GBEP Indicators to assess biogas value chain sustainability

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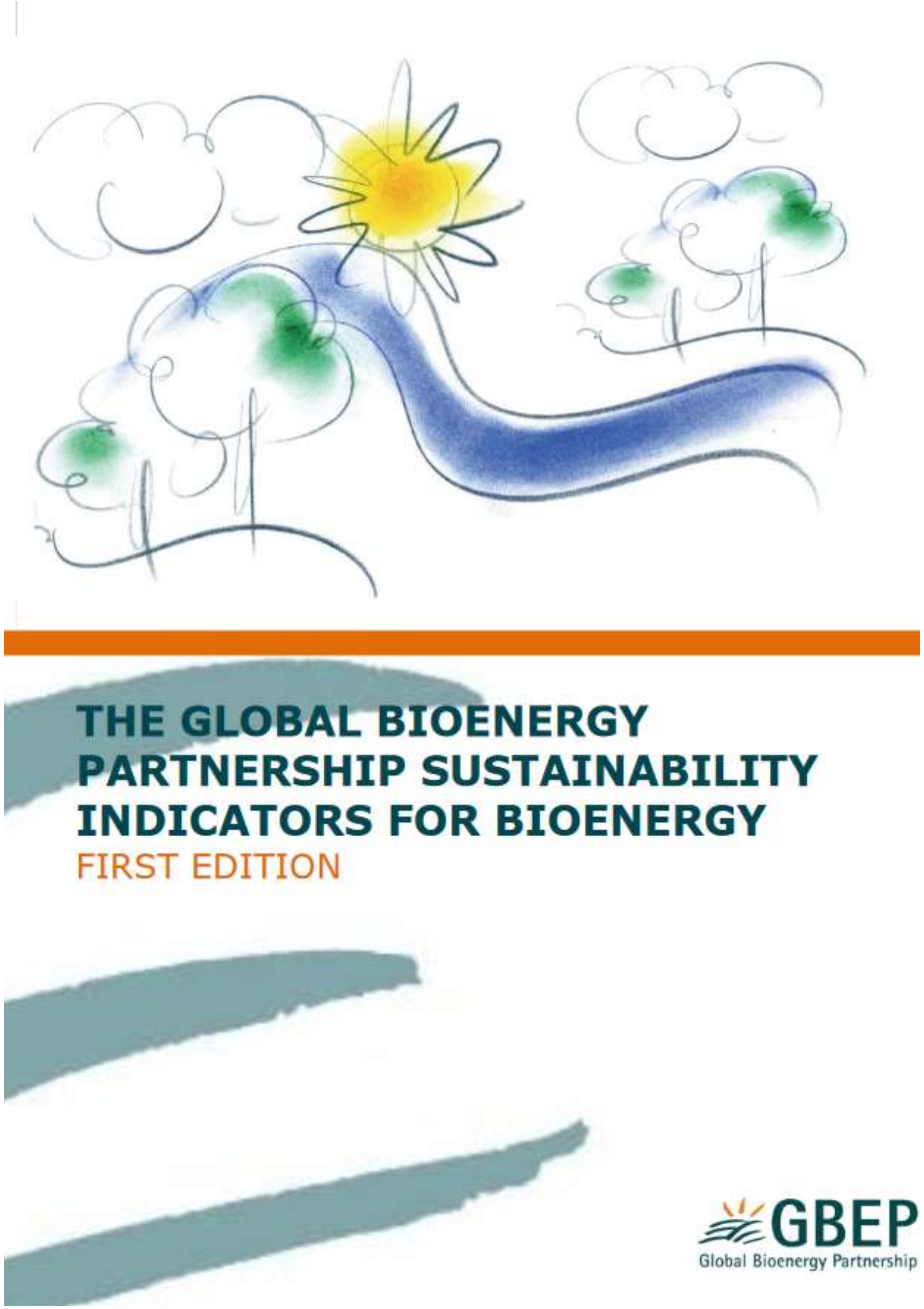
Layout

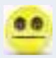
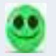
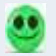
- Summary of indicator's assessment
- Main indicators presented:
  - 1. Lifecycle GHG emissions (Env);
  - 2. Soil quality (Env);
  - *8. Land Use Land Use Change (Env).*
  - 12. Jobs in the bioenergy sector (Soc);
  - 19. Gross Added Value (Ec);
- Conclusions



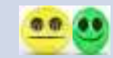
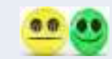
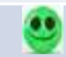
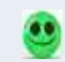
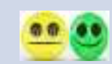
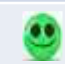
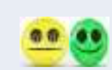
Environmental indicators

N.	INDICATORE	DESCRIZIONE	STATO
1	Lifecycle GHG emissions	Lifecycle greenhouse gas emissions from bioenergy production and use, as per the methodology chosen nationally or at community level, and reported using the GBEP Common Methodological Framework for GHG Lifecycle Analysis of Bioenergy 'Version One'.	
2	Soil quality	Percentage of land for which soil quality, in particular in terms of soil organic carbon, is maintained or improved out of total land on which bioenergy feedstock is cultivated or harvested	
3	*Harvest levels of wood resources (NOT APPLICABLE)*	*Annual harvest of wood resources by volume and as a percentage of net growth or sustained yield, and the percentage of the annual harvest used for bioenergy*	N.A.
4	Emissions of non-GHG air pollutants, including air toxics	Emissions of non-GHG air pollutants, including air toxics, from bioenergy feedstock production, processing, transport of feedstocks, intermediate products and end products, and use; and in comparison with other energy sources	
5	Water use and efficiency	- Water withdrawn from nationally determined watershed(s) for the production and processing of bioenergy feedstocks, expressed as the percentage of total actual renewable water resources (TARWR) and as the percentage of total annual water withdrawals (TAWW), disaggregated into renewable and non-renewable water sources; - Volume of water withdrawn from nationally determined watershed(s) used for the production and processing of bioenergy feedstocks per unit of bioenergy output, disaggregated into renewable and non-renewable water sources.	
6	Water quality	- Pollutant loadings to waterways and bodies of water attributable to fertilizer and pesticide application for bioenergy feedstock cultivation, and expressed as a percentage of pollutant loadings from total agricultural production in the watershed; - Pollutant loadings to waterways and bodies of water attributable to bioenergy processing effluents, and expressed as a percentage of pollutant loadings from total agricultural processing effluents in the watershed.	
7	Biological diversity in the landscape	- Area and percentage of nationally recognized areas of high biodiversity value or critical ecosystems converted to bioenergy production; - Area and percentage of the land used for bioenergy production where nationally recognized invasive species, by risk category, are cultivated; - Area and percentage of the land used for bioenergy production where nationally recognized conservation methods are used.	
8	Land use and land-use change related to bioenergy feedstock production	- Total area of land for bioenergy feedstock production, and as compared to total national surface and agricultural and managed forest land area - Percentages of bioenergy from yield increases, residues, wastes and degraded or contaminated land - Net annual rates of conversion between land-use types caused directly by bioenergy feedstock production, including the following (amongst others): o arable land and permanent crops, permanent meadows and pastures, and managed forests; o natural forests and grasslands (including savannah, excluding natural permanent meadows and pastures), peatlands, and wetlands	

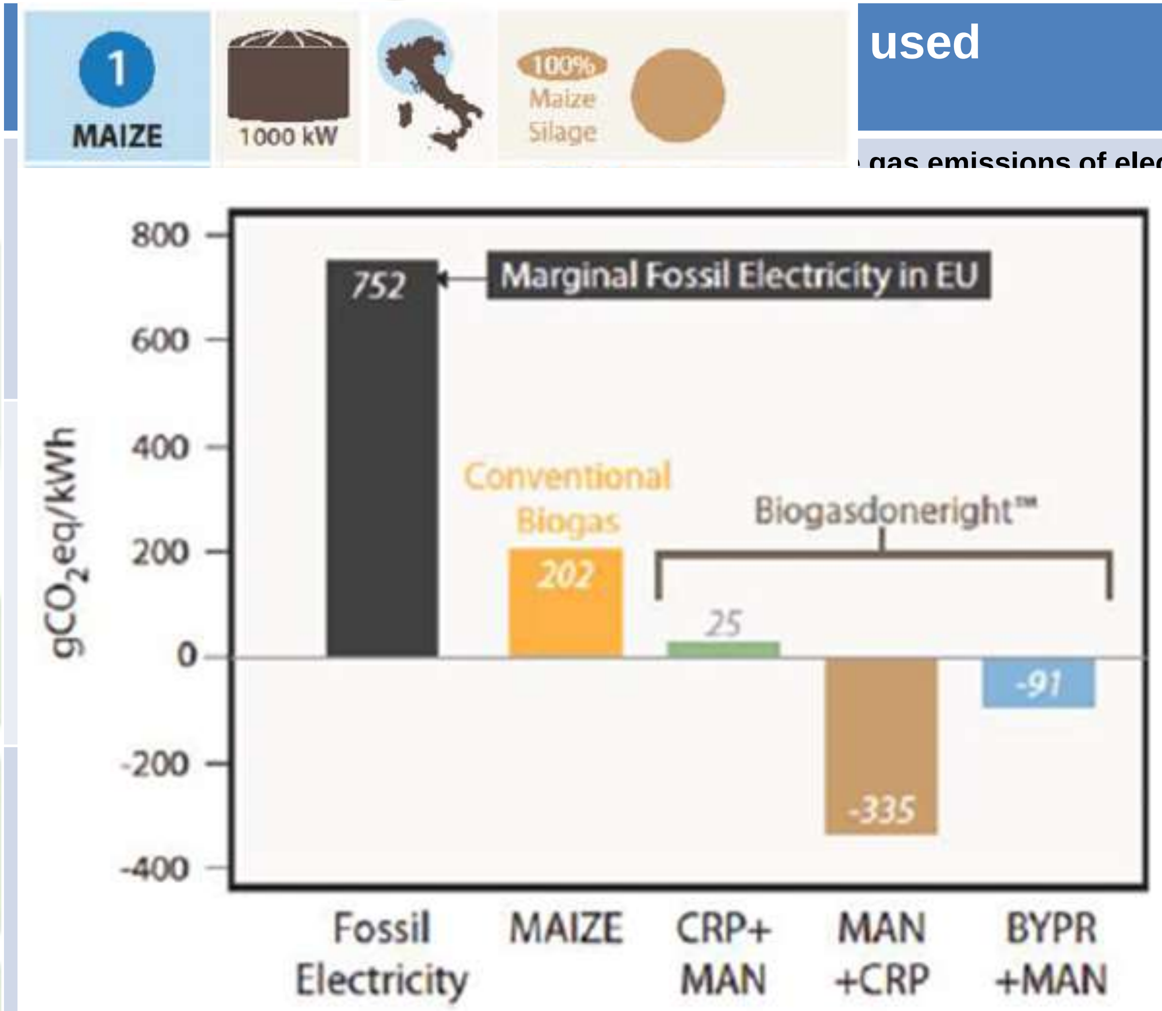
Social indicators

N.	INDICATORE	DESCRIZIONE	STATO
9	Allocation and tenure of land for new bioenergy production	Percentage of land – total and by land-use type – used for new bioenergy production where: - a legal instrument or domestic authority establishes title and procedures for change of title; and - the current domestic legal system and/or socially accepted practices provide due process and the established procedures are followed for determining legal title.	
10	Price and supply of a national food basket	Effects of bioenergy use and domestic production on the price and supply of a food basket, which is a nationally defined collection of representative foodstuffs, including main staple crops, measured at the national, regional, and/or household level, taking into consideration: - changes in demand for foodstuffs for food, feed and fibre; - changes in the import and export of foodstuffs; - changes in agricultural production due to weather conditions; - changes in agricultural costs from petroleum and other energy prices; and - the impact of price volatility and price inflation of foodstuffs on the national, regional, and/or household welfare level, as nationally determine	
11	*Change in income (PROBABLY NOT APPLICABLE)*	*Contribution of the following to change in income due to bioenergy production:* *- wages paid for employment in the bioenergy sector in relation to comparable sectors* *- net income from the sale, barter and/or own consumption of bioenergy products, including feedstocks, by self-employed households/individuals*	
12	Jobs in the bioenergy sector	Net job creation as a result of bioenergy production and use, total and disaggregated (if possible) as follows: skilled/unskilled, temporary/indefinite. - Total number of jobs in the bioenergy sector and percentage adhering to nationally recognized labour standards consistent with the principles enumerated in the ILO Declaration on Fundamental Principles and Rights at Work, in relation to comparable sectors	
13	*Change in unpaid time spent by women and children collecting biomass (NOT APPLICABLE)*	*Change in average unpaid time spent by women and children collecting biomass as a result of switching from traditional use of biomass to modern bioenergy services*	N.A.
14	*Bioenergy used to expand access to modern energy services (NOT APPLICABLE)*	*- Total amount and percentage of increased access to modern energy services gained through modern bioenergy (disaggregated by bioenergy type), measured in terms of energy and numbers of households and businesses* *- Total number and percentage of households and businesses using bioenergy, disaggregated into modern bioenergy and traditional use of biomass*	N.A.
15	*Change in mortality and burden of disease attributable to indoor smoke (NOT APPLICABLE)*	*Change in mortality and burden of disease attributable to indoor smoke from solid fuel use, and changes in these as a result of the increased deployment of modern bioenergy services, including improved biomass-based cook stoves.*	N.A.
16	Incidence of occupational injury, illness and fatalities	Incidences of occupational injury, illness and fatalities in the production of bioenergy in relation to comparable sectors.	

Economic indicators

N.	INDICATORE	DESCRIZIONE	STATO
17	Productivity	Productivity of bioenergy feedstocks by feedstock or by farm/plantation: - Processing efficiencies by technology and feedstock - Amount of bioenergy end product by mass, volume or energy content per hectare per year - Production cost per unit of bioenergy	
18	Net energy balance	Energy ratio of the bioenergy value chain with comparison with other energy sources, including energy ratios of feedstock production, processing of feedstock into bioenergy, bioenergy use; and/or lifecycle analysis	
19	Gross value added	Gross value added per unit of bioenergy produced and as a percentage of gross domestic product	
20	Change in consumption of fossil fuels and traditional use of biomass	- Substitution of fossil fuels with domestic bioenergy measured by energy content and in annual savings of convertible currency from reduced purchases of fossil fuels - Substitution of traditional use of biomass with modern domestic bioenergy measured by energy content	
21	*Training and re-qualification of the workforce (PROBABLY NOT APPLICABLE)*	*Percentage of trained workers in the bioenergy sector out of total bioenergy workforce, and percentage of re-qualified workers out of the total number of jobs lost in the bioenergy sector*	
22	Energy diversity	Change in diversity of total primary energy supply due to bioenergy	
23	*Infrastructure and logistics for distribution of bioenergy (NOT APPLICABLE)*	*Number and capacity of routes for critical distribution systems, along with an assessment of the proportion of the bioenergy associated with each*	N.A.
24	Capacity and flexibility of use of bioenergy	- Ratio of capacity for using bioenergy compared with actual use for each significant utilization route - Ratio of flexible capacity which can use either bioenergy or other fuel sources to total capacity	

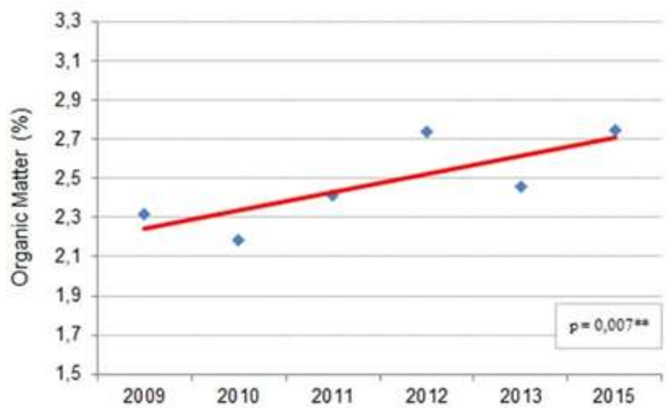
1. Lifecycle GHG emissions (Env)



used	Results
gas emissions of electricity and ... system: ... terature	CO_2 eq emissions are closely related to the type of supply chain management and clearly linked to nitrogen dioxide emissions (N_2O).
e ... We. ... Italy - 500	- Cases 2,3 4 *«circular production»* - Produce both food and Energy (*Biogasdonerigth BDR*). - BDR «carbon negative» - **Digestate Stocking** is crucial!!
	MAIZE. 202g CO_2eq/kWh (725 fossil fuel); CRP+MAN. 25,4g CO_2eq/kWh; MAN+CRP. -335g CO_2eq/kWh BYPR+MAN. -91g CO_2eq/kWh

2. Soil quality

Figura 2.3. Incremento di sostanza organica (in inglese Organic matter) nel tempo nei suoli fertilizzati con digestato. (Fonte Bezzi et. Al, 2016)



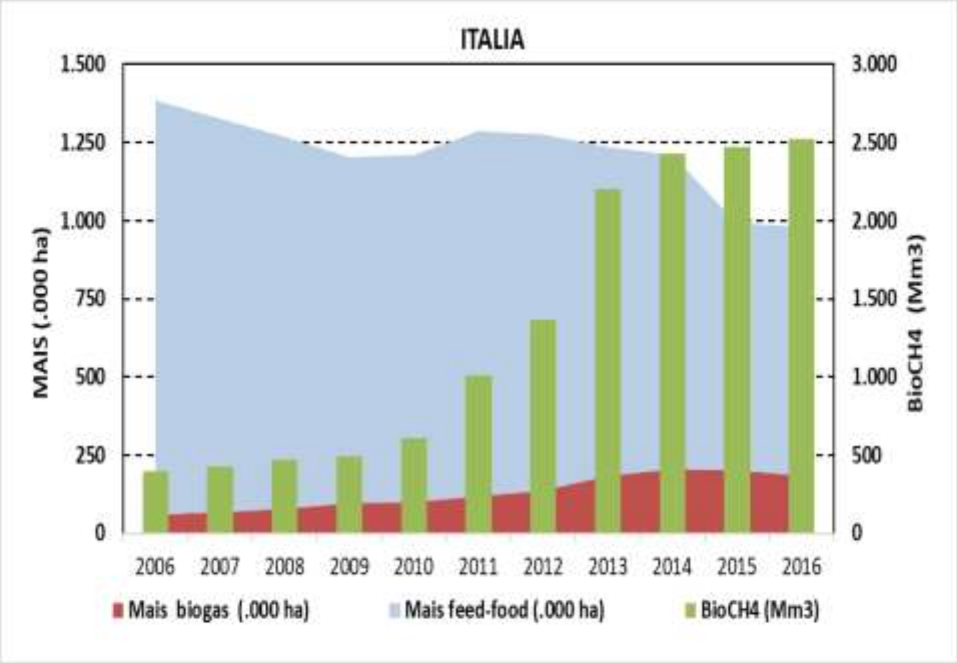
Main features	Methodology/data used	Results
		nt, but **economic and y of biogas value** t on SOC.
		for fertilization **ve soil** causes an
	- On parcels with different fertilization strategies: • Mineral • Mineral + digestate (liquid) • Mineral + digestate (solid) • Digestate Liquid + Solid + Mineral fertilizzation	e led to an increase irst year; (2017) *"capture of SOM can reach 5 g CO_2 eq per MJ in the most fruitful case, (CRP + MAN), for the field crop residues, while is* ***carbon neutral*** *for other production systems".)*
Real scale soil matter increase via digestate fertilization	Bezzi et. Al., (2016): - 6 yeras (2009-2015) - Fertility index on 8 different soils - 51 ha total area	In 7 years, an 0,5% average increase of OM (from 2,2% to2,7%) linked to a significative increase of TOC of 0,3% (from 1,3% to 1,6%)

8. Land Use Land Use Change

Land efficiency of biogas (BDR)

An higher efficiency in land use (Land efficiency) of italian agriculture (biogas sector) is shown by numbers…

(Elab. CIB based on EBA, IRENA, Eurostat, ISTAT 2017, in publication)



Although the huge development of biogas sector in Italy, MAIZE total surface decreased consistently in last years (-400.000 ha – mainly grain maize)

Italian grain maize market is affected by **low market price and phytopathology problems** (aflatoxyns). This is the reason because surfaces are decreasing consistently.

Maize for silage (also for biogas) is **maintaining its surfaces** in last years.

8. Land Use Land Use Change

Land efficiency of biogas (BDR)

Italian surfaces dedicated to biogas are today estimable in ~200.000ha, the same surface than today dedicated at set-a-side (Elab. CIB based on ISTAT, GSE and internal data)

In last years Italian sugar beet market have loss ~180.000ha of cultivation (OCM revision)

Biogas and Biomethane can be produced sustainably with conservative agriculture, high land efficiency use and integration biomasses without reduce food and feed surfaces.

			2010	2015	2020	2025	2030
(A)	Total Biomethane	(Gm^3/year)	0.70	2.20	4.20	5.50	8.00
(FCLR)	- UAA Monocrop	(ha)	85,000	200,000	250,000	300,000	400,000
		(% UAA)	1%	3%	4%	4%	6%
		(ha/Mm^3 CH_4)	121	91	60	55	50
(C x P)	- Monocrop BioCH4 yield	(m^3/ha CH_4)	6,720	6,720	6,720	6,720	6,720
(A/FCLR)	LAND EFFICIENCY	(m3/ha CH4)	8,235	11,000	16,800	18,333	20,000
(A - I)	- BioCH4 from monocrop	(Gm^3/year)	0.6	1.3	1.7	2.0	2.7
(I)	- BioCH4 from integration biomasses	(Gm^3/year)	0.1	0.9	2.5	3.5	5.3
(I)	- BioCH4 from integration biomasses	(%)	*18%*	*39%*	*60%*	*63%*	*66%*

(S. Bozzetto et al., 2017 – The development of biomethane a sustainable choice for the economy and the environment - https://www.consorziobiogas.it/wp-content/uploads/2017/05/LA-BIOGAS-REFINERY-ENG-2017-FINAL.pdf)

12. Jobs in the bioenergy sector

Tabella 12.4 Indice del numero di occupati permanenti (ULA), diretti ed indiretti, per ogni nuovo Mw installo per le fonti da energie rinnovabili, periodo di riferimento 2012-2014.

	ULA/MW installato		
	2012	**2013**	**2014**
Biogas	5,4	6,3	6,7
Biomasse solide	4,6	5,1	5,3
Idroelettrico	1	1	1
Bioliquidi	2	2,1	2,1
Eolico	0,4	0,4	0,4
Fotovoltaico	0,7	0,7	0,7
Geotermico	0,9	0,9	1

Fonte: Elaborazione CREA da dati GSE.

Indotti	3.112	1.398	1.037	307	1.071	3.783	6.442
Indiretti	2.907	1.106	1.279	316	1.445	3.262	5.528
Diretti	3.819	2.328	867	433	2.030	4.488	7.063
Totali	9.837	5.033	3.203	1.115	5.146	11.534	19.033
	Ricadute occupazionali permanenti 2015*						
	Biogas	**Biomasse**	**Bioliquidi**	**Geo**	**Eolico**	**Idro**	**Fotov.**
Indotti	3.276	1.781	1.060	368	1.779	3.832	6.517
Indiretti	3.061	1.196	870	317	1.539	3.305	5.593
Diretti	4.021	2.680	1.284	434	2.161	4.548	7.146
Totali	10.358	5.656	3.214	1.119	5.479	11.685	19.255
Dir +In	***7.082***	***3.876***	***2.154***	***751***	***3.700***	***7.853***	***12.739***
%	***18,56***	***10,16***	***5,6***	***2***	***9,7***	***20,58***	***33,40***

*Fonte: Elaborazione CREA da dati GSE. * Risultati preliminari.*

e energy production
fixed jobs, direct e indirect

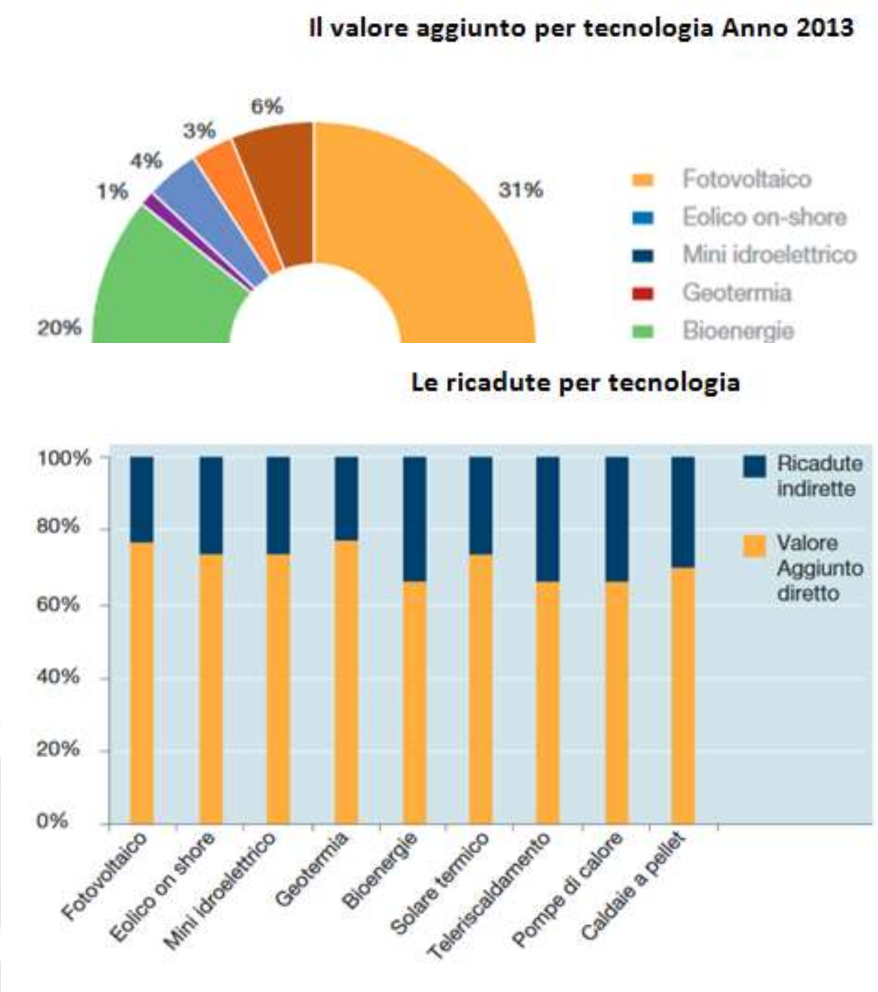
(direct and indirect), almost
ployed

ctor, with 12.739 (33,4%) of
energy).

Biogas sector provide the best ULA index for new MW installed, 6,7 in 2014.

Regarding sub-indicator 12.5, all jobs must respect ILO requirement.

19. Gross Added Value



Fonte: greenpeace, 2014

data used	Results
hases of energy er sector (2014)	2013 Renewable AV was 6 Billion Euro PHASES: "Energy Production" 43% of total AV.
	TECHNOLOGY: Photovoltaic, (1,8 Billion Euro - 31% Bioenergy, (1,2 Billion Euro – 20%)
Value for 2013 16 (GDP n-3)	INDIRECT AV: 34% of total Value. Similar value for Heat sources (heat pumps, pellet,), showing the importance of agriculture value chain.
	GDP in 2013 was 1.604.477,9 Billion Euro.
	AV bioenergy/GDP = 0,075%

Conclusions

- Processing and analysis of a huge quantity of data (from litterature and measured)
- Some indicators don’t fit with Italian features - thinked for development Countries (N.A.)
- The whole analysis confirm the global sustainability of italian biogas sector:
  - negative GHG emissioni (carbon neutral) for Biogasdoneright system
  - Increasing of SOM (SOC)
  - Increasing of fixed employment (ULA per MW installed)
  - High Added Value within RES
- LAND USE indicator shows and inversal trend between biogas and maize surfaces (biogas land efficiency)
  - Biogas farms starts to apply advanced agricultural system in order to produce food, feed and energy in efficient way.
- Scale up to national level
- Results can beused as an useful tool for Italian Ministry of agriculture:
  - to analise «impact» of biogas sector (effectiveness of policies)
  - provide elements for discussion while policies are planned
- Stepwise approach: Guidance is a very important tool (priority of indicators, steps to follow, consistency of data, etc.)

…Thank You!

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