ENERGY EFFICIENCY AND CLIMATE CHANGES IN THE WINE INDUSTRY:

PROCESSES, TOOLS AND GOOD PRACTICES EXAMPLES

The following companies are involved in this project:

INDEX

EDITORIAL COMMITTEE MESSAGE

Publication developed under the Technological Node Project "Energy and climate change: Exports sizing and competitiveness increase in the wine industry" performed by the Alberto Hurtado University, the Wine Technological Consortiums VINNOVA/Tecnovid and the Pontifical Catholic University of Chile, with the participation of the National Energy Efficiency Program of the National Energy Commission and the Prevent company. Innova Chile-CORFO financed this initiative.

The main objective of the project was to channel the interest of the Chilean wine companies in climate change and energy efficiency in a study that contributed with technical proposals to face these subjects countrywide.

Therefore, the most intensive wine process phases regarding energy and CO2 emissions were analyzed and the different improvement opportunities that can be implemented in the wine productive process were reviewed. From that start point, the available integral diagnosis tools were synthesized to develop a better management regarding energy issues and to reduce the greenhouse gas emission effect (GHG) and assembled the best practices in these subjects, in Chile as in foreign countries. Under the project frame, the energy flow understanding of the wine industry was intensified, which represents an innovative solution to the measuring technology for this industry in particular.

The project technical management was under the direction of Nicola Borregaard of Alberto Hurtado University and the coordination of the project was carried out by Elena Carretero of the Wine Technological Consortiums, Vinnova S.A. and Tecnovid S.A. In order to follow the different project phases and outline its results and action lines, a Work Team was set up, formed by the Project Team and representatives from wineries and related companies, among others. The following are the members of the Work Team:

Nicola Borregaard, Project Director, Alberto Hurtado University.
Elena Carretero, General Manager Wine Technological Consortiums, Vinnova S.A. and Tecnovid S.A.
Edmundo Bordeu, Oenologist and Researcher Pontifical Catholic University of Chile .
José Ignacio Medina, Project Assistant Universidad Alberto Hurtado.
Felipe Jara, Project Manager Wine Technological Consortiums, Vinnova S.A. and Tecnovid S.A.
Daniela Zaviezo, Project Coordinator of the National Energy Efficiency Program.
Rodrigo Valenzuela, CDM Project Manager Deuman.
Gunther Klemmer, General Manager Prevent Ltda.
Laura Noguer, Sustainable Development Coordinator Concha y Toro Winery.
Jorge Heiremans, Production Manager Santa Rita Winery.
Julio Fariña, Environment, Energy and Quality Assurance

Department Chief Los Vascos Winery.
María Elena Martinos, Marketing and Environment Manager Cono Sur Winery.
Verónica Barros, Marketing Manager Botalcura Winery.
Mauricio Naranjo, Production Manager Cousiño Macul Winery.
Cristián Infante, Planning and Development Manager Ventisquero Winery.
Matías Ovalle, Commercial Manager Cousiño Macul Winery.
Rosario Palma, Oenologist Cousiño Macul Winery.
Felipe Vial, Oenologist Botalcura Winery.
Gerardo Leal, Research and Development Department Chief Errázuriz Winery.
Marco Herrera, Operations Manager Miguel Torres Winery.
Fernando Flores, Planning and Development Engineer Ventisquero Winery.
Bárbara Wolff, Vice Manager for Corporate Communications San Pedro Winery.

The Project Team thanks the active participation and valuable inputs of the Work Team members, as well as of the support of Ann Thrupp, John Gran, from the Wine Institute of California and of the companies Greensolutions and Deuman.

CHAPTER I
INTRODUCTION

The wine viticulture and the winemaking process are part of the natural, productive and cultural Chilean landscape and have been for several centuries. The companies and workers in the sector are, in many areas, the backbone of the local economy.

Since it is an activity depending on a natural resource and highly sensitive to environmental factors (water scarcity, rain, solar radiation, soil conditions, among others) it has incorporated environmental protection as a main element of its management. This concept has been broadened and deepened lately, and presently embraces the care and good use of resources and waste and emission treatment as well as the possible effects of global climate changes

Presently, sustainable wine production is recognised as a responsibility of the sector players towards the rest of society and assumed by the companies of the sector, in all its economical, social and environmental phases.

In this context, the objective of this publication- and of the project that makes it possible – is to deepen the Chilean wine companies' interest in climate changes and energy efficiency subjects with a study that provides technical and viable proposals nationwide.

There are five powerful reasons why climate change and energy management can not be absent from the innovative and competitive sector agenda:

In first place, the 21st Century has placed sustainability on the global agenda not only as a marketing tool but also as a real requirement for the feasibility of our culture and economies.

Secondly, two of the decisive elements in a sustainable process are the energy efficiency and the decrease of Greenhouse Gas Effect (GHG) emissions. One of the decisive factors linked to the GHG emissions is energy consumption. Its decrease not only contributes to the GHG emissions decrease, but also, is a key to maintain and improve company's competitiveness and to reduce its costs. The wine industry is a highly energy demanding sector. In fact, 100% of the companies use electric energy in some of their productive processes. Also, it is recognized that there is an average relation worker-machinery ratio of 1:3.5. In other words, per each worker there are 3.5 machineries per company. A successful energy management is even more essential if we consider

the increase of the seasonable tariff during the months of higher energy consumption of the sector[1].

Thirdly, different countries worldwide have started to estimate the GHG emissions generated in products manufacturing (especially in the food sector) and to define the requirements in this subject. To move forward in these requirements it is essential to opt for a proactive strategy in the use of technologies that minimize these emissions, and at the same time be coupled with strategies to obtain better quality, more value added, and finally a better market positioning.

Fourthly, and linked to the former, consumers are presently more aware of the impact of their decisions regarding climate changes and CO2 emissions and, therefore, are more demanding when selecting a product to consume. In the wine industry, several countries are already responding to these more demanding requirements with public-private initiatives, amongst which it is important to highlight the following:

- Australia's sustainable vineyard system.
- New Zealand wine industry growth program.
- Integrated production of wine industry system in South Africa.
- Sustainable Growth program of the wine industry in United States.
- Sustainable Principles of the International Organization of the Wine Industry Commerce, FIVS.

(Source: Ann Thrupp, 2007).

Finally, an effort in energy issues at sector level means a contribution to the clean energy usage, diversification of the local energy pattern and greater energy independence on behalf of the sector by covering, based on alternative energies or energy efficiency, at least part of their needs.

For these reasons, it is essential to improve significantly the energy management in wine production. Therefore, it is necessary to optimize the processes and create more efficient use of resources, and also to control and supervise the energy consumption and the CO2 emissions connected to each phase of the production process. The improvement opportunities envisioned in this subject, aim to achieve four objectives: economic and energy saving, decrease in CO2 emissions, yield increase, and image improvement with consumers worried about the use of resources.

Now, the Chilean wine industry has galvanised these efforts to generate a new policy on this subject and has started the process towards the sustainability in phases. If the domestic wine companies modify their processes by decreasing their carbon footprints and increasing the energy efficiency, a ripple effect will be generated, which will encourage other companies to get involved with these and more sustainable objectives, generating a synergy towards domestic sustainability.

1 Before 2008, the special winter tariff considered peak hours the period from 18:00 to 23:00 hours during the months of May, June, July, August and September of each year. Since that year April was also included.

CHAPTER II
ENERGY EFFICIENCY OPPORTUNITIES AND REDUCION OF CARBON FOOTPRINT IN THE WINE INDUSTRY

Before outlining an energy efficiency strategy and carbon footprint reduction in a vineyard, it is necessary to bear in mind that "one size does not fit all", in other words, there is no tailor made model to follow. An effective strategy that allows the improvement of the energy efficiency and decreases the CO2 emissions in a vineyard will depend on the specific environment of the company. In this way an initiative with successful results in a specific vineyard, perhaps will not work in other vineyard. For this reason, it is important before investing in technology to perform an assessment of each phase of the production, in order to guarantee the expected results.

Next the most significant wine industry process phases in terms of energy consumption and GHG emissions within the wine production process are introduced and analyzed. Then, there is a discussion on the opportunities to improve the processes in these subjects.

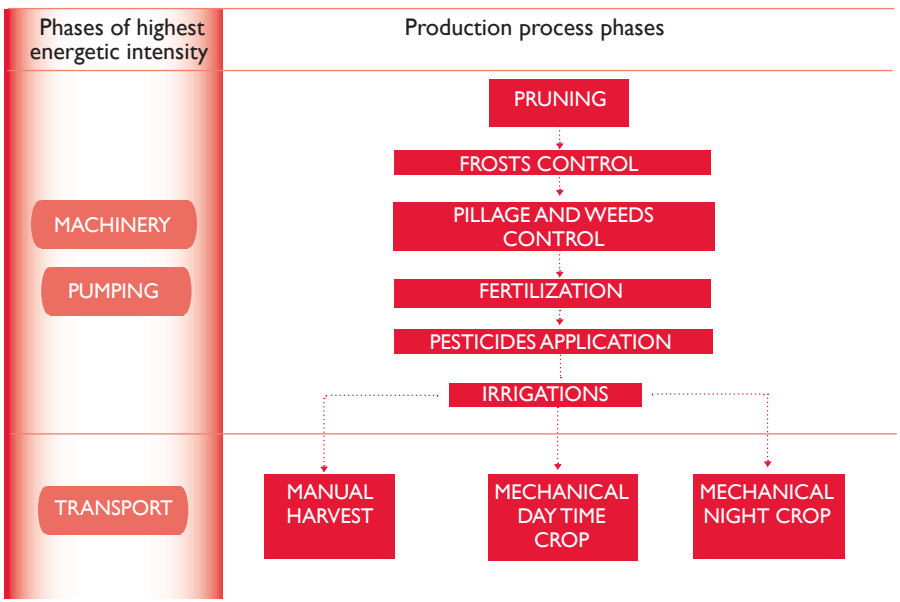
2.1 Energy consumption and carbon footprint in the wine production process.

The objective of the following figures is to show the most intensive phases in terms of energy consumption and carbon footprints. A figure of general and simplified flow in the wine-growing process and two figures of the

The **Carbon Footprint** refers to the amount of CO_2 produced by a company or a person, and its resulting contribution to the global climate changes. In some countries, such as England, some companies have started to include a "carbon label" on their products to warn consumers about the CO_2 amount involved in its production.

The **Greenhouse Gases** (GHG) are those gases that increase the natural greenhouse effect of the world. The Kyoto Protocol on Climate Change recognizes six GHG: carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), perfluorocarbons (PFC) hydrofluorocarbons (HFC), sulphur hexafluoride (SF_6). Of all of them, CO_2 is the most abundant in the planet.

FIGURE 1: WINE-GROWING PROCESS FLOW



Source: Own elaboration.

wine process of red wine and white wine respectively are included. In each of them, in the left column can be observed the more energy consuming activities (and, therefore, with greater carbon footprint), arranged according to hierarchy.

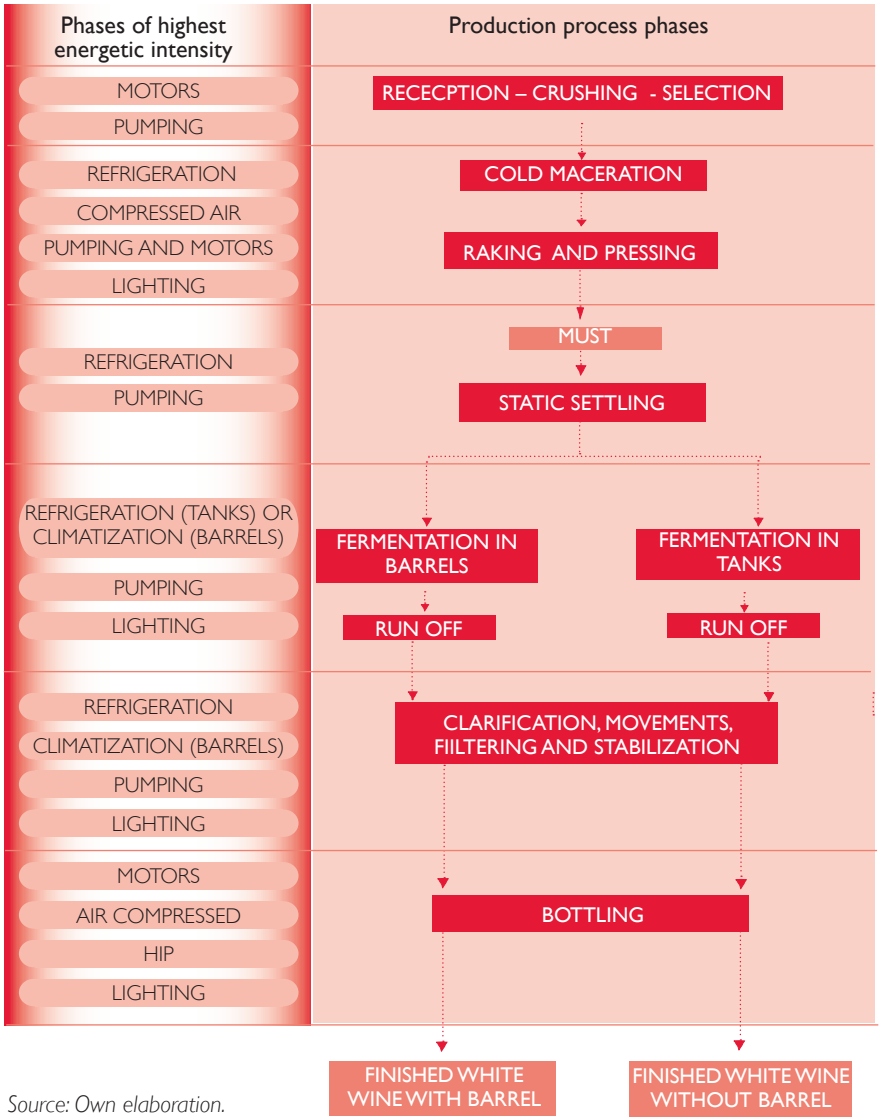
Energy consumption and carbon footprint in a wine-growing type process

As observed in Figure 1, the wine-growing process has two high energy intensity (and GHG emissions) phases. The first, in relation to crop management, refers to the use of machinery and pumps for irrigation; and the second is related to the harvest and grape transportation.

Energy consumption and carbon footprint in white wine production

In the white wine process (Figure 2) six important phases were identified regarding energy consumption, with special mention throughout the process of the refrigeration requirements.

FIGURE 2: PRODUCTIVE FLOW OF WHITE WINE



Source: Own elaboration.

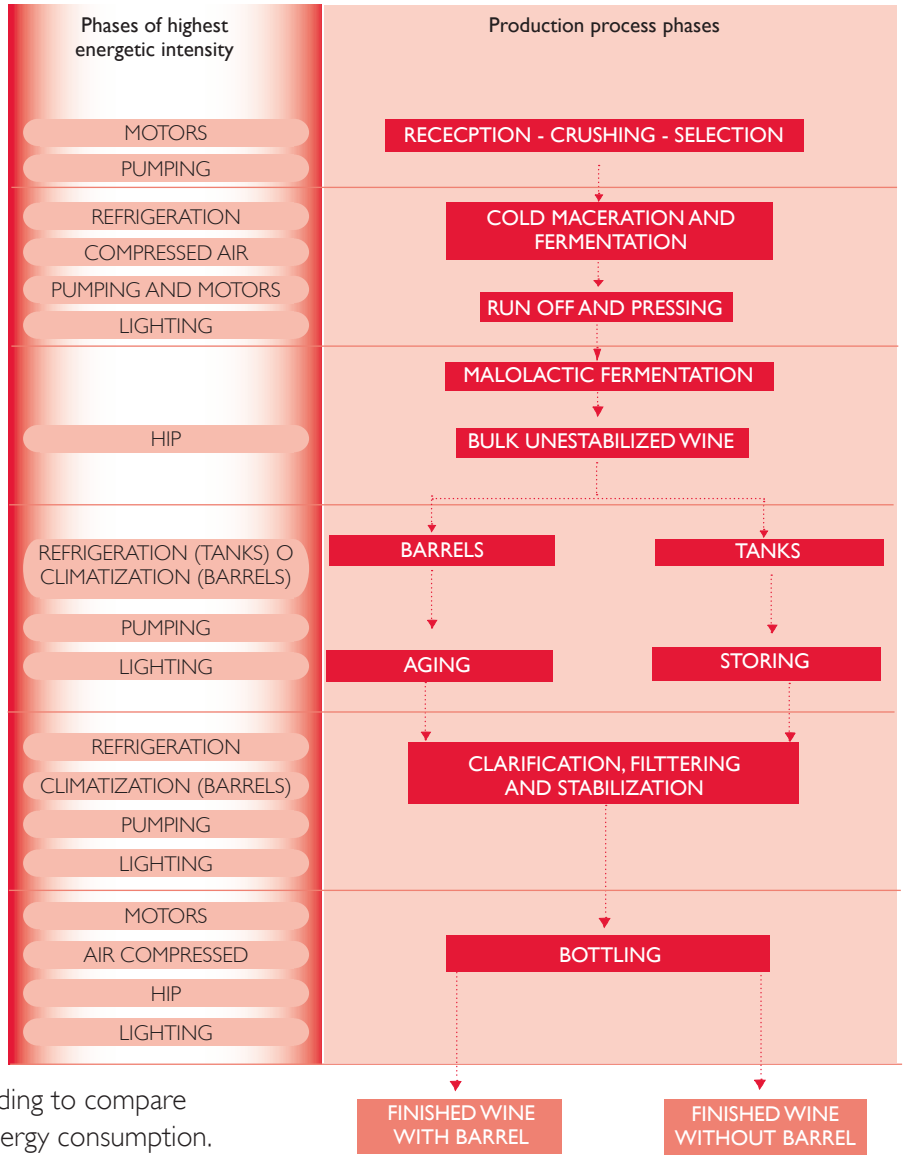
Energy consumption and carbon footprint in red wine production

As in the white wine case, in the red wine productive process six important phases in terms of energy consumption were identified, with special emphasis throughout the process on the use of heating and refrigeration equipments.

The three figures are very general and do not intend to give an exhaustive summary of the wine processes that are developed nationwide, but rather are exhibited more as a guide to identify the most important energy needs of the sector.

Therefore, it is understand that each particular wine production process is unique, in terms of the use of energy and carbon footprint. For example, a quality red wine production has a different production process than bulk white wine, which obviously has important involvements in the energy consumption per litre produced. For that reason, it is misleading to compare different type of wines, in terms of energy consumption.

FIGURE 3: PRODUCTIVE FLOW OF RED WINE



Source: Own elaboration.

In order to assist with this situation, inside the Technological Node "Exports and Competitiveness in

the Wine Sector: Energy Efficiency and Climate Change" [2], there is an "energy litre equivalent" concept under development as a benchmarking tool, which enables a comparison to be made of the energy management of different wine types through a weighing factor.

2.2. Improvement opportunities[3]

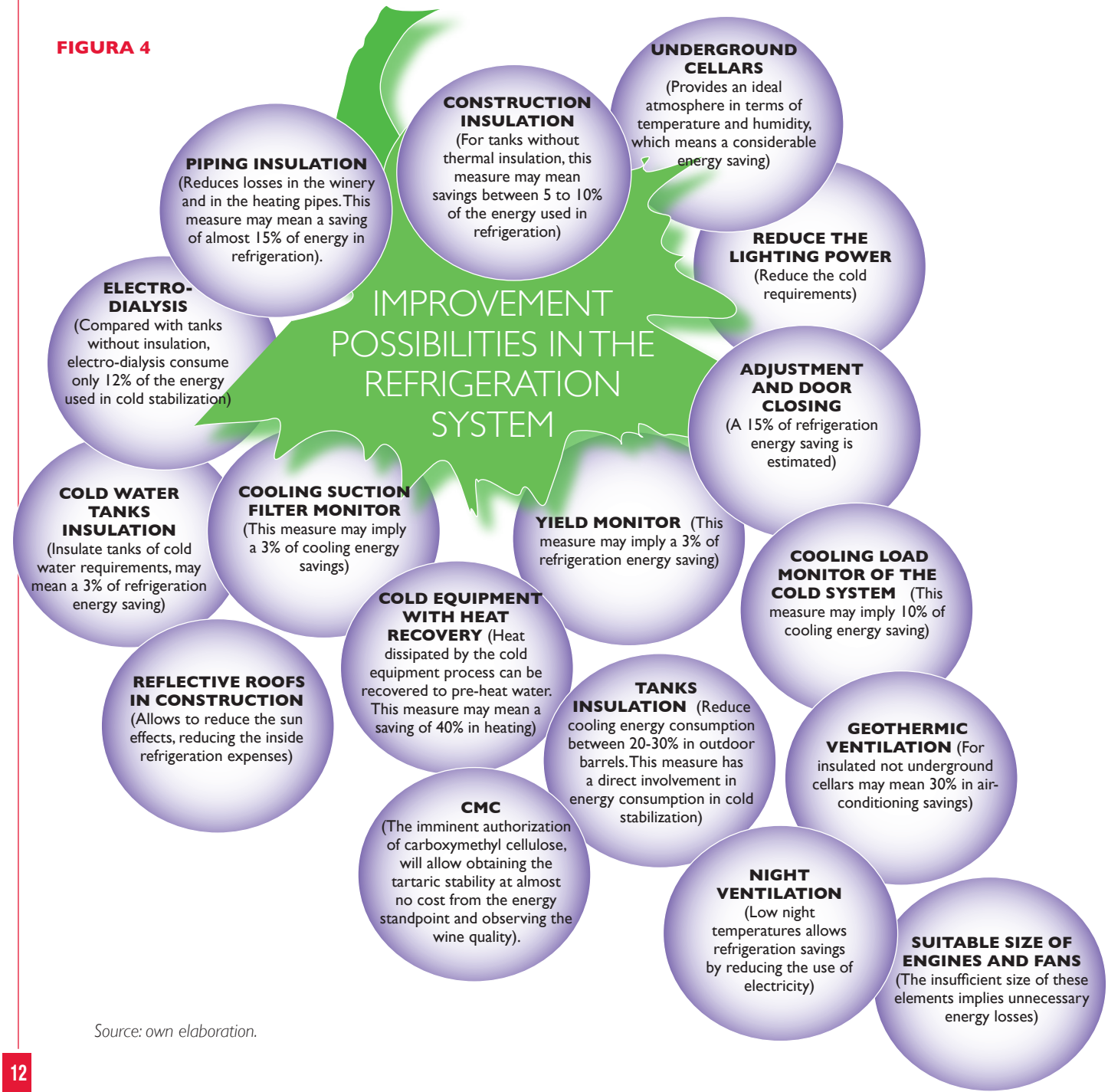
Following some opportunities to improve the energy management in wine production and consequently to reduce the greenhouse gas emissions in the sector are showed. The figures include different opportunities identified in each of the systems of the productive process: refrigeration, heating, pumping, air- conditioning, electric and lighting system. There are other improvement opportunities that may not be acceptable due to beliefs related to the wine production process. A good example of this is the different opinions in relation to low temperature requirements to obtain the desired aromas in the white wine fermentation. While, the lower the temperature in white wine fermentation the better the aroma acquired and the greater the energy consumption. Nevertheless, these aromas are non-durable, which means that often they do not reach the consumer (specially the European consumer). A potential increase in the fermentation temperature can be justified when the objective market is too far away and there are no means for the acquired aromas to survive, reducing therefore the energy consumption.

Since these systems are closely linked, probably the implementation of the above mentioned measures described in the figures that are shown next may better represent improvements in more than one system.


Viña Ventisquero

2 The Technological Node is an initiative created in the frame of the Project "Exports and Competitiveness in the Wine Sector: Energy Efficiency and Climate Change". It is made up by a network of entities and experts, which identify the technological needs of the sector and try to look for solutions.
3 Most of the improvement opportunities that are presented next are for the wineries.

FIGURA 4



Source: own elaboration.

FIGURA 5

IMPROVEMENT POSSIBILITIES IN THE HEATING SYSTEM

Source: own elaboration

FIGURA 6

REDUCE THE PUMPING NEED
(Measures like the appropriate use of gravity may reduce the pumping need. In this sense, it is recommended to receive the grapes in the upper part of the winery in order to use gravity and minimize pumping energy)

REDUCE FRICTION IN THE PUMPING SYSTEM
(To use pieces appropriately polished or covered with fixed pipings, decreases friction and increases energy efficiency. This measure may imply an energy saving of 2% to 3%)

SYSTEM CONTROL
(The objective of this measure is to turn off pumps when they are not needed or reduce charge until needed, through a remote control or a control panel)

MAINTENANCE AND SUPERVISING
(An inappropriate or poor maintenance of the pumping system efficiencies for long periods increases the energy costs. This measure may mean a pumping energy saving up to 7%)

BELT SYSTEM REPLACEMENT
(It is recommended to replace the belt drive transmission system by a coupling support pillar which may imply significant pumping energy savings)

ACCURATE PIPING MEASURING
(Oversized pipes causes unnecessary energy consumption. An appropriate adjustment of the pipes diameter may mean a saving of 5% to 20% of pumping energy consumption)

PUMP REPLACEMENTS
(There are motors between 2% to 5% more efficient than older models. The application of this measure depends of the pump hours of use)

VARIABLE SPEED FOR PUMPS
(Through a frequency controller an important pumping energy saving can be obtained)

SYSTEM ADJUSTMENT
(The system adjustment, in order to get closer to the higher yield point in the pumping curve, causes mayor energy efficiency)

USE OF MULTIPLES PUMPS
(The installation of parallel pumping systems may allow savings from 10% to 50% of energy use in pumping)

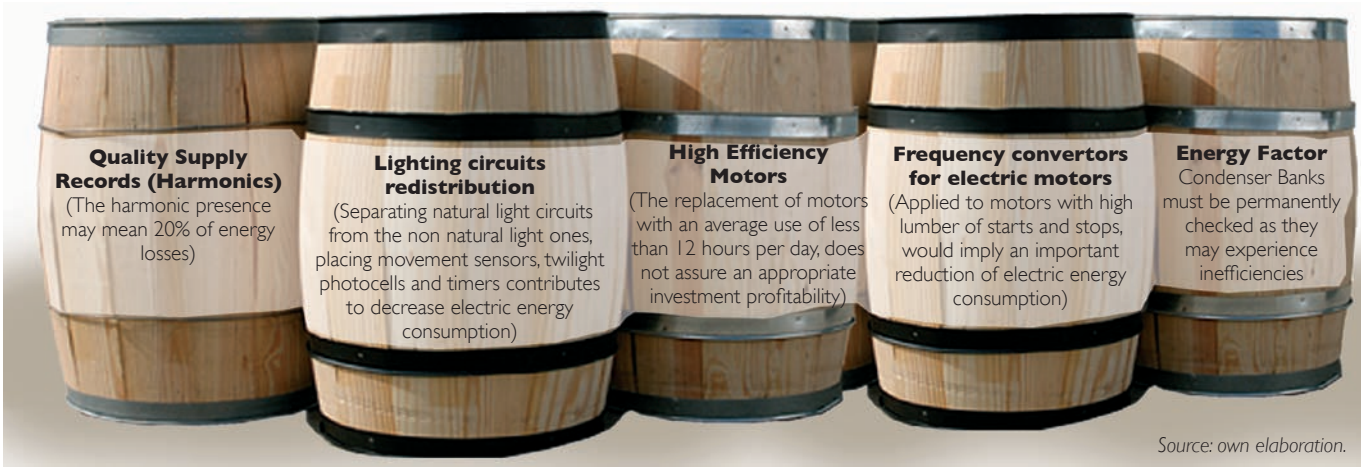
Source: own elaboration.

FIGURA 7

Source: own elaboration.

FIGURA 8

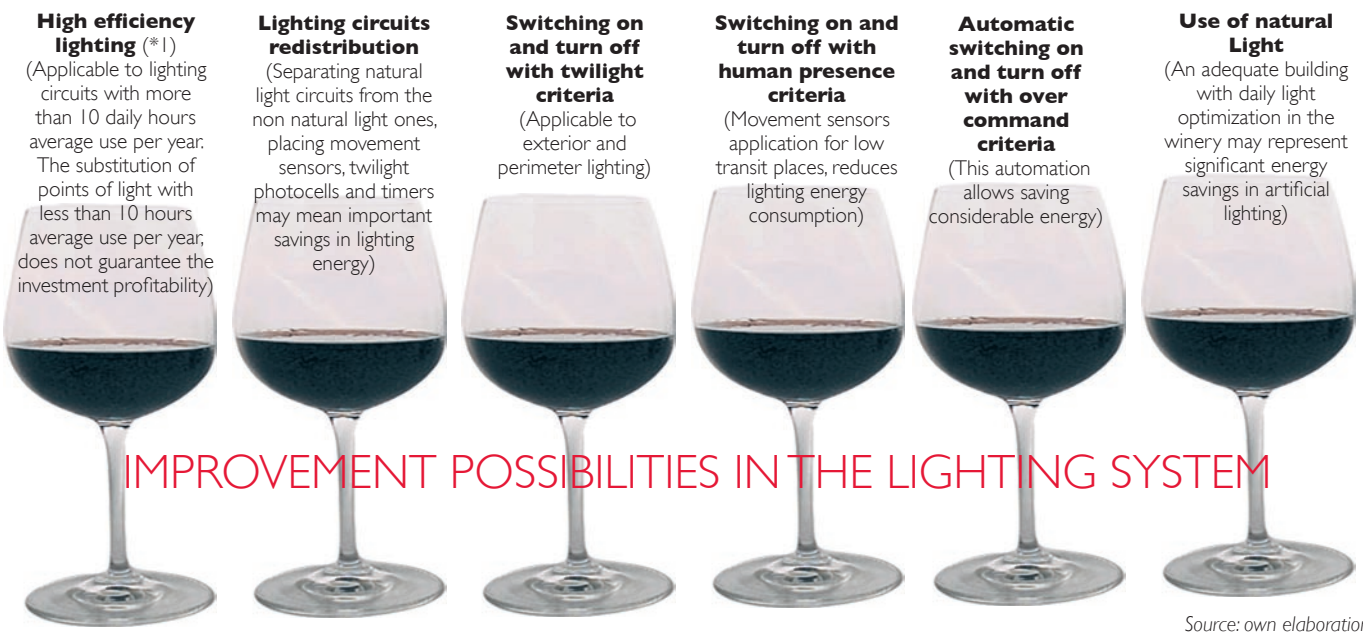
IMPROVEMENT POSSIBILITIES IN THE ELECTRIC SYSTEM



Source: own elaboration.

FIGURA 9

IMPROVEMENT POSSIBILITIES IN THE LIGHTING SYSTEM



Source: own elaboration.

**1: Today there is high efficiency lighting than can reproduce the desired color (contains color reproduction indexes). Lighting can reproduce the natural light color)*

CHAPTER III
INTEGRAL MANAGEMENT TOOLS

Due to the many opportunities and numerous solutions involved in the improvement of energy process in wine elaboration, it is necessary to have an integral vision. During the last decade different management tools have been designed enabling a comprehensive vision of energy consumption in a winery's installations.
There follows a description of three existing tools. The first, designed to measure the carbon footprint in a production process and related activities. The second is software for benchmarking in energy efficiency and water use issues. Finally, an energy diagnosis tool offered through a CORFO pre-investment instrument is presented.

3.1 International Protocol of Carbon Emissions Calculation in the Wine Industry

The interest in assessing the impact on climate change from an industry is not new. A decade ago a work team formed by the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD) was created, which joined with governments and ecological groups, elaborated the Green House Gas Emissions Protocol (GHG Protocol), and this became the most worldwide recognized and used instrument by governments and companies to understand, quantify and manage the GHG emissions. This tool is used by companies as a corporate transparency instrument (regarding the performance of the company towards the climate change), with the objective of offering a product with more added value.
Presently this group continues working in order to permanently elaborate more effective and credible programs to face the climate change. In the same way, the International Protocol of Carbon Emission Calculation in the Wine Industry, created in 2008, represents a project of the Wine Institute of California, New Zealand Winegrowers, South Africa's Integrated Production of Wine Program, and the Winemakers Federation of Australia to adapt this instrument to the wine sector. Its objective, as well as its annex document, "Greenhouse Gases Calculation", is to measure the carbon footprint of the installations and operations of wine companies of all sizes. According to its authors, the idea is that the companies use and take advantage of the Protocol and its calculations, among others, in order to:

- To perform mandatory and voluntary reports.
- To calculate their own carbon footprint.
- To supply information to clients regarding company carbon emission impact.
- To create a management tool to obtain the company's climate neutralization (which is obtained by calculating the GHG emissions generated with the objective of offsetting them somehow)
- To respond to mandatory requirements regarding carbon emissions.

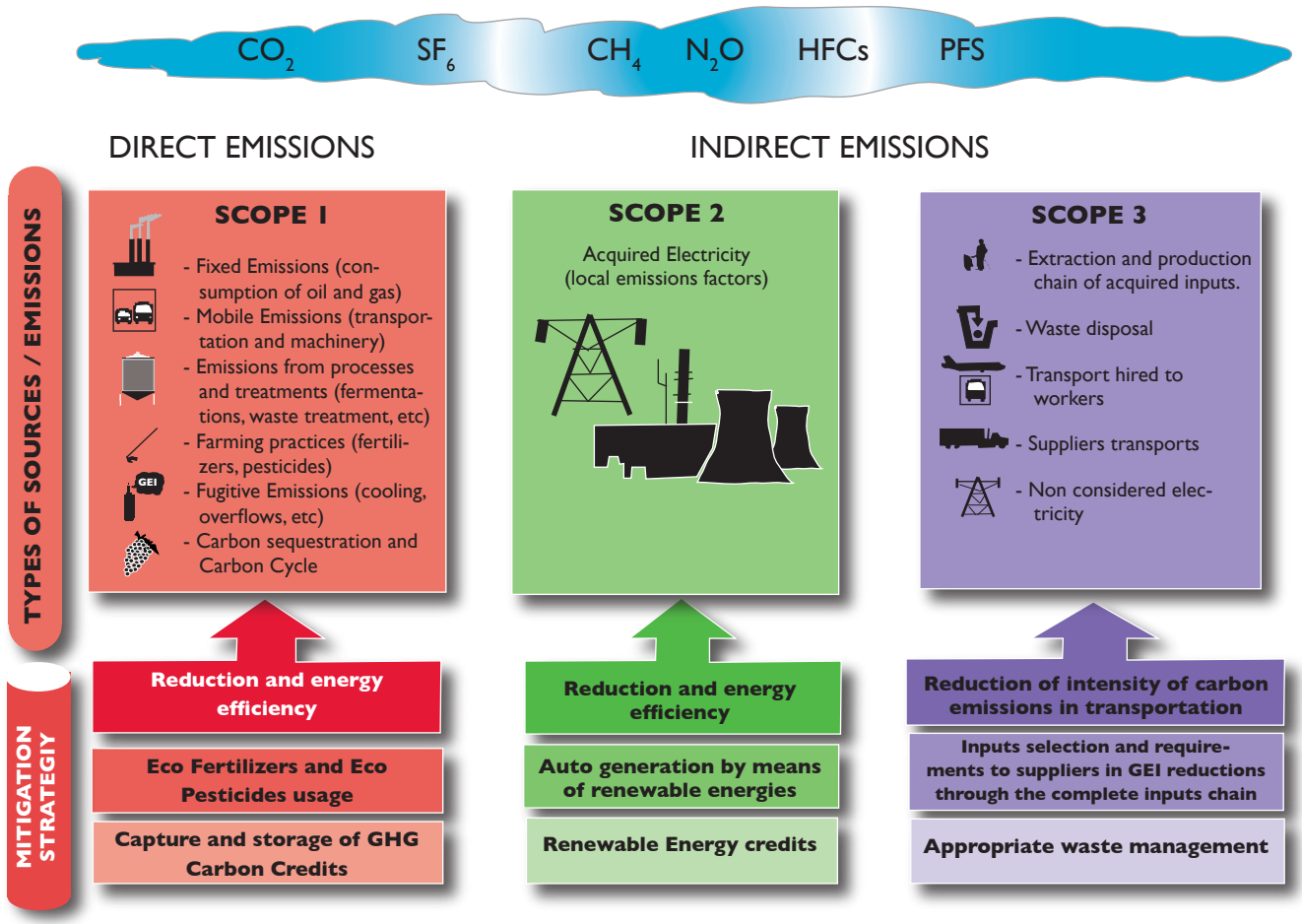
This tool is presently in a start up phase, and is already in use in wineries of the countries that participated in its development, and also in wineries from other countries, including Chile. Today there is national initiative led by the Fundación para la Innovación Agraria (FIA) (Agricultural Innovation Institute) that aims to make metric adjustments to the Protocol to suit the Chilean context.

The Protocol differences and allows to asses GHG emissions of three different scopes of action:

- Direct emissions coming from the fuel usage.
- Indirect emissions by the electricity use.
- Indirect emissions related with inputs such as fertilizers and packaging and inputs transportation to wineries.

The following Figure shows the different scopes of action and potential mitigation strategies of each of them.

FIGURE 10: GHG EMISSIONS SCOPE AND MITIGATION STRATEGIES



Source: own elaboration. Adapted from the User Guide 1.2 of the International Protocol of the GHG Emissions Calculation in the Wine Industry.

The type of sources included in each of the scopes of action depends on the business of the company. For example if the vine growing is part of the business, it is considered in the scope 1. While, if the company obtains the grapes from third parties the viticultural process is consider in the third scope. The application of this tool requires a large amount of data regarding the energy consumption of the productive process and others, and of an expert's advice due to the complexity of the work schedules and its metric.

The Protocol and the Excel spreadsheets can be downloaded from:
http://www.wineinstitute.org/ghgprotocol

3.2 BEST Winery

BEST Winery4 is a software developed by the Lawrence Berkeley National Laboratory of United States, which acts as a support to wine producers, providing basic knowledge to assess and manage the water and energy resources used in the wine making process, as well as data regarding available technologies to reduce energy and water consumption in a winery.

Considering that it is impossible to a priori define what it means to be efficient in technical and numeric terms in a winery, this tools uses the data of a reference winery. In other words, BEST Winery enables a comparison of the energy efficiency of the wine industry with an efficient standard experience. The company yield is then compared with the yield of an "optimum" (reference) wine company.

This tool allows the strategic planning of the energy efficiency and water use measures, appraising its impacts, costs and savings. One of the restrictions of this program is that it assumes default values over the productive process of the winery (for example, it assumes that the hot water system for malolatic fermentation works sixteen hours per day for four months per year).
As an example of its use, the results of BEST winery obtained from the information of a hypotactic winery are shown next (See Table 1)

This software has been applied in several wineries of California. For more information and to request the program, you should visit the following website: http://best-winery.lbl.gov. The last update of BEST Winery data was performed in June 2007.
Since July 2008 there is another program also available, named AMETHYST, developed by Ecofys Netherlands, Universita Cattolica del Sacro Cuore, Forschungsanstalt Geisenheim, Chambre d'Agriculture de Gironde and BestErgy Soluciones Energéticas SL. AMETHYST is an adjustment of the "BEST Winery" model and is available in Spanish in the website: http://www.amethyst-project.eu

4) BEST Winery does not mean "best winery" but it is an acronym whose initial means "Benchmarking and Energy and Water Saving Tool for Wine Industry".

TABLE 1: APPLICATION OF BEST WINERY IN A HYPOTHETICAL WINERY

DATA SUMMARY	
Your Winery	
Electrical Consumption (KWh/year	350568
Fuel consumption (MBtu/year)	650
Primary energy consumed (MBtu/year)	3250
Energy intensity (kBtu/box)	44,5
Water consumed (litres/year)	989000
Water intensity (litres/bottle)	12,1

Referential winery	
Electrical Consumption (KWh/year	180203
Fuel consumption (MBtu/year)	479
Primary energy consumed (MBtu/year)	1815
Energy intensity (kBtu/box)	24,9
Reduced total costs	28492
Water consumed (litres/year)	641,437
Water intensity (litres/bottle)	7,8

EII	179	
WII	154	
Detail of results		
Technical potential to improve efficiency		
Electricity (kWh saved/year)	170365	49%
Fuel (MBtu saved/year)	171	26%
Primary Energy (MBtu saved /year)	1434	44%
Water (litres saved/year)	347563	35%
Operation net costs reduction		
Electricity (US$/year)		25555
Fuel (US$/year)		2351
Total Energy		27906
Water (US$/year)		586
Total Costs Reduced		28492
CO2 potential reduction		
Total (CO2/year metric tons)		49,3

Note: EII is an energy intensity indicator relative to benchmark, while WII is a water use intensity indicator relative to benchmark.

Source: Galitzky, et. al., 2005b.

3.3. Integral diagnoses and energy audits

"Energy Diagnoses" are instruments that allow to asses at a certain point, the management and technology status of a company regarding the energy supply and consumption. These diagnoses can be from a very simple straightforward self-checking, that follow a simple pattern of questions, up to more complex formal tools.
Energy diagnoses constitute the basis of the interventions and specific improvements in energy consumption and reduction in GHG emissions issues in a company.

The two former tools mentioned above, the GHG Protocol for the wine industry and the BEST Winery software can be used to accomplish energy diagnosis. Nevertheless, if it is intended to perform a deeper energy study it is essential to carry out an external audit with a qualified professional or team, in order to obtain a clear idea of the energy consumption profile of the company and identify, therefore, the improvement opportunities that allow greater efficiency in the production process. Today in Chile there are almost twenty qualified and experienced companies that can execute energy diagnosis in companies linked to the

agro-industrial sector (most of them are registered in the Instituto Nacional de Normalización (National Standardization Institute – www.inn.cl).
One of the main problems that the small and middle size companies (PYMES) have to face to develop energy diagnosis is funding. With the objective of contributing to overcome this impediment, CORFO presently has a valuable tool, not very known in the wine industry.
It is the Pre-investment of the Energy Efficiency (PIEE) instrument.
PIEE acts as a subsidy, all companies with a net annual sale of up to UF 1million can apply to it, and it can subsidize up to 70 percent of the consultancies to a maximum of 6 million Chilean pesos.
Although each consulting company has its own system or scheme to carry out diagnosis under the PIEE framework, the applicant company must clearly define the main elements that must be present in each case.
PIEE is schemed in order that the companies obtain the following products:

- Energy efficiency audit: In order to know the company's energy sources, its uses, sub-processes and yield levels, to identify the potentials of the existing efficiencies.

- Energy efficiency measures implementation plan: Consistent in the design of an Implementation Plan of energy efficiency actions and measures, considering the priorities criteria of costs, benefits and deadlines.

- Investment projects to create a funding source: Corresponds to the development of an investment plan to carry out energy efficiency measures, considering audits, the measures, the company status and requirements of the country banking system.

Presently the future **ISO 50001 Standard** is under development, which will allow the establishment of a highly applicable energy management framework (industries, business facilities, and others). This standard will allow to systemically approach the energy yield and its impacts in the climate changes, representing, therefore, an important progress for the energy audits support. It is expected to be in published by the end of 2010 (Environmental Protection, 2008)

CHAPTER IV
WINE INDUSTRY EXPERIENCES

Next there are some notable experiences in different domestic wineries. Many of the good practices included may be very easy to reproduce, while others are more sophisticated. In this sense, it is important to mention, that many of the highlighted measures are the result of previous studies, which have identified the most suitable opportunities of improvements for the particular context of the wine company. At domestic level are described the initiatives of Santa Rita, Miguel Torres, Cousiño Macul, Concha y Toro, Ventisquero, Cono Sur, Errázuriz, Seña and Caliterra, Los Vascos and De Martino wineries, and the Cristal Chile experience. At international level, are described the initiatives of Fetzer, Emina, Cullen and Sonoma wineries.


Santa Rita Winery

4.1 Domestic Experiences

SANTA RITA WINERY[5]

Among the many energy management initiatives that Santa Rita Winery has developed it is important to mention:

Geothermic and aerothermic energy

For barrel and bottle storage rooms air conditioning has been introduced in an innovative, although very old, form of using this energy.

- Bottles storage: The winery has built an underground warehouse with a 1.2 million bottles capacity, which allows constant environmental temperatures between 15° in winter time and 18° in summer time, without major changes during the day. The fact that it is underground, besides providing excellent thermal insulation, it permits energy conduction from the underground to the environment through the concrete walls. Additionally, during the night, when the environmental temperature from the exterior is less than the interior temperature, fresh air is injected through a forced ventilation system (free cooling) at very low energy consumption. This has resulted in energy costs for such maintenance as close to zero.
- Barrel storage: Unlike the former case, this cellar, with a capacity of 4.000 barrels, is an external building where the housing insulation has been improved and, as well as the night air injection system, an automatic humidity system was incorporated, which helped to maintain the temperature thus reducing the energy costs by 80%.

5) Data provided by Jorge Heiremans, Production Manager of Santa Rita Winery.

Distance supervision

Through modern software, a remote monitoring has been incorporated for cool and hot plants of three installations. The system, which is managed by a maintenance technician from the headquarters office, allows visualizing the working parameters, alarms and energy consumption of the premises. This benefits the on line interaction by facilitating the working parameters adequacy, controlling peak hours stopping, adapting the demand generation and taking more efficient decisions for cold and hot generation .

The former has reduced maintenance costs, operation and energy consumption plus it has improved the service quality.

Accurate and by request energy

In this industry almost all the production processes that demand thermal energy are performed in a disjointed way during some periods of the year (as for example, the alcoholic and the malolactic fermentation) that occur during some hours of the day or the week (as for example, stabilization, disinfection or temperature adjustment).

As a great deal of energy is used in the maintenance of the active systems, the winery besides from planning and adjusting the need to the generation, has installed some equipment that make more efficient use of energy:

- Stabilization: After vintage and before summer, the only need for cold corresponds to the stabilization process. To improve efficiency, high power heat exchangers were installed to shorten the stabilization period, by performing weekly campaigns. The former reduced by 60% the energy cost of this process.
- Caloric Energy: Formally in Viña Carmen's winery, located in Buin, water was heated in an oil boiler at 800 ton steam/hour horsepower. This was a blind system, in which without taking into consideration the winery needs, the boiler maintained the steam temperature very "efficiently". Presently, the boiler is shut down and has been replaced by two tanks with a direct heating system where the cellarman heats only the water that is needed for its process. The former, besides producing an energy saving of 73% (from 2.537 MCAL to 685 MCAL) generated other savings related with less maintenance costs and workforce.

MIGUEL TORRES WINERY[6]

Miguel Torres winery, wanting to improve its energy management has developed several initiatives. Some of them have already started up (such as changing the ordinary light bulbs for energy saving bulbs), other initiatives are about to be implemented (solar panels) and others are under evaluation (by external audit). Next, two of the most notable initiatives implemented by this Winery are described:

Difference increase of air condition hall settings

In all the halls with climate control systems and equipments, such as product in progress, dry raw material, finished product and production lines, the differential of maximum and minimum temperature settings ranges of equipment was increased, previously agreed with the productive and quality control departments. This finally resulted as a lower use of the equipment. Table 2 shows the energy saving

6) Information provided by Marco Herrera A., head of Mantencion and Operation, Sociedad Vinícola Miguel Torres. All the indicated values are referential.

resulting from this initiative. This initiative is easy to be implemented, low investment (approximately 2 million Chilean pesos for the change of the climate controller kind) and uses a technology easy to find in the market.

TABLE 2: ENERGY SAVING DUE TO INCREASE AIR CONDITIONED HALL SETTING DIFFERENCE IN MIGUEL TORRES WINERY

Energy kwh fix setting performance °C	502.324
Invoicing	$15.218.190
Energy kwh setting performance with differential of 4 to 6°C (heat and cold)	350.433
Invoicing	$10.661.454
Annual saving Kwh	151.891
Annual saving $	$4.556.736
KWH/L Normal or Fix setting in product in progress and in finished product (1.000.000L)	0,5
KWH/L with differential setting increase	0,35

Source: own elaboration.

Switch off climate equipment according to environmental temperatures

The objective of this initiative is to switch off the climate equipment when the environmental temperature is equal to the hall control temperatures, allowing to open the doors (generally at night), decreasing therefore the energy consumption. This initiative practically has no costs and is very easy to implement.

Presently the climate hall equipment switches off manually according to the environmental temperature, but soon an automatically switch off and start up hall air injection and extraction forced control system will be implemented.

Table 3 shows the energy savings from the initiative, taking advantage of the winter environmental temperature.

TABLE 3: ENERGY SAVING BY SWITCHING OFF THE CLIMATE EQUIPMENT ACCORDING TO ENVIRONMENTAL TEMPERATURES IN MIGUEL TORRES WINERY

Energy kwh working all year	**110.570**
Invoicing	**$7.739.900**
Energy kwh working spring summer	**72.020**
Invoicing	**$5.041.400**
Annual saving Kwh	**38.550**
Annual saving $	**$2.698.500**

Source: own elaboration.

Cellar semi-underground building

Miguel Torres cellar 3 is a semi-underground building which considers in its designs aspects and factors that help to properly maintain the products, reducing considerably the energy consumed in air conditioning compared with cellars 1 and 2 of the same winery which are at ground level.

COUSIÑO MACUL WINERY[7]

The main energy consumption of a winery is in heating, refrigeration and air conditioning. Many times the systems involved in these needs are not appropriate, as they create unnecessary thermal losses, which cause a greater energy demand. These losses can be reduced starting from good insulation at the winery, to piping and tanks as well as in the entire building. This last item is very important. Next, there are some good practices that Cousiño Macul Winery has implemented.

Building insulation

Cousiño Macul Winery, located in the Buin district, is one of the few wineries that is thermally insulated. In particular, this measure reduces the thermal losses of the tanks, obtaining a considerable saving regarding to the energy needs for these purposes. Together with other measures, the thermal insulation of the building results in an important energy saving and should consider an a priori improvement possibility.

Audit through the CORFO's Energy Efficiency Pre-investment instrument (EEPI).

Through an external energy efficiency audit performed with CORFO (EEPI), Fundación Chile and the International Development Bank (IDB) subsidies, the profile of Cousiño Macul Vineyard energy consumption was analyzed and the energy improvement possibilities were identified. With the audit results in hand, a power plant was implemented for self-generation during the month of April and May of 2008 for the winemaking cellar and for the month of September for the irrigation pumps. Additionally, and through the practice of manually reducing the unnecessary electric charges, during peak hours, the self-generated kilowatts per hour (kWh)

Cousiño Macul Winery

Cousiño Macul Winery located in Buin

7) Information provided by Günther Klemmer, energy efficiency advisor for Cousiño Macul Winery and Edmundo Bordeu, Pontifical Catholic University oenologist.

were significantly reduced. The diagnosis identified other profitable projects as improvement opportunities, among which are important to mention:

- Thermal isolation for hot and cold pipes.
- Efficiency recovery of the existing gas boilers.
- Replacement of gas boilers for pellet and biomass boilers.
- Automatic active demand control system.

CONCHA Y TORO WINERY[8]

Presently, Concha y Toro Winery is carrying out projects intended to reduce the negative impacts of its process on the climate change: the carbon footprint estimates and bottle weight reduction.

In order to determine what and how much Concha y Toro contributes to the climate change, the carbon footprint of the winery during the year 2007 was calculated, in other words, the impact of all its activities measured in greenhouse gas emissions. This estimate considered direct and indirect emissions, being this last one exclusively for products that were exported to foreign markets. In the wine industry these emissions are key and, in the case of Concha y Toro, it is an important variable, due to the high percentage of the production that is destined for foreign markets. In this way, Concha y Toro identified direct relevant environmental aspects (derived from raw material, energy and water consumption) or indirect (like those related to design, packaging, and product transportation).

The carbon footprint calculation allowed Concha y Toro to discover the weight that each of its areas has in global result of this indicator. Due to this analysis, it was decided to decrease the electric and fuel consumption through the energy efficiency, appraise alternative energy sources, search inputs with less GHG emission and set specific reduction goals (where it corresponds), objectives that were integrated to its Sustainable Development Strategy.

VENTISQUERO WINERY[9]

Greenhouse Gas emissions compensation and measurement

Showing its commitment to the environment, Ventisquero Winery has performed different works in order to reduce as much as possible the impact of its operation on the environment.

Therefore, during 2007, Ventisquero Winery became the first wine company in Chile to assess and compensate greenhouse gas emissions generated in its operations. The Cantor CO2 company was in charge of registering all the greenhouse gas emissions. For that purpose, all the operations of the winery were included, from the fields to the foreign commercial offices, going through the winery and the wine transportation. In this study, the most critical operations with regard to carbon emissions were identified and was concluded that the finished product transportation was the activity that

8) Information supplied by Laura Noguer, Sustainable Development Coordinator of Concha y Toro Winery.
9) Information supplied by Cristián Infante Planning and Development Vice Manager and Fernando Flores, Planning and Development Engineer of Ventisquero Winery.

most contributed to the total carbon footprint tabulated in the winery.

Taking into consideration the former, is that it was decided to compensate the CO2 emissions generated in the wine transportation. In this way, during 2008 27 tons of carbon dioxide were offset through forest restoration projects and usage of renewable energies through Climate Care. In addition, they started to use lightweight bottles, which make a great difference to the reduction of CO2 emissions during the transportation.

Ventisquero Winery

Energy efficiency

Energy efficiency has a great influence in the carbon footprint reduction strategy of the winery. Therefore, different works are being developed on this subject, such as an energy audit for the entire winery operations, from the winemaking to the bottling, together with the Prevent company. The first phase of this audit consisted in identifying all the energy inefficient operations, in order to continue with the second phase that is focused in completely improving or modifying the way of developing operations that nowadays are inefficient from the energy point of view.

CONO SUR WINERY[10]

Cono Sur Winery has developed a clean action plan (which comprises the natural management of vineyards) organic production, ISO certifications and CO_2 emissions compensations, obtaining the Carbon Neutral® status delivery. Its initiatives in this regard are the following:

Organic and sustainable agriculture

Cono Sur has implemented two friendly environmental systems in its vineyards: organic production and sustainable agriculture.

- Organic production: An organic wine is made with organically cultivated grapes, which implies an integral farming and crop, without the usage of any harmful chemical substance, such as fertilizers, pesticides, herbicides, or fungicides. To date, more than 201 hectares of different varieties of grapes have been incorporated into the organic production program.
- Sustainable agriculture: Complementary to the former, the purpose is to use natural alternatives in an agriculture system to fertilize, prevent and control pests, disease and weeds. The company started to use sustainable agriculture in 1998, with the objective of reducing the environmental impact of its activities, avoiding as far as possible the usage of harmful and non-natural elements, through the application of physical measures such as geese, sheep, insects and plants layouts in the farming. In this way, the system is self-regulated and a clean and healthier product is obtained.

Carbon footprints management

Within its climate change action plan, Cono Sur Vineyard calculated its carbon footprint, taking into account all their activities. In this estimate transportation sticks out (due to exports), which contributes 60% of the total GHG emissions. With this information, Cono Sur decided to compensate its carbon footprint linked to transportation, obtaining the Neutral Carbon® certification.

Carbon footprint compensation

The Neutral Carbon® delivery status, means that the CO_2 emissions caused by the Cono Sur wines transportation, has been measured and compensated through projects of Greenhouse Gas (GHG) emissions reduction. Its mechanism is very simple: per each CO_2 ton produced by Cono Sur in its wine transportation around the world, a ton is invested to be reduced by means of compensation projects. In other words, carbon emissions are compensated through carbon savings. Hereby it is mainly invested in renewable energy projects and especially, in the case of Cono Sur Winery, in a wind energy program in Turkey.

ERRÁZURIZ, SEÑA AND CALITERRA WINERIES[11]

The group of wineries formed by Errázuriz, Seña and Caliterra have been developing environmentally friendly good practices studies and initiatives in the agricultural and in the oenological area. These practices are focused in a sustainable management of the wine growing

10) Information supplied by María Elena Martinos, Marketing and Environment Manager of Cono Sur Winey.
11)Information supplied by Gerardo Leal, Research and Development Department Chief of Errázuriz Winery

process (including organic and biodynamic concepts) less usage of phytosanitary products, adequate training and record systems, accurate precision viticulture, efficient use of energy, water and fuel in vineyards, and the management of wastes which are not agrochemicals. In terms of energy, some of the most notable initiatives are:

Energy consumption reduction for cooling system

The Errázuriz, Seña and Caliterra group has implemented a series of measures to reduce energy consumption in cooling system:

- Thermal isolation of fermentation tanks.
- Implementation of a "free cooling" system at the barrel cellar that controls the entrance of air from the outside, normally during the night, allowing fresh air to enter from the outside and the automatic stoppage of the cooling system, with a saving capacity of 20%. Also, there is an insulation system that consists in a double layer both in the cellar roof and in the walls with west exposure (the hottest surfaces of the cellar), which allows an air circulation that rises and is eliminated through the more superficial layer.
- Pneumatic valves incorporation in the piping system which allows an automatic and precise locking of the cold and hot water networks, which avoids possible unnecessary energy mixtures and losses.
- Cooling system pumps control through a computer centre. They also work in a sequential form depending on the necessary cooling requirements. (In the past bigger pumps existed and were all working at the same time, using unnecessary energy for the requirements)
- Division of wine stabilization tanks that work with glycol from the general circuit and their programming at temperatures between -5° and +5° with the objective of turning this project more efficient

Energy consumption reduction for the heating system

Regarding energy consumption reduction for heating, Errázuriz Winery has implemented the following strategies:

- Use of solar panels for heating consumption water in service areas. The system consists of 21 solar panels that heat 8.000 litres between 60°C and 70°C. During vintage time, this amount of water is totally consumed in the service area. At other times (from October to February) 4.000 litres are distributed for showers and 4.000 litres for industrial consumption at the cellar.
- Thermal energy cogeneration from the oil generators used to produce electricity. This thermal energy,


Errázuriz Winery

in the form of warm water, is used in showers and washbasins in the personnel bathrooms and industrial consumption.
- The system heats 10.000 litres of water at peak hours (which corresponds to the five hours that the generator works from April to September), of which 4.000 litres are for services and 6.000 litres for industrial consumption at the cellar. This allows that the water demand in services during a year does not require other type of energy and that part of the warm water consumption of the cellar be replaced by these sources

Bioclimate system in Don Maximiano winery

The winery consists of 1.731 m2 , and houses 37 tanks with a capacity of 350.000 litres. Its construction was performed under sustainable standards in terms of energy, incorporating natural light that comes through the windows and a central skylight. The winery also has a geothermic system that allows maintaining it at a higher temperature than the exterior climate in a natural way around 20° C during the winter time. This system consists in horizontal concrete tubes buried three meters depth from which air is extracted through extractors and fans (this system is called bioclimate). Additionally the Max Reserva winery has 5.500 m2, housing 221 tanks and skylights systems equivalent to 7% of the roof surface, which allows 100% illumination of the cellar, eliminating the electric light requirements during the day.

Sustainable packaging

Caliterra Winery uses in its labels "Green Seal" certified paper, 50% made out of recycled paper and free of chlorine in its elaboration process alternative fibres and coming from sustainable managed forests and certified by the FSC (Forest Stewardship Council).
Meanwhile the "screw cap" wine seals are 100 percent recyclable, of less energy use in its production and low weight. The light PET bottles are recyclable and do not break. Cartons are made of "craft" paper, elaborated by 80% of recyclable fibre and that uses from 15% to 20% less cellulose and less water in its manufacturing.

LOS VASCOS WINERY[12]

Los Vascos Winery has performed a series of measures to reduce direct and indirect GHG emissions, among which are:

Good agricultural practices

Los Vascos Winery has integrated to its vineyards management the following measures in order to reduce its negative impacts to the environment:

- Nitrogen application based in analysis by lot.
- Phytosanitary preventive applications.
- Phytosanitary products applications according to load charge of pest or illness.
- Waste management, waste separation of domiciliary, dangerous and recyclable wastes.
- Irrigation technification.

Solar panels for equipment disinfection

The winery has eight thermo panels units with a total of 16 m2 of solar utilization. Since 2006, the winery allocates 600 litres/day of hot water, obtained from the solar panels, to disinfection of equipment, which means

12) Information supplied by Julio Fariña, Environment, Energy and Quality Assurance Department Chief at Los Vascos Winery.

an annual save in energy consumption by 70% for this concept.

Solar panels for the malolactic fermentation maintenance

Los Vascos has installed 90 thermo panels over the roof of its wineries to obtain the thermal requirements of tanks during the malolactic fermentation of wine. These panels aim to pre-heat 10.500 litres of water per day. Then, the 35° requirements are reached through electric energy. This installation allows savings of 50% during the winter months and to work at zero cost during the rest of the year.

Installation of "solatube"

By using Solatube technology, it has been possible to reduce electric light consumption from 8:00 am to 8:00 pm during the summer months and at least during six hours in winter. This technology allows to use the solar light driving it to the central areas of the plant and creating angles in the conduction tube, which has a capability to transmit more than 99% of the light received. This means a saving in electric light consumption of nearly 80%.

Insulation of temperature exchangers, cold and heat pipings

The temperature exchangers use to be near, which causes thermal short circuits (between the pipings that drive cold and heat). Its insulation allowed to greatly reduce the thermal losses, and with it, the energy consumption.

Installation of cooling and heating jackets for all the stainless steel tanks

The installation of jackets in all the stainless steel tanks from 6.000 to 40.000 litres reduced the water use for heating or cooling such tanks. This initiative had the objective of decreasing water consumption.

DE MARTINO WINERY[13]

De Martino Winery has developed several initiatives in different environments in order to decrease the waste generation and its impacts, optimize the water, energy and natural resources uses and prevent the environment impacts, among which it is important to mention:

Organic production

Presently, De Martino winery has 300 hectares of certified organic vineyards with the Carmenere, Cabernet Sauvignon, Malbec and Merlot varieties and in white wines with Sauvignon Blanc and Semillon varieties. This has caused a decrease in the negative impacts over the climate change, through the safe and efficient application of phytosanitary products.

Good Management of water use

The good management in the use of this resource has meant a decrease of water consumption up to 30%, which, at the same time, has generated an energy consumption reduction, by the effects of pumping. To obtain this achievement the winery workers were trained and made aware of the impact regarding the use of resources, and personnel were hired with exclusive knowledge of the control of the water usage.

13) Information supplied by Carlos Muñoz, Project and Development Chief at De Martino Winery.

Carbon Credits transaction

After being the first winery in the world to approve a Wastewater Treatment (WWT) methodology in the United Nations, the De Martino Winery will be able to make Carbon Credits transactions by the end of 2009.

The "De Martino WWTP upgrade" project, was presented to the Clean Development Mechanism set up in the Art. 12 of the Kyoto Protocol, of the United Nations Framework Convention on Climate Change, being dully ratified by the Chilean Republic Senate in July 2002; in order to later obtain the official registration before the competent organization of the United Nations on August 25th 2008.

VIÑEDOS EMILIANA[14]

Presently, the winery has 1.100 hectares that are farmed in a sustainable, organic and biodynamic[15] way. The practices and biodynamic grapes are certified by Demeter Germany, the practices and organic grapes by IMO Switzerland and the sustainable practices by ISO 14001.

For Viñedos Emililana, the energy efficiency and climate change subjects have priority and have been seriously and consequently approached. Therefore, for Viñedos Emiliana the carbon footprint decrease of the vineyard is inserted in an integral approach that is shown in its "green" program of June 2008, which establishes deadlines and real projects to contribute in a serious way to decrease emissions, through energy efficiency, production practices and management that are respectful with environment and clean energies, among others.

Next, some of the activities developed in these terms are described.

Decrease of greenhouse gas emissions

- Project to neutralize carbon emissions and improve the energy efficiency: Presently, Emiliana is in the last phase of an important and innovative project supported by CORFO that intends to turn Los Robles (its main vineyard) premises, into a unit in which both its production as well as the products that are commercialized from it, will be carbon neutral. The most notable is that it aims to turn into a close unit from the energy and carbon stand point, standing therefore in a leadership position in the industry at global level. By close unit it is understood as a productive unit, that regarding energy, does not use energies from off-site locations, providing it exclusively from its own sources or in house. With this purpose, an energy audit is taking place by a qualified company and it is in the process of CO2 neutral certification by a German certifying company. Therefore the net emissions of GHG in Los Robles premises, along the whole productive chain, were quantified, from the field to the cellar door, identifying the issuing sources and the waste,

14) Information supplied by José Guilisasti, Agricultural Manager of Viñedos Emiliana.
15) Biodynamic agriculture is based in the complex relation that exists between the plant, animal and mineral kingdom. The biodynamic practice is performed in accordance with the rhythms and activities of the cosmos. This viticulture philosophy has its roots in old agricultural practices that recently have started to be scientifically understood. In the organic agriculture, meanwhile, native flowers, vegetation and biodiversity are part of the pests control method helping to offset the harmful effects of the soil degradation. In both agricultural forms, pests control, disease and nutrition are based in the use of organic products and biological controls, not being allowed the use of chemical products

besides the GHG net emissions generated in the transportation and distribution process of the production coming from the premise.

- Recycle: With the objective of decreasing indirect GHG emissions it was created the three R management (Reduce, Reuse and Recycle), with a recycle program that quantifies the delivery of certified recyclers. Specifically, waste are managed as follows:

Waste	Recycle company and authorized campaign.
Cardboard/Paper	Direct sale SOREPA S.A. Recycle campaign Fundación San José
Plastic	Direct sale Recovery and plastic products plant Mufer y Cía. Ltda.
Glass	Donation Recycle Campaign CODEFF
Scrap/metals	Direct sale Gerdau Aza (through its agent in the VI Region)

Likewise, Viñedos Emiliana has installed differentiated containers for each waste. For that reason, old barrels have been reused and adapted as containers for the different wastes (paper-cardboard/glass/plastic/organic wastes).

Clean energies

- Solar Panels: In Casablanca and Los Morros farms, Emiliana has installed solar panels to use to heat the water of homes. It is under study the final effect of the energy saving throughout the year.
- Biodiesel: Used in tractors and machineries.

Sustainable Packaging

"Eco Glass" bottles are used, 15% lighter than the traditional bottles.
Bottles contain 30 percent of recycled glass.
Cartons are 100 percent recycled.
The "screw caps" are 100% recyclable and use less energy in their production.
For the labels of some brands Econat paper is used, the pulp for which is certified by FSC in 60% and the other 40% is used consumer waste.

CRISTAL CHILE: LIGHTER BOTTLES[16]

It is very important that the wineries select and demand inputs with a less involvement in the carbon footprint.

In this sense, Cristal Chile started to receive at the end of 2007, requirements from its customers for producing lighter bottles, as the bottles weight affects the CO2 emissions that take place in the Chilean wine transportation to foreign markets. In view of it, there were analyzed the technological possibilities of the products commercialized in England, one of the most demanding markets regarding the carbon footprint. Therefore, the bottling was reviewed and worked on the bottling design to keep the same image but with a lighter weight. The Ecoglass bottling family was born in that moment, being 10% to 15% lighter.

This reduction has resulted in between 15.000 to 20.000tons less glass production per year, which translates to less glass melting, less CO2 generation per bottle and a reduction of freight costs to foreign countries. In the same sense, it is estimated that with the same capacity installed it is possible to produce between 31.500.000 to 42.000.000 more bottles per year, which means that Chile could export between 2.600.000 to 3.500.000 more wine boxes annually without increasing its glass production.

Today, the complete Pic28 Ecoglass line is already available, which changes from 490 grs. bottles to 420 grs. bottles

From May 2009, the Pic16 Ecoglass and Standard Ecoglass lines are included, plus the new Bordeux 187,5 Ecoglass.

The wineries that at the beginning of 2009 were already using Ecoglass are:

Santa Rita, Concha y Toro, Miguel Torres, Errázuriz, Santa Inés-De Martino, Botalcura, Montes, Anakena, Santa Emiliana, Cremaschi, Terranoble and Via Wines.

16) Information supplied by Sebastián Ovalle Braun, Sales Vice Manager for Wine Area at Cristalerías de Chile S.A.