

Gasification - a key technology in the energy transition and for the circular economy

Status and Perspectives of Bioenergy Exploitation in Italy, including Hydrogen Production

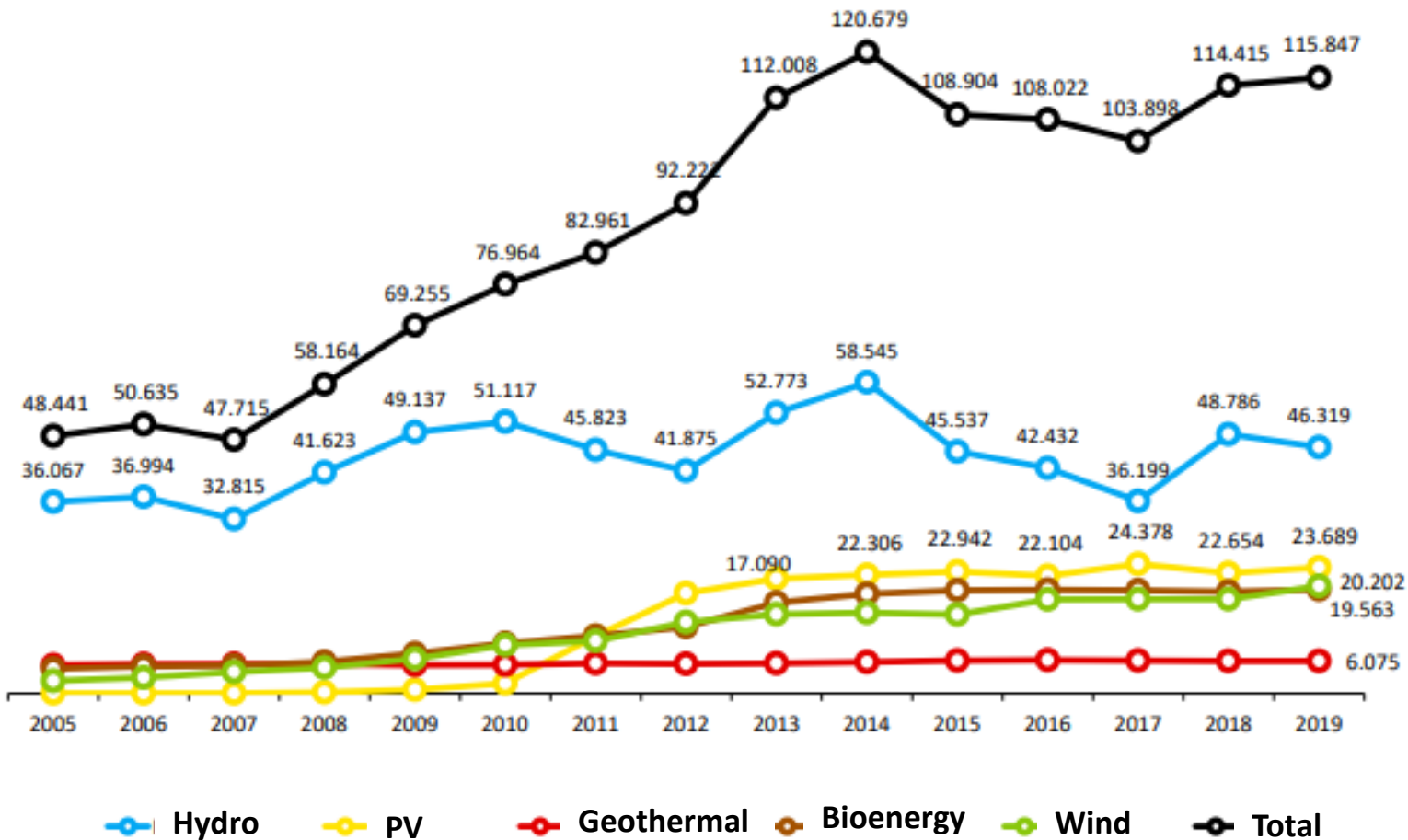
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PRESENT STATUS OF BIONERGY IN ITALY

IT: CURRENT SITUATION IN THE ELECTRICITY SECTOR

Evolution of the electricity production from RES - GWh [Source: GSE]



- In 2019, production from renewable sources reached **116 TWh**, slightly increasing from 2018 (+1.3%).
- Very positive was the performance of **wind plants (+14.8%)**. Also production from **PV increased (+4.6%)**.
- **Bioenergy production increased a bit (+2.1% with respect to 2018)**. Bioelectricity production in 2019 came from the **42.3% from biogas, 33.8% from solid biomass (12.3% from organic fraction of USW) and 23.9% from bioliquids**.

IT: CURRENT SITUATION - BIOENERGY IN THE ELECTRICITY SECTOR

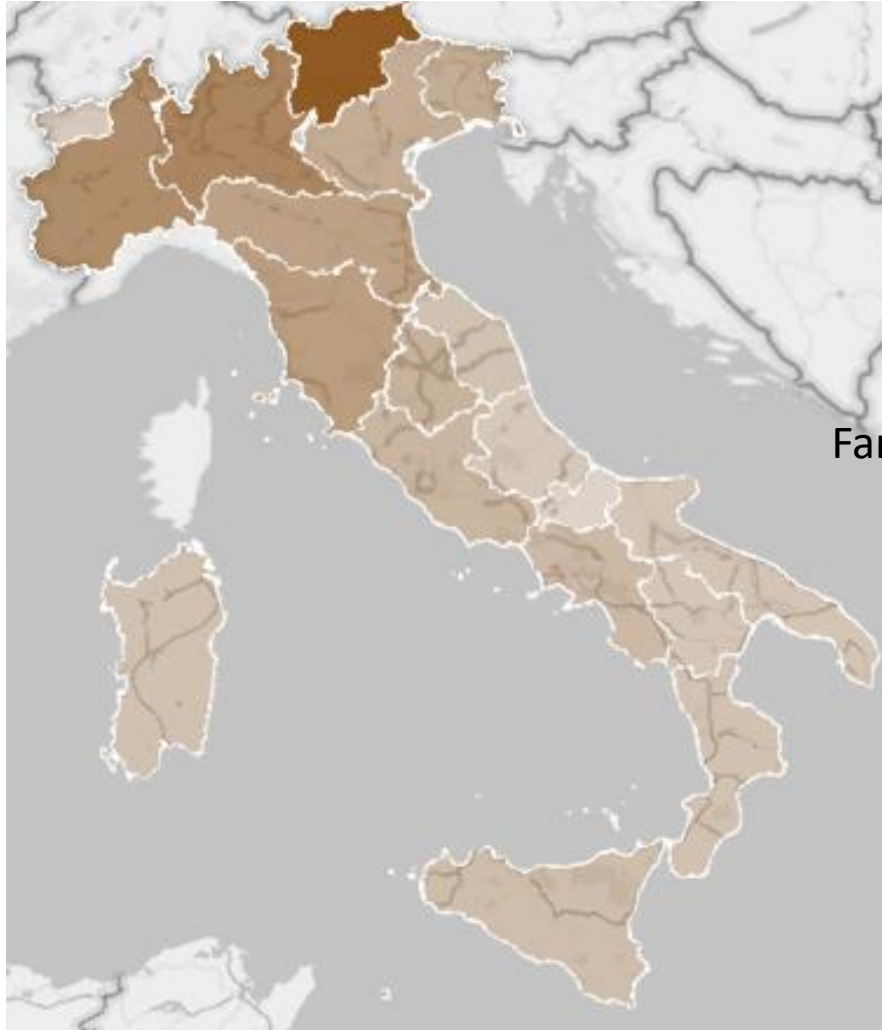
Installed capacity from bioenergy by Regions [Source: GSE]



- In 2019 **bioenergy power plants capacity** (4,120 MW from biomass, biogas and bioliquids for a total of 2,946 plants) represented the **7.4% of the total RES capacity** installed in Italy. The **average capacity** of bioenergy power plants is small, **less than 1 MW**.
- **40.8%** of the total capacity (1,681 on 4,180 MW), is powered by **solid biomass**, **35.4% by biogas** and the remaining **23.8% by bioliquids**.
- **The majority of bioenergy plants are located in the North**, mainly in Lombardia (933 MW), Emilia Romagna (639 MW), Veneto (370 MW) and Piemonte (353 MW).
- **The 64.2% of the total national production is located in 5 Regions:** Lombardia (22.6%), Emilia Romagna (15.5%), Veneto (9.0%), Piemonte (8.6%) and Puglia (8.5%)

IT: CURRENT SITUATION - BIOENERGY IN THE ELECTRICITY SECTOR

Number and installed capacity of syngas plants from bioenergy supported by GSE in 2020 by Region [Source: GSE]



Syngas plants installed capacity [kW]



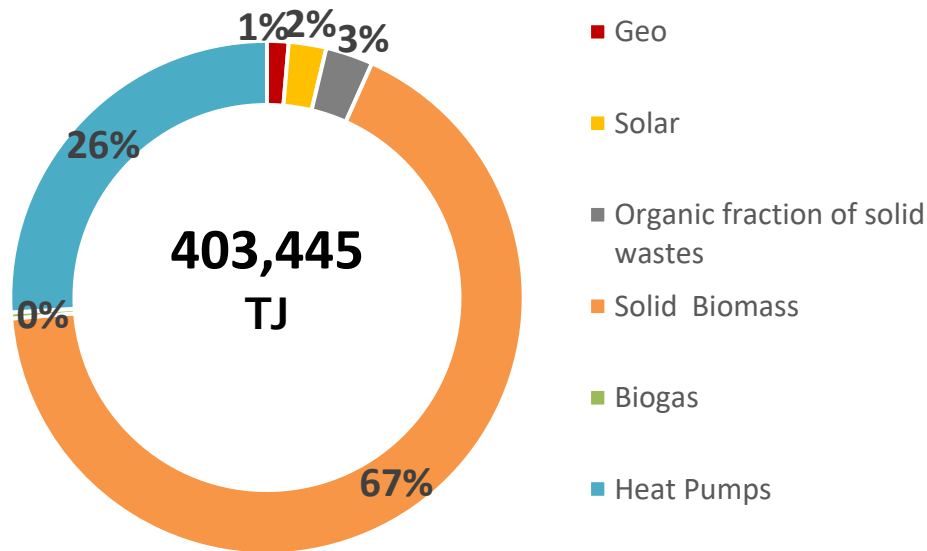
Fare clic per inserire testo

- In 2020, according to GSE database, there were **248 syngas bioenergy power plants** into operation in Italy corresponding to an installed capacity of about **49 MW**.
- More than the **75% of the capacity** is concentrated in the Northern part of the Country

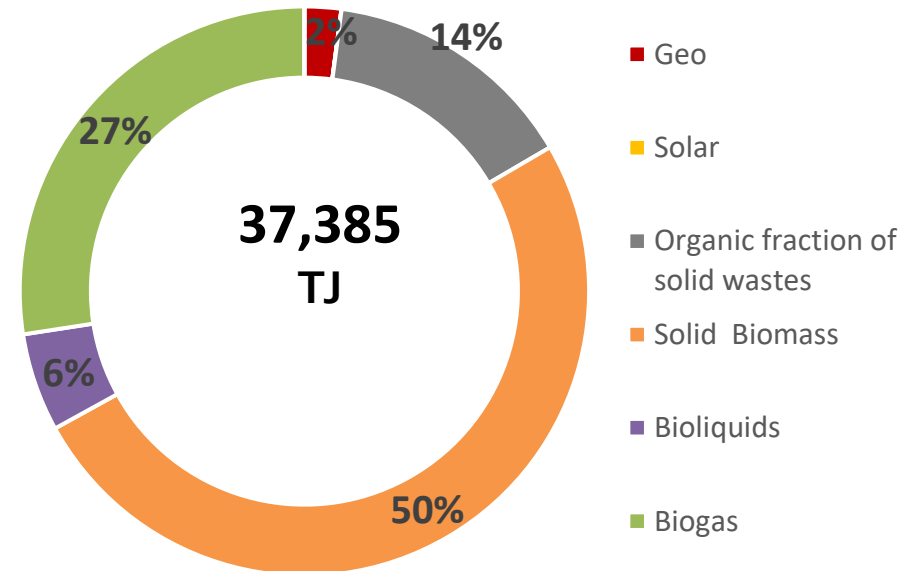
IT: CURRENT SITUATION IN THE HEATING SECTOR

- In 2019, the energy consumption from renewable sources in the heating sector in Italy amounted to 445,316 TJ (10.6 Mtoe), of which 91% attributable to direct consumptions from households and companies. The residual 9% represented the production of derived heat produced in energy plants (89% CHP) and sold to third parties mainly through DHC networks.
- Considering both direct uses and derived heat **the main source used for heating purposes in Italy in 2019 was solid biomass**. The **main contribution came from firewood** (widely used in traditional installations) and **pellet** (in more modern and efficient appliances) in the **residential sector**.

Direct energy consumption in the heating sector in 2019
[Source: GSE]

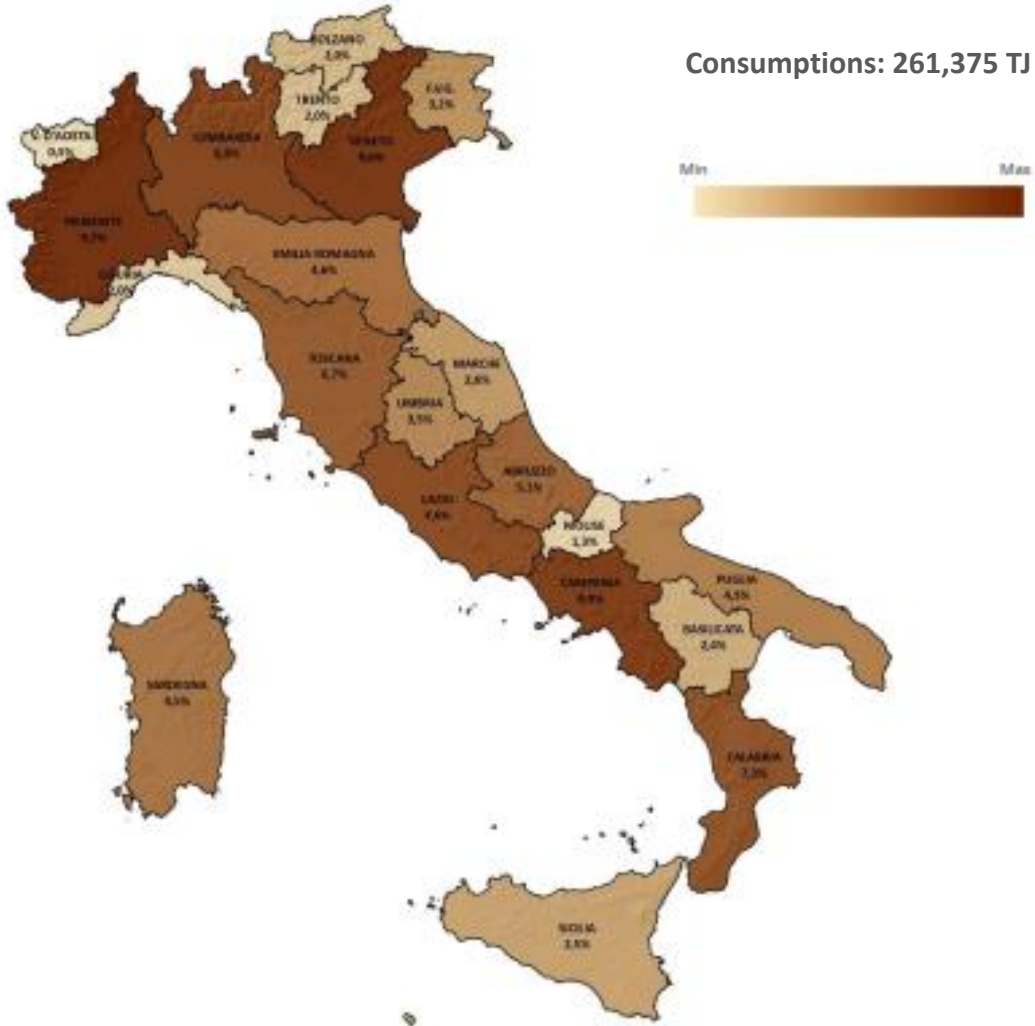


Derived heat consumption in the heating sector in 2019
[Source: GSE]

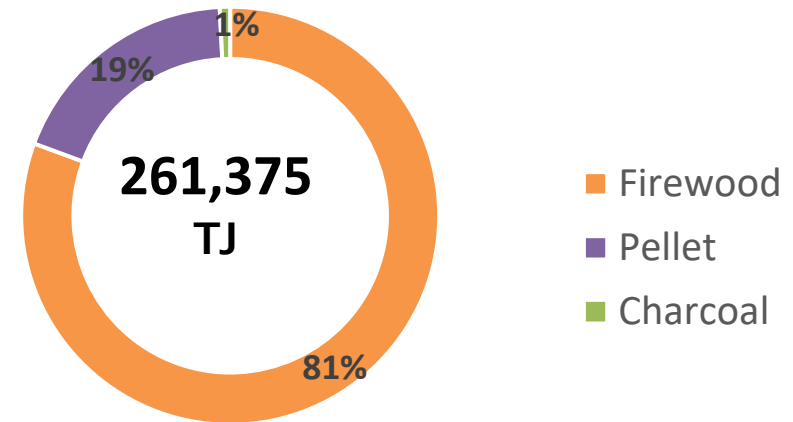


IT: CURRENT SITUATION - BIOENERGY IN THE HEATING SECTOR

Direct consumptions of biomass by Regions in the residential sector [Source: GSE]



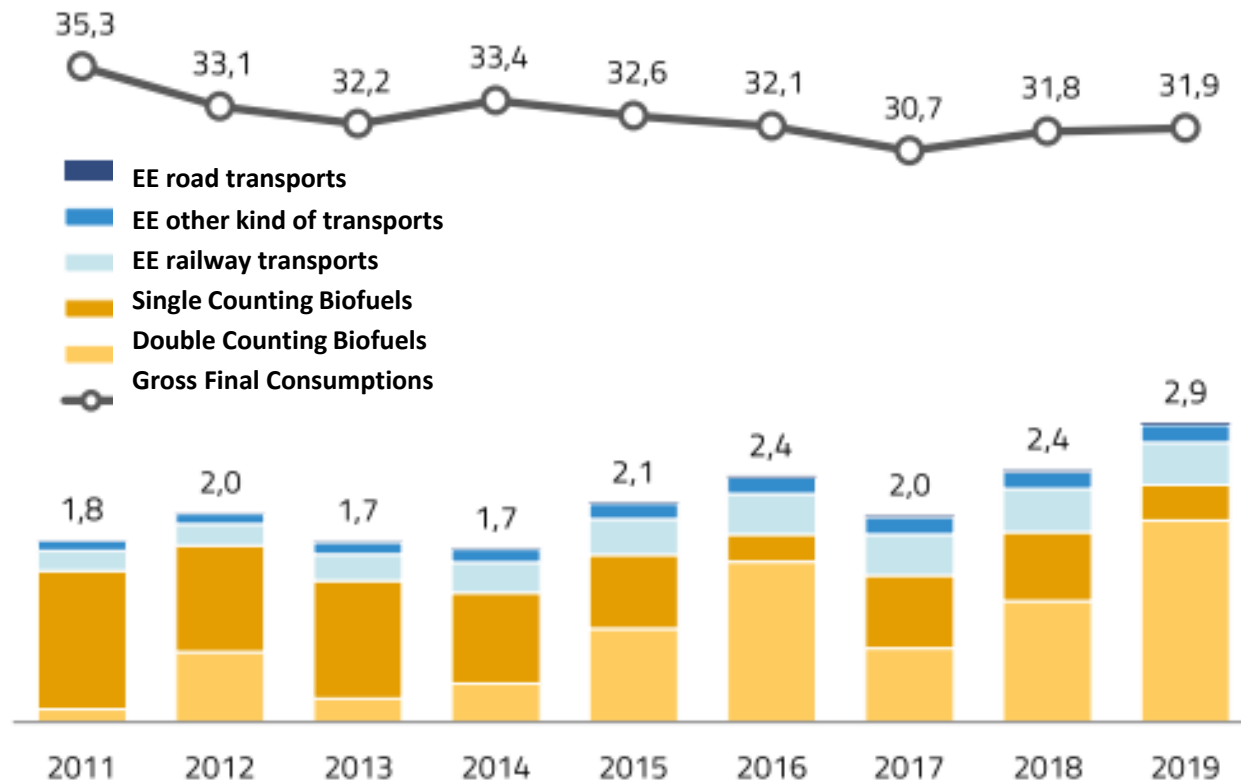
- The use of solid biomass for heating purposes in the residential sector is widespread in the Peninsula. The Regions with higher consumptions are Piemonte, Veneto and Lombardia (18.9% of total consumptions). In 2019 about 18 million ton of solid biomass was consumed in Italy, in the residential sector (stoves, fireplaces, boilers...)



- People purchase the 45% of consumed firewood, the remaining 55% use totally or partially self produced or recuperated wood. Use of pellet is increasing; pellet is mainly imported. Charcoal is mainly used for cooking purposes

IT: CURRENT SITUATION IN THE TRANSPORT SECTOR

RES in the transport sector by sources (including double counting) and gross final energy consumptions (Mtoe) [Source: GSE]

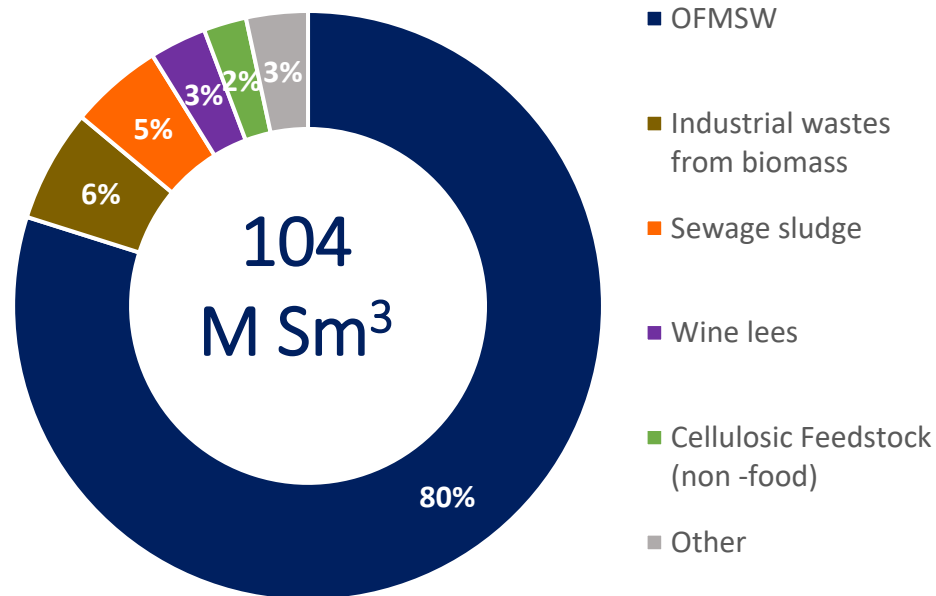


- In 2019, over 1.5 million tons of biofuels were consumed in Italy, almost exclusively sustainable (less than 20 tons were not sustainable) with an energy content of 55,140 TJ (1,317 ktoe). Over 95% of these volumes is represented by the biodiesel; the incidence of bio-ETBE is very small (2.4%), that of bioethanol is negligible.
- Double counting biofuels, (including advanced biofuels) represented about the 74% of biofuels released for consumption in 2019.

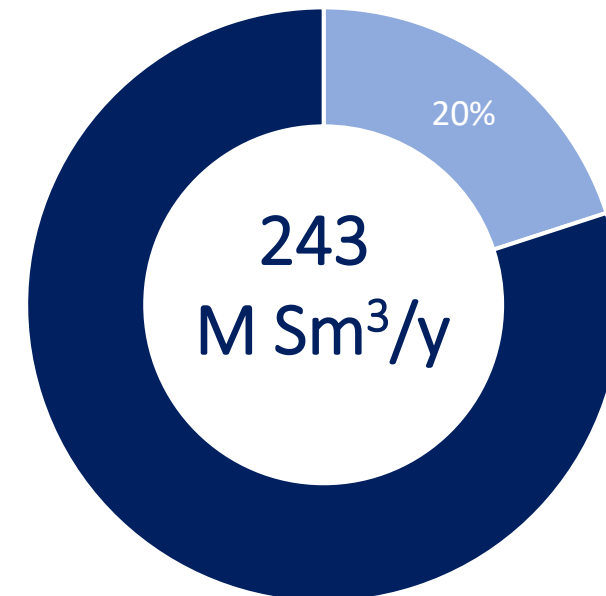
BIOMETHANE IN THE TRANSPORT SECTOR

- From 2018 GSE selects biomethane production plants (new or converted) eligible to access to MD 2nd March 2018 support scheme
- In 2020 GSE supported **21 advanced biomethane production plants (27,980 Sm³/h production capacity) generating about 104 M Sm³ (80% from OFMSW)** corresponding to **161,455 CICs with a value of about 61 M€ (375 €/CIC)**. In addition, about 30 plants are currently eligible to access to incentives.
- GSE monitors the progresses towards the achievement of maximum production capacity eligible to be supported that is equal to **1.1 bn Sm³/y**. **Currently we cover about the 22% of the limit**

Advanced biomethane supported by feedstock



Maximum production capacity monitoring



ITALY ENERGY SYSTEM EVOLUTION THE ROLE OF BIONERGY

Power system de-carbonization

New energy sources mix, new challenges



Italy, as well as Europe and most of the world, is engaged in the fight against climate change

A fundamental path is to reduce fossil fuel use:

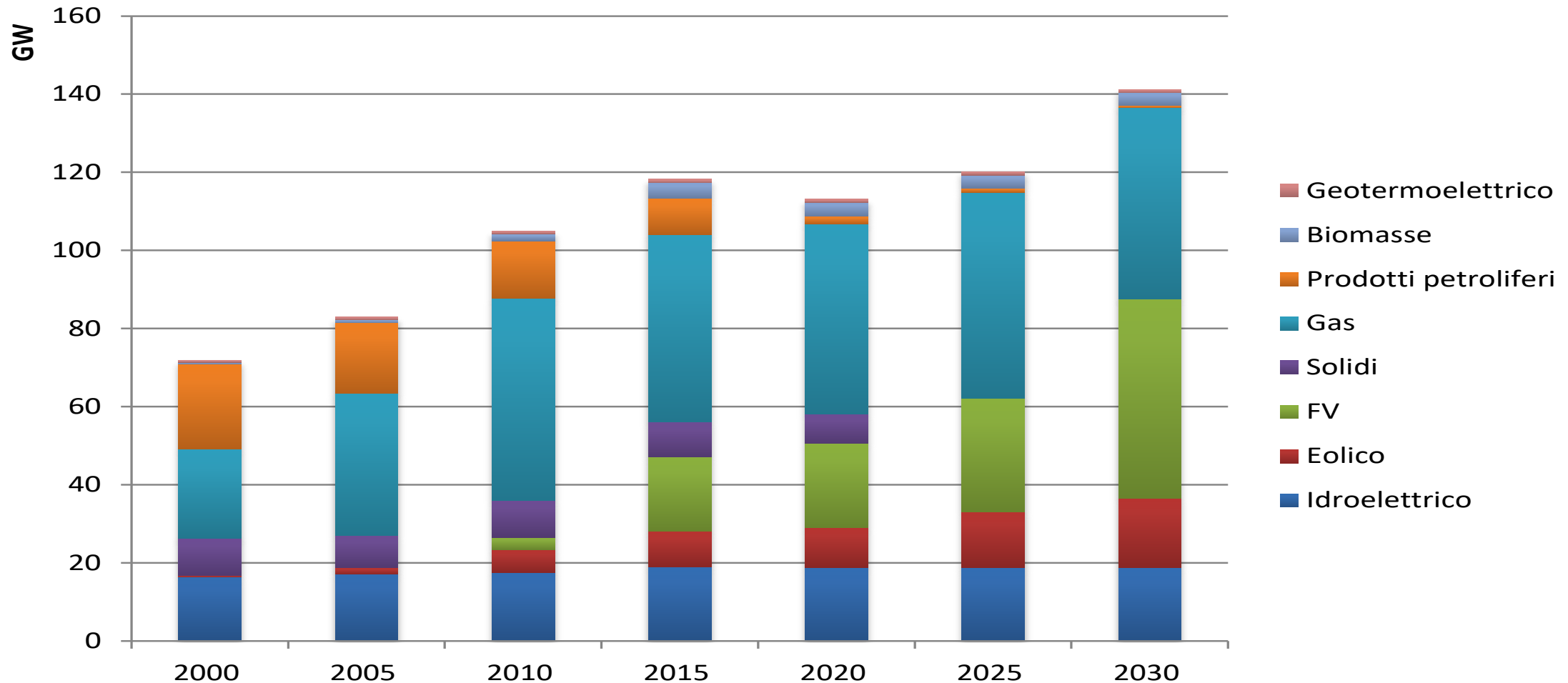
- Renewable sources exploitation, starting from power generation, to be extended to heating/cooling and transport sectors
- Energy efficiency improvement

Italian National Energy and Climate Plan is addressing these objectives, taking into account

- Energy cost for the users
- Security of supply

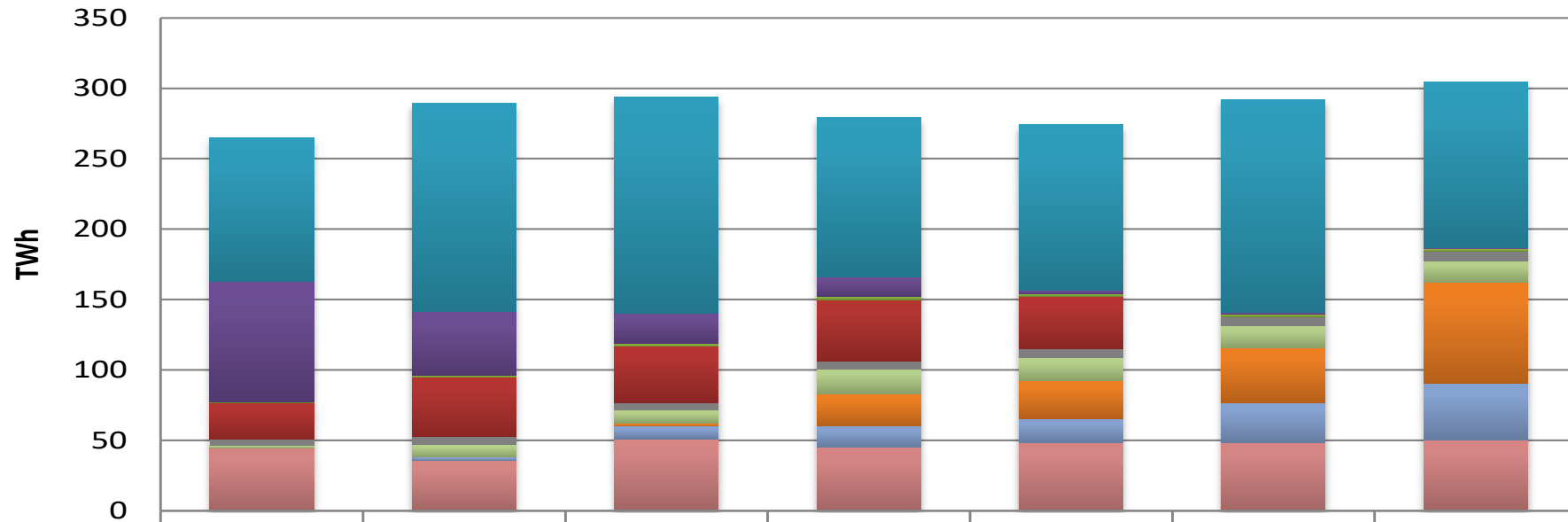
Italian generation mix up to 2030

Installed capacity



Italian generation mix up to 2030

Electricity production



| | 2000 | 2005 | 2010 | 2015 | 2020 | 2025 | 2030 |
|----------------------|-------|-------|-------|-------|-------|-------|-------|
| Gas naturale | 101.7 | 147.6 | 153.5 | 113.1 | 117.4 | 150.9 | 118.1 |
| Prodotti petroliferi | 85.7 | 45.3 | 21.2 | 13.9 | 2.4 | 1.3 | 0.6 |
| Rifiuti non rinnov. | 0.4 | 1.3 | 2.0 | 2.3 | 2.1 | 1.9 | 1.6 |
| Carbone | 25.9 | 42.3 | 39.9 | 43.3 | 36.9 | 0.0 | 0.0 |
| Geotermoel | 4.7 | 5.3 | 5.4 | 6.2 | 6.7 | 6.9 | 7.1 |
| Bioenergie | 1.6 | 8.9 | 9.4 | 17.0 | 15.8 | 15.4 | 14.9 |
| Fotovoltaico | 0.0 | 0.0 | 1.9 | 22.9 | 27.0 | 38.5 | 71.7 |
| Eolico | 0.6 | 2.3 | 9.1 | 14.9 | 17.5 | 28.8 | 40.6 |
| Idroelettrico | 44.3 | 36.1 | 51.1 | 45.5 | 48.2 | 48.2 | 50.1 |

Italian power system: scenario at 2030



"PNIEC 2020" scenario (CO2 emissions - 43 % compared to 1990 level)

- Gas and hydro generation roughly unchanged
- Generation from coal and oil disappears
- Big PV and wind increase (x 3 compared to 2020 level)
- As today, CCGT operate at low load factor → some of them could be retired

New, more ambitious scenarios are being investigated (at European level, -55% at 2030, carbon neutrality at 2050)

CRITICAL ISSUES:

- Adequacy ("firm" generation capacity decreases)
- Flexibility (non programmable sources increase)

What is the "perfect" energy source ?



In a transition towards zero emissions, we would need a source:

- Renewable (low CO2 emissions in a "LCA" evaluation)
- Affordable
- With acceptable local pollutant emissions
- Available and reliable
- Controllable and flexible

Does it exist ?

- Hydro with reservoir
- **Bioenergies**

Biomasses: a renewable source (with some constraints)



- CHP with wood chips: CO₂ emissions (LCA) \approx Building Integrated PhotoVoltaics (some tenths of g_{CO2}/kWh)
- Biogas for
 - Power
 - Heat
 - Biomethane

CO₂ emissions depend on feedstock and digestate management
With proper operation, it may be sustainable (even negative emissions may be reached)

Adequacy: how much capacity is needed ?

According to Terna, the Italian TSO, the thermal capacity (LOLE = 3h) needed at 2030 is about 55 GW

- New gas fired capacity (no coal neither oil at 2030)
- Use thermal capacity in a very flexible way (load load factor)

Wide room for programmable RES, in particular **bioenergies** (solid biomass CHP, biogas)



Biomasses: adequacy contribution

| | Capacity (MW) | Production (GWh el) | Eq. Hours/year | Load factor |
|---------------|---------------|---------------------|----------------|-------------|
| WIND | 10715 | 20202 | 1885 | 22% |
| PV | 20865 | 23689 | 1135 | 13% |
| SOLID BIOMASS | 783 | 4197 | 5360 | 61% |
| BIOGAS | 1455 | 8277 | 5689 | 65% |

2019 data

High load factor (wind x 3, PV x 5) → higher bioenergy CAPEX is partly compensated

Good adequacy contribution:

- Bioenergies run over 60 % of the year
- Energy source easy to store, always available

Power system flexibility

A «de-carbonized» power system will have huge non programmable capacity (sun, wind). New flexibility resources are needed:

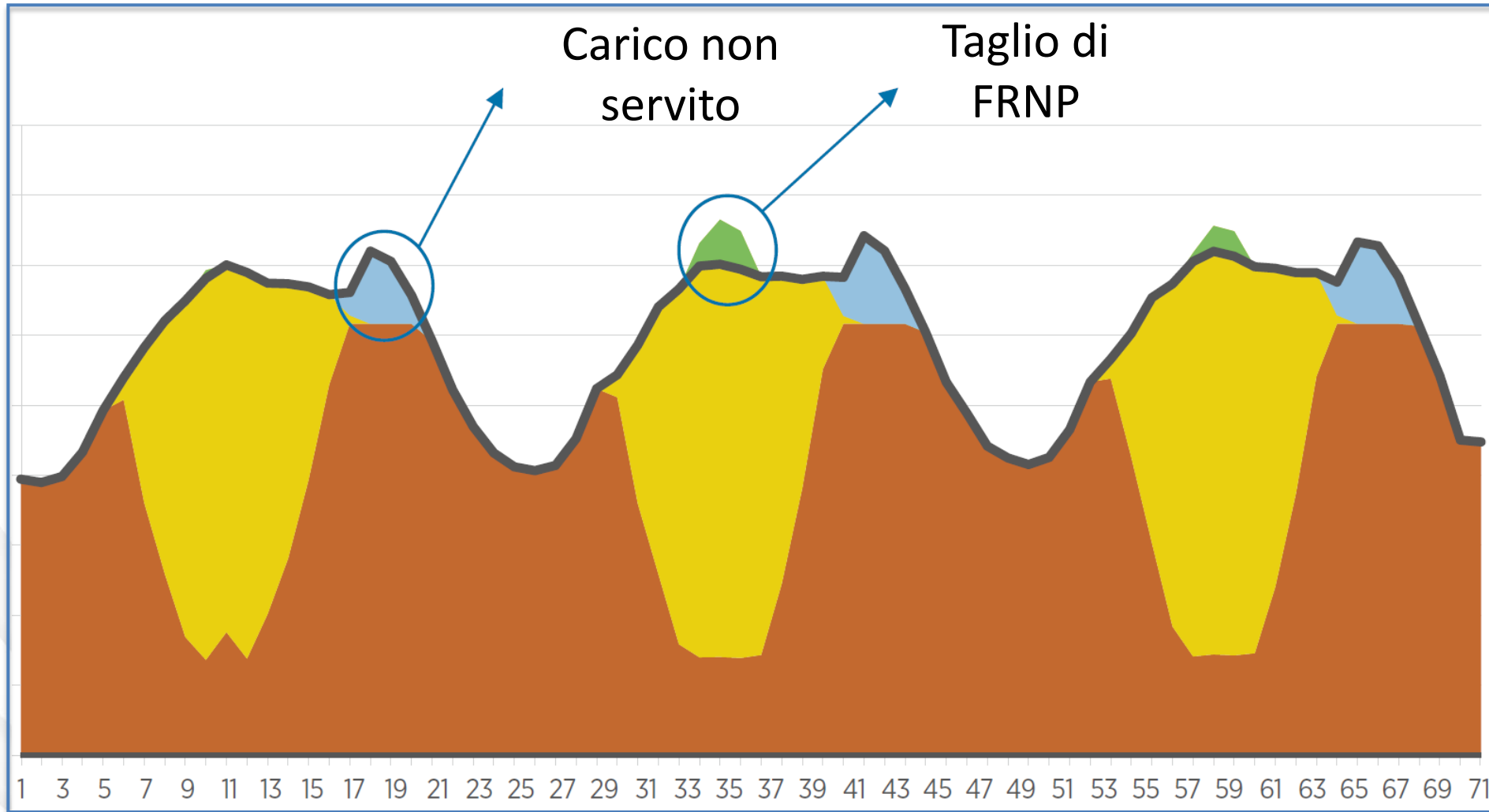
- Electric storage (PH, batteries)
- Programmable RES: bioenergies, geothermal, hydro with reservoir
- A limited contribution from non Programmable RES
- Demand Response
- Vehicle to grid
- Cross border interconnections

All of these resources are limited, and in any case expensive.

The consequence is that the "gas phase out" has to be postponed for many years

Power system flexibility issues

MW



Flexibility Resources



"Green" Hydrogen production, what are the options ?

- Most obvious option: electrolysis fed by Non Programmable (sun, wind, hydro run for river)
 - 😊 Power System Balancing → greater RES "Hosting Capacity"
 - 😊 Commercial Technology, even if evolving
 - 😞 Low productivity → CAPEX incidence high
 - 😞 For wind, long term H₂ storage is needed
- Alternative: biomass, organic waste (thermochemical processes)
 - 😊 High productivity --> lower CAPEX incidence
 - 😊 No long term H₂ storage needed
 - 😊 Potentially, negative emissions !
 - 😞 No Power System Balancing (but it can be done with flexible polygeneration electricity/heat/hydrogen)
 - 😞 Limited resources available (but more wood exploitation is possible)
 - 😞 Commercial technologies, but reliability and maintenance should be improved



Thank you for your attention

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