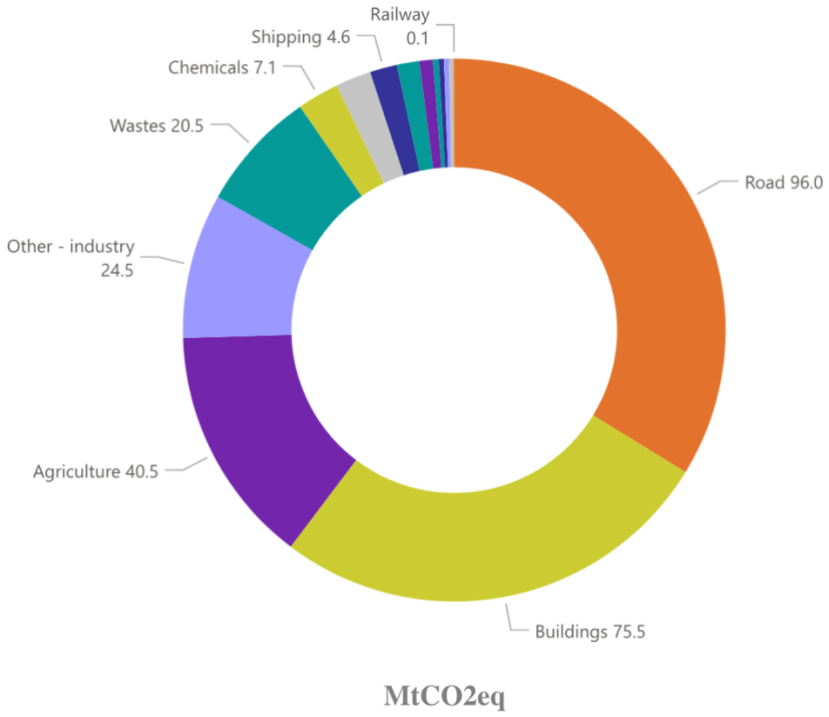

Figure 2 – *Emission contribution of the individual sectors compared to the total included in Effort Sharing. Date 2021. ECCO elaboration on ISPRA2021 data.*

In order to be able to analyse and make alternative or complementary proposals to those currently present in the NECP, a *bottom-up* 2021-2030 emissions scenario has been developed, i.e. **starting from the policies and their expected effect,** in order to highlight their risks and opportunities. The scenario, called ECCO-FF55, has been developed for the four main macro-sectors of energy production and use: power, buildings, industry and transport. These account for 76% of emissions and are the sectors with the greatest abatement potential by 2030. The work is not based on the use of a model, strictly speaking, but on a simplified **bottom-up evaluation methodology developed to associate emission reductions with the policies and measures framework, providing information on their priorities and effectiveness, investment needs and the reform framework needed to enable the transformation.**

For each sector, the following chapters will show:

1. The main characteristics of the sector, the emission share, the historical trends and the main drivers of these trends.
2. The main differences compared to the NECP2023 scenario.
3. The policies underpinning the ECCO scenario, highlighting priorities and, where possible, integrating cross-cutting dimensions, in particular the financing of measures.

Attached to the document, a table is provided with concrete examples of 'flagship measures' for each sector, which shows the information that would be necessary to be able to **accompany each measure from its design to its implementation.** Where possible, indicators for monitoring the measures have also been indicated.

The paper does not assume scenarios for process emissions from industry (7%), the LULUCF sector (Land Use, Land-Use Change and Forestry) (6% as removals), agriculture (9.6% energy and non-energy): for these sectors the scenario data have been taken as they are from NECP2023. Similarly,

the production potentials of biofuels were assumed to be equal to those of the NECP and a sensitivity analysis was carried out.

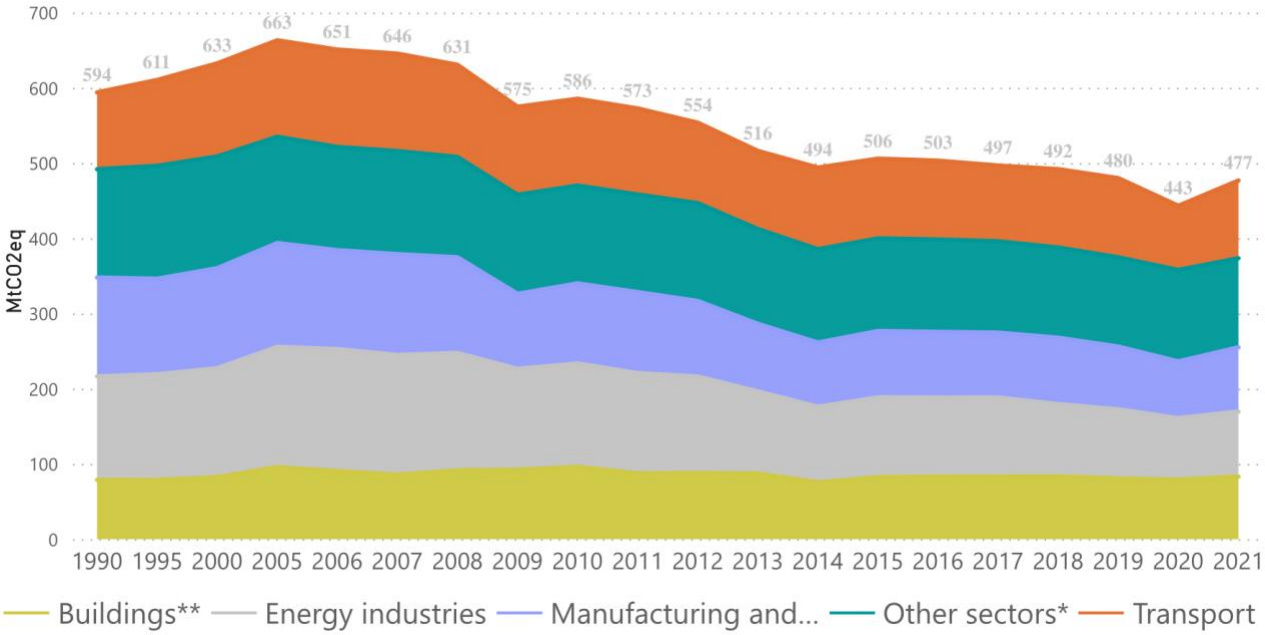

Figure 3 – *Historical evolution of GHG emissions by sector, excluding LULUCF. Other sectors* includes emissions from other energy and fugitive uses, agriculture (livestock and crops) and waste - Source: ECCO elaboration on UNFCCC data [MtCO2eq]*

The ECCO-FF55 scenario considers **Italy's commitment at the G7 towards a substantially decarbonised power system by 2035[4],** enhancing the results obtained from the dedicated modelling exercise. In addition to adhering to the commitments Italy made at the international level, this methodological choice is based on the need to **facilitate the transition across all economic sectors.** In general terms, within the energy consumption sectors, the main *drivers* of reduction are energy efficiency, the electrification of energy consumption, and the production and use of green hydrogen in hard to abate industries.

Only a competitive and decarbonised power system that guarantees stability and energy security for households and businesses can concretely enable the decarbonisation of the country 's energy consumption sectors and economic system. The ability to envision a new power system, able to effectively support the rapid uptake of renewables with appropriate and innovative solutions for stability and supply security forms, represents the foundation of a plan capable of achieving the objectives and aligning the country with the committed decarbonisation pathway.

Given the strategic relevance of the decarbonisation of the power sector, the ECCO-FF55 scenario is based on a modelling analysis explicitly developed for the power sector and fully integrates its results into the overall reduction scenario (i.e the ECCO-Artelys scenario).

[4] Comuniqué 2023 https://www.whitehouse.gov/briefing-room/statements-releases/2023/05/20/g7-hiroshima-Leaders-communique/#:~:text=We%20reaffirm%20our%20commitment%20to,temperature%20rise%20within%20reach%20and, which recalls the communiqué of the previous year https://www.bmuv.de/fileadmin/Daten_BMU/Download_PDF/Europa_International/g7_climate_energy_environment_ministers_communique_bf.pdf

In the period 2021-2030, the ECCO-'*Fit For 55' (*ECCO-FF55) scenario envisages an overall reduction of **-54.5%** in GHG emissions **compared to 2005[5],** reaching a value of **270 MtCO2eq by 2030,** compared to **312 $MtCO_{2eq}$** in the NECP (cf. Table 84 of the NECP 2023), achieving the reduction targets set out in the 'Fit for 55' package for Italy.

According to the results of the ECCO-FF55 scenario:

- The sector contributing most significantly to the reduction is the **power sector**, which, accounts for 37% of total reductions. Here, the primary *drivers* include the robust penetration of renewables in the power system, as assumed in the ECCO- Artelys scenario.
- As far as energy emissions from the **manufacturing industry** are concerned, they contribute to the reduction by 22%[6]: the primary *drivers* considered for this sector include leveraging the **electrification** potential for medium to low-temperature process heat, targeting the use of biomethane in energy-intensive sectors, exploiting **green hydrogen** generated through the decarbonisation of the power system, and initiating the decarbonisation process of the **former ILVA of Taranto plant[7].**
- The **transport** sector contributes for 20% of the reductions. The envisaged measures primarily focus on **reducing the demand for private transport** through the *implementation* of policies outlined in the NRRP (National Recovery and Resilience Plan) and various planning tools for sustainable mobility. In this context, certain proposed amendments to the NRRP (National Recovery and Resilience Plan) regarding mobility measures are critically highlighted alongside the emphasised need for highly effective *governance* of the Plan in coordination with local government levels to ensure the successful implementation of these measures. The expected **increase in the number of Battery Electric Vehicle (BEVs)** in the fleet to 3.5 million cars is lower than the NECP's projection of 4.3 millions, despite policies being more focused towards fleet electrification. Regarding the **shipping sector,** reductions are anticipated due to the implementation of the NRRP (National Recovery and Resilience Plan) investments in electrifying national port docks (i.e. cold ironing) and partially replacing the ferry fleet for shipping people and vehicles to and from the islands[8].
- In the **building sector[9],** the contribution to the overall reduction amounts to approximately 16%. The principal drivers are the **enhanced electrification** of final consumption, achieved through the accelerated replacement of traditional heating systems with (exclusively) electric heat pumps, and an increase in the rate of **renovations up to 2030** from the current value of 0.37% to 4% by 2030. This represents a significant increase compared to the rate of 1.9%

[5] Reference year for EU climate and energy policies. This translates to 48% compared to 1990 emission levels, the basis for communicating the EU's commitment to the Paris Agreement. This is Italy's contribution to the Union's total contribution, which amounts to -55% compared to 1990 levels.

[6] On the basis of ECCO calculations, it is estimated that the push for electrification contributes to a reduction in particularly in the ESR sectors, which saw emissions reduced by 38% compared to 2005.

[7] In order to be consistent and to make comparisons, in line with the emission scenarios of the NECP, the emissions relating to the former ILVA of Taranto are counted partly in the energy industries sector (for the share relating to the production of coke) and, in part, in the industrial sector (for the production of steel from blast furnaces).

[8] This last contribution, considered in ESR, will have to be quantified as an ETS following the inclusion of the sector in the EU ETS, as provided for in the last revision of the Directive.

[9] It should be noted that, with regard to the 'energy' emissions of the agricultural sector which, following the classification of the inventory, are 'merged' with the civil sector, no specific measures have been envisaged, although the potential for reduction is quite significant (the sector emits about 7MtCO2eq). While respecting the objectives of the RED Directive, it could be envisaged to allocate at least part of the potential biofuels for heating and traction of agricultural machinery, moving the current SADs for the promotion of alternative fuels.

assumed in the NECP for the period 2021 to 2030. The measures supporting this scenario include targeted incentives for deep renovations and replacement of heating systems, based on a reform hypothesis for the current eco and superbonus mechanisms promoting energy efficiency.

The scenario accounts for the emission trends and the historical inertia observed within individual sectors, whilst identifying a framework of priority measures. These measures are distinctly aimed at bridging the emissions *gap* identified in the NECP, especially for the *Effort sharing* sectors, notably in transport, building and industry.

	2005	2030	
		NECP	ECCO-FF55
		MtCO2eq	
From ENERGY USES, of which:	**488**	**232**	**189**
Energy Industries	160	51	41
Industry (including manufacturing other comb.)	92	41	34
Transport	128	77	64
Building sector	96	56	43
Of which agriculture*	9,2	7	7
Other energetic and fugitive uses	12	7	7
From OTHER SOURCES, of which:	**106**	**81**	**81**
Industrial Processes	46	33	33
Agriculture (cultivation and livestock)	35	32	32
Waste	24	16	16
Total (excluding LULUCF)	**594**	**312**	**270**
LULUCF	-36	-35	-35
Of which ESR	**344**	**216-223**	**193**
Distance to ESR targets		**22-29,1**	**-1**

Table 3 – *Historical evolution of GHG emissions by sector (source: ISPRA) and emission scenario for 2021-2030 (source: ECCO elaboration)*

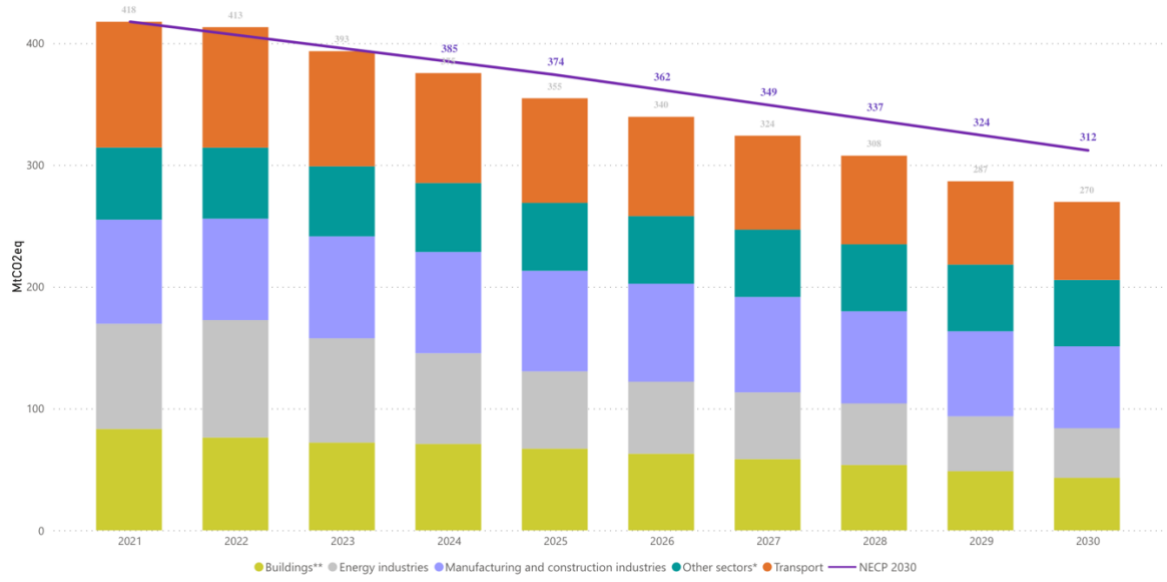

Figure 4 – *ECCO-FF55 emission scenario for 2021-2030, excluding LULUCF, and comparison with NECP scenario - Source: ECCO elaboration [MtCO2eq]*

BUILDING SECTOR

The main features of the building sector

- In 2021, greenhouse gas emissions from the building sector account for 75.5 $MtCO_{2eq}$ and represent 18% of the national total emissions. Non-residential buildings account for 25 $MtCO_{2eq}$, and residential buildings for the remaining part.
- Emissions have increased by about 5$MtCO_{2eq}$ since 1990, reaching their maximum level equal to 88$MtCO_{2eq}$ in 2010. The reduction is very low, only 12% compared to 2005, (from 86.7 to 75.5$MtCO_{2eq}$).
- Natural gas represents the main energy source, covering 50% of final energy consumption.

The greenhouse gas emission reduction scenario

- In the ECCO-FF55 scenario, emissions from buildings are equal to **35.6** MtCO2eq in 2030, with a reduction of 58% compared to 2005 (-49% vs 1990; -53% vs 2021). The largest contribution comes from **residential** sector, in which emissions are expected to decrease by **-61% compared to 2005 levels.**
- Compared to the NECP 2023 scenario, which forecasts building sector emissions at 48MtCO2eq in 2030, the ECCO-FF55 scenario shows a greater reduction of **about 12** MtCO2eq by 2030.
- **Compared to the NECP,** the ECCO-FF55 scenario **simulates a greater electrification of final consumption due to a faster replacement of traditional heating systems with electric heat pumps.**
- In the residential sector, the NECP takes into account a requalification rate of 1.9% in the period 2021-2030, compared to the ECCO-FF55 scenario. The latter estimates an **increasing rate from the current value of 0.37% to 4% by 2030.** The estimated average annual **investment** in the period 2024-2030 is **14 billion euros** and could be partly covered by the revenues obtained by a reform of the framework of electricity and gas tariffs. They account for about 6 billion euros per year. In 2022, the Superbonus determined investments for about 42 billion euros.

Which policies for decarbonisation

- The NECP **refers to a list of current measures suggesting their reform.** However, in most cases it remains just **indicative and does not inform of the needed changes** in those climate policies that generate the most significant impacts on public costs. On the contrary, the ECCO-FF55 scenario suggests targeted and synergistic measures aimed at promoting energy efficiency and end-user electrification:
    - **For residential buildings:** Reform of current tax deduction scheme
        - A longer timeframe, until at least 2030
        - Harmonization and rationalization of incentives currently in force
        - Premium for interventions that achieve high results in terms of reduction in energy consumption and emissions
        - Ban on incentives for fossil fuel-based technologies, including hybrid
        - Possibility of credit assignment in order to make energy renovation affordable to all income classes

- ***For public buildings:***
  - **A fund** dedicated to the renovation of **public housing and schools**

Priority Enabling Policies

- Reform of the tariff structure to rebalance price signals for electricity and gas: nowadays the unbalance of tax and non-tax charges between electricity and gas bills favours gas consumption, thus slowing down electrification. This issue is not taken into account into the NECP
- Research and training programs addressed to construction companies and workforces in the building sector aimed at ensuring that they have the needed knowledge and skills
- Definition of a system of indicators to evaluate the effectiveness of policies and make any changes along the way

Following transport and energy industries, buildings represent the third sector for GHG emissions. In the period 1990-2021 it accounts for 20% of the total emissions in the energy sector.

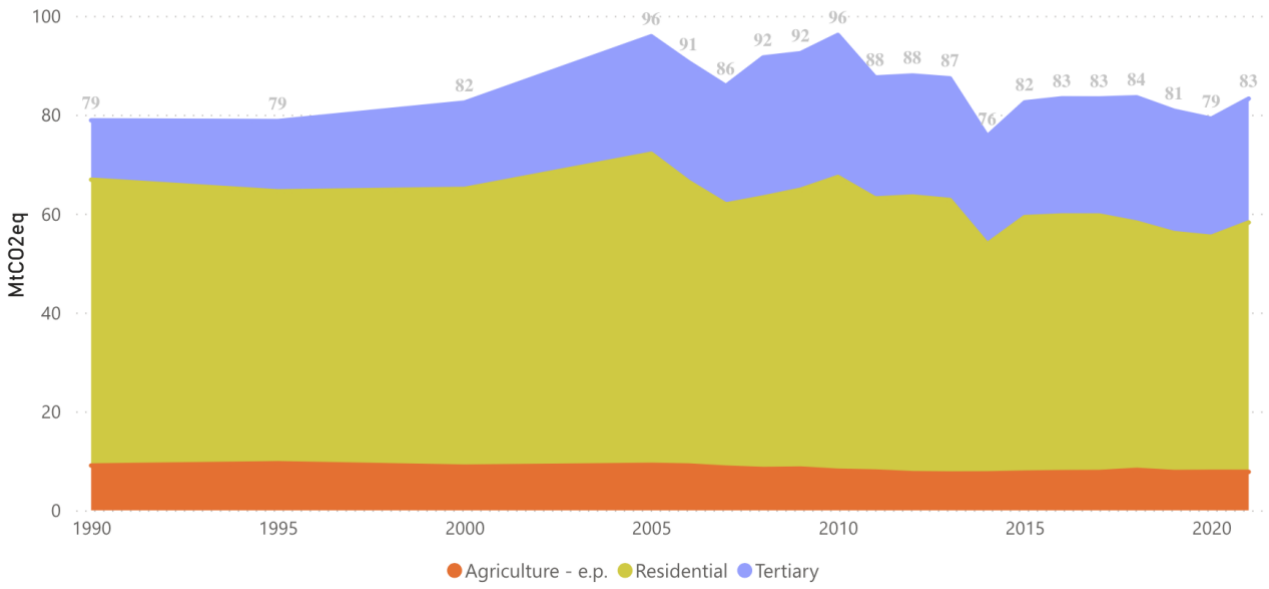

Figure 5 – *Trend of CO2eq emissions in the civil sector from 1990 to 2021. Agriculture represents the share of emissions due to energy processes alone.*

In 2021 the building sector recorded 75.5MtCO2eq of GHG emissions (+8% compared to 1990). Residential buildings account for 67% of the total. The remainder is generated by commercial and public buildings, and has grown significantly over the years, accounting today for more than 30% of total emissions. By looking at the trend from 1990 to 2021 it looks like to be stable, with a maximum in 2005 that is slightly above the 2010 level. And this despite the resources allocated to energy efficiency policies, in force since 2007 and boosted in 2020 with the introduction of the deduction rate at 110%. In fact, GHG emissions remain stable even in recent years, with an estimated average reduction of 1% due to the implementation of the so-called 110% Superbonus.

Despite the huge investments in building requalification, the trend of GHG is stagnating in the sector. This is due to high **share of fossil fuels** in energy consumption, which **has not changed substantially**

since 2010. More than 50% of the energy consumption in the residential sector is still covered by natural gas, followed by solid biofuels (wood, pellets) for almost 20% and electricity with 19%. In the non-residential sector, the latter covers a greater share of energy demand, but natural gas remains the primary energy source with a share of more than 40%.

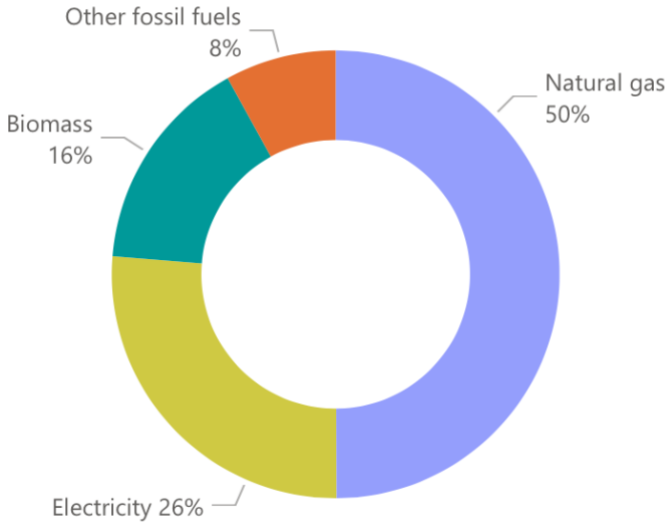

Figure 6 – *Fuel consumption in % in the building sector in 2021.*

The Italian building stock is characterized by over 60% of buildings being over 45 years old. However, contrary to what is often raised about the impossibility of adapting 'historic' buildings to modern efficiency standards, properties built before 1919 represent just 15% of the entire heritage. Additionally, those built between 1919 and 1945 add up to another 10%. For these categories, renovation works will encounter greater challenges and must take into account particular historical and architectural constraints, identifying tailor-made technical and systems solutions. However, the majority of interventions should primarily concern the portion built between 1950 and 2000, characterized by absent or inadequate energy efficiency criteria and a high level of thermal dispersion[10]. Analysing energy certificates, in fact, out of the 4.5 million Energy Performance Certificates (EPCs) present in the Information System (SIAPE), almost 55% identify a label greater than or equal to F, with estimated annual CO2 emissions of 38.5 kgCO2/sqm.

The ownership structure, on the other hand, can represent an advantage as Italy has one of the highest ownership rates in Europe (73% in 2021). In light of decarbonisation goals and the improvements of home safety, there arises the need to identify a long-term decarbonisation strategy capable of effectively achieving climate and energy objectives in an economically efficient manner**.**

DESCRIPTION OF THE ECCO-FF55 SCENARIO

As for other sectors, the ECCO-FF55 scenario starts from the UNFCCC inventory emissions of 2021, the year in which it emitted 75.5 Mt of CO_{2eq}, broken down as follows:

- 25.0 Mt CO_{2eq} in the non-residential sector;

[10] Buildings built between 1945 and 2000 account for 66% of the entire Italian building stock

- 50.5 Mt CO_{2eq} in the residential sector.

In terms of energy demand, in 2021 the sector consumed 47.9 Mtoe, of which 16.9 Mtoe in the commercial sector and 31.0 Mtoe in the residential sector. In both sectors, natural gas represents the main energy source.

The scenario focuses on the variables with the greatest potential for decarbonisation:

1. the improvement of energy efficiency, assuming an increasing requalification rate over the period of analysis, and
2. the electrification of end-use consumption, by replacing fossil fuel-based heating systems with exclusively electric heat pumps.

Unlike the NECP, the ECCO-FF55 scenario assumes an increasing **rate of deep renovation,** and consequently a greater retrofitted area per year, **and a faster deployment of electric heat pumps as replacement of traditional fossil fuel boilers.**

The proposed simulation is affected by both the binding EU target of reducing final consumption by 11.7% compared to the Primes Reference 2020 scenario and the obligation for annual energy savings (equal to an annual average of 1.49%), which drive the sector to pursue a greater effort on energy efficiency. Additionally, it is worth noting the effects of RES targets, which aim to increase the proportion of final consumption covered by renewables, specifically in cooling and heating services.

In this context, for the residential sector, the scenario foresees an increase in the rate of requalifications: for deep renovations[11] it assumes an increase from the current 0.37% up to 4% by 2030, as a result of incentive policies that promote retrofitting interventions **with an integrated approach capable of achieving high results in terms of both consumption and emissions reduction;** For other type of renovations (medium and low), the current 1%[12] remains constant. In this perspective, the scenario assumes restrictive policies towards heating systems with negative effects on GHG emissions, especially in urban areas characterized by particularly critical air quality levels. For this reason, the scenario foresees a faster replacement of oil-based heating systems with electric heat pumps, aiming at triggering dynamics for a profound change in the energy mix, today characterized by a high share of fossil fuels.

Furthermore, alongside the contribution of energy efficiency, there is a push towards the electrification of end-use consumption through individual interventions involving the replacement of fossil fuel-based heating systems with electric heat pumps. Priority is given to those using heating oil. These interventions, in addition to those already included among deep renovations, allow for the clean heating of a further 7.5% of the total occupied area by 2030.

For the non-residential sector, the ECCO-FF55 scenario simulates a **constant requalification rate** during the analysis period, which is slightly higher than the one estimated by the Strategy for Energy Renovation of National Building Stock (STREPIN), attached to the 2019 NECP. In addition to the energy efficiency and RES targets, the reduction of consumption is driven by specific measures for the public sector: the energy efficiency directive proposes an annual reduction rate of final

[11] Deep renovations include interventions that act in an integrated way on the building-plant, generating annual energy savings of more than 60%.
[12] The scenario considers 2022 as the reference base year and takes into account the interventions activated by the Superbonus until 31.12.2022.

consumption for public buildings equal to 1.7%, as well as an extension of the annual 3% buildings renovation obligation to all the levels of public administration.

Finally, the simulation also considers the effect of the increase in the average annual temperature on heat demand, corresponding to a decrease in heat consumption of 1,260 ktoe (about 140 ktoe per year)[13] by 2030, accounting for 10% of total energy savings between 2021 and 2030.

In ECCO-FF55 scenario, total GHG emissions are equal to 35.6 Mt CO_{2eq} by 2030, corresponding to a reduction of 59% compared to 2005 levels (-49% vs 1990; -53% vs 2021) (Figure 7). Total final energy consumption accounts for 35.4 Mtoe, 26% less than in 2021. The share covered by fossil fuels fell by 54% compared to 2021, with **natural gas decreasing from 23.9 Mtoe in 2021 to 11.5 Mtoe in 2030, and other liquid fuels below 0.4 Mtoe.**

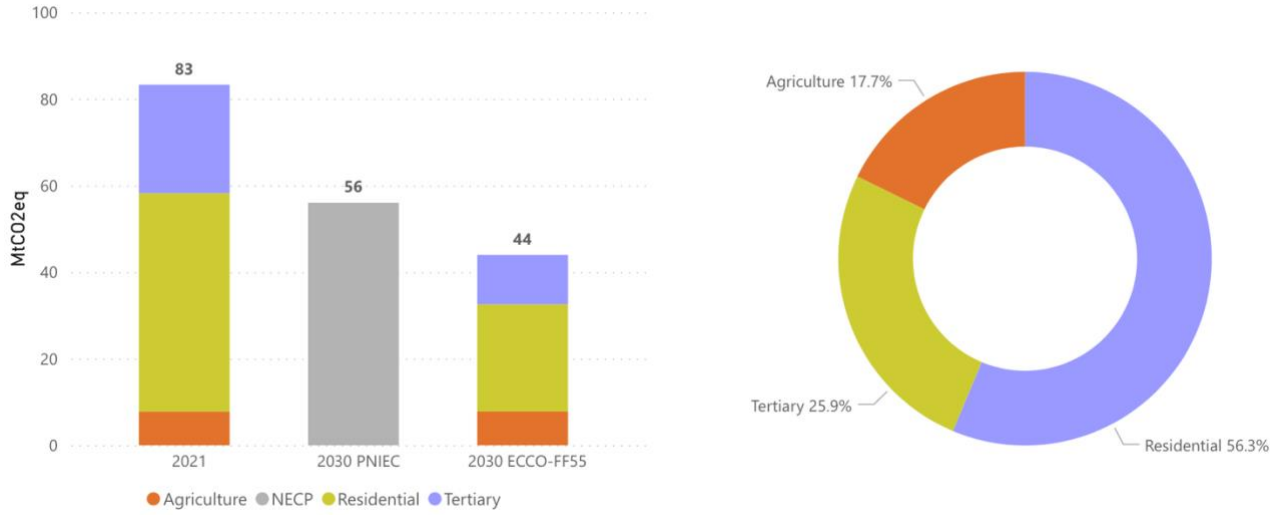

Figure 7 – *Comparison of CO2eq emissions for civil sector. This sector, in line with the national inventory and the NECP, includes the residential, Tertiary and Agriculture energy sectors by 2030 and % contributions in the FF55 scenario.*

Compared to the 2023 NECP, the ECCO-FF55 scenario estimated a further 23% reduction in GHG emissions (Figure 6). This is due to a stronger push towards energy saving interventions and electrification of final consumption, **through policies that exclude traditional fossil fuel- based systems from incentive mechanisms.** Unlike the 2023 NECP, the decline in emissions is faster during the period 2025-2030 period, even compared to the trend observed for 2021-2025. This is to account for an initial ramp-up phase, necessary for the development and launch of a long-term renovation plan for the building stock and for an adequate development of the construction and installation sector, which is experiencing a learning period in the use and installation of innovative technologies. To this end, it is essential for policies to have a long-term horizon and become as structural as possible.

From an energy point of view, the sector consumption is expected to decrease to 35.4 Mtoe by 2030 for the ECCO-FF55 scenario, compared to 41.0 Mtoe estimated by the NECP 2023 scenario.

[13] For this simulation, the RCP 2.8 scenario was taken into account, based on the evidence of the Emissions Gap Report 2022 and the temperature gradient estimated by ISPRA in the following publication: https://www.isprambiente.gov.it/files2018/pubblicazioni/rapporti/R_277_17_Consumienergetici_HDD.pdf

In the residential sector (Figure 7), natural gas is the fuel most affected by the reduction in consumption, with a cut of about 48% compared to 2021. At the same time, there is an **expansion of the electric vector, albeit relatively limited in absolute terms due to energy efficiency measures.** The contribution of biomass is assumed to remain constant, while **liquid fuels are expected to decline significantly.** The comparison with the NECP remains limited only to the total consumption expected by 2030, as the Plan does not include an estimate of the evolution of the energy mix in both residential and non-residential sectors.

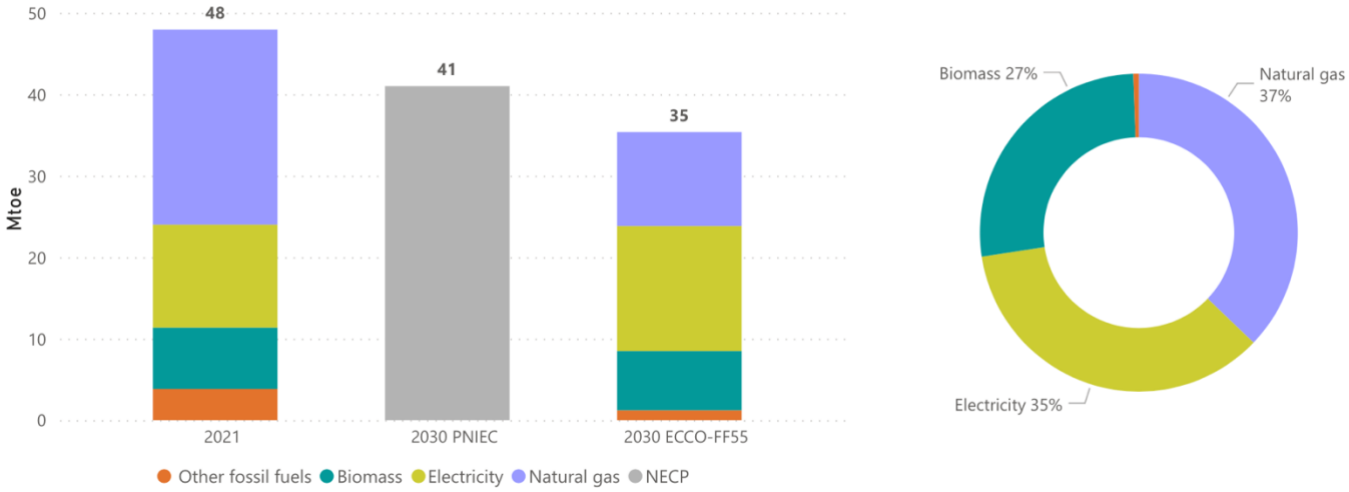

Figure 8 – *Final energy consumption in 2030 for the residential sector and % contributions in the ECCO-FF55 scenario.*

The share of electricity in final consumption for the non-residential sector is already quite high, as it reaches almost 50%. The ECCO-FF55 scenario confirms the central position of the electric vector, which increases by just 0.2 Mtoe, once again due to the effect of targeted energy efficiency measures. Natural gas reduces by about 59% compared to 2021, significantly lowering its weight in the energy mix, as do the remaining fossil fuels. Additionally, the contribution of biomethane in the building sector is estimated equal to 1 billion cubic meters by 2030.

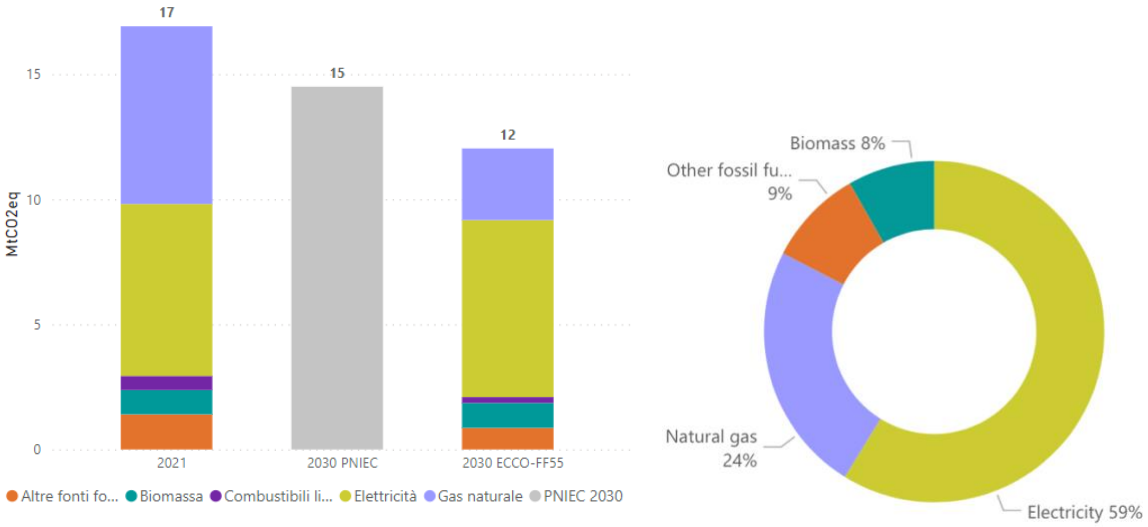

Figure 9 – *Final energy consumption in 2030 for the tertiary sector and % contributions in the ECCO-FF55 scenario.*

POLICIES AND MEASURES UNDERPINNING THE ECCO-FF55 SCENARIO

Compared to the extensive list of measures related to the energy efficiency dimension that the NECP recalls in the latest update, the following analysis focuses on the measures with the greatest potential impact on the decarbonisation path for the building sector and on the removal of barriers to the electrification of end uses. These measures were prioritized in the development of the ECCO-FF55 scenario.

Tax deductions for residential buildings

Italy has had a tax deduction scheme dedicated to building renovation since 1998, and one aimed at energy efficiency since 2007, the year the Ecobonus came into force. The latter was further strengthened in 2020 with the introduction of the 110% rate (Superbonus). Despite the investments activated – amounted to over 42 billion in 2022 – the trend of emissions reduction is not sufficient to achieve the2030 targets. The **Ecobonus appears to be poorly targeted towards savings and emission reduction,** at least by looking at the cost per ton of CO_2 abated, precisely because it is not tied to any check of the real consumption reduction (post-intervention). This is even more valid for generic renovations incentives (Bonus Casa), which completely lack conditionality regarding energy efficiency targets.

In just two years, over € 88 billion has been eligible for deduction with the Superbonus (September 2023), more than double the investments activated from 2014 to 2021 with the Ecobonus. It is worth noting that this instrument was introduced during the Covid-19 pandemic crisis to promote a key sector of the Italian economy, namely construction, thereby supporting GDP (Gross Domestic Product) in the context of the crisis. It was not a measure aimed at the efficiency and decarbonisation of homes. In terms of unit energy savings, it has generated a non-negligible cost for the state budget: about 6 Euros/kWh/year compared to 2.8 Euros/kWh/year of the Ecobonus.

According to the analysis conducted by the Parliamentary Budget Office, in 21.4% of the interventions completed by 2022 (amounting to approximately 20 billions) a deep energy requalification was achieved, i.e. corresponding to average energy savings of over 82%. Moreover, about 60% of the units

involved were in the lowest energy labels G and F, and in half of the case they reached the highest-label A (ranging from A1 to A4) thanks to interventions. Additionally, the Budget Office estimates that 21.5% of the renovated properties are capable of generating 70% of the total annual savings, absorbing 28% of the total investment. **Prioritising resources towards interventions that guarantee a greater consumption reduction, starting from buildings with the worst energy performance that show the highest savings potential, is crucial, especially in alignment with the** European EPBD Directive. This need for optimisation is further highlighted in the latest report "Greenhouse gas emissions in Italy: reduction targets and emission trends" published by ISPRA, according to which under current policies (including those identified by the NRRP, which take into account the Superbonus) the construction sector will be able to achieve an emission reduction of just 1% (compared to what would be achieved without interventions). Considering the inertia historically recorded by the sector, this trend that is insufficient to achieve the 2030 targets. According to ISPRA's analysis, **under the current measures, natural gas would continue to be the primary energy source used in the sector.** The significant costs of the interventions and their duration over time (such as the installation of a new systems presumably has a life cycle of 25-30 years) require a greater alignment between energy efficiency interventions and decarbonisation targets. Maintain natural gas as the primary energy source poses a challenge due to the need for transitioning away from fossil fuels.

To make Decree-Law No. 63/2013 on tax deductions for energy requalification more aligned to the sector's decarbonization pathway, it is fundamental taking into account the following criteria:

- **the extension of the time horizon for tax deductions until at least 2030** and the alignment with the targets for consumption and emission reduction. This facilitates the planning of interventions preventing inflationary and speculative phenomena.
- **Harmonising the existing schemes** (such as ecobonus, bonus casa, bonus facade, etc.) to more effectively allocate resources towards energy efficiency interventions.
- Introducing **premium to support interventions with a significant impact on emissions reduction and energy efficiency** (such as deep renovations guaranteeing savings of over 60% and promoting the progressive transition away from fossil fuels). For instance, in the paper we assumed the following rates:
    - In the case of deep renovations:
        - for multi-family buildings: 90% until 2025, 75% in 2026-2030
        - for single-family buildings: 65% until 2025, 50% in 2026-2030
    - In the case of partial renovations:
        - for multi-family buildings: 50% until 2025, 36% in 2026-2030
        - for single-family buildings: 36% until 2025
- Assessment within the Energy Performance Certificates (EPCs) of a pre- and post-intervention monitoring of energy consumption and emission.
- **Exclusion of fossil fuel-based systems from the technologies eligible for the tax deduction** (gas condensing boilers and hybrid systems).
- Application of the maximum tax rate for interventions that replace the heating system with *carbon-neutral* technologies if they fall within territorial areas not served by the gas network, or with particularly poor air quality levels.
- Elimination of the current distinction between "driving" and "driven" interventions. The incentive scheme must assess the interventions as a whole with respect to both the consumption and emission reduction and must be aimed exclusively at interventions with a significant positive impact on the latter.

- Maintenance of the credit transfer mechanism as a necessary tool for greater social accessibility to clean technologies, both to support lower incomes and to overcome the landlord-tenant dilemma.

Policies for the public sector

The new Energy Efficiency Directive (EED) asks the public sector to take the leadership in energy efficiency, acting as a driver to stimulate market transformation towards more efficient products, buildings and services, and to encourage behavioral changes in citizens and businesses regarding energy consumption. According to Article 5 of the EED, public administrations are required to plan energy-saving actions in schools, hospitals, nursing homes and social housing, with the aim of improving the quality of the indoor environment and supporting households in energy poverty. With 500,000 dwellings, social housing now accounts for 2% of Italy's residential stock. According to literature estimates[14], a plan for the renovation of these buildings, paired with a program to increase their number – 650,000 families are on the waiting list for social housing[15] –, would require an investment of around 15-20 billion euros. These types of buildings, as well as schools, need greater and dedicated resources in order to overcome the economic barriers (e.g., landlord-tenant dilemma[16], impossibility of access to credit, etc.), informational and cultural barriers (e.g., lack of information of both the available technologies and financial instruments) that make the deployment of energy efficiency measures even more difficult among low-income classes. Part of the resources of the Social Climate Fund could be dedicated to the renovation of public housing.

At the same time, it is estimated that 40 billion euros will be needed to renovate the entire school building stock, consisting of 56,000 buildings for a total of over 84 million square meters. Half of these resources are needed by 2030 in the ECCO-FF55 scenario to maintain a renovation rate of 5% per year.

For these building types, schools and social housing, dedicated measures with **coverage of 100% of expenses** are proposed. The necessary resources could be partly provided through non-repayable loans, using funds already allocated by the NECP, and partly through a fund continuously fed by the value of current energy bills, duly discounted to account for a minimum percentage of savings.

Tax and parafiscal charges between electricity and gas bills

Alongside the presence of fiscal incentives, **energy costs represent the variable with the higher impact on the economic sustainability of different technological solutions,** particularly concerning winter heating. For example, with the current tariff structure, and without considering tax deductions, only in the case of a high initial energy demand, the electric solution (electric heat pump, radiant floor heating, photovoltaic plat and induction cooktop) generates a cash flow capable of balancing the initial investment, operating energy costs and maintenance costs.

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[14] Ruggieri G., Zangheri P. (2020). https://fondazionefeltrinelli.it

[15] https://www.forumdisuguaglianzediversita.org/wp-content/uploads/2023/07/FORUMDD_Report-110-per-cento-DEF.x87346.pdf

[16] 41% of households in poverty live in rented accommodation, compared to a national average of 18%. https://www.forumdisuguaglianzediversita.org/wp-content/uploads/2023/07/FORUMDD_Report-110-per-cento-DEF.x87346.pdf

The electricity tariff is more burdened with more tax and parafiscal charges than the gas tariff. This results in a price signal that discourages consumers from adopting electric appliances to meet their heating and cooking needs, thereby slowing down the electrification process and increasing the payback time. The unbalance is determined by the fact that the electricity tariff includes both the charges due to the ETS in the production phase and the entire cost for the previous development of RES. On the other hand, in the gas sector energy efficiency programmes are mostly financed by general taxation.

Under ordinary market conditions, i.e. at pre-energy crisis 2021-2022 values, **a household pays tax and parafiscal levies of € 22.9/GJ for the electricity bill compared to € 7.7/GJ applied to the gas bill.** During the 2021-2022 energy crisis, thanks to the zeroing of system charges in the electricity bill, this unbalance was reduced. However, from the second quarter of 2023, system charges were reintroduced, while VAT at 5% on gas consumption (instead of 10-22%) was extended. **This further increased the gap in tax and parafiscal charges in favour of gas over electricity,** not only disincentivising electrification, but also continuing to provide support to the gas bill, which remains indiscriminate in terms of commitment to savings and efficiency and compared to the actual needs of the beneficiary. In this regard, in the event of further increases in raw material prices due to market dynamics, support mechanisms should not incentivize behaviours that are incoherent with decarbonisation and energy efficiency. They should not be proportional to consumption but should be designed as a fixed contribution linked to an income/asset assessment of the consumer's economic situation.

Under these conditions, common to several European countries, the diffusion of electric solutions, despite significant incentives, is likely to remain limited. To mitigate this barrier, Europe has proposed, from 2027, or 2028 in the case of exceptionally high energy prices, to extend the ETS emissions trading system to domestic heating (ETS II). The effect of this measure in providing a more favourable price signal for electricity consumption will be limited, as well as he impacts on the final consumer – it is estimated that this would generate an average increase in monthly heating expenditure of € 10 per household[17]. A rebalancing of the tax and parafiscal charges between the electricity and gas bills would have a more significant impact.

In this regard, the scenario takes into account the positive effect of a reform of taxation and parafiscal charges, in particular regarding energy products, as a coherent and virtuous tool in the integration of energy systems to support families and businesses in their efforts towards decarbonization, efficiency, and energy independence. In this work, a reform of the gas and electricity tariff structures has been hypothesised. This could generate revenues to be allocated to **the financing of decarbonisation measures, such as the Ecobonus, and providing them stability over time.**

A reform of the tariff structure should take into account the following principles:

- Being functional and effective with respect to the decarbonisation pathway, taking into account the embodied emission of the product, in coherence with the energy carriers of other sectors.

[17] https://www.ansa.it/europa/notizie/sviluppo_sostenibile_digitale/2023/05/05/ecco-da-ets2-aumenti-minimi-7-euro-al-mese-su-carburanti_29a0b5d3-d8cf-44fd-a4e8-60f6b3e3cb23.html

- Paying particular attention to the economic and social impacts by developing proposals in favour of the most vulnerable income classes who do not have access to sufficient financial resources.
- Ensuring the competitiveness of companies and the innovation process, through on the one hand a coherent view of the fiscal and parafiscal charges and on the other hand the resources available for decarbonization.
- Fornire un disegno quanto più possibile stabile nel tempo in maniera da avere una previsione del gettito pubblico a fronte di un progredire degli obiettivi di decarbonizzazione;
- Providing a design that is as stable as possible over time in order to have a forecast of public revenues to be addressed to polices for the decarbonisation.

Local measures for the fossil fuel phase put in heating demand

The ECCO-FF55 scenario envisages an acceleration of the fossil fuel phase out (liquid fuels, such as oil and diesel) through an increase in the deplyoment of electric heat pumps as a primary heating system, by replacing the traditional and less efficient oil-fired boilers. This is not only due to climate objectives but also as a mitigation action for the poor air quality, which reaches particularly critical levels for many days[18] in some areas of the peninsula. Air pollution has significant negative health impacts, increasing the risk of premature death and diseases such as stroke, heart and lung disease. Italy, which pays the highest price within the EU in terms of premature deaths[19], needs to reduce the level of key pollutants (particulate matter, nitrogen dioxide and ozone), also in view of the new EU Directive on air quality that reduces limit values by 2030 and 2035.

In addition to transport, agricultural and industrial activities, household heating contributes to emissions from various pollutants, in particular, fine particulate matter $PM_{2.5}$, which is particularly high, for example, in Po Valley – the Italian area most at risk.

For this reason, the ECCO-FF55 scenario considers the planning **for the phase out of the most polluting fossil fuels, starting from heating** consumption, as a priority for municipalities characterized by high levels of pollutants. In this regard, there is a need for coordination between the ministries, research agencies and municipalities to encourage the adoption of such a plan and introduce a premium (e.g. maximum rate) for buildings located in these municipalities. It is also proposed to include municipalities and areas not yet covered by gas network, because there the transition to electric solution could accelerate.

Measures to overcome non-economic barriers

The heterogeneity and complexity of the building sector, as well as the success of a decarbonisation plan for Italian real estate, require a high level of expertise and professionalism of all the stakeholders involved: from the municipal technicians, to the designer/energy managers, to the installers, the banks, the administrators, up to the property owners. It is necessary to develop an organizational system that, by involving all the stakeholders, can reach a high degree of maturity and implementation speed by 2030. Hence the need to invest in **the training of qualified technical**

[18] https://discomap.eea.europa.eu/atlas/?page=Air-pollution
[19] https://ambientenonsolo.com/la-valutazione-del-rischio-sanitario-per-la-qualita-dellaria-dellagenzia-europea-per-lambiente/

personnel at the local level (already insufficient to manage the administrative workload smoothly); develop research and **training** for construction companies and operators in the sector to identify the most reliable technological solutions, which are aligned with the decarbonisation pathway; provide upgrading courses for condominium administrators to speed up the procedures for approving interventions and applying for building permits.

MONITORING INDICATORS

The adoption of a monitoring system to track the progress and effectiveness of the implemented interventions, in terms of energy and emission targets, is essential for introducing any corrections to the existing policies. The ECCO scenario identifies a series of indicators, some already public, others to be developed, to be evaluated at least annually.

Primary indicators:

- GHG emissions in residential and non-residential sectors. Source: ISPRA
- Primary and final energy consumption by source. Source: MEES/Eurostat
- Emission intensity for final energy consumption. Source: ISPRA
- Rate of electrification. Source: ISPRA
- Share of renewable energy for summer cooling and winter heating. Source: ESM/MEES
- Number of buildings (or surface area in sqm) renovated by type; requalification rate by type of intervention (low, medium, deep). Source: ENEA (Italian National Agency for New Technologies)
- Number of heating systems installed and replaced with electric solution, both in number and power (MW-kW). Source: ENEA

Secondary indicators (useful for assessing the progress of the measures enabling the decarbonisation of the sector):

- Final energy consumption by building type (kWh/sqm). Source: MASE/ENEA
- Average energy cost for different types of consumers. Source: ARERA
- Average renovation cost by type of intervention. Source: To be evaluated
- Public resources addressed to building renovation. Source: MEF (Ministry of Economy and Finance)
- Number of one-stop-shops per capita. Source: To be evaluated
- Number of buildings with a smart meter. Source: to be evaluated (Enel/Terna?)
- Percentage of electric heat pumps produced and sold in the market (Italian and European). Source: Anima Percentage of electric heat pumps produced and sold in the market (Italian and European). Source: Anima Percentage of electric heat pumps produced and sold in the market (Italian and European). Source: Anima

INVESTMENT NEEDS

In the residential sector, energy renovations (deep and low or medium) envisaged by the ECCO-FF55 scenario in the period 2023-2030 entail an estimated total investment of € 193 billion. The public share is 53%, or € 103 billion. Annually (for 7 years starting from 2024) the public investment exceeds 14 billion euros. In addition to these, the renovation of schools requires 20 billion euros and about 55

billion for commercial and office buildings (of which 23% is accounted for public buildings). Total annual public expenditure is estimated at € 5.7 billion (includes schools and PA offices).

A share of the annual public expenditure could be covered by a reform of the current tax and parafiscal structure of the gas and electricity bill, as described above. The estimated revenue that could be allocated to the financing of energy efficiency is 5.8-6.0 billion euros/year. The proposed revision of the taxation and parataxation of tariffs does not increase the charges already present on the bill today. In additions, there are revenues from the new ETS II that are estimated equal to € 2.1 billion/year, according to a preliminary analysis that considers a CO2 price of € 45/tCO2. Furthermore, it is possible to consider a contribution from European funds, in particular from the NRRP fund, in the case of a possible resource reallocation, and from the Social Climate Fund from 2026 to support low-income classes against energy poverty.

BOX – THE SOCIO-ECONOMIC IMPACTS OF ENERGY TRANSITION – EXISTING INCENTIVES FOR ENERGY EFFICIENCY

The right to adequate housing, understood as the economic, social and cultural right according to UN, entails ensuring a standard of living adequate for health and well-being for oneself and one's family, and it is a fundamental human right (Constitutional Court, sentence No. 119 of 24 March 1999). A strategy for the renovation of the built environment cannot fail to include the social dimension in its assessments and in the definition of policy measures. However, attention to the social impacts of renovation policies is particularly lacking in the NECP, which fails to seize the opportunity to combine energy transition and the fight against inequalities, by integrating decarbonisation objectives towards interventions that simultaneously improve the quality of life and promote the development of the most vulnerable territories.

Italy has introduced tax incentive policies for building requalification since 1998, extending them since 2007 to promote energy efficiency. These, from the Bonus Casa to the Ecobonus, are distributional policies that tend to have a **regressive nature,** i.e. they benefit more those taxpayers with medium-high income, who have sufficient liquidity and tax capacity to claim the deduction. Thanks to the mechanisms of the invoice discount, the credit transfer and the 110% rate, the Superbonus has led to a greater progressivity in the redistribution of resource, although partial. Even those who did not have the availability to pay in advance, those who had zero fiscal space, or those who were not homeowners of the were able to access the incentive. However, the permanence of a deduction covering the expenditure and the possibility of transferring the credit to third parties are not mechanisms which the State budget can sustain in the long run; and indeed they have been modified and limited starting from 2023. The regressive effect of these mechanisms, which need to be revised to better allocate resources towards decarbonisation objectives, so as to be an effective lever for private investment and for the structuring of an entire supply chain suitable for the required path, is an intrinsic feature of them. But in a phase of technical and technological immaturity, incentives, adequately planned according to the different phases of the innovation process, are **functional to favour the "learning curve" of technologies.** In other words, they accelerate the reduction of production and installation costs of new technologies, so that thanks to economies of scale they become accessible to all income classes.

The problem of the fight against energy poverty, and more generally of "housing deprivation", is a much more complex issue, even just in terms of identification, which cannot be addressed exclusively with building bonuses and with a differentiation of deductions based on ISEE (Equivalent Economic Situation Indicator). The effect would be marginal and not exhaustive to effectively reduce the phenomenon. A multi-year strategy and a plan for housing in a systemic and lasting logic is needed that not only responds to the needs of decarbonisation, but also reflects the criteria of just transition, and that works by geographical area, inserting building renovation within a broader strategy of urban regeneration. The Social Climate Fund or the Urban Regeneration Fund have precisely this objective and can be sources of funding.

THE ITALIAN CLIMATE CHANGE THINK TANK

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