OIV COLLECTIVE EXPERTISE

METHODOLOGICAL RECOMMENDATIONS FOR ACCOUNTING FOR GHG BALANCE IN THE VITIVINICULTURAL SECTOR

2017

OIV
International Organisation of Vine and Wine
Intergovernmental Organisation

WARNING

This document has not been submitted to the step Procedure for Examining Resolutions and cannot in any way be treated as an OIV resolution. Only resolutions adopted by the Member States of the OIV have an official character. This document has been drafted in the framework of Ad-hoc experts' group "Carbon footprint" and experts' group "Sustainable production and climate change". This document, drafted and developed on the initiative of the OIV, is a collective expert report.

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ABBREVIATIONS

ABC Association Bilan Carbone (France)

ADEME French Agency for Environment and Energy Management

BSR Business Social Responsibility (nonprofit business network and consultancy, USA

CCWG Clean Cargo Working Group

CLECAT European Association for Forwarding, Transport, Logistics and Customs Services

ELCD European Life Cycle Database

FIVS Worldwide Federation for the Alcohol Beverage Industry

FNADE National Federation for Antipollution and Environmental Activities (France)

GHG Greenhouse gas

GIS Sol French Scientific Interest Group, established in 2001, managing an information system on the soils of France

HFCs and PFCs hydrofluorocarbon; perfluorinated chemicals

IEA International Energy Agency

IFEU Institute for Energy and Environmental Research (Germany)

IFV French Wine and Vine Institute

INRA French National Institute for Agricultural Research

IPCC Intergovernmental Panel on Climate Change

LCA Life cycle assessment

LCI Life cycle inventory

LPG Liquefied petroleum gas

LT Long term

MC Moisture Content

NMVOC Non-methane volatile organic compounds

NVC Net Calorific Value

OIV GHGAP OIV Greenhouse Gas Accounting Protocol

OIV International Organisation for Vine and Wine

PE Polyethylene

PET Polyethylene terephthalate

PP Polypropylene

PS Polystyrene

PVC Polyvinyl chloride

ST Short term

tCeq/ha Ton of carbon equivalent per hectare

tCO2eq/ha Ton of carbon dioxide equivalent per hectare

TEU Twenty-feet equivalent unit

TJ, MJ Terajoule, Megajoule

UIC International Union of Railways

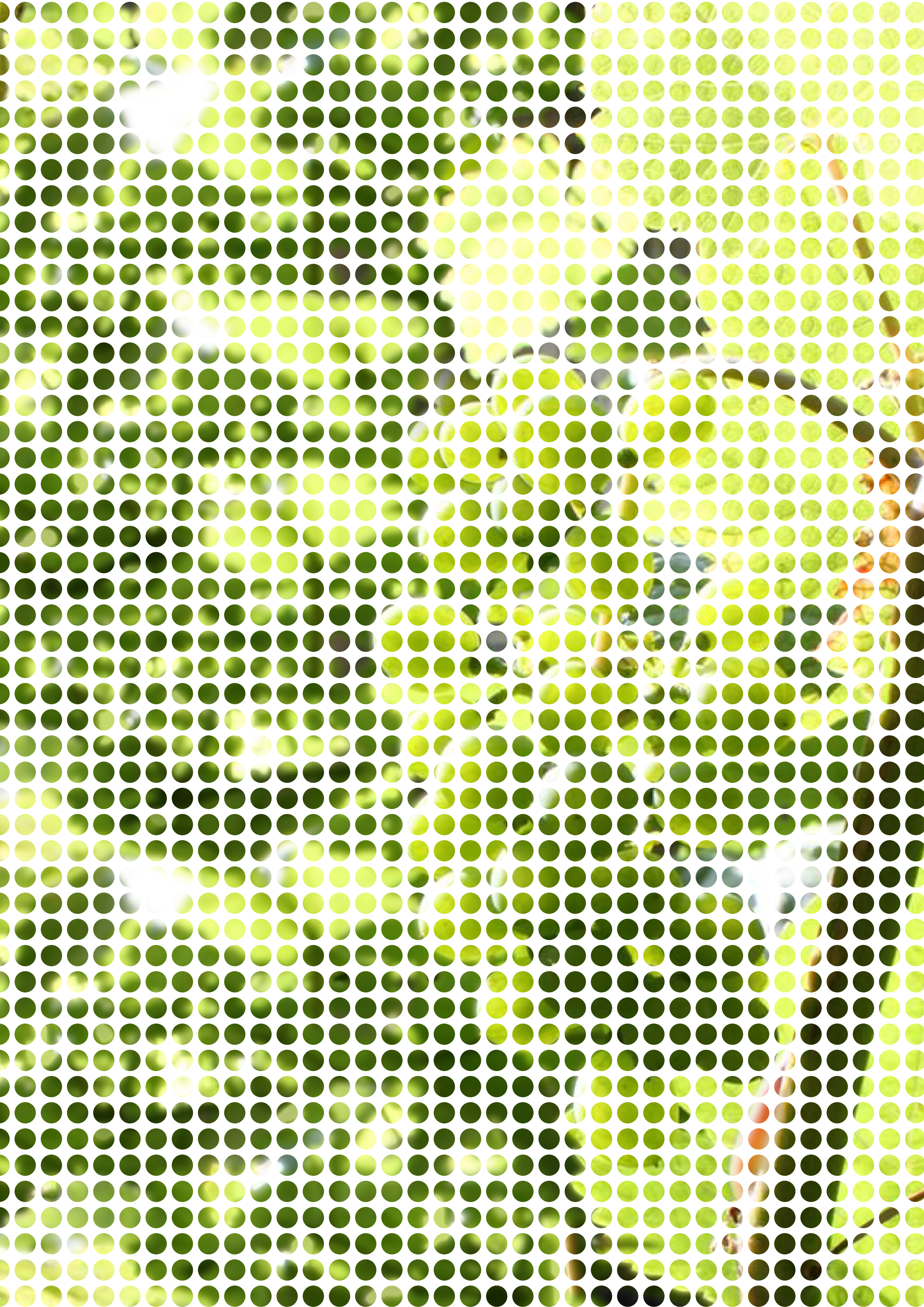
UNGDA National Union of Alcohol-Distillers Groups (France)

WBCSD World Business Council for Sustainable Development

WFA Winemakers Federation of Australia

WRI World Resources Institute

WSTA Wine and Spirit Trade Association



CHAPTER 1 GENERAL CONSIDERATIONS

1. Scope of the document

At the General Assembly of Tbilisi, Georgia[1] the OIV decided to develop an **International Protocol for the accounting of greenhouse gas emissions in grape and wine production (OIV GHG protocol)**.

The **general principles** of the OIV GHG protocol were set up in October 2011[2]. The **general objective** of the Protocol, is *"to provide organisations, businesses and other stakeholders with clear and consistent method for the complete assessment of the GHG emissions associated with vine and wine companies' activities"*.

Specific objectives of the OIV GHG protocol are:

• To help companies working in the vitivinicultural sector to prepare a GHG inventory that represents a true and fair account of their emissions, through the use of standardized approaches and principles.
• To simplify and reduce the costs of compiling a GHG inventory
• To provide business with information that can be used to build an effective strategy to manage and reduce GHG emissions
• To increase consistency and transparency in GHG accounting and reporting among various companies and GHG programs.

Having set up the general principles of the OIV GHG protocol, the OIV defined recognised greenhouse gases in the vine and wine sector and specified the inventory of emissions and sequestrations that have to be taken into account while estimating GHG emissions balance (resolution OIV-CST 503AB-2015). Based on the prescriptions of the **general principles**, this resolution proposes a clear separation of the production process into identifiable units and specifies the scope of each of them.

The adoption of this resolution is a very important step. Indeed, if determination of universal emission values is a complicated task, the inventory of actions and inputs to be included in the protocol needs to be as clear as possible and remain comparable among different geographical zones.

The next step in this process is to provide methodological guidance for enterprises wishing to conduct GHG balance accounting during the lifecycle of a product.

We will present an overview of:

- Issues related to GHG accounting within an enterprise;
- available databases and considerations on the availability of data and on the management of data uncertainty; and
- available methodologies for the estimation of emissions of unit process as mentioned in the OIV GHG protocol as well as in benchmark values for each category.

2. GHG accounting: before we start

a. Why do we account for GHG balance?

GHG balance accounting is a management tool which enables the identification, evaluation and quantification of major sources of GHG emissions.

This GHG emissions "picture" of the enterprise will enable it to set realistic and scientifically based objectives (both in terms of value and in terms of time) for the reduction of GHG emissions. The feasibility of objectives should be considered with caution.

[1] Resolution OIV-CST-425/2010
[2] Resolution OIV-CST 431/2011

Both too optimistic and very low objectives may have a negative impact on the enterprise image. For example, an enterprise wishing to become carbon neutral in one year may be seen by some as wishing to benefit solely from communicating on GHG emission strategy at the expense of not being able to achieve its environmental goals. In addition, an enterprise with very unambitious objectives may also be considered negatively if it has not established a specific policy or made considerable efforts to reduce GHG emissions. "Green washing" is known to have been responsible for giving enterprises a negative image in several industrial sectors.

Once the objectives are set, a plan of action aimed at reducing GHG emissions can be established. Here again, GHG balance accounting can be an appropriate management tool for enabling management to track progress towards reducing GHG emissions.

b. Frequency of GHG accounting

The frequency of GHG balance accounting should be considered with care. Indeed, some countries have already started to set up regulatory requirements for GHG accounting (France, Loi n° 2010-788 12 July 2010 – Grenelle II, etc...) for enterprises of more than 500 employees.

The frequency of 3 years – chosen by France - is a compromise between several factors:

• GHG balance accounting consumes resources: **it has a cost and takes time**. Required expertise is frequently not available in the enterprise. Consultancy services from specialized enterprises are often required. Specific training for enterprise staff is necessary.
• Changes in GHG emissions may not be visible from year to year.

Nevertheless, experience gained from large industrial companies which have implemented GHG accounting for several years now shows that a frequency of 3 years may be difficult to achieve. Indeed, the knowledge and experience gained during a protracted GHG accounting process can be lost after a lapse of time.

In general, at global level there is no obligation for GHG balance accounting for small companies. Companies wishing to start GHG balance accounting should consider the most appropriate frequency for them depending on their objectives and communication strategy.

c. Exact value or approximation?

Obtaining an exact value may be extremely difficult and costly, sometimes even impossible. The objectives of the enterprise in terms of GHG footprint reduction should always be kept in mind. In case the unit process is not considered by the action plan of the enterprise (for example "land use change" for an enterprise which has set a goal of 30% GHG emissions' reduction from logistics operations), the value should be estimated/obtained in the most simple or direct way.

The difficulty or impossibility of obtaining the exact value of a unit process should not be an obstacle or hinder the whole process of GHG footprint reduction or sustainability approach.

This document lists the most important databases so far established that can be used for quantifying GHG emissions in the viticultural sector. Included in the document are guidelines for the quantification of all unit processes considered by the OIV inventory of GHG (resolution OIV-CST 503AB-2014), modalities of attribution of each unit process to one of the three scopes (see below), eventual difficulties in measuring or estimating the value, and finally, the availability of scientific data. The differences observed between the values in different databases are also considered.

3. Boundaries of the system

From cradle to grave

As described by the OIV GHG protocol[3] : GHG emissions should cover the whole life cycle of the final product.

"From cradle to grave" principles are applied:

- Enterprise protocol: from grape production to winemaking and packaging
- Product protocol: grape production, wine processing and packaging, distribution and retail, end-life phase (including use phase) covering disposal and recycling.

a. Enterprise protocol: scope 1, 2 or 3?

Three scopes are usually considered for calculating a GHG footprint under the enterprise protocol.

In the vitivinicultual sector the OIV defines[3] the scopes as following:

- **Scope 1**: direct GHG emissions. Direct Greenhouse Gas emissions, or Scope 1 emissions, occur from items directly controlled by and owned by the company. This "control" means that the company has the power to directly influence the GHG emissions of the activity.
- **Scope 2**: Purchased power utility.
- **Scope 3**: indirect GHG emissions. For the vine and wine industry, emissions categorised as Scope 3, are emissions that occur as a consequence of producing a finished saleable vitivinicultural product, emitted from equipment or plant owned and controlled by another company, but on which the enterprise retains an indirect control.

The overall scope of the GHG balance calculation method should be chosen taken into account the particularities of the enterprise and its production process.

According to ISO 14064, scope 3 emissions are not mandatory for the enterprise protocol. Nevertheless, in the viticultural sector these emissions are usually significant, especially, in cases where the enterprise purchases some of its grapes. According to resolution OIV-CST 431-2011, Scope 3 emissions shall be included depending on data availability.

The choice of the scope should be explained and documented.

b. Product protocol

Under the product protocol, the reduction of GHG emissions should be assessed for the life cycle of the product[4]. The unit processes should be detailed (itemized) and grouped into life-cycle stages (inputs and raw material acquisition, production, distribution, use and end of life). GHG emissions and removals from the product's life cycle should be assigned to the life cycle stage in which the GHG emissions and removals occur.

4. Available data for the vitivini-cultural sector

a. General considerations: adequacy of the data

According to ISO 14067, **site-specific data** should be collected for all individual processes under the financial or operational control of the organization undertaking the GHG balance calculations and shall be representative of the processes for which they are collected.

Data quality should be characterized by both quantitative and qualitative aspects.

[3] Resolution OIV CST 431-2011
[4] ISO 14067

Secondary data – which should be documented - should only be used for inputs where the collection of site-specific data is not possible or practicable, or for processes of minor importance, and may include literature data, calculated data, estimates or other representative data.

A GHG balance study should use data that reduce bias and uncertainty as far as practicable by using the best quality data available.

Data quality requirements shall be specified to enable the goal and scope of the Carbon Footprint (CFP) study to be met. The data quality requirements should address the following:

- Time-related coverage
- Geographical coverage
- Technology coverage: specific technology or technology mix
- Precision: measure of the variability of the data values for each data expressed (e.g.: variance)
- Completeness: percentage of the flow that is measured or estimated
- Representativeness: qualitative assessment of the degree to which the dataset reflects the true population of interest (geographical coverage, time period, technology used, etc...)
- Consistency
- Reproducibility
- Sources of the data
- Uncertainty of the information

b. Data quality requirements

Environmental science is a relatively new discipline and the quality of data is continually evolving so it is essential for businesses to have access to new developments if they are to be expected to substantiate claims.

Data considered should be assessed regarding their:

- Time related representativeness
- Technological representativeness
- Geographical representativeness

One of the examples of assessment process can be given by the Product Environmental Footprint (PEF) Guide (EC Joint Research Center, 2012), where a clear classification and rating of data quality is provided. Data are rated from 1 (very good) to 5 (very poor) on six parameters.

c. Recommended databases

All sources listed below comply with the following criteria:

• they are publicly available;
• can be directly used by GHG inventory developers (Databases that require companies to also purchase consulting services or specific software tools to access them are not included in the list); and
• for all sources an internet site exists where users can review information related to the methodology and source of data.
• Information about access is included (free of charge, fee, necessity to register on the website, etc...)

The Greenhouse Gas Protocol and its recommended third party databases.

http://www.ghgprotocol.org

The Greenhouse Gas Protocol was jointly adopted in 1998 by the World Business Council for Sustainable Development (WBCSD) and the World Resources Institute (WRI).

The Corporate Standard of the GHG Protocol was considered as a basis for the ISO standard 14064-I: Specification with Guidance at the Organization Level for Quantification and Reporting of Greenhouse Gas Emissions and Removals.

The GHG Protocol provides a non-exhaustive list of available **third party databases**, where the users can find data on product life cycle and corporate value chain (scope 3) GHG inventories.

The list can be consulted on the following link:

http://www.ghgprotocol.org/Third-Party-Databases

Bilan Carbone® (FRANCE) and its Base Carbone database

The Bilan Carbone® is a GHG methodology elaborated by the Association Bilan Carbone (ABC). This project has been selected by ADEME to become the **organization behind the most widely-used greenhouse gas emission diagnostics system in France**.

http://www.basecarbone.fr/

Bilan Carbone manages a national public database containing a set of emission factors and their sources of data. The database is intended to facilitate regulatory or voluntary Greenhouse Gases accounting. This database is derived from historical data of Bilan Carbone.

Different levels of access and of service are available. Free access and the possibility of consulting quantitative data on emission factors in various areas can be accessed on the creation of a user account, but there is a lack of data for the viticultural sector.

For indirect emissions other than energy the following data are available:

- Transport of persons
- Transport of products
- Purchased goods (inputs and infrastructure)
- Purchased services
- Waste
- Agriculture and land use change

EcoInvent - Switzerland

http://www.ecoinvent.ch/

EcoInvent - a not-for-profit association founded by the Swiss Federal Institute of Technology Zurich (ETH Zurich) and Lausanne (EPF Lausanne), the Paul Scherrer Institute (PSI), the Swiss Federal Laboratories for Materials Science and Technology (Empa), and Agroscope, Institute for Sustainability Sciences.

Several thousands of LCI datasets are available in the areas of agriculture, energy supply, transport, biofuels and biomaterials, bulk and specialty chemicals, construction materials, packaging materials, base and precious metals, metals processing, ICT and electronics as well as waste treatment.

Free access is not available. Purchase of an annual license is required.

European Life Cycle Database (ELCD)

The ELCD (European reference Life Cycle Database), first released in 2006, comprises Life Cycle Inventory (LCI) data from front-running EU-level business associations and other sources for key materials, energy carriers, transport, and waste management. The respective data sets are officially provided and approved by the named industry association.

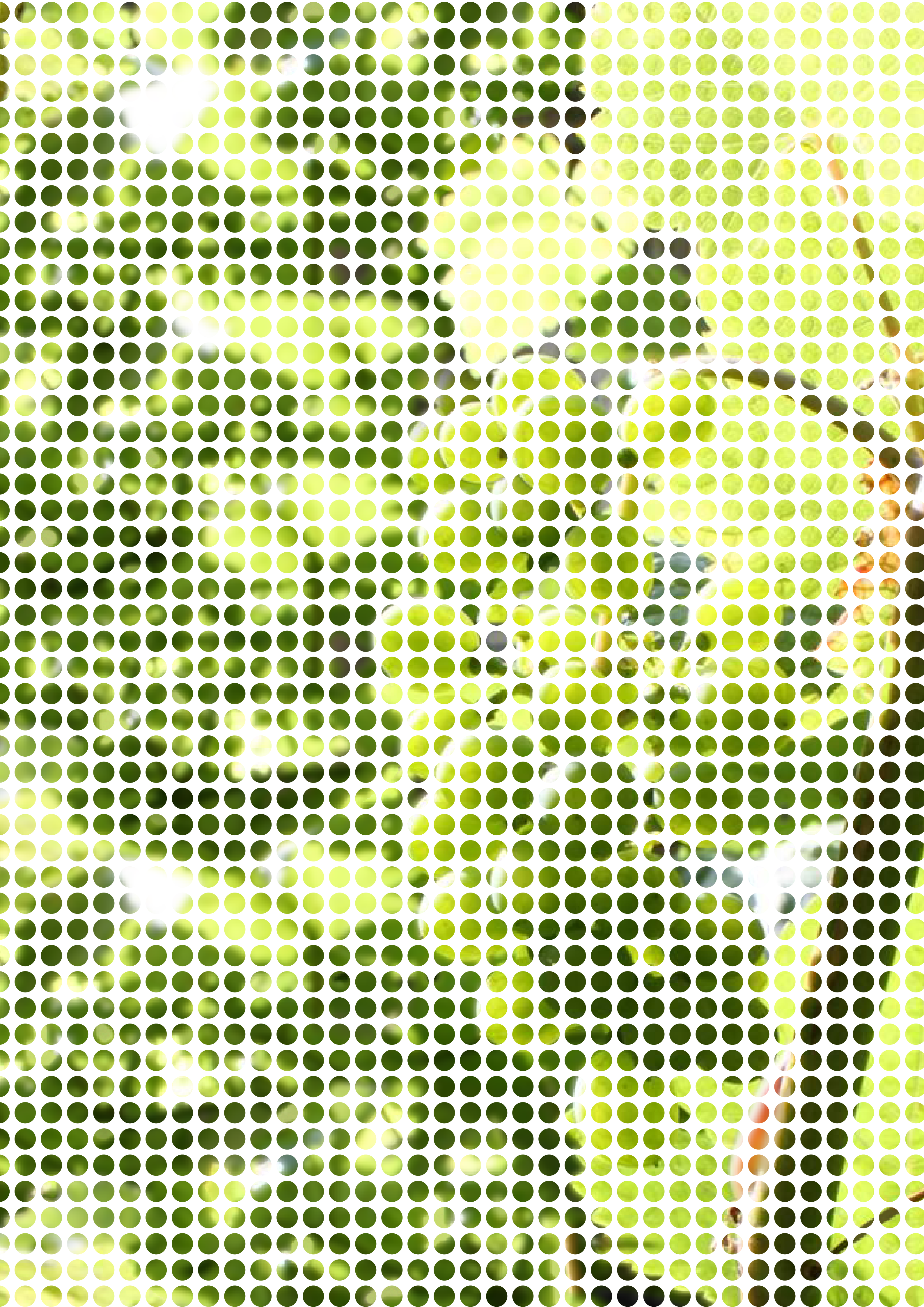
The access to data is free, upon acceptance of a license.

http://elcd.jrc.ec.europa.eu/ELCD3/

IPCC

http://www.ipcc-nggip.iges.or.jp/software/index.html

And other databases and references on IPCC http://www.ipcc-nggip.iges.or.jp/



CHAPTER 2 CALCULATION OF GHG EMISSIONS/STORAGE BY INVENTORY CATEGORY

This part of the document examines each unit process considered by the OIV inventory of GHG emissions and sequestrations[5].

Examples of calculations and several benchmark values are provided.

1. Vineyard (scopes 1 and 3)

a. Land use changes

- Modification if the land use affects the following pools of carbon:
- Soil organic carbon
- Above-ground biomass
- Below-ground biomass
- Litter[6]

Dead wood (in the case of deforestation before conversion to vineyard)

Finding exact data for carbon storage in the soil is not easy. The generation of data sources varies geographically and depends on a number of parameters, like soil quality, cultural practices, density of plantation, etc…

Direct measurement of carbon stored in the soil may be done before conversion to vineyard. Nevertheless, in most cases, estimation of carbon storage in the newly planted vineyard remains the most appropriate and practical approach.

Evolution of carbon sink in the soil over time

20 years: appropriate period for accounting and amortization of carbon storage

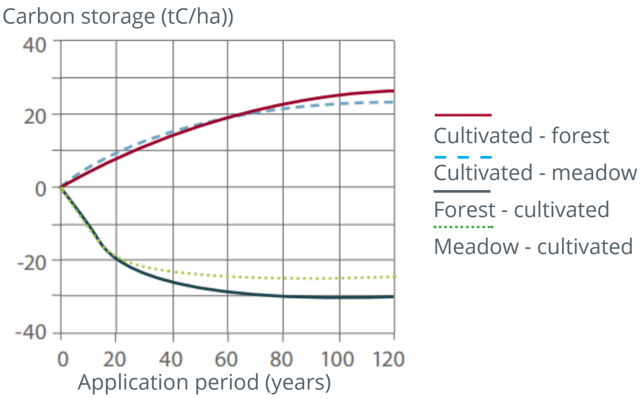
Carbon stock in the soil is an important pool of carbon affected by the land use change.

Land use changes modify the carbon sink of the soil. This may result in an emission of CO_2 or CO_2 capture. The storage / release of carbon caused by soil condition change are **phenomena that occur over long periods**.

The kinetics of the process varies over time. As shown on the graph below, during the first 20 years the speed of CO_2 release is twice as high as the speed of storage (Arrouays et al., 2002).

Figure 1 Evolution of carbon sink following a land use change

95% Confidence interval for these values is + - 40%[7]



Source : (Arrouays et al., 2002)

According to the general principles of GHG accounting in the viticultural sector[8] assessment of the impact of land use change should include:

- all direct land use change occurring in the **20 years prior to the assessment** being carried out
- **One-twentieth (5%)** of the total emissions arising from the land use change shall be included in the GHG emissions of the company in each year over the **20 years following the change in land use**.

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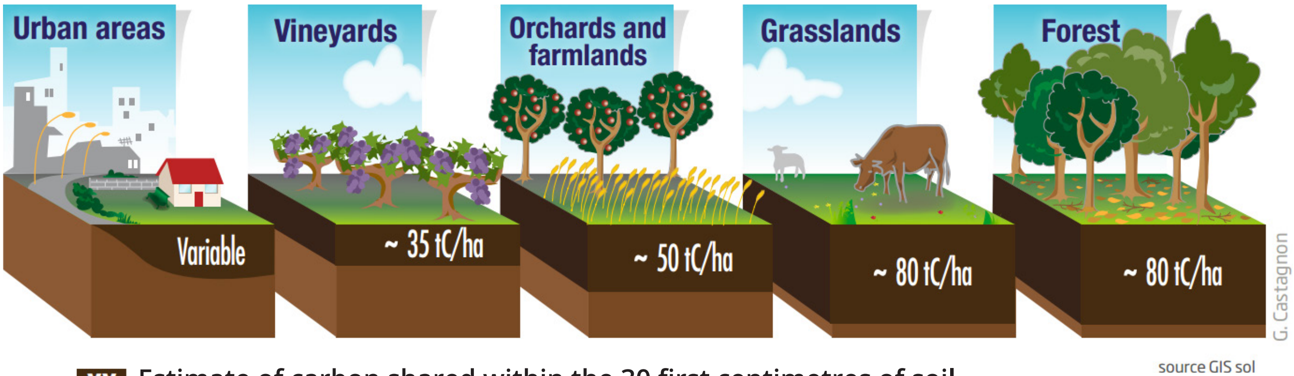
[5] Resolution OIV CST 503AB-2015
[6] The litter layer-also known as the L and O horizons-is the layer of dead plant material that lies on top of the mineral soil. During forest regrowth, the litter layer may accumulate rapidly, so changes in its carbon content are an important component of a total carbon inventory in ecosystems (Richter and Markewitz, 1996). During a cycle of forest harvest followed immediately by regrowth, however, there is usually little overall change in carbon storage in the forest floor (Johnson, 1992). IPCC
[7] ADEME, Base Carbone
[8] Resolution OIV CST 431 -2011

Proposed values and methodology for a reconversion to a vineyard

ADEME (France) has published (ADEME, 2014) the following data on carbon storage in differently occupied soils:

Figure 2 Variations in organic carbon sink depending on land use in France



XX Estimate of carbon shared within the 30 first centimetres of soil

Organic matter stocks in forests, grasslands and low vegetation growing in highlands are large, whereas stocks are quite low in vineyards, farmlands and Mediterranean zones. Quantifying stocks is difficult in urban areas; nevertheless, a significant amount of carbon could be stored under green spaces. carbon stored in forest litter is not taken into account.

Source : GIS sol; (ADEME, 2014)

These estimations are based on data published by GIS Sol (French Scientific Interest Group, established in 2001, managing an information system on the soils of France). The study is based on data provided by the National Network of Measurement of the Soils Quality[9]. Carbon stocks on 0-30 cm, for seven main types of land use, in metropolitan France are provided in the dataset.

The whole file can be found: http://www.gissol.fr/donnees/tableaux-de-donnees/stock-de-carbone-par-region-et-par-occupation-du-sol-3045.

Based on the study conducted by INRA, ADEME (ADEME, 2014) proposes the following values that could be used for estimation of carbon stock changes in the soils:

Table 1 Emission factors for carbon release or sink in the soil due to a land use change in France

	Cropland	Meadow	Forest	Peri-urban non waterproofed	Peri-urban waterproofed
Cropland		-1.80±0.95	-1.61±0.88	0	190±80
Meadow	3.48±1.1		-0.37±0.73	0	290±120
Forest	2.75	0.37±0.37		0	290±120

**intCO$_2$eq/ha*
Source: ADEME Base Carbone

[9] It should be stressed, that the data given are indicative and should be considered with care. In comparison to forests, orchards and meadows, vineyard' data are based on a much smaller samples (42 for vineyards, 884 for crops and 586 for forests).

As a first approximation, no change of soil carbon stock is considered for the creation of a peri-urban non waterproofed zone (park, garden, lawn, stadium, etc...). By contrast, when water is prevented from entering a soil (building, parking, road, etc...) total destruction of carbon stock in the soil is accounted for.

Evolution of carbon sink in the above-ground biomass

The change in biomass is only estimated for **perennial woody crops**. For annual crops, an increase in biomass stocks in a single year is assumed equal to biomass loses from harvest and mortality in the same year – thus there is no net accumulation of biomass carbon stocks (IPCC, 2006a).

Therefore, carbon stock changes in above ground biomass should only be accounted for when the land use is changed:

- From orchards to vineyard
- From forest to vineyard
- From vineyard/forest/orchard to peri-urban waterproofed or not land (buildings, roads, car parks, etc.).

Some default values for above-ground woody biomass are given in the tables here below (table 2 and table 3):

Table 2 Default coefficients for above ground woody biomass and harvest cycles in cropping systems containing perennial species (IPCC, 2006a)

Default coefficients for above-ground woody biomass and harvest cycles in cropping systems containing perennial species					
Climate region	Above-ground biomass carbon stock at harvest (tonnes C ha1)	Harvest / Maturity cycle (yr)	Biomass accumulation rate (G) (tonnes C ha-1 yr-1)	Biomass carbon loss (L) (tonnes C ha-1 yr-1)	Error range[1]
Temperature (all moisture regimes)	63	30	2.1	63	±75%
Tropical, dry	9	5	1.8	9	±75%
Tropical, moist	21	8	2.6	21	±75%
Tropical, wet	50	5	10.0	50	±75%

Note: Values are derived from the literature survey and synthesis published by Schroeder (1994).

[1] Represents a nominal estimate of error, equivalent to two times standard deviation, as a percentage of the mean.

Table 3 Carbon fraction of aboveground forest biomass (in tons of C of dry matter)(IPCC, 2006a)

Carbon fraction of above-ground forest biomass Tonnes C (Tonnes dry matter)-1			
Domain	**Part of tree**	**Carbon Fraction (FC)**	**References**
default value	**all**	**0.47**	**McGroddy et al. 2004**
Tropical and Subtropical	all	0.47 (0.44-0.49)	Andreæ and Merlet 2001, Chambers et al. 2001, McGroddy et al. 2004, Lasco and Pulhin 2003
	wood	0.49	Feldpausch et al. 2004
	wood, tree d < 10 cm	0.46	Hughes et al. 2000
	wood, tree d ≥ 10 cm	0.49	Hughes et al. 2000
	foliage	0.47	Feldpausch et al. 2004
	foliage, tree d < 10 cm	0.43	Hughes et al. 2000
	foliage, tree d ≥ 10 cm	0.46	Hughes et al. 2000
Temperature and Boreal	all	0.47 (0.47-0.49)	Andreæ and Merlet 2001, Gayoso et al. 2002, Matthews 1993,, McGroddy et al. 2004
	broad-leaved	0.48 (0.46-0.50)	Lamlom and Savidge 2003
	conifers	0.51 (0.47-0.55)	Lamlom and Savidge 2003

Evolution of carbon sink in the below ground biomass

Below ground biomass in forests can be estimated using the following conversion tables (IPCC, 2006a).

Table 4 : Ration of below-ground biomass to above-ground biomass; tons of roots' dry matter

Ratio of below-ground biomass to above-ground biomass (R)				
Domain	**Ecological zone**	**Above-ground biomass**	**R [tonne root d.m. (tonne shoot d.m.)-1]**	**References**
Tropical	**Tropicalrainforest**		0.37	Fittkau & Klinge, 1973
	Tropical moist deciduous forest	above-ground biomass < 125 tonnes ha^{-1}	0.20 (0.09 - 0.25)	Mokany *et al.*, 2006
		above-ground biomass > 125 tonnes ha^{-1}	0.24 (0.22 - 0.33)	Mokany *et al.*, 2006
	Tropical dry forest	above-ground biomass < 20 tonnes ha^{-1}	0.56 (0.28 - 0.68)	Mokany *et al.*, 2006
		above-ground biomass > 20 tonnes ha^{-1}	0.28 (0.27 - 0.28)	Mokany *et al.*, 2006
	Tropical shrubland		0.40	Poupon, 1980
	Tropical mountain systems		0.27 (0.27 - 0.28)	Singh *et al.*, 2006
Subtropical	**Subtropical humid forest**	above-ground biomass < 125 tonnes ha^{-1}	0.20 (0.09 - 0.25)	Mokany *et al.*, 2006
		above-ground biomass > 125 tonnes ha^{-1}	0.24 (0.22 - 0.33)	Mokany *et al.*, 2006
	Subtropical dry forest	above-ground biomass < 20 tonnes ha^{-1}	0.56 (0.28 - 0.68)	Mokany *et al.*, 2006
		above-ground biomass > 20 tonnes ha^{-1}	0.28 (0.27 - 0.28)	Mokany *et al.*, 2006
	Subtropical steppe		0.32 (0.26 - 0.71)	Mokany *et al.*, 2006
	Subtropical mountain systems		no estimate available	
Temperate	**Temperate oceanic forest, temperate continental forest,Temperate mountain systems**	conifers above-ground biomass < 50 tonnes ha^{-1}	0.40 (0.21 - 1.06)	Mokany *et al.*, 2006
		conifers above-ground biomass 50- 150 tonnes ha^{-1}	0.29 (0.24 - 0.50)	Mokany *et al.*, 2006
		conifers above-ground biomass > 150 tonnes ha^{-1}	0.20 (0.12 - 0.49)	Mokany *et al.*, 2006
		Quercus spp. above-ground biomass > 70 tonnes ha^{-1}	0.30 (0.20 - 1.16)	Mokany *et al.*, 2006
		Eucalyptus spp. above-ground biomass < 50 tonnes ha^{-1}	0.44 (0.29 - 0.81)	Mokany *et al.*, 2006
		Eucalyptus spp. above-ground biomass 50- 150 tonnes ha^{-1}	0.28 (0.15 - 0.81)	Mokany *et al.*, 2006
		Eucalyptus spp. above-ground biomass > 150 tonnes ha^{-1}	0.20 (0.10 - 0.33)	Mokany *et al.*, 2006
		other broadleaf above-ground biomass < 75 tonnes ha^{-1}	0.46 (0.12 - 0.93)	Mokany *et al.*, 2006
		other broadleaf above-ground biomass 75- 150 tonnes ha^{-1}	0.23 (0.13 - 0.37)	Mokany *et al.*, 2006
		other broadleaf above-ground biomass > 150 tonnes ha^{-1}	0.24 (0.17 - 0.44)	Mokany *et al.*, 2006
Boreal	**Boreal coniferous forest, Boreal tundra woodland, Boreal mountain systems**	above-ground biomass < 75 tonnes ha^{-1}	0.39 (0.23 - 0.96)	Li *et al.*, 2003; Mokany *et al.*, 2006
		above-ground biomass > 75 tonnes ha^{-1}	0.24 (0.15 - 0.37)	Li *et al.*, 2003; Mokany *et al.*, 2006

Evolution of carbon sink in the litter and dead wood

IPCC (IPCC, 2006a) proposes the following values for litter and dead wood carbon stocks:

Table 5 Default values for litter and dead wood carbon stocks (in tons C/ha)

Tier I Default values for litter and dead wood carbon stocks (tonnes C ha^{-1})				
Climate	**Forest Type**			
	Broadleaf Deciduous	**Needleleaf Evergreen**	**Broadleaf Deciduous**	**Needleleaf Evergreen**
	Litter carbon stocks of mature forests (tonnes C ha^{-1})		**Dead wood carbon stocks of mature forests (tonnes C ha^{-1})**	
Boreal, dry	25 (10 - 58)	31 (6 - 86)	n.a [b]	n.a
Boreal, moist	39 (11 - 117)	55 (7 - 123)	n.a	n.a
Cold Temperate, dry	28 (23 - 33)	27 (17 - 42)[a]	n.a	n.a
Cold Temperate, moist	16 (5 - 31)[a]	26 (10 - 48)[a]	n.a	n.a
Warm Temperate, dry	28.2 (23.4 -33.0)	20.3 (17.3 -21.1)	n.a	n.a
Warm Temperate, moist	13 (2 - 31)[a]	22 (6 -42)	n.a	n.a
Subtropical	2.8 (2 - 3)	4.1	n.a	n.a
Tropical	2.1 (1 - 3)	5.2	n.a	n.a

Source:

Litter: Note that these values do not include fine woody debris. Siltanen et al., 1997; and Smith and Heath, 2001; Tremblay et al., 2002; and Vogt et al., 1996, coverted from mass to carbon by multiplying by conversion factor of 0.37 (Smith and Heath, 2001).

Dead Wood: No regional estimates of dead wood pools are currently available − see text for further comments

a Values in parentheses marked by superscript "a" are the 5th and 95th percentiles from situations of inventory plots, while those without superscript "a" indicate the entire range.

b n.a. denotes 'not available'

b. Carbon stored by the vine

Overall importance of vine biomass in carbon storage for the vineyard

The quantity of carbon stored by vines depends on:

- Plant density
- Training and trellising system
- Vine-rootstock variety,
- Vigour, age and status of vineyard
- Irrigation and other cultural practices

(Keightley, 2011) proposes a valuation methodology to measure **carbon stock in a vineyard**. The following values have been found for a Californian vineyard planted with Sangiovese[10].

According to the results obtained, **vine wood constitutes only 2%** of the total vineyard carbon sink of.

Table 6 : Carbon storage in a vineyard (vines, fruit, soil), example of a Californian vineyard (Keightley, 2011)

	Biomass/ha	Organic carbon/ha	% of total
Vines (wood)	4 102 kg	1 846 kg	1.8%
Fruit	13 500 kg	1 358 kg	1.3%
Soil		94 000 kg	96.9%
Total		97 000 kg	100.0%

The vineyard was sampled with a terrestrial laser scanning technique, paired with soil sampling and fruit yield. This provided a comprehensive spatial characterisation of vineyard carbon storage.

This study found that vines averaged 1.93 kg of dry biomass (0.87kg carbon) per plant. When combined with root biomass, vines constituted only 2% of the total perennial vineyard carbon (including soil carbon storage).

Some methodological suggestions for the estimation of carbon stored by the vine set out below

SHORT TERM (ST) carbon storage by the vine: grapes; non-permanent vine growth

Calculation of short term (ST) carbon storage by the **vine is optional**. In cases where short term carbon storage is accounted for, GHG emissions resulting from biodegradation of vine structures in the soil should also be accounted for.

> There are only few data on carbon storage in non-permanent vine structures. An approximation is often made that the balance of storage and emissions in one year is zero.

IPCC (IPCC, 2006) uses this approximation.

The calculator elaborated by ADEME and IVF (France) does not account for short term carbon storage.

Estimation of total carbon stored in vines – LONG TERM CYCLE (LT)

Estimation of above ground vine perennial biomass (LONG TERM - LT)

Above ground vine perennial biomass can be calculated as:

above ground perennial biomass = wood density + wood volume

The volume of the above ground wood can be estimated by considering the vine as a cylinder. For a cordon training system, the vine can be considered as two cylinders: trunk and cordon. Renewal parts (e.g. shoots or leaves) should be not considered in this estimation.

The length and the width of each cylinder should be measured.

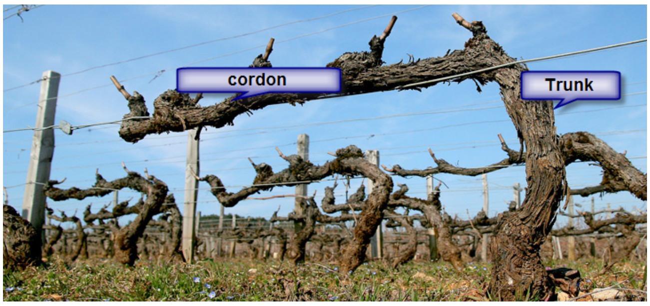
volume of trunk = 1/4 π × length of trunk × width of the trunk²

[10] Characteristics of the site:
- Vine variety: Sangiovese
- Age of the vines: 8 years old at the time of the study, 2006
- Training system: bilateral cordons and spur pruned
- Vineyard spacing: 1.83 m in a raw and 3.66 between row
- Soil: identified as Dierssen clay loam (Durixeroll) and managed with shallow tillage two to three times per year to control weed and incorporate pruning waste

The volume of cordon can be calculated with the same formula.

above ground volume of vine = volume of trunk + volume of cordon

Figure 3 : estimation of above ground vine perennial biomass



The dry biomass needs to be determined after the total volume is calculated; to do this the vine wood density has to be determined.

In one particular case, the vine **wood density was determined as 0.95g dry weight/cm3 fresh volume**[11] (Williams et al., 2011).

Vine wood density does not vary significantly with the age of the vine or with the vine variety. In the absence of site specific data this value can be used as standard.

Estimation of the total perennial vine biomass (above and below ground)

While it is possible to measure and estimate vine above ground biomass, it is difficult to measure directly the below-ground vine biomass without destroying the plant.

Several references (Mullins et al., 1992), (Clingeleffer and Krake, 1992), (Williams and Biscay, 1991) provide the following relationship between above and below-ground vine perennial biomass:

whole vine biomass = 1.42 × biomass above ground

Mass above ground is composed of the trunk and cordon; roots constitute 30% of vine total perennial biomass (1-1/1.42=29.5%).

Calculation of total carbon stored in vines (LT) Schlesinger, 1997) provides a carbon content of 45% of dry weight of vine wood.

Carbon stored in vines can be therefore estimated from the measure of above-ground vine perennial biomass as follows:

C total vine = 1.42 × 0.45 × Biomass above ground

Vine biomass above ground can be estimated or measured. Total carbon storage per hectare can then be calculated by multiplying by the number of plants per hectare.

Permanent and incremental storage or loss of carbon due to vineyard and soil management (LONG TERM CYCLE)

Annual growth can be measured by comparison between vine biomass in the vineyard of the previous year with the actual year.

$$\text{annual growth} = \text{vine biomass}_{n} - \text{vine biomass}_{n-1}$$

Or estimated (assuming linear evolution) according to the formula:

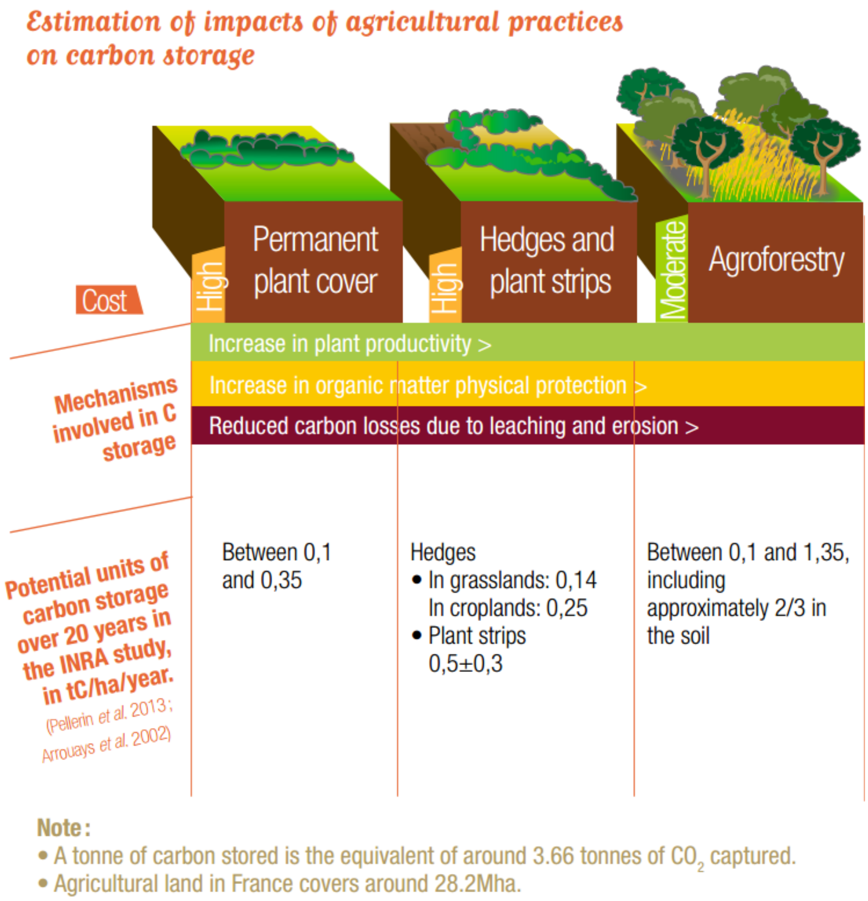
$$\text{annual growth} = \frac{1}{n} \times \text{vine biomass}_{n}$$

Carbon storage in the soil can be increased by soil/crop management. Keightley, 2011) In order to return higher amounts of organic matter to the soil, it is necessary to favour soil cover by including intermediate crops in the rotation and grassing between the rows in vineyards and orchards.

The following figure shows the potential units of carbon storage over 20 years in the INRA study, in tCeq/ha·per year.((Arrouays et al., 2002); (ADEME, 2014))

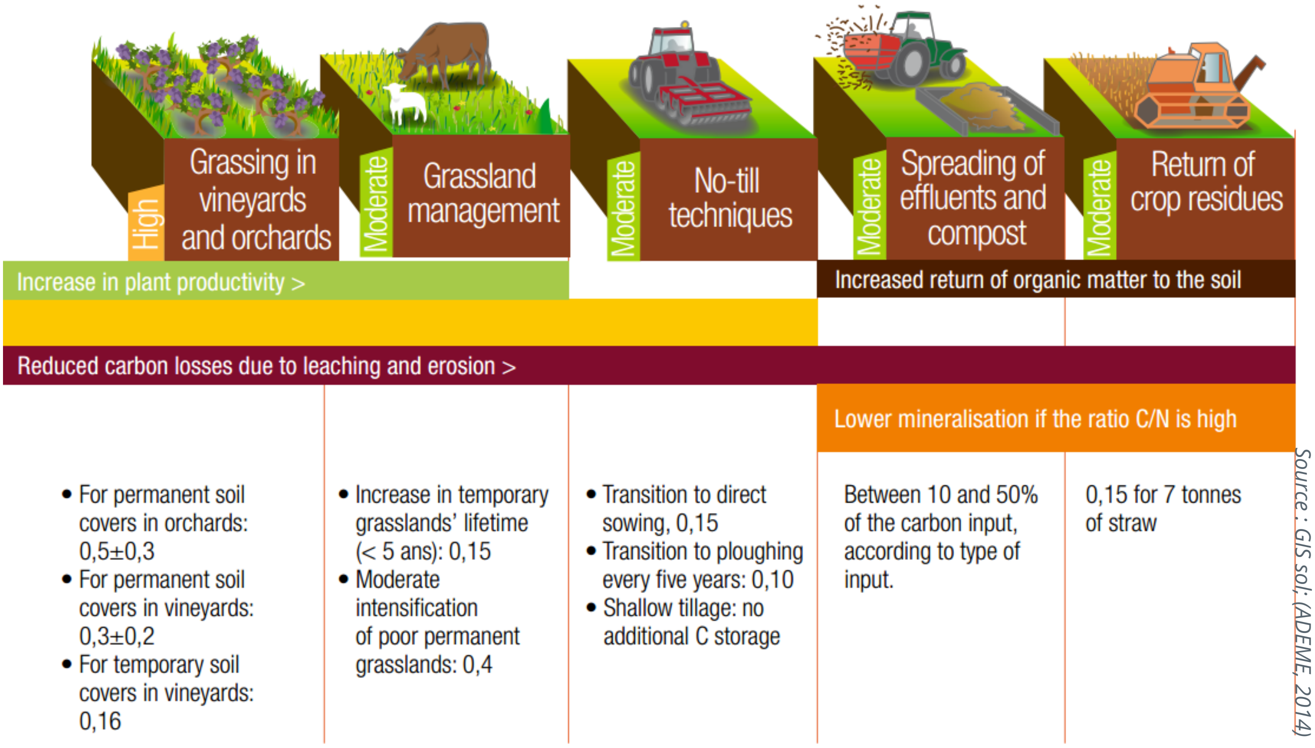
11 Chardonnay vine, California organic vineyard

Figure 4 : Potential of carbon storage over 20 years in the agricultural soils (continues next page)



Source : GIS sol; (ADEME, 2014)

Figure 4 : Potential of carbon storage over 20 years in the agricultural soils (continuation)



c. Biodegradation of vine structures in the soil

In case carbon sequestration in vine biomass (Short Term Cycle) is accounted for, GHG emissions relating to biodegradation of vine structures in the soil should also be taken into consideration.

If ST carbon storage in vines is not taken into consideration (cf. 1.b), accounting for emissions relating to biodegradation of vine structures in the soil is recommended, but not mandatory[12].

d. N_2O emissions resulting from nitrogen fertilization

N_2O flows are not easy to measure or estimate. A lot of parameters can influence the emissions (climate, type of soil, etc...).

Based on a publication (Bouwman, 1996) and actualised following the publication (Stehfest and Bouwman, 2006), the IPCC established (IPCC, 2006b) a default methodology (tier 1) for the estimation of N_2O emissions from soil:

• N_2O emissions from soil are due exclusively to the application of fertilizers and to the degradation of plants residues in the soil
• Total emissions are equal to 1% of the N introduced to the system (fertilizers + residues)

$$\text{N-N}_2\text{O (kg/ha/year)} = 0.01 \text{ (N synthetic fertilizers + N organic ferilizers + N plants residues)}$$

At this stage, few countries have available data and more detailed estimations are recommended.

[12] resolutions OIV-CST 2015-503AB; OIV-CST 2012-431

IPCC has developed a specific calculator for the estimation of N_2O emissions from soil from nitrogen fertilisation: https://discover.amee.com/categories/Fertilizer_associated_soil_N2O_emissions/data/calculator

Alternatively, (Lesschen et al., 2011) worked on the differentiation of nitrous oxide emission factors for agricultural soils. Type of soil and annual rainfall were considered to calculate N_2O emissions.

e. CH_4 emissions from soil

CH_4 (methane) emissions from upland soils (i.e. in aerobic conditions) are negative or close to zero, therefore, vineyards do not produce methane, but oxidize CH_4 to CO_2. That level of oxidation is reduced by N-fertilizing, **and can be considered as negligible** (Roger and Le Mer, 2003).

2. On-site fuel used (scope 1 and 3)

a. Emissions from fossil sources

Under this item, all fuel used directly or indirectly by the enterprise for machinery (tractors, forklifts, harvesting machinery, bottling machinery, boilers, etc...) are considered.

Emissions arising from the use of fuel for transport activity should be accounted using the same methodology, but reported separately. Emissions arising from transport activities are discussed under the points 7.a and 7. b.

Scope 1: Fuel used by machinery owned by the enterprise,

Scope 3: Fuel used by rented equipment, as well as fuel used by an external contractor in vineyard operations.

Two types of calculations are possible: when the amount of fuel is known (this is usually the case for vineyard owned equipment) and when the amount of fuel is not known (usually, by external contractors).

For traceability and management accounting reasons, it is recommended to separate fuel consumption into different units and at least two categories should be considered:

- Emissions from vineyard operations
- Emissions from winery operations

More detailed classification can be done, provided data are available and of good quality.

Separation under several categories will allow the enterprise to see more clearly the evolution of GHG emissions from year to year and thus to adjust management practices.

Amount of fuel consumed is known (scope 1 or 3)

Calculation modalities

When information on the quantity of fuel consumed is available, the following equation, proposed by the IPCC (IPCC, 2006c) should be used:

$$\text{GHG Emissions} = \sum_{a,b} [\text{Fuel}_{a,b} * \text{EF}_{a,b}]$$

Where

• a: type of fuel (e.g; petrol, diesel, natural gas, LPG, etc...)
• b: machinery type
• Fuel $_{a,b}$: Quantity of energy contained in the fuel a and consumed by the machinery b, measured in mega**joules** (MJ).)
• EF_a: emission factor of the fuel a, measured **in kilograms of CO_2eq by megajoule** (kg/MJ). This is equal to the carbon equivalent content of fuel per megajoule multiplied by 44/12 (relative molecular mass of CO_2 divided by relative molecular mass of carbon).

The EF emission factor takes account of all the carbon in the fuel including that emitted as CO_2, CH_4, CO, NMVOC.

Fuel $_{a,b}$ is obtained by multiplying the quantity of fuel used (in tons) by the Net Calorific Value of the fuel a (NCV), measured in megajoules by ton.

GHG emissions from fuel combustion are influenced by two fuel parameters: energy content (Net Calorific Value – NCV) and its carbon content.

Values for emission factors and Net Calorific Value

Fuel specific values can be found in different sources.

IPCC publishes default values:

• NCV default values can be found in the table 1 of the Chapter 1 of (IPCC, 2006c),
• Default values for emission factors can be found in the Chapter 3 MOBILE COMBUSTION of the (IPCC, 2006c).

Emission factors have been harmonized at European level into the new standard **EN 16258 "Methodology for the calculation and declaration of energy consumption and greenhouse gas emissions of transport services"**. (EN 16258, 2012). Practical issues related to the use of this standard are described in details in the guide "Calculating GHG emissions for freight forwarding and logistics service" published by CLECAT (European Association for Forwarding, Transport, Logistics and Customs Services) in April 2012 (CLECAT, 2012).

If available, country specific values should be used both for NCV and emission factors. Countries publish these values in specific reports:

• AUSTRALIA: National Greenhouse Accounts Factors, Table 3 http://www.environment.gov.au/system/files/resources/b24f8db4-e55a-4deb-a0b3-32cf763a5dab/files/national-greenhouse-accounts-factors-2014.pdf
• Etc…

The following table presents a compilation of emission factors and NCV for road transport published in the (IPCC, 2006c), **chapters 1 and 3**. It should be noticed that original data present also the low and upper limits for each value. The data here below are given as indicative values and it is thus recommended to consult the IPCC report and data base, as well as national sources before starting the inventory.

Table 7 Fossil fuel consumption default emission factors (well to wheel); (IPCC, 2006c):

Fuel type	Kg CO_2 /TJ	Kg CH_4/TJ	Kg N_2O/TJ	NCV (TJ/Gg), Gg = 10^3 ton
Motor Gasoline	69300	33	3.2	44.3
Gas / Diesel Oil	74100	3.9	3.9	43
Liquefied Petroleum Gas	63100	62	0.2	47.3
Compressed Natural Gas	56100	92	3	48
Kerosene	71900			43.8
Liquefied Natural Gas	56100	92	3	48
Lubricants	73300			40.2

Amount of fuel consumed is not known (scope 3)

This situation is not frequent in the viticultural sector and occurs when soil works are subcontracted. If it is not possible to obtain reliable data from the subcontractor on the fuel consumed, estimations can be done based on the following parameters:

- Type of equipment
- Load factor
- Type of fuel
- Power
- Hours of work
- ....

General information is available in the IPCC recommendations on energy (IPCC, 2006c).

The calculator developed by Winemakers Federation of Australia (WFA) proposes some default values, as well as a simple to use exce file allowing the estimation of GHG emissions from fuel consumed, when the quantities are not known: http://www.wfa.org.au/resources/carbon-calculator/.

Emissions from biomass and biofuels: production and transport

Life cycle assessment (LCA) approach should be applied here.

Only emissions arising from the production and transport of the biofuel should be accounted for. Emissions from the combustion of biofuels are not included.

- **Biofuel**

Viticultural enterprises rarely produce biofuel. In case of utilization of biofuel for various needs of the company, emission factors should be requested from the fuel provider. Below are some examples of values for various types of biofuel. The values are provided by the Biomass Energy Centre (UK government information centre for the use of biomass for energy in the UK).

http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,163182&_dad=portal&_schema=PORTAL

Table 8 Emission factors for biofuels (transport) (BIOMASS Energy Centre, UK)

Fuel	Net Calorific Value (MJ/kg)	Energy density (MJ/L)	Carbon Content	Approx. life cycle GHG emissions (gCO_2eq/L)
Bioethanol (from sugar beet)	27	21	52%	724
Bioethanol (from wheat)	27	21	52%	511
Biodiesel (from rapeseed oil)	37	33	77%	1334
Biodiesel (from waste vegetable oil)	37	33	77%	437
Petrol	44	32	87%	2600
Diesel	42.8	36	86%	3128

- **biomass**

If vegetal material is used for heat production (pruning wood), CO_2 emissions occurring during production of biomass can be calculated, see part 1.a.

Emissions of GHG due to the production of viticultural biomass should not be double-counted.

• If the biomass used results from long-term CO_2 accumulation (vine wood): emissions from wood burning should be accounted for.
• The biomass used results from short-term cycle growing (pruning cane), emissions from burning should **not** be accounted for.

Here below are presented some default values of emission factors for biomass. The values are provided by the Biomass Energy Centre (UK government information centre for the use of biomass for energy in the UK).

http://www.biomassenergycentre.org.uk/portal/page?_pageid=75,163182&_dad=portal&_schema=PORTAL.

These figures for wood pellets include the hammer mill and pelleting process, however do not include sourcing the feedstock and any pre-processing such as drying. If starting from green wood then drying could be a very major component, however pellets are often made from dry waste wood that has been dried for another purpose, such as joinery. These figures also do not include transport (which is included in the figures for wood chips).

Table 9 Emission factors for biomass - heating and power. (BIOMASS Energy Centre, UK)

Fuel for heating and power	Net Calorific Value (MJ/kg)	Carbon Content	Approx. life cycle CO_2 emissions (including production)	
			Kg CO_2eq/GJ	Kg CO_2eq/MWh
Wood chips (25% MC[13])	14	37.5%	5	18
Wood pellets (10% MC starting from dry wood waste) from dry wood waste)	17	45%	4	15
Wood pellets (10% MC starting from green wood using gas)	17	45%	22	80
Grasses/straw (15% MC)oil)	14.5	38%	1.5 to 4	5.4 to 15

[13] MC: Moisture Content

3. Electricity production in-situ: photovoltaic panels, wind generators (scope 3)

Emissions due to the production, operation needs and disposal of equipment (**Life Cycle Assessment approach**) should be considered. Emission factors depend on the technology used and geographical location. The following table presents recommended emission factors:

Table 10 GHG emissions from electricity production from renewable sources

Type of generator	Emissions (in $kgCO_2eq/kWh$)	Source	Comments
Photovoltaic	0.055	ADEME (2014)	For Europe
	0.053	(Hondo, 2005)	For Japan
	0.039	(de Wild-Scholten et al., 2014)	Australia
	0.089	(de Wild-Scholten et al., 2014)	Iceland
Wind	0.007	ADEME (2014)	Life Cycle Assessment (LCA) analysis shows that for a modern wind generator working in Northern Europe (inland) the average GHG emission factor would be of 4.8 g CO_2eg/kWh. This value is highly dependent on the load factor of the generator during the year. It is recommended to retain the value of 7 g CO_2eg/kWh
Geothermic	0.045	ADEME (2014)	

4. Waste disposal, reuse and recycling (scope 1 and 3)

Waste produced should be categorised by quantity and type. Waste disposal and treatment carried out by the company itself (compost for example) should be considered under scope 1.

Type of waste	Total Quantity (tons/year)	% treatment by the company (Scope 1)	% treatment outside the company (Scope 3)
Plastic			
Glass			
Other mineral (metal, etc...)			
Paper/ cardboard			
Food waste (including wine)			
Waste water			

Waste disposal undertaken by municipal services should be accounted for under scope 3.

a. Waste disposal and treatment

GHG emissions during waste disposal and treatment depend on the country/region specificities in the modalities of waste treatment and valorization. Country specific mix values for recycling, incineration, composting etc... should be considered.

• Transversal GHG emissions

Transversal emissions are common to all waste and are caused by the transport of waste and by the operation of the waste treatment plant.

It is difficult to give an exact value for these emissions. Companies usually have no control over how the waste is treated and can hardly improve its GHG emissions from waste treatment. Therefore an approximation should be considered.

ADEME (2014) proposes to use the following values (FNADE and Bio Intelligence Service, 2008)

- Waste transport: 18 kg CO_2/ton of waste
- Emissions related to the operation of waste treatment plant:
  - Incinerator: 18 kg CO_2/ton of waste
  - Landfill: 15 kg CO_2/ton of waste

Estimations can also be done using the approach described in 7.a (emission factors per kg*km)

Some datasheets include these emissions in the total waste treatment emission value. Care should be taken not to account for these emissions twice.

• Emissions by type of treatment and type of waste

It is difficult to provide universal data for all countries. Values depend on the waste treatment technology, transport options, valorization mix, etc...

ADEME (2014) has published the following data for waste treatment emissions:

Only fossil CO_2 is taken into account. Biogenic CO_2 is not included. Data include waste transport emissions and emissions from operating the waste treatment facility. Average values are given for France's average mix for waste treatment.

Table 11. Emissions for waste treatment (ADEME, 2014)

Type of waste	Incineration ($kgCO_2eq/ton$)	Landfill storage ($kgCO_2eq/ton$)	Compost ($kgCO_2eq/ton$)	Average ($kgCO_2eq/ton$)
Organic waste				
Paper	46.6	1020	86.7	43.1
Cardboard	46.6	983	86.7	37.9
Food waste (including wine)	46.6	649	86.7	48.1
Plastic waste				
Average plastic	2680	33	-	877
PET	1990		-	
PVC (Polyvinyl chloride)	1440		-	
PE (polyethylene)	2910		-	
PS (polystyrene)	3140		-	
PP (polypropylene)	3020		-	
Mineral waste				
Glass	46.6	33	-	
Metal	46.6	33	-	
Waste water	0.262 (kg $CO_2eq/m3$)		-	

b. Direct reuse

Emissions of all GHG should be accounted for. Special attention should be paid to CH_4 and N_2O emissions.

c. Recycling

Paper/cardboard, PET, glass and metals are recyclable.

Recycling of waste materials generates "avoided" emission. Indeed, recovered material is used to produce new products thus limiting the use of raw materials. Emissions from production of the new materials are thus reduced.

Avoided emission factors can be calculated as (examples of values, ADEME, 2014)

Table 12 : Calculation of « avoided emissions » due to recycling of metal, PET and paper (ADEME, 2014)

Material	Emission factor for production from raw material ($kgCO_2eq/ton$)	Emission factor for production from recycled material ($kgCO_2eq/ton$)	Avoided emissions due to recycling ($kgCO_2eq/ton$)
Metal (Fe)	3190	1100	2090
PET	3263	202	3062
Paper/cardboard	To be updated	To be updated	To be updated

While calculating "avoided emissions", only the non-recycled part of the material should be taken into consideration. Otherwise the benefit is accounted for twice.

Example of calculation:

10 tons of steel produced from 60% of recycled material and 40% of raw material is recycled.

Avoided emissions are: 40%*10*2090 = 8360 kgCO2, or 836kgCO2/ton of material

5. Infrastructure and machinery (scope 3)

a. Infrastructure and capital items (scope 3)

Production of machinery/equipment

Emissions related to infrastructures, machinery and, in general, capital items are included in the secondary boundaries of the Enterprise Protocol (scope 3), **when they make a material contribution**. Due to the longevity of wine sector infrastructure and machinery and their consequent relative small contribution to the product carbon footprint, they should be, in general, **excluded from the Product Protocol**[14].

Repair and maintenance work to capital items are also included in the secondary boundaries[14].

Emissions related to fuel and energy consumption by the machinery and infrastructure should not be accounted for under this item, as they are accounted for under the categories "on-site fuel used" and "purchased power utility".

More generally, under this point we consider only the emissions from the fabrication/construction of infrastructure and machinery. For this reason, **an adapted system of amortization**, taking into account the lifetime of equipment/infrastructure under consideration, should be introduced.

[14] Resolution OIV-CST 431-2011, I.6 and II.6

Few data are available in the literature regarding the production of machinery. ADEME proposes to consider a rough approximation here by taking the same value as the one assumed for transport vehicles production: **5.5 tons CO_2eq/ton of machine**.

This value should be amortised for the life period of equipment (usually 10 years).

In any case, machinery consumes fuel and electricity and in general GHG emissions related to the operations of machinery are largely higher that the ones due to the production of equipment.

Carbon sink in wooden equipment (oak barrels, wooden posts, wooden structures)

- **Emissions during the production process**

It is difficult to provide exact data for emissions arising during various phases of production of barrels and other wooden objects. Emissions from bucking, skidding, timber, transportation, etc., should be accounted for. ADEME (2014) gives an approximation of **36.6 kg CO_2eq/ton of wooden product**.

Similar data can be found in ELCD

- **Considering carbon storage**

Wooden items could be considered as a carbon sink. Nevertheless, the carbon sink is real only if the carbon is stored for a long period of time and if the trees are replanted (i.e. if the wood is managed sustainably).

According to the OIV GHGAP[15], the carbon sink can be accounted for if the wooden items have a life of **more than 20 years**. ADEME (2015) provides the value of carbon sink of **1850 kg CO_2eq/ton of wooden product**[16].

6. Emissions related to cooling and refrigerating systems (scope 1)

Under this item we consider specific CO_2 and non CO_2 emissions occurring during refrigeration and cooling. Emissions related to energy and fuel consumption are not accounted for here as they have already been accounted for under "on-site fuel used" and "purchased power utility".

More specifically, fugitive gases from cooling systems, as well as dry ice utilization are accounted for here. CO_2 emissions from dry ice: CO_2 emissions from production and use of dry ice should be accounted for.

Dry ice can be produced in different ways; it can be collected as a by-product in a chemical process (ammonia production process), biological process (fermentation) or recovered from natural sources. In these cases, only the GHG emitted by the gathering process shall be accounted. (Most common case)

If the dry ice is produced by combustion of oil or gas with dry-ice production as only purpose, the amount of CO_2 emitted by combustion should be accounted for, in addition to the GHG emitted by the production process. This production method is common in Asia.

Source: http://ecojetinc.com/ecopress/wp-content/uploads/2012/10/EIGA-Environmental-Impact.pdf

Emission factors for fugitive gases can be found in the 4th (2007) and 5th (2013) IPCC reports[17].

[15] OIV-CST 431-2011: General principles of the OIV greenhouse gas accounting protocol for the vine and wine sector
[16] ADEME considers that **a life of 100 years is required** for wooden products to be considered as carbon sink
[17] https://www.ipcc.ch/publications_and_data/ar4/wg1/en/ch2s2-10-2.html

7. Transport

a. General considerations: differences between enterprise and product protocols

According to the "Greenhouse gases accounting in the vine and wine sector – recognised gases and inventory of emissions and sequestrations" resolution (OIV-CST 503AB/2015), the following activities should be taken into consideration under the product and enterprise protocols:

Enterprise protocol:

All movements within the company boundaries are included in the Enterprise Protocol[18]

➢ **Movements of products**

◦ All transport activities in the vineyard and during the winemaking process (inputs, waste, residues, by-products and the products themselves, like wine, grapes, etc.)

◦ Transport of the wine from the winery to the customer or the consumer. The company boundary will fix the limit of the inclusion of emissions. In general, the final point is the retailer or the tax warehouse. In the case of internet wine selling, the transport/mailing of the wine until the consumer will be included

➢ **Movements of people**

◦ Transport of employees during winemaking process

◦ **Excluded**: transport of employees to their place of work

◦ Business travels

◦ **Excluded**: Transport of the consumer to the place of retail

These activities are accounted for under Scope 1 if the transport vehicle is under company ownership or control and under scope 3 otherwise.

Product protocol:

All movements occurring **during the life cycle of vitivinicultural product** should be accounted for (grape production, wine processing, distribution and retail, end-life):

➢ **Movements of products:**

◦ Transport of inputs from their purchase point to their place of use

◦ Transport activities in the vineyard and during the wine making process

◦ Transport of waste or residues to a disposal centre

◦ Transport of by-products (Transport for reuse purposes, as grape marc for distillation or pruned canes (for compost or biomass) from the winery are included, if under the direct control of the company producing the by-product. If not, they are excluded, as they are part of a new product life cycle).

◦ Transport of the finished wine from the winery to the retailer or consumer.

◦ Transport of waste or residues to a recycling centre.

➢ **Movement of People**

◦ **Included**:

  ▪ movement of employees during the vitivinicultural process inside the company

◦ **Excluded**:

  ▪ Business travel (if not directly linked to the winemaking process)

  ▪ Travel of employees to their place of work

  ▪ Transport of consumer to and from the point of retail purchase

b. Transport of goods

General recommendations

The following recommendations apply to all means of transport and should be taken into account when calculating emissions from transportation:

[18] OIV-CST 431-2011: General principles of the OIV greenhouse gas accounting protocol for the vine and wine sector

a) For owned vehicles, emissions due to fuel consumption should be accounted for and related to emission standards (the default values depend on the region of origin of the emissions: Europe Euro classes, USA EPA classes, Japan JP classes). It is preferable to use data of quantity of consumed fuel, or, alternatively, mileage).

b) For third party vehicles, travel data are to be accounted for according to: type of vehicle, load capacity (train, ship, or gross weight class for truck, etc.), emission standard, load factor (the load factor defines the weight, based on freight type and percent load of the vehicle), empty trip factor (km empty/km loaded), destination and typical route.

c) in accordance with ISO and European standards (EN 16258, 2012) the following should also be considered :

◦ enterpise protocol: direct emissions (tank to wheel)

◦ product protocol:

- direct (tank to wheel)
- **and** indirect or upstream emissions ("well to tank") emissions during the transport of crude oil to the refining plant before the refining process followed by distribution of the fuel itself, before it is used by vehicles,

TEU: commonly accepted unit of measure in wine logistics

The following units of transport are usually considered:

TEU: twenty-feet equivalent unit

- **Bottled wines**: 10 tons TEU in dry/ insulated/ reefer containers
- **Bulk wine**: Flexitank or ISO tank of 24 tons = 2.4 TEU of 10 tons[19].

Calculation by sections is recommended

The best way of calculating emissions arising from transport activities is to separate the emissions by sections (also called legs of a journey), i.e. road (company cars, highway road transfer of products, etc.), off-road (tractors in the vineyard, etc.), railways, water-borne navigation and air.

Transport modes and means used in the viticultural sector

Transport modes:

- Water-borne (deep/short sea, river barge)
- Road and off road
- Airfreight
- Rail freight

Container equipment:

- Dry
- Reefer
- Dry Insulated
- Flexitank (for moving bulk wine)
- Tanker vessel (for moving bulk wine)

Selection of available on-line tools for GHG emissions estimation due to transport activities

Exact calculation of CO_2 emissions during transportation is very complex. A number of professional organizations are working on these issues all over the world.

A selection of the most complete and internationally validated calculators of CO_2 emissions for logistics is proposed:

EcoTransIT

Applicable for following transport modes
Road
Rail
Air
Water

EcoTransIT World calculates environmental impacts of different carriers across the world. This is possible due to an intelligent input methodology, large amounts of GIS-data and an elaborate basis of computation.

[19] Clean Cargo Working Group would in principle allow the application of a "rule by 3" to calculate CO_2 emissions of Flexitank (24 tons average). As a result CO_2 emissions of Flexitank 24 tons = CO_2 emissions of 2.4 TEUs x 10 tons (CCWG TEU definition)

Data and methodology are scientifically funded and transparent for all users. Regular updates are conducted both on data and methodology.

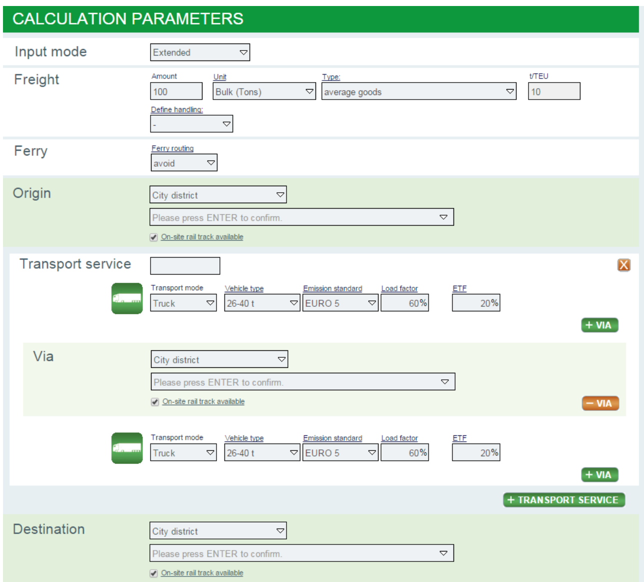
EcoTransIT® World is controlled and financed by the EcoTransIT® World Initiative (EWI). The technical implementation is done by the consulting company IVE GmbH in Hanover, whereas the Institute for Energy and Environmental Research IFEU (Heidelberg, Germany) and INFRAS (Bern, Switzerland) are responsible for the computation methodology and emission factors.

EcoTransIT calculator is available for free via the website http://www.ecotransit.org/

Road, rail and air transportation emissions can be calculated and compared. The user can include information on load and empty trip factors. Data on different emission standards are available (Euro, EPA, JP).

Different types of planes, vessels and trains can be used.

Figure 5 EcoTransIT: example of utilisation for calculation of GHG emissions for various transport modes



Itineraries can be adjusted: the user can choose to indicate a simple path "To-From" or detail the route by indicating "via" locations.

Maritime trade lane emissions: Clean Cargo Working Group

Applicable for following transport modes

Sea

Clean Cargo Working Group (CCWG)[20] has developed tools and methods to calculate the CO_2 footprint for a single shipment or a total transportation company, and to assess supplier environmental performance.

CCWG focuses on sea emissions calculation with focus on CO_2 and SOx. The underlying methodologies for collecting data are different between CCWG and EcoTransIT.

Every year CCWG collates individual vessel data (Excel sheets) from sea carriers. EcoTransIT emissions data are calculated from scientific/ university sources.

For EcoTransIT the frequency of update varies according to transport mode (e.g. rail in 2013, sea in 2014); and the update does not happen every year but less often.

CCWG is sponsored by BSR (Business Social Responsibility, an NGO of Californian origin).

Useful reports:

• CCWG Progress Report 2015 (August 2015)[21]. This report provides aggregate average trade lane emissions factors for the years 2009-2014. The list of companies that have provided their data is also indicated. This data can be used to refine results obtained with EcoTransIT.

• How to Calculate and Manage CO_2 Emissions from Ocean Transport (February 2015)[22].

[20] http://www.bsr.org/
[21] https://www.bsr.org/our-insights/report-view/clean-cargo-working-group-progress-report-2015
[22] http://www.bsr.org/reports/BSR_CCWG_Calculate_Manage_Emissions_2015.pdf

Useful calculators:

The list is non-exhaustive and other calculators may be included

FIVS GHG emissions calculator

Applicable for following transport modes
Sea
Road
Rail
Air

https://fivs.org/wm/strategicInitiatives/fivsForesee.htm

Wine and Spirit Trade Association (WSTA) carbon calculator

Applicable for following transport modes
Sea
Road
Rail
Air

The UK trade (WSTA) has developed a tool for calculating GHG emissions for the movement of goods from winery to warehouse, often over very large distances. The calculation methodology for sea routes is updated every year to ensure alignment with the Clean Cargo Working Group.

http://www.wsta.co.uk/resources/carbon-calculator

Other calculators?

c. Transport of people

Only emissions from transport during business travel should be accounted here. Emissions arising from transport of employees from home to the place of work, as well as transport of consumers to the place of retail are excluded both from enterprise and product protocols[23].

Road transportation

Usually, the quantity of fuel consumed is known for the vehicles owned by the company. The same methodology as the one mentioned under point 2.a (on site fuel used).

In case of rented vehicles or services bought (motor coaches, taxi, etc.) estimations should be done:

- Distances travelled
- Fuel consumption

Emission factors of the fuel can be found in the Table 7.

Air transportation

This means of transport is one of the most "heavy" ones in terms of GHG emissions and one of the most complicated ones in terms of calculations. A number of calculation models exist and could be used for the OIV GHGAP.

Emissions depend on the type of plane, emission factor of the fuel and on the route taken. Usually airline companies provide data on CO_2 emissions per passenger for each journey

Preference should be given to calculators provided by the airline companies that carried out the flight. The data provided are more accurate, as they take into account the type of plane and fuel used by the company. Generic calculators, giving information without taking into account the airline company, do not account for all relevant information.

International Civil Aviation Organization has developed a calculator for carbon dioxide emissions from air travel:

http://www.icao.int/environmental-protection/CarbonOffset/Pages/default.aspx

[23] Resolution OIV-CST 431-2011

Train

In case of transport by train, data on GHG can be provided in order of preference by:

- The transportation company, that sometimes provides the CO_2 emissions for the travel or emissions per km.
- Government' organisations calculating data on national train transport emissions.
- IEA/UIC's yearly publications of data on CO_2 emissions: it is available for many countries (depending on the year). For other countries, if no national data is available, world average data can be taken as an estimate. Data available on yearly published Railway Handbook (IEA, 2015).

http://www.uic.org/IMG/pdf/iea-uic_2015-2.pdf

d. Non-energy emissions during transportation

Non-energy emissions result from the air conditioning and refrigerated mobile transportation. This is relevant for the vine and wine sector, since the grapes and wines are often transferred under cooler temperatures. Some guidance is provided in the Volume 3, Chapter 7, Table 7.8 of the IPCC Guidelines (IPCC, 2006), regarding HFCs and PFCs.

8. Purchased power utility (scope 2)

The emission factor for the purchased power utility depends on a number of parameters: country; region, fuels used to produce electricity in the given area (coal, nuclear, wind, etc...).

To obtain the exact emission factor, the origin and production method of electricity produced need to be known. These data are usually provided by the local supply network. Estimation models exist, based on the technologies used in the country, quantity of energy sold and bought outside the network.

GHG protocol proposes a specific tool for calculation of GHG emissions from purchased power electricity. The tool takes into account all available emission factors by country and region (emission factor sources: IEA and IPCC): http://www.ghgprotocol.org/calculation-tools/all-tools

More detailed and updated information on a regional level can be found directly from the company producing power utility. Here below some examples of national sources:

• FRANCE (Réseau de transport d'électricité) : http://www.rte-france.com/
• ITALY (Italian Greenhouse Gas Inventory 1990-2014. National Inventory Report 2016"): http://www.isprambiente.gov.it/it/pubblicazioni/rapporti/italian-greenhouse-gas-inventory-1990-2014.-national-inventory-report-2016
• SPAIN (The National Commission of Markets and Competition): http://gdo.cnmc.es/CNE/resumenGdo.do?anio=2013
• AUSTRALIA (The Government of Australia - Department of Climate Change and Energy Efficiency): http://www.climatechange.gov.au/climate-change/greenhouse-gas-measurement-and-reporting/tracking-australias-greenhouse-gas-emissions/national-greenhouse-accounts-factors%E2%80%94july-2013

9. Inputs (scope 3)

The GHG emissions arising **from the production** of the main vitivinicultural inputs are included in the secondary boundaries of the calculation of the Enterprise Protocol (EP) (scope 3), and shall be included in the Product Protocol[24].

It should be stressed out that emissions **of N_2O from soil due to the application of fertilisers** are accounted for under **scope 1** (1.d).

a. Inputs in viticulture

Trellis structures

Table 13 : Emission factors for trellis equipment (ADEME, 2014)

input	Elission factor (kgCeq/t)	Source
New inox wire 18/8	5250	ADEME (2014)
New inox wire 18/9	4600	ADEME (2014)

Fertiliser production

Fertilizer production is highlighted in literature. (Bosco et al., 2011) show that fertilizer and pesticide production could constitute the most important input to total GHG emissions during the viticultural phase.

It is not easy to give estimated CO_2 emissions for each fertilizer, so a number of parameters can be taken into account:

GHG emissions during the production of fertilizers depend on the technological process used.

Modern technologies produce less GHG emissions than older ones. Energy consumption is not the same. It is therefore difficult to make solid estimations of GHG emissions only knowing the nature of the fertilizer. (Kongshaug, 1998) proposed a model of "building blocks". This model links energy consumption and GHG emissions to the **"building block"** constituting the final products. All kinds of fertilizers can be divided into these building blocks, and consequently energy consumption and GHG emissions can easily be estimated for them.

The main energy requirement for the production of fertilizers is linked to the nitrogen component; 92.5% for N, 3% for P2O5 and 4.5% for the K_2O component on a global basis. Production of the most common phosphate fertilizers (DAP/MAP and SSP/TSP) with modern technology releases excess energy due to the huge surplus energy formation in modern sulphuric acid processes.

Table 9 (Kongshaug, 1998) presents estimates of CO_2 emission and energy consumtion for a number of fertilisers for three classes of technological process: old, modern and average European production facilities. The estimations are given for **production facilities in WESTERN EUROPE**. For example, the production of one ton of ammonium nitrate (which contains 33.5% of N), causes emissions of 1 to 2.5 tons of CO_2 due to the energy consumed during the manufacturing process, depending on the technology and methodology used.

Energy use and raw materials used can also influence the GHG footprint of fertilisers (Blonk et al., 2012)

Emissions of CO_2 due to fertilisers' production can vary in different parts of the world. If (Kongshaug, 1998) deals with technological differences among production plants in Western Europe, (Blonk et al., 2012) publishing estimated carbon footprint and N_2O emissions in six regions of the world:

[24] Resolution OIV-CST 431-2011

- West Europe
- East Europe (including Russia)
- South America
- North America
- Asia
- Australia

Two major parameters are taken into account in the estimations: country' (or geographical zone') energy mix and technological processes used.

- **Energy mix** used in different parts of the world. Natural gas is the main source of energy for ammonia production. Nevertheless, natural gas production and distribution causes losses. Big differences are observed among countries in their gas production and distribution systems. This means that emission factors of natural gas combustion (56.1 kg CO_2 eq/GJ) should be corrected accordingly. The corrections are considerable, and can reach up to 55% (for Russia and Central Europe). If taken into account, on average, around the world, the CO_2 emissions due to natural gas combustion for fertiliser production should be increased by 30%.
- **Technological process used**. Technology is not the same all over the world. Some technologies cause more GHG emissions than others. One of the major examples used is the emission of N_2O (GHG with a Global Warming Potential (GWP) of 298) during nitric acid production. The amount of N2O emitted depends on combustion conditions (pressure, temperature), catalyst composition, burner design and emission abatement technologies. The quantity of N_2O emitted can vary from 4.5 to 12.6 kg N20/tHNO_3.

(Blonk et al., 2012) summarise the results for estimated carbon footprints for different types of fertilisers and compare the numbers with those found in other major publications on the subject:

Table 14 : Calculated carbon footprint (cradle to gate) for the most used N-fertilizers produced in different global regions compared with figures from literature (Blonk et al., 2012)

Global region	Urea	Nitrogen solutions (liquid UAN)	Anhydrous Ammonia	Ammonium Nitrate	Calcium Ammonium Nitrate	Ammonium Sulphate
Calculated values (in kg CO_2eq/per kg N)						
World average	5.00 (4.41 - 5.63)	7.27 (2.65 – 16.75)	4.21 (3.27 – 5.29)	9.47 (6.60–14.14)	9.51 (6.65 – 14.18)	3.33 (0.94 – 6.23)
Western Europe	3.49 (3.06 – 3.88)	5.77 (2.11 – 10.38)	2.85 (2.19 – 3.44)	7.99 (5.25 – 10.04)	8.03 (5.29 – 10.08)	2.14 (0.75 – 4.67)
Russia + central Europe	4.82 (4.41 - 5.36)	7.08 (4.51 – 14.11)	4.04 (3.44 – 4.98)	9.28 (7.94 – 13.89)	9.33 (7.98 – 13.93)	3.18 (1.37 – 5.84)
North America	3.75 (3.29 – 4.17)	6.04 (2.74 – 12.79)	3.11 (2.40 – 3.75)	8.27 (6.15 – 12.76)	8.31 (6.18 – 12.79)	2.40 (0.75 – 4.67)
China + India	7.41 (6.64 – 8.34)	9.65 (5.23 – 17.12)	6.36 (5.16 – 7.98)	11.80 (10.18 – 16.71)	11.86 (10.24– 16.77)	5.20 (1.69 – 8.17)
Rest of world	3.63 (3.18 – 4.18)	5.91 (3.49 – 13.62)	2.99 (2.30 – 3.89)	8.14 (6.77 – 12.73)	8.18 (6.80 – 12.76)	2.28 (0.75 – 5.46)

Between brackets are indicated minimum and maximum values

ADEME (2014) publishes the following values for the production of fertilizers. These data are given by the GES'TIM guidelines and are recognized by the Ministry of Agriculture and Fishery in France.

Table 15 : Emission factors for main fertilisers' production

Type of fertilizer	Unit of nutritive element	Emission factor ($kgCO_2eq$/t of nutritive element)
Anhydrous ammonia	Ton N	2980
Ammonium nitrate 33.5%		5860
Urea		3700
Calcium ammonium nitrate 30% (CAN) - lime 30% (CAN)		6100
Trisuperphosphate (TSP)	ton P_2O_5	581
Potassium chloride (KCl)	ton K_2O	451
Fertiliser - ternary	ton N	5030
	ton P_2O_5	940
	ton K_2O	510
Fertiliser – binary PK	ton P_2O_5	570
	ton K_2O	450
Fertiliser – binary NK	ton N	2970
	ton K_2O	450
Fertiliser – binary NP	ton N	4310
Fertiliser average nitrogen	ton N	5340
Fertiliser average phosporic	ton P_2O_5	570
Fertiliser average potassic	ton K_2O	450
Manure	Ton	3320
Compost	Ton	To be updated

More information on energy use and GHG emissions during fertiliser' production and use can be found in the following publications:

• A Review of Greenhouse Gas Emission Factors for fertiliser production. This report was drafted for the International Energy Agency under the Bioenergy Task 38:20 (Wood and Cowie, 2004)
• "Carbon emission from farm operations" (Lal, 2004) shows a synthesis of the available information on energy use in farm operations, and its conversion into carbon equivalent. The study is not limited to fertilizer production and use, but provides a synthesis of available data on GHG emissions from all farm operations.

Production of phytosanitary products

It is extremely difficult to provide estimates of emission factors for the production of phytosanitary products but, in the calculations the production of active elements of the product is considered. Commercial denominations of phytosanitary products depend on the active molecules presented and are not standardized between various commercializing companies.

Data published by ADEME (2014) for average phytosanitary products are set out below and are valid in Europe with an uncertainty factor of 30%.

Table 16 : Emission factors for phytosanitary products

Phytosanitary product	Emission factor ($kgCO_2eq$/ton of active molecule)
Average phytosanitary product	920
Average herbicide	915
Average fungicide	613
Average insecticide	25500

b. Inputs in winemaking

The inputs that are listed in the OIV International Oenological Codex are included.

Some examples of values that can be found in major databases:

Table 17 Emission factors for oenological products

Oenological product	Emission factor ($kgCO_2eq/t$)	Source
Citric acid, monohydrate	3300	ADEME (2014)
Tartric acid (D, L)	3300	ADEME (2014)
Sorbic acid	807	ADEME (2014)
Egg albumin, isinglass, gelatin, whey, potassium caseinate	1508	IFV (2011)
Other acids and salts of acids	3300	ADEME (2014)
Bentonite, kaolin	1100	ADEME (2014)
Potassium bisulfite	1470	ADEME (2014)
Calcium carbonate	75	ADEME (2014)
Chips (Wood)	10	IFV (2011)
Rectified ethanol of vitivinicultural origin	1830	ADEME (2014)
Arabic gum	400	UNGDA
Microoragnisms and extracts (bacteria, yeast, yeast cell)	2200	ADEME (2014)
Milk proteins, milk powder	5107	ADEME
Brine (sodium chloride)	169	ADEME (2014)
Liquid SO_2	440	ADEME (2014)
Sugar (sucrose)	200	IFV (2011)
Tannins	2200	ADEME (2014)
Diatomaceous earth, diatomite, perlite	1010	ADEME (2014)
Ammonium sulphate	733	ADEME (2014)

ADEME: French Agency for Environment and Energy Management

c. Inputs for cleaning the winery

The following emission factors for cleaning products are published by ADEME (2014):

Table 18 Emission factors for winery cleaning inputs

Inputs for cleaning the winery	Emission factor (kg. eq.CO_2/t)	Source
Nitric acid (50%)	3180	ADEME (2014)
Phosphoric acid	1420	ADEME (2014)
Soda liquid (50%)	587	ADEME (2014)
Solid sodium hydroxide	458	ADEME (2014)
15% sodium hypochlorite	920	ADEME (2014)
Sodium sulfate	473	ADEME (2014)
Antifoam products	1830	ADEME (2014)

d. Inputs for bottling/packaging

The following emission factors can be found in major databases:

Table 19 : Emission factors for bottling items

Inputs for bottling	Emission factor (kg.eq.CO_2/t)	Source
PET bottle	3400	ADEME (2014)
PET	3224	WFA GHG calculator
Bag-in Box (3L,5L,10L)	725	AVENTERRE/IFV
Glass (from recyclate 70%)	810	ADEME (2014)
Glass (from recycled 54%, reuse rate 7% - average EU, Turkey, Switzerland)	791	ECLD (2014)
Antifoam products	1830	ADEME (2014)

e. Inputs for wine closures

Some examples of values that can be found for wine closures in various databases:

Table 20 Emission factors for wine closures

Closure	$kgCO_2eq$/ t closure	source
Additional composite cap (aluminium 35% recycled / LDPE) effervescent vine - 1 g	7700	ADEME (2014)
Additional composite cap (aluminium 35% recycled) effervescent vine - 3.2 g	5680	ADEME (2014)
Additional composite cap (aluminium 70% recycled / LDPE) effervescent vine - 1 g	4030	ADEME (2014)
Additional composite cap (aluminium 70% recycled) effervescent vine - 3.2 g	3300	ADEME (2014)
Additional tin cap	17100	ADEME (2014)
Screw cap (aluminium 35% recycled + PE seal / tin) - 4.8g	10600 10633	ADEME (2014) WFA calculator
screw cap (aluminium75% recycled + PE seal / tin) - 4.8g	7300	ADEME (2014)
Agglomerate quiet wine cork - 5.5g	2200	ADEME (2014)
Effervescent wine cork LA2R - 9.5g	4770	ADEME (2014)
Natural still wine cork - 3.5g	2310 438	ADEME (2014) AMORIM[25]
Muselet - 5.6 g	3850	ADEME (2014)
Natural Cork & PVC Capsule	2490	WFA calculator
Agglomerate Cork & PVC Capsule	4253	WFA calculator
Agglomerate Cork & Aluminium Capsule	4863	WFA calculator

The differences among published data can be explained by the differences in the methodology used, but also by the product chosen (country of production, transport conditions, recycled material used, recycling phase, etc...).

[25] (CORTICEIRA AMORIM, 2008)

f. Inputs for outer or transport packaging

Several values are given below :

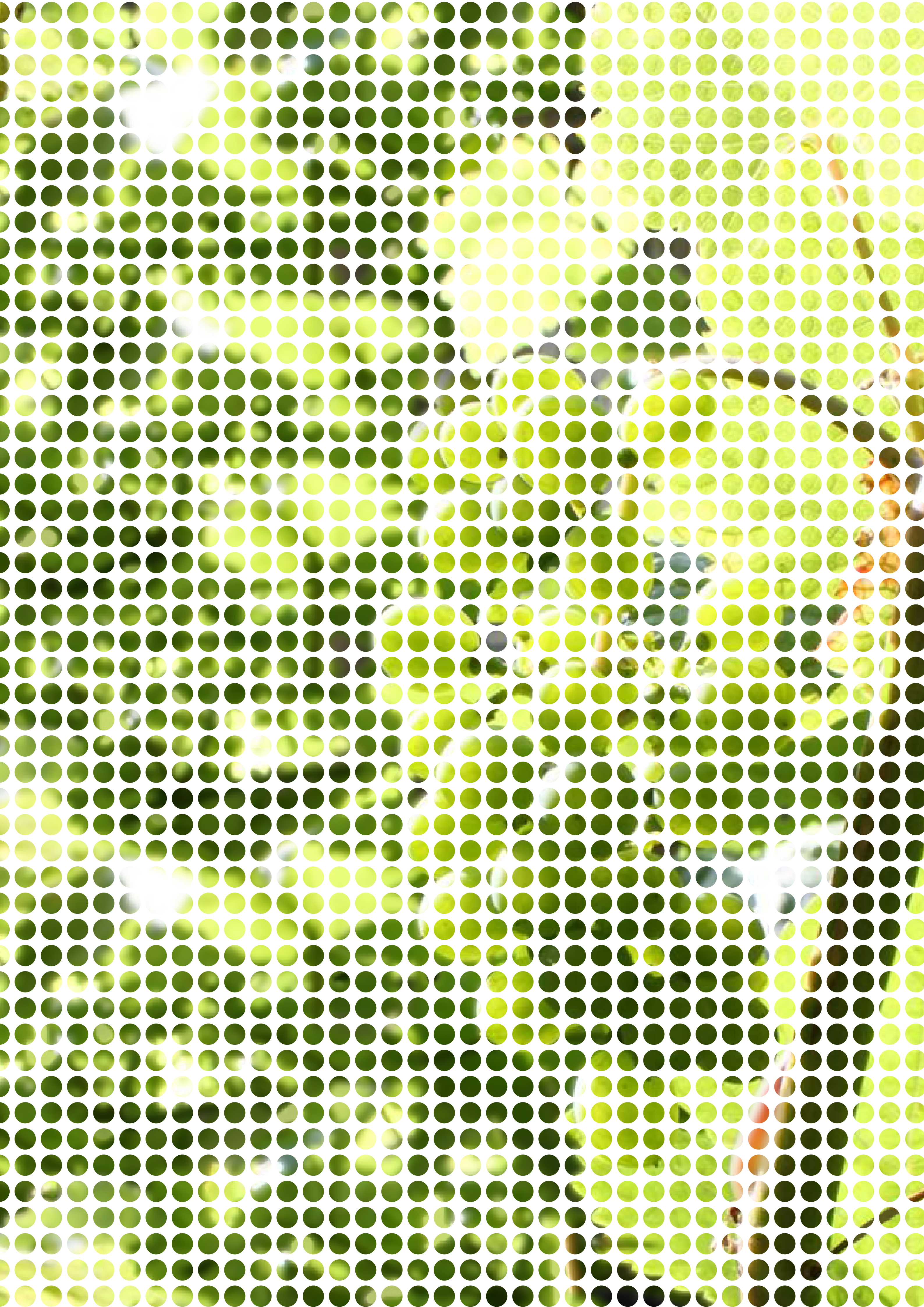
Table 21 Emission factors for outer and transport packaging

Input	Emission factor (kg.eq.CO /t)	Source
Paper labels (printed)	2930	ADEME (2014)
Glue (starch)	550	ADEME (2014)
Plastic film PET (non recyclable)	5500	ADEME (2014)
Cardboard	1060 1792	ADEME (2014) WFA GHG calculator

g. Emission during vineyard development phase (first 3 years)

These emissions should be accounted for in the product protocol.

They include emissions arising from agronomical operation during non-productive period of the vineyard, including emissions of nursery production chain, divided by 30 years of “standard” vineyard duration.



CHAPTER 3 WHAT PHASE OF PRODUCTION MAKES THE MOST IMPORTANT CONTRIBUTION TO GHG EMISSIONS

This section includes some studies that have analysed and quantified the GHGs emitted during two wine production phases.

(Bosco et al., 2011) studied the GHG emissions occurring during agricultural and winemaking/ processing phases. The results show that the agricultural phase plays an important role, with a considerable value of total global warming potential, compared with the wine processing phase.

Viticultural (Agricultural) phase

Within the agricultural phase the main processes generating GHG emissions were fertilizer and pesticide production.

The pre-production phase (tillage, fertilization, weed and pest, management, vineyard binding, material transport) were not significant in the context of the whole phase of production.

In the vineyard-planting phase, diesel consumption for the deep tillage operation done before planting was considerable.

Vinicultural (Wine processing) phase

Some studies ((Aranda et al., 2005); (Pattara et al., 2012) ; (Benedetto, 2013)) are formal life cycle analyses and their calculation include energy use and GHG emissions associated with the production and transport of inputs such as fertilisers and pesticides.

Within the wine processing, the production of glass bottles covers a great part of carbon footprint, over the total global warming potential. The weight of glass bottle should be considered with care

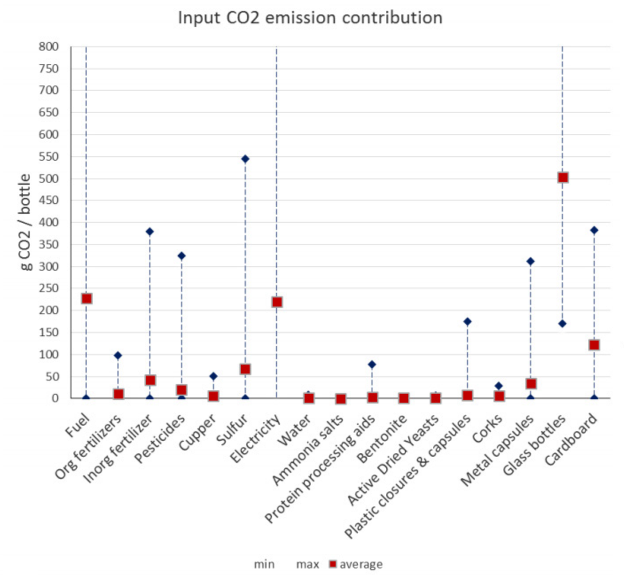
Finally, the GHG emission ranges for the vitcultural (grape growing) stage could be found in some relevant reviews (Garnett, 2007).

The ECOPROWINE project (ECO/11/304386) conducted GHG emissions analysis in 84 pilot medium-size wineries in Italy, Spain, France, Austria, Germany, Greece, Bulgaria, Portugal and Switzerland. The majority of pilot wineries were small family owned producers (< 20 ha of vineyard and < 100.000 bottles/year), but larger firms and cooperative wineries were also represented.

The results show that even taking into account the variability in size among wineries, glass, fuel, electricity and cardboard are by far the major contributors to GHG emission in a winery.

Nevertheless, this evaluation did not include plantings, building, equipment, internal transportation, and marketing activities, and other production factors that can have a significant impact on the carbon footprint of a finished product.

Figure 6 : Input CO_2 emission contribution (Zambrana et al., 2014)



Source: (http://www.ecoprowine.eu/results/2014/oct/12/d14-evaluation-assessment/)

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