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PRINCIPI DI BUTERA: THE CARBON FOOTPRINT IN THE SICILIAN WINE INDUSTRY*

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Abstract

The carbon footprint is a parameter introduced to quantify the emissions of greenhouse gases generated within an organization, product or service. In particular, the carbon footprint measures all greenhouse gases (carbon dioxide CO_2, methane CH_4, nitrous oxide N_2O, hydrofluorocarbons HFCs, sulphur hexafluoride SF_6, perfluorocarbons PFCs) that are able to metabolize a particular system of reduction and consumption. This work is based on the implementation of the carbon footprint within the wine industry in the Sicilian context. For this purpose we present a case study of a historical leading company in the wine sector. It is called "Principi di Butera" and it is based in Butera, a small town in the province of Caltanissetta, in the heart of Sicily.

Keywords: carbon footprint, green economy, technological innovations, viticulture in Sicilia, wine industry

1. Introduction

The presence of greenhouse gases in the earth's atmosphere, for example, carbon dioxide (CO_2) methane (CH_4), is one of the basic requirements for the existence of life on our planet. Greenhouse gases allow solar radiation to enter crossing into the atmosphere, but at the same time hinder the output of the radiation infrared emitted from the Earth's surface. However, it is not good to have a concentration. It goes of climate-warming gases' Earth's atmosphere, as, (temperature changes, global warming) negative effects on agriculture, in the

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same way as it is not availability of water, as well as quality of life and the health of the people who will populate the world in the coming decades. This concentration is due to excessive production of anthropogenic greenhouse gases. That from all the activities and economics carried out by man in the field agriculture (primary sector), industry (secondary sector) and services (tertiary sector) (Ingrago et al., 2015; IPCC, 2015; Giunta et al., 2019; Matarazzo et al., 2019a; Metz et al., 2005).

One of the tools for quantifying greenhouse gas emissions is (CF), known as a carbon footprint. It is a parameter introduced to quantify greenhouse gases generated throughout Life of a product or service. In particular, how much CO_2 is capable of a system consumption.

There are different types of Carbon footprint, regulated by the Standard ISO (International Standard for Organization)

• Carbon Footprint of an organization; reference legislation is ISO 14064 (2006) and divides into (Bastianoni et al., 2014):

1. ISO 14064-1 (2006): specifies the principles and requirements at the organisational level of quantification and accounting for emissions.

2. ISO 14064-2 (2006): illustrates the principles and a project-level guide for and reducing emissions.

3.ISO 14064-3 (2006): defines.

4. requirements and principles those who are interested in the validation and control of GHG (green house gases) assertions.

It is then divided into three additional Scopes:

Scope I: This refers to all direct GHG emissions generated by sources that are ownership or under the control of the organization. They are therefore covered by:

- emissions due to direct consumption of how natural gas or diesel used for heating and energy production on site
- emissions related to the fleet of vehicles owned by the organisation
- emissions from leaks and releases of gas into the atmosphere by systems refrigeration.

Scope 2: Indirect GHG emissions produced by the organization during the exploitation of electrical or thermal energy, produced outside its borders. In that case, you can't call a direct responsibility to the organization, even if you're a indirectly a certain degree of influence on emissions.

Scope 3: the range of issues that the organization has to account for is very wide. From this section basically includes all emissions not in the previous scopes, in fact called “other indirect emissions” and are associated, for treatment and waste management, for example.

• Product Carbon Footprint: The voluntary standard that governs product carbon footprint is the ISO 14067 (2018) “Greenhouse gases Requirements and guidelines for quantification”. This regulation defines the requirements and guidelines for quantifying a product's carbon footprint consistently international standards for regulatory lifecycle assessment (Clasadonte et al., 2013a, 2013b; Chiusano, 2016; ISO 14040, 2006; ISO 14044, 2006; Liu et al., 2015; Matarazzo et al., 2019b; Pernigotti, 2013).

Climate change has been recognised as one of the most challenging that organizations, governments and citizens will have to face in the coming decades because of their big future impact on both natural systems and human socio-economic systems. One of the most innovative tools in terms of the challenge to climate change is the Carbon Footprint. This innovative tool will be implemented in “Principles of Butera” winery. It is located in Butera in the province of Caltanissetta, in the heart of Sicily, recognized to date as one of the most interesting regions in Italy for potential in the viticulture, especially thanks to the large and prestigious red wines. Today the company is committed to exalting this unique land, rich in sunshine and perfumes, producing World-Class Wines that express the whole and the soul of the Sicily. Through the use of the carbon footprint, it was possible to compare the different emissions generated along the production of the winery. This comparison allows the company to understand which among them is more impactful in such as to be able to intervene through innovative and sustainable reduction systems.

2. Case study: Principi di Butera

Principi di Butera, located in Butera in Caltanissetta, is like one of the leading companies in the Sicilian wine set. Butera's story is profoundly linked to the nobility of Sicily's millennial story, the ancient Trinacria that for its geographical location was crossroads of all civilizations of the Mediterranean. The name Butera seems derive from King Bute, the first of the siculi kings who, with the Sicans and Greek settlers, inhabited formerly this strategic territory of southern central Sicily. The vineyards of the Princes Estate of Butera, the influence of particular conditions pedoclimatics: solar radiation, for a number of hours in the course of the year within the entire temperate climate band; Ideal microclimate, positively conditioned by the sea breezes; thermal excursion.

Principi of Butera produces DOC and GT quality wines and divides its products into three different categories: cru, selections, and sparkling wines. The term “cru” in wineology, indicates a particular vineyard of a precise geographical area, from which a wine is obtained considered to be of above-average quality and therefore particularly valuable (Fig. 1).

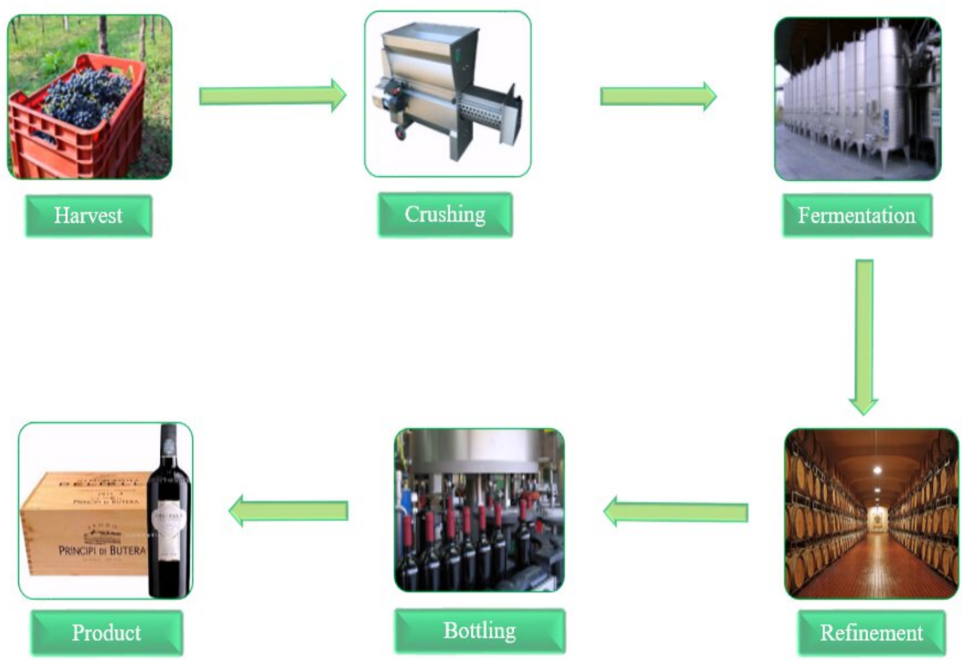

Fig. 1. Stages of the wine process

The production cycle of wine is a complex process consisting of five fundamental phases: harvest, crushing, fermentation, refinement (mature and aging) and bottling. The harvest, the harvesting of the fruit, represents the first phase of the process that leads to the wine's grapes. After the grapes, we proceed with the crushing. The crushing is carried out through so-called “pigiatrices”. The crushing is the first mechanical operation to which it comes after and has the function of extracting the juice and the pulp from the berries, giving life to the must that will then have to be transformed into wine. After the crushing, follows the fermentation phase, that will lead to getting the wine properly said. Butera Principles in addition to fermentation classical (alcoholic) for some of its wines operate another type of fermentation: the malolactic fermentation. This type of fermentation occurs after fermentation. It's a biochemical process that happens to bacteria lactic that with their metabolism turn the malic acid, naturally present, in lactic acid, through a reaction of decarboxylation in such a way as to lower lightly the acidity of the wine. Next step is refinement that in Principi of Butera has a duration of nine to eighteen months, reaching four years for cru wines.

The last phase of the productive process concerns the bottling. The bottling of the wine can be seen as the final phase of the cellars processes. With the bottling the wine “Comes to Light” in its final shape and from here the evolution continues that ends with the bottle's opening. Principi of Butera dedicates specialised wines chain to be marketed within the large retail (GDO). In addition, to promote environmental sustainability, the company acts biologist’s agriculture, where vineyards are organic and not certified, arable land are organic from 2019, while olive groves are in organic from 2020 (www.principidibutera.it).

3. Material and methdos

The sector is one of the fundamental pillars of Italy, being a sector that is constantly developing and spreading. In such a changin context as that of the wine industry, companies need to pay particular attention to developments in the environment national and, especially, of the international one, that sees the continued birth of new competitors and new attractive geographical areas. The ontroduction of wine in Italy must be mainly due to the Phoenicians and the Greeks. While the history of Sicilian wines is long and varied and has sent in a very ancient era. In Italy and in viticulture and enology were introduced by the Minoic-micenei colonizers perhaps as early as the 1500 A.C. (Antonaros, 2006; Cannizzaro, 2017; Casavola et al., 2011). Italy is a country with an ancient tradition in the wine production and is currently the second wine producer in the world and the first for volume exports. The wine sector is crucial to the economy Italian in that it is one of those that manage to guarantee excellent results especially abroad. The Italian wine production is one of the made in Italy's most appreciated excellences abroad and in fact the whole world identifies Italy as the paradise of the enogastronomia. In Italy the wine sector has about 310 thousand companies with a total turnover of around 13 billion euros, which corresponds to about 8% of the national turnover of the Food&Beverage. In addition, there are 658 thousand hectares of land invested by companies. The entire sector denoted a high export propensity, with a 6.2 billion generated on foreign markets (www.unicreditgroup.eu). On this side peaks of excellence are recorded in the segments of DOP/IGP wines and sparkling wines with an export propensity that stands at its high respectively to 58% and 63%. Sicily, instead, it is considered the fourth Italian region for wine produce with about 4.3 million hectoliters (9% of Italian production), of which more than 81% is quality wine (IGP 53% - DOC/DOCG 28%). This type of data confirms the constant path of growth of Sicily, driven by a strongly oriented approach to quality. The region ranks second in Italy together with Emilia Romagna and after Veneto, for certified wines.

In particular, there are 31, of which 24 DOP wines and 7 IGP wines (Law 164, 1992; Regulation 479, 2008; Regulation 607, 2009; Stasi et al., 2008). Production in Sicily, on the other hand, in 2019 is around 4.3 million hectoliters.

A leading role for the growth of the Sicilian wine sector is also represented by the exports of Sicilian wines that, in 2019, see an increase in the markets although it still remains very concentrated in few countries: Germany, the United Kingdom and Usa represent over 55% of exports. Sicily is currently experiencing a new renaissance with wine both in terms of production and marketing. In addition to wineries that produce the most, are also raising their quality standards to reach premium segments in many different markets. In fact, in 2019 there were exports for a value of 136 million, with a small of the 3%compared to the previous one (www.inumeridelvino.it; Decreto Legislativo 61, 2010).

4. Results and discussion

Carbon is a measure that expresses in CO_2 equivalent the total number of greenhouse gases directly or indirectly associated to a product, an organization or a service. In accordance with the Kyoto Protocol, greenhouse gases to be included are: carbon dioxide (CO_2), methane (CH_4) nitrogen oxide (N_2O), hydrofluorocarbons (HFCs), sulfur hexafluoride (SF_6) and perfluorocarbons (PFCs). TCO_2eq (tons of equivalent CO_2) allows to express the greenhouse effect produced by these gases in reference to greenhouse effect produced by CO_2, considered to be one. This tool is then used within Principles of Butera applying the first paragraph of the ISO 14064 (2006) "*Specification with guidance at the organization level for quantification and reporting of greenhouse gas emissions and removals*" concerning the guidelines and principles for quantifying and accounting for greenhouse gas emissions. This is aimed at obtaining the Carbon Footprint value and drafting GHG emissions inventory. An inventory of greenhouse gas emissions divided into direct and indirect emissions is then drawn. With regard to the type of direct greenhouse gas emissions, it refers to emissions from sources that are directly owned and controlled by organization. These are the greenhouse gas emissions from the installations present within its own organizational boundaries and due to the activities, that take place directly within the company's boundaries. The type of indirect greenhouse gas emissions from energy consumption, on the other hand, concerns emissions from the use of electricity, steam and other sources of energy imported and consumed by the organization. Indirect gas emissions as a result of the generation of electricity, heat and steam. It means non-biogenic emission due to fossil fuel consumption for the electricity then purchased by the company and used throughout the plant (Table 1).

Table 1. Inventory of issued sources of the organization divided by categories

Category	*Process*	*Emission source*	*Emission modality*	*Parameter*
	Heat generation	Steam generation	Stationary natural Gas combustion	Natural gas volume
Direct emissions		Boiler	Stationary natural gas combustion	Natural gas volume
	Transport	Company cars	Fuel consumption	Km traveled
	Winemaking	Alcoholic fermentation	CO_2 produced by alcoholic fermentation	Mass of CO_2
	Winemaking	Refrigeration	Cooling with liquid CO_2 of the grapes	Mass of CO_2
Emission to import of elecricity	Electricity supply	Establishment	Electricity consumption	Kw/h

Source: Principi di Butera

Of the GHGs taken into account to ISO 14064 (CO_2, CH_4, N_2O, NF_3, SF_6 which added hydrofluorocarbons and and perfluorocarbons and any other relevant GHGs) the only species found in the farm are the carbon dioxide (CO_2), methan (CH_4) and nitrogen oxide (N_2O). Because of the lack of information, it was not possible to proceed with calculations for each source, so they will be considered only some emission sources.

Before it was researching the conversion factor for such GHGs in CO_2eq, the GWP (Global Warming potential), more specifically the GWP declined on a 100 years' time, called GWP 100, as required by the normative (Table 2). The emissive sources present in the company's heat generation processes are the steam generator used in the production plant and the boiler heating offices. Both rely on the stationary burning of natural gas from which are issued CO_2, CH_4 e N_2O. Before calculating natural gas emissions in CO_2 equivalent it was necessary to identify the emission factor of the various GHGs, obtained by ISPRA (Table 3).

Table 2. Climate-altering power of main gases

GLOBAL WARMING POTENTIAL	
GHG	***GWP100***
CO_2	1
CH_4	28
N_2O	265

Source: Principi di Butera

Table 3. Emission factors for the combustion of natural gas

Emission factors natural gas	
GHG	tCO_2eq/Sm^3
CO_2	1.972
CH_4	0.00099
NO_2	0.00280

Source: Principi di Butera

To obtain the emissions of the various GHGs expressed in CO_2 equivalent, using the emissive factor first identified, you can use the Eqs. (1-3):

$$\textit{Emission from } CO_2 = \textit{Consumption natural gas* FE } CO_2/100 \quad (1)$$

$$\textit{Emission from } CH_4 = \textit{Consumption natural gas * FE } CH_4/100 \quad (2)$$

$$\textit{Emission from } N_2O = \textit{Consumption natural gas * FE } N_2O/100 \quad (3)$$

Below are reported the annual emissions for each of two sources in the year 2019.

By adding up the contributions of plants and offices, we get the value of the total emissions due to heat generation from stationary combustion of natural gas equal to 112.5 tCO_2 equivalent. With regard to alcohol fermentation, it can be said that a bottle of wine involves on average an emission of 1.83 $kgC0_2$ equivalent related to all the productive process; of that emission, 9% is due to fermentation processes. On this basis it was possible to derive a maximum emissive factor for fermentation processes in the winery. So the emission factor for fermentation processes is 0.1647 expressed in kilograms of CO_2 equivalent on bottle ($kgCO_2$, eq/ bottle). This value is expressed in relation to the single bottle of wine produced with particular reference to the most popular wine format of 0.75l. The 99% of bottles produced from Butera Principles have a format from 0.75l. So are used the production values of general bottles of the year 2019. Below are the annual production values obtained by the company (Tables 4 and 5).

Table 4. GHG emissions for heat generation for the production plant

PLANT			
2019			
Natural gas consumption	***Emissions from CO_2***	***Emissions from CH_4***	***Emissions from N_2O***
Sm^3	tCO_2,eq	tCO_2,eq	tCO_2,eq
3,420	67.44	0.033	0.095
		OFFICES	
Natural gas consumption	***Emissions from CO_2***	***Emissions from CH_4***	***Emissions from N_2O***
Sm^3	tCO_2,eq	tCO_2,eq	tCO_2,eq
2,280	44.96	0.022	0.063

Source: Principi di Butera

Table 5. Total annual production of bottles in 2019

Bottles production 2019	**FE**	**Emission**
1000,000	0.1647	164.7

Source: Principi di Butera

As for the company's electricity supply, national average emission factor is used. In addition, in electricity generation the only GHG of interest involved is carbon dioxide. The required emission factor is the national average emission factor for electricity consumption (Eq. 4), compiled by ISPRA in the Report 303/2019.

Emission Factor (FE) National Electricity Consumption 2018 (gC02/kWh) = 284.8 (4)

It is then possible to take the calculation of the equivalent CO_2 emissions expressed in tons (t) with data on the company's total electricity consumption (Eqs. 5-6). To obtain the equivalent $C0_2$ emission, you will have to multiply the electricity consumption of the company for the factor of electric and multiply it to his time for its "global warming potential" (GWP_{100}, $CO_{2)}$:

*Emissions CO_2, eq =electricity cons. ∗ (FE) national el. consumption 2018 * GWP_{100}, CO_2.* (5)

Total company electricity (kWh) =649267 CO_2 emissions equivalent in tons (t)= 161.53 (6)

With regard to direct emissions, it is calculated how much C02 equivalent expressed in terms of tons coming from the source of heat generation and of alcohol fermentation for an annual amount equal to 277.5. Instead, for indirect emissions category are approximately 161.5 tonnes of CO_2. To conclude, study shows that the category of GHG that impacts most of the environment is the "Direct Emissions" category with 277.5 tons of CO_2 equivalent on the category of indirect energy consumption with 161.53 tonnes of CO_2 equivalent. However, it was not possible to quantify emissions transport and refrigeration system for lack of information. Through the use of the footprint, therefore, it was to compare the emissions generated along the production process of the winery of this Case Study. This comparison will allow to the company to figure out which of these emissions is more impactful in such a way that they can intervene through the realization of innovative and sustainable systems of reduction and consumption

5. Concluding remarks

In this paper have been quantified the emissions concerning the sources of heat generating (plants and office heating), alcoholic fermentation, energy consumption through the application of voluntary normative ISO 14064-1:2006.

Through the use of the innovative carbon tool, which is spreading widely among companies sensitive to environmental issues, it was possible to compare the different emissions generated along the productive process of the company that is the subject of this case study. To conclude, the application of this innovative tool could bring many advantages to the company Principles of Butera since promotes continuous improvement in terms of environmental sustainability, monitor results while making it easier to track performance and progress reducing greenhouse gas emissions and encourages changes in consumers behaviour contribute to reducing greenhouse gas emissions by making it easier to choose product on their part based on lifecycle data using changes climate change as a purchasing motivation. In fact, thanks to this innovation and this study Butera Principles can gain a threefold advantage: environmental benefit from reducing greenhouse gases, an economic benefit from the increase in market share thanks to the eco-friendly consumers behaviour as they call for concrete action to countering climate change and social benefits by enhancing Corporate Social Responsibility, that is the promise of the company to behave in an ethical and right manner, going beyond mere compliance with the law, and enriching management choices with ethical, social and environmental issues. For companies that, in a context that sees award-winning providers of low-emission products or services, the Carbon footprint can be a useful tool to enhance their activities and to promote their own policies of social and environmental responsibility. It should also be pointed out that these types of benefits can be achieved by other wineries sensitive to environmental issues, being the Carbon Footprint a tool that you can generally apply to all types of companies. In addition, study found that, comparing emissions from other wineries, the CO_2 issued by the company results almost in the average.

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