BIOMASS AVAILABILITY FROM OLIVE FARMING AND OLIVE OIL INDUSTRY: RESULTS OF A DELPHI METHOD TECHNIQUE SURVEY

Adriano Ciani[1]
Enrica Rossetti[2]
Gaetano Martino[3]
Marina Bufacchi[4]

ABSTRACT: Renewable energies as indigenous source of energy will have an important role to play in reducing the level of energy imports, mitigate climate change and enhance energy security[5]. Biomass offers a large unexploited technical potential and is currently competitive and economically viable. This study deals with the availability of the raw material and its potential use for energy production purpose. An e-mail Delphi method technique survey to be administered to experts in the field of olive farming and olive oil production industry was performed. The questionnaires designed elicit and develop individual responses to the problems posed and enable the experts to refine their views as the group's work progresses. The work findings reveal a considerable interest of experts for obtaining energy from biomass. Furthermore, it seems to be a chance for environment saving and an economical opportunity for farmers.

Keywords: Biomass, olive, renewable energy, Delphi method

1 INTRODUCTION

RENEWABLE ENERGY

In this study we take into consideration the availability and the use possibilities of the biomasses from olive oil production in Mediterranean and European Countries. Our objective is to provide a picture of the experts evaluations about the challenges posited? in such a business area.
Renewable source of energy are currently unevenly and insufficiently exploited in the European Union. Although many of them are abundantly available, and the real economic potential considerable, renewable sources of energy make a disappointing small contribution to the Union's overall gross inland energy consumption, which is predicted to grow steadily in the future (COM(97)599)[6].

The EU has a clear framework to steer its energy and climate policies up to 2020. This framework integrates different policy objectives such as reducing greenhouse gas (GHG) emissions,

[1] Department of Agricultural Economics and Food Sciences, University of Perugia, Italy
[2] Institute for Mediterranean Agriculture and Forest Systems, Italy. e.rossetti@hotmail.it.
[3] Department of Agricultural Economics and Food Sciences, University of Perugia, Italy.
[4] Institute for Mediterranean Agriculture and Forest Systems, Italy
[5] Ericsson, K., Nilsson, L.. Assessment of the potential biomass supply in Europe using a resource-focused approach, *Biomass and Bioenergy* 30, 1–15, 2006.
[6] COM (97) 599, (26/11/1997) http://europa.eu/documents/comm/white_papers/pdf/com97_599_en.pdf

securing energy supply and supporting growth, competitiveness and jobs through a high technology, cost effective and resource efficient approach. These policy objectives are delivered by three headline targets for GHG emission reductions, renewable energy and energy savings.

The EU is making progress towards meeting the 2020 target of 20% renewable energy in gross final energy consumption. In 2010, the renewable share in the EU was 12.7% compared to 8.5% in 2005. In the period 1995-2000 when there was no regulatory framework, the share of renewable energy grew by 1.9% a year[7].

Agriculture is a key sector for the European strategy of doubling the share of renewable energies in gross energy demand in the European Union by 2010. New activities and new sources of income are emerging on-farm and off-farm. Among those, the production of renewable raw materials, for non food purpose in niche markets or the energy sector, can represent a new opportunity for agriculture and forestry and contribute to job creation in rural areas[8].

A number of studies in the literature conclude that agro-industrial residues are a suitable source of biomass for electricity production[9] [10] [11] [12] [13]; however, its use as an energy source is hindered by several limitations, such as for instance the seasonal supply of waste (correlated to the seasonality of the main product); or the high investment costs required for waste pre-treatment[14].

RAW MATERIAL AVAILABILITY

Olive tree groves are a typical feature of the Mediterranean landscape, and in Europe they represent the ancestral crops of countries such as Italy and Spain, where olive oil production has represented an export-oriented industrial activity since at least two millennia[15].

The worldwide surface grown with olive trees amounts to almost 8.6 million hectares, mainly located in the Mediterranean Sea basin[16]. Such crops require frequent pruning, which

---

[7] COM (2013) 169, Brussels, 27.3.2013 http://ec.europa.eu/energy/consultations/doc/com_2013_0169_green_paper_2030_en.pdf

[8] COM (97) 599. Op. Cit.

[9] Caputo A, Scacchia F, Pelagagge P.. Disposal of by-products on olive oil industry: waste-to-energy solutions. *Appl Therm Eng*;23(2):197–214, 2003.

[10] Kuiper L, Sikkema R, Stolp J.. Establishment needs for short rotation forestry in the EU to meet the goals of the commission's White Paper on renewable energy. Biomass Bioenergy; 15(6):451–6, 1998.

[11] Boateng A, Walawender W, Fan L, Chee C. (1992). Fluidized-bed steam gasification of rice hull. Bioresour Technol;40(3):235–9.

[12] Malaspina F, Cellamare C, Sante L, Tilche A. Anaerobic treatment of cheese whey with a downflow–upflow hybrid reactor. Bioresour Technol 1996;55(2): 131–9.

[13] Mussatto S., Dragone G, Roberto I. (2006). Brewers' spent grain: generation, characteristics and potential applications. J Cereal Sci;43(1):1–14.

[14] IDAE. Spanish Renewable Energy Plan 2005–2010. Tech. rep., Institute for Diversification and Saving of Energy; 2005. See also: http://www.idae.es/.

[15] Talbert, R. (Ed.), 1985. Atlas of Classical History. Routeledge, London, p. 216. ISBN 0- 415-03463-9 (quoted pp. 126–127, ''Trade in the Roman World").

[16] FAOSTAT, 2009. SUA Crops Primary, year 2003. <http://faostat.fao.org/DesktopDefault.aspx?PageID=355&lang=en#ancor> (accessed 28.07.09).

generates the equivalent of at least 1 oven dry ton (odt) of residue biomass per hectare[17]. In Italy alone, the annual amount of residue derived from the pruning of olive groves, vineyards and other orchards has been estimated to 2.85 million tonnes, net of the amounts already recovered for traditional utilization[18]. That explains why pruning residue generally plays an important role in any analysis of biomass availability conducted in these regions[19] [20].

Olive oil is nearly totally produced in the Mediterranean region. Three quarters of the annual production in the world comes from European Union countries around the Mediterranean Sea. As the demand of olive oil is rapidly increasing worldwide, environmental pollution posed by olive mill wastes (OMW) is a growing problem especially in the Mediterranean region. The olive oil producer countries have been facing a serious challenge to find an environmentally sound and economically viable solution in handling and disposal of OMW[21].

The waste products derived from olive oil extraction are an aqueous effluent (vegetation water) and a solid residue, mainly containing the olive skin and stone (olive husk). The amount of vegetation water produced depends upon the milling process, ranging from about 50 kg of water per 100 kg of olives in a traditional batch mill to about 110 kg of water per 100 kg of olives in a continuous process. Olive oil production has a significant role in the Italian agro-industrial production; the Italian production of vegetation water reaches 3 million cubic meters and, being a seasonal activity, it is concentrated in a 3-month period[22].

The paper is organized as follows: Par 2 illustrates the objective and the method of the analysis, Par 3 illustrates the empirical investigation design, Par 4 illustrates data analysis and discussion and in Par 5 there are the paper conclusions.

2 OBJECTIVE AND METHOD

In order to gathering information about availability of raw material and its potential use for energy production in the Mediterranean areas, a Delphi method survey was performed. The specific

[17] Laraia, R., Riva, G., Squitieri, G. (2001). I rifiuti del comparto agroalimentare. Studio di settore. Rapporto ANPA no 11/2001. ANPA, Roma, p. 149 (in Italian).
[18] Di Blasi, C., Tanzi, V., Lanzetta, M., (1997). A study on the production of agricultural residue in Italy. Biomass and Bioenergy 12 (5), 321–331.
[19] Bernetti, I., Fagarazzi, C., Fratini, R., (2004). A methodology to analyze the potential development of biomass energy sector: an application in Tuscany. Forest Policy and Economics 6, 415–432.
[20] Spinelli, R., Picchi, G., 2010. Industrial harvesting of olive tree pruning residue for energy biomass Bioresource Technology 101 (2010) 730–735.
[21] Azbar, N., Bayram, A., Filibeli, A., Muezzinoglu, A., Sengul, F., Ozer, A. (2004). A review of waste management options in olive oil production. Critical Reviews in Environmental Science and Technology Volume 34, Issue 3, 2004, Pages 209-247
[22] Vitolo, S., Petarca, L., Bresci, B. 1999- Treatment of olive oil industry wastes Bioresource Technology 67 (1999) 129-137

goal was to investigate how the technological idea at the basis of the project is perceived by expert of the field.

DELPHI METHOD TECHNIQUE SURVEY

"Project Delphi" was the name given to an Air Force-sponsored Rand Corporation study focused on understanding the use of expert opinion[23]. The objective of the Delphi methodology was to ''reduce the negative effects of group interactions''[24] and to obtain the most reliable consensus of opinion of a group of experts[25]. The Delphi method is named after the ancient Greek oracle at Delphi, who offered visions of the future to those who sought advice[26] [27]. In its original form, the Delphi method is a long-range forecasting technique that elicits, refines, and draws upon the collective opinion and expertise of a panel of experts[28]. On a practical level, the Delphi method is an alternative to formal meetings, interviews, or other face-to-face interactions. Unlike meetings where often not everyone can be present, the Delphi method allows all participants to have equal opportunity to be involved with the decision-making process.

The Delphi method was developed as a way to overcome negative effects of person-to-person interactive groups, such as the 'the tendency of low-status members to 'go along' with the opinions of high-status members in spite of contrary feelings''[29] [30]. Other weaknesses felt by face to- face meetings, such as following a single thought, getting side tracked, and losing sight of the goal of the discussion[31], are less problematic for the Delphi method. Four features that eliminate such problems and characterize the Delphi method are: anonymity, iteration, controlled feedback and statistical group response[32].

DESIGN

---

[23] Dalkey & Helmer, (1963). An experimental application of the Delphi Method to use of experts. Management Science 9, 458-467.
[24] Gupta, U. G., & Clarke, R.E. (1996). Theory and application of the Delphi technique: a bibliography (1975-1994). Technological forecasting and social change, 53(2), 185-211;
[25] Dalkey & Helmer, (1963). An experimental application of the Delphi Method to use of experts. Management Science 9, 458-467.
[26] Cassino, K. (1984). Delphi panel: A practical 'Cristal ball For researches. Marketing news, 18, 10-11;
[27] Gupta, U. G., & Clarke, R.E. (1996). Theory and application of the Delphi technique: a bibliography (1975-1994). Technological forecasting and social change, 53(2), 185-211;
[28] Theory and application of the Delphi technique: a bibliography (1975-1994).
[29] Torrance, E. (1957); Group decision making and disagreement. Social forces, 35, 314-318;
[30] Van de Ven, A. (1974). Group decision making and effectiveness. Kent, O: Kent State University Press;
[31] Dunnette, M.,Campbell, J., Jaastad, K. (1963). The effect of group participation on brainstorming effectiveness of two industrial samples, Journal of applied psychology, 47, 308-318;
[32] Rowe, G., Wright, G., Bolger, F. (1991). Delphi: a reevaluation of research and theory. Technological forecasting and social change, 39(3), 235-251;

The essence of the technique is fairly straightforward. It comprises a series of questionnaires sent, in our case by SurveyMonkey platform (SM), to a pre-selected group of experts. The questionnaires are designed to elicit and develop individual responses to the problems posed and to enable the experts to refine their views as the group's work progresses in accordance with the assigned task[33].

The first questionnaire (Q1) poses the problem in broad terms and invites answers and comments. The answers to Q1 are summarised and used to construct a second questionnaire (Q2). Q2 presents the results of Q1 and give respondents an opportunity to re-evaluate their original answers in the light of comprehensive feedback on the response of the whole group. During this interactive process issues can be clarified, areas of agreement and disagreement can be identified, and an understanding of the priorities can be developed.

The first stage of a Delphi process is of crucial importance. If respondents do not understand the aim of the Delphi exercise, they may answer inappropriately, become frustrated or lose interest[34].

In the second questionnaire experts can argue in favor or against each item. The benefits which can reasonably be expected at the Q2 stage are the identification of areas of agreement and disagreement amongst panelists as well as issues requiring further clarification.

3 EMPIRICAL INVESTIGATION

SURVEY DEVELOPMENT

Subscription on the SM professional "Gold plan" provided access to additional features useful for survey development as for example Question Logic (the possibility to direct respondents to different sections of the survey on the basis of answered questions).

One of the existing online templates was selected to create the draft of the first round survey. The subsequent surveys had been created then each time by copying and editing the previous one.
The appropriate identifying logo of the research project (Fuel From Waste Project: funded by the European Union in the frame of the 7th Framework Programme) was uploaded into the survey as a header on each page.

---

[33] Adler, M., Ziglio, E. (1996). Gazing into the Oracle- The Delphi method and its Application to Social Policy and Public Health, Jessica Kingsley Publishers, London;
[34] Delbecq , A.L., Van de Ven, A.H., Gustafson, D.H. (1975). Group techniques for program planning: a guide to nominal group and Delphi process. Glenview, IL: Scott-Foreman and Co.

Questions were built by copying and pasting the statements by a word document, selecting from SM the question type and response options. There was an additional field for comment after each group of statements.

For the round one survey, a five point rating scale was used, and response choices ranged from 0 (strongly disagree) to 5 (strongly agree). For round two, the acquired information was used to build a staked bar chart of the whole responses.

SURVEY ROUNDS

Q1. The questionnaire is divided in different sections. The first one is realized in order to give to respondents the possibility to focus attention on the aim of the work by means of an open answer question about energy from waste.

The later questions section concerns respondents' general and demographic information, to characterize the panel of experts we deal with (age, qualification, profession, experience, main activity).

Then there is the group of knowledge and attitude questions: the first group is administered as lists of questions about investments (human, physical, administrative, others), geo-location and amount of waste and information sources about this matter; the second one is administered as a Likert scale about desirability and feasibility of production of energy from waste.

At the end of the questionnaire we provided a section for respondent to make comments on any issue of the questionnaire (suggest clarifications, argue in favor or against issues, and ask questions).

The questionnaire was administered using an e-mail invitation; in this way experts can choose to participate in the group communication process when they prefer, and may choose to contribute to that aspect of the problem to which they feel more interested to contribute.

Respondents have to understand clearly the aim of the survey. For this reason, we provided them with a brief abstract of the Delphi method and of the aim of the study in the invitation message.

Q2. The second questionnaire was realized summarizing the panelists answers with staked bar charts depicting the distribution of responses indicating each statement's rating for level of agreement. The experts were asked to confirm or reject their previous answer and to give a comment on the review.

DISTRIBUTION OF THE ROUNDS

The SM email collector method was selected to distribute a personalized email message to each panel member[35] with a URL link to the survey. A list containing the panel e-mail addresses and names was realized and an ID number was assigned to each panel member in order to track responses between rounds and provide individual feedback.

For each round of the survey, emails were scheduled for distribution, with five follow up reminder emails to non-respondents per round[36] [37] [38] [39]. The list of respondents from each round was copied into new recipients list for subsequent round.

Piloting the survey is a crucial step for a good Delphi research design[40] [41].The survey was pilot tested as recommended by Presser. Feedback resulted in minor wording changes and editing for clarity only[42].

DELPHI PANEL.

There is no agreement on an ideal panel size, this being a balance between large numbers (difficult to manage and having high attrition rates) versus a small panel size (potentially introducing bias and lack of variability)[43].

In this study, the panel of experts was composed by specialists on olive farming and olive oil producers, as well as professors, experts from trade associations and from bio-energy branches.

4 DATA ANALYSIS AND DISCUSSION.

A small subsample of respondents to be interviewed was randomly selected in order to test the questionnaire with a pilot test. The text of the invitation contains a brief introduction to the project, the aim of the survey, the contacts of the coordinator and the link to FFW website. The invitation was signed by the project coordinator.

---

[35] Joinson, A.N., Reips, U.-D (2007). Personalized salutation, power of sender and response rates to Web-based surveys, Computers in Human Behaviour, 23 (3), pp. 1372-1383.10.1016/j.chb.2004.12.011

[36] Cowman, S., Gethin, G., Clarke, E., Moore, Z., Craig, G., Jordan-O'Brien, J., Mclain, N., Strapp, H. (2012). An international e-Delphi study identifying the research and education priorities in wound management and tissue repair. Journal of Clinical Nursing, 21 (3-4), pp. 344-353. doi: 10.1111/j.1365-2702.2011.03950.

[37] Delbecq, A., Gustafson, D., Van de Ven, A. (1986) Group Techniques for Program Planning: A Guide to Nominal Group and Delphi Processes. Green Briar Press, Middleton, Wi.

[38] Edwards, P.J., Roberts, I., Clarke, M.J., Di Guiseppi, C., Wentz, R., Kwan, I., Cooper, R., Pratap, S. (2009). Methods to increase response to postal and electronic questionnaires, Cochrane Database of Systematic Reviews, (3);

[39] Geist, M.R. 2010- Using the Delphi method to engage stakeholders: A comparison of two studies, Evaluation and Program Planning 33 (2010) 147–154

[40] Latour, J., Hazelzet, J., Duivenvoorden, H., van Goudoever, J., (2009). Construction of a parent satisfacting instrument: perceptions of pediatric intensive care nurses and physicians, Journal of Critical Care 24 (2), 255-266.

[41] Presser, S., Couper, M.P., Lessler, J.T., Martin, E., Martin, J., Rothgeb, J.M., Singer, E. (2004). Methods for testing and evaluating survey questions, Public Opinion Quarterly, 68 (1), pp. 109-130. Cited 59 times. doi: 10.1093/poq/nfh008

[42] Gill F.J., Leslie, G.D., Grech, C., Latour, J.M. (2013). Using a web-based survey tool to undertake a Delphi study: Application for nurse education research, Volume 33, Issue 11, November 2013, Pages 1322-1328

[43] Group Techniques for Program Planning: A Guide to Nominal Group and Delphi Processes. Op. Cit.

After the web survey was uploaded and operated on the survey website, the next phase was to deliver the survey to potential respondents. Now the matter is the invitation designs (how respondents should be invited), the use of pre-notification and reminders, and the use of incentives[44].

As for the invitation design, contacts are messages sent to respondents with the purpose to inform them of the upcoming arrival of a survey. Only for the pilot test a pre-notification strategy was applied, in order to obtain a feedback. Such approach was unfeasible for the administration of the whole survey, because of the large number of contacts. We used, instead, the e-mail invitation strategy.

Society-related and respondent-related factors influence participation decision in a web survey. As referred by Groves, the social level factors are related to social cohesion and public attitude towards the survey industry[45]. Furthermore, there are trends of decreasing response rates around the world over the past several decades[46] [47] [48]. Furthermore, the official sponsorship of a survey is found to affect response rate. Generally, survey sponsored by academic and governmental agencies have higher response rate[49] [50] [51] [52] [53]. For this purpose the invitation text introducing the questionnaire was signed by the coordinator of the Project and the link to the FFW Project web site was embedded in the invitation.

Table 1. Number of sent *e-mail*, *filled questionnaire and response rate.*

File folder		sent	filled	% ans/file folder
Q1	ITALIANS	387	53	13,70
	ENGLISH	236	23	9,75
Q2	ITALIANS	53	42	79,25
	ENGLISH	23	19	82,61
tot Q1		623	76	
tot Q2		76	61	

At the end of the first round

[44] Fan, W., Yan, Z. (2010) Factors affecting response rates of the web survey: a systematic review, Computers in Human Behaviour 26 (2010), 132-139.

[45] Groves, R.M., Cialdini, R.B., Couper, M.P. (1992) Understanding the decision to participate in a survey. Public Opinion Quarterly, 68, 299-308.

[46] Atrostic, B.K., Silberstein, A., Winters, F., Bates, N. (2001). Nonresponse in federal household surveys: New measures and new insights. Journal of Officil Statistics, 17, 209-226.

[47] Baruch, Y. (1999). Response rate in academic studies: a comparative analysis. Human Relations, 52, 421-438.

[48] De Heer, W. (1999). International response rates trend: results of an international survey, Journal of Official Statistics, 21, 233-255.

[49] Fox., G., Crask, M.R., Kim, J. (1988). Mail survey response rate: a meta-analysis of selected techniques for inducing response. Public Opinion Quarterly, 52, 467-491.

[50] Goyder, J. (1982). Further evidence on factors affecting response rates to mailed questionnaires. American Sociological review, 47, 550-553.

[51] Heberlein, T. A., Baumgartner, R. (1978). Factors affecting response rates mailed questionnaires: a quantitative analysis of the published literature. American Sociological Review, 43, 447-462.

[52] Manfreda, K.L., Bonsiank, M., Berzelak, J., Haas, I., Vehovar, V. (2008). Web surveys versus other surveys modes. International Journal of Market Research, 50, 79-104.

[53] Waltson, J.T., Lissitz, R.W., Rudner, L.M. (2006). The influence of web-based questionnaire presentation variations on survey cooperation and perceptions of survey quality. Journal of Official Statistics, 22, 271-291.

questionnaires were fulfilled.
This is the expert panel that has been used for the second round questionnaire.

PANEL CHARACTERISTICS

We pointed out the main characteristics of the panel in order to give an evaluation of its quality and representativeness (variability of professions, age, and educational qualification).

About the age class, 2.6% of respondents were younger than 30. 69.3% were between 30 and 50, the others were older than 50.

Concerning the educational qualification, we had no answers for primary education and middle school, only 1 panelist had high school level, 17% of respondents had a university degree, and 92% had a postgraduate qualification such as master or PhD.
Concerning the profession, 4% of respondents were businessmen, 21% were professors and 52% were researchers in the field.

5% of panelists had an experience in the field shorter than 5 years, 49% between 5 and 15 years, 21% between 16 and 25 years and 21% over 25 years.

The main activity of panelist was: 73% public research, 6.6% private sector research, 6.6% farming, 6.% agro-industrial production, 1.3% local policy, 1.3% national policy and 1.3% energy production.

With these information we can assess that the panel is quite various for age and years of experience in the field. In the other panelist features the variability is lower because of the e-mail source used for the composition on the panel: official data from CINECA (non profit Consortium. made up of 56 Italian universities and 3 Institutions), from Italian and International associations in the field of agro-industry and energy production. It was expected that the greater percentage of respondents were graduate, as employed in the research sector. For businessmen of agro-industrial sector, the response rate has been low because of the delicate connection between agro-industrial sector and the inclination to the survey compiling.

About information sources on production of energy by biomass, 32% of panelists selected magazines, 23% selected specialists, 21% selected TV, internet, radio, 11% colleagues and 10% trade associations.

Concerning information about knowledge of panelist (questions about investment in the field of energy production from biomasses, and quantity of biomass produced in the belonging area), unfortunately this information seemed too much technical and just few respondents gave an answer about the local situation.

The responses and qualitative feedback from the first round survey were reviewed and comments included for thematic analysis. This process resulted in the revision of the survey for round two.

Descriptive statistic was used to report and review the panel demographic characteristics. Stacked bar charts were presented in the round two of questionnaires to depict the distribution of responses indicating each statement's rating level of importance. These were sent to all panelists, together with a brief summary of their previous answers, asking them to give a comment on the distribution of the responses and confirming or rejecting the preceding choice.

These comments give us information about the attitude of panelists.

STAKED BAR CHART USED FOR REALIZATION OF Q2.

Table 2: Staked bar charts depicting the distribution of responses indicating each statement's rate for level of agreement concerned with "energy production from biomass".

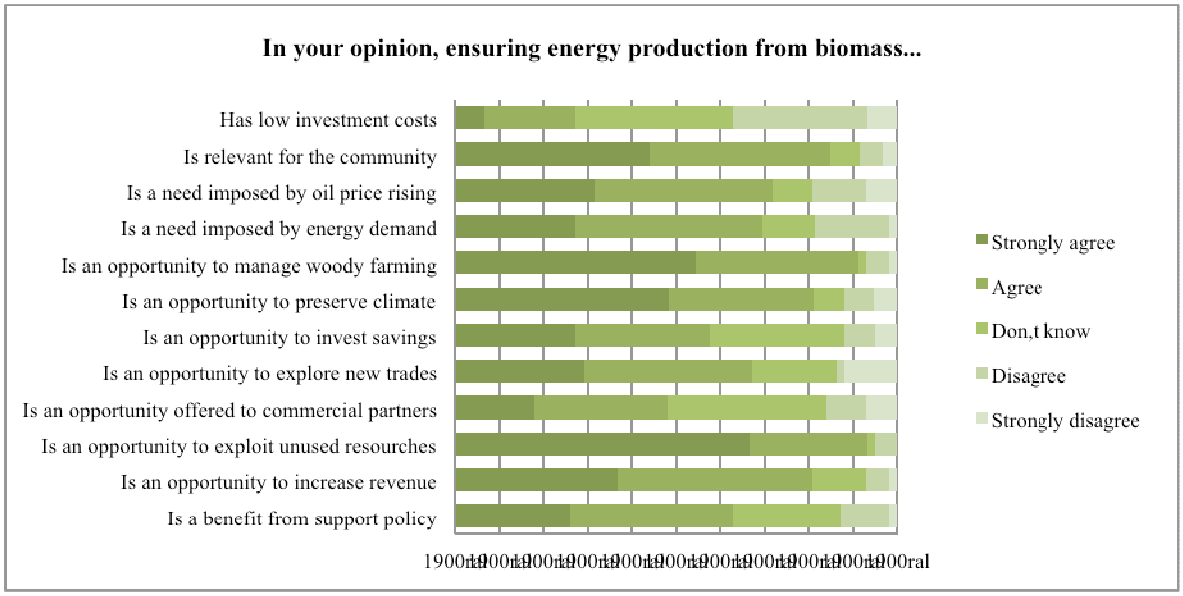
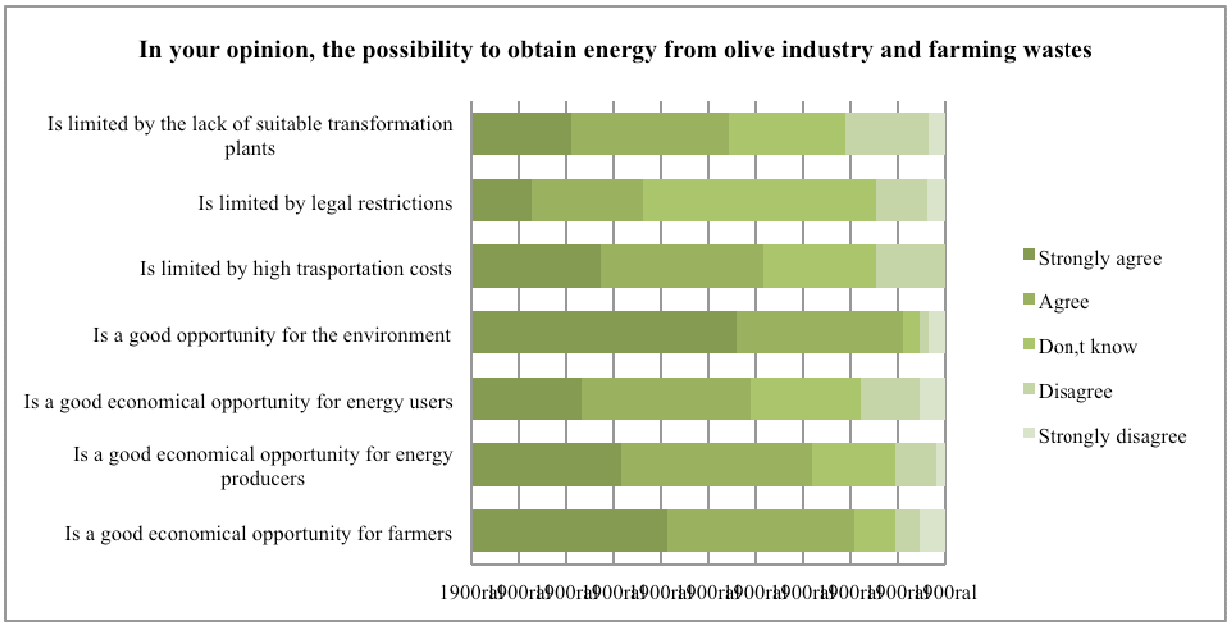


Table 3: Staked bar charts depicting the distribution of responses indicating each statement's rate for level of agreement concerned with "obtaining energy from olive industry and farming wastes".



Concerning the panelists attitude outcomes, experts pointed out a very high level of agreement referred to the issues related to the energy by biomass production. In particular it seems to be a chance for farmers in managing woody farming wastes and exploit unused resources.

The statements who obtained the lower level of agreement referres to investment costs. Panelists seems to do not agree with the low level of investment required to ensure energy production statement.

For the issues concerned with the possibility to obtain energy from olive industry and farming wastes, the main boundary for the diffusion of the wastes exploitation seems to be the legal restrictions and, at second step, the lack of siuitable trasformation plants.

In any case, this possibility is considered a chance for saving environment and an economical opportunity for farmers.

5 CONCLUSIONS

The study investigates the experts' evaluation of the possibility to exploit the biomasses from olive oil production in Mediterranean and European Countries.

The value of the investigation is mainly due to the fact there is not a comprehensive understanding of these possibilities due to several issues related to several factors such as: the logistic of the energy production systems, technology to be efficiently employed and legal constraints.

Facing such issues, enterprises need to refine their own perspective about the business perspectives, integrating the inducements and the constraints of legislation, especially in the field of environment protection.

To evaluate the real possibilities is a difficult matter, as the knowledge in the technological field it is not completely integrated in the practices, so codified and tacit knowledge do not fully provide the expected benefit in terms of efficient organization and technology implementation.

Our results show that projecting their codified knowledge in the field of business opportunities, experts confirm the possibilities to invest in the energy from biomass production and also the need to enhance the scientific knowledge including the one concerned with the design of business models.

ACKNOWLEDGEMENTS

This study was developed under FFW Project (www.fuelfromwaste.eu), funded by the European Union in the frame of the 7th Framework Programme.

REFERENCES

ADLER, M., ZIGLIO, E.. *Gazing into the Oracle- The Delphi method and its Application to Social Policy and Public Health*, Jessica Kingsley Publishers, London, 1996.

ATROSTIC, B.K., SILBERSTEIN, A., WINTERS, F., BATES, N. Nonresponse in federal household surveys*:* New measures and new insights. *Journal of Officil Statistics*, 17, 209-226, 2001.

AZBAR, N., BAYRAM, A., FILIBELI, A., MUEZZINOGLU, A., SENGUL, F., OZER, A.. *A review of waste management options in olive oil production. Critical Reviews in Environmental Science and Technology*, Volume 34, Issue 3, 2004, Pages 209-247, 2004.

BARUCH, Y.. Response rate in academic studies: a comparative analysis. *Human Relations*, 52, 421-438, 1999.

BERNETTI, I., FAGARAZZI, C., FRATINI, R.. A methodology to analyze the potential development of biomass energy sector: an application in Tuscany. *Forest Policy and Economics*, 6, 415–432, 2004.

BOATENG A, WALAWENDER W, FAN L, CHEE C.. Fluidized-bed steam gasification of rice hull. *Bioresour Technol*; 40(3): 235–9, 1992.

CAPUTO A, SCACCHIA F, PELAGAGGE P.. Disposal of by-products on olive oil industry*:* waste-to-energy solutions. *Appl Therm Eng*; 23(2):197–214, 2003.

CASSINO, K.. Delphi panel: A practical 'Cristal ball For researches. *Marketing news*, 18, 10-11, 1984.

COM 599, (26/11/1997) http://europa.eu/documents/comm/white_papers/pdf/com97_599_en.pdf, 1997.

COM, 169, Brussels, 27.3.2013 http://ec.europa.eu/energy/consultations/doc/com_2013_0169_green_paper_2030_en.pdf, 2013.

COWMAN, S., GETHIN, G., CLARKE, E., MOORE, Z., CRAIG, G., JORDAN-O'BRIEN, J., MCLAIN, N., STRAPP, H.. An international e-Delphi study identifying the research and education

priorities in wound management and tissue repair. *Journal of Clinical Nursing*, 21 (3-4), pp. 344-353. doi: 10.1111/j.1365-2702.2011.03950, 2012.

DALKEY & HELMER. An experimental application of the Delphi Method to use of experts. *Management Science*, 9, 458-467, 1963.

DE HEER, W.. International response rates trend: results of an international survey, *Journal of Official Statistics*, 21, 233-255, 1999.

DELBECQ , A.L., VAN DE VEN, A.H., GUSTAFSON, D.H.. *Group techniques for program planning*: a guide to nominal group and Delphi process. Glenview, IL: Scott-Foreman and Co, 1975.

DELBECQ, A., GUSTAFSON, D., VAN DE VEN, A. *Group Techniques for Program Planning*: A Guide to Nominal Group and Delphi Processes. Green Briar Press, Middleton, Wi, 1986.

DI BLASI, C., TANZI, V., LANZETTA, M.. A study on the production of agricultural residue in Italy. *Biomass and Bioenergy*, 12 (5), 321–331, 1997.

DUNNETTE, M., CAMPBELL, J., JAASTAD, K.. The effect of group participation on brainstorming effectiveness of two industrial samples, *Journal of applied psychology*, 47, 308-318, 1963.

EDWARDS, P.J., ROBERTS, I., CLARKE, M.J., DI GUISEPPI, C., WENTZ, R., KWAN, I., COOPER, R., PRATAP, S.. Methods to increase response to postal and electronic questionnaires, *Cochrane Database of Systematic Reviews*, (3), 2009.

ERICSSON, K., NILSSON, L.. Assessment of the potential biomass supply in Europe using a resource-focused approach, *Biomass and Bioenergy*, 30, 1–15, 2006.

FAN, W., YAN, Z. Factors affecting response rates of the web survey: a systematic review, *Computers in Human Behaviour*, 26, 132-139, 2010.

FAOSTAT. SUA *Crops Primary, year 2003*. <http://faostat.fao.org/DesktopDefault.aspx?PageID=355&lang=en#ancor> (accessed 28.07.09).

FOX., G., CRASK, M.R., KIM, J.. Mail survey response rate: a meta-analysis of selected techniques for inducing response. *Public Opinion Quarterly*, 52, 467-491, 1988.

GEIST, M.R. Using the Delphi method to engage stakeholders: a comparison of two studies. *Evaluation and Program Planning*. 33, 147–154, 2010.

GILL F.J., LESLIE, G.D., GRECH, C., LATOUR, J.M.. *Using a web-based survey tool to undertake a Delphi study*: Application for nurse education research, Volume 33, Issue 11, November 2013, Pages 1322-1328.

GOYDER, J.. Further evidence on factors affecting response rates to mailed questionnaires. *American Sociological Review*, 47, 550-553, 1982.

GROVES, R.M., CIALDINI, R.B., COUPER, M.P. Understanding the decision to participate in a survey. *Public Opinion Quarterly*, 68, 299-308, 1992.

GUPTA, U. G., & CLARKE, R.E.. Theory and application of the Delphi technique: a bibliography (1975-1994). Technological forecasting and social change, 53(2), 185-211, 1996.

HEBERLEIN, T. A., BAUMGARTNER, R.. Factors affecting response rates mailed questionnaires: a quantitative analysis of the published literature. American Sociological Review, 43, 447-462, 1978.

IDAE. *Spanish Renewable Energy Plan 2005–2010*. Tech. rep., Institute for Diversification and Saving of Energy; 2005. See also: http://www.idae.es/.

JOINSON, A.N., REIPS, U.-D. Personalized salutation, power of sender and response rates to Web-based surveys, *Computers in Human Behaviour*, 23 (3), pp. 1372-1383.10.1016/j.chb.2004.12.011, 2007.

KUIPER L, SIKKEMA R, STOLP J.. Establishment needs for short rotation forestry in the EU to meet the goals of the commission's White Paper on renewable energy. *Biomass Bioenergy*; 15(6):451–6, 1998.

LARAIA, R., RIVA, G., SQUITIERI, G.. I rifiuti del comparto agroalimentare. Studio di settore. *Rapporto ANPA no 11/2001*. ANPA, Roma, p. 149 (in Italian), 2001.

LATOUR, J., HAZELZET, J., DUIVENVOORDEN, H., van GOUDOEVER, J.. Construction of a parent satisfacting instrument: perceptions of pediatric intensive care nurses and physicians. *Journal of Critical Care*, 24 (2), 255-266, 2009.

MALASPINA F, CELLAMARE C, SANTE L, TILCHE A. Anaerobic treatment of cheese whey with a downflow–upflow hybrid reactor. *Bioresour Technol* 1996; 55(2): 131–9.

MANFREDA, K.L., BONSIANK, M., BERZELAK, J., HAAS, I., VEHOVAR, V.. Web surveys versus other surveys modes. *International Journal of Market Research*, 50, 79-104, 2008.

MUSSATTO S., DRAGONE G, ROBERTO I.. Brewers' spent grain: generation, characteristics and potential applications. *J Cereal Sci*; 43(1):1–14, 2006.

PRESSER, S., COUPER, M.P., LESSLER, J.T., MARTIN, E., MARTIN, J., ROTHGEB, J.M., SINGER, E.. Methods for testing and evaluating survey questions. *Public Opinion Quarterly*, 68 (1), pp. 109-130. Cited 59 times. doi: 10.1093/poq/nfh008, 2004.

ROWE, G., WRIGHT, G., BOLGER, F.. Delphi: a reevaluation of research and theory. *Technological forecasting and social change*. 39(3), 235-251, 1991.

TALBERT, R. (Ed.). *Atlas of Classical History*. Routeledge, London, p. 216. ISBN 0- 415-03463-9 (quoted pp. 126–127, ''Trade in the Roman World"), 1985.

SPINELLI, R., PICCHI, G.. Industrial harvesting of olive tree pruning residue for energy biomass. *Bioresource Technology*, 101 (2010) 730–735, 2010.

TORRANCE, E. Group decision making and disagreement. *Social forces*, 35, 314-318, 1957.

VAN DE VEN, A.. Group decision making and effectiveness. Kent, O: Kent State University Press, 1974.

VITOLO, S., PETARCA, L., BRESCI, B.. Treatment of olive oil industry wastes. *Bioresource Technology*, 67 (1999) 129-137.

WALTSON, J.T., LISSITZ, R.W., RUDNER, L.M.. The influence of web-based questionnaire presentation variations on survey cooperation and perceptions of survey quality. *Journal of Official Statistics*, 22, 271-291, 2006.