



Biomethane, the green molecule to enable energy transition

Challenges and barriers of a developing market in Italy

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In a nutshell

Biomethane production will play an important role in **decarbonizing** Italian economy, as it is expected to step up from **0.2 bcm in 2021 to up to 10 bcm in 2050**.

Two main **barriers** have to be overcome: **logistic** challenges and **regulatory** hurdles.

Regarding logistics, biomethane can be either **injected** directly into the **gas infrastructure** or **liquefied** and transported inland to the end-users.

Pipeline connection is **prevalent**. However, gas injection development is slowed down by a cumbersome **bureaucratic** approval **procedure**.

European and Italian policymakers are addressing regulatory challenges to provide useful instruments to boost biomethane production, among which a **renewed incentive scheme** (Ministerial Decree 15 September 2022).

Several questions are still open, but the involvement of committed stakeholders can ensure a **promising development of a home-grown sector**.

The Biomethane Question in Europe

CARBON NEUTRALITY BY 2050

RED II



40%
emission reduction



32%
share of RES

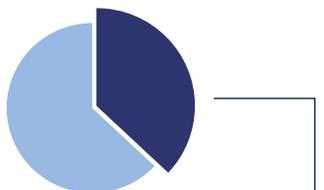
FIT FOR 55



55%
emission reduction



40%
share of RES



37%
of European gas
consumption was
imported from
Russia

Biomethane in Europe

Over the last 13 years the European Union has committed its policy to back energy transition and **taken concrete steps to mitigate climate change**. The 2009/28/EC Renewable Energy Directive (RED I) is the cornerstone of this effort, revised in 2018 with the 2018/2001 Renewable Energy Directive (RED II), setting common EU targets for 2030 in terms of a 32% share of renewable energy in European energy consumption and 40% CO₂ emission reduction compared to 1990.

In 2019 Covid-19 pandemic spread rapidly through the globe and Europe was not untouched. Along with lockdowns came an unanticipated economic crisis. Given how tightly energy use is coupled with economic growth, oil, gas, coal and electricity consumption inevitably steeply dropped. In this context in 2021 the European Commission has proposed a set of measures called "Fit for 55" to achieve carbon neutrality in 2050 that sets a binding target of a 55% emission reduction and 40% share of renewable energy.

Early this year Russia invaded Ukraine and, together with yet another economic downturn, **energy security came to the forefront of the public discussion**, given that in 2021 EU depended on Russia for 37%^[1] of its overall natural gas consumption and Italy marginally above average with a 38%^[2] share. **The RePowerEU package**, yet to be fully approved, is designed to address energy security concerns through a wide array of measures and further increases the 2030 renewable target to 45%.

European policy-makers role is no longer addressing the energy transition considering exclusively **environmental sustainability** concerns but **encompasses securing diversified and reliable energy supplies** that can concur to a new **energy logistic model**.

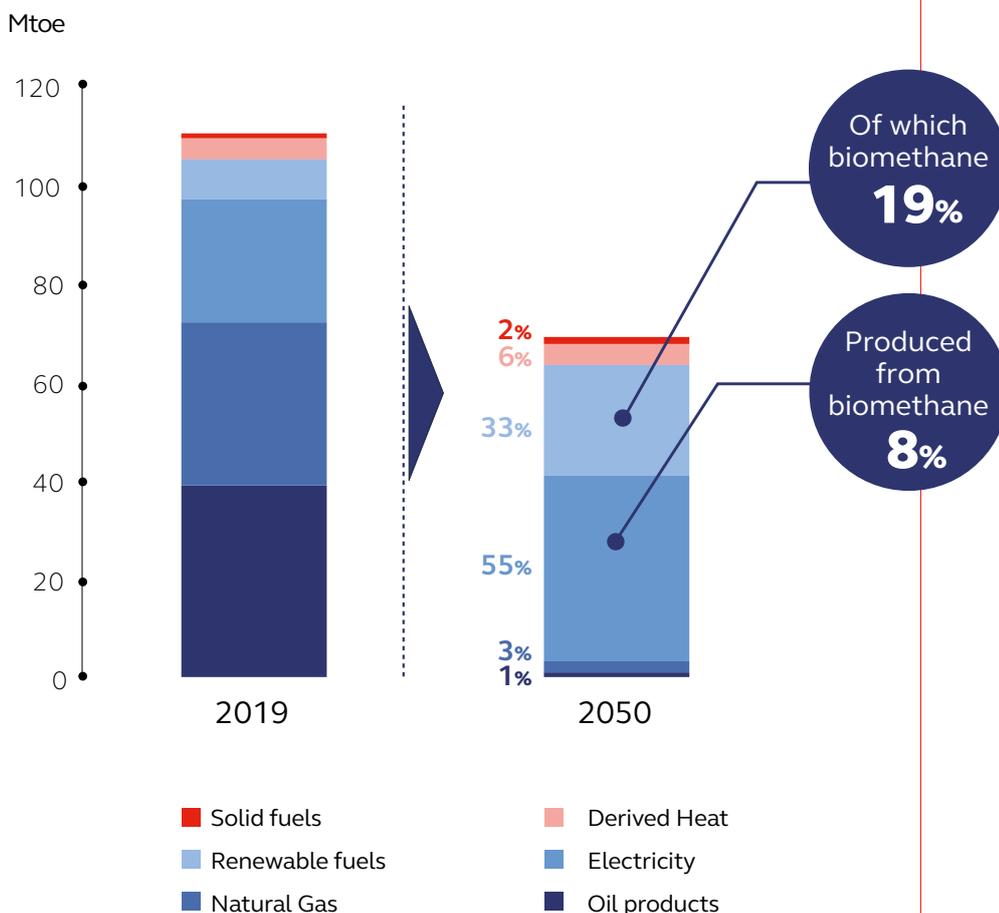
[1] Statistical Review of World Energy 2022, BP

[2] Italian Ministry of Environment and Energy Security

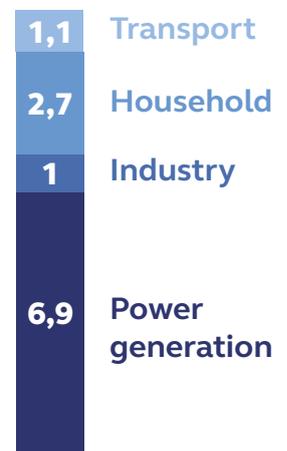
These challenges require a **suitable future energy mix, comprising biomethane**. This green gas can meet a wide range of end-uses, exploit the same infrastructure as natural gas, technologically mature and widespread, and play a facilitating role in the energy transition while answering the current energy security emergency.

EVOLUTION OF FINAL CONSUMPTION BY ENERGY SOURCES IN ITALY

RSE, Achieving Net Zero Emissions in Italy by 2050: Challenges and Opportunities

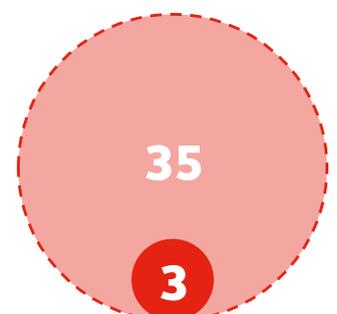


BIOMETHANE CONSUMPTION BY 2050 [BCM]



Source: RSE, Achieving Net Zero Emissions in Italy by 2050: Challenges and Opportunities

REPOWEREU SET THE TARGET OF BIOMETHANE PRODUCTION AT 35 BCM BY 2030



RePowerEU 2030 target [bcm]

Current EU production [bcm]

Thus, a sizeable contribution of the future energy mix is forecasted to come from local **biomethane** production, and the EU has set a target in the RePowerEU plan requiring this industry to step up **from the current 3 bcm yearly production to 35 bcm in 2030**.

2021 PREVALENT LOGISTIC MODEL* FOR SELECTED EUROPEAN COUNTRIES

GRID INJECTION	Belgium, Denmark, Estonia, France, Germany, Netherlands, Spain
GRID INJECTION AND TRUCKING	Italy, Sweden

*considering logistic solutions adopted by at least 15% of plants

Biomethane has a set of features that makes it an **ideal partial substitute** of fossil natural gas:



Renewable

Feedstock is renewed with each production cycle and does not include depletable sources



Sustainable

Replacing natural gas with biomethane reduces overall GHG emissions along the value chain. Indeed, the greenhouse effect generated by the biomethane production and consumption is much lower than the impact of the gases released by the disposal of the feedstock



Storable

Biomethane can exploit the same storage sites as fossil gas, it allows production-consumption decoupling and hence its use acquires a strategic dimension



Programmable

Biomethane can decouple geographical and seasonal variations between energy production and consumption, achieving synergies with other renewable sources



Circular

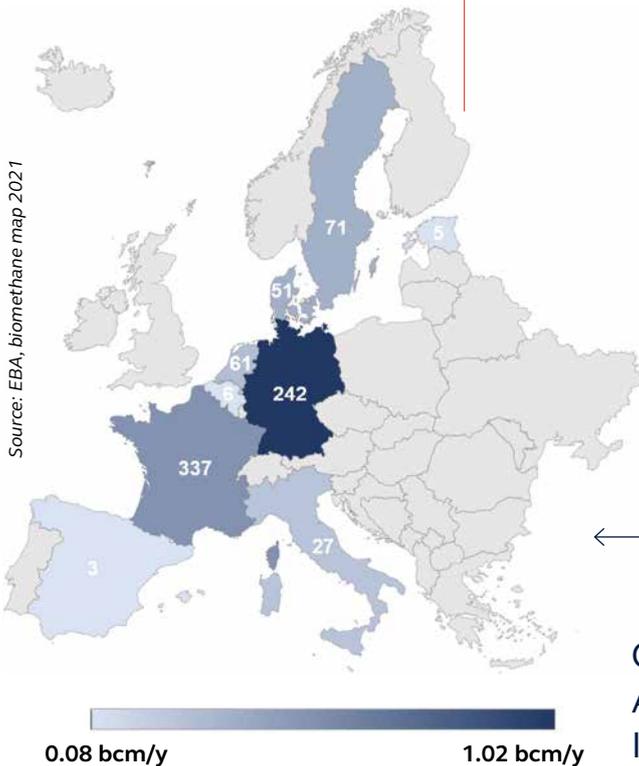
Biomethane shortens the gas supply chain valuing local waste and agricultural byproducts and turning them into feedstock



Ready to dispatch

Biomethane can be transported through the existing methane infrastructure

Europe is already moving in this direction. As we can see from the infographic on the right, **Germany and France show the highest current production and number of plants in Europe**. Furthermore, we can also observe that average **plant size varies greatly among different countries** depending on local development trends. **Italy** still presents a **low number** of plants and an extremely **limited share of potential** already exploited, while having the highest average plant size because Italian biomethane is mostly produced from municipal waste treatment plants.



CURRENT BIOMETHANE PRODUCTION AND NUMBER OF PLANTS IN 2021 IN SELECTED EUROPEAN COUNTRIES

Biomethane in Italy: critical concerns

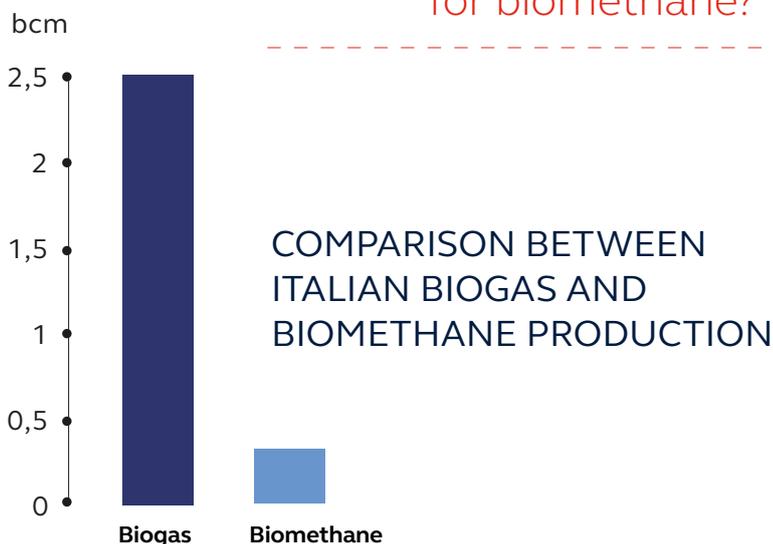
Italian biomethane production hit 220 million cubic^[3] meters in 2021 and is expected to grow up to 6 bcm already before 2030. Therefore, **present production is still far from both results of other countries and ambitious targets** set by RePowerEU plans.

On a more pleasant note, **Italian biogas production tops European and global statistics^[4]** as a result of its strong sector expansion over the last decade due to a regulatory framework able to promote plants construction and cogeneration adoption. This key aspect opens to important reflections, as **Italy has the potential to significantly boost biomethane production over the next years**. Feedstock abundance from agri-food markets and the need to manage urban waste offer opportunities to include a relevant biomethane share in the energy production mix introducing **over 1000 new plants by 2026**, equally distributed among converted biogas plants and greenfield sites. **According to RSE, Italian annual production potential could yield up to 10 bcm** (mostly from anaerobic digestion, but with significant contribution from wastewater and thermal gasification) **by 2050^[5]**. This scenario raises some questions:

What prevented biomethane production from growing in Italy until today?

1

Why has the 2016 third largest global biogas producer lagged behind European front-runners in the race for biomethane?



CURRENT ITALIAN BIOMETHANE PRODUCTION

0,2 bcm

EXPECTED ITALIAN 2030 BIOMETHANE PRODUCTION

6 bcm

[3] Assogasmetano

[4] IEA, Outlook for biogas and biomethane: Prospects for organic growth

[5] RSE, Achieving Net Zero Emissions in Italy by 2050: Challenges and Opportunities

Logistic complexity in biomethane diffusion

[6] Review of technologies for biomethane production and assessment of Eu transport share in 2030, M. Prussi a, et al.

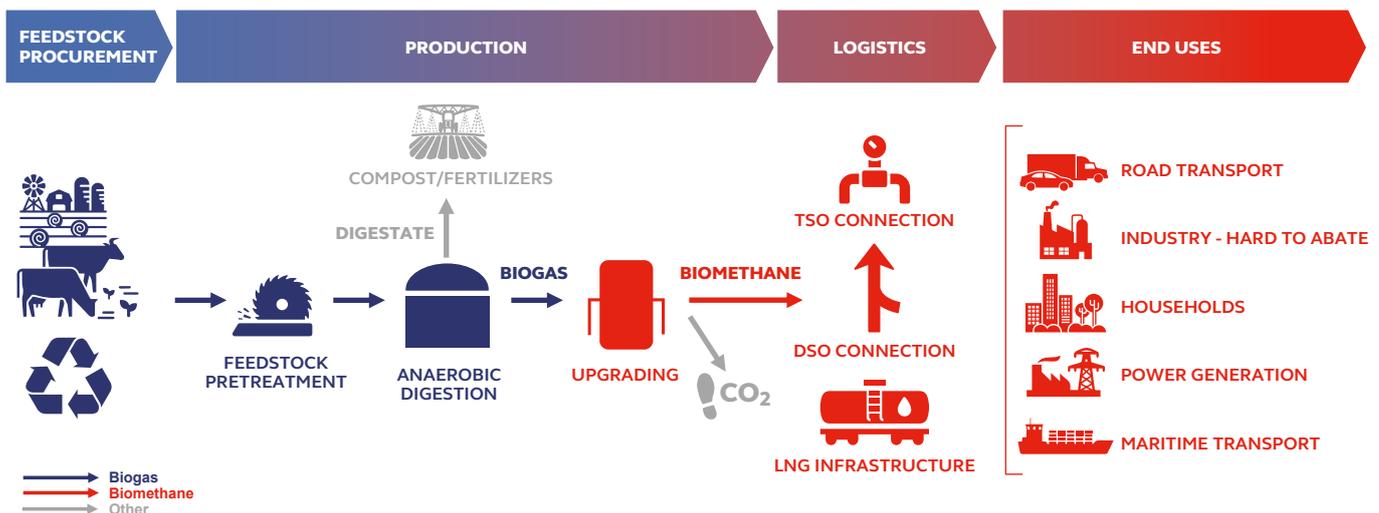
Biomethane peculiarities bring complexity in traditional gas logistics

Biomethane has the potential to play a significant role in the future of Italian energy transition and ensure **national energy security**: as a carrier that can be easily transported and stored through existing infrastructure, it offers the opportunity to **cover different end-uses while replacing CO₂ intensive sources and decoupling energy production and consumption**.

Nevertheless, identifying the best way to integrate it into the energy framework is still a puzzle: Biomethane and natural gas are identical in their chemical composition thanks to the upgrading process consisting in removing impurities from biogas yielding up to 99% pure methane^[6] today. Yet, gas **logistics will undergo drastic changes** caused by biomethane production peculiarities and value chain.

BIOMETHANE VALUE CHAIN

Main production steps from feedstock procurement to end uses



Below is presented a list of the most significant ones, and their main impact on the gas network:

Small-scale production volumes

Average production rate for Italian plants at the beginning of 2021 was 980cm/h and is expected to **decrease** according to the development of agri-biomethane, with a current average size currently around 610cm/h for Italian agri-biomethane plants[7]. This means that the **infrastructure will need several injection points to transport significant amounts of biomethane.**

Decentralized production

Several production sites are **distributed over the whole territory requiring a ramified pipeline network**. In 2021 approximately 78%^[7] of biomethane facilities were in northern regions, but **significant development is expected in the South of Italy in the coming years.**

Constant production rate

Biomethane plants output do not vary over the year, because once feedstock supply is met, plant and upgrading unit sizes are the only drivers.

Considering these three characteristics, it is **extremely difficult to identify a preferred logistics model for biomethane between pipeline connections and CNG/LNG trucking.**

[7] EBA, biomethane map 2021



←

IN 2021, **78%**
OF BIOMETHANE
PLANTS WERE IN
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BUT GREATER
DEVELOPMENT
IS EXPECTED
IN THE SOUTH

UP TO
3 YEARS
 FOR DELIVERY POINT
 DUE TO LONG
**PERMIT ACQUISITION
 AND CONSTRUCTION
 TIMES**

REVERSE-FLOW
 FACILITIES
 IN EUROPE^[9]:

15

operational

25

under construction

16

feasibility studies

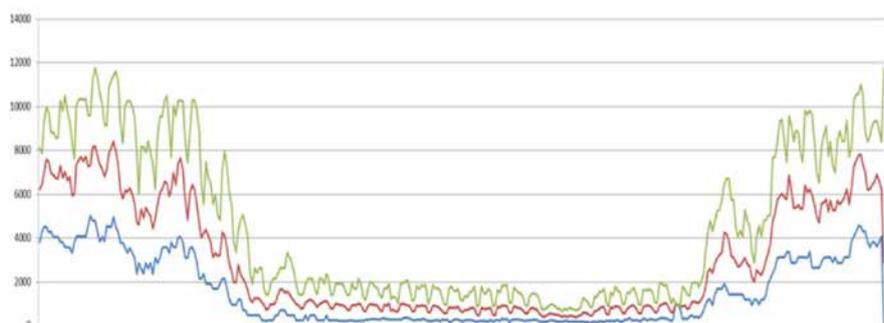
Pipeline: transport or distribution networks?

The infrastructure network currently used to dispatch natural gas is ready to immediately accept biomethane, as it is indistinguishable from natural gas, enabling a gradual replacement of fossil gas.

To complicate matters are aspects related to gas connection constructions: **biogas plants to be converted are often located far from gas transport grid**, which leads to larger investments and up to three years for new delivery points, around 30% of which for construction. The increasing number of production sites, expected to rise to 3.5 bcm (1.1 for transport sector alone) of biomethane production in Italy by 2026 according to recent estimates related to NRRP measures^[8], will significantly burden on TSOs commercial units, possibly slowing development further down.

A key role in addressing logistics complexity will be played by DSOs: the complete digital transformation of the assets and the repurposing of distribution grid allow to create fair conditions to accommodate biomethane, stimulating production and enabling widespread use. Being branched and spread out even over isolated areas, distribution networks may facilitate connection with biomethane plants, as well. To consider distribution network connection and its possible downsides, the third biomethane logistics peculiarity need to be addressed: **constant production over the year**. Today, this constitutes a technical problem since **typical local consumption profiles DSOs must satisfy are extremely variable** and Italian DSOs are not allowed to store natural gas. Such a mismatch between profile trends in several timespans becomes critical when DSOs cannot accommodate biomethane and therefore the product cannot be sold, wasting investments and discouraging the development of the green gas sector. The technological answer to this issue is ready and **commercially available on the market and is called reverse-flow**: it allows gas to flow from lower pressure pipelines to higher ones, from distribution to transport networks.

TYPICAL LOCAL CONSUMPTION PROFILE FOR DSOS DOESN'T MATCH CONSTANT PRODUCTION RATES



[Source: Utilitalia, MCTER 2022]

[8] Italian Ministry of Environment and Energy Security

[9] Gas4Climate, Manual for national biom. strategies

It is therefore clear that reverse-flow moves the problem to another level, from a technical perspective to a normative dimension: **the main issue to tackle is the regulatory** one, however it is expected to be addressed soon^[10].

Liquefaction and Inland Transport: a complementary logistic model

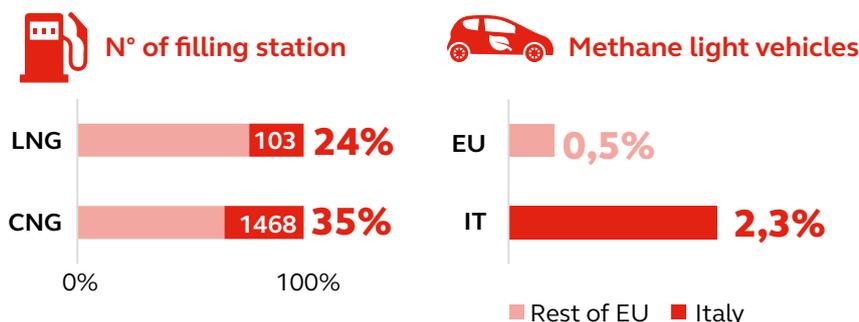
Pipelines are not the one and only solution to deliver biomethane to end-users. By compressing or liquefying green gas, respectively bio-CNG and bio-LNG can be produced. This inevitably leads to take into consideration a different biomethane logistics model that requires to rely on **trucking for biomethane distribution**. For this reason, compression ratio becomes one of the important variables to mention for CNG-/LNG-inland transport, and **liquefaction ensures 600 times smaller volumes to be transported**. Biomethane liquefaction guarantees multiple advantages making it a suitable complementary logistic model to pipeline connection:

Ready to use Biomethane for transport applications. In Italy, the transport sector has always been the preferred choice for biomethane end-uses and bio-LNG represents an already established fuel product

Diffusion of filling stations Close to production sites to ease logistics efforts. Italy is at the European forefront for CNG and LNG refueling station thanks to the high penetration of green mobility^{[11][12]}

Self-consumption For producers to fuel agricultural machinery

Promotion of consortiums Encouraging multiple small size biomethane producers from the same area to collaborate and jointly invest in liquefaction technology



[10] Progetto pilota consultazione aree 250/21

[11] Italian Ministry of Environment and Energy Security

[12] Liquefied biomethane for heavy-duty transport in Italy: A well-to-wheels approach, P.Trazi et AL.

WHEN THE
PIPELINE IS MORE
THAN 2 KM AWAY,
LIQUEFACTION
PLANTS BECOME
COST-EFFECTIVE



NEW INCENTIVE
SCHEME APPROVED,
MINISTERIAL DECREE
15 SEPTEMBER 2022

Even so, in 2021, only 4^[7] biomethane production facilities have invested in liquefaction units in Italy due to regulatory obstacles policymakers still need to overcome and economic barriers. The main issue related to biomethane-based bio-LNG lies in the **investment cost for liquefaction units**, hence they become cost-effective only in case of plants further away than 2 km from existing pipelines^[13].

To mitigate such issue, current **Italian incentives introduced in 2022 provided for a partial refund** of liquefaction and distribution investments. Expanding the view looking at the whole Italian regulatory system, **biomethane market development has been slowed down by a few regulatory inconsistencies** that the policymakers have so far managed to address partially.

The role of regulation and bureaucracy

The obstacles to overcome

The international momentum aiming at a widespread diffusion of biomethane facilities in Italy has been hindered by a few major regulatory obstacles.

First, companies and small agri-entrepreneurs that intend to install and run a biomethane plant must undergo a **cumbersome bureaucratic process** which discourages or prevents them from taking this path. Indeed, the authorization path for construction may require, according to national and regional regulations, an environmental impact assessment (whose subjection criteria are sometimes determined on a case-by-case basis).

Furthermore, if the producer applies for the connection to the grid, the TSO/DSO needs to receive the public and private permits for its construction. These permits require the project approval by the competent authorities (including each involved municipality) and the collection of the acts of occupation (with eventual expropriation, if necessary) of each implied private property that is during the construction phase. Therefore, the duration for the release of these permits cannot be quantified a priori, but it can be up to 24 months^[14]. In addition, the fact that **biomethane produced from organic fraction of municipal waste was considered waste itself** further hindered the authorization of several new biomethane plants.

In December 2021, with the **RED II** implementation in the Italian legislation, the so-called “**end of waste**” status was introduced for the biomethane production process, streamlining the process and reducing permitting time.

Furthermore, many companies have preferred to stick to biogas plants without installing the upgrading system due to an unfavorable incentive scheme: biogas incentives for cogeneration have a long timeframe (in some cases up to 2027 for electricity produced from renewable sources), resulting in a lower propensity to convert biogas plants and face new investment for upgrading units.



THIS PROCESS MAY
TAKE UP TO
24 MONTHS

[14] Assolombarda - La filiera del biometano: strumenti, meccanismi di funzionamento e opportunità

2018

**Ministerial
Decree
2 March 2018**
Transport sector
incentives based
on CIC

Current Italian incentive scheme since 2018

The Italian policymaker has defined a set of measures to mitigate regulatory issues and promote biomethane development, both through targeted interventions and the implementation of broader European energetic policies.

Until October 2022, **biomethane regulatory framework in Italy has been based on the 2 March 2018 Decree of the Ministry of Economic Development**, which applies both to greenfield biomethane production plants and to converted (even partially) biogas to biomethane facilities installed before 31 December 2022. The period of validity of this regulation, which will be replaced by the recently approved 15 September 2022 Decree, was recently extended to 31 December 2023 by the Ministerial Decree of the Ecologic Transition signed on 5 August 2022. The incentive framework introduced in 2018 is specifically dedicated to promoting the use of biomethane in the transportation sector, in order to achieve European renewable source targets. In particular, it establishes that the producer is given a number of **Certificates of Release for Consumption of biofuels (CIC)** based on the quantity and the quality of biomethane injected into the natural gas network. CICs are handed over to the producer by the national energy service company (GSE).

A CIC is released for every 10 Gcal of biomethane produced, but specific kinds of feedstock^[15] benefit from a double counting to promote the most sustainable biomasses. In addition, the biomethane derived other distinctive types of matrices (e.g., specific agricultural by-products and the MSW organic fraction) is considered "advanced" and leads to additional incentives. For producers who sell biomethane as fuel in a gas filling station (both in the CNG or LNG form), an increased number of CICs is guaranteed.

[15] Listed in the Annex 3 to the Ministerial Decree of 10 October 2014

The gradual evolution of regulatory framework

Aside from the aforementioned “**end of waste**” status for the biomethane production process, **Italian policymakers have introduced a set of measures to address the challenges that the sector has faced since 2018**. The regulatory action has been mainly focused on sustainability, on simplifying the plant approval process, on facilitating liquefaction and reviewing the feedstocks list for advanced biomethane.

In the Italian National Recovery and Resilience Plan (NRRP) only sustainable biomethane is subsidized, and the Legislative Decree 199/2021 - transposing the RED II - has defined two **criteria that must be met to define biomethane sustainable**:

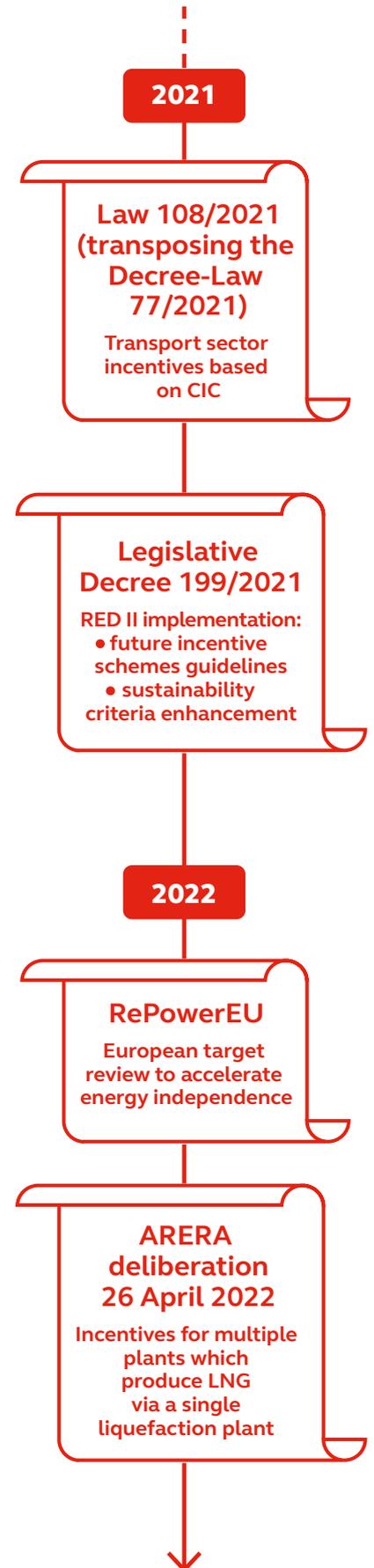
50%-80%
CO₂ EMISSION
REDUCTION

FEEDSTOCK
NOT FROM
ECOSYSTEM WITH
HIGH BIODIVERSITY
OR THAT
CAN CAPTURE CO₂

The bureaucratic process required for facility construction and grid connection has been streamlined over the years. For instance, after consulting associations of agri-entrepreneurs, biomethane producers and sample of energy companies, the parliament approved the law 108/2021 (transposing the Decree-Law 77/2021) which introduced several administrative simplifications concerning the connections to gas transport network and a simplified authorization procedure for the construction of small-scale biomethane plants, which represents one of most common reasons for client abandonment after quotation. The **Legislative Decree 199/2021** shows policymakers' efforts in this direction by slimming down the approval process for gas connections introducing a **simplified application procedure for new plants with a capacity under 500cm³/h** (more than 50% of plants in Italy).

As far as bio-LNG logistic model is concerned, in order to promote synergies between small neighboring biomethane producers, the deliberation of the Italian energy regulatory authority (**ARERA**) published on 26th April 2022 introduced the possibility of transporting via **trucking bio-LNG produced by multiple production plants** to a single liquefaction plant **without losing access to the incentives**.

Finally, the **enlargement of the list of feedstocks suitable for advanced biomethane** with further types of matrices derived from agriculture, breeding, forestry and food industry sectors^[16] can be read as an attempt to encourage agri-biomethane development that will play a key role in the sector.



[16] Law 108/2021 (transposing the Decree-Law 77/2021)

October 2022, Italy: latest updates

At the end of October, the **15 September 2022 Decree of the Ministry of Ecological Transition** was published. The Decree defines a new full incentive framework for the development of biomethane in Italy.

The decree, **financed through 1.7 billion euros from the NRRP**, will become fully effective after GSE (the Italian Energy Service Operator) **publication of application rules defining how producers will access incentives**, expected by the end of November.

Investors will receive a 40% capital contribution on eligible investment costs for converted biogas plants and greenfield sites, and their network connection. Based on feedstock composition and production capacity, **different specific investment costs are eligible** to access such contribution, as illustrated in the first of the tables below.

Similarly, based on production capacity and feedstock, **different incentive tariffs on biomethane production are introduced:**



Plants producing **less than 250 Smc/h injecting gas into DSO/TSO grid will benefit from a Feed-in Tariff**, based on reference values deducted of the % reduction offered during Auctions.



Plants with **higher production capacity than 250 Smc/h and all plants not injecting gas into TSO/DSO grid will benefit from a Premium Tariff**, where average monthly biomethane **Guarantees of Origin values and gas market price will be deducted from the Reference Tariffs** according to Auctions.

Production capacity thresholds related to the maximum specific investment cost could imply that economic considerations may affect the development of the agri-biomethane sector and the average sizing of agri-plant in order to take full advantage of the incentive scheme.



MAXIMUM SPECIFIC INVESTMENT COSTS AND CAPITAL CONTRIBUTION FOR DIFFERENT PLANT TYPES

Plant type	Biomethane production Capacity C_p	Maximum specific investment cost for new plants [€/Smc/h]	Maximum specific investment cost for converted biogas plants [€/Smc/h]	% capital contribution
Agricultural plants	$C_p \leq 100$ Smc/h	33'000	12'600	40%
	100 Smc/h $< C_p \leq 500$ Smc/h	29'000	12'600	40%
	$C_p > 500$ Smc/h	13'000	11'600	40%
Waste (organic fraction) plants	Any	50'000	-	40%

Source: 15 September 2022 Decree of the Ministry of Ecological Transition

REFERENCE TARIFFS FOR NEW BIOMETHANE PLANTS AND AGRICULTURAL CONVERTED PLANTS

Plant type	Biomethane production Capacity C_p	Reference Tariff [€/MWh] for new waste and agricultural plants and for converted agricultural plants
Small agricultural plants	$C_p \leq 100$ Smc/h	115
Other agricultural plants	$C_p > 100$ Smc/h	110
Waste (organic fraction) plants	Any	62

Source: 15 September 2022 Decree of the Ministry of Ecological Transition

The new incentive rate will be applied to **biomethane net production for a duration of 15 years and all end-uses, including self-consumption, will be admitted**. Subsidizing all end-uses may imply that, in case of non-competitive or unfavorable prices able not to control the entrepreneurial risk, the producers using liquefaction could evaluate to sell their products abroad in a **“single biomethane market” logic**, and Italy bio-LNG demand may struggle to be met.

Regarding **waste plants**, the reference tariff is certainly cheaper than other types of plant because of the opportunity to benefit from **other revenue streams**. This regulatory framework may favor the development of waste plants in **more advantageous geographical areas: well-established waste management systems, availability of feedstock supply and possible local competition** on waste treatment will be key factors to take into consideration for the development of the sector.

Biomethane today and a glimpse of the future

Biomethane is one of many factors concurring to European **journey toward energy sustainability** and zero-emission target satisfaction.

For Italy in particular, biomethane production development is a great **opportunity to establish a flourishing home-grown industry covering the whole value chain**, thus creating new jobs and exploiting synergies with existing industries and strategic infrastructures, while contributing to meet a **greener, more stable national energy system**.

Given its great **biogas** production, **feedstock** availability and developed **gas network**, **Italy has the potential to become one of European main biomethane producers** and **most recent regulatory measures seem to lead the way toward such a development**.

However, **many questions still need to be answered**. Will the 15 September 2022 Ministerial Decree and incentive scheme satisfy stakeholders' needs and bring new blood to biogas conversion and green-field plant construction?

Will policymakers find solutions to problems concerning the construction of new delivery points, thus promptly allowing TSO/DSO reverse-flow and further simplifying permit acquisition?

What role can liquefaction play in biomethane logistics, considering all possible end-uses and recent LNG success?

Which end uses will be chosen as field of application for biomethane by 2050, and how could their electrification impact on sector growth?

The coming months and 2023 will already be crucial to answer questions like these and to **build a path toward biomethane development in Italy**. In order to rapidly overcome sector difficulties and barriers, **contribution from all stakeholders** (agricultural players, investors, DSOs, TSOs, policymaker) **are needed**.

In a rapidly evolving European context, biomethane has the potential to play a key role on the medium term for the Italian energy security and transition.

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