RESULTS:
Compared to BS:
AS1 “+ SLURRY”: impact reductions for the impact categories affected by cereal silage production (PM -77%, TA -134% and eutrophication -191% TE, and -97% ME). The higher MFE involves a reduction of the use of mineral N fertilisers. For CC, OD, HTc and FE, BS shows a higher Impact due to the higher production of EE from non-renewable fossil sources. AS2 “NO BIOGAS”, due to the complete substitution of EE from biogas with non-renewable energy sources, shows the worst environmental performances for all impact categories except for HTnoc and ME. For CC, the worsening of the impact is related to the slurry storage in open tanks that takes place instead of AD. Furthermore, the lower availability of N (in the animal slurry respect to digestate) requires a supplemental consumption of N fertilisers respect to AS1 “+ SLURRY” and BS. For AS1 “+ SLURRY”, for all the evaluated impact categories there are benefits related to the replacement of N fertilisers and/or the replacement of the traditional storage of slurry in open tank. Thanks to this latter effect, the benefits for PM, TA and TE are higher than the impacts (for such reason the value shown in Figure 2 is below zero). The impact of slurry transport is small, except for HTnoc and MFRD. In contrast, for AS2 “NO BIOGAS”, there are no benefits and the credits for AD of slurry and N fertiliser substitution are lost because the biogas production is stopped.

CONSEQUENTIAL LIFE CYCLE ASSESSMENT OF ELECTRICITY PRODUCTION FROM BIOGAS IN ITALY
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INTRODUCTION
In Italy, above all in the Northern regions, in the last 20 years, thanks to a favourable subsidy framework, about 1800 AD plants fed with agricultural feedstock have been built. Despite the higher supply cost, thanks to public subsidy, several plants are fed mainly with dedicated crops (above all maize silage).

The Aim of this study analyze the consequences related to a change in the actual subsidy framework for renewable energies and, in particular, the deletion of the grants for biogas production. To this purpose a consequential life cycle assessment (cLCA) was performed.

BASELINE AND ALTERNATIVE SCENARIOS

MATERIALS & METHODS

Hypothesis: No subsidy for electricity (EE) produced using cereal silages

Respect to the BASELINE SCENARIO (actual situation, 8.2 TWh of electricity from agricultural AD plants) two Alternative Scenarios were evaluated:

AS1 called “+ SLURRY”, only animal slurry are used → reduction of electricity production from agricultural AD plants due to a change in the digester feeding;

AS2 called “NO BIOGAS”, grant deletion causes the stop of the AD plants

In both the scenarios the electricity not produced from the AD plants is replaced from non-renewable energy sources. The effects of future scenarios were evaluated with a partial equilibrium model.

SYSTEM BOUNDARY: “from cradle to AD plant gate”: all the processes (e.g., biomass production and transport, biomass conversion into biogas and then into EE, digestate management) directly included in the biogas-to-energy production system were considered as well as all those directly affected by related consequential changes (e.g., crops fertilisation, slurry management, EE production form fossil fuels). Distribution and use of the electricity were excluded.

ASSUMPTIONS
1) AD avoid their traditional slurry storage carried out in open tanks
2) AD allows to better exploit the nitrogen content of slurry: digestate has a higher Mineral Fertiliser Equivalent (75% instead of 65%) respect to slurry
3) in AS1 “+ SLURRY” scenario, the animal slurries used to replace the cereal silages must be transported over a longer distance (5 km instead of 3 km)
4) the impact of the EE by AD plants was assessed as a weighted mean value of 30 biogas plants previously evaluated by means of LCA
5) in AS2 “NO BIOGAS” scenario: EE production from biogas must be completely replaced by non-renewable energy and the benefits of AD and slurry management are lost. Contrariwise to AS1 “+ SLURRY”, the increased use of slurry involves environmental benefits (emissions avoided by traditional storage and increased use of fertiliser avoided)

RESULTS:

<table>
<thead>
<tr>
<th>Feedstock</th>
<th>Feeding mix</th>
<th>Produced Electricity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maize silage</td>
<td>30% 0%</td>
<td>62% 0%</td>
</tr>
<tr>
<td>Other silages</td>
<td>10% 0%</td>
<td>16% 0%</td>
</tr>
<tr>
<td>Pig slurry</td>
<td>25% 46%</td>
<td>3% 20%</td>
</tr>
<tr>
<td>Cow slurry</td>
<td>25% 46%</td>
<td>8% 47%</td>
</tr>
<tr>
<td>Other matrix</td>
<td>10% 9%</td>
<td>12% 33%</td>
</tr>
</tbody>
</table>

For AS1 “+ SLURRY”, for all the evaluated impact categories there are benefits related to the replacement of N fertilisers and/or the replacement of the traditional storage of slurry in open tank. Thanks to this latter effect, the benefits for PM, TA and TE are higher than the impacts (for such reason the value shown in Figure 2 is below zero). The impact of slurry transport is small, except for HTnoc and MFRD. In contrast, for AS2 “NO BIOGAS”, there are no benefits and the credits for AD of slurry and N fertiliser substitution are lost because the biogas production is stopped.