

A survey system to present the status of anaerobic digestion in Europe in different sectors – Agriculture, industrial, urban waste and waste water sector

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Abstract

The RAMIRAN Anaerobic Digestion (AD) Task Group has completed a second survey of the status of European biogas for the years 2010/12. The survey has been split into agricultural, industrial, urban waste and wastewater sectors and data has been collected from eleven countries for at least one of these sectors. The questions included driving forces, the number, type and size of plants, substrates, utilisation of digestate and energy production. AD was found to be well established in most participating countries. GE still remains predominant regarding the number of AD units. Feed-in tariffs remain the strongest driving force, and energy production the dominant goal. AD in GE is still dominated by maize digestion in small plants, whereas the opposite is true in DK and IT. There relatively large plants are preferred and manure is the dominant feedstock. Based on the findings of the first two surveys, the questionnaire is considered suitably short and concise.

Introduction

The use of renewable energy has to increase in order to reduce the CO₂ net emission and the dependence on fossil fuels. In 2009 the EU passed a directive with the objective to enhance the contribution of renewable energies to 20% of the total energy needs by 2020 [1]. In the recent past, utilisation of bioresources has entered a decisive and dynamic phase in Europe. Bioresources, primary, waste and processed to biofuels provided a share of approx. 7.5 % to the end-energy in 2009, making bioenergy a provider of more than 50% of all renewable energy in Europe. Estimations for bioresource use for energetic purposes let expect a rise by a factor 2.25 in 15 years from 2005 to 2020. Bioenergy supply chains are considerably different throughout the member states [2]. Beside others, biogas generation by anaerobic digestion (AD) plays an important role. For example, it is the main source of bioelectricity in Germany and UK [2]. In 2008 the RAMIRAN task group on “Anaerobic digestion” was established. It includes members from European Countries that proposed to collect data about AD using a questionnaire. The purpose is to produce a picture of AD development and to present a strategy for collecting reasonably reliable data with less effort from experts. The first overview on AD in Europe was presented at the RAMIRAN 2010 conference. Using the updated procedures a second survey representing the situation of AD in the period 2010/12 was elaborated.

Material and Methods

The first questionnaire version contained 112 questions to judge AD in a country [1a]. Since it was too complex and for a lot of the questions no information was available, the questionnaire was simplified. 8 pages are now contained (*Contact information, General questions, Driving forces, Data on biogas plants and technologies, Substrates, Installed electrical power, Types of biogas plants, Biogas, Digestate, To finish off*) and subdivided into further questions (qu), in total 36. The experience showed, that experts had sectorial information mostly. For that reason, the questionnaire was designed in 4 versions covering the following sectors: *industry, agriculture, urban waste, wastewater* [3]. The urban waste questionnaire does not consider biogas from landfills. Since the goal was to get a comprehensive overview in a minimum of time, the request to fill out the questionnaire was sent 3 weeks before deadline to the task group members. The information on the plans to make a new survey was formulated around 2 months earlier with the intention that the members could start with data collection and to spread the information to other person to enlarge the network. Data input was carried out based on own surveys or on nationally available survey literature. The entries were combined available in xls and country-specific in pdf format. The evaluation in this paper focus on the entries regarding *current status* (qu3), *trend* (qu4), *goals* (qu5), *driving forces* (qu6), *facility numbers* (qu8), *substrate amount* (qu10,12), *substrate type* (qu11,13), *digester volumes* (qu19). The same topics were considered in the RAMIRAN 2010 presentation [1b] with which we compare the actual results.

Results

22 questionnaires were filled out: 9 for agriculture (AT, CH, DK, FR GE, 2xIT, NL, PL); 4 for the industry (CH, FR, GE, SE); 6 for the urban waste (CH, FR, ES, GE, 2xPT); 3 for the wastewater (CH, DK, FR). Most countries considered AD to be well established in various sectors with exception of FR, PT, and SE. This is an improvement compared to 2008/9, where only CH and GE were considered as well established. Regarding the trend slight to strong increases are expected in most countries and sectors; in 2008/9 mainly strong increases were expected. The countries which were considered as well established in the 2008/9 period still expect further strong increases in some sectors (CH and GE in urban waste), in other sectors the situation is considered stable and focused on quality improvement. NL and IT expect a decrease in the agricultural sector, in NL because of the stabilizing of energy prices and the increase of cosubstrates prices (Table 1).

Table 1. Current status (above) and trends (below) in the respective countries

Question	AT	CH	DK	ES	FR	GE	IT	NL	PL	PT	SE
Few facilities in specific regions		<i>i</i>			<i>u</i>					<i>ia</i>	<i>ia</i>
Several facilities distributed in whole country		<i>au</i>			<i>aiw</i>				<i>au₁</i>	<i>u</i>	<i>u</i>
Well established in whole country	<i>a</i>	<i>w</i>	<i>aw</i>	<i>u</i>		<i>ai</i>	<i>a</i>	<i>a</i>	<i>u₂</i>		<i>w</i>

Question	AT	CH	DK	ES	FR	GE	IT	NL	PL	PT	SE
Actual situation will not change		<i>i</i>								<i>ia</i>	<i>i</i>
Quality of existing systems will improve		<i>w</i>	<i>w</i>			<i>ai</i>					
Slight increase expected	<i>a</i>	<i>a</i>	<i>a</i>	<i>u</i>	<i>iuw</i>	<i>ai</i>				<i>u₁</i>	<i>uw</i>
Strong increase expected		<i>u</i>			<i>a</i>	<i>u</i>	<i>a₁</i>		<i>a</i>	<i>u₂</i>	<i>a</i>
Decrease expected							<i>a₂</i>	<i>a</i>			

a-agriculture sector, i-industrial sector, u-urban waste sector, w-wastewater sector

Favorite regarding goals was the energy generation, similar as in 2008/9. Some goals varied sector-wise, e.g. landfilling was not important for agricultural AD in all countries and stabilization of urban waste was similar important as energy generation in FR. Additional goals were given by FR (volume reduction), NL (profit), and PL (problematic waste management from agro-alimentary industry and slaughter sector). The feed-in tariffs, partly combined with governmental aids for installations, were the most important drivers in a lot of countries, similar to 2008/9. But the tariffs, and therefore the relevance for the different sectors, may be different. In DK, for example, the feed-in tariff changed in 03/2012 from 75 DKK (€100)/MWh of electricity produced to 115 DKK (€154)/MWh of energy produced, which may lead to end-use of biogas other than electricity production. In IT 280 €/MWh are paid for energy fed into the grid. The PT biogas feed-in tariff ranged from 115 to 117 €/MWh. It will

change in 04/2013. In SE a law regulating CO₂ emission as well as possibilities to apply for funds for installations had minor impacts; general energy security and independence were considered as major drivers. In CH existing nuclear power plants will not be replaced, which will drive AD (Figure 1).

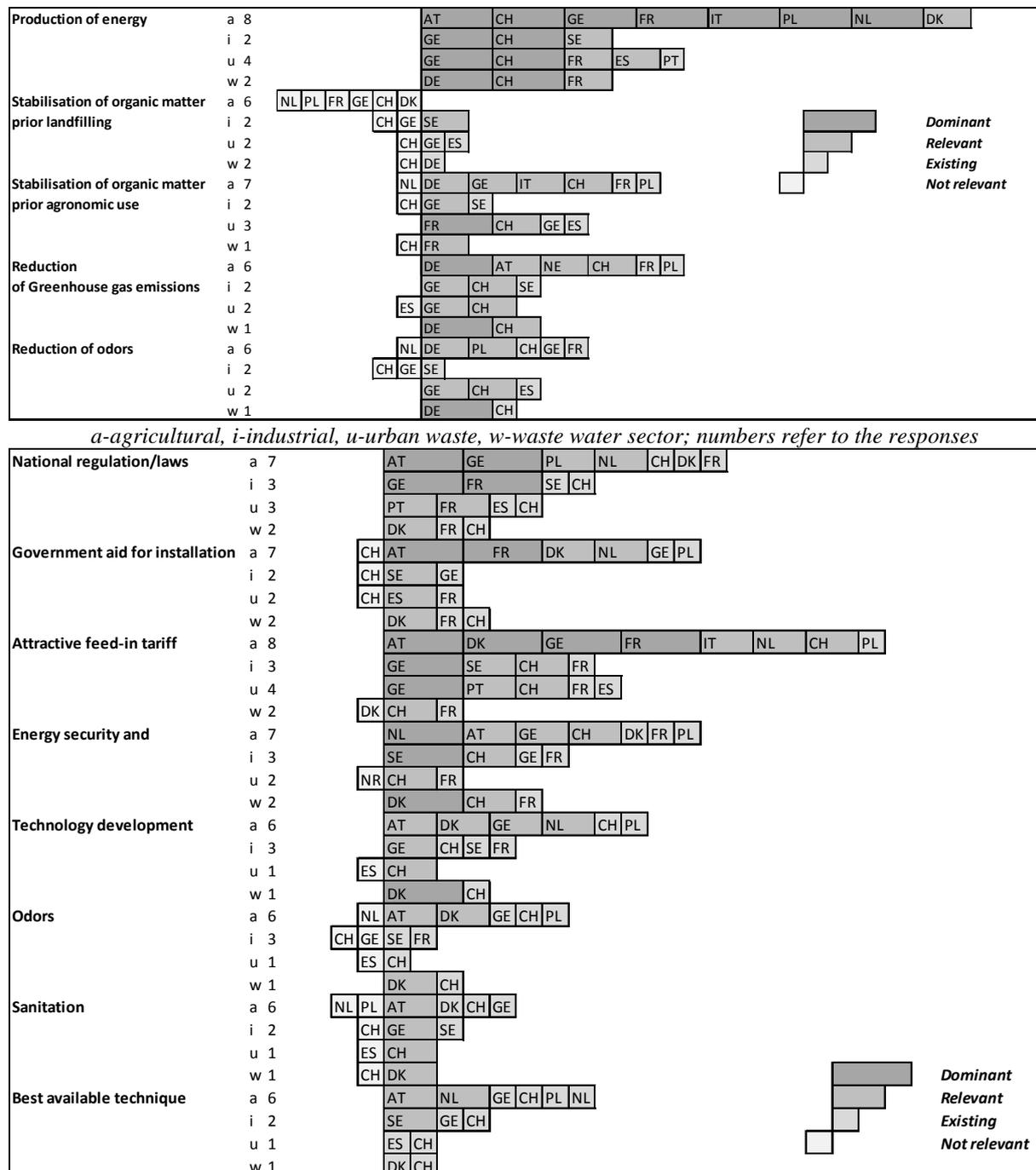


Figure 1. Goal (above) and driving forces (below) in the respective countries.

Table 3. Substrate amounts used for AD in various countries

In Mio Mg/a	DK	FR	GE	IT	PL	SE
Liquid and Solid Manure	1.7	0.43	20	7.5	0.3	0.3
Energy Crops	0.02	-	25	6.5	-	0.03
Crop residues	0.02	-	-	0.6	-	-
Wastes from Agro-food industry	-	7.8	-	-	-	0.2
Urban Waste	-	0.2	-	-	-	0.2
Wastewater	0.05	7.0	-	-	-	5.6

In 2008/9 wastewater sludges showed to be quantitatively the most important in IT, PL, PT, SE. Maize was most important in GE. As shown in Table 3, for 2010/12 maize seems to be still most important in GE, whereas waste

from agro-food industry and wastewater sludges are most important in FR, cattle and pig manure in DE and in IT cattle manure, followed by maize are the most important. In SE wastewater dominated.

Table 4. Number of AD facilities in various countries

Country	Agri-culture	Agro-food industry	Domestic wastewater treatment	Municipal wastes treatment	Centralised codigestion plants
AU	300	-	-	-	-
CH	80	22	463	28	-
DK	50	5	61	0	22
ES	22	-	>40	30	-
FR	41	80	60	9	7
GE	7000	100	1000	100	100
IT	760 ¹	35 ¹	60 ¹	260 ¹	-
	994 ²	-	-	-	-
NL	80	20	60	10	20
PL	-	-	-	-	170
PT ³	-	-	7	25 ⁴	-

¹ Data from official statistics 2012; ² Most actual evaluation from 03/2013 by CRPA; ³ Units to produce electricity or CHP; ⁴majority is landfill gas

Most AD facilities still exist in GE (Table 4). Compared to the previous period they have almost doubled. Very strong increase we could observe for IT and PL; less than 30 were counted for PL

and less than 250 for IT in the previous period. Different countries have slightly different categories for statistical counting. In SE for example in total 229 plants were counted in the categories waste, co-digestion, industrial waste water, farm and landfill. Also PT counts landfill biogas.

Table 5. AD numbers (agriculture) for different digester volumes

Volume (m ³)	< 500	500-1000	1000-3000	3000-5000	>5000
GE	3000	1000	1000	2000	200
DK	0	0	25	25	22
IT	5	15	180	270	290

A lot of different reactor sizes are in use (Table 5). As large reactors were already preferred in IT in the previous period, the newly built facilities in DK and GE belong primarily to the larger

sizes. In SE no information are available, but they can be considered as mainly >1000 m³.

Conclusion and perspectives

The central challenge to any questionnaire is to get responses. A clear structure and clearly formulated questions help. The questionnaire is now brief enough and has concise form. Only minor changes may be necessary. In some cases not all questions were answered. This can be attributed to a lack of time for the countries with well-established AD and to a lack of data for the others. The questionnaire will become earlier distributed next time. An extension to further experts from additional countries is necessary too. Especially the wastewater sector needs to be enlarged. Possibilities for up-date on a routinely basis with wide dissemination have to be found.

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