OCCASION

This publication has been made available to the public on the occasion of the 50th anniversary of the United Nations Industrial Development Organisation.

DISCLAIMER

This document has been produced without formal United Nations editing. The designations employed and the presentation of the material in this document do not imply the expression of any opinion whatsoever on the part of the Secretariat of the United Nations Industrial Development Organization (UNIDO) concerning the legal status of any country, territory, city or area or of its authorities, or concerning the delimitation of its frontiers or boundaries, or its economic system or degree of development. Designations such as "developed", "industrialized" and "developing" are intended for statistical convenience and do not necessarily express a judgment about the stage reached by a particular country or area in the development process. Mention of firm names or commercial products does not constitute an endorsement by UNIDO.

FAIR USE POLICY

Any part of this publication may be quoted and referenced for educational and research purposes without additional permission from UNIDO. However, those who make use of quoting and referencing this publication are requested to follow the Fair Use Policy of giving due credit to UNIDO.

CONTACT

Please contact publications@unido.org for further information concerning UNIDO publications.

For more information about UNIDO, please visit us at www.unido.org

UNITED NATIONS INDUSTRIAL DEVELOPMENT ORGANIZATION
Vienna International Centre, P.O. Box 300, 1400 Vienna, Austria
Tel: (+43-1) 26026-0 · www.unido.org · unido@unido.org

Improving Energy Efficiency and Promoting Renewable Energy in the Agro-Food and Other Small and Medium Enterprises (SMEs) in Ukraine
Project GF/UKR/11/004

REPORT

Energy Efficiency Benchmarking in the Sugar Subsector of the Ukraine's Agro-Industrial Sector

Drafted by: M. Maslikov

Kyiv 2012

This page internally left blank

CONTENTS

SUMMARY

This report is prepared in the scope of implementation of GEF/UNIDO Improving Energy Efficiency and Promoting Renewable Energy in the Agro-Food and Other Small and Medium Enterprises (SMEs) in Ukraine Project.

The main task of this analysis is to identify energy efficiency in the food industry, specifically, in the production of flour and bakery with the use of benchmarking. The approaches, methods and findings of this analysis will be further disseminated among all the stakeholders.

The report presents the findings of energy efficiency benchmarking in the flour and bakery productions via comparing their specific indicators of energy consumption per unit of output. These indicators are compared both among themselves and against those at the best enterprises of the relevant profile.

We hope that this report would popularize benchmarking and provide an impetus to its applications at food industry enterprises in Ukraine.

INTRODUCTION

The growing competition encourages domestic enterprises to seek new ways and methods to raise management efficiency, ensure stable competitiveness based on identifying and launching of innovations. The pressure of energy costs has become so high that threatens not only competitiveness of the enterprises but rather their existence.

One of these effective tools that provides an enterprise with the possibility to steadily build up productivity, improve performance, be energy efficient is benchmarking.

Benchmarking is the process of analysis and comparative assessment of the methods used in an organization to carry out its functions. This assessment may be conducted either inside an enterprise or organization (comparison of individual structural units or links) or by comparing an enterprise performance results with those of other enterprises. Based on the comparison findings, the enterprise may identify weaknesses in its production processes, find new effective ideas and select the best ways to improve based on the other companies' lessons learned.

Benchmarking stipulates ongoing analysis and assessment of the existing methods of production used at an enterprise through comparing it with the best internal and external practices with further launching of the most effective approaches.

Benchmarking is a very common practice in the world. The main idea underlying benchmarking emerged at the beginning of XX century. The most striking example was Henry Ford's visit to the slaughterhouse in Chicago. The carcasses hung on the hooks and the conveyor moved them from one worker to another with each worker doing his portion of processing. This manufacturing method inspired Mr.Ford and he launched it in the form of automobile conveyor.

The term "benchmarking" was introduced by Xerox in 1979 and within the fifteen years benchmarking spread all over the world at an incredible speed with its applications being available almost in all spheres of manufacturing and service provision. This analysis may be applied to any enterprise or organization operations, starting with performance of first aid stations and fire-fighting crews and ending with the strategic benchmarking at Coca-Cola, Sony, Kraft, etc. The enterprises establish benchmarking associations to perform unbiased analysis, where the main goal is its absolute confidentiality. So, enterprises may share the best practices while not disclosing their business secrets.

They are the following associations *inter alia*:

The Association for Benchmarking Health Care

ISO Benchmarking Association

Electric Utility Benchmarking Association

Knowledge Management Benchmarking Association

Technology Assessment Benchmarking Association and many others.

Unfortunately, the threat of hostile takeover induces enterprises to protect all their information related to energy consumption and product output, therefore benchmarking applications in Ukraine are very limited.

POTENTIAL ROLE OF BENCHMARKING IN IMPROVING ENERGY EFFICIENCY OF AGRO-FOOD ENTERPRISES

Energy efficiency of the industrial enterprises in Ukraine has been and remains low. This is a result of the long-run decline in production, and cheap fuel and energy upon the production revival. However, the situation with the energy prices has dramatically changed. In the latest five years, the cost of energy for Ukrainian enterprises has grown:

eight times - for natural gas;

twice – for electricity.

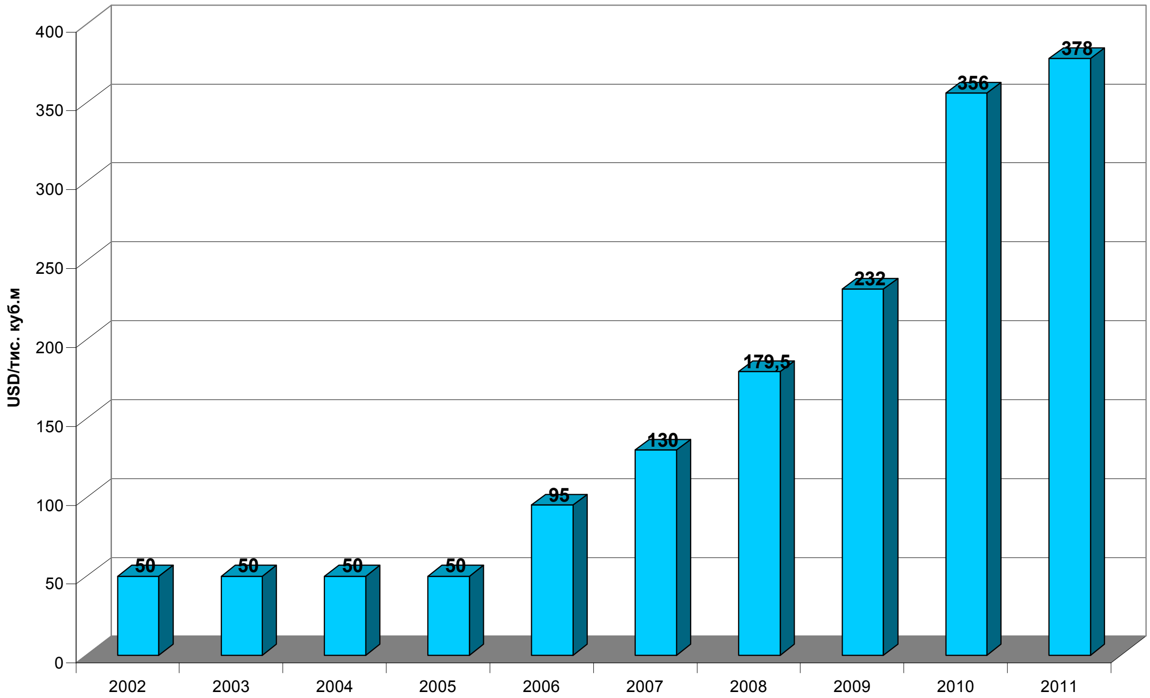

Diagram 1. Dynamics of natural gas price increase.

Every enterprise endeavors to save energy in various ways. However, the lack of experience in taking certain steps or misconception of the expected savings result in overspending of the finance, which are extremely scarce. This is the consequence of the lack of energy management systems and the lack of energy efficiency benchmarking.

Significant energy consumption values are inherent to the food production. This is attributable to the need of product thermal processing and sanitary rules, and cause an extensive use of thermal energy and natural gas, at the same time product preservation requires cold generation thus causing high electricity consumption.

And the enterprises' generating facilities are mostly obsolete. For instance, steam generation by 25-year-old boilers characterized by lower than 80% coefficient of efficiency is commonplace. Those boilers are manually controlled and the only measurement device is a steam pressure manometer and it is used to control the boiler accordingly. As concern cold generation, compressor refrigerating systems not always correspond to compressor performance capability, as the summer air temperatures have grown and the refrigerating systems are worn out. This causes overconsumption of electricity, as the compressors work in the inefficient mode.

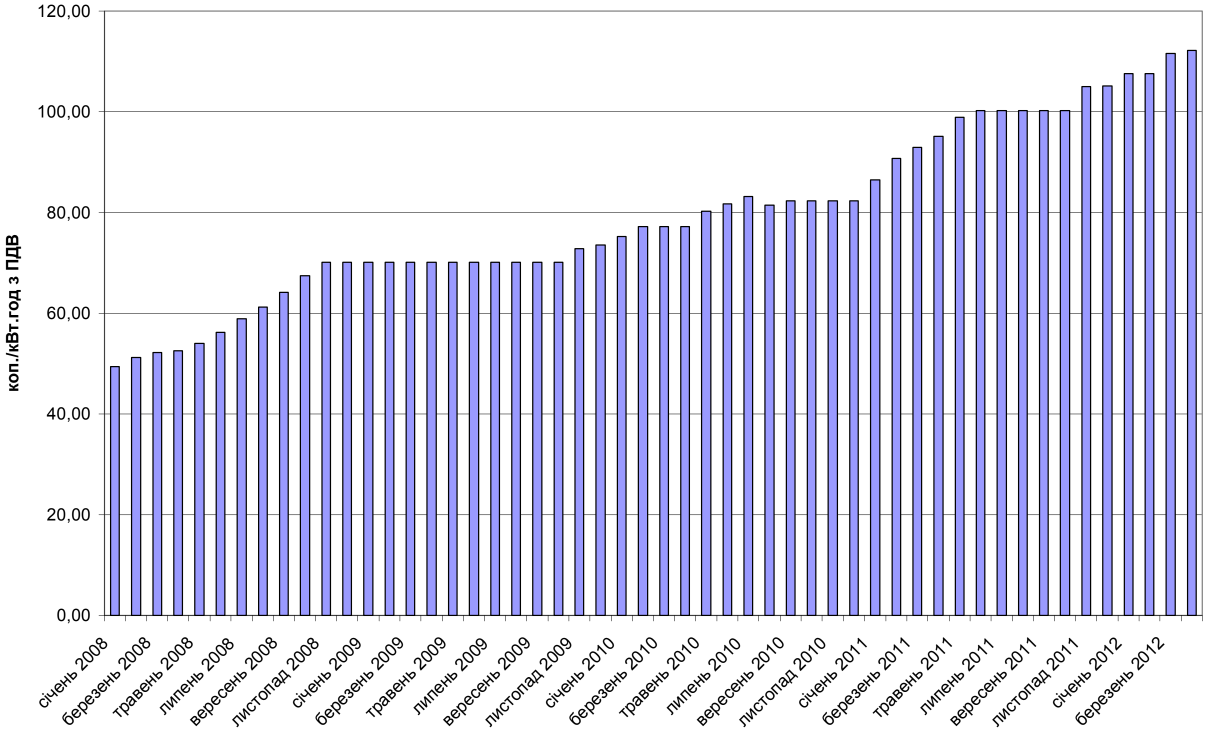

Diagram 2. Dynamics of electricity price increase

Energy efficiency benchmarking provides the opportunity to find out how effectively an enterprise uses energy resources as compared to its competitors and the best similar enterprises in the sector. It helps to identify the spots where energy is excessively consumed. For instance, what stage energy is wasted at: at generation, transportation or when consumed for product manufacturing?

However it is not essential to use only competitive or sectoral benchmarking. This method is flexible and provides the capability to compare enterprises from different sectors, although not in full, but by individual processes, workshops or sectors. For example, the following issues may be analyzed:

- How much more energy do we consume for heating office premises than others? Why? What is the least cost solution to this problem?
- Why do we consume more fuel than other enterprises to generate steam? What is the best solution to reduce this indicator value?
- What potential percentage reduction in electricity bills may we achieve through application of the three-zonal tariff? Why do some enterprises manage to reach higher savings than others?
- What secondary sources of thermal energy do other enterprises use for hot water supply?

They are only several issues that benchmarking may help to address, however, an economic effect upon receipt of benchmarking findings and launch of the best practices offers an enterprise significant energy saving opportunities.

Energy Efficiency Benchmarking Methodology

Energy efficiency benchmarking is based on comparing of energy spending indicators in actual values per unit of output.

A model benchmarking curve reflects enterprise efficiency as a function of total product output at similar enterprises or as a function of total number of enterprises operating at this energy efficiency level or lower.

The most ineffective enterprises are portrayed in the left lower part of the curve with the most effective ones being represented in its upper right part. Benchmarking curve shapes will differ for various industries and regions. However, as a rule, several enterprises are most efficient while several enterprises are very inefficient. This situation is expressed in the form of steep region of the curve in the first and the last deciles, respectively. Between these two polar groups, the curve is usually depicted in the form of broad linear dependence between energy efficiency and cumulative output (number of enterprises). This relation could be used for approximate assessment of energy saving potential, which is defined as 50% of the difference between efficiency in the first and the last deciles.

The most efficient enterprise within the benchmark curve is taken to identify the Best Practicable Technology (BPT). Physical product output should be used, where possible, to identify an enterprise location by deciles. Where the data is lacking or unreliable, this approach may not be applied and deciles are formed on the basis of the number of enterprises.

Two other types of analysis could be applied to contribute to the enterprise-related data. They are based on average Specific Energy Consumption (SEC) per unit of output for the sector, region or country (I type) and Energy Efficiency Index (EEI) developed by Phylipsen et al. (2002) and Neelis et al. (2007) in the Netherlands (II type).

SEC analysis employs an average current SEC value at the national or regional level depending on data availability. Where no input data is available for this kind of analysis, statistics provide only the basis for evaluation of the energy efficiency. Statics enables analysis of the information on the use of energy resources at industry-specific (sector-specific) level including all production processes in a certain sector.

Country's EEI assessment j for sector x with production processes i is accomplished according to the following equation:

$$EEI_{j,x} = \frac{TFEU_{j,x}}{\sum_{i=1}^{n} P_{i,j} \times BPT_{i,x}} \quad (1)$$

where TFEU – actual use of energy in sector x according to the energy balance compiled by the International Energy Agency (IEA) (Petajoule (PJ) per year),

P – output of product i in country j (thousand tons (Mt) per year),

BPT – the best practicable technology for manufacturing product i (Gigajoule (GJ) per ton of products)

N – number of products to be pooled.

If the country's energy efficiency is the highest in the world, all processes for the sector (industry) would take BPT values. In this case, EEI of the country or region is equal to 1.

These approaches may be applied to identify energy efficiency potential for sector x in country or region i as follows:

$$Potential = 1 - \frac{International\ benchmark\left(BPT\ or\ SEC_{lowest,x}\right)}{SEC_{j,x}} \quad (2), \text{або}$$

$$Potential = 1 - \frac{EEI_{lowest,x}}{EEI_{j,x}} \quad (3)$$

Therefore, benchmarking provides the capability to evaluate energy efficiency of an individual enterprise as compared to other enterprises and economic sector as a whole, and to identify energy saving potential.

BRIEF DESCRIPTION OF THE INDUSTRY AND ITS SPECIFIC FEATURES IN TERMS OF ENERGY SAVING

The sugar industry is one of the largest in the food industry of Ukraine considering both its long history (over 160 years), and its volumes of production and consumption.

In 2011 season, 77 sugar factories were in operation in Ukraine. The production capacities of the factories are presented in table 1 below. They processed 17.365 million tons of sugar beet and produced 2.057 million tons of sugar (1.4% of the 2011 total global output).

Table 1

Daily production capacity, thous. t of sugar beat	Number of factories in operation in 2011	Total daily production capacity, thous. t sugar beat
<2	19	30.27
2 … 3	39	102.55
3 … 6	14	71.08
6 … 10	5	36.3
Total	77	240.2

Small capacity factories, where the equipment is obsolete, form the basis of the production capacity. This results in low efficiency of the production as compared to the European sugar industry, including high specific power inputs. In 2010/2011 marketing year, France, where 25 factories were in operation, manufactured 4.257 million tons sugar of beet, Germany (20 factories) manufactured 3.442 million tons.

Raw material for sugar production in Ukraine is sugar beet with its root crop containing some 75% of water and 25% of dry substances, specifically, 17.5% of saccharose. Saccharose content in beet depends on the seed quality and conditions of crop growing (temperature, precipitation, etc.).

Sugar beet harvesting starts in late August and ends in September-October (depending on a region and weather). They are delivered to sugar factories and stored in piles prior to processing. A factory is launched in operation when minimum prerequisite amount of beet is accumulated in piles. The factory operates for 30 through 100 days a year depending on the amount of beet delivered for processing, and then it halts operations. The rest of time is a maintenance period (some factories during those periods process raw cane sugar imported to Ukraine).

Once cleaned from stones, sand and organic impurities, root crops are washed and chipped to facilitate saccharose extraction. Saccharose is extracted from the chips with diffusion apparatuses of various types (column, rotary, inclined) where the water warmed up to 75-85 ºC or the condensate moves counterflow against chips and extracts soluble substance from them – saccharose and non-sugars. Relative expenditure of the solution (diffusion juice) pumped out from the apparatus depending on the apparatus type and chips quality is 105-140%

of the chips mass. Increased pumping out decreases sugar losses with sugar-free chips (marc) and does not result in significant increases in the heat and electricity consumption for sugar production. Marc is used as forage for cattle. It is dried in a marc-drier and granulated to extend its life cycle.

At the temperature over 75º C, pectin substances fast swell and chips elasticity decreases. At the temperature under 70º C, microorganisms demonstrate intensive growth thus damaging the chips. Therefore the temperature is maintained at 70...75ºC in an active part of a diffusion apparatus with steam warming chambers, warming the feeding water up or circulating the juice warmed up to 90-100 ºC through an active part of a diffusion apparatus.

At this stage, the heat consumers are feeding water, juice warming systems and steam warming chambers (for inclined warming apparatuses).

The diffusion juice at the temperature of 35-45 ºC passes multistage treatment including preliminary and principal defecation (treatment with lime solution), first and second saturations (treatment with carbon dioxide) and sulphitation (treatment with sulfur dioxide). Lime and carbon dioxide are obtained at the enterprise through burning limestone in shaft furnaces (coal is used). Sulfur dioxide is also obtained at the enterprise by burning sulfur in furnaces. In the treatment process, the juice is many times warmed up by steam or condensed steam.

At the treatment stage, the heat consumers are juice warming systems at various treatment stages.

The clean juice, warmed up in the group of warming devices is evaporated in a multiple effect evaporator system. The evaporator system consists of several evaporator apparatuses which the juice passes while being evaporated. The evaporator apparatuses are connected so that the steam evaporated in the first heating chamber is fed to the second heating chamber, while the steam evaporated in the second heating chamber is fed to the third chamber and so on. The steam evaporated in the last chamber is fed to the barometric condenser which provides vacuum in the last chamber body, gradually decreasing pressure and boiling temperature from the first to the last chamber body. This kind of design ensures the capability to use the heat from steam condensation process many times. Various modifications of four- and five-chamber evaporators are most often applied in Ukraine. Thanks to water evaporation, the content of dry matter in the juice grows from approximately 14% prior to the evaporator to 65-72% in the syrup after the evaporator.

An evaporator is not only the main consumer of steam generated by steam generators at the sugar factory, it also plays an important role in heat supply to the enterprise since the compressed steam at various pressures (secondary steam) obtained in the course of evaporation is used to warm the juice, water, syrup boiling and for other consumers. This provides the capability to reduce consumption of the steam generated by steam generators. Warming up most products is grouped. For instance, the juice could be warmed under the scheme “condensate – secondary steam from chamber 5 – secondary steam from chamber

4”. This scheme, despite high complexity, provides the capability to use low-temperature secondary energy sources.

Condensates of heating steam from the evaporator and from most other consumers are collected into condensate receivers. Condensate of the heating steam from the first chamber and partially from the second chamber is returned to feed steam generators in the sugar factory’s cogeneration plant. Heat from other condensates that could contaminated with sugar and do not fit for feeding steam generators are used to heat the juice in heat exchangers. The cooled condensates are used to feed the diffusion apparatus and for other needs.

The syrup from the evaporator is fed to vacuum apparatuses for boiling, where water residues are evaporated under vacuum at the temperature about 67 ºC. While the syrup is boiled, powdered sugar is added, saccharose from the syrup is crystallized on its fine crystals – the crystals grow. Once the crystals reach the required size, the mixture of crystals and massecute syrup (sugar/glucose syrup mixture) are separated in centrifuges. The obtained wet sugar is dried with warm air, packed and supplied to storage. The syrup containing certain amount of saccharose and other dissolved substances is returned for repeated boiling till saccharose is not derived from it in full. Boiling is either two- or three-stage process. The sugar from the second and third boiling stages is dissolved with cleared juice and supplied to vacuum apparatuses of the previous level. The residues of sugar-free syrup (molasses) are used as fodder additive or for production of alcohol, yeast, milk acid and other products.

Vacuum apparatuses are main consumers of thermal energy at this stage. Thermal energy is also consumed for sugar drying, clearing, warming up syrup and in molasses receivers.

Sugar factories are supplied energy under the cogeneration scheme where heat and electricity are generated in parallel at own cogeneration plants. These cogeneration plants have counter-pressure steam turbines that prevent heat losses for condenser and have the highest efficiency coefficient. This enables utilization of the steam generated by the turbine thus increasing the efficiency coefficient of energy output.

The excessive condensate generated during juice evaporation is returned to the cogeneration plant and provides the capability to operate the plant’s steam generators in condensate mode thus significantly decreasing the needed productivity of water chemical desalting equipment. Condensate, in contrast to water from technical water supply sources, has the temperature of 90…120 ºC increasing the cogeneration plant’s efficiency coefficient and decreasing the fuel consumption.

Specifics of the production in terms of energy consumption:

1) **seasonality of operations** – sugar refining seasons under the Ukraine's conditions last from 30 to 100 days;

2) **24 hours a day operation –** during the season time, some suspensions of production are possible due to raw material delivery interruptions or technical failures; they are undesirable as they require repeated launch of production lines and entail unproductive expenditure of raw materials and energy;

3) **high heat and electricity demand**, fluctuating in relatively small range during a day and during a sugar refining season;

4) **various heat carriers and their parameters** available in the heat supply system of the factory: water steam under various pressures, condensates, hot water, hot air, stack gases, etc.;

5) **large amount of secondary energy resources** (evaporated steam, condensates, hot water, гаряча вода, stack gases, etc.), which may be and are used largely.

6) **well-developed and effective heat technology scheme** (as compared to other subsectors) that is described by high heat consumption, long history of the subsector and seasonality of operation that provides time for annual modernization during the maintenance period;

7) availability of **own cogeneration plants,** which simultaneously generate steam and electricity to meet the needs of production, as well as heating, ventilation and hot water supply systems. Therefore, efficiency of energy consumption is defined by **specific fuel equivalent consumption** (calorific value – 7,000 kcal/kg) for processing of sugar beet (juice derivation) in **kilograms per ton of processed beet or in percentage of processed beet weight** (w/w). Calculations are based on beet weight, not on the weight of produced sugar, because sugar output from various quality beet (first of all differing by their sugar degree) may vary materially while fuel consumption figures change far less.

ANALYSIS FINDINGS

Specific fuel consumptions for sugar beet processing in 2010 and 2011 seasons by sugar factories of Ukraine have been selected to perform comparative analysis. The data have been collected from 35 factories characterized by the best and the worst energy efficiency indicators in the industry (see annex 1).

A benchmarking curve depicted on diagram 3 has been built using the proved technique [2].

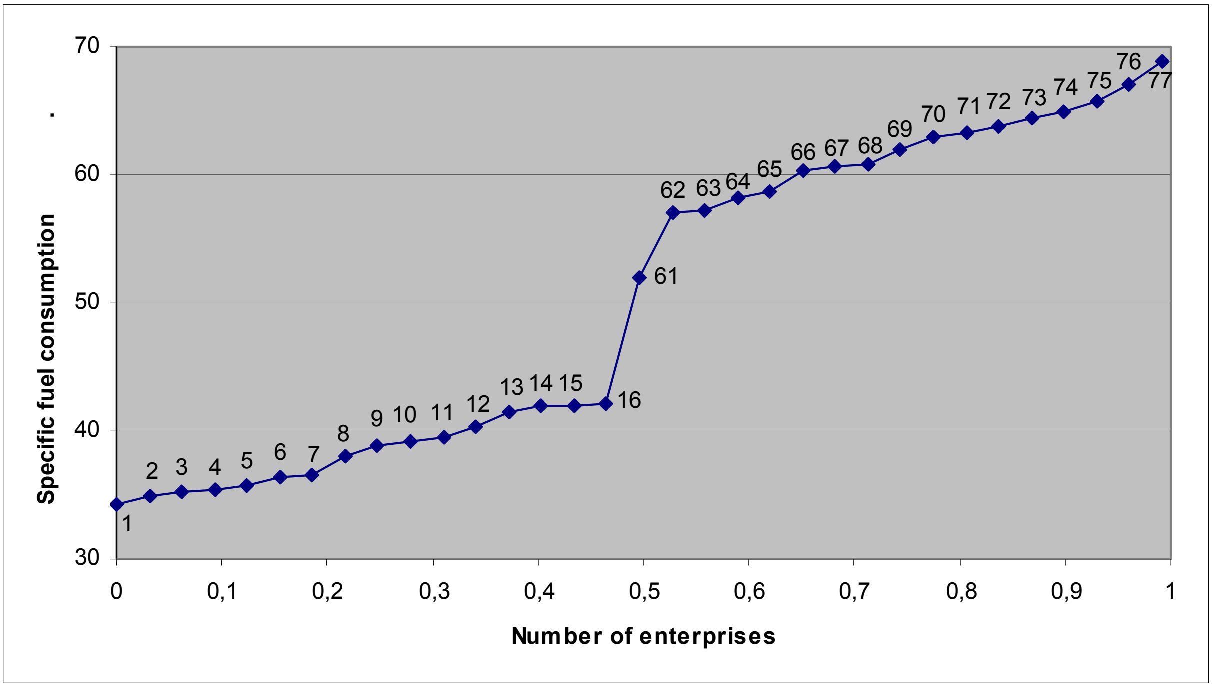

Diagram 3 - Benchmarking curve of unit heat consumption in the form of specific fuel equivalent consumption (kg fuel equivalent/t of beet)

The curve is used to identify enterprises' energy efficiency indicators (in per cent of fuel equivalent to processed beet weight ratio).

The most efficient enterprise – 34.3 kg of fuel equivalent/ton of beet
The least efficient enterprise – 68.9 kg of fuel equivalent/ton of beet.

BAT = 34.3 kg f.e./t of beet
BPT = 36.0 kg f.e./t of beet.

Assuming that the fuel consumption at the factories, which data are unavailable, was equal to the industry average in 2011 (**48.1 kg f.e./t of beet),** the curve somewhat changes (diagram 4):

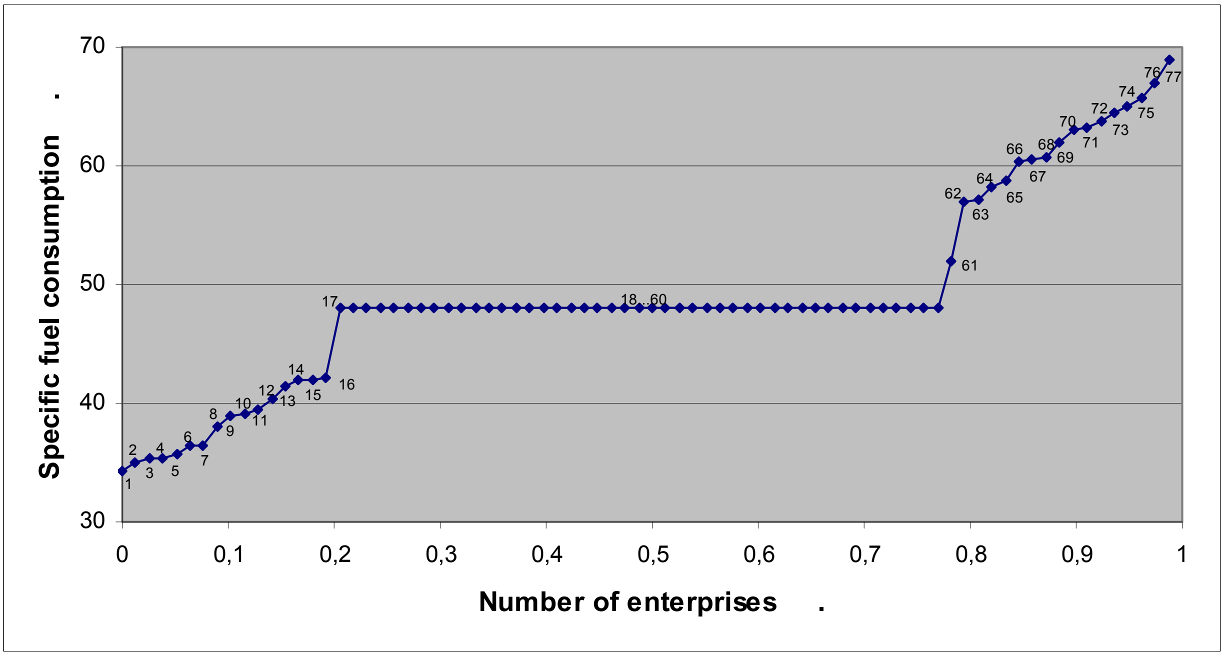

Diagram 4 - Benchmarking curve of unit fuel consumption in the form of specific fuel equivalent consumption (kg fuel equivalent/t of beet) including the enterprises, which data is unavailable

In this case, BPT somewhat changes:

The most efficient enterprise – 34.3 kg of fuel equivalent/ton of beet
The least efficient enterprise – 68.9 kg of fuel equivalent/ton of beet.

BAT = 34.3 kg f.e./t of beet
BPT = 38.0 kg f.e./t of beet.

No separate analysis for electricity has been conducted, since sugar industry enterprises have their own electricity generating capacities and supply themselves with their own electricity. Therefore, electricity consumption is included in fuel consumption balance.

CONCLUSIONS

1. Specific energy consumption by the sugar manufacturing enterprises varies in the range:
   fuel equivalent: from 34.3 kg f.e./t of beet to 68.9 kg f.e./t of beet;
   This difference is due to:
   - various schemes of heat supply at the enterprises;
   - different age and technological efficiency of processing and energy generating equipment;
   - differing degrees of the use of secondary heat resources (heat of hot condensates, vapors, etc.);
   - differing length of manufacturing seasons, that depends on the amount of procured raw materials;
   - differing quality of raw materials (sugar beet);
   - differing qualifications of the enterprise staff;
   - differing degree of factory top management’s commitment to energy-saving.

2. The average specific fuel consumption in the industry according to statistic data makes up **48.1 kg f.e./t of beet**. **16** enterprises out of the selected 32 enterprises, which data are available, are more effective than the average level in the industry - **48.1 kg f.e./t of beet**.

SOURCES

1. M. Yarchuk. Outcomes of the Ukraine’s sugar beet industry activities in 2011. Materials of the international scientific and technological conference of Ukraine’s sugar industry “Methods to Improve Efficiency of Sugar Beet Processing and its Scientific and Technological Support”. K. 2012.

2. Global Industrial Energy Efficiency Benchmarking. An Energy Policy Tool.– Working Paper.– November 2010

ANNEXES

Annex 1

Data on fuel equivalent consumption by the sugar factories of Ukraine in 2010-2011

No.	Factory	Productivity, t/day		Specific fuel equivalent consumption for juice extraction, kg f.e./t beet
		design	actual	
1	2	3	4	5
1	“Chevonsky Tsukrovyk” PJSC	2,200	1,980	34.3
2	“Volochysk-Agro” Ltd., production enterprise “Narkevytsky Sugar Factory”	2,600	2,358	35
3	“Dovzhenko Agrifirm” Ltd., production enterprise “Yareskivsky Sugar Factory”	3,000	2,421	35.3
4	IPK “Poltavazernoprodukt” Ltd., production enterprise “Globino Sugar Factory”	3,380	2,981	35.4
5	“Green Valley” Agricomplex Ltd. (Tomashpil Sugar Factory)	1,950	1,704	35.8
6	“Chortkivsky Sugar Factory” Ltd.	6,000	6,300	36.4
7	“Podillya” Food Company PJSC (Kryzhopil)	6,000	5,500	36.5
8	“Radekhivsky Tsukor” Ltd.	6,000	5,442	38
9	“Palmirsky Sugar Factory” Ltd.	6,000	5,450	38.9
10	“Khorostkivsky Sugar Factory” Ltd.	6,000	5,014	39.1
11	“Kmilnytske” Ltd., production enterprise “Zhdaniv Sugar Factory”	1,800	1,610	39.5
12	“Dobrobut” Agrifirm Ltd., production enterprise “Kobelyaky Sugar Factory”	6,000	6,800	40.4
13	“Orzhytsky Sugar Factory” Ltd.	6,000	5,540	41.5
14	“Salivonkivsky Sugar Factory” OJSC	5,110	4,750	42
15	Chervonozavodsk affiliate of “Rise-Maximko” PJSC	8,500	6,041	42
16	“Krayevyd” Ltd. (Zgurivsky Sugar Factory)	2,000	1,610	42.1
17	“Teofipol Sugar Factory” OJSC	6,000	5,587	no data
18	“Krasny” Lynovytsky Sugar Factory” PJSC	2,500	1,877	no data
19	“Rokytnyansky Sugar Factory” OJSC	3,000	2,892	no data
20	“Maryinsky Ukrpromzbut” Ltd. (Brodetsky Sugar Factory)	2,070	1,899	no data
21	“PANDA” LTD (Selyshansky Sugar Factory)	1,440	1,450	no data
22	“PANDA” LTD (Talnivsky Sugar Factory)	2,760	2,760	no data
23	“PANDA” LTD (Tsybulivsky Sugar Factory)	3,000	2,400	no data
24	OJSC “Uzin Sugar Factory”	1,700	1,640	no data
25	“Lanniv Sugar Factory” private enterprise	1,900	1,630	no data
26	“Sugar Factory after Tsuriupa” PJSC	2,000	1,940	no data
27	“Gorokhiv Sugar Factory” OJSC	4,550	4,000	no data

Annex 1. Continued

1	2	3	4	5
28	“Trading house “Shepetovka Sugar” Ltd.	2,890	3,200	no data
29	“White Well” JV Ltd. (1st Sugar Factory after Petrovsky)	3,000	2,139	no data
30	PJSC “2nd Sugar Factory after Petrovsky”	3,000	2,700	no data
31	“Niva” agricultural enterprise” Ltd. (Dubno)	4,950	4,500	no data
32	“Zbrazhsky Sugar Factory” Ltd.	3,000	2,950	no data
33	“Oleksandriysky Sugar Factory” Ltd.	3,050	2,820	no data
34	“Kozivsky Sugar Factory” Ltd.	3,000	2,500	no data
35	“UK.AZ.-Druzhba” Ltd. (Zhovtnevy Sugar Factory)	3,030	2,450	no data
36	“UK.AZ.-Druzhba” Ltd. (Ugroyidsky Sugar Factory)	2,000	2,000	no data
37	“Nosivsky Sugar Factory” Ltd.	1,590	1,390	no data
38	“Yuzefo-Mykolaivska agro-industrial company” Ltd.	1,500	1,486	no data
39	“Gnidavsky Sugar Factory” PJSC	4,900	4,500	no data
40	“Nafkom-Agro” SC (Orikhiv-based)	1,500	1,400	no data
41	“Borschivsky Sugar Factory” Ltd.	3,000	3,000	no data
42	“Europesugar” private enterprise (Ivanychiv Sugar Factory)	3,000	2,542	no data
43	“Lanivetsky Sugar Factory” Ltd.	3,300	2,750	no data
44	“Kagarlyk Sugar Factory” OJSC	1,800	1,370	no data
45	“Illinetsky Sugar Factory” Ltd.	1,940	1,300	no data
46	“Agro XXI” Ltd. (Babino-Tomakhivsky)	1,770	1,521	no data
47	“Novoivanisky Sugar Factory” OJSC	1,700	1,480	52
48	“Starokostyantynivtsukor” Ltd.	3,000	2,670	no data
49	“Sokolivsky tsukor” JV, “Podilski Sugar Factories” Ltd.	2,500	2,500	no data
50	“Prism-14” Ltd. (Kashperivsky Sugar Factory)	1,500	1,360	no data
51	“Tsukrove” Ltd.	2,650	2,168	no data
52	“Pervukhinsky Sugar Factory” PJSC	2,120	2,200	no data
53	“Crystal” Ltd. (Baryilivsky Sugar Factory)	2,500	2,000	no data
54	“Khmilnytske” Ltd., Zhdaniv Sugar Factory production enterprise	3,000	3,000	no data
55	“Zorya Podillya: Food Company Ltd. (Gaisyn-based)	3,500	3,500	no data
56	“Moyivsky tsukor” JV, “Podilski Sugar Factories” Ltd.	2,100	2,100	no data
57	“Turbiv Sugar Company” Ltd.	2,500	2,440	no data
58	“Krasnosilsky Sugar Factory” Ltd.	1,750	1,750	no data
59	“Shamrayivsky Sugar Factory” DLC	3,000	3,000	no data
60	“Novomyrgorodsky tsukor” Ltd. (Kapitanivsky Sugar Factory)	2,550	2,550	no data
61	Research and production fund “Sintal’D” Ltd (Kongresivsky)	1,440	1,300	57
62	“OJSC – Zhashkiv Sugar Factory” Ltd.	2,660	2,000	57.2

Annex 1. Continued

1	2	3	4	5
63	"Savinska Agroindustrial Company" Ltd.	3,050	2,450	58.2
64	"Khreschatyk" Sugar Factory Ltd.	3,000	2,600	58.7
65	"Gorodenka" Sugar Factory Ltd. TOB	2,000	1,940	60.3
66	"Spetstekhnika" Ltd. (Yagotyn Sugar Factory)	3,000	3,000	60.6
67	"Obodivsky Sugar Factory" affiliate of "Agroprodinvest 2005" Ltd.	1,500	1,266	60.8
69	"Buchach Sugar Factory" Ltd.	3,000	2,650	62
70	"Gor-Pustovarivsky Sugar Factory" PJSC	1,640	1,169	63
71	"VIK – R.S.F." Ltd. (Myronivka Sugar Factory)	2,700	2,427	63.2
72	"Klembivsky Sugar Factory" Ltd.	1,710	1,460	63.8
73	"Agro-Vild Ukraine" industrial enterprise (Sichnevy)	1,380	1,380	64.5
74	"Yavir" PSP (Murafsky Sugar Factory)	750	700	65
75	"Krasylivsky Sugar Factory" PJSC	1,650	1,300	65.7
76	"Kornynsky Sugar Factory" OJSC	1,700	1,540	67
77	"Ivankivsky Sugar Factory" SC	2,000	1,403	68.9