ENERGY FROM BIOGAS: A REAL OPPORTUNITY FOR TERRITORY AND ZOOTECHNICAL FARMS IN THE PROVINCE OF FOGGIA (ITALY)

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Abstract

In the last years, the Italian energy-environmental situation has been characterized by the development of renewable resources into the energy system, thanks to the adoption of new tools for their promotion, according to European Community goals. Among theses, vegetal and animal biomass represents a resource of great interest for the agricultural and zootechnical world, above all local, thanks to the various economic and environmental effects deriving from its transformation in energy.

In this context, the province of Foggia, a northern area of the Apulia Region, due to its agro-zootechnical vocation, seems designated to become a suitable area in which to create a bio-energetic district, able to allow the development of biomass use, through a diversification and modernization of the agricultural and zootechnical sector.

The present paper intends to focus on potential production of energy from biogas deriving from anaerobic digestion of zootechnical effluents available in the territory; this is to evaluate the economic and environmental future feasibility.
From the results of the analysis, it seems clear that good potentialities of biogas production in some specified areas exist, and in these areas a fair number of intensive breeding zootechnical farms are located. Consequently, these farms could take

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advantage of the opportunity, offered by the energy and environmental national policy (Legislative Decree 387/2003 and Legislative Decree 152/2006), in order to integrate their own business activity, reduce internal energy costs, those of zootechnical effluents disposal and, on the whole, contribute to the decrease of fossil fuel use and its impact on the atmosphere in the province of Foggia.

Riassunto

Lo scenario energetico-ambientale, delineatosi negli ultimi anni in Italia, è stato contraddistinto dallo sviluppo e dal potenziamento delle fonti di energia rinnovabile grazie agli strumenti di incentivazione messi a disposizione dalle norme in materia, derivanti dagli indirizzi stabiliti dalla Unione europea (Ue). La biomassa vegetale ed animale rappresenta, tra queste, una risorsa di grande interesse per il mondo agricolo e zootecnico, soprattutto locale, per le diverse ripercussioni economiche ed ambientali conseguenti alla sua trasformazione in energia.

In questo contesto la provincia di Foggia, zona a nord della Puglia, regione del Mezzogiorno d'Italia, per la sua spiccata vocazione agro-zootecnica, sembra poter essere destinata a diventare un'area adatta alla realizzazione di un distretto bioenergetico, in grado di favorire per l'appunto l'impiego della biomassa attraverso una diversificazione e modernizzazione delle attività aziendali prima menzionate.

Il presente lavoro ha inteso soffermare l'attenzione sulla possibile produzione di energia da biogas, derivante dalla digestione anaerobica dei reflui zootecnici disponibili sul territorio, al fine di valutarne la fattibilità futura in termini economici ed ambientali.

Da una prima indagine, è emerso che, nel territorio considerato, esistono effettivamente delle potenzialità di questo tipo, soprattutto in alcune specifiche zone in cui è localizzato un discreto numero di aziende zootecniche ad allevamento di tipo intensivo.

Queste ultime potrebbero pertanto cogliere l'opportunità, offerta dalle nuove linee della politica energetica ed ambientale nazionale (D. Lgs 387/2003 e D. Lgs 152/2006), e di conseguenza regionale e provinciale, di integrare la propria attività imprenditoriale, di diminuire i costi energetici interni e quelli di smaltimento degli effluenti zootecnici e, in senso più generale, contribuire alla riduzione dell'impiego delle fonti fossili e del loro impatto nell'atmosfera della provincia di Foggia.

Keywords: Biogas; Zootechnics; Renewable energy; Province of Foggia

Introduction

Biomass may be used as is, through its direct combustion, or having undergone bio-thermo-chemical tranformation processes to produce secondary resources, among which biogas. Biogas may derive from the natural process of methanization of organic waste present in landfills or from anaerobic digestion of purification sludge, crops, agro-industrial by-products and animal effluents. Once produced, it can be burnt in the traditional boiler to produce heat, used as fuel in power or cogeneration plants, in the car industry or fed into gas pipelines. Currently, it is mostly used to generate electricity.

Although biogas represents the most widespread biofuel in Europe, it is still not widely used in Italy and even less so in the Apulia region. In 2006, its primary national production was approximately 355 ktep (that is, 6.6% of total EU quantity), equal to 1.2% of the total energy offered. Conversion of biogas into electricity was 1,239 GWh, which in the same year represented 2.6% of production deriving from renewable national resources (1-2). However, this last value highlighted a significant increase rate, equal to 100% over the last decade.

The majority of electricity from biogas is obtained from organic waste present in landfills which, thanks to the current law in force (Legislative Decree 36/2003 (3) assimilated from Directive 99/31/CE (4)), foresees that gas deriving from it must be captured; a small quantity is also due to anaerobic digestion of crops and agro-industrial waste. Other raw materials are purification sludge and animal effluents which, together, do not amount to 4% of the quantity of biogas generated in 2006 (5).

Therefore, plants for the production and transformation of biogas into electric and thermal energy are beginning to be considered an interesting opportunity, both from an economic and environmental point of view, above all, in the agricultural and zootechnical sectors. These sectors traditionally possess the raw materials necessary to feed the micro-organisms which produce this fuel. For example, animal effluents become a resource to be valued and put to best use, together with agricultural waste or dedicated crops, with a view to increasing farmer-breeder income .

The province of Foggia, an area in the north of the Apulia region, due to its agro-zootechnical vocation, seems destined to become a suitable area in which to create a bio-energetic district, able to allow the development of biogas use, as a renewable source, through a diversification and modernization of the aforementioned sectors.

In particular, it has been ascertained that the estimated biogas potential deriving from zootechnical liquid, throughout the territory, is rather significant, being equal to approximately 13 Mm^3/year. From this, by means of a cogeneration system, it is possible to obtain 23 GWh electricity (18% of the demand for electricity in the agricultural sector registered in 2005) and 46 GWh thermal energy (6-7).

The present study aims at verifying if, within the administrative area in question, there are areas with high levels of livestock and, therefore, intensive breeding farms able to create biogas plants which are economically convenient.

Characteristics of the zootechnical sector

The province of Foggia, situated to the north of the Apulia region, in the southern Italy, consists of 64 administrative districts and extends over an area of 719 thousand hectares, 82% of which is represented by Utilised Agricultural Surface (UAS).
The territory is characterised by the presence of a vast plain (Tavoliere) and two mountainous-hilly areas (the Daunia sub-Appennine area and the Gargano promontory).

Fig. 1 - The Apulia region and the province of Foggia

There are 3,032 zootechnical farms subdivided as follows: 50% sheep-goat breeding, 40% cattle-buffalo, 3% swine and the remaining part

containing different species (including poultry) (8). These are mainly situated in the Gargano mountain area and the Tavoliere plain, where the highest number of the largest farms are concentrated.
The total number of livestock present in the territory is illustrated in Table 1: poultry and other species have not been included since no data was available.

TABLE 1

TYPES OF LIVESTOCK IN THE PROVINCE OF FOGGIA (2007)

Type	Number of heads
Cattle-buffalo	52,263
Sheep-goat	149,791
Swine	7,690
Total	209,744

(Source:(8))

Compared to values registered in 2000 and published in the agricultural census (9), a significant increase in the number of cattle and buffalo may be seen, as may a reduction in the number of sheep (Figure 2), even if the division, in terms of percentage, has remained more or less the same, that is, with a prevalence of sheep-goat breeding in the provincial territory, with more than 70% (Figure 3).

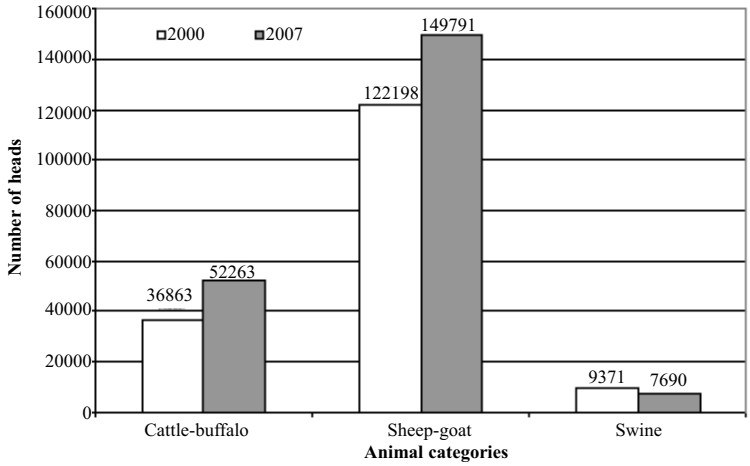

Fig. 2 - Number of livestock heads in the province of Foggia (2000-2007).
(Source: data processing (8-9))

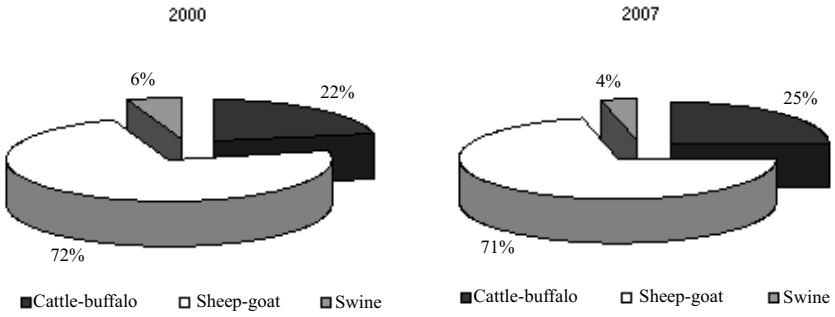

Fig. 3 - Percentage variation in the division of breeding farms (2000-2007). *(Source: data processing (8- 9))*

Potential areas

The Apulia region administration, with the Decision of the City Board n. 2036 of 30th December 2005 (10), indicated the Nitrate Vulnerable Areas (NVA) present within the territory and, with the subsequent Decision n. 19 of 23rd January 2007 (11) established a Plan of action to highlight interventions necessary for the reduction of pollution caused by nitrates deriving, in particular, from animal effluents and/or mass use of fertilizers (as foreseen by the "Nitrates Directive" n. 676 of 12th December 1991 (12), assimilated in Italy with Legislative Decree 152/1999 (13), thereafter abrogated and substituted by Legislative Decree 152/2006 (14)).

Moreover, the Decree of the Agriculture and Forestry Ministry of 7th April 2006 (15) defined the nitrate vulnerable areas of zootechnical origin as those upon which no more than 170 kg/ha of nitrates may be used and those ordinary ones where such a value doubles (340 kg/ha).

From this study, the province of Foggia resulted part of the territory in which 90% of NVA were present (Figure 4), comprising the areas (1) of Lesina, Carpino, San Severo, Foggia, Cerignola and Trinitapoli, for a total surface area of 82 thousand hectares, 11% of the total administrative surface area and 14% of the UAS.

(1) Each area includes a series of documents from the land registry books (territories) belonging to different administrative districts.

Fig. 4 - Nitrate Vulnerable Areas.
(Source: data processing (16))

Among the various strategies for the management of zootechnical effluents, able to re-address the agricultural-environmental balance, and therefore reduce degradation of the areas highlighted, the production of biogas currently seems to be the most opportune: this, by virtue of the transformation of effluents in a stabilized fermented subsoil which presents, compared to initial material, a reduced quantity of the organic substance, on average equal to 60%, greater quality, due to the decrease in organic nitrogen content (10%) and greater fluidity. With such characteristics it may be spread on land as is, like purification sludge, since it is still in its decomposition phase, according to current norms (Legislative Decree 99/1992 (17)), or as a true amendant, as foreseen by Legislative Decree 127/2006 (18), after having undergone a composting process aimed at a further improvement of its agronomic quality (in particular with a reduction in ammonium ions).

The use of digested sludge in agriculture, due to its significantly high content of mineral nutrients and its stabilized organic substance (due to the degradation of labile fractions and the concentration of the recalcitrant ones), thus increases the whole quality of the soil (biological, structural and nutritional, together with the conservation of carbon), representing a precursor to humus. Moreover, its use reduces the units of synthesized nitrogen introduced into the soil-water bearing layer, allowing to restore the fertility conditions of the NVA in the province of Foggia.

Also the aims of European energy policies, to increase production of electricity from renewable energy sources (Directive n. 77 of 2001 (19)), assimilated on at a national level with Legislative Decree 387/2003 (20), support the generation of biogas with a view to reducing atmospheric pollution deriving from the emission of greenhouse gases from fossil sources. Within this context, animal effluents represent a precious raw material for biogas production plants (as foreseen by Regulation 1774/2002 (21)).

Therefore, in using this, the Foggia territory could benefit, not only from environmental benefits strictly connected to soil contamination, but also from those relative to the reduction of climate altering gases (in particular, carbon dioxide and methane).

In order to pinpoint the potential areas suited to the creation of biogas plants within the province of Foggia, a study was carried out on the zootechnical farms in the area, based on the type of breeding and size.
Preference was given only to those concerning cattle-buffalo and swine breeding with a high number of livestock per stall, that is intensive breeding farms. In fact, the latter having to deal with the problem of the disposal of excessive quantities of sewage could find such a system both convenient and advantageous.

The following were not taken into account: 1) sheep and goats, since, even if high in number, they are bred on extensive or semi-extensive areas, thus not allowing the continuous systematic collection of effluents, in part already spread over the land; 2) the temporary stalls and private and public slaughterhouses, which will be analysed in more detail in a future study.

Cattle/buffalo breeding farms

As already mentioned, the percentage of cattle-buffalo farms in the province of Foggia is equal to more than 40%. 26% have less than 10 heads, 54% have from 11 to 50 heads, while only 20% have more than 50 animals (8).

Due to the characteristics of the local zootechnical sector, among those farms with a number of heads greater than 50, those defined as intensive breeding centres are those with more than 100 heads (table 2). Within the area considered, these are situated in 22 administrative districts: Apricena, Cerignola, Foggia, Lucera, S. Severo, Stornarella, San Ferdinando di Puglia, Torremaggiore, Trinitapoli (part of the Tavoliere plain); Cagnano Varano, Carpino, Lesina, Manfredonia, Mattinata, Monte Sant'Angelo, Peschici, Rignano Garganico, San Giovanni Rotondo, San Marco in Lamis, Sannicandro Garganico, Vico del Gargano and Vieste (in the Gargano promontory).

The locations of the farms throughout the area led to a further selection of the sites. Only those farms having a consistent number of over 350 heads have been taken into account, for which disposal of effluents produced becomes a worrying problem and economic investment more convenient for scale economies which may be created (Table 3).

Within the context of the creation of a bio-energy district, another proposal was put forward: that is, to choose only those administrative districts in which there are at least three farms having this characteristic; this was done to reduce the costs of collection of raw material and transport to a minimum. The choice fell upon Manfredonia (having a surface area of 350 km^2), and where three farms with a high number of buffalo are situated, San Giovanni Rotondo (260 km^2), where there are four cattle farms and Cerignola, where there is a breeding farm with more than 1,000 heads of buffalo (as many as in the three farms in Manfredonia).

TABLE 2

CATTLE/BUFFALO FARMS HAVING AT LEAST 350 HEADS (2007)

Administrative district	Farms	Number of heads
Manfredonia (buffalo)	1	411
	2	362
	3	359
San Giovanni Rotondo (cattle)	1	618
	2	592
	3	417
	4	376
Lesina (cattle)	1	354
Rignano garganico (cattle)	1	376
Apricena (cattle)	1	365
San Marco in Lamis (cattle)	1	364
Cerignola (buffalo)	1	1 007

(Source: data processing (8))

TABLE 3

CATTLE/BUFFALO FARMS AND HEADS OF LIVESTOCK PER ADMINISTRATIVE DISTRICT

Administrative districts	Number of farms	Farms with more 100 heads	Total number of heads
Accadia	22	0	599
Alberona	33	0	480
Anzano	3	0	4
Apricena	35	8	2 368
Ascoli Satriano	20	0	704
Biccari	29	0	577
Bovino	13	0	196
Cagnano Varano	72	1	2 120
Candela	4	0	23
Carlantino	1	0	17
Carpino	42	5	1 898
Casalnuovo Monterotaro	9	0	79
Casalvecchio di Puglia	1	0	2
Castelluccio dei Sauri	3	0	167
Castelluccio Valmaggiore	11	0	232
Castelnuovo della Daunia	8	0	84
Celenza valfortore	6	0	40
Celle San Vito	6	0	94
Cerignola	9	1	1 114
Chieuti	6	0	118
Deliceto	12	0	98
Faeto	10	0	178
Foggia	64	4	2 729
Ischitella	13	0	255
Lesina	9	1	901
Lucera	29	4	1 200
Manfredonia	70	14	5 042
Mattinata	51	3	1 939
Monte Sant'Angelo	90	9	4 784
Monteleone di Puglia	42	0	534
Motta Montecorvino	1	0	6
Ordona	4	0	6
Orsara di Puglia	23	0	239
Ortanova	4	0	68
Panni	13	0	283
Peschici	3	1	253
Pietra Montecorvino	3	0	31
Poggio Imperiale	6	0	53
Rignano Garganico	26	4	1 469
Rocchetta S.Antonio	11	0	196
Roseto Valfortore	22	0	569
San Paolo Civitate	7	0	155
San Ferdinando di Puglia	1	1	205
San Giovanni Rotondo	60	11	4 542
San Marco in Lamis	89	14	5 371
San Marco la Catola	2	0	18
San Severo	14	1	291
Sannicandro Garganico	95	16	5 702
Sant'Agata di Puglia	22	0	317
Serracapriola	4	0	36
Stornara	1	0	20
Stornarella	1	1	106
Torremaggiore	3	0	275
Trinitapoli	5	1	482
Troia	20	0	418
Vico del Gargano	12	3	1 022
Vieste	36	2	1 312
Volturara Appula	16	0	222
Volturino	5	0	20
Total	**1232**	**105**	**52 263**

(Source: data processing (8))

Swine breeding farms

Concerning the situation relative to the breeding of swine and based on the data available, less complete compared to that of cattle-buffalo farms, the area chosen is Cerignola, south of the Tavoliere plain, where more than 50% of animals are concentrated (Table 4). In this district of 600 km2, there is really only one farm which has the total quantity of swine.

TABLE 4

SWINE FARMS AND HEADS OF LIVESTOCK PER ADMINISTRATIVE DISTRICT (2007)

Administartive districts	Farms	Number of heads
Cagnano Varano	2	20
Castelluccio Valmaggiore	1	9
Cerignola	1	4 024
Chieuti	1	2
Lucera	1	9
Manfredonia	1	45
Monte Sant'Angelo	3	44
Ordona	1	523
Orsara di Puglia	4	180
Ortanova	1	800
San Marco in Lamis	1	10
Troia	3	2 024
Total	**20**	**7 690**

(Source: data processing (8))

From this initial study, nine intensive breeding farms have been found and are situated in three different areas (Figure 5): four have a high number of cattle in the administrative district of San Giovanni Rotondo; three of buffalo in Manfredonia; two of swine and buffalo in the area of Cerignola.

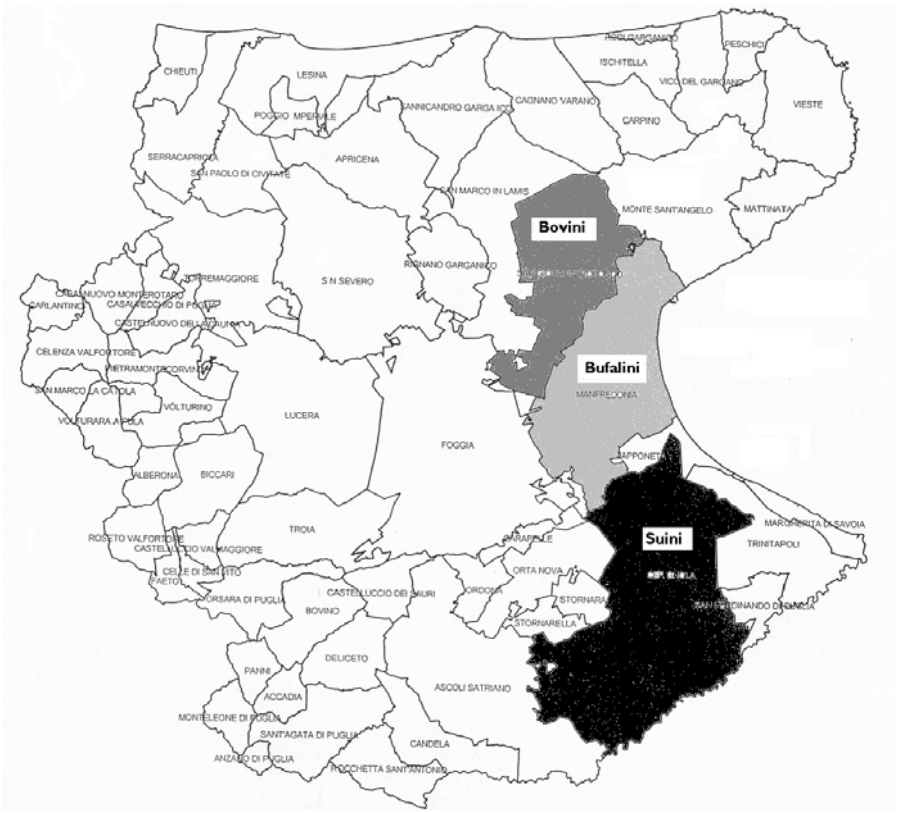

Fig. 5 - The agricultural administrative districts selected

Production of biogas, energy and digested sludge

In order to determine the quantity of zootechnical effluents producible and fuel (in terms of biogas) deriving from it, reference is made to a method already used in the initially selected intensive breeding farms (22-23).

The calculation was done considering that the farms produce only sewage. The choice of this type of effluent comes from the assumption, as previously highlighted, that it is often difficult to dispose of, compared to manure which, on the contrary, due to its intrinsic characteristics, can be used directly as a superior quality agronomic amendant (greater preservation of nitrogen and yield in humus) (24).

Consequently, a yearly average quantity of liquid produced per type of animal is obtained (Table 5).

After having estimated this value, the potential in terms of biogas was evaluated, considering average yields obtained from the process of anaerobic digestion of organic substance (o.s.), contained in the sawage (2) (Table 6) (25). Consequently, the quantity of biogas producible in the selected farms is equal to more than 1,2 Mm^3, 9% of the province total (6).

The biogas obtained may be used to generate heat and/or electricity by means of a cogeneration syste (3) (Table 7).

TABLE 5

VOLUME OF SEWAGE PER FARM SELECTED

Agro-admin.	Farm	Number of	Total quantity of sewage
Manfredonia (buffalo)	a	411	5 918
	b	362	5 213
	c	359	5 170
	Total	**1 132**	**16 301**
S. Giovanni R. (cattle)	a	618	8 899
	b	592	5 047
	c	417	6 005
	d	376	5 414
	Total	**2 003**	**25 365**
Cerignola	a (swine)	4 024	22 656
	b	1 007	14 500
	Total	**5 031**	**37 156**

*Data for the production of buffalo sewage are the same as those for cattle (Decree of 7th April 2006)
(Source: data processing)

(2) The total average quantity of biogas produced from 1 litre of cattle sewage, or for convention, 1 m^3 is equal to 15.0 m^3 and for 1 litre of swine sewage to 15.6 m^3 (based on the method used).
(3) This system allows for recovery of the heat produced during combustion by means of an appropriate exchanger: part of the heat recovered is used to heat the digester and the remaining part is conveyed for thermal use. Thus, cogeneration allows for the use of up to 90% of the energy content of the fuel, 30% in electric energy and 60% in heat, therefore, from 1m^3 of biogas 1.9 kWh of electricity and 3.8 kWh of heat is obtained, considering that the low heating value of the biogas is equal to 23 MJ/kg.

TABLE 6

QUANTITY OF BIOGAS PRODUCIBLE IN THE FARMS SELECTED

Farms selected	Type of sewage	Total quantity of sewage in m^3/year	Total biogas quantity in m^3/year
Manfredonia (n. 3)	Buffalo	16 300	244 500
San Giovanni Rotondo (n. 4)	Cattle	25 365	380 475
Cerignola (n. 2)	Swine, Buffalo	37 156	570 934
Total		**82 299**	**1 195 909**

(Source: data processing)

TABLE 7

QUANTITY OF EQUIVALENT ENERGY

Farms selected	Totale biogas quantity m^3/year	Quantity of thermal energy kWh/year	Quantity of electric energy kWh/year
Manfredonia (n. 3)	244 300	928 340	464 170
San Giovanni Rotondo (n. 4)	380 475	1 445 805	722 903
Cerignola (n.2)	570 934	2 169 549	1 084 775
Total	**1 247 879**	**4 543 694**	**2 271 848**

(Source: data processing)

From the estimated data, approximately 464 MWh of electric energy would be produced with a plant that collects sewage from the three farms in Manfredonia; almost 723 MWh from that of the four farms situated in the agro-administrative district of San Giovanni Rotondo; more than 1 084 MWh from the plant situated in the area of Cerignola. However, it is evident that these values represent a theoretical quantity which would be difficult to realise since, as known, the yields of biogas may vary based on the techniques used, both in the realisation phase and in the actual digestion phase, on the type of subsoil (only zootechnical effluents or mixing with vegetable materials) and on the type of feeding of the micro-organisms and of the livestock.

This energy could meet the internal requirements of the farms (on average 8-9 MWh/year or 20-30 kWh/day) or those of the entire agro-administrative district, thus reducing the need to resort to fossil sources.

An alternative solution could be to create one large plant to which the whole quantity of sewage produced by the nine farms would be conveyed, thus producing electricity for the benefit of the whole province. The capacity should be slightly greater than 300 kW, this value being obtained from the ratio between the potential quantity of electricity feasibly generated and the maximum number of operating hours, that is, 7,500 as seen from various research in existing literature (25); while the volume of the digester is equal to approximately 2,700 m^3, that is 9 m^3 for every kW installed (26).

Collection of sewage could be carried out using a definite network system of pressurised pipelines for a distance of no more than 50 km (to avoid high costs) or by means of tankers (27).Therefore, for example, nearly 2.3 GWh deriving from this solution could reduce the demand for electricity of the whole agriculture sector of the territory in question by 1.8% , referring to the values registered in 2005 (129.6 GWh) (7).

On the other hand, the estimated quantity of thermal energy will be equal to, respectively, 928 MWh, 1,446 MWh and 2,170 MWh.

In this case, the use of the heat produced becomes difficult since the economic limits of the transmission of this form of energy must be taken into consideration. Half of it will be lost and 30% of the remaining amount will essentially serve to feed the same gasification process and the remaining 70% to heat the stalls and the living areas. A much more interesting solution would surely be to use all the heat produced from one large plant for a tele-heating project, that is, to distribute it, by means of a fluid vector (hot water or steam), through a network of isolated underground pipes, to the nearby housing facilities.

The digested sludge obtained (in general equal to 90% of initial material) could be spread as is, should the agricultural surface allow it (ideal seasons for cultivation, compatible crops, non-vulnerable areas, quantities exceeding the absorption capacity of the land) or it could undergo separation of its solid from its liquid fraction, using appropriate techniques. The solid component may be sent for composting, whereas the liquid one directly spread on the ground if compatible, or conveyed for purification process.

In both cases, the advantage to the farm is economic, since there is a reduction in internal energy costs due to self-supplying; in costs relative to the purchase of fertilisers since having used the digester as is; in costs of sewage disposal. There are also benefits deriving from the eventual sale of electricity, which has diffusion priority on the network, compared to that supplied by fossil sources, or Green Certificates (GC), of heat or raw material (zootechnical effluents or agricultural waste). The environmental advantages must not be forgotten, for example, the decrease in excessive amounts of nitrates, due to the production of stabilizing and deodorising zootechnical effluents. Their spreading, or further treatment, does not only reduce the risks of contamination of groundwater, since being part of areas with high permeability, but also the process of eutrophication of the superficial water bodies.

Furthermore, it is necessary to consider the reduction of carbon dioxide in the atmosphere, from a minimum of 25% to 67% (in the case of a complete use of thermal energy produced in cogeneration), deriving from the treatment technique of waste to the low emission of greenhouse gas, like, anaerobic digestion.

Lastly, there is a lesser need of surface areas in relation to the waste treated, thanks to greater compactness of the anaerobic plant and a reduction in the problem of disagreeable odours, a lesser cost, since the greater odour-hygiene phases are carried out in a closed reactor and the exhausted gases are represented by the biogas produced (used and not emitted into the atmosphere), thus avoiding compromising the health and hygiene conditions of the surrounding towns (15).

Conclusions

The province of Foggia is characterised by a high presence of zootechnical farms, and consequently heads of livestock, and by a surface area (equal to approximately 14% of the UAS) recognised as a nitrate vulnerable area. For this reason, the opportunity offered by anaerobic digestion plants to produce biogas for energy purposes and to stabilise the zootechnical effluents seems rather convenient both with a view to reducing contamination of soil and groundwater, due to the excessive spreading of the effluents, of the atmosphere, due to the decrease in greenhouse gas emissions, both for a diversification and a modernisation of the sector in the context of an increase in income for the breeder.

Only some agro-administrative districts present the typologies and farm size which seem to be adequate to reach the technical sustainability of the plants proposed or, at least, to allow for the realisation of scale economies. They are situated in the flatland and hilly agro-administrative districts of Manfredonia, San Giovanni Rotondo and Cerignola.

The nine farms, selected according to criteria of convenience and economic-environmental stability, could alone meet the needs of 1.8% of electricity demand of the whole agricultural sector in Foggia, referring to the values registered in 2005.

The precise location and the characteristics of these farms could allow for a more appropriate analysis of the effective costs and benefits deriving from the implementation of an anaerobic digestion plant. Based on these evaluations, it would also be possible to examine and study the opportunity of creating a consortium association able to render the production of biogas in the province of Foggia efficient to a maximum, further lowering the costs (investment, recovery of raw material, transport, etc.) and making the creating of a bio-energy district feasible, which would allow for a greater economic development of the province of Foggia, according to the criteria of environmental sustainability.

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