2013

Cost-benefit analysis of the use of different energies in greenhouses/glasshouses

USAID

AgBiz Program

EPICENTAR
economy · planning · innovation
Your partner of choice

USAID AgBiz Program *(www.agbiz.com.mk) overall objective is to increase incomes for all participants in selected Macedonian agricultural value chains by increasing sales (domestic and exports), improving productivity, enhancing the agricultural business environment, and increasing access to finance. AgBiz builds off of the existing capacity and expertise of Macedonian professionals and lead firms and farms to create a new understanding in the market for imbedded business development services and fee-based service delivery. EPICENTAR International is selected and responsible for implementation of the Fresh Fruits and Vegetable component as Lead Facilitator.*

EPI Centar International *(www.epicentar.com.mk) is a consulting company, providing consultancy and expertise to strengthen the capacities of individuals, private companies and local communities, for achieving greater economic results.*

The company provides services such as:

- *Support in drafting and conducting Market/Sector/Product Specific Research, Analyses and Studies, Plans and/or other Strategic Documents essential for the success of an organization;*
- *Planning, Implementation Management and Monitoring and Evaluation of Donor and/or Agency Funded Projects;*
- *Assistance in locating the most suitable business partner in Macedonia and business representation in the country;*

Positive changes are a compound part of the work and are achieved through raising people's awareness, capacity building approach and direct community interventions.

EPICENTAR's ultimate objective is to become a reliable "partner of choice" for the implementation of donor and/or agency funded Projects.

Disclaimer

This publication was produced for review by the United States Agency for International Development. It was prepared by EPICENTAR International.

"The authors views expressed in this publication do not necessarily reflect the views of the United States Agency for International Development or the United States Government."

Skopje, April 2013

Authors:

Ljubomir Dimovski, Director, EPI CENTAR International, Skopje
Vesna Garvanlieva, Business Development Specialist, EPI CENTAR International Skopje
Stevan Orozovic, Evaluation and Monitoring Expert, EPI CENTAR International, Skopje
Gordana Pop Simonova, PhD, Institute of agriculture, Skopje
Dame Dimitrovski, PhD, Faculty of mechanics, Skopje
Goce Georgievski, Technical Consultant for Greenhouse Production

Contents

List of abbreviations 5
Executive summary 6
1. Introduction and objectives 7
2. Institutional and legal framework for greenhouse production in the Republic of Macedonia 8
3. Sustainable technology for the heating and cooling of protected environments 11
4. The existing greenhouse capacities in the Republic of Macedonia 12
a. Structure of the greenhouses 16
b. Greenhouse Production Characteristics 16
c. Average annual yields 17
d. Production cycle 17
e. Greenhouse Heating & Cooling Methods Used 19
f. Small individual greenhouses 19
g. Glass covered greenhouses 20
h. Greenhouses using geothermal energy 20
i. Heating & Cooling Cost Share 22
5. Conclusions and Recommendations for improvement of the production in protected areas 24
j. Sustainable heating and cooling methods 24
k. Greenhouse structure 24
l. Double polyethylene cover 25
m. Retrofitting 25
n. Winterizing openings 26
o. *Insulation* 26
p. Existing foundation and side walls 26
q. Add a Thermal Blanket 27
r. Heating System Efficiency 28
s. Environmental Control 29
6. Recommendations for new products and technologies 29
7. Conclusions and Recommendations for policy and support system improvement 31
8. References 35
Annex I 36

List of abbreviations

PE – Poly-ethylene
IPARD - Instrument for Pre-Accession Assistance from the European Union
MKD- Macedonian Denar
ACDF- Agricultural Credit Discount Fund
CHP – Combined Heat and Power
HAF – Horizontal Air Flow
GHG – Greenhouse Gas
PVC - Polyvinyl Chloride
UV - Ultra-Violet
MAFWE – Ministry of Agriculture, Forestry and Water Economy

Executive summary

The greenhouse sector in the Republic of Macedonia is one of the largest employment generators, both permanent as well as seasonal. Since the establishment of the first PE tunnels and later with the development of glasshouses, by the end of 70s, the sector has undergone severe crises, but the production and the revenues have remained relatively stable. The challenge of the sector in general is in diversifying the export market, which is possible only if the product responds better to export market requirements in terms of crop diversity, applied technologies, quality, grading and packaging.

Macedonian vegetables have a very good reputation in the region with their fresh recognizable taste and aroma. It will be a challenge in the future to preserve this reputation due to the lack of investment in modern technologies that will reduce the cost of production. Limiting factors for profitable glasshouse production in the Republic of Macedonia are the extreme temperature changes in winter and summer season.. For that reason, not only that the glasshouse capacities are underutilized, but the expensive tomato hybrids that are intended for at least 10 months cropping period cannot return the investment within the short cropping period of 3-4 months. The seasonal production and avoidance of the extreme winter conditions due to the high costs for heating also evokes problems with a very low marketing price because the harvest is set to a specific period which overlaps with the harvest period in the plastic tunnels at the same time.

The institutional and educational systems in Macedonia do not keep pace with the latest developments in the greenhouse industry. In absence of the know-how, the greenhouse operators are directed to search for consultancy, technology and equipment from foreign suppliers and providers.

Some of the Macedonian operators have made large investments in the greenhouse production in order to follow the market demands. However, the substrate cultivation is not entirely adopted by the operators and they are completely dependent on the services provided by the supplier. It is of crucial importance to support them in this initial period of new production in identifying the bottlenecks and eventually providing intervention for optimal usage of the new technology.

1. Introduction and objectives

More than 70% of the total quantity of fresh vegetables exported from Macedonia is produced under protected cultivation (greenhouses, including plastic tunnels) whereas less than 30% are produced in modern glasshouses. Most of the greenhouses in the country use heating systems that are primitive and based on the use of heavy oil or wood as the main energy source. The exhaust emission and the losses of energy are enormous. Besides the negative environmental effects, the costs related to this type of heating are high, making the production very expensive and not very competitive.

In the last decade, there have been numerous efforts to introduce alternative energy sources, which will be more cost-effective and sustainable in terms of the use of natural resources. For that purpose, the Government and the donor projects encourage the introduction and installation of heating systems that use alternative energy like solar energy, biomass, thermal water etc.

As the price of energy is permanently increasing, heating costs negatively influence the productivity and overall competitiveness of fresh vegetable producers and it is necessary to introduce "alternative" energy sources in the agriculture. Therefore, as part of the AgBiz Program, the Fresh Fruit and Vegetable Value Chain component, EPI Centar in coordination with several greenhouse companies and their integrated farmers prepared this analysis based on the opportunities and cost-benefits of using different energy sources for heating along with recommendations for the most appropriate system for the greenhouses and glasshouses in Macedonia.

The analysis was prepared in the period January - April 2013. , Greenhouses are heated during this period and in order to obtain real-time data, several meetings and field visits with the representatives of several greenhouse companies were performed. The conducted surveys included the following greenhouses producing vegetables of different types in protected areas:

- Kanet Agro, Negorci
- Badzo PT, Bogdanci
- Eko oaza Samandov, Shtip
- Vegefresh, Kuklis
- IGN Magro, Chucher-Sandevo

In addition, the study conclusions and recommendations have been discussed on one hand with a group of individual agricultural households producing plastic tunnel products through focus group discussions and on the other hand, with some of the members of the Association of Glasshouse Producers through the Economic Chamber of Macedonia.

The end results provide a comparison analysis of the heating systems for greenhouses and glasshouses. In addition, it provides recommendations for the value chain participants for the most cost efficient systems and opportunities for energy savings through the implementation of environmentally friendly technology. The term "greenhouse" used in

the study refers to all protected areas (glasshouse and plastic tunnels) with installed heating systems which were analyzed within the scope of the study.

2. Institutional and legal framework for greenhouse production in the Republic of Macedonia

The delayed privatization process has restrained glasshouse operators from making necessary expenses for maintenance and re-equipment. For many glasshouse operations, there is an acute lack of working capital for heating, which means that these greenhouses have no competitive advantage over plastic tunnels production regarding the time of harvesting. In the last 15 years and so there have been no significant investments in the glasshouse sector, which has lowered the output and substantially raised the cost of production. Only recently some modifications have been made in the sense of technology modernization and computerization.

Part of the greenhouse companies are organized in the Association of Greenhouse Producers that operates within the Economic Chamber of Macedonia. The other part of the companies operates with the Agro Business Chamber which is part of the Macedonian Chambers of Commerce. Even though these companies are one of the largest job generators in this sector, there is a serious lack of communication and understanding between the Associations and the government bodies; therefore a National Strategy for greenhouse production has not been developed yet.

The competencies for the greenhouse sector in the Republic of Macedonia are located in several institutions, including:

- The Ministry of Economy
- The Ministry of Agriculture, Forestry and Water Economy
- The Ministry of Environmental and Physical Planning
- The Ministry of Transport and Communications
- The Energy Regulatory Commission
- The Local Self-Government

The key documents setting out the Government policies for Macedonia's the development of agriculture and rural development include:

(i) the Government's Pre-Accession Economic Programme;
(ii) the National Agricultural and Rural Development Strategy for 2007-2013 with the National Plan (IPARD Program) and in coherence with the national strategic objectives for EU Integration;
(iii) the Industrial Policy for 2009-2020;
(iv) the Strategy on Food Safety;
(v) the Fourth Program for Stimulating Investments for 2011-2014;

(vi) the Public Investment Program.

The Agency for financial support of agriculture and rural development is a part of the operating structure for implementing the funds from the fifth component of the Instrument for Pre-Accession Assistance of the European Union (IPARD).

Due to the situation arising from the consummation of fresh vegetables infected with *Escherichia coli*, there was a drastic reduction in sales of vegetables, especially exports, lower prices, and cancellation of purchases by foreign buyers. In this situation, a large part of the production of cucumbers and tomatoes produced in greenhouses was sold on the domestic instead on the foreign markets. Reduced sales and prices adversely affect the income of greenhouse producers. In addition to the problems with the foreign markets, the greenhouse companies suffer a negative revenue impact and higher production costs due to the increased investment in seed and fertilizers which have higher prices compared to the previous years. In addition, the price of the heavy oil drastically increased by 269% compared to the price in 2009.
In 2011, the Association of Greenhouse Producers within the Economic chamber of Macedonia held a meeting in the Ministry of Agriculture on which the current situation and problems of greenhouse production and sales were presented, with suggestions and requests directed to a partial compensation of suffered damages and assistance with specific measures to increase direct payments for greenhouse production to 500,000 MKD/ha, compensation for the increased cost of heavy oil amounting to 50% of the value of spent heavy oil, enabling the use of favorable working capital loans (with interest rates no higher than 4%) and higher repayment period (5 years with 1 year grace period) by means of ACDF, Compensation Fund, earmarked loans for primary agricultural production and other sources, such as loans earmarked for repayment of loans to commercial banks, increasing the maximum loan of 100,000 € to 700,000 €, and additional compensation from funds collected from European funds for suffered damages for the vegetable producers as a result of disruption in the market due to the emergence of *Escherichia coli*.

The greenhouse constructions in the current legislation are defined as "temporary construction", and this causes issues in the terms of tax obligations to the companies. The companies are complaining that they cannot gain full ownership of the land and construction due to this issue, and they demand that the land on which the greenhouses are built to be transformed into construction land. It is pointed out that in the latest version of the national Law on Agricultural Land, the fee amount for legalization of the objects is foreseen and too high (10 MKD/m^2) and should be revised. Other anomalies regarding the greenhouse production are located in several legislatives that directly or indirectly regulate the greenhouse production. These laws refer mostly to the regulation of heating sources, irrigation and energy use. The greenhouse companies pointed out several articles in the Law on waters that should be revised and modified according to their suggestions in order to comply with higher efficiency in their functioning.

More than 40 ha of greenhouses in Macedonia are heated with geothermal waters. The geothermal energy source is currently the most cost-effective energy source for heating compared with the use of heavy oil or natural gas because of the price. But, as of January 17^{th,} 2012, by the decision of the Government of the Republic of Macedonia, the price of

geothermal waters is increased by five times from the initial price per m³ of geothermal water (Annex I). At the same time, the greenhouse companies that are interested to invest in new geothermal wells are pointing out that the activities for new welling are very expensive (circa 700.000 € per well) and there is no guarantee that the wells will result with water temperatures needed for use of heating, nor that the water flow per second will be sufficient to be used in geothermal pumps. That issue increases the risk additionally and draws even more attention to the fact that there have not been any geological researches performed in this field for the assurance of their investments. Thus, the investments can grow up to a few million Euros for innovative geothermal technologies that can be consistent with the needs of the producer.

Temp. interval for calculation	Average temp by interval	Needed amount of heavy oil	Heavy oil equivalent (Em)	Heavy oil price M1=HC	Subjugation coefficient (Ka)	Compensation coefficient (Kn)
t1 (°C)	t1= tv1(°C)	Q(KWh)	(kg)	(MKD/Kg)		(MKD/m³)
1	2	3	4	5	6	7= (4*5*6)
31-40	35	9.27	0.93		0.075	
41-50	45	20.87	2.09		0.075	
51-60	55	32.46	3.25		0.075	
61-70	65	44.06	4.41		0.075	
71-80	75	53.33	5.34		0.075	
>81	81	62.6	62.27		0.075	

Table 1: Calculation for concession compensation for the exploited amount of geothermal water per m³, Official Gazette of RM 12/2012

The greenhouse companies pointed out that the government has not established a special fund for geological researches as a strategic measure for future development of the exploitation for this energy source. Other issues regarding the development of the geothermal use are located in the institutional "labyrinth", as the greenhouse companies are calling it. At the moment, the Ministry of Economy has the authority over this energy source and the greenhouse companies point out that there is no coordination between the Ministry of Economy and Ministry of Agriculture, and therefore problems occur regarding the applicability of their decisions. The existing greenhouse companies in the Republic of Macedonia permanently employ more than 2.400 people. The greenhouses are situated in the rural areas, and therefore their development is directly connected with the rural development of Macedonia. However, there is no significant institutional support towards the development of the greenhouse sector in the frames of the national strategies for agriculture and rural development. Actions should be taken regarding either the creation of a separate specific strategy for the development of the greenhouse production, or its integration in the existing documents.

3. Sustainable technology for the heating and cooling of protected environments

Sustainability is a concept in which emphasis is placed on practices with low environmental impact using less energy and fossil-fuels-dependent products to achieve the same goal. One of the benefits of engaging in sustainable practices is that it can increase the productivity and value of a greenhouse while lessening its environmental impact.

Sustainable greenhouses must be resource conserving, socially supportive, commercially competitive and environmentally friendly. They rely mainly on cultivation techniques, equipment management and constructive materials aimed to reduce agro chemicals, energy and water consumption as well as waste generation.

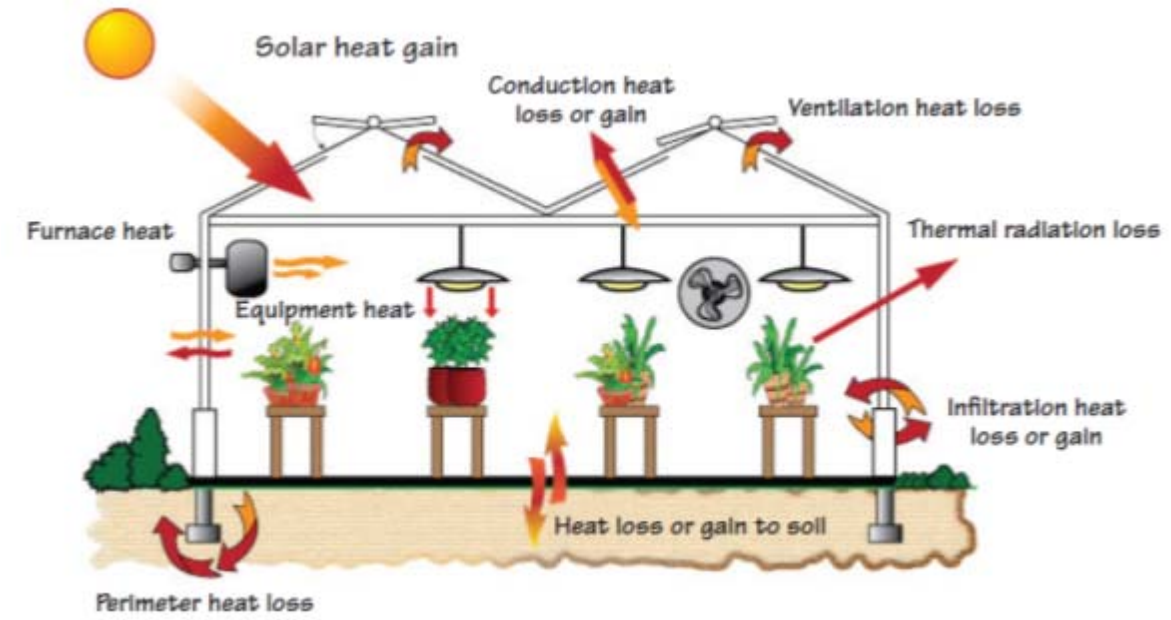


Figure 1: Greenhouse heat loss and gain pathways illustration

The objectives, whose aim is sustainability, can be obtained by the following means:

- Efficient management of climatic parameters;
- Use of renewable energy sources, replacing fossil fuels;
- Use of innovative greenhouse covering materials with good physical properties and low waste generation;
- Optimized use of water and pests control.

One of the contemporary solutions used in European greenhouses is the use of *combined heat and power (CHP) systems*, also known as cogeneration systems. Commonly, they use an internal combustion engine or gas turbine to drive an electric generator and generate electricity in addition to heat. The heat produced is supplied to the greenhouse through perforated tubes to provide CO_2 enrichment. Because CO_2 enrichment is beneficial during the day, the CHP operate during the day and the heat produced in excess of the greenhouse demands is stored in large water tanks and it is used during the night period.

The electricity produced is usually used in the greenhouse (supplementary lighting etc.) or sold to the electric grid.

Geothermal energy has been used most extensively in agriculture for greenhouse heating. While the worldwide use of geothermal energy in greenhouse heating increases by 3% annually, Macedonia reported a decrease in geothermal greenhouse use, due to economic problems (World Geothermal Congress data). Also, some problems can occur regarding the use of geothermal heating. The water supply may be highly corrosive (Gevgelija – Badzo), the cost of drilling a well as well as the accompanying piping and pumping is considerable for deep water sources, which increases the cost significantly.

Other geothermal sources are not used at present. There is a trend in the world of using geothermal energy in depth beyond 1.000m. The investment prices are higher, but the reliability of the sources is also higher. The Macedonian geothermal potential can also be developed by using the heat from the geothermal energy sources during the summer period.

Passive greenhouses are a contemporary way of future exploitation. Because of the high investment, there are no passive greenhouses in Macedonia yet. But, following the trend of fuel prices and other commodities, one can assume that they will be constructed in the near future. Passive greenhouses have well-insulated opaque surfaces, the south wall pitched at an angle equal to the latitude and many water- filled barrels to collect heat.

Figure2: Passive greenhouse illustration

4. The existing greenhouse capacities in the Republic of Macedonia

Macedonia has approximately 260ha of agricultural cultivable area under glasshouses, but the exploitation of these capacities ranges between 70%-75%. Most of the greenhouse complexes are blocks of 6-24 ha units in extent. In addition, the area of vegetables cultivated under plastic tunnels is not precisely known, however it is estimated to be between 4.000 and 6.000ha, used mainly for the cultivation of tomatoes, cucumbers and peppers.

Analyzing the large producers, the heating system used is generally made of fuel supply system, fuel burner, heat exchanger, heat distribution system and a control unit. The heating systems used in the large greenhouses in Macedonia are central systems, where the boilers are located in a separate house outside the greenhouse and the heat (mainly warm water) is distributed to the greenhouses by a distribution system (steel pipes).

Picture 1: Distribution of the heating system used in a glasshouse

The hot water is delivered to the greenhouses by a main supply and return systems of pipes that are insulated from the surrounding to minimize heat loss. A secondary net of pipes is installed inside the greenhouse, and it delivers heat to the crop by convection and radiation.

Picture 2: Heating pipes

Material: Iron

Purpose: The heating pipes are also used as a driving power for the harvesting carts

Picture 3: High position of heating pipes

Material: Iron

Warm water boilers are generally used in order to ensure a continuous optimized thermostat regime. Heavy fuel and petrol are the main energy sources, while geothermal water is being used in smaller amount. The clear price advantage against heavy oil heating should stimulate greenhouse operators to investigate the assumptions indicating the existence of over 200 geothermal wells in Macedonia.

The small producers use external boilers, typically on wood. The system is connected to mail steel pipes and secondary plastic thermo pipes. Measurements of temperature and humidity are manual, and interventions in the systems are intermittent.

Picture 4: Heavy oil Boiler

Installed in 1973

Heating capacity: 6 ha

Place of origin:
The Netherlands

-

Picture 5:
Boiler chamber with chimneys

Picture 6:
Propane-Butane Tanks

Usage:
Installed but not in function

Picture 7:
Hot water reservoir

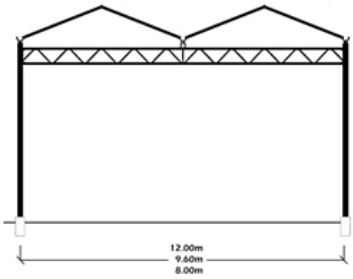
Capacity: 50t

Temperature: 65°C

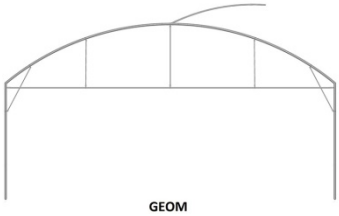
-

a. Structure of the greenhouses

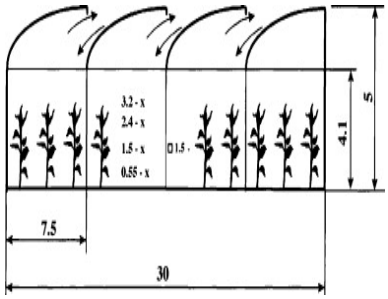
The first line of defense in efficient heating of a greenhouse is the structure itself. Losses vary depending on the greenhouse covering and the age of the structure. In general, newer structures will have better seals around the coverings and openings than older houses. The most commonly types of greenhouses used in Macedonia currently is the Venlo type, which includes a heating system where the total investment consists solely of the purchase of the entire greenhouse with the existing construction, heating system and glass cover. This requires investments in renewal of durable equipment, which is limited to the minimum at present. The glasshouses in Macedonia are generally multi-span, single wall and are mainly imported from dealers from Holland, Bulgaria or Israel. So far, 250 ha multi-span glasshouses and only 20 ha single-span ones have been built. The prevailing construction is that of the Dutch 'Venlo' 3.20 m, mixed with the Bulgarian type while in plastic covered greenhouses the old domestic type construction is being followed by the Israeli or Greek type.



Dutch Venlo type



Greek type



Israeli type

The tunnels are covered mainly with PE UV stabilized, with CO extruded 3 layer film and PVC is used as well. The plastic materials have a thickness of 18-20μ. PE is used mainly for mulching and straw for cucumber growing. The plastic film for tunnels is usually used for three years. Aluminum and galvanized steel are used along with wood for plastic greenhouses, while galvanized steel and steel + aluminum are preferred for glasshouses. Some of the producers use a double layer of plastic covering but it is not a sealed cover and it is only used not to allow the heat to go fast to the sealing of the greenhouse.

Picture 8: Venlo type greenhouse,

b. Greenhouse Production Characteristics

Of the 260 ha of agricultural cultivable area under glasshouses (blocks of 6-24ha per unit) only 70%-75% of the capacities are used. The area cultivated under plastic (foil) tunnels is not precisely known and it is estimated between 4.000ha to 6.000ha mainly for the cultivation of tomatoes, cucumbers and peppers. Although the production of peppers is very favorable in the south-east part of Macedonia, the greenhouse producers are generally not interested in the production of peppers for fresh vegetable markets so this production is reduced drastically.

Crop	2005	2006	2007	2008	2009	2010
	ha	ha	ha	ha	ha	ha
Tomatoes	117.2	120	121	140.6	154.2	147.0
Cucumbers	45.5	42.5	50.4	54.0	55.8	62.0
Pepper	39.0	1.5	2.0	3.8	5.0	3.0

Table 2: Production area in ha of tomato, cucumber and pepper, stat.gov.mk

c. *Average annual yields*

Yields per unit are quite variable depending on the year, producer, variety, cultivation technology, etc. It is noted that the vegetables produced with hydroponics have bigger yields than the production on soil. This production technology is mostly implemented for the production of tomatoes. The difference between the yields of tomatoes produced on soil and with hydroponics is very high.

The yields of the traditional production on soil vary from 150t/ha to 200 t/ha, and with hydroponics the average yield varies from 450 to 600 t/ha, depending of the variety. Cucumbers have an average yield of 220 t/ha. The average yield of peppers is 35-36 t/ha for some varieties that are meant for the processing industry.

Out of the total agricultural land planted with vegetable, 23% is planted with peppers, 15% with watermelons, 9% with tomatoes, cabbage 5%, melons 3%, cucumbers 2% and the remaining 43% are planted with other vegetables (22.9% potato, 8.3% beans, 5.5% onions, 1.2% strawberries etc).

d. *Production cycle*

Although a number of other crops are cultivated under protected covers, such as early potatoes, watermelons under small tunnels and strawberries under a plastic soil cover, the largest area is planted with tomato, cucumber and hot pepper. The start of cultivation depends on the possibility of heating the greenhouses. The few glasshouse operations that have the financial means to purchase sufficient heavy oil and start nurseries (first tomato, later the more cold-sensitive cucumber) already in November, transplant the seedlings in

December and harvest the crop in February and March when very high prices can be obtained. Most glasshouse operators, who cannot afford the heating expenses, start later to save on fuel consumption but obtain lower prices for the crop.

According to the Ministry of Agriculture, Forestry and Water Economy, the total area of active glasshouses is 260 ha. The collected data show that 184 ha of the glasshouses produce tomatoes and cucumbers with the expected harvest of 17.115t of early tomatoes and 8.650t of cucumbers. Cabbage is produced on 17 ha with the expected yield of 650t and sweet peppers on 3ha with the expected yield of 105t.

Table:

GLASSHOUSE	MUNICIPALITY	Production area	Expected yield	Production realization	% of realization
		ha	t	t	
EKO-OAZA SAMANDOV	Gevgelija, Stip	24	4 130	2,560	62
ANSKA REKA	Valandovo	30	3 690	1,346	36
DOBRA DOO	Kocani	11	1 160	1,075	93
KANET AGRO DOOEL	Gevgelija	35	3 800	1,530	40
HAMZALI AD	Strumica	27	3 160	3,160	100
VARDAR OZ AD	Veles	12	1 500	930	62
GRADINAR OZ AD	Sveti Nikole	14	1,500	1,120	75
GREEN HOUSE, s. Gorni Podlog	Kocani	9	1,120	1,010	90
BADZO P-T	Valandovo	10	3,000	1,680	56
	Total:	184	23,060	13,581	59

The production in the plastic tunnels starts with the nursery of the seed in the second half of October in heated tunnels, and in the middle of January in unheated tunnels. The agro-technical operations take part in February/March with harvest in May/June, depending on whether or not, the tunnels are heated. When heating is applied, this is done subsoil by passing hot water through plastic tubes that are laid below the ground. However, most foil tunnels are not heated and thus come later into production.

Harvest cycle for tomatoes	Harvest date in heated tunnels	Harvest date in unheated tunnels	Average price (€/Kg)	Percentage from the total production
I Cycle	20.04	15.05	1.15	3%
II Cycle	25.04	25.05	1	7%
III Cycle	01.05	15.06	0.50	59%
IV Cycle	07.05	30.06	0.25	31%

Table: Difference in the harvesting time between heated and unheated plastic tunnels

The total average amount of harvested tomatoes in heated plastic tunnels is 80-90 t/ha. The plastic tunnels are heated with improvised furnaces on wood. Average heating costs: 20.000 €/ha. The average consumption of wood: 500 m³/ha.

Although a number of other crops are cultivated under a protected cover, such as early potatoes, watermelons under small tunnels and strawberries under a plastic soil cover, the largest area is planted with tomato, cucumber and hot pepper. Most of the tomato varieties grown in greenhouses are: Belle, Balet, Magnus, Yena, Alandra, Bonito and Geronda. There are short cucumber varieties (Adrain, Pontia, Jazer), long type cucumbers (Navada, Kalunga, Palmera) as well as gherkins (Motiva, Componist, Parker, Levina). The quantities of peppers grown in protected areas are insignificant compared to the aforementioned crops. Predominant pepper varieties are: Fortesa and Struma (hot peppers) and Pinokio (sweet peppers).

e. Greenhouse Heating & Cooling Methods Used

Heating is used in all glasshouses and also in some plastic covered greenhouses. Warm water boilers are generally used in order to ensure a continuous optimized thermal regime. However, the heating period is short; therefore, the plastic covered greenhouses start with the production in the second half of January; the main reason being the heating costs in the cold winter periods.

f. Small individual greenhouses

Most of the small plastic covered greenhouses in Macedonia use wood as an energy source for heating because of its relatively low price and thus most of the producers can afford it. On the other hand, the use of wood as emergent requires additional labor, disposal of the ashes etc. The burners used are located outside the greenhouse to optimize the greenhouse space and are manually controlled with no possibility of automation of parts of the process, depending on the environmental conditions in the greenhouse. The distribution system consists of steel pipes and plastic distribution pipes for hot water.

Since the boilers are outside the greenhouse, part of the heat is lost. Thus, introducing the boiler inside the greenhouse can contribute to higher heat utilization, but there is an

additional need of exhaust gas control. Also, the implementation of additional burner utilizators can contribute to 10% heat gain.

In addition, regular service periods, cleaning of the systems can be related to fewer heat losses. Also, measuring equipment positions on representative positions, detailed analysis of readings and weather prognosis can contribute to better environmental conditions and additional fuel saves.

The fuel consumption varies between producers, depending on the first sowing, type of seeds, the structure of the greenhouse, location etc. For example, the typical fuel needs for one layer plastic covered greenhouse are assumed to be 500m3/ha.

g. Glass covered greenhouses

Most of the glasshouse vegetable producers use fossil fuels (heavy oil, petrol or coal) as a main source of energy. The heating system is described above. The fuel consumption depends mostly on the first sowing, type of seeds, structure of the greenhouse, location, additional geothermal source of energy etc. It is very important for the producers to be able to obtain sufficient quantities of fuel with standardized quality.

Picture 9: Boilers for heating on M-2

Picture 10: Covering of glasshouses two layer

The Burner – boiler systems are mainly old, and with reconstruction and development they can be up to 9% more efficient.
Replacing the heavy oil with other energy sources is dependant mostly on fuel prices at the moment and projections of fuel prices in the future. Utilization of "cheaper" fuels: wood, coal etc, requires total reconstruction of the boiler rooms that implicates additional strategic investments.

h. Greenhouses using geothermal energy

Part of the producers (around 46ha in Strumica, Gevgelija, Kocani and Vinica) use geothermal warm water as a primary source of heat. More than half of the producers have their own geothermal wells and the other part pay additional fees to the distribution companies, per m³ of distributed hot water. In addition to this, there is a secondary energy source in the greenhouses that use geothermal water as a heating source, which is usually

liquefied petroleum gas or Heavy oil and is only used in extreme conditions if the primary (geothermal) heating system cannot maintain the desired temperature.

Investigations and research to utilize geothermal energy for all greenhouse producers is an attractive and up to date subject. Although the investment in new wells, piping and pumping systems is very high (the last investment in well is approximated to 700.000 EUR), most producers find this option attractive and profitable. Even more, the use of geothermal energy sources as a replacement for the utilization of fossil fuels can largely contribute to respecting the Environmental Laws and Policies, reducing the local air pollution and decreasing the emission of GHG to a great extent.

Picture 11: Electric pumps for distribution of hot water

Picture 12: Corroded heating pipes with pressure regulators

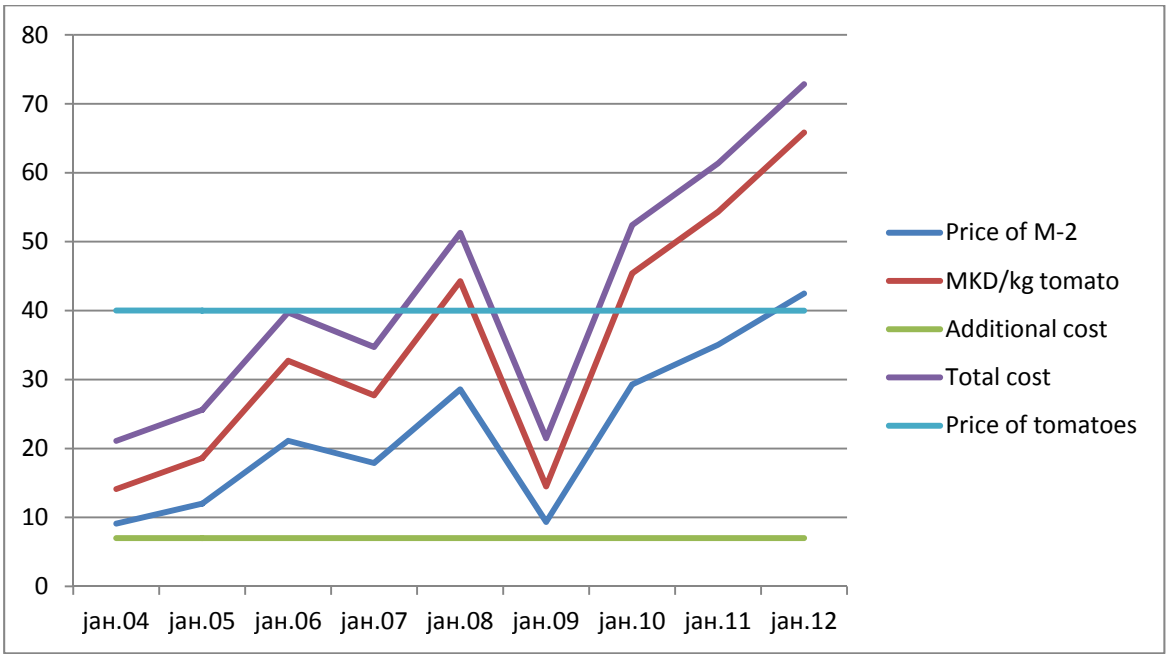
The cooling in all greenhouses is mainly static of mist and fog type and ventilation is achieved through ridge ventilation and also through combined type (with gable and side wall).

i. Heating & Cooling Cost Share

Most of the glass-covered greenhouse producers produce tomatoes. To heat the greenhouses in the full length of the season the producers, use around 133t/ha, when using only heavy oil. The average yield of tomatoes in the winter period is up to 90t/ha. Some of the renewed glass greenhouses can harvest more than 230t of tomatoes per year and around 140t from the winter harvest.

Table 1 shows the prices of tomatoes as well as the cost share of heating (heavy oil)during the winter period in the last decade,
The price of heavy oil at the moment is 42,471 MKD/kg. (01.2011 the price of M-1was 35,057 MKD/kg; 01.2010 the price of M-1 was 29,287MKD/kg; 01.2009 the price of M-2 9,352 MKD/kg; 01.2008 price 28,558 MKD/kg; 01.2007 price 17,885MKD/kg; 01.2006 price 21,116 MKD/kg; 01.2005 price 12,004 MKD/kg; 01.2004 price 9,107 MKD/kg).

Figure 6: Cost share of heating 2004 – 2014 in MKD (Energy regulatory commission, Greenhouses group – Macedonian chamber of commerce).



The average consumption of heavy oil per produced kg during the winter season is 1,5kg of heavy oil i.e. 1,5 t of heavy oil per 1 t of tomatoes produced.

Table 12: Calculation of greenhouse production costs for tomatoes grown on soil

Product	*Quantity*	*Unit measure*	*Production price*	*Total MKD*
Tomato	58.200	kg	19	1,105,800
1. Variable costs	*Units*	*Quantity*	*Unit measure (MKD)*	*Total MKD*

Fertilizer NPK	kg	1,500	23	34,500
Ploughing	Two ploughings (ha)	2	6,000	12,000
Milling	ha	1		8,000
Anti-rodent control	ha	1	4,000	4,000
Plastic foil	kg	750	120	90,000
Seed	grams	130		45,000
Manure	tone	20	2	40,000
Mineral fertilizer		1,500		30,000
Pesticides				65,000
Tying up (strings)				8,500
Transplantation		35	500	17,500
Hoeing up		40		20,000
Drop by drop system		10		5,000
Filtering		60		30,000
Wrapper		60		30,000
Tying		40		20,000
Cutting ends of the plant		10		5,000
Pesticides, labor		20		10,000
Harvest, packaging		160		80,000
				534,500
Total preparation and production				236,500
Package				145,000
Water costs				32,000
Other costs				55,000
Property tax				4,500
Total variable costs				771,000
Gross margin				334,800
Variable cost per kg of tomato				5.75 MKD/kg

5. Conclusions and Recommendations for improvement of the production in protected areas

j. Sustainable heating and cooling methods

Increased fuel costs and winters colder than normal make heating costs a significant burden on many greenhouse operations. The problem can be addressed in several different ways. Growers can conserve energy in the greenhouse, evaluate alternative or additional fuel sources or heating systems, evaluate growing temperatures and other production practices, consolidate operations into less space, critically evaluate when to bring the next greenhouse into production, and streamline operations.

Regardless of what a grower does to reduce the energy use, he still has to examine how to pay for increased costs related to higher fuel prices. Growers have suffered increases in the prices of pots and plastic as well as peat, pesticides and fertilizers over the last few years. In addition to the increased direct costs of heating, growers are faced with higher transportation costs as well - not just for the products they are delivering - but also for those they receive.

Small producers in Macedonia usually have plastic greenhouses sized up to 0,5ha and have one or more units. Even some of the larger producers have numerous units single spanned. The single snap greenhouses in Macedonia are usually oriented in such a way that the length runs east-west. This orientation maximizes winter sunlight and heat gain in the greenhouse.
Gutter connected greenhouses are to be oriented with the length running north-south so that the shadows cast by the gutters move during the day.
By connecting more greenhouses, the surface area for a given covered area is lowered, so there is less heat loss, and less energy required for heating the greenhouse. By connecting more than 4 typical small plastic greenhouses, the surface area can be lowered up to 40%.

Glass glazed greenhouses in Macedonia; produce mainly crops on one vertical level. By strategically moving the crops over the floor and moving the heating system closer to the crops root, the energy saves can be more than 15%. Additionally, in greenhouses with suitable height, the producers can plant different crops, according to their needs of light, heat and period of the year.

k. Greenhouse structure

As already mentioned, the first line of defense in efficient heating of a greenhouse is the structure itself. Losses vary depending on the greenhouse covering and the age of the structure. In general, newer structures will have better seals around the coverings and openings than older houses.
Covering material basic characteristics (Source: Energy conservation for commercial greenhouses NRAES-3)

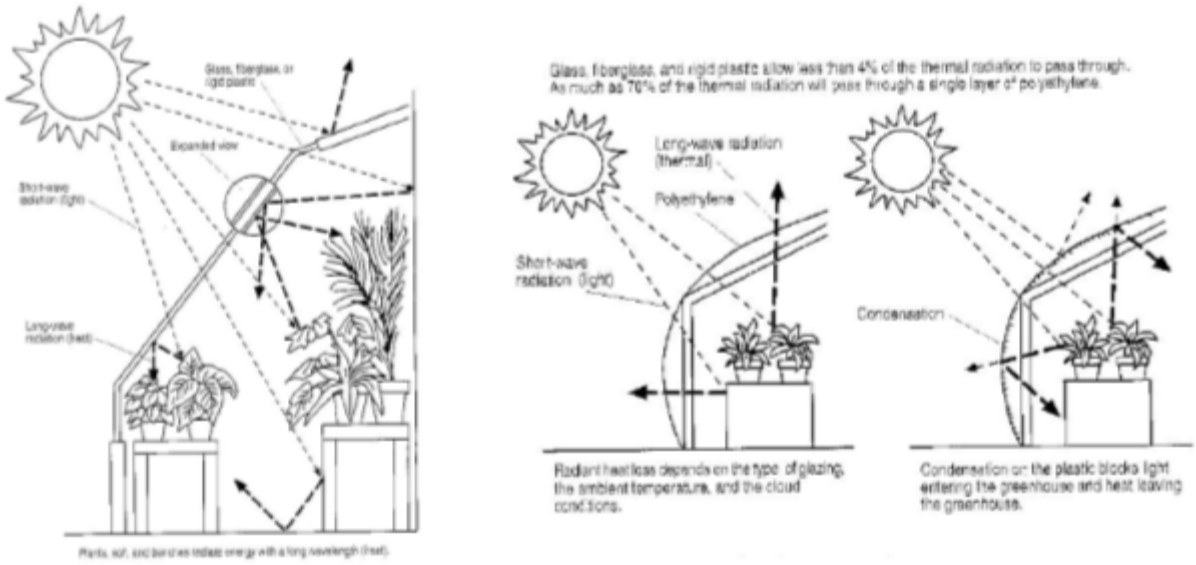
Material	% light transmission	U-value (W/m2 K)	thermal transmission	Life expectancy (years)
Glass				
Single	88-93	6,2	3	25+
Double	75-80	3,9	less than 3	25+
Acrylic				
Single	90	6,4	less than 5	30+
Double	84	2,8-3,2	less than 3	30+
Polycarbonate				
Single	90	6,2	less than 3	10 to 15
Double	78-82	3,0-3,6	less than 3	10 to 20
Triple	74-76	2,4-3,0	less than 3	10 to 20
Polyethylene film				
Single	87	6,8	50	3 to 4
Double	78	4,0	50	3 to 4
Double with IR	78	2,8	less than 20	3 to 4

l. Double polyethylene cover

Double polyethylene (poly) coverings reduce heating costs about 45% compared to single poly coverings. Most greenhouses in Macedonia that are used for winter production use one layer but have some kind of secondary poly covering. Small scale producers use the secondary poly only during the nights and mostly for the seedlings. Different polyethylene films vary from 35% to 60% heat loss. The most important parameter of the film is the thermal value. Selecting films that reduce water condensation will enhance light transmission and improve heat retention. Maintaining proper inflation between double poly layers is critical to maximizing the insulation value of the covering.

m. Retrofitting

A glass greenhouse can be covered with one or, preferably, a double, inflated layer of poly for extra insulation during the winter. A single layer of film over glass can reduce annual heating costs by 5% to 30% whereas a double (inflated) layer can reduce costs 30% to 50%. One should keep in mind that there is a tradeoff between increased energy efficiency and reduced light transmission with additional layers of poly.



Source: Reducing greenhouse energy consumption, S. Stanford, 2011

n. Winterizing openings

The biggest heat lost in greenhouses is from openings. A tight greenhouse with few air leaks around vents or doors will cost less to heat. Repairing holes in the plastic, glass or doors, keeping doors closed, and other openings tightly sealed is of vital importance.

o. Insulation

It is of great significance to insulate the end walls of the greenhouse, especially the north end wall. In most parts of Macedonia, the north end wall provides very little light for crop production. This wall can actually be constructed of a solid material (like wood). Chip wood will lose about the same amount of heat as a double poly wall. The producers are to insulate this wall according to their resources. Reflective (foil backed) insulation boards provide better insulation than other rigid foam boards. By placing them with the reflective side facing the greenhouse, the effect is bigger. Windbreaks outside the greenhouse along the north wall are a way to lower the heat transfer. It can be achieved by planting conifers for screening or a temporary fence material to divert the wind over the greenhouse.
Cleaning the top surface of the glass greenhouses has a significant role in infiltration of solar energy. In Macedonia, only few of the producers have found a way to clean the top glass surface. By regularly cleaning it, the light infiltration can be up to 12% higher.

p. Existing foundation and side walls

If the foundation of the greenhouse was not insulated during construction, make sure that all gaps or holes below the foundation board are filled or repaired. If the greenhouse has a concrete knee wall, insulating the inside of it with insulation board can significantly reduce heat loss.
Greenhouses that have building fans or vents for humidity control and oxygen and carbon dioxide ratio need to insulate secondary fans and vents to reduce heat loss through unused areas during the winter.

Reflective insulation boards can be added to the inside of any flat greenhouse wall but it should not extend above the crop or bench height. Leave a small airspace between the insulation and the sidewall to prevent freezing of the greenhouse wall. Be sure that the reflective surfaces are not in contact with perimeter heating pipes. Sidewall insulation can reduce annual heating costs up to 5%.

q. Add a Thermal Blanket

Up to 85% of the heat loss from a greenhouse occurs at night. Using a thermal blanket to retain heat at night can be a cost efficient investment. These blankets are easier to install and create less shading in gutter-connected houses than in a Quonset house. Remember to use a porous curtain material so that condensation from the underside of the roof of the greenhouse will not pool above the plants. Use a flame-resistant material or, for growing structures, a thermal blanket that alternates flame-resistant and non-flame-resistant material. For greenhouse structures where an internal curtain cannot be installed, external curtains are available that can reduce radiation loss from the greenhouse at night. Blankets offered primarily for heat retention can reduce energy use by up to 50%, whereas blankets offered as combination thermal blanket and summer shade protection can reduce winter energy use 25% or more.

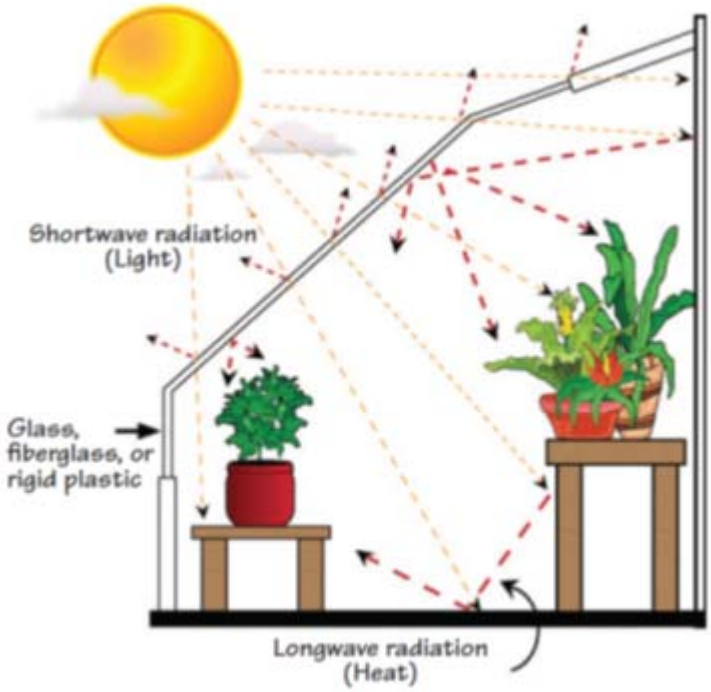
Thermal blankets and shading (Source: Reducing greenhouse energy consumption, S. Stanford, 2011)

Type of Screen	Light transmission (ave. %)	Energy savings at night (%)
Semi-porous fabric	Shading/energy saving	
XLS 14	55	52
XLS 15	45	57
XLS 16	35	62
XLS 17	25	67
Porous construction	Shading/ Ventilation	
XLS 14 F	58	20
XLS 15 F	49	20
XLS 16 F	38	25
XLS 17 F	27	30
Aluminet R-50%	50	20
Aluminet R-60%	60	40
Aluminet R-70%	70	50

Insulation values of some selected greenhouse single pane glass covering / thermal blanket combinations (Source: Reducing greenhouse energy consumption, S. Stanford, 2011)

Blanket description	U value (W/m2 K)
Single glass glazing	6,2
Aluminized Polyethylene tubes	3,1
White-white spun bonded polyolefin film	2,9
Heavy weight grey white spun bonded film	2,4
Light weight grey white spun bonded film	3,2
Clear polyethylene film	2,5
Black polyethylene film	2,7
Aluminium foil-clear vinyl film laminate	2,3
Aluminium foil - black vinyl film	3,6
Alunimium fabric	2,2

When using thermal blankets, the opening of the blanket is not to be done too quickly over a chill sensitive crop. To allow mixing of the air, the blankets are to be opened about 50cm for half hour before opening them completely. Some producers wait until the sun has risen and warmed the air above the blanket before opening it and allowing that air to mix with the rest of the greenhouse air. That may be dictated by the light requirements of the crop.
The thermal blankets are to be kept open during snowstorms. The blanket should be left open to allow the heat to reach the roof to prevent snow accumulation on the roof of the greenhouse.



r. Heating System Efficiency

Maintaining maximum heating efficiency of the existing heating system is critical to reducing heating costs in the greenhouse. For this purpose, annual maintenance is

required: examination of the equipment for physical damage to any parts of the system, checking the vent pipe and air inlet or discharge pipes for obstructions, furnaces should be cleaned and adjusted at least once per year, controlling that the boiler, burner and backup systems are operating in peak efficiency, cleaning the soot from inside the furnace. A small layer of soot can increase fuel consumption by as much as 10%.
Though the fuel choice is limited by the price, the producers are to use the proper fuel for the system for maximum efficiency.
It is necessary to use more of the heat gained from the system itself. Insulating the boiler or distribution pipes in areas where heat is not needed is vital. Also, cleaning the heating pipes or other heat radiation surfaces frequently can contribute to heat gain. All motors and pumps are to be properly maintained for maximum efficiency.
Reducing air leaks and heat loss in the greenhouse will make the house "tighter" which will also tend to increase the relative humidity. Regardless of the type of heating system used, installing a sufficient number of horizontal air flow (HAF) fans to adequately circulate the air inside the greenhouse is an advantage. Good air circulation will improve temperature and humidity uniformity in the greenhouse, which reduces the incidence of cold pockets in the greenhouse and improves plant quality and uniformity. Monitoring the humidity level in the greenhouse, generally keeping it below 80% to minimize disease incidence is necessary. The HAF fans should be located around 1m above the plants and aligned parallel to the sidewalls of the greenhouse so that the air is circulated around the house in a rotational pattern. Air circulation with the fans should be maintained around 0,3 to 0,6m/s. In winter operations, the HAF fans should be running continuously to improve temperature and humidity uniformity in the greenhouse.

s. Environmental Control

The use of aspirated thermostats, electronic thermostats and calibrated sensors can limit the curves of over- and under-heating, and save up to 3% of fuel. Thermostats should be in locations representative of the rest of the greenhouse.

6. Recommendations for new products and technologies

The delayed privatization process of the glasshouse production sector in the 90s has restrained the glasshouse producers in undertaking the necessary investments for maintenance and new equipment. An additional constrain is the acute lack of working capital for the glasshouse sector in order to cover the operating expenses for heating. This leads to the fact that the glasshouses are not gaining the intended competitive advantage over the greenhouses for all year round production.. Thus, instead of continued supply of vegetables starting with the production from the glasshouses, then from the plastic tunnels and followed by the open field production, the supply of the glasshouse production and the plastic tunnel production supply represents an inter-competition rather than a competitive advantage of the overall supply chain.
Since there have been no significant investments in the glasshouse sector in the last 15 years, the output is significantly lowered and the cost of production substantially increased. Only recently, some improvements have been made in the area of technology modernization and computerization.

It should be emphasized that the greenhouse production of vegetables heated with geothermal water enjoys a clear comparative advantage that could be further exploited. Several of the existing greenhouse companies seek strategic partners for investment since the greenhouse production is capital-intensive in addition to the need for improvement of the technology and management.
Some of the individual specialized private greenhouse operators appear ready to upgrade their low-cost plastic tunnels for more sophisticated foil tunnel technology that will allow earlier harvesting and higher yields through a better climate control.
The greenhouse vegetable production sector in Macedonia is faced with the low average yield per ha due to the prevailing vegetables production in low plastic tunnels and small sized fragmented plots as well as fragmented small farms without strong associations of vegetable growers with lobbying power. On the other hand, there is a lack of production coordination between the large scale glasshouse producers and the small scale greenhouse producers that have a matching production season.

There is no particular national strategy for vegetable development including greenhouse crop production and vegetable marketing, which is both economically and socially very important for the country, providing employment for over 13.000 individuals. In order to maintain and further extend the export markets towards Western Europe, some measures need to be taken to pass from extensive to a more intense phase of protected cultivation, i.e. improving the technology for greenhouse production diversification in time, species and cultivars.

- *Re-introduction of floriculture production in greenhouses and glasshouses*

The production of cut flowers is small and organized on family farms located mostly in Gevgelija, Strumica and Valandovo region (open field or in plastic tunnels). The exact number of the small scale producers is not officially recorded; however, it is below 200 families. This small value chain is not well organized and faces high concerns related both to the production quality and productivity due to the small size, although Macedonia has the potential for re-introducing the floriculture. In the late 60s up to the late 80s, Macedonia, as part of the Ex-Yugoslavian republics, was an important regional producer of floriculture products,. There is experience, know-how and tradition that could serve as a basis for future investments in this area.

- *Increase of the soil-less production technology*

Modern greenhouse & glasshouse production technologies are imported via the equipment and input material providers, representatives of foreign producers, mainly from the Netherlands and Israel. These companies supply the glasshouses with the necessary seeds, fertilizers, predators for biological control, etc. Few of the domestic greenhouse producers' use modern soil-less production technology where rock wool, perlite and peat are used as substrate. However this technology is not widely accepted due to high investment and operating costs.

- *Introduction of biological and integrated pest control*

Drip irrigation and fertigation are very common in glasshouses; however, there are still some examples of furrow irrigation. In glasshouses, fertigation is generally performed with dosing pumps and diluters. The greenhouses are disinfected using steam (mainly in glasshouses) and other chemical treatments. Biological and integrated pest control has been applied successfully in some glasshouse blocks, as the unique control. Biological products have been produced as well, but this kind of production needs further stimulation i.e. controls, labeling and price mechanism.

- *Research and Education*

The institutional and educational systems in Macedonia do not keep a pace with the latest developments in the greenhouse production technology. For this reason, the greenhouse producers are compelled to use foreign consultancy services for the technology applied and equipment supplied. In most cases, the consultancy is part of the purchase of the glasshouse equipment from the foreign suppliers. Furthermore, the suppliers provide the technical know-how usually during annual service contracts, which represents a significant cost in the overall operation. The existing vegetable departments of agriculture faculties need to increase their activities in building the local capacities for agricultural services in this area both for the glasshouse and plastic tunnel production.

7. Conclusions and Recommendations for policy and support system improvement

The greenhouse sector in the Republic of Macedonia is one of the largest employment generators, permanent as well as seasonal. As the price of energy is permanently increasing, heating costs influence negatively the productivity and overall competitiveness of fresh vegetable production and it is necessary to introduce "alternative" energy in agriculture. In this respect, the policy makers should make efforts to support the greenhouse sector by a number of measures that can increase the regional competitiveness of the sector.

The recommended measures are as following:

- *Development of a national strategy for protected cultivation* – The greenhouse production sector is a significant contributor to the GDP and provides employment for around 13.000 individuals. The potentials for the development of the sector are high and far from the present exploitation. The good agricultural climate and producers' experiences provide a good basis for future development of the sector. In order to realistically plan and implement measures for the support of the sector development, there is a need of an adequate, comprehensive analysis of the current situation that will present a basis for the establishment of development mechanisms. Therefore, a national strategy in this area is of crucial importance that will cover both the analysis and potential solutions for the current problems the producers are experiencing in the matter of competitiveness, seasonality and

sustainability. In addition, it will set the ground for support of future investments in the sector and development of the rural areas of Republic of Macedonia.

- *Design of a subsidy system for the use of heavy oil during the winter season* – At this moment, producers that use only heavy oil for heating their greenhouses do not produce during the first few months of the year as it is not economically viable due to the high production costs. For that reason, Macedonia is not all-year-round tomato producer and it has difficulties satisfying the buyers' needs on the export markets. The buyers, due to their own supply contracts with the supermarket chains and HoReCa demand all year round, supply products with a permanent quality and quantity. This is the reason for the emerging problems of maintaining the established market links and creating new ones. Appropriate support in this area through a subsidy support system will help producers (based on heavy oil) overcome the difficulties in the first three months of production. The subsidy system will reimburse part of the purchase costs for heavy oil used for heating and will relief the producers from the pressure and the liabilities resulting in higher organization in the overall fresh vegetables supply chain. The subsidy should correspond to the real costs that the current greenhouse producers are facing and should ensure positive financial operations and all year round production. The exact calculations should be based on a detailed cost analysis considering the real expenses and providing support from all glass house producers.

- *Joint research of new geothermal wells* for agriculture according to a National Strategy and developed regulations – As a mean of reducing global GHG emissions and local pollution, by using geothermal energy, it would be a competitive advantage to form a local fund for a joint research of new locations for geothermal wells. The process of exploration and research should be supported by the State and the Investor, and the energy produced will be used for early vegetable production and other competitive advantages (tourism etc.)

- *Establishment of a revolving fund for new geothermal dwellings* – During the interviews and analyses a large number of producers showed some interest to invest in new geothermal wells, as they are the most efficient and environmentally friendly energy source. Few of them have made some efforts and own investments for new geothermal dwellings. The dwelling is an expensive process that might go up to 700.000 Euros per dwell (at current costs). An appropriate support system for new dwellings of geothermal sources will have a significant positive effect on the development of the sector. An assistance though the establishment of a revolving fund for new dwellings that can cover some portion of the dwelling costs, (e.g. 50%) if the investor finds an adequate source, will decrease the initial investment costs, as there will be reimbursement of some or all of the costs from the revolving fund.

Once the adequate source is found, the producers will sign a concession agreement, and in an appropriate time span (e.g. 10 years) will return the resources to the revolving funds. The fund will be replicable and sustainable. After the first cycle of implementation is finished, the fund collects the charges for using joint geothermal resources and providing funds for further exploration and other producers to replicate the technology.

- *Redesign of the regulation on charges for using geothermal energy* – Each early vegetable producing country has its own advantages it relies on. The Macedonian advantages are: more than 200 sunny days in a year and available geothermal waters. By using these advantages, the Macedonian producers can be competitive on the regional and European markets. The Government needs to revise the legislation on charging the usage of geothermal energy. At the same time, the process of applying for dwelling permit is burdensome and there are numerous difficulties of *legal and administrative* nature. Reorganizing the administrative and legal routes for permits and supporting dwelling can cause lowering the expenses for early production, higher export value of Macedonian vegetables and higher interest for production.

- *Resolution of the status of the greenhouse construction* – The unresolved status of the greenhouse construction is crucial. The price for the legalization of the greenhouse constructions (10 MKD/m²) is relatively high and it is a limiting factor for the current companies as well as for the potential foreign or domestic investors. The parcels on which the greenhouses are built are still registered as agricultural land instead of construction land as they should be. This transformation will increase the stability and the investment safety. With the resolution of the status of the greenhouse construction and the land on which the greenhouses are built, the greenhouse companies will be motivated for future investments in the development of the capacities and will also be encouraged to a more intensive use of the EU pre-accession instruments.

- *Introduction of subsidies for the installation of energy efficient systems in glasshouses*- By subsiding investments in energy efficiency measures, the Macedonian production will be more competitive and it can grow. The measures will foresee support for the highly efficient energy systems for glasshouse production, which will enable energy costs savings. The same trend will follow in Macedonian export and creation of the brand name for Macedonian tomato, Macedonian peppers etc.

- *Subsidies and legislation framework for combined heat and power generation (CHP) in agriculture* - In most of the greenhouses in Macedonia heating is from boilers for hot water. Building CHP is closely connected to finding a suitable heat consumer in the

area of production. Since the greenhouses are good heat consumers during the winter months, and at the same time Macedonia has a lack of electrical energy, the obvious solution is to use CHP and sell the heat to the greenhouses and electricity to the network. The Ministry of Economy should enable the producers to invest in CHP with some privileges. The Energy Regulatory Commission should make it possible for these units to be connected to the national electricity network and use benefits for producing in a co-generation cycle.

8. References

1. Input-output analysis for water consumption in Macedonia, Jordan Hristov, Aleksandra Martinovska-Stojceska, Yves Surry, SLU 2012
2. Strategija za razvoj na energetokata vo Makedonija za periodot 2012-2016
3. Modern technologies for utilization of geothermal energy and its influence to the environment, S. Armenski, R. Filkovski, Geothermal energy in Macedonia – Kochani depression, Kochani 2011
4. Opportunities for encouraging and financing investments based on the geothermal potential of the Republic of Macedonia, B. Angelova, Kochani 2011
5. Opportunities for using geothermal energy in the Republic of Macedonia, R. Fotev, Kochani 2011
6. Analysis of the regulation for exploration, exploitation, and utilization of geothermal water in the Republic of Macedonia, Z. Panov, Kochani 2011
7. Geothermal system GEOTHERMA, J. Naumov, T. Kushevski, S. Gushkova, 2011
8. Dealing with the high cost of energy for greenhouse Operation, J.G.Latimer, Virginia Tech, 2009
9. Biomass energy for heating greenhouses, S. Stanford, 2010
10. Using curtains to reduce greenhouse heating and cooling costs, S. Stanford, 2011
11. Energy conservation opportunities for greenhouse structures, Eugene A. Scales & Associates, Inc., 2012
12. Perfecting temp and light, Energy efficiency annuals, M. Blanchard, E. Runkle, P. Fisher, J. Erwin, Greenhouse grower, 2010
13. Greenhouse energy management, W. N. Nelson, 2008
14. Renewable sources of energy, S. Armenski, lectures, 2009
15. Energy from agriculture – Energy for agriculture, Biogas, D. Dimitrovski, 2010
16. Alternative greenhouse heating systems, B. M. Jenkins, California Agriculture, 1995
17. Greenhouse heating with geothermal heat pump systems, A. Chiasson, GNC Bulletin, 2005
18. Reducing greenhouse energy consumption, S. Stanford, 2011
19. Assessment study for geothermal resources, CESESN SpA, World Bank Energy Sector, Government of the Republic of Macedonia, Ministry of Economy, 2001
20. EPI CENTAR "Profile of the Macedonian Fresh Vegetable Value Chain" study developed for the USAID AgBiz Programme in Macedonia, 2008
21. Macedonian Consulting Group: Floriculture and Horticulture Sectors in the Republic of Macedonia, Prepared for the Embassy of the Kingdom of the Netherlands, Skopje, Macedonia, Final Report, 2008
22. MAFWE, Information on Vegetable Production, Department of Field Crops, May, 2011

Annex I

Стр. 74 - Бр. 12 Службен весник на Република Македонија 26 јануари 2012

418.

Врз основа на член 64 од Законот за минерални суровини („Службен весник на Република Македонија“ бр. 24/2007, 88/2008, 52/2009, 6/2010, 158/2010, 53/2011 и 136/2011), Владата на Република Македонија, на седницата, одржана на 17.01.2012 година, донесе

ТАРИФНИК

ЗА ИЗМЕНУВАЊЕ И ДОПОЛНУВАЊЕ НА ТАРИФНИКОТ ЗА УТВРДУВАЊЕ НА ВИСИНАТА НА НАДОМЕСТОЦИТЕ ЗА ИЗДАВАЊЕ НА ДОЗВОЛИ И КОНЦЕСИИ ЗА ВРШЕЊЕ НА ДЕТАЛНИ ГЕОЛОШКИ ИСТРАЖУВАЊА И КОНЦЕСИИ ЗА ЕКСПЛОАТАЦИЈА НА МИНЕРАЛНИ СУРОВИНИ

Член 1

Во Тарифникот за утврдување на висината на надоместоците за издавање на дозволи и концесии за вршење на детални геолошки истражувања и концесии за експлоатација на минерални суровини (“Службен весник на Република Македонија“ бр. 72/2007, 19/2009, 105/2009, 60/2010 и 94/2010), во член 4 став (1) точката 3 се менува и гласи:

“За експлоатација на геотермални води според просечната температура на водата, по формулата Kn = [Em*(M1-HC)*K], каде се: Kn – концесиски надоместок (den/m3), Em – еквивалент на мазут (kg), (M1-HC) – цена на мазут (den/kg) и K – коефициент на зафаќање (K = 0,075). Тековната пресметка за висината на концесискиот надоместок е дадена во Табела, а ќе се врши према просечната рафинериска цена на мазутот (M1-HC) во den/kg од претходната календарска година.

Табела Пресметка на концесиски надоместок за експлоатирана количина на 1m3 геотермална вода за 2012 година

Температурни интервал за пресметка	Просечна температура по интервал	Потребна количина на мазут	еквивалент на мазут (Em)	Цена на мазут (M_1- HC)	Коефициент на зафаќање (Ka)	Концес. надомес. (Kn)
t_1 (ºC)	$t_1 = t_{v1}$ (ºC)	Q (kWh)	(kg)	(den/kg)		(den/m^3)
1	2	3	4	5	6	7 = (4*5*6)
31-40	35	9.27	0.93		0.075	
41-50	45	20.87	2.09		0.075	
51-60	55	32.46	3.25		0.075	
61-70	65	44.06	4.41		0.075	
71-80	75	53.33	5.34		0.075	
>81	81	62.6	6.27		0.075	

“

Член 2

Овој тарифник влегува во сила наредниот ден од денот на објавувањето во „Службен весник на Република Македонија“.

Бр. 51-8075/1-11
17 јануари 2012 година
Скопје

Заменик на претседателот
на Владата на Република
Македонија
м-р **Зоран Ставрески**, с.р.