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Energy Efficiency in the industry of Ukraine
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REPORT

ON ENERGY AUDIT

AT *MASSANDRA*

PRODUCTION AGRICULTURAL CORPORATION

MASSANDRA, UKRAINE

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PREFACE

As part of Delivery Order #30, Industrial Energy Efficiency - Ukraine, the U S Agency for International Development (***USAID***) sponsored energy efficiency audits at 24 industrial plants that met the criteria of ***USAID***

Each facility was evaluated based on selection criteria (approved by USAID) for the selection of target plants The criteria included a long-term economic viability of the plant, its financial condition, its generation of export revenues, production output versus nominal capacity, energy conservation potential, possibilities of project replication at similar enterprises and its access as a demonstration facility to other plants

This report details the findings of ***BURNS & ROE ENTERPRISES, Inc*** energy report performed at the main winery of the Massandra agricultural corporation

1 0 EXECUTIVE SUMMARY

1 1 Introduction

The Massandra production agricultural corporation (PAC) is a modern, dynamically growing enterprise well-known throughout the world, the largest of its kind in Ukraine

The firm's management continues renovation of production lines and search for new technologies to allow the enterprise to expand the production output and manufacture guaranteed quality products

The tasks of the audit were as follows

- informal energy management training
- recommendation of appropriate steps in order to improve energy efficiency and of energy saving equipment that may be purchased by the ***USAID*** funds

The team consisting of two representatives of US firm ***Burns and Roe*** who are experts in the field of energy management - Victor Svistunov and Vladimir Prokopenko - carried out an energy audit from March 16 through 20 1998 in accordance with the tasks of the project and prepared preliminary information on the state of energy utilization the Head enterprise of the Massandra PAC The results of the energy audit will be furnished in a report

Since this plant is very large, a one week site visit is not sufficient to adequately audit the entire facility The site visit was restricted to one week However, the engineering staff were trained to identify improvements that would be representative of the entire plant In many cases it was necessary to focus the auditing efforts on one system or only on a portion of the plant Therefore, this audit is based on what could be accomplished during the one week allocated While this audit contains numerous recommendations for the plant management, the plant management is encouraged to perform a complete audit of the entire facility Hopefully, the plant management will consider hiring the engineers trained under this project to continue this work, which will result in a complete understanding of energy usage within the plant, as well as a complete listing of all potential, energy improvement projects

1 2 Brief survey

- The Massandra PAC by Ukrainian standards is a stably functioning enterprise
- Out of total cost for energy resources heat makes up over *70%* Over *50%* of electric power consumption goes for bottling plant and boiler room, and also for refrigeration and compressed air generation at the compressor unit These consumption facilities define primary sources of energy conservation The enterprise uses considerable amounts of water In the total production costs energy expenses amount to *18 7%*

- As expected the energy audit team has discovered many attractive opportunities of improving energy efficiency at the current energy and fuel prices When energy prices were ***20 to 30*** times lower the energy improvement measures were not cost efficient Presently the energy efficiency improvement is cost effective though difficult to implement due to high interest rate of the bank credit and general economic challenges due to the bartering settlement system and mutual non-payments
- The lack of energy submetering does not permit to set up a base for energy savings and introduce energy management system
- A considerable reserve for energy conservation is the improvement of steam use efficiency by introduction of steam traps, enhancement of thermal insulation of steam- and condensate piping, and increase of condensate recovery

Reduction of electric power use can be achieved by improving the efficiency of refrigeration and compressed air generation and consumption systems, and by introduction of energy efficient lighting sources

1 3 Recommendations

The following table 1 1 is a summary of energy conservation opportunities identified for the facility, the estimated savings as well as the cost savings and the paybacks for opportunities with implementation periods under one year

For example, ECO #1 "Energy management institution" will set up systematic energy conservation activities by establishment of an energy management section responsible for the control and analysis of the energy consumption at the plant and development of recommendations for renovation and improvement of any energy saving systems

To encourage the facility to implement energy efficiency and energy conservation, USAID is contributing energy auditing equipment to the plant This equipment consists of standard energy auditing instrumentation and meters that will enable them to implement an energy saving activity

ECO #2 "Improvement of combustion efficiency in DKVR-4-13 boilers" will optimize combustion of natural gas in boilers utilizing portable combustion analyzer, improve combustion efficiency and, consequently, reduce consumption

ECO #3 "Recovery of condensate from the bottling unit" will allow by installation of condensate storage receiver in the thermal distribution unit of the bottling facility and subsequent pumping of condensate to the boiler room to reduce the use of natural gas and high-cost chemically treated potable water

ECO #4 "Thermal insulation of steam- and hot-water piping" will cut down direct losses of thermal energy at the sections 253 meter long

ECO #5 "Installation of steam trap units" will reduce steam use without deterioration of thermal characteristics of the equipment with simultaneous improvement of its efficient use of its thermal potential at the pasteurizing plants, bottle washing machines, etc

ECO #6 due to shutting-off of power transformers at the TP-720, TP-719, TP-124 of total capacity of 1,840 kVA during off-time will reduce electric power consumption by idling transformers

ECO #7, 11 by introduction of instrumental metering of insulation state, temperature of energy carrier and optimal use of electric equipment capacities will exclude impractical modes of its operation and reduce energy consumption

Table 1 1

The list of energy conservation opportunities

ECO priori ty #	Description	Electri city, 1,000 kWh	Natural gas savings, 1,000 m^3	Potable water savings, 1,000 m^3	Annual savings, US$ (1997 prices)	Project cost, US$, (1997 prices	Payback, years
1	Institution of energy management system	33 1	31	2 4	13,000	6,200	0 47
2	Improvement of combustion efficiency in DKVR4-13 boiler		95 6		7,933	6,500	0 82
3	Recovery of condensate from the bottling unit		41 3	3 4	17,092	12,480	0 73
4	Steam piping insulation		59		7,948	5,157	0 65
5	Installation of steam trap units in steam consuming systems		36 9		3,066	3,000	0 98
6	Turn-off of transformers for idle days and shifts	132 5			5,564	6,500	1 17
7	Monitoring of boiler equipment operation and temperature modes of heat consuming equipment		5 2		701	1,000	1 4
8	Conversion of space heating from steam to hot water		60 2		8 095	1,500	0 18
9	Automatic energy metering system	83	77 5	6	40,000	60,000	1 5
10	Energy efficient lighting of enterprise	56			2,353	2,545	1 1
11	Monitoring of electric motor capacities and electric power use	17 1			718	1,000	1 4
	Total	**321 7**	**406 7**	**11 8**	**106,470**	**105,822**	

ECO #8 "Conversion of space heating system from steam to hot water" by excluding the overheating and condensate losses from heating systems will reduce gas consumption by 20%

ECO #9 "Automatic energy metering" will lead to an objective picture of energy use, will encourage energy conservation activities, specify energy use by production units for in-plant settlements without manual operations

ECO #10 due to installation of 79 efficient lighting sources instead of DRL-250 lamps and conventional lamps for the external lighting will increase reliability and reduce total use of electricity

Capital investment to the amount of US34,837 into energy efficiency improvement with short-term payback (ECO # 1-5, 8) will lead to annual savings of US$57,134, and reduction of electric power use by 33 1 thousand kWh and natural gas use by 324 thousand cubic meters Investment of US$71,045 into energy efficiency with payback

periods of more than 1 year (ECO # 6, 7, 9-11) will lead to annual savings of US$49,336 and will cut down electric power use by 288 6 thousand kWh and natural gas use by 82 7 thousand cubic meters additionally, implementation of ECO-1 and 9 will lead to saving 8 4 thousand cubic meters of potable water Payback periods of ECO #2, 9, 11 are significantly less than the service life of the implemented proposals

Total reduction in electric power use will be at 321 7 thousand kWh (19 4 % of the 1997 use), in natural gas at 406 7 thousand cubic meters (26 3%) and in potable water use at 8 4 thousand cubic meters (7%) Implementation of the proposed ECOs will reduce emission of pollutants into the atmosphere by 5 77 tons a year including solid particles by 1 42 tons, CO by 0 18 tons, NO_x by 0 99 ton, SO_2 by 3 18 tons

The ECOs above can be implemented at various industrial enterprises i e serving as the standard solutions of a common problem

1 4 Production management and energy management

A particular feature of each industrial enterprise is focusing managerial attention at the production issues and desire to expand production output Due to this attention is not always paid to the vitally important issue of energy efficiency and costs

At the Massandra winery as at the major part of Ukrainian industrial enterprises the energy costs in the past due to the low cost constituted an insignificant share in the production costs, therefore, energy conservation was a low priority

Over the last few years energy price rises resulted in energy becoming a large expense In 1997 energy costs at the Massandra PAC amounted to approximately 20 percent of the production costs

Currently at he Massandra PAC as at other Ukrainian industrial enterprises there is a wish to implement large-scale projects in order to achieve significant energy cost savings Concurrently at the enterprise there is a vast number of small-scale energy conservation opportunities with short payback periods

The general mistake is to disregard small-scale energy opportunities as savings per unit of production may be small For example, installation of steam traps may seem less attractive than the large-scale project of renovating the bottle washing plants or introduction of energy metering system But similar small-size projects are extremely important and if we take into account total number of steam traps to be installed the sum total of savings from this project is significant

The majority of Ukrainian industrial enterprises have the chief power engineer offices where specialists in various fields of power and energy are employed The responsibilities of these specialists include assurance of reliable supply of various types of fuel and energy to production lines of appropriate quality and quantity, and ensuring energy savings However, due to cuts in production costs typically the specialists of auxiliary services are the first to be laid off, energy supply service included This results in remaining specialists mostly tackling not the energy

efficiency issues at their plants but ensuring that there is adequate supply of energy But with the rise in energy prices and the uncertainty of availability of all fuels, an energy manager to conserve energy becomes important The enterprise should seriously consider establishing an energy manager position as a minimum, and for large industries, possibly even an energy management section

These people should routinely be monitoring all operations, and especially reviewing monthly energy consumption This monthly data should be graphed and compared to previous months and years to determine any variations in consumption, identify causes of them and make decisions on the necessary energy consumption remedial measures to prevent unreasonable energy use For instance, if monthly consumption increases, the reasons why should be determined and if appropriate, steps taken to correct any problem

In addition, the energy management staff should also review each process, and look for energy saving opportunities, certification of technologies and equipment for energy efficiency They should see that all cost effective energy improvements are implemented, beginning with items identified in this energy audit They should then also have responsibility to review all proposed changes to the facility to ensure that each process is as energy efficient as possible It would be good to have a thermal specialist (someone who is knowledgeable about steam, refrigeration, hot water, and natural goes systems) and an electrical specialist

In many facilities the energy management section is assigned an energy goal, such as "reducing the overall energy usage by five percent per year" While the percentage goal can vary, this type of challenge industries gives a benchmark by which the section can be evaluated And in industries in Ukraine, where energy efficiency is just at its infancy, the percentage goal could even be higher The enterprises should also have an incentive program, in which employees are encouraged to submit energy efficiency improvement ideas

1 5 Implementation

Implementation of ECOs listed in Table 1 1 is planned following completion of regular phases of the project

2 0 GENERAL BACKGROUND

Name - The Massandra production agricultural corporation

Managing director - Nikolai K Boyko

Chief engineer - Victor I Lanetzky

Phone No (0654) - 33-02-47, 35-30-46

Fax No (0654) - 32-59-57

Mail address 334233 UKRAINE, Republic of Crimea, Massandra, Vinodela Yegorova str 9

2 1 The enterprise history

The Massandra production agricultural corporation established in 1936 includes the Main winery and nine farm wineries Livadia, Gurzuf, Tavrida, Alushta, Malorechensky, Privetny, Morskoy, Veselovsky and Sudak situated along the entire southern coast of Crimea The wine cellars of the main winery founded in 1894 contain approximately 1 million bottles of highly valuable wine and many are unique Farm wineries produce young wines which are matured at the Main winery The wines are matured between two and five years depending on the brand and technology, then they are cooled, filtered and heat-treated, bottled and shipped

Currently there are no JVs with foreign companies

The following buildings are situated at the Main winery area

- **Management building**
- **Main production unit**

- bottling shop
- dessert wine maturing unit

wine maturing and processing unit
dessert and strong wine maturing unit
strong wine maturing unit
madeira wine unit
sherry wine unit
wine maturing section
vintage wine maturing section

- **Auxiliary production unit**

maintenance shop
construction unit
power supply unit
transport unit
steam power unit

ready product unit
packing unit
wine cask unit
exhibition unit

- **Non-production facilities**

residential section
healthcare unit
kindergarten

The capital assets possess a significant degree of wear and require capital overhaul which is gradually being carried out by the enterprise

2 2. Production output

The Massandra PAC produces 28 brands of vintage wines including 1 table wine, 10 strong wines, 17 dessert wines The benefit of the Massandra wines is in the fact that they are different in their bouquets, taste and colour At international expositions the Massandra wines won 2 Grand Prix cups and 148 gold and silver medals The star brands are the White Mouscat of the Red Stone, White mouscat of Livadia, Pinot Gris, South coast Cahors, Madeira, Sherry

Annually the winery produces approximately 11 million bottles

The winery owns 5 specialized stores in Simpheropol, Alushta, Yalta, Dnepropetrovsk and Kyiv

Average number of employees is 4,000

3 0 CURRENT STATUS OF PRODUCTION

3 1 Total capacity of plant

The design capacity of the enterprise ensures output of 802,2 decalitres of wine per year

3 2 Recent production 1997 vs 1995 and 1996

In 1995-1997 the enterprise operated at reduced capacity due to the fall of the purchasing power of the population As seen from Fig 5 3 the use of production capacity is even throughout the year The production volumes are given in Table 3 1

Table 3 1

Production output

Name of product	Unit of measure	Output			% 1997 to 1996
		1995	1996	1997	
1 Wine	thousand decalitres	717 9	486 5	653	134
2 Total production • in current prices	thousand hrivnas	11,252	15,741	23,335	148

Analysis of the data from Table 3 1 shows that absolute volumes of output in 1997 as compared to 1996 amounted to *134%* This rise is explained by the fact that in 1996 reports the bottling services were not taken into account as 252 2 thousand decalitres (dal) of give-and-take raw materials were used

3 3 Prospects of development

The marketing, production and technological services of the enterprise carry out work toward the perspective development of the winery

Participation in the Sotheby's international auctions in London showed the true value of the Massandra wines at the international markets The winery continues to take part in international exhibitions Presentations and shows and to gain diplomas, medals and to win international markets

This all indicates that the winery sees its prospects of development and with improvement of social and economic situation in the Autonomous republic of Crimea and growth of the vacation business it is capable of to raise sharply the production output

3 4 Exports vs Domestic production

The Massandra PAC products are well known not only in the CIS countries but also in Sweden, Switzerland, Germany, Britain, Japan, America and regions of the world

Relation of exports to the total sales within the country over the last two years is shown in Table 3 2

Table 3 2

Exports vs Total sales, %

Types of products	1996	1997	2 months of 1998
1 Wine	34 5	52	60 1

The Massandra winery has its permanent customers, for example the Agora company from Moscow which buys monthly up to 300 thousand bottles of wine, or Fassbind of Switzerland

Exports growing with each year reflect first and foremost its high quality Second, this indicator is of considerable significance while assessing production and technical potential of the enterprise Judging from the available data the potential is high During the audit high skills of the winery staff and large amounts of imported production equipment were pointed out

4 0 FINANCIAL STATUS

4 1. Currency vs Barter

Percentage relation of bartering and currency operations to the total production output is shown in Table 4 1

Table 4 1

Indicator	1995,%	1996, %	1997, %
1 Barter	35	23	14
2 Currency	60	70	80

4 2 Viability of the plant

The primary financial results of the head winery operation are represented in Table 4 2 The analysis shows that the balance profit of the enterprise in 1997 was higher than in 1996 by *43 6*%, gross income is growing as well

Table 4 2

Main financial results

Indicator	Values by years, thousand hrivnas		
	1995	1996	1997
Gross income, including VAT excise duty	11,252 1,341 2,518	15,741 1,702 1,818	23,335 2 758 1 441
Production costs	3,535	5,730	9,469
Balance profit including from sales	4,103 3,858	6,906 6,491	9,920 9,667
Net profit (disposable by enterprise)	2,804	4,866	7,502
Actual production output	3,477	5,730	8,469

The data from Table 4 2 show that in 1997 as compared to 1996 gross income grew by 48,2%, production costs by 65,2%, actual output by 34 5% These data permit us to make conclusion of high operation efficiency of the winery by the years

Table 4 3 shows values characterizing the stable financial status of the enterprise

Table 4 3

Indicators of financial stability

Indicator	1995	1996	1997
Profitability, %	116	120	105
Liquidity factor	2 22	1 89	1 82

The plant has no wage or energy debts

All incoming and outgoing bills are collected each year and kept in the books

5 0 ANNUAL ENERGY CONSUMPTION AND COSTS

5 1 Annual consumption 1995, 1996 & 1997

The Cassandra Main winery uses primary types of energy purchased from local utilities as electric power, natural gas and water Thermal energy as saturated steam with pressure of *9* kg/cm^2 and temperature of *170* °C is generated by the in-plant boiler house equipped with two boilers of DKVR 4-13 type and one DE-6,5/13 Annual energy consumption and costs are shown in Table 5 1 Electric power and natural gas make up accordingly *8*% and *82*% of the total consumption However, the costs relation is different electric power is *10*%, natural gases– *19*%

Table 5 1

Total Energy Use by Energy Source and Cost (Based on 1997 Data)

Fuel	Annual Use	Annual Use in Gcal	Share of Energy Use, %	Annual Cost, US$	Share of Annual Cost, %
Electricity	1,655,000 kWh	1,423	8	69,510	10
Nat Gas	1,549,000 cubic m	14,406	82	128,567	19
Water	120,000 cubic m	1,800	10	480,000	71
Total	-	**17,629**	**100**	**678,077**	**100**

Fig 5 1 shows distribution of energy use by the types of energy in 1997, Fig 5 2 distribution of annual energy costs Monthly energy use is shown on Fig 5 3 through 5 5

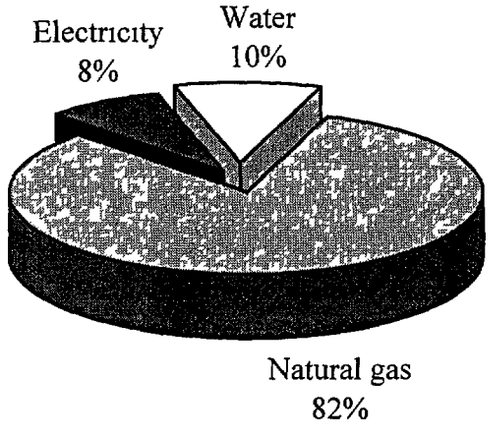


Fig 5 1 Energy use in 1997

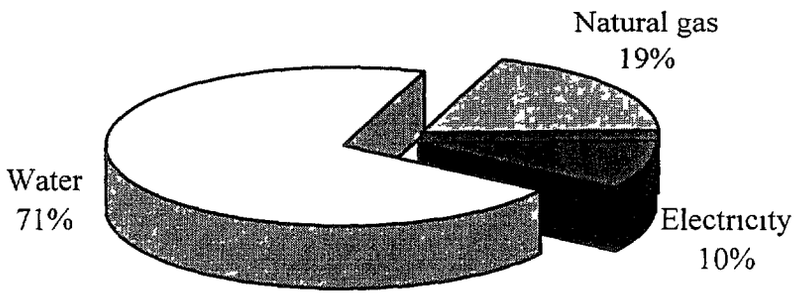


Fig 5 2 Energy costs in 1997

Table 5 2

Energy consumption at Massandra PAC in 1997

Month	Electricity use, kWh	Natural gas use, 1,000 m^3
January	156532	253
February	139558	262
March	138244	258
April	152040	125
May	135387	65
June	134452	65
July	125210	56
August	132138	40
September	129778	98
October	128724	66
November	134027	97
December	149097	164
Total	**1,655,000**	**1,549**

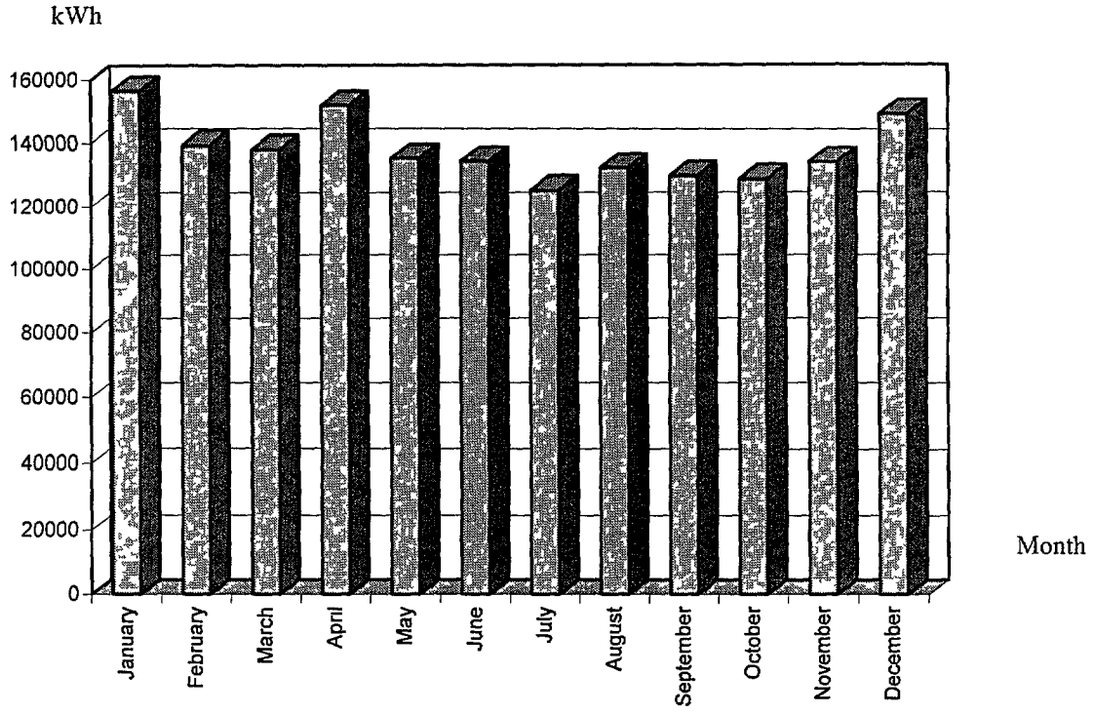


Fig 5 3 Electric power consumption

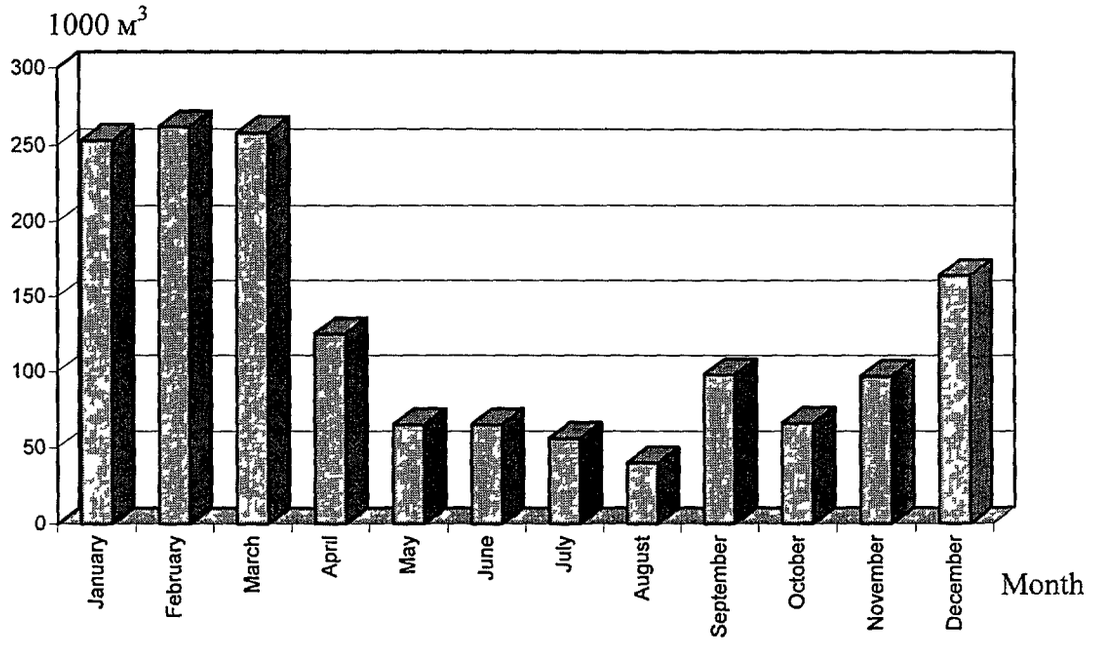


Fig 5 4 Gas consumption

Total energy use in 1997 was ***1,655,000*** kWh, natural gas – ***1,549,000*** m^3, water – ***120,000*** m^3 The workload is even throughout the year (Fig 5 3) Fluctuations in

natural gas consumption is explained by reduction in space heating and hot water supply in the summer season

5 2 Current tariffs for fuel and energy

The plant pays approximately US$670 thousand annually for its energy consumption Energy costs run approximately 18 7 per cent of the total production cost Therefore, energy efficiency measures can make a significant impact on the plant's bottom line

The electric rate structure is what is known as the two-part tariff with payment for consumed reactive power Once a year the plant negotiates a contract with the utility company on maximum consumption of active electric power according to expected requirements and pays at fixed rate for actual consumption that does not exceed the maximum negotiated limit If excessive consumption occurs the overused amount is charged tenfold In accordance with this contract the advance payment should be made for the negotiated amount of electric power consumption The is carried out monthly by active power meters installed at the input feeders The negotiated rate is 0 06 kopecks per 1 kWh ($0 03)

There is also payment for negotiated demand which applies only to peak load periods - from 8 to 10 am and from 6 to 10 pm However, the monitoring over the consumption of contracted amount of power is slack and depends on occasional checks by the electric utility personnel and, consequently, does not play much role in the power cost Reactive power consumption limit is established in a similar way

Average cost of 1 kWh of power by the winery data in 1997 was US$0 048

The natural gas comes to the plant from the city pipeline and is used mainly for generation of steam and hot water at the boiler room There are two gas meters on two sections at the gas distribution unit The monthly rate for natural gas is US$83 per 1,000 cubic meters

Cold water is supplied to the plant via five flow meters from the city pipeline The cost of water is US$2 per cubic meter plus a sewerage charge of $2, so the total cost is $4 per cubic meter

5 3 Energy use profile

The production units of the plant use the following types of energy

- electric power - 380/220 V, 50 Hz for electric drives and lighting,
- thermal energy as saturated steam at 9 kg/cm^2 for barrel steaming etc , as hot water with t = 70^{0}C for production supply and space heating,
- natural gas - for the boiler room

Production output in 1995 - 1997 is shown in Table 3 1, energy consumption by types of products is given on Fig 5 5, 5 6, 5 7

The plant does not submeter natural gas, thermal energy or electric consumption at production units, plants or by types of products so it is difficult to account accurately for the changes in the plants overall specific energy use Currently this accounting is carried out by the economic office of the enterprise by calculation on the basis of the design specific use per unit and production output The results if the energy and fuel use are reflected in the state statistical reporting form No 11 mtp "Report on the use of fuel, thermal energy and electric power"

Summarized analysis of the data from the Table 3 1 and Fig 5 5, 5 6, 5 7 shows that calculated norms of energy consumption in 1995 through 1997 are constant for the standardized types of products and work irrespective of the range of output, volumes of production etc This seems to determine the amount of energy resource consumption in the item "Other industrial consumption" which is calculated as the difference between "Industrial consumption" and calculated energy use by standardized types of products and work and where expenses for energy exceeding the standards are reflected The same item shows the non-standardized use by the types of products and work As the result "Other industrial use" was in 1996 42% of industrial use of power, 42 8% of thermal energy, and 46 2% and 32 8% in 1997 respectively, and it seems to be one of the sources of energy savings

Consumption of natural gas depends on the steam demand by production lines Annual thermal power consumption in 1997 was 1,848 Gcal In order to ensure economical running of the boiler room adjustment testing was performed by a specialized company and operation charts were worked out according to which specific fuel consumption in the nominal operation mode was 122,36 m^3/Gcal

Years	Production use, tce	Heat generation, tce
1996	1710	9915
1997	1842	11031

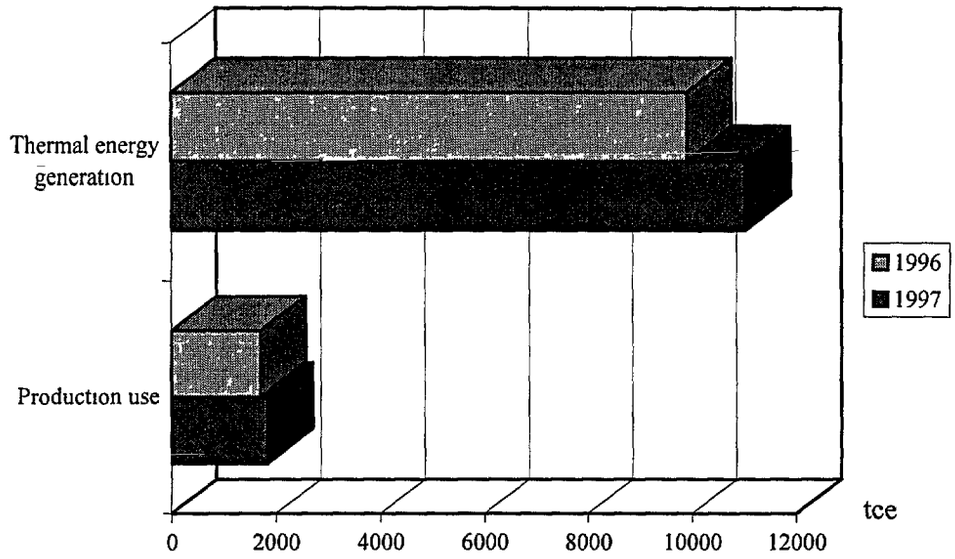


Fig 5 5 Dynamics of natural gas consumption by products or production lines

Years	Production use, Gcal	Including			
		Bottled wine	Wine processing	Wine maturing	Other production use
1996	5572	854	483	1308	2385
1997	5165	1524	726	937	1692

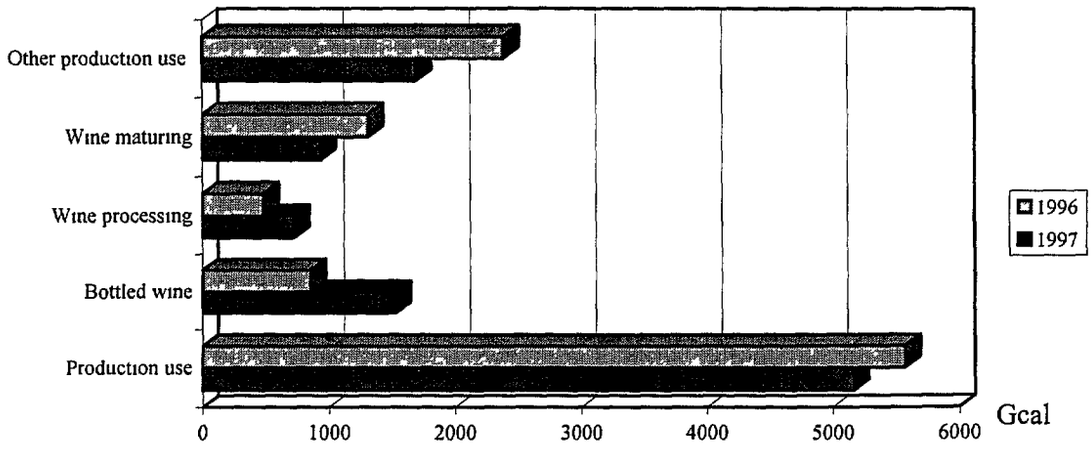


Fig 5 6 Dynamics of thermal energy consumption by products or production lines

Years	Production use, Gcal	Including			
		Refrigeration	Wine processing	Bottled wine	Thermal energy generation
1996	1483	353	91,2	134	125
1997	1570	325	114	178	160

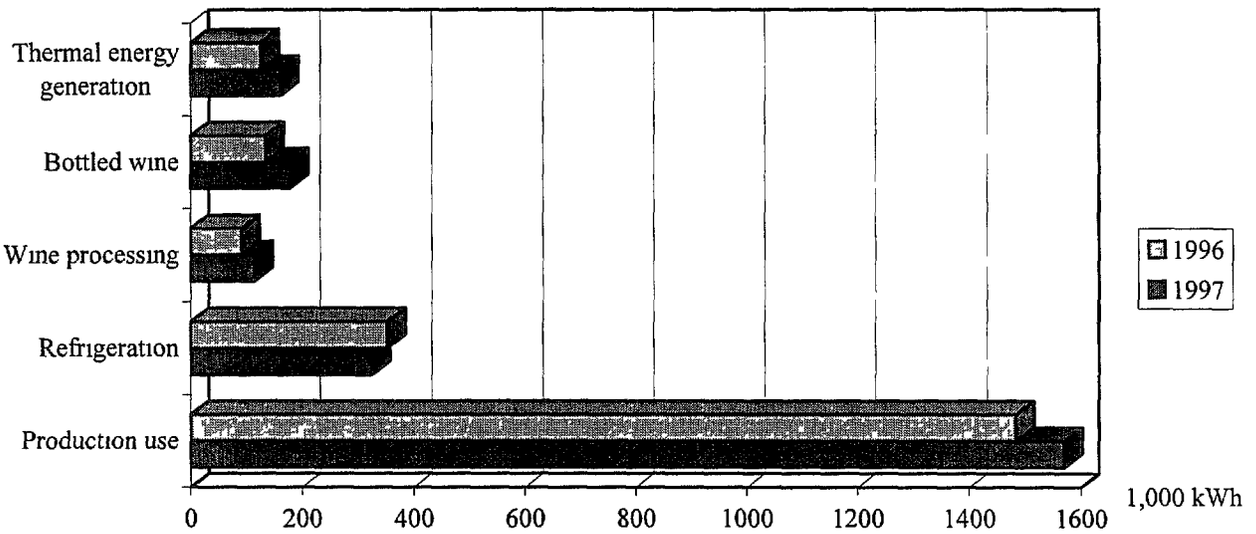


Fig 5 7 Dynamics of electricity use by products or production lines

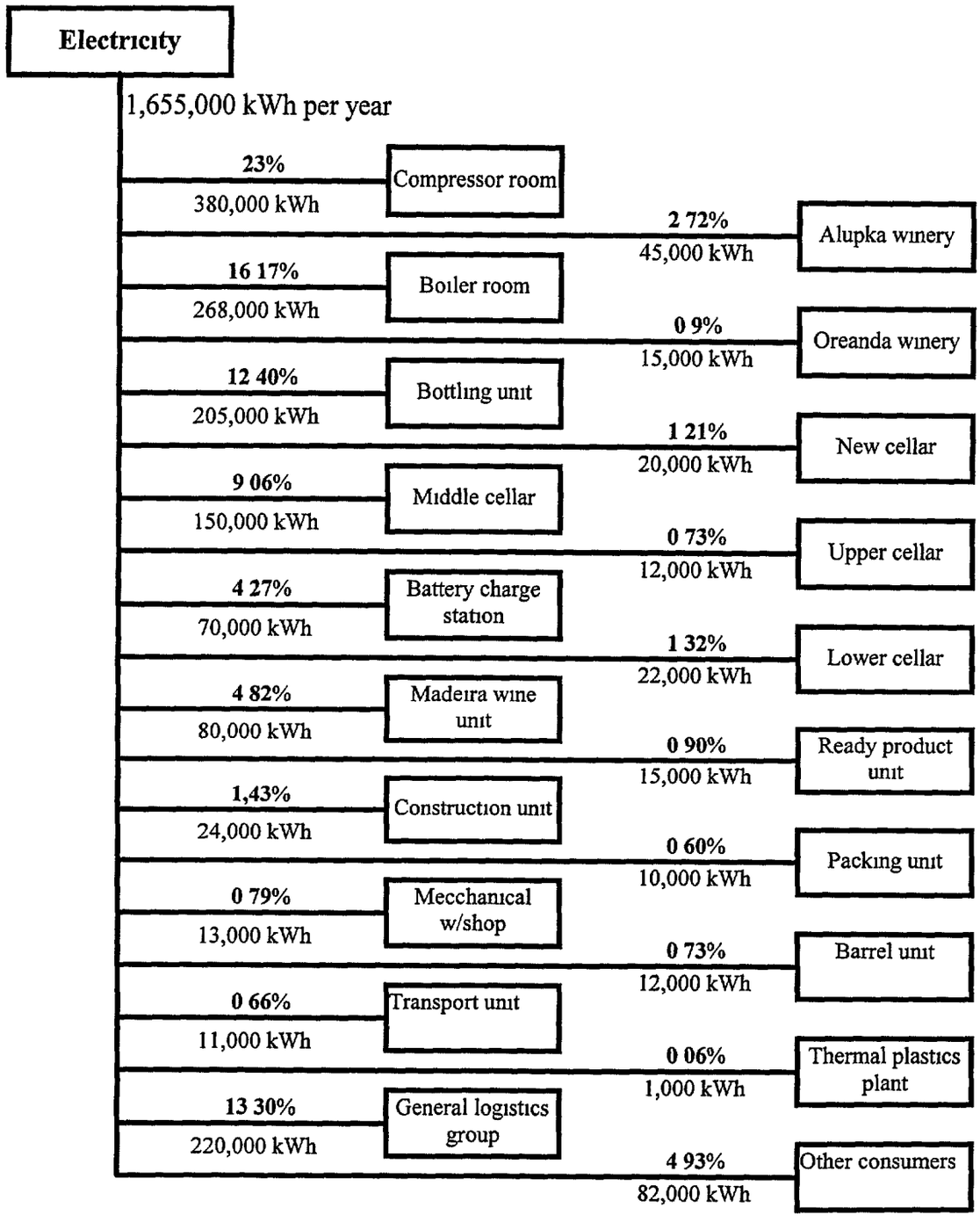


Fig 5 8 Electric power consumption balance of Massandra PAC

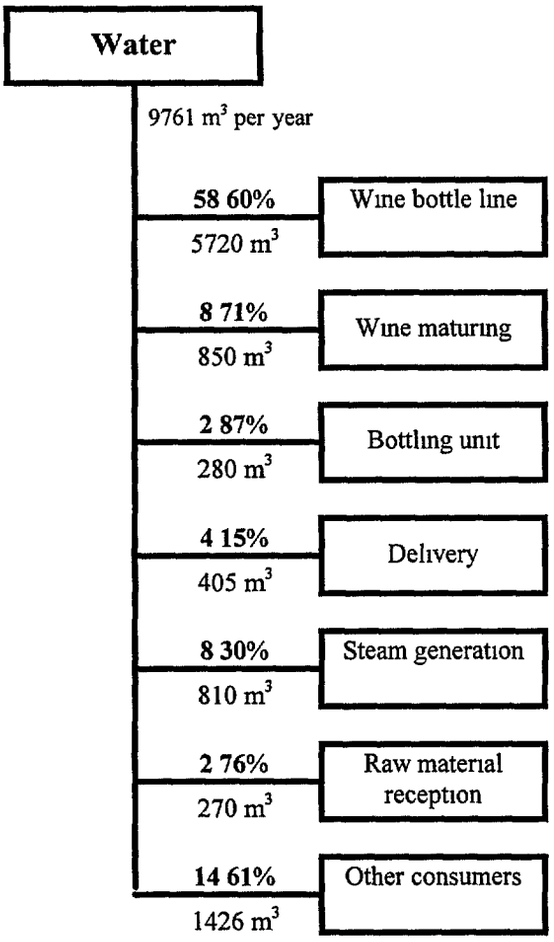


Fig 5 9 Balance of water consumption at Massandra PAC

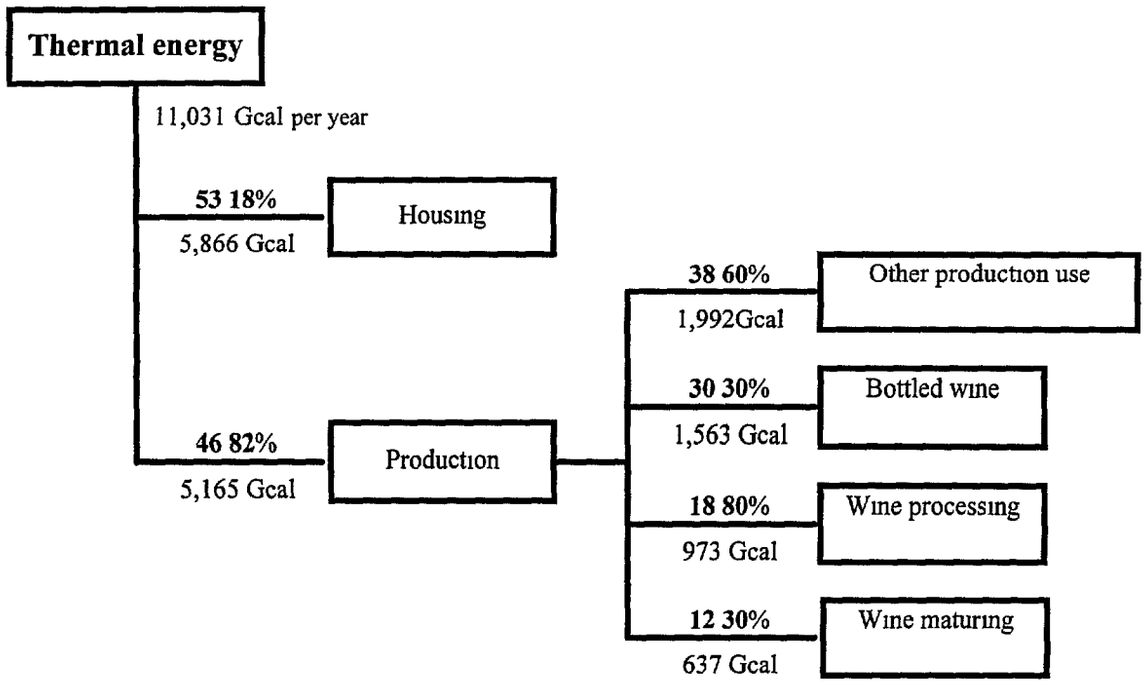


Fig 5 10 Balance of thermal energy use at Massandra PAC

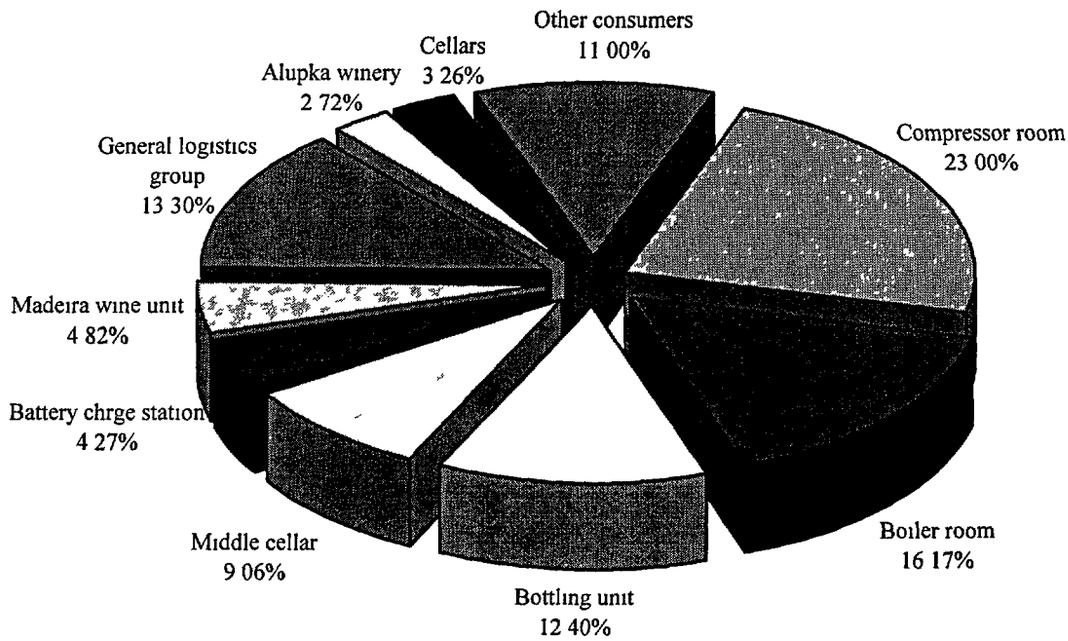


Fig 5 11 Distribution of electricity use by Massandra PAC

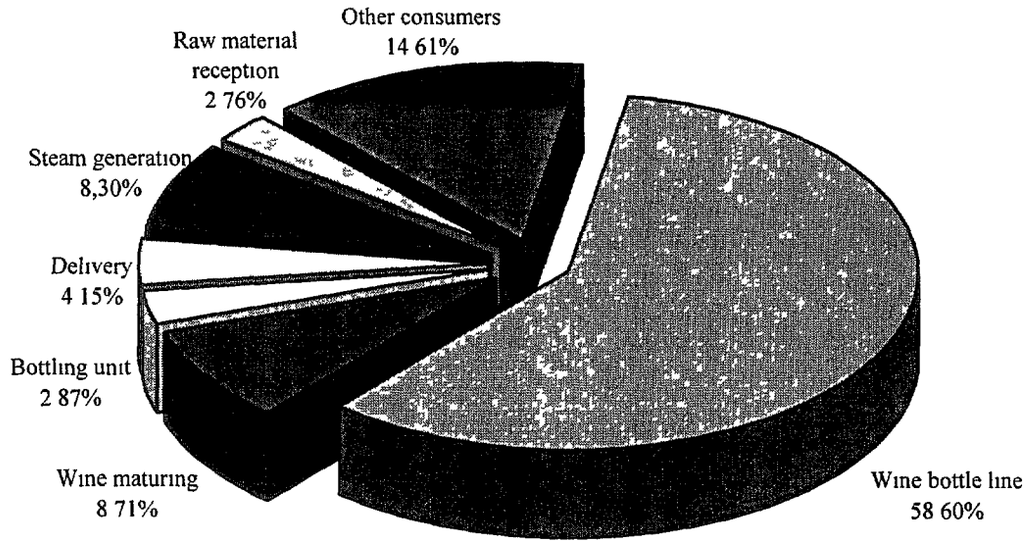


Fig 5 12 Distribution of water consumption at Massandra PAC

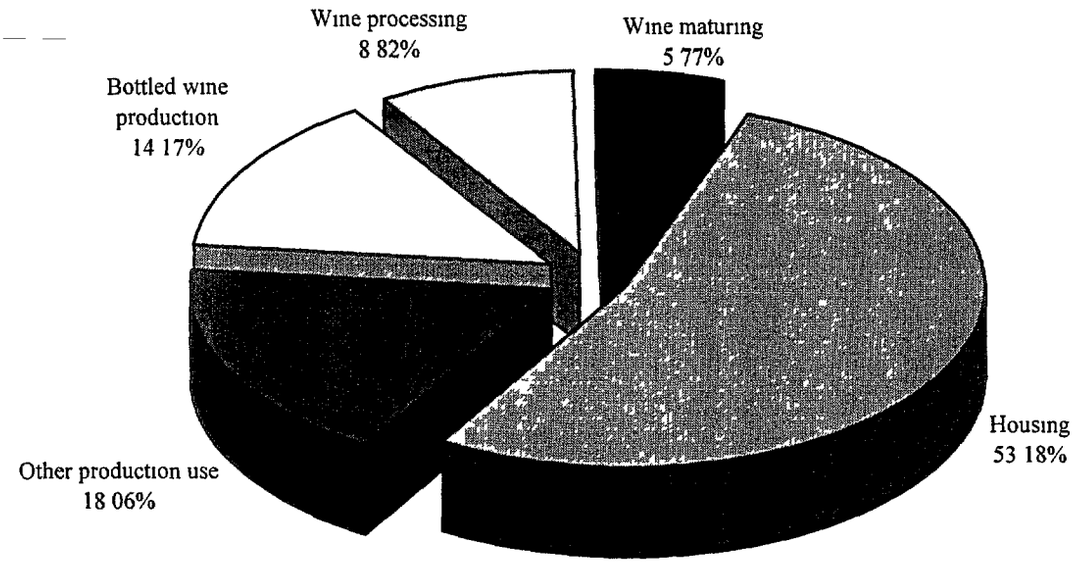


Fig 5 13 Distribution of thermal energy consumption at Massandra PAC

6 0 PREVIOUS ENERGY IMPROVEMENTS

Certain work on implementation of energy conservation measures is being carried out at the winery

- Major part of steam, condensate and hot water piping were insulated, thermal insulation is constantly maintained and overhauled
- At the wine thermal treatment unit modern imported filters of Orion type are used
- The ammonia compressor motor capacities are reviewed and the most acceptable schedule of their operation depending on the refrigeration demand is scheduled
- Air compressor control is automated They are controlled by the compressed air demand
- External lighting system is automatically switched on and off

Another ECO being implemented at the winery but not completed yet is

- Improvement of water supply system at the bottle washing plants

One problem has been the lack of extensive as well as sustained efforts in energy conservation Most of the past energy saving efforts have been conducted on a case-by-case basis without any energy saving management plan in place to systematically look for energy saving opportunities in all energy using areas of the plant Hence, a lot of energy saving opportunities in the general operation and maintenance have been overlooked

7 0 ENERGY AUDIT

The analysis of the fuel and energy use by the winery described in section 5 of this report and the study of the actual use of the energy resources resulted in development of the energy conservation opportunities (ECO) viewed below They will reduce electricity consumption by 321,700 kWh (19 4% of 1997 consumption), natural gas consumption by 406,300 m^3 (26 3%) and potable water consumption by 11,800 m^3 (9/8%)

ECO # 1 Institution of energy management

Energy management is the main avenue by which energy usage reduction and increase in consumption efficiency can be achieved This management strategy is based on conventional measurements and documentation and provides operating conditions that facilitate minimal energy consumption needed for the technology

Implementation of energy management program will result in having more detailed energy consumption records Such system will allow comparison of the energy usage to that of other enterprises for precise evaluation of energy saving projects that are considered by the facility

We recommend to introduce at the plant the energy management program to full extent The implementation of this ECO will result in reducing energy consumption by 2%

By 1997 the plant uses annually on average 1,655,000 kWh of electric power, 1,549,000 m^3 of natural gas and 120,000 m^3 of potable water The global experience and practice show that in case of institution of full-time energy management ensures 5% of fuel and energy consumption savings Energy savings will amount to

1) Electric power = 33,100 (kWh)
2) Natural gas = 31,000 (m^3)
3) Potable water = 2,400 (m^3)

Cost savings due to reduction of energy consumption = $13,000
Total cost of instituting energy management will be $6,200
Simple payback period will be 0 42 year (6 months)
See details in Appendix A 1, ECO # 1

ECO #2 Improvement of combustion efficiency in DKVR-4-13 boiler

For thermal energy supply 2 DKVR-4-13 boilers are used (one is standby) To run these boilers the operation charts have been worked out but automatic control of fuel-to-air ratio in conformity with the load is nonexistent The air consumption value is controlled periodically by the supply air pressure and gas consumption by the pressure before the burners which under the conditions of uncontrolled air infiltration does not allow one to substantiate the idea of optimal combustion processes Control of optimal combustion is carried out by subjective perception of the flame color by the boiler operator

We recommend to equip the operation personnel of the boiler unit with the ENERAC-2000 or BACHARACH combustion analyzer and to include in the operational responsibilities of the operator periodical check of combustion processes which would ensure the increase of boiler combustion efficiency and savings in natural gas

Savings of gas in the physical terms will be ***95 6*** thousand cubic meters

Cost savings will be ***US$7,933***

Implementation cost will be ***US$6,500***

Simple payback will be ***0 82*** year

See details in Appendix A 2, ECO # 2

ECO #3 Recovery of condensate from the bottling unit

The production technology of the wine bottling unit shows the use of saturated steam with the pressure of 2 kg/cm^2 amounting to ***2,400*** tons a year (by the winery data of 1997) for wine preparation, bottle washing, as well as for space heating of bottling and bottle making workshops The steam condensate is drained to the sewer The condensate temperature was 105^{0}C at the draining point

Flash steam temperature measured by the ***KURZ*** thermoanemometer at the sewer opening on the building roof (Appendix D) was 88^{0}C, flow rate was 3 m/sec

We recommend to install storage receiver for condensate at the steam distribution unit of the bottling workshop and to recover condensate with subsequent pumping to the hot water tanks of the boiler room

Savings of natural gas - 41 3 thousand cubic meters

Savings of potable water - 3 4 thousand cubic meters
Energy cost savings - $17,092
Implementation cost - $12,480

Simple payback = 0 73 year
See details in Appendix A 3, ECO # 3

ECO # 4 Insulation of steam piping

As the result of the study of the steam distribution system it was established that despite thermal insulation of main steam pipelines several branch pipes and condensate pipelines do not have proper insulation

It is recommended that the steam piping should be fully insulated

Currently it is realistic to reduce losses in thermal networks by utilizing modern efficient thermal insulation materials such as cellular plastics with thermal conductivity factor of 0 03 - 0 05 cal/ (m x hour x ^{0}C) We assume the use of the materials above

Natural gas savings will be 59 thousand m^3

Energy cost savings will be US$7,948

Implementation cost will be US$5,157

Simple payback *=0 65 year (8 months)*
See details in Appendix A 4, ECO # 4

ECO #5 Installation of steam trap units at the steam consuming systems

At the plant the 5 kg/cm^2 saturated steam is used One of the directions of industrial use of stem is the following
for heating wine in pasteurizing plants,
for water heating in bottle washing equipment,
barrel steaming,
in sauna,
for space heating

We recommend to install the following equipment with steam trap units
- pasteurizing plants - 4 traps,
- sauna - 1 trap,
- bottle washing equipment - 1 trap

The recommended proposal will improve efficiency of the steam utilizing equipment by 10-15 and more per cent

Annual energy savings will be 253 6 Gcal (36,940 m^3 of natural gas)

Cost savings will be $3,066

Total implementation cost will be $ 3,000

Simple payback = 0 98 years

See details in Appendix A 5, ECO # 5

ECO #6 Shut-off of transformers during idle time

Electric power consumers are supplied from 3 transformer substations TP-719 - two 400 kVA transformers, TP-720 - two 400 kVA transformers,TP-124 - two 320 kVA transformers As results of the load study performed with the help of the ***DRANETZ***-type electric load generator showed the most loaded was the TP-719 substation from 10,42 am on 03 17 93 to 1 20 pm on 03 18 93 (Appendix D), the maximum load was 109 7 kVA at 1 45 pm (25% of nominal load) The loads of other TP substations did

not exceed the given value In order to rid of transformer idling losses we recommend to connect the TP substations at the 0 4 kV side and shut off idle transformers

Electric power savings will be - 132 5 thousand kWh

Energy cost savings will be $5 564

Implementation cost will be $6,500

Simple payback will be 1 17 years

See details of this proposal in Appendix A 6, ECO #6

ECO # 7 Monitoring of boiler equipment operation and temperature modes of heat-consuming equipment

The winery has an extensive steam and condensate and space heating systems, however, in-built control pressure gauges and thermometers are practically absent It is impossible to perform an analysis of the efficiency of heat-using equipment, to calculate specific consumption and to promptly discover equipment deficiencies

We recommend to introduce at the plant a portable infra-red thermometer of ***"Reynger ST6"*** type that will enable monitoring of the heat consuming equipment and to supervise it regularly (***1 - 2*** times a week) the efficiency of its operation and to react promptly to the thermal energy wastes Expected efficiency improvement of the heat use is ***0 3–0 6%***

1 Estimated annual savings - 0 5%

2 Annual steam consumption - 7,157 Gcal

3 Estimated thermal energy savings

7,157 Gcal x 0 05 = 35 8 Gcal

making 5 2 thousand cubic meters of natural gas

4 Cost of 1 Gcal of steam - $19 6

5 Cost savings - 35 8 Gcal x $19,6 = $701

Simple payback will be ***1 4*** years
See details in Appendix A 7, ECO #7

ECO #8 Conversion of space heating systems from steam to hot water

At the winery on certain premises steam is used for space heating purposes (see photo in Appendix E) the share of which in the total heat balance is 40% As the temperature measurements in several rooms showed there was overheating when the temperature instead of standard 18-20°C reached 26-30°C that made personnel open windows for fresh air
We recommend to convert space heating systems to water instead of steam

Natural gas savings - 60 2 thousand m^3

Cost savings - $8,095

Cost of water- and gas pipes and other materials approximately - $1,500

Simple payback - 0 18 year i e the ECO will pay back in 1 heating season

See details in Appendix A 8, ECO #8

ECO # 9 Automatic energy metering system

Natural gas is metered at the enterprise is metered by two gas meters at the boiler room inputs

The detailed study showed that calculations of steam, electric power, gas, compressed air, hot and cold water consumption by separate production units of the winery are made by standard indicators and actual production output figures Instrument metering is non-existent

We recommend to automate commercial and technical metering using the ITEK technical instruments manufactured by the Energiya R & D institute in Kiev These instruments are metrologically certified in Ukraine and are designed for continuous and periodical measurement/registration of physical values

In order to implement the ECO it is planned to set up commercial metering of power consumption at 6 points and of potable water at 5 points

Technological metering of electric power will be implemented at 24 points, cold water at 4 points, steam at 6 points

Judging from the experience expected savings from introduction of own automatic metering at the plant and energy use planning and control system will be not less than 5% Therefore, based on the 1997 data annual savings of natural gas will be 77 5 thousand m^3 , of electric power - 83 thousand kWh, potable water - 6 thousand m^3
Cost savings - $40,000

Implementation cost - $60,000

Simple payback will be ***1 5 years***
See details in Appendix A 9, ECO # 9

ECO #10 Energy efficient plant lighting

The external lighting system of the plant area consists of SZPR lighting fixtures with 35 DRL - 400 high pressure mercury lamps, 44 DRL-250 lamps installed at 10-meter high ferroconcrete lampposts Part of the area adjacent to the production buildings is lighted by conventional 100-watt and 500-watt incandescent and 2 x 40 fluorescent

lamps The light flow of the DRL-400 lamp is equal to 23,000 lumen and service life is 6,000 hours, DRL-250 - 10,000 lumen and 2,400 hours, respectively

It is suggested to consider the proposal of replacement of DRL -400 high pressure mercury lamps for external lighting of the plant area with the DNaT-250-3 high pressure sodium lamps and DRL-250 with DNaT-100-3 using existing fixtures and replacing switching appliances with appropriate capacity The sodium lamps of the DNaT -250-3 type are manufactured nationally in the city of Poltava and have a longer operation life of 12,000 hours with the light flow of 25,000 lumen and DNaT-100-3 - 6,000 hours and 9,000 lumen, respectively

Cost savings will be ***US$2,353***

Implementation costs will be US$***2,545***

Simple payback will be ***1 1 years*** (since the service life of the selected lamps is longer than that of the existing ones the actual payback period can be less than one year)

See details in Appendix A 10, ECO # 10

ECO # 11 Monitoring and optimization of electric motor capacities

Approximately ***70***% of total electricity use of the winery are used for bottling, maturing and processing of wine materials, compressor unit and boiler room needs which amounts to ***1,140*** thousand kWh to the sum of ***47,900***$ During previous operation of the winery in case of motor failure they were replaced disregarding the minimum required capacity Hence, even similar equipment uses various capacity motors often exceeding the needs Some of the primary consumers of electric power are electric motor drives of compressor, fan and ventilation equipment

The total rated capacity of motors of ammonia and air compressors is ***435*** kW which exceeds the needs of the enterprise The measurements with the TIF-type wattmeter during the audit showed that the rated capacity of electric motors is used at ***20–30***%

We recommend to institute operation control over the actually used motor capacities (first and foremost, motors of compressors, pumps and fans) with the help of portable capacity measuring instrument set. The recommended measure will allow during 1 - 2 months to monitor the actual motor loads, analyze the efficiency and organize replacement with more efficient motors Implementation of this project will save not less than ***1,5***% of electric power used for production purposes annually, or ***17 1*** thousand kWh

Cost savings estimate is $ ***718***

Implementation cost is $***1,000***

Simple payback is ***1 4*** years

See details in Appendix A 11, ECO #11

8 0 ENVIRONMENTAL IMPACTS OF THE RECOMMENDATIONS

The most efficient way of reduction of hazardous emission in the atmosphere is the decrease of fuel and electric power use, thus the introduction of the above mentioned recommendations is vital also from the environmental standpoint In this sections calculations have been made supporting opportunities of thermal energy, natural gas and electric power savings

Since the winery meets the requirements for thermal energy using the in-plant boiler house the savings are shown as natural gas savings

Thermal energy savings from implementation of the proposed measures for the entire plant will amount to

ECO #1 - S_{1g} = 31 thousand m^3 per year
ECO #2 - S_{2g} = 95 6 thousand m^3 per year
ECO #3 - S_{3g} = 41 3thousand m^3 per year
ECO #4 - S_{4g} = 59 thousand m^3 per year
ECO #5 - S_{5g} = 36 9 thousand m^3 per year
ECO #7 - S_{7g} = 5 2 thousand m^3 per year
ECO #8 - S_{8g} = 60 2 thousand m^3 per year
ECO #9 - S_{9g} = 77 5 thousand m^3 per year

Total natural gas savings will be $S_{sum} = S_{1g} + S_{2g} + S_{3g} + S_{4g} + S_{5g} + S_{7g} + S_{8g} + S_{9g}$ = 31 + 95 6 + 41 3 + 59 + 36 9 + 5 2 + 60 2 + 77 5 = 406 7 thousand m^3 per year

Thermal energy savings calculated in the terms of natural gas we determine by the following equation (for example, for ECO #4)
$S_{3gas} = S_3 \, x \, b \, x \, 10^{-3} = 405\ 5 \, x \, 145\ 7 \, x \, 10^{-3}$ = 59 thousand cubic meters

where b is specific fuel use for generation of 1 Gcal of thermal energy, m^3 /Gcal (based on gas and heat consumption in 1997),

S_3 - thermal energy savings by ECO#4

Natural gas combustion leads to emission into the atmosphere of carbon oxide CO and nitrogen oxides NO_X

The amount of prevented emission we determine using combustion efficiency study (Appendix D) of No1 boiler that shows the following emissions

carbon oxide emission - $M_{CO} = h_{CO} \, x \, S_{sum}$ = 0 05 x 406 7 = 20 3 kg,

nitrogen oxide emission - $M_{NOx} = h_{NOx} x \, S_{sum} + (h_{NOx} - h^1_{NOx})$ x $(N_g - S_{sum})$= 0 685 x 406 7 + (0 685 - 0 233) x (1,549 - 406 7) = 795 kg,

where h_{CO}, h_{NOx}, h^{1}_{NOx} are specific emissions of carbon oxide and nitrogen oxides before and after implementation of ECO #2, kg per 1,000 m^3

The results of calculations are shown in Table 8 1

Electric power savings from implementation of the proposed measures for the entire plant will amount to

ECO #1 - W_1 = 33 1 thousand kWh,

ECO #6 - W_6 = 132 5 thousand kWh,

ECO #9 - W_9 = 83 thousand kWh,

ECO #10 - W_{10} = 56 thousand kWh,

ECO #11 - W_{11} = 17 1 thousand kWh,

Total electric power savings will be $W_{sum} = W_1 + W_6 + W_9 + W_{10} + W_{11}$ = 33 1 + 132 5 + 83 + 56 + 17 1 = 321 7 thousand kWh per year

According to the data of the Ministry of energy of Ukraine average emissions from generation of 1 thousand kWh were as follows

emissions of solid particles - 4 4 kg,

carbon oxide CO - 0 5 kg,

nitrogen oxides NO_X - 2 2 kg,

sulphur oxides SO_2 - 9 9 kg

The results of prevented pollutant emission into the atmosphere through electric power savings are given in Table 8 1

Table 8 1

Summarized indicators of prevented pollutant emission into the atmosphere as the result of proposed ECO implementation

Type of emission	Reduction through thermal energy savings	Reduction through electric power savings	Total reduction per year
Solid particles, tonnes		1 42	1 42
Carbon monoxide, tonnes	0 02	0 16	0 18
Nitrogen oxides, tonnes	0 79	0 71	1 5
Sulphur oxides, tonnes		3 18	3 18

Thus implementation of proposed measures will cut down pollutant emission into the atmosphere by 6 28 tonnes that will certainly improve ecological situation in the town of Massandra

APPENDIX A ENERGY CONSERVATION OPPORTUNITIES (ECO)

A 1 ECO - 1 Institution of energy management

ECO description

At the plant there are enormous opportunities of energy conservation by implementing simple energy management solutions which are low-cost give fast payback However, currently a formalized plan of energy management leading to reduction of operational losses is non-existent

The key to successful implementation of the energy management plan is appointment of an energy manager or institution of a commission with main responsibility of the concerted effort for energy efficiency improvement This person should

- have technical background and thorough knowledge of thermal and electrical engineering,
- be capable of teamwork with the plant staff in identifying energy conservation opportunities at production lines and presenting these ECOs to the management,
- be knowledgeable about organization of staff training in energy conservation and encourage implementation of such measures at the plant,
- be able to work out energy management strategies for energy efficiency improvement for 5-10 years

This position is non-existent presently Therefore, we recommend to appoint an energy manager at the plant who will direct the plant to more efficient energy use

The following energy conservation opportunities were identified during the energy audit that can be a starting point for implementation of a more comprehensive plan

1 **Weather-stripping of gates, doors and windows** large gates are installed at the reception section, bottling unit, delivery unit with gaps from 10 to 50 mm Cold air infiltrates through these gaps into heated area
2 **Elimination of space overheating** during the audit in some areas considerable overheating was discovered At the ambient temperature of +10^{0}C in the areas with steam heating (bottling unit, lower cellar, etc) the inside temperature reached +25 - + 28^{0}C It is necessary to organize regular monitoring of the inside temperature, for example, utilizing ***Raytec PM3L3SZ*** non-contact infra-red thermometers
3 **Improvement of energy efficiency of cold rooms** there are 2 cold rooms with 24 tanks for wine cooling to -13^{0}C

It is possible to implement energy conservation measures to reduce energy losses in cold rooms oriented at minimization of infiltration of a more humid and warm air from outside, especially during summer season

Since the cooler air is denser it has a natural tendency to "spill out" when the doors are opened The lost cold air is made up by the warmer surrounding air infiltrating into the cold rooms This warmer air then has to be cooled by the refrigeration system Also, the surrounding air usually has a higher moisture content This moisture condenses out when the air comes in contact with the refrigeration coil This condensed moisture eventually starts to freeze on the evaporator coil surface since the temperature of the refrigerant in the coil is below freezing temperature This ice built

up on the coil reduces the cooling efficiency of the coil resulting in higher energy use at the compressor

Cold air is lost continuously through the gaps in the cold doors and also when doors are opened to load/unload goods Although infiltration losses cannot be totally eliminated significant reductions can be made with the following three recommendations

- **Weather-stripping of Cold Room Doors** It was observed that the cold room doors do not shut tightly There were visible gaps when the doors are closed The cool air is constantly leaking out of the cold rooms as a result The doors should be weather-stripped to provide a tighter closure and minimize loss of cold air

- **Installation of Plastic Curtains in Cold Rooms** At present there are no barriers to minimize the cold air lost during the loading and unloading operations when the doors are kept open

It is recommended that plastic curtains be installed at the doors to create a vestibule barrier against infiltration when the doors are opened during loading/unloading operations The barrier will significantly reduce the loss of cold air when the doors have to be kept open By minimizing loss of cold air from the rooms the cooling load and hence the compressor run-time will be reduced

- **Installation of Automatic On/Off Light Switch for Cold Rooms** Presently there are six 150 W incandescent lamps in each cold room It is recommended that a mechanical door switch be added that will automatically turn off the lights when the cold room doors are closed
- **Monitoring of Heat and Cooling losses** thermal insulation of the equipment wears out due to various reasons and this leads to heat losses We recommend to monitor heat and cooling losses utilizing ***Raytec PM3L3SZ*** non-contact infra-red thermometers

Energy Savings Estimate

It is difficult to estimate the energy savings from individual energy management measures, but its not unreasonable, based on experience in the US, to expect savings anywhere from 1 to 5 percent of the plants total energy use Since the plant pays approximately US$800,000 annually in energy bills even just 2 percent savings would result in US$16,000 savings annually This is equal to savings in natural gas of 31,000 cubic meters, electricity of 33,100 kWh, potable water of 2,400 cubic meters

Implementation and commissioning costs

The costs are of two types One is a recurring cost for the salary of the energy-efficiency manager and the other is the capital cost associated with implementing the recommendations above The impact of the salary would be to lower the annual savings, however, this should not be seen as eating away the savings but as an investment because the benefits of an energy-efficiency manager more than outweigh the costs in the long run

Table A1 2 Cost Estimates for ECO-1 Recommendations

Table A 1 1

Description	Cost, US$	Cost, Hr
1 Energy management instrumentation		
• ***Raytec PM3L3SZ*** non-contact infra-red thermometer	1,600	3,200
• ***Fluke model 87*** tester	500	1,000
• ***TIF model 2000A*** wattmeter	600	1,200
2 Weather-stripping of doors, gates and windows (overall length - 500 m)	1,500	3,000
3 Improvement of energy efficiency of cold rooms		
• weather-stripping of doors	500	1,000
• installation of plastic curtains	1,500	3,000
Total	**6,200**	**12,400**

Most of these measures can to be implemented in-house by the plant staff Therefore, the labor costs are not included here

Simple payback

The typical salary for an energy-efficiency manager is US$3,000 per year

The simple payback for instituting an energy management plan is

SP = $6,200 / ($16,000-$3,000) = **0 47 year (6 months)**

A 2 ECO #2 Improvement of combustion efficiency in DKVR-2 5-13 boiler

For thermal energy supply two DKVR-4-13 boilers are used (one is standby) To run these boilers the operation charts have been worked out but automatic control of fuel-to-air ratio in conformity with the load is nonexistent The air consumption value is controlled periodically by the supply air pressure and gas consumption by the pressure before the burners which under the conditions of uncontrolled air infiltration does not allow one to substantiate the idea of optimal combustion processes Control of optimal combustion is carried out by subjective perception of the flame color by the boiler operator

The above mentioned is confirmed by the DKVR-4-13 gas combustion efficiency measurements taken with the ***BACHARACH*** combustion analyzer (Appendix D) As the measurements showed oxygen content in the exhaust pathway of the boiler was 8 1-9 6%, excess air ratio - 1 57-1 77, exhaust gas temperature after the exhaust fan - 121^{0}C , boiler gas combustion efficiency - 86 7%, after economizer - 92 6% (not considering the temperature of input air) High excess air factor is due to a crack in the brick-lining of the boiler observed during visual inspection

We recommend to equip the operation personnel of the boiler unit with the ENERAC-2000 or BACHARACH combustion analyzer and to include in the operational responsibilities of the operator periodical check of combustion processes which would ensure the increase of boiler combustion efficiency and savings in natural gas

Energy savings estimate

According to the plant data given in the form No11 MTP "Report on the results of the use of fuel, thermal and electric energy" in 1997 the plant generated 11,031 Gcal of energy while actual fuel use was G=1,848 tce or 1,593,000 cubic meters of natural gas According to the manufacturer's certificate the DKVR-4-13 boiler equipped with economizer should have efficiency of η ***=91%*** and coal equivalent fuel use of 156 93 kg of coal equivalent per 1 Gcal

The measurement results showed that average boiler efficiency was η_{ef} ***=81%*** at actual specific consumption of 176 4 kg of coal equivalent per 1 Gcal

Implementation of this measure will reduce the specific use by ***b~6%*** and it will reach 165 8 kg per 1 Gcal, average boiler efficiency will rise to ***86 2%***

Savings of gas in the physical terms will be

$S_G = G \times b = 1\ 593 \times 0\ 06 = 95\ 58$ thousand cubic meters

Annual cost savings estimate

Money savings at the price of US$ 83 per 1000 cubic meters will be

$S_M = S_G \times 83 = 95\ 58 \times 83 = US\$7{,}933$

Implementation cost

Cost of ***ENERAC - 2000*** combustion analyzer - C_1=***US$5,000***

Cost of transportation - C_2=***US$1,500***

Total $C_{COM} = C_1 + C_2$= ***5000+1500 = US$6,500***

Simple payback estimate

Annual savings in costs - S_M = ***US$7,933***

Commissioning costs - C_{COM} = ***US$6,500***

Simple payback

$SP = C_{COM}/S_M$ = ***6500/7,933= 0 82*** year

A 3 ECO #3 Recovery of condensate from the bottling unit

The production technology of the wine bottling unit sets the use of saturated steam with the pressure of 2 kg/cm^2 to the amount of ***2,400*** tons a year (by the winery data of 1997) for wine preparation, bottle washing and space heating of bottling and bottlemaking workshops The steam condensate is drained to the sewer The condensate temperature was 105^{0}C at the draining point

Flash steam temperature measured by the ***KURZ*** thermoanemometer at the sewer opening on the building roof (Appendix D) was 88^{0}C, flow rate was 3 m/sec

We recommend to install storage receiver for condensate at the steam distribution unit of the bottling workshop and to recover condensate with subsequent pumping to the hot water tanks of the boiler room

Technical data of condensate receiver tank

- volume of receiver tank -225 l,
- condensate pump for the 98^{0}C condensate,
- power - 1 x 1 1 kW,
- head - 35 m of wc,
- capacity - 1,400 kg per hour

The pump will be controlled by float level gauge

Energy savings estimate

recovery of condensate will save

$$Q_k = G_k \quad (i_1 + x_n \quad r_1) = 2{,}440 \quad 10^3 \quad (105 + 0{,}021 \quad 525\ 9) = 283\ 4 \text{ Gcal}$$

where G_c amount of unrecovered condensate, tons per year,

i_1 – thermal content of condensate with pressure in the unit, kcal/kg,

x_f– share of flash steam after steam trap, kg/kg,

r_1 steam generation heat at the initial pressure in the unit, kg/cm^2,

$$x_f = 0\ 015\sqrt{P_1} = 0\ 015\ \ 1\ 41 = 0\ 021$$

where P_1 – steam pressure in the unit, kg/cm^2

Thermal energy savings will ensure natural gas savings

$$Q_g = Q_c \quad b_T/1\ 15 = 283\ 4 \quad 167\ 5/1\ 15 = 41{,}300 \text{ m}^3$$

where b_T – actual specific consumption of natural gas according to the statistical form No11 MTP "Report on the results of the use of fuel, thermal and electric energy" for 1997, kg of coal equivalent per Gcal

Additionally boiler replenishment water will be saved to the amount of

$$Q_w = 2{,}400 \quad 1\ 4 = 3{,}416 \text{ m}^3\text{/year}$$

where *1 4* – factor of water use and boiler blowdown

Annual cost savings estimate

Cost savings due to thermal energy savings at the cost of natural gas at *83* $ per *1,000* m^3 will be

$S_T = Q_g \quad 83 = 41\ 3 \quad 83 = 3{,}428$ $

Cost of saved water at the rate of *2* $/$m^3$ and for sewerage – *2* $/$m^3$ will be

$S_T = Q_w \quad 4\ \$ = 3{,}416 \quad 4 = 13{,}664$ $

Cost savings will be higher with water treatment chemicals are taken into account

Total savings

$$S_c = S_T + S_w = 3{,}428 + 13{,}664 = 17{,}092\ \$$$

Implementation cost

Equipment costs are given in Table A 3 1 The cost of condensate receiver, pump and controls is calculated based on the ***B 2111 S*** model manufactured by ***Spirax Sarco*** Specific models and sizes should be determined during the design phase Construction and installation will be performed by the enterprise Approximate costs are $C_i = 12{,}480$ $

Table A 3 1

Description	Cost, $	Cost, Hr
1 Condensate receiver, pump and controls	5,000	10,000
2 Piping		
• length - *250* m, ∅ *55* mm	4,000	8,000
• length - *60* m, ∅ *38* mm	1,000	1,850
3 Fiberglass insulation with multi-purpose coating		
• thickness *40* mm for *250* m of ∅ *55* mm piping	2,000	4,000
• thickness *40* mm for *60* m of ∅ *38* mm piping	480	960
Total	**12,480**	**39,600**

Note Quantities of fittings, valves, etc as well as the length of piping will depend on the laying configuration and installation design Specific requirements will be determined by the supplier and the plant staff at the phase of the recovery system implementation

Simple payback

Annual cost savings – $S_a = 17{,}092$$/year

Implementation cost – $C_i = 12{,}480$$

Simple payback

$SP = S_a / C_i = 12{,}480/17{,}092 = 0\ 73$ year

A 4 ECO # 4 Insulation of steam piping

ECO description

As the result of the study of the steam distribution system it was established that despite thermal insulation of main steam pipelines several branch pipes do not have proper insulation

Particulars of broken insulation and non-insulated piping after taking measurement are given in Table A 4 1

Table A 4 1

Purpose of piping	Length, L m	Diameter, D mm	Number of valves	Number of flanges	t, °C
1 Steam	13	89	1	-	170
2 Steam	80	50	-	-	160
3 Steam	48	40	7	14	130
4 Steam	15	32	3	6	170
5 Steam	80	25	-	-	130

The condensate is returned to the feedwater tank in the boiler room where it is mixed with cold water of 15°C The feedwater tank is heated by steam to achieve 80°C

The efficiency of the steam boiler according to the measurements is 81% and efficiency of the steam distribution system is 75% Consumption of steam at the pressure of 9 kg/cm^2 is 5 ton/hour The boiler is fired round the clock while only 30% of steam goes for production purposes and 70% is used for housing heating Steam consumption for production purposes carries on 40 hours a week , 52 weeks a year

It is recommended that the steam and hot water piping should be fully insulated

The thickness of insulation should be selected depending on the piping diameter and its purpose The data are furnished in Table A 4 2

Table A 4 2

Purpose	Diameter, mm	Insulation thickness, mm
1 Steam	50 - 89	80
2 Steam	25 - 40	60

Annual energy savings estimate

We define the thermal energy waste for insulated and non-insulated pipes in accordance with the methodology [Methodological instructions for determination of losses of fuel and energy resources RD5 EDIV 015-008094 Minmashprom, Kiev, 1994]

Thermal energy waste in non-insulated pipes (Kcal/hour) is determined by the following formula

$Q_{nin} = g_{nin} \, x \, L_o \, x \, k$,

where g_{nin} - specific losses of non-insulated piping (kcal/meter x hour),

k - correction factor which depends on the air temperature and the difference between pipe wall temperature and air temperature,

L_o - given length of piping, m

$L_o = L + (1m \, x \, n)$,

n - number of valves within the section

For the pipeline #1 from Table A 4 1 we have

$Q_{nin1} = 650 \, x \, (13+1) \, x \, 0\ 95 = 8{,}645$ *kcal/hour*

Further calculations were carried out similarly and are summarized in Table A 4 3

Thermal energy waste of insulated (kcal/hour) pipelines are calculated by the formula

$Q_{in} = g_{in} \, x \, (t_1 - t_2) \, x \, a \, x \, b \, x \, L_0$

where g_{in} is specific loss over 1 meter of piping with difference $(t_1 - t_2) = 1^0C$ depending on the thickness of insulation,

t_1 - temperature of pipe walls assumed as equal to temperature of heat carrier, °C,

t_2 - temperature of the air, °C,

a - correction factor depending on the thickness of insulation, thermal conductivity if insulation material and temperature difference between heat carrier and air With insulation thickness up to 100 mm and temperature difference up to 300 °C $a = 1$,

b - wind correction factor (with wind velocity of 5 m/sec)

Presently it is realistic to cut down waste in the thermal networks by using modern efficient types of thermal insulation materials such as cellular plastics, Styrofoam and other with thermal conductivity of 0 03 - 0 05 cal/ (m x hr x °C) We assume the use of the materials mentioned above

For pipeline #1 from Table A 4 1

$Q_{in1} = 0\ 227 \, x \, (170 - 15) \, x \, 1 \, x \, 1\ 03 \, x \, 14 = 507$ *kcal/hr*

Similar calculations were carried out for all pipelines and are shown in Table A 4 3

Net savings are received taking into account the length of a pipeline and full savings - considering the steam distribution system and boiler efficiency

Table A 4 3

Pipeline No	Given length	Thermal waste without insulation	Thermal waste with insulation	Net savings	Full savings
	L_o, m	Q_{min}, kcal/hr	Q_{in}, kcal/hr	S_N, kcal/hr	S_F, kcal/hr
1	14	8,645	507	8,138	12,472
2	80	45,600	1,723	43,877	67,244
3	59	28,025	1,153	26,872	41,183
4	20	12,350	527	11,823	18,119
5	80	38,000	1,518	36,482	55,911
			Total	**127,192**	**194,930**

Thus annual savings should amount to

$S_a = 194,930$ kcal/hr x 40 hrs x 52 weeks x $10^{-6} = 405\ 5$ Gcal/year
which is equal to 59 thousand m^3

Annual cost savings estimate

Cost of 1 Gcal - $C_{GC} = US\$19\ 6$

Annual savings

$S_M = S_a x\ C_{GC} = 405,5\ x\ 19\ 6 = US\$7,948$

Implementation cost

Total cost of insulation to be installed -

$C_1 = L_{CON}\ x\ C_{INSC} = 253\ x\ 10\ 5 = US\$2,657$

where L_{CON} = total given length of water pipelines No 1-5 from Table A 4 1, in meters,

C_{INSC}, = cost of 1 meter of insulation of steam pipelines, US$ per meter

Cost of installation - $C_2 = US\$2,500$

Total estimated cost $C_{COM} = C_1 + C_2 = 2,657 + 2,500 = US\$5,157$

Simple payback estimate

Annual savings in costs - $S_M = US\$7,948$

Implementation cost - $C_{COM} = US\$5,157$

Simple payback = $S_M\ /C_{COM} = 5,157/7,948 = 0\ 65$ *year* (8 months)

A 5 ECO #5 Installation of steam trap units at the steam consuming systems

ECO description

At the plant the 5 kg/cm^2 saturated steam is used
- for heating wine in pasteurizing plants,
- for water heating in bottle washing equipment,
- barrel steaming,
- in sauna,
- for space heating

As the audit showed steam in the above mentioned heat exchangers is not used efficiently from steam heating systems steam and water mixture is drained into sewer (Appendix D) All steam utilizing production equipment is not equipped with steam traps which results in unused steam and condensate from pasteurizing units at 114^{0}C being pumped to the condensate pumping station where it is lost with flash steam, and steam from bottling machines is drained into sewer

By conversion of space heating from steam to hot water as proposed in ECO #8 the steam and condensate mixture will be no longer drained

We recommend to install the following equipment with steam trap units
- pasteurizing plants - 4 traps,
- sauna - 1 trap,
- bottle washing equipment - 1 trap

The recommended proposal will improve efficiency of the steam utilizing equipment by 10-15, besides there is a potential of reducing steam use by 4-6 times

Annual energy savings estimate

We assume that the efficiency of the steam utilizing equipment will rise by 10% The data from the thermal balance of the plant
- heat use by 4 bottle washing machines - 1,563 Gcal (1997 data)
- heat use for wine treatment - 973 Gcal

Annual energy savings will be

$Q_c = (1,563 + 973) \times 0\ 1 = 253\ 6$ Gcal
or in natural gas

$Q_g = 36\ 94$ thousand m^3

Cost savings estimate

Cost savings at the price of gas of $83 per 1,000 m^3 will be

$S_c = Q_g x\ 83 = 36\ 94 = \$3,066$ per year

Implementation cost

We recommend to install 6 steam trap units equipped with the following ***Spirax Sarco*** products

- Float-type steam trap DN 20 FT 20-32 flanged BS4504 - $360
- Trap strainer disc-type DN20 - $90
- Check valve wafer-type DN20 DCV - $50

Total - $500

Total cost of 6 units C_i = ***$3000***

Installation cost is insignificant, the work will be performed by the plant staff

Simple payback

Annual cost savings - S_c = $3,066

Implementation cost - C_i - $3,000

Simple payback

$SP = C_i / S_c = 3{,}000/3{,}066 = 0\ 98$ year

A 6 ECO#6 Shut-off of transformers during idle time

ECO description

Electric power consumers are supplied from 3 transformer substations TP-719 - two 400 kVA transformers, TP-720 - two 400 kVA transformers,TP-124 - two 320 kVA transformers As results of the load study performed with the help of the ***DRANETZ***-type electric load generator showed the most loaded was the TP-719 substation from 10,42 am on 03 17 93 to 1 20 PM on 03 18 93 (Appendix D), the maximum load was 109 7 kVA at 1 45 PM (25% of nominal load) The loads of other TP substations did not exceed the given value In order to rid of transformer idling losses we recommend to connect the TP substations at the 0 4 kV side and shut off idle transformers

Annual energy savings estimate

On the basis of experimental data (Appendix D) we can assume that ***2*** transformers at the TP-720 with ***400*** kVA capacity each, one transformer of ***400*** kW at the TP-719 and ***2*** transformers of ***320*** kVA each at the TP-124

Overall reduction of electricity losses will be

$$S_e = \frac{S\ t}{100}(5k + 0\ 5) = \frac{1840\ \ 8000}{100}(5\ \ 0\ 08 + 0{,}5) = 132\ 48 \text{ thousand kWh}$$

where $S = 2 \times 400 + 400 + 2 \times 320 = 1840$ kVA– nominal capacity of shut-off transformers, kVA,

t– duration of transformer shut-offs, hours , we assume it at $t = 8000$ hours a year,

k –economic equivalent of reactive power, $k = 0\ 08$

Cost savings estimate

Cost savings at the price of electricity of ***0,042***$ will be

$S_T = S_e\ \ 0\ 042 = 132{,}480\ \ \ 0\ 042 = 5{,}564$ $ per year

Implementation cost

Implementation cost is explained by the necessity of re-switching of transformers and laying of additional cables between TP-719 and TP-124 ***250*** meter long and between TP-719 and TP-720 ***150*** meter long

Cost of cables – ***3500*** $

Cost of laying the cables – the work will be carried out by the plant personnel, splitting and connection of cables by a specialized company – ***3000*** $

Total costs $C_T = 3{,}500 + 3{,}000 = 6{,}500$ $

Simple payback

Annual cost savings – $S_T = 5,564$ \$

Implementation cost – $C_T = 5,500$ \$

Simple payback

$SP = C_T/S_T = 6,500/5,564 = 1,17$ years

A.7 ECO # 7 Monitoring of boiler equipment operation and temperature modes of heat-consuming equipment

ECO description

The winery has an extensive steam and condensate heating system, however, in-built control pressure gauges and thermometers are practically absent It is impossible to perform an analysis of the efficiency of heat-using equipment, to calculate specific consumption and to promptly discover equipment deficiencies

We recommend to introduce at the plant a portable infra-red thermometer of ***"Reynger ST6"*** type that will enable monitoring of the heat consuming equipment and to supervise it regularly (*1 - 2* times a week) the efficiency of its operation and to react promptly to the thermal energy wastes Expected efficiency improvement of the heat use is ***0 3–0 6%***

Annual thermal energy savings estimate

Annual savings – ***0 5%***

Annual steam consumption – *7,157* Gcal

Estimated thermal energy savings

7,157 Gcal ***0 005*** = ***35 8*** Gcal,

that makes ***5 2*** thousand m^3 of natural gas

Cost of 1 Gcal of steam – ***19 6$***

Cost savings

35 8 Gcal $***19 6*** = $***701***

Recommended equipment and its cost

The cost of the portable infra-red thermometer of ***"Reynger ST6" type*** – $***1,000***

Simple payback

$***1,000/$701*** = ***1 4*** years

A 8 ECO #8 Conversion of space heating systems from steam to hot water

At the winery on certain premises steam is used for space heating purposes (see photo in Appendix E) the share of which in the total heat balance is 40% As the temperature measurements in several rooms showed there was overheating when the temperature instead of standard 18-20°C reached 26-30°C that made personnel open windows for fresh air, besides the condensate is not returned to the boiler room
We recommend to convert space heating systems to water instead of steam

Annual thermal energy savings estimate

As the global experience shows conversion of space heating systems from steam to hot water will reduce heat consumption by up to 20%

Thermal energy savings will be

$S_{p1} = Q_g \quad 0\ 4 \quad 0\ 2 = 5{,}165$ Gcal $\quad 0{,}4 \quad 0{,}2 = 413$ Gcal/year

where Q_g–is annual consumption of thermal energy, Gcal,

$0\ 4$ –is share of steam used for space heating,

$0\ 2$– is share of heat use reduction from implementation of the proposal

It is equal to $60\ 2$ thousand m^3 of natural gas

Annual cost savings estimate

Cost savings in terms of money at the cost of 1 Gcal of heat at $19{,}6$\$ will be

$S_{p2} = S_{p1} \quad 19\ 6 = 413 \quad 19\ 6 = 8{,}095$ \$ per year

Implementation cost

Implementation cost is explained by the necessity of construction of return pipeline of the heating system, construction and installation will be performed by the plant personnel

Cost of piping and other materials will be approximately

$C_m = 1{,}500$\$

Simple payback

Annual cost savings – $S_{p2} = 8{,}095$ \$

Implementation cost – $C_m = 1{,}500$ \$

Simple payback

$SP = C_m/S_{p2} = 1{,}500/8{,}095 = 0\ 18$ year

The conversion will payback during one heating season

A9 ECO # 9 Automatic energy metering system

ECO description

Natural gas is metered at the enterprise is metered by two gas meters at the boiler room inputs

Electric power is supplied via the 10 kV cable to three transformer substations at the bottling unit (2 x 400 kVA), at the compressor unit (2 x 400 kVA), in cellars (2 x 320 kVA)

Each substation is equipped with two three electric meters i e there are three metering points The readings are taken down manually every month and the bills are paid Considering payments for the negotiated demand at $3 5 per 1 kW the current average electricity cost is $0 042 per 1 kWh

The detailed study showed that calculations of steam, electric power, gas, compressed air, hot and cold water consumption by separate production units of the tannery are made by standard indicators and actual production output figures Instrument metering is non-existent

We recommend to automate commercial and technical metering using the ITEK technical instruments manufactured by the Energiya R & D institute in Kiev These instruments are metrologically certified in Ukraine and are designed for continuous and periodical measurement/registration of physical values

Introduction of the ITEK-X1X allows consumers to pay their electric power bills by the one-rate tariff differentiated according to the daytime zone which in conjunction with the measures of reduction of the maximum hour consumption provides a considerable cost effect that has been proven by more than annual operation at numerous Ukrainian facilities

ITEK-210 and ITEK-310 are intended for commercial and technical metering of electric power (differentiated by time) and build-up of automatic metering and control systems of electric power use (AMCSEPU) in combination with electric meters of three-phase induction type equipped with pulse generation devices (E440, E870, UP-1, UP-2, UP-3, SU-500) or electronic (Siemens, Landys and Gyr, Alpha-ABB, etc) with pulse output They support 64 (for ITEK-210) or 12 (for ITEK-310) metering channels, 4 tariff zones, day schedule for all metering channels is a 5 days' minimum, 2 independent data interfaces

ITEK-210 can be used in combination with or instead of the installed TsT-5000 systems by connection to the existing matrix of primary measurement converters The ITEK-210 is included in the State register of measurement devices of Ukraine

The ITEK-410 is designed for 4 metering channels and is similar to the above devices Additionally it supports tariffs differentiated by peak consumption and demand, and provides monitoring and control over consumption process Daily schedules from 4 channels are stored for not less than 1 month

Introduction of ITEK-X2X allows consumers to meter resources with high accuracy and pay the bills for actual consumption but in proportion to the area

ITEK-220 and ITEK-320 are designed for automatic commercial metering and telemetric control of supply and consumption of liquids, gases, steam and thermal energy in combination with any primary measurement converters of consumption, temperature, pressure and pressure drop with standardized output parameters at supplier's (thermal power plant, district heat, boiler houses) and consumer's sites (industrial enterprises, public utility facilities) The ITEK-X20 devices are designed in conformity with requirements of RD-50-213-80, PR34-70-010-85, State standard 6651-84 and recommendations R75 of the Ministry of health

ITEK-220 and ITEK-320 intended for the facilities of the first metering group (up to 4 facilities) with a complex configuration of supply and recovery piping (ITEK-220), and for the facilities of the first or second metering groups (one facility) (ITEK-320)

In order to implement the ECO it is planned to set up commercial metering of power consumption at 6 points and of potable water at 5 points

Technical metering of electric power will be implemented at 24 points, of potable water at 4 points, steam at 6 points

Annual energy savings estimate

Judging from the experience expected savings from introduction of own automatic metering at the plant and energy use planning and control system will be not less than 5%

Therefore, based on the 1996 data annual savings of natural gas will be 77 5 thousand m^3 , of electric power - 83 thousand kWh, of potable water - 6 thousand m^3

Annual costs saving estimate

Currently the plant pays for the energy US$0 8 mln Thus the energy savings in money terms will amount to

$$S_E = 800,000 \times 0\ 05 = US\$40,000$$

Implementation costs

Cost of equipment and construction in US$
Commercial metering of electricity, and technical water = $20,000
Technical metering of electricity and cold water = $30,000
Construction and installation costs = $10,000

Total estimated costs

$$C_{est} = = US\$60,000$$

Simple payback estimate

Annual savings in costs - S_M = US$40,000

Commissioning costs - C_{COM} = US$60,000

Simple payback

$$SP = C_{est}/S_M = 60{,}000/40{,}000 = 1\ 5\ years$$

A 10 ECO #10 Energy efficient plant lighting

ECO description

The external lighting system of the plant area consists of 79 SZPR lighting fixtures with 35 DRL - 400 high pressure mercury lamps, 44 DRL-250 lamps installed at 10-meter high ferroconcrete lampposts Part of the area adjacent to the production buildings is lighted by conventional 100-watt and 500-watt incandescent and 2 x 40 fluorescent lamps The light flow of the DRL-400 lamp is equal to 23,000 lumen and service life is 6,000 hours, DRL-250 - 10,000 lumen and 2,400 hours, respectively

It is suggested to consider the proposal of replacement of DRL -400 high pressure mercury lamps for external lighting of the plant area with the DNaT-250-3 high pressure sodium lamps and DRL-250 with DNaT-100-3 using existing fixtures and replacing switching appliances with appropriate capacity The sodium lamps of the DNaT -250-3 type are manufactured nationally in the city of Poltava and have a longer operation life of 12,000 hours with the light flow of 25,000 lumen and DNaT-100-3 - 6,000 hours and 9,000 lumen, respectively

Calculation of annual electric power savings

The electric power use of the SZPR lighting fixtures with DRL - 400 mercury lamps is

$$P_{F1} = (P_{L\,1} + P_{SW,\,1})\ x\ cos\phi$$

where $P_{L\,1}$ is the capacity of DRL - 400 mercury lamp, W,
$P_{SW\,1} = 85$ W is capacity of switching appliances,
$cos\phi = 0\ 98$

$$P_{F1} = (400+85)\ x\ 0\ 98 = 475 \text{ Wh} = 0\ 475 \text{ kW}$$

Amount of the power used by 35 lighting fixtures over 1 year at average 10-hour use is

$$P_1 = P_{F1}\ x\ n\ x\ F$$

where $n=35$ is the number of lighting fixtures,

$F=10\ x\ 365 = 3{,}650$ hours - annual time of lighting operation
$P_1 = 0\ 475\ x\ 35\ x\ 3{,}650 = 60{,}681$ kWh

The electric power use of the SZPR lighting fixtures with DNaT -250-3 lamp

$$P_{F2} = (P_{L\,2} + P_{SW\text{-}2})cos\phi$$

where $P_{L\,2} = 250$ W is the capacity of DNaT - 250-3 lamp,
$P_{SW\,2} = 34\ 7$ W is capacity of switching appliances,
$cos\phi = 0\ 98$

$P_{F1} = (250+34\ 7) \times 0\ 98 = 279$ Wh $= 0\ 279$ kWh

Power used by 35 lighting fixtures over 1 year at average 10-hour use is

$P_1 = P_{F1} \times n \times F = 0\ 279 \times 35 \times 3{,}650 = 35{,}642$ kWh

Annual energy savings by using DNaT-250-3 lamps

$S_{E_E} = P_1 - P_2 = 60{,}681 - 35{,}642 = 25{,}039$ kWh

The electric power use of the SZPR lighting fixtures with DRL - 400 mercury lamps is

$P_{F1} = (P_{L\ 1} + P_{SW,\ 1}) \times \cos\phi$

where $P_{L\ 1}$ is the capacity of DRL - 250 mercury lamp, W,
$P_{SW\ 1} = 54\ 1$ W is capacity of switching appliances,
$\cos\phi = 0\ 98$

$P_{F1} = (250+54\ 1) \times 0\ 98 = 298$ Wh $= 0\ 298$ kW

Amount of the power used by 35 lighting fixtures over 1 year at average 10-hour use is

$P_1 = P_{F1} \times n \times F$

where $n=44$ is the number of lighting fixtures,

$F = 10 \times 365 = 3{,}650$ hours - annual time of lighting operation
$P_1 = 0\ 298 \times 44 \times 3{,}650 = 47{,}859$ kWh

The electric power use of the SZPR lighting fixtures with DNaT -100-3 lamp

$P_{F2} = (P_{L\ 2} + P_{SW\ 2})\cos\phi$

where $P_{L\ 2} = 100$ W is the capacity of DNaT - 100-3 lamp,
$P_{SW\ 2} = 7$ W is capacity of switching appliances,
$\cos\phi = 0\ 98$

$P_{F1} = (100+7) \times 0\ 98 = 105$ Wh $= 0\ 105$ kWh

Power used by 44 lighting fixtures over 1 year at average 10-hour use is

$P_1 = P_{F1} \times n \times F = 0\ 105 \times 44 \times 3{,}650 = 16{,}683$ kWh

Annual energy savings by using DNaT-100-3 lamps

$S_{E_E} = P_1 - P_2 = 47{,}859 - 16{,}863 = 30{,}996$ kWh

Total electricity savings at the plant will be

25,039 kWh + *30,996* kWh = *56,035* kWh

Annual cost savings estimate

Cost savings at the price of electric power of US$0 042 per 1kW

$S_M = S_{E\,E} x\ 0\ 042 = 56{,}035\ x\ 0\ 042 = US\$2{,}353\ 7$

Implementation costs

Cost of one DNaT -250-13 lamp with appliances - C_2 = US$*35*

Cost of one DNaT -100-13 lamp with appliances - C_2 = US$*30*

Construction and installation costs not included since the work will be carried out by the plant personnel

Implementation cost - $C_i = 35\ x\ 35 + 30\ x\ 44 = \$2{,}545$

Simple payback estimate

Annual cost savings of external lighting systems - S_M = US$2,353

Implementation costs = C_i = US$2,545

Simple payback

$SP = C_i/S_M = 2{,}545/2{,}353 = 1\ 1$ *years*

Since the service life of the selected lamps is longer than that of the existing ones actual payback period will be less than 1 year

A 11 ВЭС № 11 Monitoring and optimization of electric motor capacities

ECO description

Approximately *70%* of total electricity use of the winery are used for bottling, maturing and processing of wine materials, compressor unit and boiler room needs which amounts to *1,140* thousand kWh to the sum of *47,900*$ During previous operation of the winery in case of motor failure they were replaced disregarding the minimum required capacity Hence, even similar equipment uses various capacity motors often exceeding the needs Some of the primary consumers of electric power are electric motor drives of compressor, fan and ventilation equipment

The total rated capacity of motors of ammonia and air compressors is *435* kW which exceeds the needs of the enterprise The measurements with the *TIF*-type wattmeter during the audit showed that the rated capacity of electric motors is used at *20–30%*

We recommend to institute operation control over the actually used motor capacities (first and foremost, motors of compressors, pumps and fans) with the help of portable capacity measuring instrument set. The recommended measure will allow during 1 - 2 months to monitor the actual motor loads, analyze the efficiency and organize replacement with more efficient motors Implementation of this project will save not less than *1,5%* of electric power used for production purposes annually

Annual savings estimate

1 Annual electricity savings (calculated) – *1,5%*

2 Annual electricity use by motors (according to the balance) - *1,140,000* kWh

3 Annual electricity savings estimate

1,140,000 kWh *0 015* = *17,100* kWh

4 Cost of *1* kWh – $*0 042*

5 Cost savings

17,100 kWh $*0 042* = $*718*

Recommended equipment and its cost

Cost of a single set of portable instruments of "*2000 A Wattprobe*" and "*Power Factor Meter, TIF 2300*" type considering overheads and contingencies – $*1,000*

Simple payback

$*1,000*/$*718* = *1,4* years

APPENDIX B SPECIFICATIONS FOR THE REQUIRED EQUIPMENT

Table B 1

Specifications of equipment for delivery to the Massandra PAC

ECO No by section 7	Equipment designation	Type, model	Manufacturer, country	Basic parameters	Requirement		Price		Shipment cost		Note
					Unit	Qty	Hr	$ US	Hr	$ US	
1	2	3	4	5	6	7	8	9	10	11	12
ECO No 1	Non-contact infrared thermometer	Model *PM3L3SZ*	"*Raytek*", USA	$t = -20 + 1000$ °C $L_{measure} = 10$ m	pcs	1	–	1600	–	1600	
	Electric power/demand analyzer	Model *DRANETZ*	"*Dranetz Technologies, Inc*",USA		pcs	1	–	5000		5000	
	Portable anemometer	Model *444HT*	"*Kurz Instruments, Inc*", USA		pcs	1	–	1300	–	1300	
	Multimeter	Model *87*	"*Fluke Mig Co, Inc*", USA		pcs	1	–	500	–	500	
	Power factor meter	Model *TIF 2300*	*Davis Instruments* 4701 Mount Hope Drive Baltimore, MD 21215		pcs	1		599		690	
	Wattmeter	Model *TIF 2000 A*	"*TIF Instruments, Inc*", 9101 N W 7th Avenue Post Office Box 1338 Miami, Florida 33238-9990, USA		pcs	1	–	600	–	600	
ECO No 2	Combustion analyzer	*ENERAC - 2000*	*Energy Efficiency Systems, Inc*, 1300 Shames Drive, Westbury, NX 11590 USA	Analyzed gases O_2, CO_2, SO_2, NO_x	pcs	1	-	5000	-	5000	
ECO No 3	Condensate receiver	*Spirax Girdlestone Series* model *B2111S*	"*Spirax Sarco Inc*" P O BOX 119 ALLENTOWN, PA	Receiver - B, Pump-1FYC21	pcs	1	-	10000	-	10000	
	Steam piping insulation	*Fiberglass with aluminum casing*	USA	$t = 150$ °C $d_y = 38$ mm $d_y = 55$ mm	m	 60 0 250 0	 27 34 27 34	 14 7 14 7	 1640 6835	 880 3675	

Continuation of Table B 1

1	2	3	4	5	6	7	8	9	10	11	12
ECO No 4	Thermal insulation materials	***Fiberglass with aluminum alloy***	***USA***	***t = 150*** °C ***d_y = 25*** mm ***d_y = 32*** mm ***d_y = 40*** mm ***d_y = 50*** mm ***d_y = 89*** mm	m	 80 15 48,0 80,0 13,0	 19 5 19 5 19 5 19 5 19 5	 10 5 10 5 10 5 10 5 10 5	 1560 300 940 1560 254	 840 150 504 840 140	
ECO No 5	Float-type steam trap	***FT 20-32***	***"Spirax Sarco Inc"*** P O BOX 119 ALLENTOWN, PA	***DN = 20*** ***P_y = 16*** kg/cm^2	pcs	6	-	445	-	2730	
	Condensate strainer	***FIG33***	***"Spirax Sarco Inc"*** P O BOX 119 ALLENTOWN, PA	***DN = 20*** ***P_y = 16*** кг/см^2	pcs	6	-	110	-	660	
	Check valve	***DCV1***	***"Spirax Sarco Inc"*** P O BOX 119 ALLENTOWN, PA	***DN = 20*** ***P_y = 16*** kg/cm^2	pcs	6	-	90	-	540	
ECO No 9	Energy control and metering set	***ITEK*** (US-made components)	R&D "Energiya$^+$", 252056 city of Kiev, Pobedy blvd 37, bldg 22, Ukraine	Commercial metering Technical metering	pcs pcs	1 1	– –	20000 30000	– –	20000 30000	
ECO No 10	Fluorescent lamp	***GE Electronic Biax^{TM} T***	***GE Electronic***, USA	***U = 220 V*** ***P = 20*** W	pcs	155	–	20	–	3100	
	Fluorescent lamp	***Ralux "Radium"***	R&D "Epotex", city of Kiev, Pobedy blvd, 56, Ukraine	***U = 220 V*** ***P = 20 W***			24	13	3720	2015	
	High pressure sodium lamp with switching and control equipment	***DNaT-250-3*** ***DNaT-100-3***	JSC Poltava gas discharge lamp works city of Poltava, Zavodskaya str 3, Ukraine	***U = 220 V*** ***P = 250 W***т ***P = 100 W***	pcs Pcs	35 44	– –	35,0 30,0	–	1225 1320	

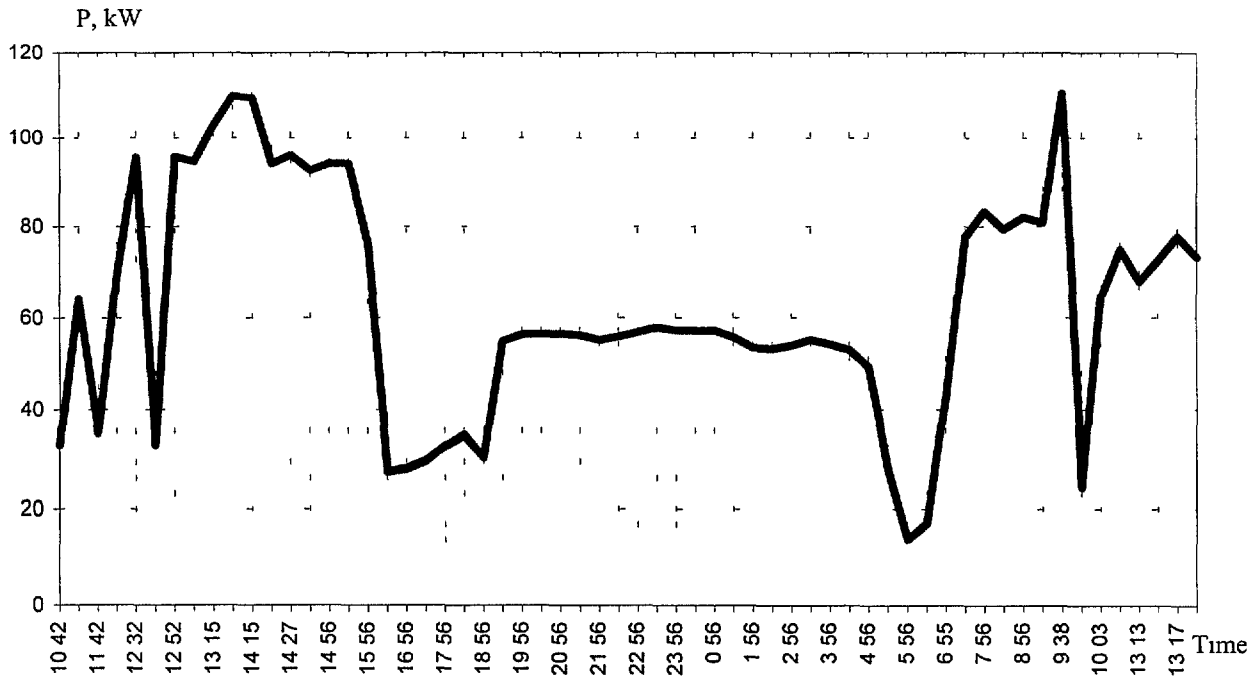
APPENDIX C COLLECTED AND MEASUREMENT DATA

Measurement results of combustion efficiency of natural gas in DKVR - 4 - 13 boiler of the Massandra boiler house on 03 17 98

Measurement No1 (after boiler)	Measurement No1 (after boiler)	Measurement No3 (after fan)	Measurement No4 (after fan)
BACHARACH MODEL CA300NSX	BACHARACH MODEL CA300NSX	BACHARACH MODEL CA300NSX	BACHARACH MODEL CA300NSX
**********	**********	**********	**********
COMBUSTION ANALYZER	COMBUSTION ANALYZER	COMBUSTION ANALYZER	COMBUSTION ANALYZER
ID _____	ID _____	ID _____	ID _____
SER NO VCO 512	SER NO VCO 512	SER NO VCO 512	SER NO VCO 512
TIME 09 32	TIME 09 34	TIME 09 09	TIME 09 13
DATE 17, 03, 98	DATE 17, 03, 98	DATE 17, 03, 98	DATE 17, 03, 98
FUEL NATURAL GAS	FUEL NATURAL GAS	FUEL NATURAL GAS	FUEL NATURAL GAS
PRIMRY TEMP <C> 34	PRIMRY TEMP <C> 34	PRIMRY TEMP <C> 7	PRIMRY TEMP <C> 7
STACK TEMP <C> 234	STACK TEMP <C> 233	STACK TEMP <C> 122	STACK TEMP <C> 121
% OXYGEN 9 5	% OXYGEN 9 6	% OXYGEN 8 1	% OXYGEN 9 3
% EXCESS AIR 76	% EXCESS AIR 77	% EXCESS AIR 57	% EXCESS AIR 73
% CARBON - DIOXIDE 6,4	% CARBON - DIOXIDE 6,3	% CARBON - DIOXIDE 7,2	% CARBON - DIOXIDE 6,5
PPM CARBON - MONOXIDE 3	PPM CARBON - MONOXIDE 3	PPM CARBON - MONOXIDE 4	PPM CARBON - MONOXIDE 4
PPM MOX 55	PPM MOX 56	PPM MOX 67	PPM MOX 60
PPM SULFUR - DIOXIDE 0	PPM SULFUR - DIOXIDE 0	PPM SULFUR - DIOXIDE 0	PPM SULFUR - DIOXIDE 0
% EFFICIENCY 86,7*	% EFFICIENCY 86,7*	% EFFICIENCY 93,1*	% EFFICIENCY 92,6*
% STACK LOSS 13,3*	% STACK LOSS 13,3*	% STACK LOSS 6,9*	% STACK LOSS 7,4*
TEST PERFORMED BY	TEST PERFORMED BY	TEST PERFORMED BY	TEST PERFORMED BY

* – without taking into account input air temperature

Summarized results of TP-719 load study at the Massandra PAC
March 17 - 18 1998



Note

1 Measurements taken by the "***DRANTEZ***" electric power/demand analyzer

2 During the measurements the TP-719 supplied the bottling unit, ready product unit, boiler room (partially), motor transport unit, office building, battery charge unit, office building, mechanical work shop, external lighting system

Fragments of printout of TP-719 measurement results by "***DRANTEZ***" electric power/ demand meter

#Dm 102 9 kW 80 PF
17-Mar-98 13 15 45

#Dm 109 7 kW 81 PF
17-Mar-98 13 45 45

#Dm 109 4 kW 80 PF
17-Mar-98 13 15 45

Status
17-Mar-98
14 21 38

A	235 4	V
B	236 5	V
C	230 8	V
A	170 8	A
B	159 9	A
C	154 4	A
A	40 22	kVA
B	37 83	kVA
C	35 66	kVA
T	112 9	kVA
A	35 51	kW
B	27 71	kW
C	30 77	kW
T	94 01	kW
A	18 88	kVAR
B	25 74	kVAR
C	18 01	kVAR
T	62 64	kVAR
A	88	PF
B	73	PF
C	86	PF
T	83	PF

PDm 96 67 kW

#Dm 94 14 kW 80 PF
17-Mar-98 14 56 42

#Dm 94 06 kW 80 PF
17-Mar-98 15 26

#Dm 76 15 kW 80 PF
17-Mar-98 15 56 04

#Dm 27 45 kW 54 PF
17-Mar-98 16 26 42

#Dm 28 00 kW 54 PF
17-Mar-98 16 56 42

#Dm 29 56 kW 57 PF
17-Mar-98 17 26 42

#Dm 32 55 kW 62 PF
17-Mar-98 17 56 42

#Dm 34 71 kW 64 PF
17-Mar-98 18 26 42

#Dm 30 16 kW 50 PF
17-Mar-98 18 56 42

#Dm 54 83 kW 80 PF
17-Mar-98 19 26 42

#Dm 56 37 kW 80 PF
17-Mar-98 19 56 45

#Dm 56 46 kW 80 PF
17-Mar-98 20 26 14

#Dm 57 14 kW 78 PF
18-Mar-98 00 26 42

#Dm 57 17 kW 71 PF
18-Mar-98 00 56 42

#Dm 55 72 kW 78 PF
18-Mar-98 01 26 42

#Dm 53 46 kW 71 PF
18-Mar-98 01 56 42

#Dm 53 16 kW 77 PF
18-Mar-98 02 26 42

#Dm 53 93 kW 78 PF
18-Mar-98 02 56 42

#Dm 55 14 kW 78 PF
18-Mar-98 03 26 42

#Dm 54 23 kW 77 PF
18-Mar-98 03 56 42

#Dm 52 95 kW 77 PF
18-Mar-98 04 26 42

#Dm 49 37 kW 75 PF
18-Mar-98 04 56 42

#Dm 28 26 kW 68 PF
18-Mar-98 05 26 42

#Dm 13 93 kW 53 PF
18-Mar-98 05 56 42

#Dm 17 21 kW 53 PF
18-Mar-98 06 26 42

#Dm 42 80 kW 59 PF
18-Mar-98 06 56 42

#Dm 77 59 kW 95 PF
18-Mar-98 07 26 42

#Dm 83 28 kW 93 PF
18-Mar-98 07 56 42

#Dm 79 41 kW 94 PF
18-Mar-98 08 26 42

#Dm 82 05 kW 80 PF
18-Mar-98 08 56 42

#Dm 80 86 kW 88 PF
18-Mar-98 09 26 42

Status
18-Mar-98
09 38

A	234 4	V
B	235 6	V
C	229 9	V
A	214 1	A
B	192 3	A
C	200 2	A
A	50 22	kVA
B	45 32	kVA
C	46 06	kVA
T	141 0	kVA
A	40 52	kW
B	31 75	kW
C	38 22	kW
T	110 5	kW
A	29 66	kVAR
B	32 33	kVAR
C	25 71	kVAR
T	87 70	kVAR
A	81	PF
B	70	PF
C	83	PF
T	78	PF

PDm 94 21 kW

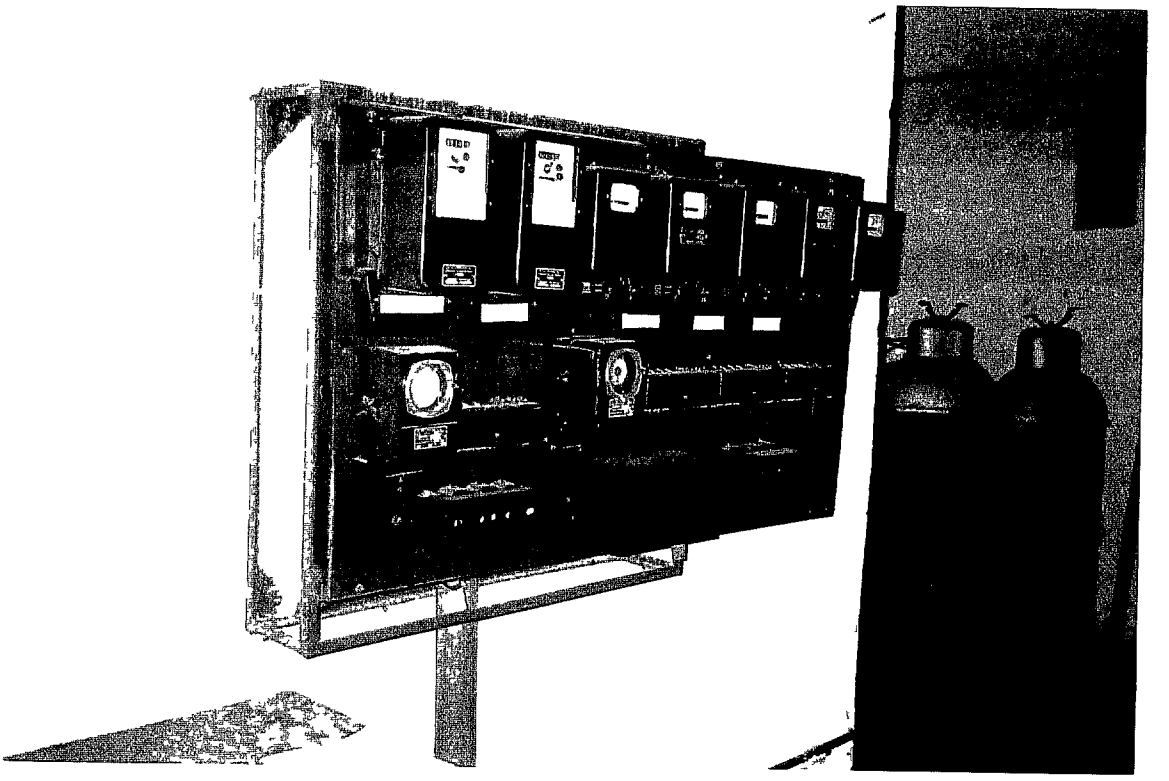
Status
18-Mar-98
13 15

A	232 8	V
B	234 0	V
C	227 5	V
A	155 6	A
B	122 6	A
C	133 5	A
A	36 22	kVA
B	28 71	kVA
C	30 40	kVA
T	94 11	kVA
A	29 73	kW
B	17 10	kW
C	25 82	kW
T	72 66	kW
A	20 69	kVAR
B	23 07	kVAR
C	16 04	kVAR
T	59 80	kVAR
A	82	PF
B	60	PF
C	85	PF
T	77	PF

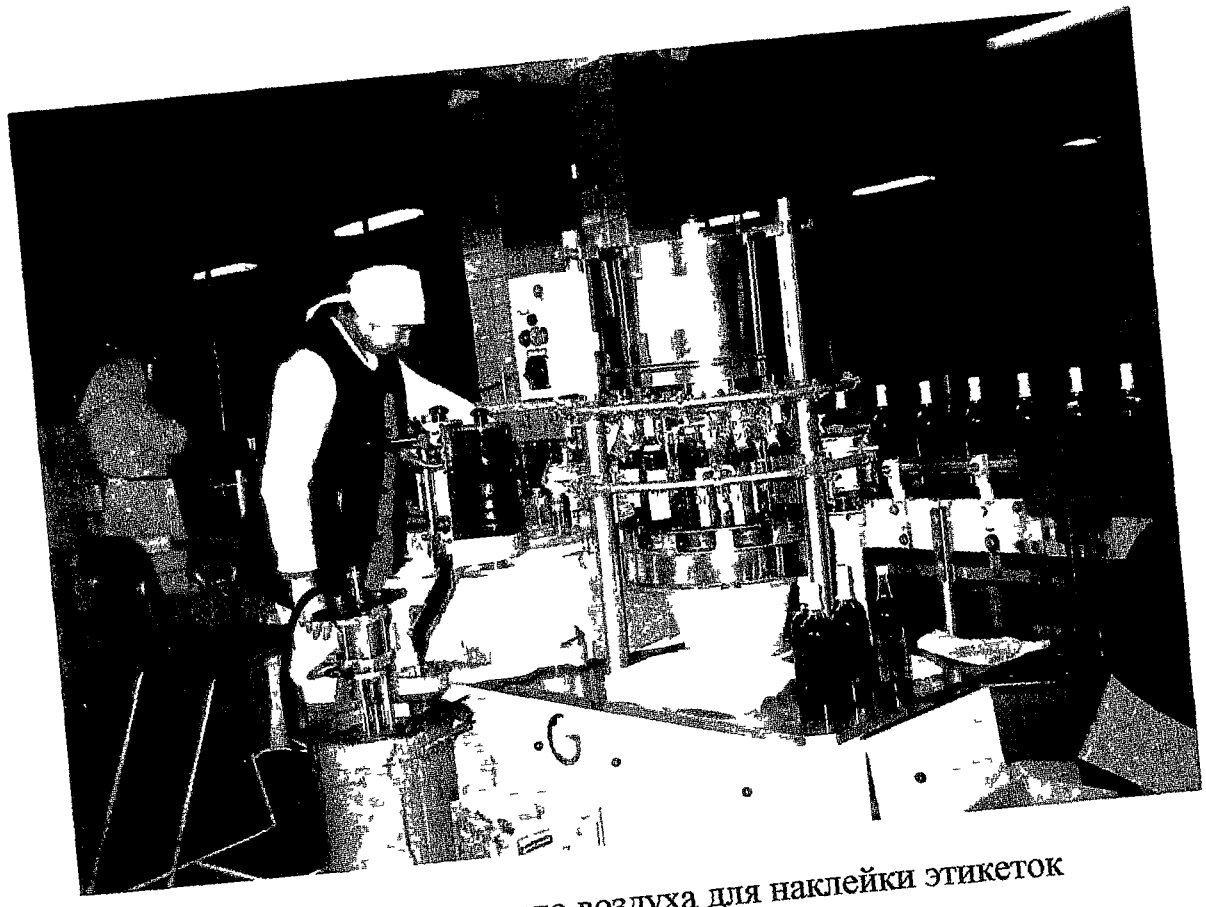
PDm 66 37 kW

APPENDIX D PHOTOGRAPHS OF THE PLANT

Главный Массандровский подвал
Main Massandra cellar



Пункт учета электроэнергии
Electricity metering station

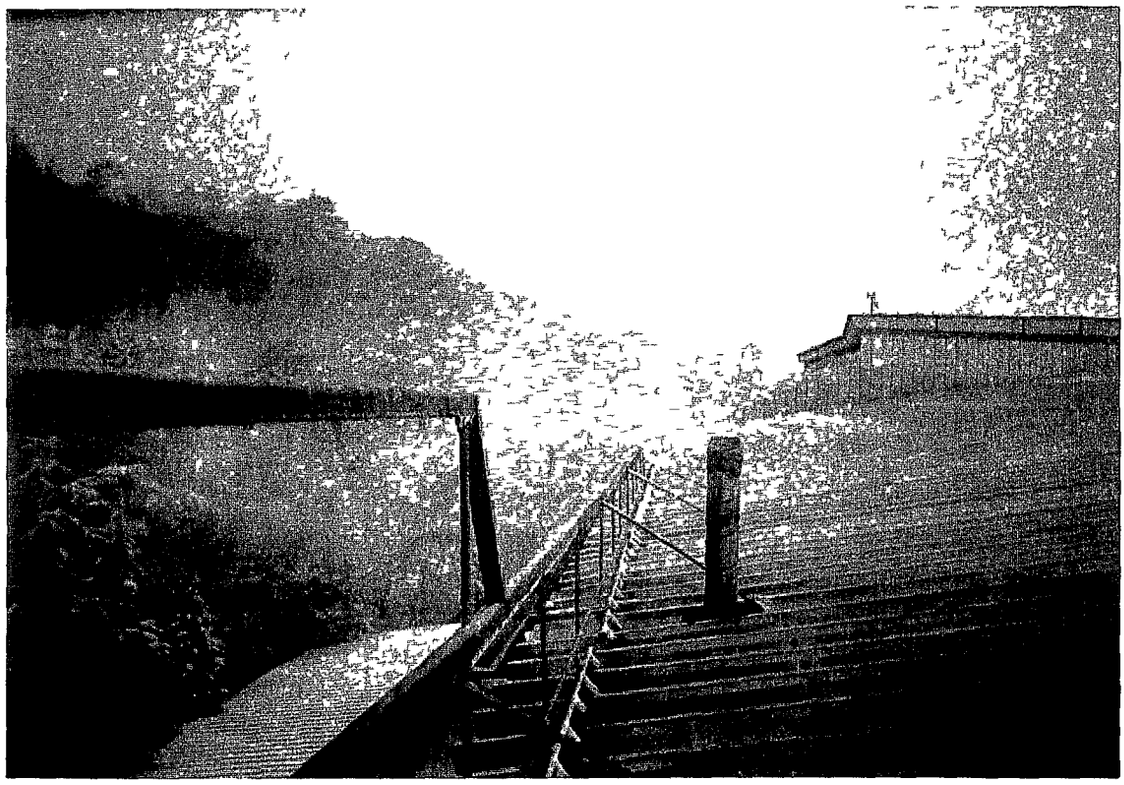


Использование сжатого воздуха для наклейки этикеток

Compressed air - driven labelling

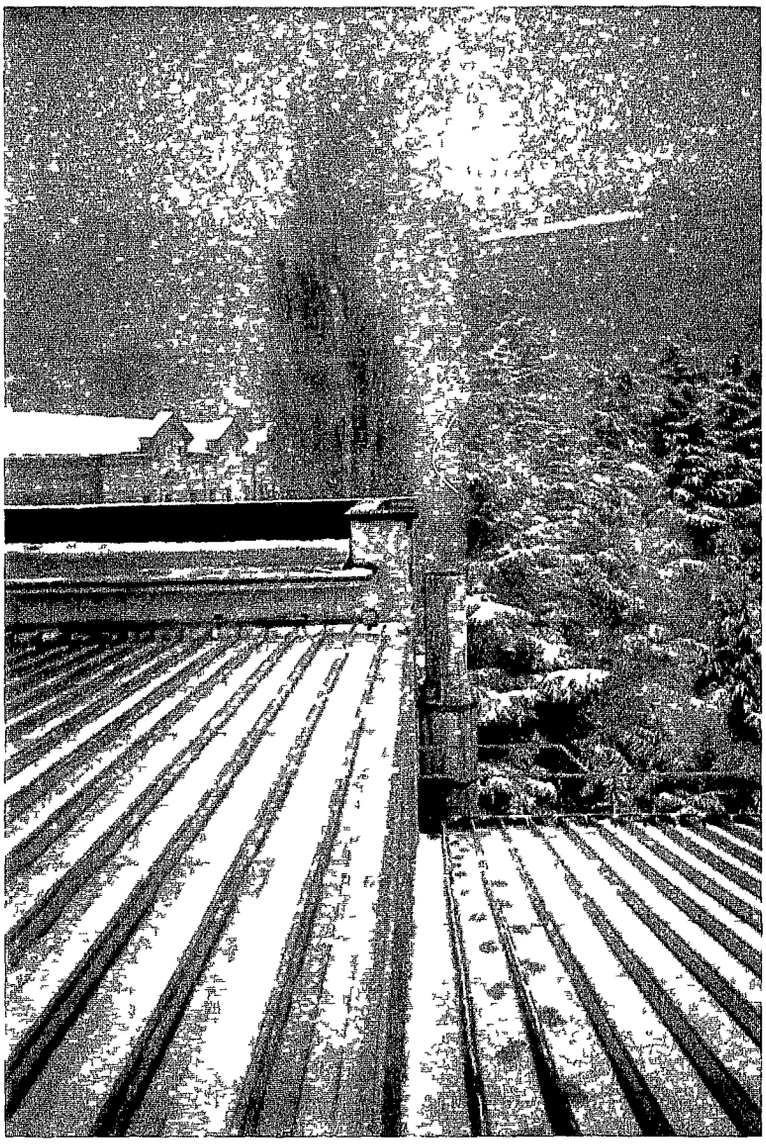
Акцизноклеечная машина - потребитель сжатого воздуха

Excise duty stamping machine is a consumer of compressed air

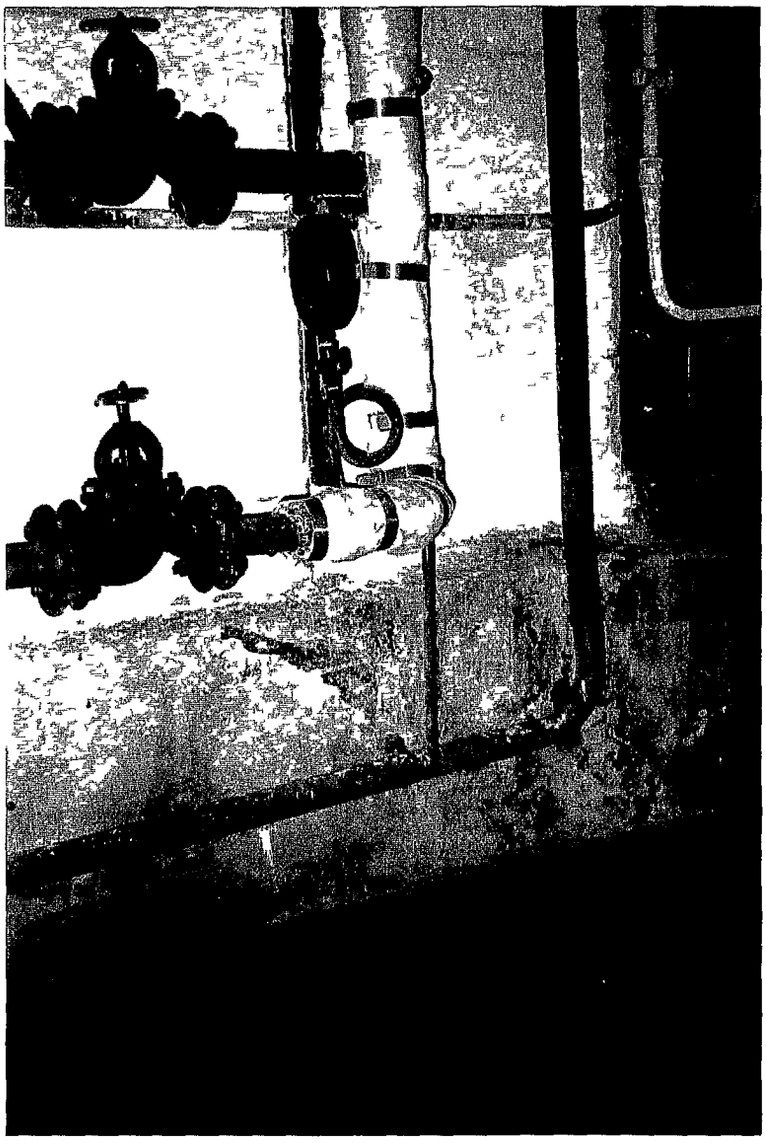


Выход пара вторичного вскипания от системы парового отопления в точке сброса конденсата в канализацию
Flash steam from steam heating system drained into sewerage

Регистр парового отопления подключен к канализационному стояку
Steam heater connected to sewerage line



Вентиляционный выброс от участка бутыломоечных машин
Ventilation outlet from bottle washing line



Поврежденная обмуровка котла ДКВР - 4/13

Damaged brickwork of DKVR - 4/13 boiler

Обмерзание трубопроводов на участке обработки вина холодом
Freeze - up of pipelines at the cold treatment unit

APPENDIX E ABBREVIATIONS AND UNITS OF MEASUREMENT

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Currency rates of exchange

1 hrivnia - local currency unit
1hrivnia = US$0 54 as of December 1997

Conversion factors

Heat

1 cal = 4 187 J
1 kcal = 4 187 kJ = 3 968 BTU
1 Gcal = 4 187 x 10^3 = 4 187 GJ
1 BTU = 1055 J = 1 055 kJ = 1 055 x 10^3 MJ
1 tce (tonne of coal equivalent) = 7,000 kcal x 3 968 BTU= 27,78 x 10^6 BTU = 27,78 MBTU

Power

1 W = 3 6 x 10^3 J = 3 6 kJ
1 kW = 3 6 x 10^3 kJ = 3 6 MJ = 860 Kcal
1 MW = 3 6 x 10^3 MJ = 860 Kcal
1 kcal = 1 163 x 10^3
1 Gcal = 1163 kW = 1 163 MW
1 kW = 1 36 HP

Pressure

1 kg/cm^2 = 1 atm
1 atm = 101 325 kPa = 0 1 MPa
1 bar = 10^5 Pa = 100kPa = 0 1 MPa

Length

1 mm =0 03937 in = 0 00328 ft
1 cm = 0 3937 in = 0 0328 ft
1 m = 3 937 in = 3 281 ft

Weight

1 gram = 2 2046 x 10^3 lb
1 kg = 2,2046 lb
1 t = 1000kg = 2 2046 x 10^3 ft

Area

1 cm^2 = 0 155 square in = 1 076 x 10^3 square ft
1 m^2 = 1 55 x 10^3 square in = 10 76 square ft

Volume

1 m^3 = 35 31 cu ft = 1000 l
1l = 35 31 x 10^3 cu ft
1l = 0 264 US gal

Heat content

1 kJ/kg = 0 43 BTU/lb
1 kJ/m^3 = 26 84 x 10^3 BTU/cu ft
1 MJ/m^3 = 26 84 BTU/cu ft
1 Ccal/m^3 = 4,187 kJ/m^3 = 0 112 BTU/cu ft

Temperature

^{0}C = 0 56 (^{0}F-32)

ABBREVIATIONS

CIS - Commonwealth of Independent States
ECO - energy conservation opportunity
ESCO - energy service company
etc - et cetera
Hr - hrivnia
i d - id est
JSC - joint-stock company
mln - million
TACIS - Technical Assistance to CIS countries
tel - telephone
thou - thousand
US - United States
USAID - United States Agency of International Development
TP - Distribution unit (DU)
Hr - Hrivna
USAID - US Agency for International Development
TP - distribution unit
yr - year

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UNITS OF MEASUREMENT

BTU - British thermal unit
^{0}C - degrees Celsius
cm^2 - centimeter squares
^{0}F - degrees Fahrenheit
g - gram
Gcal - gigacalory
GJ - gigajoule
h - hour
kcal - kilocalory
kg - kilogram
kgf - kilogram-force
kV - kilovolt
kV-A - kilovolt-ampere
kW - kilowatt
kW h - kilowatt hour
Lm - lumen
m - meter
m^2 - meter squared
m^3 - meter cubed
min - minute
MJ - megajoule
mm H_2O - millimeters of the water column
MW - megawatt
t - tonne
t - tonne of coal equivalent
t/h - tonnes per hour
W - watt

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