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Italy's biomethane investment under the national recovery and resilience plan: a flagship initiative for Europe's sustainable fuel transition

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Introduction

The transition to sustainable fuels is a key priority for the European Union as part of its broader strategy to decarbonize hard-to-abate sectors. Within this context, Italy has leveraged the EU Recovery and Resilience Facility (RRF) to launch a transformative program aimed at fostering biomethane production. This initiative exemplifies how public recovery funds can trigger systemic change by aligning financial incentives, environmental safeguards, and market-based mechanisms.

The strategic design of the biomethane measure

The biomethane measure within Italy's National Recovery and Resilience Plan (NRRP) (European Union, 2025) is a multi-dimensional policy tool. It supports both new biomethane production infrastructure and the conversion of existing agricultural biogas plants. This dual approach allows for rapid scaling of capacity, particularly by upgrading plants already embedded in rural areas. Crucially, the measure adheres to the EU's Renewable Energy Directive (RED II) (European Commission, 2018) and the Do No Significant Harm (DNSH) (European Commission, 2021) principle, ensuring that only sustainable feedstocks (e.g., agricultural residues, organic waste, manure) are eligible.

This feedstock scope aligns with advanced biofuel criteria, avoiding dedicated energy crops to minimize indirect land-use change (ILUC) risks. Newly built plants must be fueled by "agricultural matrices" or organic waste or be existing biogas facilities undergoing reconversion. By limiting inputs to wastes and residues, Italy's program ensures that supported biomethane yields high net climate benefits and does not compete with food production.

Beyond focusing on the end product (biomethane), the policy encourages upstream and downstream best practices in agriculture and waste management. For example, projects must implement low emission digestate management (e.g., covered slurry storage) and leak mitigation measures. These requirements, embedded in the 2022 Ministerial Decree (Italian Ministry of the Environment and Energy Security, 2022), mean that developers need to incorporate Leak Detection and Repair (LDAR) programs and gas capture systems for their plants. Such provisions ensure environmental integrity across the value chain. In sum, by addressing feedstock sourcing, farming practices, and emissions controls, the NRRP biomethane measure creates synergies between the energy, agriculture, and waste sectors while upholding stringent sustainability standards (Figure 1).

Biomethane NRRP Diagram

Inputs:

- Sustainable feedstock (waste, residues)
- EU recovery funds (>€2bn)
- Regulatory impetus (RED II, DNSH)

Policy Instruments:

- Capital grants (40%)
- Feed-in tariff (15 yrs)
- Competitive tenders (2023–25)
- Sustainability criteria (GHG limits, LDAR, etc)

Outcomes:

- about 2.3 bcm/yr new biomethane by 2026
- approximately 570 projects funded
- GHG emissions reduction

FIGURE 1
Schematic illustration of Italy's NRRP biomethane initiative.

Financing mechanisms and incentives

The financial model underpinning the biomethane investment combines capital grants and operational subsidies. Up to 40% of eligible investment costs are covered through upfront grants, while a 15-year feed-in tariff provides stable income for the biomethane produced. This two-level mechanism de-risks projects for investors, stimulates market entry, and accelerates project pipelines.

The program aims to deploy an additional 2.3 billion cubic meters (bcm) of biomethane annually. This target nearly doubles Italy's current production and represents a meaningful shift in the national gas mix. The relevant allocation, more than 2 billion euro, positions this measure among the most financially ambitious in Europe's post-COVID green transition (Table 1).

Sustainability and compliance requirements

Access to the incentives is conditional on meeting rigorous sustainability criteria set by EU and national regulations. Project operators had to obtain all environmental and construction permits and demonstrate compliance with RED II sustainability requirements before bidding. In particular, the biomethane produced must qualify as a sustainable advanced biofuel. For plants supplying the transport sector, this means using feedstocks listed in Annex IX (e.g., manure, crop residues, wastewater sludge, biowaste) and achieving at least 65% greenhouse gas (GHG) emissions reduction versus fossil fuel (International Renewable Energy Agency, 2017). Plants targeting other end-uses (e.g., heating) face an even stricter threshold of ≥80% GHG reduction. These GHG performance metrics ensure that only high-impact

projects (in climate terms) receive support. They effectively rule out crop-based biogas pathways with lower net savings or high ILUC risk (International Council on Clean Transportation, 2021).

Equally important, the NRRP measure incorporates the EU's DNSH obligations (European Commission, 2020) to avoid significant environmental harm. The implementation guidelines (GSE Rules) require developers to detail how they will control air pollutant emissions and prevent methane leakage across the supply chain. Concrete measures include gas-tight digesters, capturing biogas during upgrading, and continuous leak monitoring. The decree even deems investments in fugitive emission monitoring equipment and digestate treatment as eligible costs for the 40% grant. By funding these items, the program incentivizes best practices such as covered storage of digestate (to avoid methane venting) and flaring or oxidation of residual biogas. This approach aligns with expert recommendations that concerted methane management is essential to secure the climate benefits of biogas. Industry data show that without strict controls, biogas plants can emit 2%–5.5% of their output as methane, which would erode the GHG savings. Italy's policy response—mandating strong mitigation—ensures supported projects truly deliver net emissions cuts.

Geographical equity was another consideration in project selection. The NRRP explicitly encourages a balanced regional distribution of funds. While many proposals are naturally concentrated in the north (where livestock farms and agro-industry are abundant), efforts have been made to also spur biomethane development in southern and central regions. By spreading investments, the measure not only reduces waste and emissions but also serves as a rural development tool, creating jobs and income in various provinces. Biomethane thus emerges as both a climate policy and a territorial cohesion policy (Table 1).

TABLE 1 Below summarizes the key features of the incentive program and the outcomes of the tender rounds to date (update on 30 June 2025).

Aspect	Details
Capital grant (CAPEX)	40% of eligible investment costs (non-repayable)
Feed-in tariff (OPEX)	Guaranteed premium tariff for 15 years on injected biomethane
Tender rounds (auctions)	5 competitive rounds (January 2023–January 2025) allocating about 253,000 Smc/h (standard cubic meters per hour) in addition to the FORSU projects
Sustainability criteria	Only advanced feedstocks (waste/residues); GHG savings $\geq 65\%$ (transport fuel) or $\geq 80\%$ (other uses) required. Must implement LDAR (leak detection and repair), covered digestate, and other DNSH measures
Early results	About 572 projects selected across 5 calls (about 50% new builds and 50% biogas reconversions) The indicative distribution of projects is 64% in the North, 11% in the Centre, and 25% in the South and Islands

Environmental impacts of biomethane

A core motivation for Italy's biomethane investment is its potential to deliver significant environmental benefits across the fuel's lifecycle. Lifecycle GHG Emission Reductions: When produced from truly sustainable feedstocks, biomethane offers drastic reductions in greenhouse gas (GHG) emissions compared to fossil fuels. In fact, multiple studies show that biogas upgraded to biomethane from organic wastes can achieve very high lifecycle emissions. This is because capturing methane from sources like manure or landfill waste and using it as fuel prevents the release of a potent GHG that would otherwise escape into the atmosphere. Waste-based biomethane pathways generally exceed the EU's renewable fuel GHG savings thresholds with ease, often cutting emissions by well over 100% when accounting for avoided methane. Italy's decision to specific eligible feedstocks to wastes and residues is pivotal: it ensures the climate impact of the supported biomethane is maximized and avoids pathways that undermine climate goals. Equally important is controlling methane leakage during production and upgrading. Even a small percentage of unintentional methane release can erode the climate benefits of biomethane, given methane's high global warming potential. The IEA warns that today's biogas/biomethane plants may emit 2%–5.5% of their output as fugitive methane—levels notably higher than in the fossil gas industry (International Energy Agency, 2020).

Thus, Italy's mandate for leak detection, closed digestate storage, and other best practices is an essential component to ensure that the biomethane produced truly delivers on its net GHG reduction promise. Which is significantly higher than average losses in the natural gas industry. To preserve the GHG savings, it is critical to push these losses as low as possible—ideally below about 1%. Key mitigation strategies include covered digesters and storage tanks, thermal oxidizers for vented gas during upgrading, and rigorous LDAR programs to fix any leaks. Italy's NRRP program has explicitly integrated such measures, as discussed, by making leak-prevention technology and monitoring part of the incentivized investment costs. This policy design ensures that public funds support not just quantity of biomethane, but quality in terms of emissions performance. By contrast, less controlled expansion of biogas could lead to “green gas” that offers little climate advantage. Italy's approach serves as a model for marrying growth with strict environmental oversight in the biogas sector.

Beyond GHG emissions, scaling up biomethane raises considerations about feedstock competition and availability. The

Italian scheme's focus on residual biomass means it largely taps materials that are currently underutilized or disposed of (manure, organic wastes, etc.). This minimizes direct competition with other uses; for instance, manure can be managed via anaerobic digestion and still returned to fields as fertilizer (digestate), and food waste diverted to biogas would otherwise be composted or landfilled. Nevertheless, as biomethane production expands, ensuring a sufficient and sustainable feedstock supply will be an ongoing challenge (ENEA, 2025). Italy is in well-positioned in this regard: a recent ENEA study estimates Italy's technical potential from Annex IX-A feedstocks at about 5.6 bcm of biomethane per year. This suggests the 2030 target (about 5.7 bcm) is achievable with domestic residues, though it would require efficiently mobilizing a large fraction of available manure, crop straw, municipal biowaste, and sewage sludge (Ministry of the Environment and Energy Security, 2024). In some regions (especially those with fewer intensive farms or less organized waste collection), feedstock scarcity could constrain projects.

Competitive allocation framework

Unlike fixed-price feed-in tariffs of the past, Italy's NRRP biomethane incentives are allocated via competitive tenders. The Gestore Servizi Energetici (GSE), the Italy's state-owned energy services operator for renewables and efficiency, administers auctions wherein project developers bid for access to the subsidies (GSE, 2023). This auction-based approach increases cost-effectiveness by letting market forces reveal the needed support level. Each tender had a predefined capacity quota (in Smc/h of biomethane production) available, and participants effectively compete on the required subsidy (e.g., by offering a discount on the reference tariff rate). The GSE then ranks bids primarily by lowest incentive requested per unit output. In the event of ties or very close offers, the environmental performance can act as a tiebreaker—proposals with superior GHG emission savings or that target the transport sector (advanced biofuel use) were given priority as per the decree's criteria. This ensures that, all else equal, a project delivering greater climate benefits wins over a less effective one. Such scoring rules have encouraged developers to optimize both economically and ecologically, for example, by improving their plant's efficiency and reducing leakage to strengthen their bid.

The use of auctions reflects a broader EU trend toward market-based mechanisms for renewables support. It enhances

transparency, reduces public expenditure per unit of GHG avoided, and promotes innovation. By introducing competition, Italy's framework incentivizes efficiency and drives down the cost of biomethane production over time, ensuring that public funds deliver maximum environmental return on investment.

Implementation progress and results

Between January 2023 and January 2025, five tender rounds were concluded under this scheme. Oversubscription in each round signaled high investor interest, and the quality of projects improved with each iteration as the industry gained experience. Projects selected thus far span a spectrum of scales and innovations—from farm-based micro-digesters to large industrial biomethane hubs and municipal waste-to-energy facilities that epitomize circular economy principles.

Early evidence suggests several positive knock-on effects. The investment has begun to strengthen local bioeconomy networks, linking farmers, waste operators, and energy companies. Technical know-how in designing, building, and operating anaerobic digesters and biogas upgrading units has been enhanced, building domestic expertise in this growing field. Perhaps most significantly, Italy's success is spurring replication interest from other EU countries. In this way, the biomethane measure is already becoming a benchmark for post-pandemic green recovery, illustrating how targeted funding can seed a self-sustaining sustainable fuel market.

The funded projects span a range of sizes and feedstock types. Notably, the awarded projects are for greenfield biomethane plants (new installations) and for conversions of existing biogas-electricity plants into biomethane producers. This balanced outcome reflects the dual strategy of the scheme. Many of the new plants are associated with municipal organic waste processing or large agro-industrial facilities, whereas the converted plants are mostly on-farm digesters switching from CHP to gas upgrading.

Discussion and european implications

Italy's experience underscores the importance of linking climate goals with pragmatic economic by combining substantial public funding with competitive allocation and strict sustainability rules, Italy created conditions for rapid scale-up without sacrificing environmental integrity. This model—high ambition matched by detailed implementation mechanisms—can inform other EU Member States aiming to boost biomethane as part of their REPowerEU 2030 goals (35 bcm/year EU-wide).

One notable aspect is how Italy leveraged its national context and strengths to enable this success. A few enabling conditions stand out:

- **Agricultural and Waste Resource Base:** Italy has a large agricultural sector (second-largest biogas producer in Europe historically) and a well-established system for separate collection of organic waste. These provide ample feedstock for biomethane. Countries with less organic waste recycling or smaller farming industries might face more

feedstock constraints, requiring greater emphasis on waste imports or energy crops (which come with sustainability trade-offs).

- **Existing Gas Infrastructure:** Italy's extensive natural gas grid and widespread gas distribution even in rural areas make injecting biomethane relatively straightforward. Many farms and towns are already connected to the gas network, lowering the hurdle for new plants to deliver biomethane into end-use. In contrast, some EU countries (e.g., those without a dense gas grid or those that rely more on district heating) might find it harder to utilize distributed biomethane production.
- **Market Structure and Scale:** Italy's agricultural landscape includes many medium-sized family farms and cooperatives rather than a few very large operations. This fragmentation meant that aggregation of feedstock through consortia or developers was necessary—indeed we see new partnerships forming where multiple farms supply a single biomethane hub. While fragmentation can be a challenge, Italy's approach turned it into an opportunity by encouraging consortium bids and broad participation. Other countries might have more centralized models (e.g., Denmark's large energy companies driving biomethane and centralized manure processing) which can ease implementation but might not engage local stakeholders as widely.

In summary, Italy's NRRP biomethane initiative provides a valuable case study in designing and executing a large-scale sustainable fuel program. It highlights that with the right mix of funding, regulation, and local capacity, even a sector like gas—traditionally hard to decarbonize—can undergo a rapid transition. For Europe, replicating this success will require tailoring the approach to each Member State's conditions. Countries with strong agriculture or waste sectors and gas infrastructure (such as France, Spain, or Poland) could adopt similar incentive schemes to unlock their biomethane potential. In doing so, attention must be paid to sustainability (ensuring feedstocks are truly renewable and minimizing methane slip) as well as to timing (aligning project development with 2030 climate targets). Italy's early results are encouraging in that they suggest biomethane can be scaled quickly when barriers are removed. Finally, this example reinforces the role of EU-level support: Italy's program was made possible by NextGenerationEU recovery funds—a reminder that strategic public investment can kick-start markets that thereafter become self-sustaining. As other countries plan their green recovery investments or Cohesion Policy funding for 2021–2027, the Italian biomethane model stands out as a flagship initiative marrying climate action with economic renewal.

Conclusion

Italy's biomethane investment under the NRRP illustrates how public recovery funds can catalyze systemic change in the energy sector. Through a carefully designed mix of financial incentives, competitive procedures, and stringent environmental safeguards, the initiative is setting a precedent for sustainable fuel deployment across Europe.

By proactively integrating climate policy with economic recovery, it has been demonstrated that green investments can deliver multi-faceted benefits. Looking ahead, there are both challenges and opportunities on the horizon. On the one hand, European actors must address issues such as ensuring a consistent supply of sustainable feedstock, upgrading gas grids and refueling infrastructure, and maintaining public support for waste-to-energy projects. There is also the task of harmonizing standards and certifications (e.g., for biomethane Guarantees of Origin) across the EU, so that sustainable gas can flow freely and credibly between countries. On the other hand, the opportunities are immense. Successful models of biomethane deployment can be replicated and scaled up across Europe, contributing significantly to EU targets for renewable gas and emissions reduction.

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