RENEWABLE ENERGY UTILIZATION FEASIBILITY FOR AGRICULTURAL COMPANY – GEORGIA CASE

Vakhtang BERISHVILI
Bank of Georgia University, 0194, Tbilisi, Georgia
vberishvili@bog.edu.ge
Eter GEJADZE
Bank of Georgia University, 0194, Tbilisi, Georgia
e.gejadze@bog.edu.ge

Abstract
There is no doubt that fossil fuels are expensive energy resources. Their use also leads to the environmental problems. Although there is a tendency of increase in renewable energy capacity, its share in global final energy consumption is relatively low. This paper aims to increase awareness of renewable energy role in corporation value creation. The research studies the potential of the use of agricultural biomass residues available for the company and evaluates several investment projects using the example of Geoagro ltd, and assesses their impact on company's value. The paper also studies the feasibility of use of alternative renewable energies such as biomass and solar energy for company needs and finally assesses the profitability of the two. Regarding the methodology, the paper *uses the standard financial valuation techniques such as Net Present Value and Internal Rate of Return in order to compare alternative investment projects. The results showed that the direct sell of biomass – hazelnut shells creates the highest value. While comparing the profitability of using alternative energies, it was showed that the best option is to eliminate natural gas use and switch to biomass fuel.*

Key words: *biomass; company value; hazelnut shell; renewable energy; solar power.*

JEL Classification: *Q01; Q42; G32*

I. INTRODUCTION

An increasing world interest in renewable energy sources stems from the fact that the prices of non-renewable energy sources are rising and they have a negative impact on the environment. Countries around the world are looking for ways to be less dependent on traditional energy sources and are enthusiastically involved in various activities promoting clean, renewable energy sources and raising awareness. The public interest as well as the interest of scientific circles, and the real threats of climate change can explain the active involvement of companies and entrepreneurs in this field and urge them to change their behavior and consider environmental activities in their short-term or long-term plans.

The purpose of this paper is to study how the renewable energy project can affect the company's value. To this end, the paper examines the prospect of creating additional value for a small and medium enterprise, Geoagro Ltd via renewable energy projects. This challenging initiative strives to increase the value of the company with the help of sustainable development strategy, which in its end, serves to achieve two sub-objectives:

- Cost optimization;
- Effective management of agricultural waste;

Potentially, it is feasible to achieve both sub-objectives using renewable energy sources.

In 2017, the company worked out a development plan to plant hazelnut gardens on 1000 hectares of land. If the project advances and is eventually implemented, the company will become the second largest hazelnut producing company in Georgia. This plan will enable the company to develop export and pave the way for obtaining finances on international capital markets.

Naturally, it is in the interests of the company and its owners to increase the value of the business, which will contribute to the following: finding a cheap source of financing, recruiting new business partners or selling the business. Accordingly, the company needs a sustainable development strategy. The latter implies arranging energy saving and energy-efficient processes as well as replacing non-renewable energy sources with renewable ones. Due to the fact that the company operates on over 1000 hectares of land and covers perennial agricultural products, it has the potential to produce renewable energy from biomass. The purpose of the work is to conduct a feasibility study and evaluate the real potential of renewable energy sources available to the company.

II. LITERATURE REVIEW

Corporate sustainable development simultaneously serves several purposes, such as: gaining competitive advantage, increasing profitability, achieving stakeholder satisfaction, boosting reputation, and including environmental activities in the company operations, etc. According to Bos-Brouwers (2010), the sustainable development strategy is mainly endorsed by large corporations; however, this strategy can be equally profitable for small and medium enterprises. The works of Bebbington (2000) and Sage (1999) reinforce this argument; the authors argue that both companies and investors share the idea that making investment with the consideration of sustainability principles creates long-term values.

The sustainable energy development strategy should encompass three major technological changes: energy conservation, higher energy efficiency during the production process and the use of renewable energy sources instead of conventional ones (Ahmad, 2014).

Renewable energy is derived from inexhaustible resources and has the capacity to meet the world's energy demand. Solar, wind, water, sea, biomass and geothermal sources are all renewable energy sources. As of 2017, these sources managed to meet only 15% -20% of world demand. This figure applies to the energy obtained from the combustion of traditional biomass for cooking and heating purposes in developing countries, as well as the energy produced in powerful hydroelectric power stations. Interestingly, the share of the modern renewable energy is made up of solar, wind, geothermal and modern bio energy is only about 10% (REN21, 2018).

In recent decades, there has been a significant increase in the use of new renewable resources (solar photovoltaic, wind and water) for the energy production. This is due to the factors such as the increase in the number of wind turbines, decline in photovoltaic price and the development of environmental policies in the last decade (Javier Farfan, 2016).

Price reduction, technology improvements, and the increasing accessibility encourage businesses to consider renewable energy sources as an alternative to their own energy needs.

In accordance to geographical limitations only the wind, solar and biomass energy sources were worth examining in the study - the company owns a land in Samegrelo-Zemo Svaneti region, Abasha municipality where hydropower and geothermal resources are not available.

WIND POWER

Over the last decades, there has been a decline in the costs of wind power facilities. Furthermore, the risks associated with the use of this kind of energy power are becoming less, which positively affects the funding costs. Technology improvements, strong turbines, and efficient determination of the location made the wind power even more accessible. In 2017, the offshore wind power generation increased by 30% in the energy sector (REN21, 2018).

Georgia has little experience using wind power. In 2016, the wind power plant was built in the Gori Municipality with the collaboration of European Bank for Reconstruction and Development (EBRD). The plant capacity is 20.7 MW and the annual output - 88 million kWh; the total costs of wind power plant were 26.4 million Euros (Georgian Energy Development Fund, 2017).

Despite the rising competitiveness of wind power sources, its economic success is ultimately determined by the amount of produced energy, which is largely dependent on the wind strength (speed), wind speed distribution and direction of speed. While considering the project of wind turbines, meteorological forecasts and assessments are thought to be of utmost importance. One of the most problematic issues in wind energy production is the selection of turbine location.

It is rather noteworthy that the wind power also has a negative impact on the environment: acoustic noise, the visual side and bird mortality. Additionally, electromagnetic flows produced by wind turbines cause some difficulties to the radio, television and the radar. Most of the problems can be solved with the technological refinement of wind turbines. For instance, with the help of aero-acoustic tools, it is possible to select wing configuration in such a way that makes it more “silent” (Herzog, 2001).

In terms of the natural potential of the wind power, the territory of Georgia can be divided into four zones:

1. High velocity zone
2. Partially high-speed and low-speed zone
3. Low-speed mountain range with an effective exploitation zone
4. Low-speed mountain range with a limited exploitation zone

The rest of the territory of Georgia with its mountain range cannot be utilized for the exploitation of wind power plants (Gelovani, 2004).

SOLAR POWER

There are two main types of technologies that transform the sunbeams into energy: the method of turning sunbeams into electricity - photovoltaic panels (PV) and solar thermal power. PV is a solid semiconductor that transforms solar energy into electricity by itself.

Through 2017, PV had a leading position in additional sources of energy. The annual market of panels grew almost by a third and the new production amounted to 98 GWdc1. While solar panels are concentrated in only several countries, by the end of 2017, there was at least 1 GW installed on all continents of the world - in at least 29 countries. An important share of energy production via solar PV has been recorded in Italy, Germany, Greece and Japan. It is noteworthy that the costs of solar panel installation have been significantly reduced whereas its efficiency has gone up, which eventually explains the growing trend of sales (REN21, 2018).

BIOMASS

Biomass is a product of biological origin or the waste derived from agriculture, forestry or related industries. Bio energy occurs during the plant photosynthesis with the radiant energy from the sun. Practically, it is the solar energy and it does not have any additional greenhouse effect: when burning bio energy, the amount of excreted carbon dioxide is usually absorbed during the plant growth (Herzog, 2001).

According to the Global Status Report of 2017, the traditional use of biomass (heating and cooking) constitutes to almost 8% of world energy consumption, and 5% - of modern consumption.

In developed countries, biomass is mostly utilized for the production of main energy power. Thanks to the highly developed technologies, biomass has the capacity to be turned into electricity, gas and liquid fuel. Accordingly, biomass consumption can make us less dependent on oil. For example, the biomass production for transportation purposes increased by 2,5 % (REN21, 2018).

The report, Biomass for Heat and Power – Opportunity and Economics prepared by several institutions (The European Climate Foundation, Sveaskog, Södra, and Vattenfall) offers interesting options of utilizing biomass resources. The report communicates that it is not entirely clear which option of biomass application is the best one. However, on a small scale, direct combustion has advantages over electricity generation (European Climate Foundation, 2010).

Other authors believe that biomass direct combustion is easy since it does not require any initial treatment and complex chemical processes; however, it is the least effective way to obtain energy and / or heat. Modern technologies make it possible for us to process biomass so as to get far more efficient biofuel (Herzog, 2001).

Biomass fuel is widely used - briquettes and pellets. The processing methods reduce the biomass volume by several times, which make transportation easier and reduce expenses.

The pelleting process includes the thinning of raw material, then drying, crushing and squeezing (by pressure). Calorific value of 1 tone of pellets is approximately 5,000 kWh (18 GJ).

The production of briquettes needs less operating expenses compared to pellets, as biomass materials require less preliminary preparation or crushing into even particles. The second advantage of the briquetting is that it can be assembled in the proximity to raw materials. Biomass waste by-products and reusing them onsite for the energy as opposed to their transportation to another location or landfill can save utilization costs.

In terms of investment, there are less capital expenditure and maintenance costs for producing briquettes than pallets. Provided that transportation is one of the main criteria, the pellets have more advantages when transporting, as the bulk density is higher than in case of briquettes, especially when the latter is of a large size and loaded – there is more air between loaded briquettes (Young & Khennas, 2003).

Biomass briquettes are mostly made from bio waste and other organic materials, and are mainly used for generating electricity, heating systems and cooking. The energy content per 1 ton of briquettes is almost 5,000 kWh (18 GJ).

The use of agro-waste as opposed to sawdust, usually reduces productivity and may require the modification of feeding mechanism. Hence, when choosing briquette-producing machines, it is better to find the machines that are commonly used with such materials and under such conditions (Ferguson, 2012).

Different types of machinery are used for biomass briquetting:

- Piston Press
- Screw Press
- Roller Press

[1] GWdc – Gig watt direct current

- Agglomerator

When purchasing a machine, there are two main criteria to consider:

1. Type, quantity and quality of raw materials;
2. Accessibility of briquettes machines and their spare parts on the market.

Recommendations on the briquetting technology are available in many scientific sources (Ferguson, 2012; Young & Khennas, 2003).

Investments

According to Bloomberg New Energy Finance Report, as of 2017 the investments in the clean (green) energy sector reached $ 333.5 globally. The indicator has increased by 3% since 2016, which is mainly due to the solar system boom in China (Bloomberg New Energy Finance, 2018).

It is also interesting that the International Finance Corporation (2017) developed a guidebook - Converting Biomass to Energy, which is targeted at developers and investors. The guidebook describes what processes biomass project consists of, what information, and technical and financial resources are required to ensure the successful functioning of the biomass energy project. According to the guidebook, it is essential to conduct biomass resource assessment as a prerequisite for the project implementation. Having determined the stability of resource supply, the authors deem it necessary to study the resource seasonality to decide on the appropriate volume of plants and machinery, the biomass production cycles and the production plan. The study explains that the amount of resource obtained from the biomass depends not only on the existence of its suppliers, but also on the transportation and storage costs.

In Georgia, there are only briquettes produced out of all energy sources. For its market analysis, we referred to the UNDP-funded study examining the companies on the market. According to the research, briquettes are manufactured in limited quantities and with delays due to the lack of raw material supply and irregular sales. In 2017, companies produced 40 tons of briquettes. Price for 1 ton of briquettes including the delivery and the value added tax ranges from 350 GEL to 700 GEL depending on the season and delivery conditions. The average price is 550 including the transportation costs and 300-450 GEL without the delivery (onsite). There was an average price of 350 GEL used in the calculations; this price does not include value added tax. It should be taken into consideration that in Ukraine the price of one ton is 100-120 euro and in case there is more demand or price rises on the Georgian market, importing briquettes from Ukraine will be quite profitable and will compete with local production.

According to the National Statistics Office of Georgia estimated volume of agricultural biomass waste is 30,000 tons, which is mainly composed of hazelnut waste. Almost half of the waste is used by hazelnut processing enterprises for heating (National Statistics Office of Georgia, 2017) and the rest of the waste goes on sale (At present, the price varies between 0,10-0,2 GEL and alters with the seasonality). The sale price makes it difficult to produce briquettes out of the biomass. The average price of 1 kg of hazel nutshell is 0.14 GEL.

Hazel nutshell has a wide range of uses in the world. Besides its direct use as fuel, hazel nutshell is used in the manufacture of furniture in the form of a ground nutshell, garden maintenance and so on. According to some sources, it is used in the production of ceramics (L.P. Cruz Lopes, 2012). It is known that the company that uses 25 % of the global hazel nut supply – Ferrero planned to use hazel nutshell in the packaging of its products (Moulds, 2015). As the market analysis shows, direct hazel nutshell sale is also quite common in Georgia. The main reasons behind this are its high thermal efficiency, availability and its simple use as fuel. As commonly known, except for family farming, municipal buildings as well, for instance, kindergartens use hazel nutshell to provide heating (Chikhladze, 2016).

Hazel nutshell is a direct substitute for firewood. The price of 1 kg is 0.14 GEL on average, and during a winter season, a family needs about 2-2,5 tons of hazel nutshells for heating. For the same purposes, it is possible to buy 10 cubic meters of firewood for 250-300 GEL in total in Georgian regions.

As a significant factor, businesses should consider having commercially suitable technology (for electricity or heat production). This also determines the financial viability of the project itself. The selection of technology depends on the type of biomass, fuel, the amount of investment costs, the size of the plant and of course, the type of the final product such as energy / heat (International Finance Corporation, 2017).

III. METHODOLOGY

Based on the objectives of the company, literature review and primary analysis, the study concentrated on the biomass and solar power projects. On the next stage review and analyses of technological, organizational, economic and financial aspects of each project were conducted.

The projects have been assessed in comparison with "business-as-usual" scenario, which covers the following aspects:

- Current energy price (both the market price and the price based on own production costs);
- Description of all related costs associated with the waste or solar power production and the adequacy with the project;
- Assessing the investment and determining influential factors;

The following indicators are used for the project assessment:

1. Net present value (NPV)
2. Internal rate of return (IRR)

NPV is the sum of all cash flow, including invested funds.

$$NPV = \sum_{t=o}^{n} \frac{CF_t}{(1+i)^t}$$

where i is discount rate, t – time period, CF_t – net cash flow during "t" period and n – quantity of time periods.

As a rule, the weighted average cost of capital (WACC), which is the average weighted cost of the company's different types of capital, is used as a discount rate. Decision-making criteria are as follows: if NPV exceeds 0, the project creates value and it is possible to be implemented.

IRR is the rate, which makes the present value of net cash flows equal to zero. The project creates value and can be implemented provided that IRR exceeds WACC (Brigham, 2014).

The weighted average cost of capital rate used in the paper is based on the company's audit report of 2017. It relies on the company's industry market data and comprises 16.63%.

In order to determine the project feasibility, it is essential to evaluate all the alternatives that the company has and to compare these alternatives with each other and reach a decision based on the above indicators.

For investors and business owners it is important to consider not only the present conditions but also to review various scenarios in order to consider possible changes in the future to make an optimal decision. The sensitivity analysis examines the impact of some factors on the project by changing these factors while all the other parameters remain the same. This process evaluates the significance of the risk and future forecasts.

Duration of the project used for assessment is based on the estimated life expectancy of agrarian projects on the one hand, and duration of energy projects, on the other, which is the period of 20 years. (International Finance Corporation, 2017).

Expense assessments do not include the costs that the company has already incurred; only the additional costs for biomass stock management are included. Due to the fact that the company owns 7-ton capacity storage facility, which can be used to store hazelnuts as well as the hazel nutshell, its costs are not included in the calculations of the nutshell profitability. There are also no costs of the drying facility, which the company should own in any case.

While conducting the solar energy-project analysis, we referred to the website of the German-Chinese company, Omnik New Energy Co. Ltd. Through its website, this company enables users to create solar power projects, which, based on the project territory, will provide the information on the temperature interval, maximum and minimum forecasting solar energy. (Omnik New Energy, 2018). Consequently, the assessment of the solar energy application included the data on variable temperature and maximum and minimal sunlight based on the specifics of the territory - Abasha Municipality

IV. DATA ANALYSIS AND RESEARCH RESULTS

Company Overview

Geoagro Ltd was established in 2014 and nowadays, it is one of the largest agro companies in Georgia. Since 2014, it had been cultivating annual plants. In 2017, the company adopted a new development plan – planting hazelnut gardens on up to 1,000 hectares of land, arranging appropriate infrastructure and purchasing agricultural technology.

The selected hazelnut cultivar is Italian Tonda Giffoni, which is estimated to be the most demanded type by Ferrero and other European confectionery companies. This variety is distinguished with a round, medium sized nut weighing about 2,6 grams. The hazelnut yield is estimated at 44-47% (Bergougnoux, 1978).

The hazelnut garden will reach its maximum yield of 4.2 kg per tree when the plants are 8 years old.

Renewable Energy Potential at the Company Level

With the consideration of the global experience, making renewable energy a part of the company's operating activities is claimed to be the contributing factor to the sustainable development.

While discussing the renewable energy potential at Geoagro Ltd level, at the first stage we filtered out the energy sources that are related to neither the company’s geographical area, nor its products and future prospects; these were hydro, wind and geothermal energy sources. The company operates in the western part of Georgia, Abasha municipality. There is no hydropower and geothermal energy potential in that area. Similarly, according to Georgia's wind energy atlas, the Abasha municipality does not fall into the category of areas favorable for wind power.

The agricultural waste - biomass and solar energy may still be interesting for the company.

It is not feasible to produce liquid or hydrocarbon fuels from biomass as it requires significant infrastructural changes in the region, changes in the legislation and 50-100% more investment costs as compared to the briquette producing enterprise. Pellet production requires 50-80% more capital expenditure and there is no market for pellets in Georgia. Entrepreneurs might have to enter the competitive market of Europe, which would not be economically justified due to large transportation costs.

Agricultural Waste Biomass Assessment

As a new source of operating income, the company has the capacity to create additional value out of the waste biomass obtained from the hazelnut gardens. At the same time, the company will be able to reduce the operating costs.

The research evaluated the incremental costs and revenues over company’s main operational activities (hazelnut cultivation and sale) caused by biomass use.

The parameters used in the project evaluation are listed in Table 1.

Table 1 Main Assumptions Used for Biomass Volume Calculations

Main assumptions	
Distance between trees (m) [2]	5x3.5
The maximum yield obtained from a tree [2]	4.2
The pruning waste obtained from hazelnut trees (kg) [3]	1.4
The effectiveness of taking the pruning waste out of the field [3]	60%
The hazel nutshell proportion in the whole nut (with shell) mass [3]	62%
Initial moisture content of hazelnuts (with shells) [4]	28%
Final moisture content of dried hazelnuts (with shells) [4]	6%

For research purposes, we believe that the weight of the hazel nutshell obtained annually from dried nuts from 1000 hectares of land consists of 1,134 tons and the pruning waste taken out of the hazelnut tree gardens - 479 tons.

During the research (the autumn of 2018) the Georgian Lari exchange rate ranged from 2.56 to 2.7 for 1 USD. For research purposes, we used the average rate - 2.6 Lari per US dollar. At that time the exchange rate of Georgian Lari to Euro amounted to 3 GEL for 1 EUR.

Based on the literature review, we have discussed three options of biomass use:

- Direct sale of biomass
- Production of fuel (briquettes) obtained from solid biomass processing
- Its direct application as fuel

Unlike the hazel nutshell, there is no market for pruning waste. Therefore, the option of direct sale was filtered out of pruning waste applications.

[2] The distance between the trees and the source of the hazelnut yield coefficient are subject to the contract between the company and the hazelnut plant provider, which is a confidential document.
[3] For pruning waste coefficient obtained from the hazelnut trees and the nutshell proportion in the nut mass, we have used the Field Survey of Potential for Biomass Use for Energy in Georgia as a source (WEG, 2014).
[4] The information on the initial and final moisture content of the nutshell is reviewed in several scientific works (Cetin & Ali, 2011), (D. Monarca, 2013) and by the Order N 21002 of the Revenue Service of the Ministry of Finance of Georgia “on the nut drying costs” (Georgia Revenue Service, 2015).

The Analysis of the Options

The research covered the following directions and options:

1. **PRODUCTION OF ENERGY FROM BIOLOGICAL WASTE (HAZEL NUTSHELL, THE PRUNING WASTE):**

   a. Waste sales
   b. Producing fuel from the waste
   c. Waste use for the company's needs (drying nuts)

2. **PRODUCTION OF SOLAR POWER**

   a. According to the volume of electricity consumed by the company
   b. Only with the use of the administrative building roof area

Direction 1. Using biomass

Sales

Since the pruning waste cannot go on sale due to the absence of the relevant market, only the nutshell sales will be discussed. As a result of calculations, with the consideration of 16.63% rate, the net present value of the project (NPV) will be 287,175 GEL for the 20-year period.

Fuel production

With the selection of briquette producing machines, relevant recommendations in scientific sources have been used (Ferguson, 2012).

The estimated volume of minimum initial investment is given in
Table 2.

Table 2 Minimum Capital Needs for Briquetting Production

Description	USD	GEL
Hammer Mill	5,000	13,000
Drying System	25,000	65,000
Briquette machine w/screw press	180,000	312,000
Screw Conveyer	7,500	19,500
Building renovation	50,000	130,000
Total Equipment costs	**267,500**	**695,500**
Equipment installation (10% of equip. price)	26,750	69,550
Total Investment	**294,250**	**765,050**

According to the selected technology, it was possible to determine the briquette yield coefficient (95%) from biomass. This means that after full utilization of the land and once the company yields the maximum amount of harvest as well as the max. amount of biomass, on average, 1,077 tons of briquettes will be produced from 1,134 tons of hazelnut shell and 455 tons of briquettes – from 479 tons of pruning waste.

As there is a market for the hazel nutshell, we have reviewed the briquette production from the pruning waste alone and in order to get the full picture, we have also discussed briquette production from the hazel nutshell separately from the pruning waste.

The volume of production and quantity of raw materials can determine operating costs. Electricity consumption depends on the machinery operation, the amount of raw materials and working hours. Labor costs depend on the number of employees, daily working hours and working days per year. For the research purposes, the company is considered to work 2,400 hours a year.

The results are the following:

The net present value of the briquettes production from the hazelnut shell alone is negative -17,654 GEL. IRR is 16.2%, which is less than the capital cost.

When estimating the investment volume of briquette production from the pruning waste, it is necessary to consider the additional costs of the chipping equipment for the pruning waste, which accounts for 13,000 GEL.

According to the calculations, the net present value of the briquettes production from pruning only is negative - 402,976 GEL; IRR is 7.6%.

The briquette production from the nutshell and the pruning waste has a positive net present value of 178,842 GEL and 19.2% IRR. In this case, the increase in value is caused by the economies of scale - the revenues provided from the pruning waste are much higher than the investment and operating costs generated by its inclusion.

The company can use biomass for its direct utilization as an energy source in the operating activities.

Our study showed that drying hazelnuts with the moisture content of the 28% to 6% requires an average 2,734 GJ of energy annually received from natural gas.

Since the first harvest is expected in the third year, there is no need for drying costs for the first two years. In the third year it will require 4 tons of biomass (65 GJ energy). The volume of biomass needed is increasing year by year and will reach its maximum in year 10 when about 150 tons of biomass per year is required. For the same purposes 106,028 GEL natural gas is needed annually.

We have also included the costs of converting the natural gas operated dryer into a biomass-operated machine (39,000 GEL) and purchasing biomass chipping equipment (13,000 GEL). Having saved on the natural gas consumption, the net present value is 159,939 GEL.

Since the use of the pruning waste is economically justified for drying purposes, we have assessed one more option of the briquette production - with reduced pruning waste. In this case, the net present value of biomass fuel production is 63,597 GEL provided that one chipper is enough for the briquette production as well as processing biomass for the dryer. IRR is 17.6%.

Direction 2. Evaluation of the solar power use

Due to the restrictions imposed by the state, the company can only use its land for agricultural purposes. Therefore, it is not possible to use the energy generated by solar panels to obtain additional direct revenue, hence, the energy can only be used for the company's own purposes. Consequently, energy production is considered as an energy-saving method. The Net metering mechanism enacted by the Georgian legislation makes it possible for the company to supply the excess electricity to the grid and get it back for free in case of need. This means that it is possible to generate as much energy as the company needs, regardless of the peak load.

Electricity is used for the drip irrigation system for the plant nursery and the administrative office.

The irrigation system will be actively working for 4 months: April, July, August and September. The energy consumed during this period should be 75,000 kWh. The administrative office consumes an average of 2940 kWh per month. The annual aggregate consumption is 335,280 kWh, which is 70,687 GEL on a yearly basis according to the existing tariff at the research period - September 2018. As mentioned above, there are less costs in the first (20,087 GEL) and the second (39,062 GEL) years.

The parameters of energy consumption forecast are given in
Table 3.

Table 3 Forecasted Energy Consumption per annum

Month	Energy consumption by Irrigation system By month (kwh)	Energy consumption by Administrative office By month (kwh)	Total energy consumption By month (kwh)
January	-	2,940	2,940
February	-	2,940	2,940
March	-	2,940	2,940
April	75,000	2,940	77,940
May	-	2,940	2,940
June	-	2,940	2,940
July	75,000	2,940	77,940
August	75,000	2,940	77,940
September	75,000	2,940	77,940
October	-	2,940	2,940
November	-	2,940	2,940
December	-	2,940	2,940
Total	**300,000**	**35,280**	**335,280**

According to the results of the analysis, in order to generate 335,280 kWh of energy annually, solar panels will be installed on the area of 1,769 m2. The investment required for project implementation amounts to

418,664 GEL.

The calculations have shown that the NPV of the project in case of 20 years of economic lifetime is negative and equals to - 143,424 GEL; IRR is 10.2%. It should be noted that the assessment does not include alternative costs of land; the NPV will be further reduced if these cost are considered. At the next stage of the research, we discussed the possibility of installing solar panels on the roof of the administrative office in order to save energy. It turned out that in this case the net present value is negative - 22,877 GEL; IRR- 8.9%.

SENSITIVITY ANALYSIS

At the very last stage of the research, we decided to see how the economic reasonability of the projects would change with the alteration of different parameters. To this end, we conducted the sensitivity analysis.

We found the change in the briquette price rather interesting with respect to biomass materials (Table 4).

Table 4 NPV Variability with Briquette Price

	Briquette price						
	130%	120%	110%	100%	90%	80%	70%
NPV	194,537	123,806	53,076	(17,654)	(88,384)	(159,114)	(229,844)

In case of photovoltaics, we examined the change in electricity price as well as the change in the volume of initial investment, based on current tendency (Table 5).

Table 5 NPV Variability with Initial Investment Volume and Electricity Price

		Initial investment						
	NPV	130%	120%	110%	100%	90%	80%	70%
Electricity price	130%	(165,267)	(123,402)	(81,538)	(39,673)	2,191	44,055	85,920
	120%	(199,850)	(157,986)	(116,122)	(74,257)	(32,393)	9,472	51,336
	110%	(234,434)	(192,570)	(150,705)	(108,841)	(66,976)	(25,112)	16,752
	100%	(269,018)	(227,153)	(185,289)	(143,424)	(101,560)	(59,696)	(17,831)
	90%	(303,601)	(261,737)	(219,873)	(178,008)	(136,144)	(94,279)	(52,415)
	80%	(338,185)	(296,321)	(254,456)	(212,592)	(170,727)	(128,863)	(86,999)
	70%	(372,769)	(330,904)	(289,040)	(247,175)	(205,311)	(163,447)	(121,582)

V. RESULTS AND CONCLUSIONS

The net present values of the possible options and internal rate of return are given in Table 6.

Table 6 List of Options and Option Evaluation Results

Option	Evaluation Method	Result
Biomass		
1. Sell hazelnut shell directly	NPV	287,175
2. Briquette production from pruning only	NPV	-402,976
	IRR	7.6%
3. Briquette production from all pruning & shells	NPV	178,842
	IRR	19.2%
4. Briquette production from shells only	NPV	-17,654
	IRR	16.2%
5. Use of pruning for drying	NPV	159,939
6. Briquette production from shells and leftover pruning	NPV	63,597
	IRR	17.6%
Solar		
1. Solar panel for company's full energy requirement	NPV	-143,424
	IRR	10.2%

2. Solar panel for administrative use only	NPV	-22,877
	IRR	8.9%

The biomass options 2 and 4 are not deemed reasonable at all, since their implementation diminishes the value. Options 1 and 3, 1 and 6, 3 and 5, 3-6 are mutually exclusive. However, options 1 and 5 or 5 and 6 are feasible to be implemented in combination; hence, the value created by these options can be summed up.

Having done the comparison, it is obvious that we are getting much more net present value (447,114 GEL) by selling nutshell and the use of the pruning waste rather than any other single option or using the pruning waste for drying purposes and briquettes production from the remaining biomass (223,536 GEL).

The use of solar power does not have any economic justification for the company.

The sensitivity analysis illustrates that a 10% increase in the price of briquettes is enough to make the briquette production from the hazelnut shell only economically justified. In this case, if the nutshell market is reduced and the briquette price goes up along with the growth of its market, the company will have an alternative source of income.

When it comes to the solar power application, the project will yield a positive economic outcome only in the event of having both indicators altered by 20% or one of them by more than 30%.

VI. REFERENCES

1. Ahmad, S. &. (2014). Selection of renewable energy sources for sustainable development of electricity generation system using analytic hierarchy process: A case of Malaysia. Renewable energy, 458-466.
2. Bebbington, J. (2000). Sustainable development: a review of the international development, business and accounting literature. Univ of Aberdeen Acct, Finance & Mgmt Working Paper No. 00-17.
3. Bergougnoux, F. G. (1978). The hazel tree.-Production and culture [Corylus avellana]. Paris: Institut de Vulgarisation pour les Fruits, Legumes et Champignons (INVUFLEC).
4. Bloomberg New Energy Finance. (2018). Retrieved from Bloomberg New Energy Finance: https://www.bloomberg.com/impact/impact/bloomberg-new-energy-finance/
5. Bos-Brouwers, H. E. (2010). Corporate Sustainability and Innovation in SMEs:. Business Strategy and the Environment, 417–435.
6. Brigham, E. E. (2014). FInancial Management: Theory and Practice. South-Western,: Cengage Learning.
7. Cetin, M., & Ali, E. (2011). Artificial drying of newly harvested Turkish hazelnuts. Natural Products, 184,185.
8. Chikhladze, M. (2016, April 4). sheshis ghumelidan tkhkilis nachuchit uzrunvelkofil avtomatizebul sistemamde. Retrieved from http://www.gurianews.com: http://www.gurianews.com/article/mtavari/sazogadoeba/37271
9. D. Monarca, M. C. (2013). Assessment of the energetic potential by hazelnuts pruning in Viterbo's area. Journal of Agricultural Engineering, volume XLIV(s2):e117.
10. European Climate Foundation. (2010). Biomass for heat and power Opportunity and economics.
11. Ferguson, H. (2012). The potential for briquette enterprises to. GVEP Iternational.
12. Gelovani, M. (2004). Sakartvelos qaris energetikis atlasi. Tbilisi: KARENEGRO.
13. Georgia Revenue Service. (2015, 06 15). tkhilis shrobis satsarmoo danakargis damtkicebis shesakheb. Order N21002. Tbilisi, Georgia.
14. Georgian Energy Development Fund. (2017). QARTLI WIND FARM. Retrieved from GEDF Georgian Energy Development Fund: http://gedf.com.ge/project/4-qartlis-qaris-eleqtrosadguri
15. Herzog, A. V. (2001). RENEWABLE ENERGY SOURCES. Encyclopedia of Life Support Systems (EOLSS). Forerunner Volume-'Perspectives and Overview of Life Support Systems and Sustainable Development.
16. International Finance Corporation. (2017). Converting Biomass to Energy. Washington, D.C.
17. Javier Farfan, C. B. (2016). Structural changes of global power generation capacity towards. Journal of Cleaner Production, 370 - 384.
18. L. P. CRUZ LOPES, J. M. (2012). NEW PRODUCTS FROM HAZELNUT SHELL. Conference: ECOWOOD 2012-5th International Conference on Environmentally-Compatible Forest Products. 05-7 September 2012, Fernando Pessoa University, Oporto, Portugal. Oporto: Fernando Pessoa University.
19. Moulds, J. (2015, April 21). Chocolate company Ferrero to make packaging using Nutella leftovers. Retrieved from www.theguardian.com: https://www.theguardian.com/sustainable-business/2015/apr/21/ferrero-packaging-nutella-nutshell-biomass-biofuel
20. National Statistics Office of Georgia . (2017). Shinameurneobebshi energoresursebis mokhmareba. Tbilisi: National Statistics Office of Georgia .
21. Omnik New Energy. (2018). Retrieved from Omnik New Energy: http://www.omnik-solar.com/
22. REN21. (2018). RENEWABLES 2018, GLOBAL STATUS REPORT. REN21.
23. Sage, A. P. (1999). Sustainable development: issues in information, knowledge, and systems management. Information Knowledge Systems Management, 1(3, 4), 185-223.
24. WEG. (2014). Assesment of Wood and Agricultural Residue Biomass Energy Potential in Georgia. Tbilisi: World Experience for Georgia.
25. Young, P., & Khennas;, S. (2003). Feasibility and Impact Assessment of a Proposed. Consultancy Report to the Business Linkages.